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ABSTRACTS

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SYMPOSIA AND ORAL SESSIONS

Pathology

1 A novel approach in developing in vivo experimental model to discriminate antigenic variations in infectious bursal disease viruses. V. Durairaj*, H. S. Sellers, and E. Mundt, *University of Georgia, Athens.*

Infectious bursal disease (IBD) is an immunosuppressive disease in chickens caused by infectious bursal disease virus (IBDV). IBDV is a double stranded RNA virus belonging to family *Birnaviridae*. IBDV targets proliferating B-lymphocytes in the bursa of Fabricius (BF). Differences in vaccination programs and presence of antigenic different IBDV can cause antigenic drift leading to evolution of antigenically different IBDV. Thus, characterizing antigenicity of IBDV field isolates plays a critical role for the use of vaccines. In previous studies we described antigenic different IBDV field isolates. Here we report the establishment of an in vivo experimental model to discriminate between antigenic different IBDV using the IBDV variant strain E/Del as standard. High-titer serum was generated in chickens against the E/Del strain. A standard volume in different dilutions mimicking different virus neutralization (VN) titers was injected in 3-week-old SPF birds using 3 different routes, intravenous, subcutaneous, intramuscular. Chickens were bled at different time points to determine the dynamics of the VN titers. The data showed that the most efficient route was either intravenous or subcutaneous. For the infection model the chicken serum in different dilutions was subcutaneously injected into chickens. The birds were bled 24 h later and challenged with 10 CID_{50} of the E/Del virus. The obtained serum was tested for the VN titer. Seven d after challenge birds were necropsied for collecting bursal samples. The VN titer in the chicken serum correlated with dilution levels of the injected serum samples. Bursal lesion scores were used to determine the breakthrough VN titer in the chicken model. The advantage of this in vivo model is that it can be used to determine the breakthrough VN titer in chickens without vaccinating them. Furthermore it is expected that truly antigenic variant IBDV will break through significant higher VN titers. Also, detection is based on lesions in the most susceptible organ for IBDV, the bursa of Fabricius.

Key Words: infectious bursal disease, antigenicity, experimental model, bursal lesion score, virus neutralization assay

2 Comparison of a rapid immuno-migration based commercial kit and real time PCR for detection of avian influenza viruses in hunter-killed ducks. T. V. Dormitorio*, L.J. Donahue, and J. J. Giambrone, *Auburn University, Auburn, AL.*

Waterfowl are the principal hosts of influenza A viruses (AIV). A simple, rapid, and sensitive method to detect AIV is needed in surveillance studies especially for highly pathogenic viruses such as H5N1. Cloacal swabs were collected from hunter-killed ducks in a wildlife refuge in Florida. Swab samples were inoculated into embryonated eggs followed by hemagglutination (HA) test. Out of 229 swabs, 23 were HA positive (HA+). Rapid Immuno-Migration (RIM) based commercial kit and real-time RTPCR (RRT-PCR) were used for detection of AIV from both allantoic fluids (AF) and swab specimens of HA+ samples. The RIM kit did not detect AIV directly from swabs, whereas RRT-PCR detected 16 out of 23. RRT-PCR showed 10 AIV positives on AF samples in contrast to 8 by the RIM kit. Although the RIM kit was almost as good as RRT-PCR in detecting AIV from allantoic fluids, it was clearly shown that RRT-PCR was much more sensitive when cloacal specimens were used for testing. Therefore, passage in eggs of swab samples from healthy wild ducks is needed when using the RIM kit to detect AIV. Nevertheless, important advantages the RIM kit has over RRT-PCR are: 1) it is rapid and simple; 2) can be stored at room temperature; and 3) there is no need for expensive equipment or technical expertise.

Key Words: avian influenza viruses, Rapid Immuno-Migration, real-time PCR, hunter-killed ducks

3 High-throughput proteomic analysis in chicken lung with avian influenza virus infection by mass spectrometry. Y. Wang*[1], Y. Shi[1], Y. Song[2], Y. Zhang[2], J. Yuan[2], S. Y. Dai[2], V. Brahmakshatriya[3], B. Lupiani[3], S. M. Reddy[3], S. J. Lamont[4], and H. Zhou[1], *[1]Department of Poultry Science, Texas A &M University, College Station, [2]Department of Plant Pathology and Microbiology, Texas A&M University, College Station, [3]Department of Veterinary Pathobiology, Texas A&M*

University, College Station, [4]Department of Animal Science, Iowa State University, Ames.

Avian influenza virus (AIV) not only causes significant economic losses in poultry production, but also is of big concern to human health. The objective of this study was to identify proteins associated with AIV infections in 2 genetically distinct, highly inbred chicken lines that differ in AIV resistance (Fayoumi is moderately resistant and Leghorn is susceptible to AIV infection). Chickens were inoculated with 107 EID50 of H5N3 AIV or PBS at 3 weeks of age and lungs were collected at 4 d post infection. Proteins with equal amount of cytosolic, membrane, nuclear and cytoskeletal fractions were extracted by differential detergent fractionation followed by a trichloroacetic acid/acetone precipitation (total 8, 2 per line per treatment group). Proteins were then digested into peptides by trypsin and desalted using a peptide Macrotrap. Tryptic peptides were separated using multidimensional protein identification technology, which were subjected to data-dependent MS/MS acquisition. Resulted MS/MS spectra were searched via Sequest against the chicken protein database in Ensembl. Fisher Exact test was used to determine significantly differentially expressed proteins between treatment groups or genetic lines. There were 2742, 3049, 2002, and 2577 proteins identified in infected, and non-infected Fayoumi, and infected and non-infected Leghorn, respectively. Based on the cut-off P-value of 0.01 and fold-change of 2, there were 1408 and 612 proteins differentially expressed between infected and non-infected birds within Fayoumi and Leghorn lines, respectively. Between genetic lines, 1038 and 640 proteins were differentially expressed within infected and non-infected groups, respectively. More proteins had higher expression levels in Fayoumi than Leghorn birds pre-inoculation. More proteins were highly expressed in Leghorn than in Fayoumi birds post infection. Within genetic lines, more proteins were downregulated in Fayoumi and more were upregulated in Leghorn with AIV infection. Differentially expressed proteins identified in this study could lead to new directions in the development of anti-viral drugs or vaccines in poultry.

Key Words: AIV, chicken, lung, protein, MS/MS

4 The importance of thrombocytes for the pathogenesis of H5N1 avian influenza. K. A. Schat*[1], J. Bingham[2], J. Buttler[2], L.-M. Chen[3], S. Lowther[2], T. Crowley[2], R. J. Moore[2], R. Donis[3], and J. W. Lowenthal[2], *[1]Cornell University, Ithaca, NY, [2]CSIRO, Livestock Industries, Australian Animal Health Laboratory, Geelong, Australia, [3]Influenza Branch, Centers for Disease Control and Prevention, Atlanta, GA.*

The Asian clades of highly pathogenic (HP) H5N1 avian influenza virus (AIV) can cause 100% mortality in chickens within 24 to 48 h post infection (pi) often in the presence of high levels of proinflammatory cytokines. In contrast, infection in ducks may result in variable levels of mortality after 5 to 8 d pi. A publication in 1973 suggested that AIV can infect and replicate in thrombocytes. Chicken thrombocytes are nucleated, highly phagocytic cells and can release high levels of proinflammatory cytokines shortly after stimulation with LPS. To investigate the potential role of thrombocytes in the pathogenesis of HP H5N1 avian influenza we infected chickens and ducks with reverse genetics generated A/VN1203/04 with either K or E at PB2–627. Chicken thrombocytes were positive for AIV at high titers at 18 and 24 h post infection (pi) and as early as 12 h pi at the same time that spleen cells were positive. Virus replication in thrombocytes was confirmed using qRT-PCR assays for genomic RNA and mRNA. Microarray analysis of thrombocytes at 18 h post infection indicated upregulation of TLR3, STAT1, IRF7, and IFNAR2. In addition, SOCS 1, MX1 and several cell adhesion molecules (SELE, VCAM1, CD274), were also significantly upregulated. The amino acid at position PB2–627 did not influence the infection in thrombocytes. In contrast with infection in chickens, thrombocytes obtained from infected ducks were either negative or positive at very low levels. Mutation of the HA cleavage site to the low pathogenic form resulted in systemic infection in chickens without causing mortality and thrombocytes were negative for virus infection. These results show that chicken thrombocytes can replicate HP H5N1. A model will be presented to explain the role of thrombocytes as a major contributing factor to the rapid mortality in chickens.

Key Words: avian influenza, thrombocytes, pathogenesis, chickens, ducks

5 Fecal shedding and internal organ colonization following exposure of laying hens to different oral doses of *Salmonella* Enteritidis. R. K. Gast*, R. Guraya, J. Guard, and P. S. Holt, *Egg Safety and Quality Research Unit, USDA Agricultural Research Service, Athens, GA.*

Contaminated eggs produced by infected laying hens continue to pose a significant public health concern as a leading source of transmission of *Salmonella* Enteritidis infections to humans. A recently implemented national regulatory program for egg-producing flocks in the United States seeks to control egg-borne transmission of illness to consumers via a diverse program of mandatory risk reduction practices plus testing to detect infected flocks. However, many aspects of *S.* Enteritidis infections in laying hens, including the precise relationship between the magnitude of oral exposure and important infection parameters such as the duration of fecal shedding and the numbers of bacteria that reach internal tissues, remain unresolved. In the present study, groups of laying hens were experimentally infected with oral doses of 10^4, 10^6, or 10^8 cfu of a phage type 13a strain of *S.* Enteritidis. In one set of trials, fecal shedding was monitored for 8 wk after inoculation. In a second set of trials, the number of *S.* Enteritidis cells in the livers of infected hens was determined at 5 d and 20 d post-inoculation. At 1 wk post-inoculation, the frequency of fecal shedding of *S.* Enteritidis ranged from 23.8% for the 10^4 cfu dose to 87.5% for the 10^8 cfu dose. Detectable fecal shedding had ceased by 4 wk post-inoculation in the 10^4 cfu group, but small percentages of the other 2 inoculated groups were still shedding at 8 wk post-inoculation. After inoculation with 10^8 cfu, significantly ($P < 0.05$) greater numbers of *S.* Enteritidis were isolated from livers at both 5 d and 20 d post-inoculation than for either of the lower doses. These results demonstrate that the oral exposure dose has significant effects on important parameters of *S.* Enteritidis infection in laying hens which could potentially influence the outcome of testing efforts. Understanding testing results and refining testing protocols requires an understanding of how different levels of exposure are likely to be detected by particular sampling methods.

Key Words: *Salmonella* Enteritidis, exposure dose, fecal shedding, internal organs

6 Effect of live attenuated F-strain derived *Mycoplasma gallisepticum* vaccine dosages on in vivo *M. gallisepticum* populations in layers. R. Jacob*[1], E. D. Peebles[1], S. A. Leigh[2], S. L. Branton[2], and J. D. Evans[2], *[1]Mississippi State University, Mississippi State, MS, [2]USDA/ARS Poultry Research Unit, Mississippi State, MS.*

Mycoplasma gallisepticum (MG) F-strain derived live attenuated vaccines (LAVs) are commonly utilized within the table egg industry to

limit economic losses associated with virulent MG outbreaks. To determine the in vivo MG populations associated with the F-strain derived LAVs and the effect of dosage on the subsequent in vivo vaccine strain populations, 150 mycoplasma-free Hyline W-36 layers were housed in biological isolation units (10 birds per unit) through 16 wk of age. A randomized control study design was used. At 10 wk of age, birds of each biological isolation unit were vaccinated via eye-drop with one of 3 F-strain derived vaccines, at one of 5 levels ($1 \times$, $10^{-1} \times$, $10^{-2} \times$, $10^{-3} \times$, or $0 \times$). Undiluted ($1 \times$) LAV titers were 1×10^8 cfu/mL and 8.6×10^7 cfu/mL for the commercially available F-strain derived LAVs (Poulvac Myco F and AviPro MG F) respectively, and 1.5×10^8 cfu/mL for a laboratory derived strain (FMG-99). At 6 wk post-vaccination, in vivo MG populations were estimated via palatine fissure swabs and subsequent quantitative Taqman-based Real Time PCR assays. Data were analyzed using Kruskal-Wallis and Wilcoxon tests for significance within and between the treatments. With the $10^{-3} \times$ treatments, in vivo MG populations were detected at low incidence (10%) among FMG-99 and Poulvac Myco F vaccinated birds and treatment associated MG populations were significantly reduced. The incidence of detectable in vivo MG increased with higher dosages, but MG population estimates did not correlate directly with dosage. Within LAV treatments, the highest MG populations were associated with the $10^{-2} \times$ dosage of AviPro MG F and the $10^{-1} \times$ dosages of Poulvac Myco F and FMG-99 and equaled 5.23 ± 0.4, 5.78 ± 0.2, and 4.99 ± 0.3 $\log_{10}$ cfu/mL (mean ± SE), respectively. The results indicate a minimum threshold dosage for the LAVs, beyond which the dilutions result in inconsistent colonization.

Key Words: layer, vaccine, *Mycoplasma gallisepticum*, PCR

7 *Bacillus licheniformis* significantly improves broiler production parameters under sub-clinical necrotic enteritis conditions when added to a standard diet containing virginiamycin. G. F. Mathis*[1], B. S. Lumpkins[1], I. Knap[2], and A. Kehlet[2], *[1]Southern Poultry Research Inc., Athens, GA, [2]Chr. Hansen, Hørsholm, Denmark.*

A 42 d feeding study was conducted to evaluate the effects of dietary supplementation of *Bacillus licheniformis* (DSM5749) when added to a diet containing antibiotic growth and fed to birds with sub-clinical necrotic enteritis. Birds were reared in floor pens with built up litter to immolate US commercial practices, and to mimic sub-clinical necrotic enteritis the birds were challenged with a fresh broth culture of *Clostridium perfringens* at d 19, 20 and 21 of age. A total of 2160 one-day-old male Cobb x Cobb broilers were randomly distributed to 9 replicates of 60 chicks and each fed 1 of the 4 treatments. All feeds were formulated using US commercial corn-soybean meal based diet and contained the coccidiostat Salinomycin at an inclusion rate of 60 g/ton. The experimental diets consisted of T1) Control; T2) Control + 15 ppm Virginiamycin; T3) Control + 15 ppm Virginiamycin + *Bacillus licheniformis* (DSM5749) 4E5 cfu/g feed; and T4) Control + 15 ppm Virginiamycin + *Bacillus licheniformis* (DSM5749) 4E6 cfu/g feed. Weight Gain (WG) and Feed Conversion Ratio (FCR) were measured at 0–42 d. At 42 d of age birds fed diets containing *Bacillus licheniformis* and Virginiamycin had WG ranging between 1.946 to 1.976 kg, which was a 30 to 60 g (1.7–2.2%) improvement compared with birds fed diets containing only Virginiamycin (1.915 kg). In addition, the feed conversion ratio was improved 4 points with birds fed diets containing *Bacillus licheniformis* and Virginiamycin (1.760 to 1.747 g/g), compared with the birds fed the diet containing only Virginiamycin (1.786 g/g). In this experiment, it can be concluded that *Bacillus licheniformis* (DSM5749) significantly improves live production parameters in sub-clinical necrotic enteritis affected birds when used as an add-on to a standard diet containing an antibiotic growth promoter.

Key Words: *B. licheniformis*, Virginiamycin, sub-clinical necrotic enteritis, broiler

8 Molecular characterization of histomoniasis. B. Lynn, L. Lollis, L. R. McDougald, and R. B. Beckstead*, *The University of Georgia, Athens, GA, USA.*

Histomonas meleagridis is the causative agent of histomoniasis, also known as Blackhead disease. Extracted DNA from 28 *H. meleagridis*-infected avian liver or cecal samples from multiple hosts and geographic locations was analyzed for variation in 5.8S rRNA and flanking internal transcribed spacer regions (ITS 1 and ITS 2). Samples were amplified by polymerase chain reaction (PCR), sequenced, and compared with known sequences from GenBank accessions of *H. meleagridis* and other related protozoa. The analyses revealed significant genetic variation within *H. meleagridis* sequences and suggested the possibility of multiple genotypes within the samples or possible misdiagnosis. A phylogenetic analysis using only the 5.8S rRNA sequence grouped all but one *H. meleagridis* sample into one clade, including GenBank accessions submitted from Europe. This analysis suggests that the 5.8S region is a reliable in identifying *H. meleagridis*. To identify sequence components required for the regulation of gene expression in *H. meleagridis* the splinkerette PCR method for the isolation of flanking genomic DNA was modified to identify the entire β tubulin gene, including promoter and polyadenylation signal sequences. Identification of these sequence elements can be used to design an expression vector system specific for *H. meleagridis* and demonstrates the use of splinkerette PCR to identify upstream and downstream sequences surrounding known genes in organisms that lack a sequenced genome.

Key Words: histomonas, Blackhead, gene expression, diagnostics

9 Development of deoxynivalenol-induced morphological changes in relation to broiler performance during chronic exposure to the toxin. A. W. Yunus*[1], M. Z. Khan[2], H. Zaneb[3], H. Rehman[3], B. K. Anna[4], K. Robert[4], K. Ghareeb[1], A. A. M. Abd-El-Fattah[1], M. Twaruzek[4], G. Jan[4], and J. Böhm[1], *[1]University of Veterinary Medicine Vienna, Vienna, Austria, [2]University of Agriculture, Faisalabad, Punjab, Pakistan, [3]University of Veterinary and Animal Sciences, Lahore, Punjab, Pakistan, [4]Kazimierza Wielkiego University, Bydgoszcz, Poland.*

Low levels of deoxynivalenol (DON) are known to negatively affect intestinal morphology without affecting performance of chicken. To understand the significance of these changes, 75 broiler chicks (7 d age) were randomly allotted to 3 dietary treatments i.e., basal (0.2 mg DON/kg), low DON (2 mg DON/kg), and high DON (18 mg DON). Increasing dietary levels of DON were found to decrease weekly weight gain in a linear ($P < 0.05$) way during first 3 wk of exposure. After 3rd wk of exposure, birds under DON diets were found to compensate for the previous reduction in weight gain. In the 2nd wk of exposure, the DON diets to variable degrees resulted in lower relative density (weight/unit length) and villus height in small intestine. These changes became statistically significant in the 4th wk of exposure and were also accompanied by reduced short circuit current in jejunum. However, a seemingly compensatory increase in the length of small intestine was noted in the 4th wk of exposure. Thus, the apparent digestibility of macro nutrients in the 4th wk of exposure was not

negatively affected by the DON diets. In the 5th wk of exposure, birds from each treatment were fed on basal diet overnight and then given crude DON extract (2.8 mg DON per bird) directly into the crop. At 5 h post-intubation, higher ($P < 0.05$) amount of both the parent mycotoxins and the metabolite products were found in all the pre-cecal segments of gut in birds reared on DON diets. Plasma levels of DON at 1 h post-intubation (peak level) were lower ($P < 0.05$) in the birds reared on high DON diet. These data indicate that the birds previously exposed to DON could not only efficiently transform the parent toxin into metabolites, but could also prevent their transfer to systemic circulation. We propose that the DON-induced morphological changes in intestine could be, in part, a local adaptation to chronic toxin exposure. However, there is also evidence that low levels of DON, previously thought to be safe for chicken, can negatively affect broiler performance during initial phases of exposure.

Key Words: absorption, deoxynivalenol, intestine, performance

10 Impact of different levels of silver-nanoparticles (Ag-NPs) added to the diet on performance, oxidative enzymes, and blood parameters in broiler chicks. F. Ahmadi* and F. Rahimi, *Islamic Azad University, Sanandaj Branch, Kurdistan, Iran,*

This research was carried out to investigate effects of silver-nanoparticles (Ag-NPs) on traits of productivity, oxidative stress enzymes and some blood parameters in broiler chicks. For this study, a total of 240 one-day-old male broiler chicks (Ross 308) were allocated in a completely randomized design (CRD) consisting of 4 groups of 60 birds and 4 replicate pens per group with 15 birds per pen. Basal diet supplemented with different levels of Ag-NPs (Diameter 14 ± 0.8 nm) was provided ad libitum throughout the study (42 d). Experimental diets included: 0 (Control), 200, 400 and 600 ppm Ag-NP/kg of feed. At the end of the study period, one bird with a body weight closest to the treatment mean weight was selected from each pen for study. Blood samples were collected. A portion of the blood was allowed to coagulate for preparation of serum. The other portion was heparinized for plasma collection. Serum and plasma samples were stored at −20°C until analysis. The birds were then slaughtered, spleen, thymus and bursa of Fabricius removed, weighed, and relative organ weights calculated. The results showed that Ag-NPs had no significant effect on growth performance but compared with controls a decreasing trend in feed efficiency was observed. Relative bursa weight was lower in birds receiving Ag-NP in comparison with control group ($P < 0.05$). The lowest bursa weight observed in birds receiving the 600ppm Ag-NPs. Ag-NPs had a significant effect on oxidative stress enzymes activity in comparison to the control group ($P < 0.01$). Blood parameters such as ALT, AST, ALP, TP, albumin, gamma-globulin, triglyceride, and cholesterol were significantly affected by Ag-NP addition to the diet of broiler chicks ($P < 0.05$).

Key Words: broiler, blood parameters, lymphoid organs, oxidative stress state

11 Genetic characterization of a vaccine strain of Fowlpox virus. D. Tripathy*, B. Fadl-Alla, and F. Robles, *University of Illinois.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

12 In vivo estimation of breast muscle depth in the turkey (*Meleagris gallopavo*) using ultrasound technology and its correlation to breast meat yield. L. A. Case*[1,2], B. J. Wood[2,1], and S. P. Miller[1], [1]*University of Guelph, Guelph, Ontario, Canada,* [2]*Hybrid Turkeys, Kitchener, Ontario, Canada.*

Currently, in vivo estimation of breast meat yield is based on conformation score in the turkey industry. Ultrasound measurements of muscle depth were analyzed to determine if these objective trait measurements could be used for selection in a breeding program. Two measurements of breast depth, one taken horizontally across the chest and one parallel to the keel, were captured using an ultrasound machine. Including the muscle depth traits in a linear regression on breast meat yield increased the proportion of variation explained by 4% and 11% in the male and female lines, respectively. The heritabilities of the muscle depth traits ranged from 0.42 – 0.67. These values were higher than the heritability for conformation score in both in the male line (0.37) and female line (0.38). The ultrasound traits also showed high genetic correlations to breast meat yield, ranging from 0.50 to 0.74, indicating that selection on the depth traits would result in a correlated improvement in breast meat yield. This has the potential to improve the rate genetic gain in breast meat yield, which would increase turkey production profitability.

Key Words: ultrasound, breast meat yield, heritability, selection

13 Genetic factors contributing to fat deposition in chicken. M. K. Nassar* and G. A. Brockmann, *Humboldt-Universität zu Berlin, Germany.*

While excess accumulation of body fat reduces the nutritional and economic value of a chicken considerably, increased intramuscular fat content could be a favorable trait for meat quality. In the present study, a genome scan was performed to detect genomic loci that affect the fat deposition in white adipose tissues and muscle in 278 males at 20 weeks of F_2 populations of reciprocal crosses between 2 divergent chicken lines, the partially inbred line New Hampshire (NHI) and the inbred line White Leghorn (WL77). The NHI line had been selected for high meat yield and WL77 for low egg weight before inbreeding. The inbreeding coefficients of the NHI and WL77 lines were about 86 and 99%, respectively. Chickens were genotyped for 123 marker loci covering 25 chromosomes. Linkage analysis provided evidence for a highly significant (F = 11.28) quantitative trait locus (QTL) influencing white adipose tissue mass on GGA4 with a peak F-value at 77.29 Mb and a significant (F = 8.96) QTL on GGA2 at 43.70 Mb, which explained 7.6 and 6.7% of the phenotypic F_2 variance, respectively. The NHI QTL allele affecting white adipose tissue mass on GGA4 had negative additive effect (−5.3 g), while the QTL on GGA2 had positive additive effect (4.3 g). A highly significant (F = 11.92) QTL for intramuscular fat content was mapped on GGA2 at 33.10 Mb that accounted for 9% of the phenotypic F_2 variance. The confidence interval overlapped with the QTL region for white adipose tissue mass. The GGA2-QTL had additive effect (0.3%), where the allele derived from superior line NHI tended to increase intramuscular fat content. Additional highly significant loci for intramuscular fat content were identified on GGA15 and 26, which have not been reported previously in other crosses. Our crossbred populations provide valuable basis for the further fine-mapping and subsequent candidate-genes identification for fat deposit traits. The final identification of genes contributes to our understanding of the complex inheritance pattern of the fat deposit traits in chicken.

Key Words: inbred chicken line, quantitative trait loci, white adipose tissue, intramuscular fat content

14 Validation of microsatellites linked to a candidate gene, as markers for ascites and economically important traits in broilers. S. Krishnamoorthy*, R. F. Wideman, D. D. Rhoads, G. F. Erf, and N. B. Anthony, *University of Arkansas, Fayetteville.*

Ascites syndrome continues to inflict financial losses to the world poultry industry despite years of investigation on its underlying cause. In the United States, ascites is generally controlled by slowing early growth performance which ultimately reduces meat yield and limits realization of the true genetic potential for broilers. A linkage group of 2 microsatellite markers and a candidate gene associated with ascites susceptibility have been identified on chromosome 9 in research lines divergently selected 15 generations for ascites susceptibility. These same microsatellite markers were found to also be descriptive for 3 commercial broiler lines. For one of the 2 microsatellite markers, a BB homozygote was present in 60% of all the birds in the ascites resistant research line, but only 6% in the ascites susceptible line. In 2 commercial lines, that same genotype was 8 and 14% of all genotypes. In a hypobaric model where about 50% of the commercial birds developed ascites, the BB homozygotes showed 0 and 7% ascites susceptibility. Interestingly, the BB genotype was absent in the third commercial line which had a higher incidence of overall ascites mortality compared with the other commercial lines. The second microsatellite marker also had genotypes found to be associated with ascites resistance. These microsatellite markers show utility in several different lines and therefore, could be used for marker assisted selection to improve ascites resistance. However, previous studies have shown the resistant and susceptible research lines to differ in feed efficiency and breast yield. Preliminary data also indicates that these markers are associated with performance traits. Data will be presented to more clearly elucidate the quantitative effects of this locus on production traits.

Key Words: ascites, microsatellites, marker-assisted selection

15 Novel use of an in vivo reagent to transfect germ line stem cells in chicken. B. J. Jordan*[1], R. B. Beckstead[1], and M. Stark[2], [1]*University of Georgia, Athens,* [2]*Brigham Young University.*

The chicken is a well-established model system for studying vertebrate embryogenesis, but creating transgenics to study mutants has proven difficult. Viral infections are predominantly used to create transgenic chicks, but the rate of transgenesis is low. Additionally, there are size and sequence restraints when using virus, which make it unsuitable for many applications. To create a more versatile method of chick transgenesis, we are using a transposable element (TE) system paired with an in vivo transfection reagent to generate transgenic chicks. The TE system incorporates a transposase enzyme, which recognizes a specific DNA sequence called a transposon. The enzyme excises the transposon from its original location and inserts it into another genomic location. The transposon contains a GFP gene for tracking of insertion into active genes by fluorescent microscopy. We have proven this system effective with in vitro cell culture and in vivo embryonic injection experiments. The TE system is delivered to cells using an in vivo

transfection reagent, JetPEI. This reagent is a charged polymer that interacts with DNA to form a bundle, which is endocytosed by cells. Once inside, the bundle ruptures and the TE DNA is released into the cell where integration can occur. We tested the efficacy of the in vivo delivery system by injecting a mixture of in vivo reagent with a constitutively expressed GFP gene. This mixture was injected into Stage X embryos and incubated for 5 d. The embryos were removed, imaged for GFP expression and sectioned and stained with germ cell markers. Imaging showed localization of GFP to the germinal ridge, along with other tissues. Staining with germ cell markers confirmed that the reagent transfected DNA into germ cells. With transfection possible, we can now pair the JetPEI reagent with the TE system to utilize a novel and powerful tool for creating transgenic chicks.

Key Words: transgenic, transposable element, transfection reagent, embryogenesis, germ cells

16 Gene expression profiles of ceca in different broiler lines infected with wild-type and mutant *Campylobacter jejuni*. A. Nazmi*[1], J. Zhang[1], X. Li[1], C. L. Swaggerty[2], M. H. Kogut[2], H. Chiang[1], Y. Wang[1], K. Genovese[2], H. He[2], V. J. Dirita[3], I. Pevzner[4], and H. Zhou[1], *[1]Texas A&M University, College Station, [2]United States Department of Agriculture, College Station, Texas, [3]University of Michigan, Ann Arbor, [4]Cobb-Vantress Inc., Siloam Spring, AR.*

The gram-negative bacterium *Campylobacter jejuni* (*C. jejuni*) is a serious human pathogen associated with several million cases of diarrhea around the world annually. Chicken products contaminated with *C. jejuni* are one of the major sources for human infection. Two broiler lines, line A and line B, have been previously shown to confer resistance (line A) or susceptibility (line B) to *C. jejuni*. In the present study, a chicken whole genome microarray was used to profile gene expression in the cecum after *C. jejuni* inoculation. One-day-old chicks from each line were challenged orally with mutant, wild-type *C. jejuni* or PBS, and ceca were harvested at 24 and 36 h post-inoculation (PI). After total RNA was isolated, 8 biological replicates were used to study infected and non-inoculated birds at each time point within each line. The LOWESS method was used to normalize the signal intensity of each gene and data was reported on the log2 scale. A mixed model including line, treatment, time point, array, dye, and all 2-way interactions among treatment, time, and line was used to identify differentially expressed genes ($P < 0.01$). For line A, there were 382 and 106 genes differently expressed at 24 h PI, and 271 and 347 genes at 36 PI in mutant and wild-type, compared with non-infected birds, respectively. For line B, there were 672 and 1021 genes differently expressed at 24 h PI, and 3807 and 2393 genes at 36 h PI in comparisons of mutant versus control group, and wild-type versus control group, respectively. These results suggest that there was significantly more host immune response in the susceptible line than in the resistant line. Further signal pathway analysis between A line and B line in respond to *C. jejuni* inoculation is underway.

Key Words: broiler, *Campylobacter jejuni*, cecum, immune response, microarray

17 Blood leukocyte transcriptomics of broiler chicks infected with avian pathogenic *Escherichia coli*. E. Sandford[1], M. Orr[1], X. Li[2], H. Zhou[2], T. Johnson[3], S. Kariyawasam[4], P. Liu[1], L. K. Nolan[1], and S. J. Lamont*[1], *[1]Iowa State University, Ames, [2]Texas A&M University, College Station, [3]University of Minnesota, St. Paul, [4]Pennsylvania State University, University Park.*

Colibacillosis caused by avian pathogenic *Escherichia coli* (APEC) causes significant losses to the poultry industry. Enhanced genetics of host defense mechanisms will reduce reliance on antimicrobials. To develop effective genetic selection programs, greater understanding of the genetics controlling immune response to infection is needed. A chicken 44K microarray was used to measure gene expression in peripheral blood leukocytes (PBL). Commercial broiler chicks (2 wk old) were vaccinated or mock-vaccinated against APEC. Two weeks later, chicks were experimentally infected with APEC or mock-infected. Whole blood was collected 1 or 5 d post-infection and PBL isolated. A pathology category (mild or severe) based on internal lesions was assigned at necropsy to mock-vaccinated, infected chicks. This generated 10 total treatment groups: vaccine status, infection status, and necropsy day as a priori factors; pathology category as a posteriori. Linear mixed model approach was used to test for significant differences in contrasts of interest. Many (1914) genes were differentially expressed (DE) in PBL collected on d 5, between mild and severe pathology categories of mock-vaccinated, infected birds (Q value <0.05). On both days, many DE genes were detected between groups with severe lesions and the mock-vaccinated, mock-infected control groups (1097 and 506 genes on d 1 and 5, respectively). In groups with severe lesions, 107 DE genes were detected between d 1 and 5. Severe pathology resulted in greater induction in gene response than repression. No vaccination effect was detectible in microarray analysis of the PBL, despite significantly lower lesion scores among vaccinated chicks. Examination of biological processes by DAVID revealed many terms related to immune response and metabolic processes. We report expression differences not only between infected and mock-infected chicks, but also between mild and severe pathologies, providing a foundation for candidate gene studies and development of marker assisted selection for effective immune response and resistance to APEC. Funding: USDA 2008–35604–18805 and 2007–38420–17767

Key Words: APEC, microarray, PBL

18 Genetic characterization of Red junglefowl (*Gallus gallus*) in India. M. Thakur*[1,4], M. Fernandes[1], R. Kalsi[2], R. Kaul[3], and S. Sambandham[1], *[1]Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, India, [2]Mukandlal National College, Yamuna Nagar, Haryana, India, [3]Wildlife Trust of India, Sector-Noida, U.P 201 301, India, [4]Kurukshetra University, Kurukshetra, Haryana, India.*

Genetic diversity of Red Junglefowl (RJF), the sole ancestor of present day chicken, has been explored throughout its distribution range in India to propose a conservation action plan for the genetically endangered species. In total, 145 RJF samples were collected from 5 different zones i.e., Northern, Eastern, Central, Southeast and Northeast of the country and 358 alleles were distinguished across 22 microsatellite markers. The observed heterozygosity was lowest (Ho = 0.3636) in the central RJF population while it was highest (Ho = 0.6459) in the northeastern RJF population. Number of alleles per locus (Na) and the effective number of alleles per locus (Ne) ranged from 6 to 19 and 2.7317 to 8.5601with mean (±s.e.) allelic number of 16.2727 (±5.3735) and 5.5275 (±1.8175), respectively. The observed heterozygosity across the loci ranged between 0.2263 and 0.7609, with mean (±s.e.) of 0.5045 ± 0.1406 while expected heterozygosity ranged 0.6363 to 0.8746 with mean (±s.e.) of 0.7983 ± 0.0795. We found PIC value was higher than 0.5 in all 22 loci with the highest value 0.873 (MCW0081), therefore, these loci were informative and could be employed for further genetic studies on chicken. Thirteen loci confirmed to Hardy-Weinberg equilibrium ($P > 0.05$) and no evidence for linkage disequilibrium was

observed among pairs of loci. Nei's Genetic distances were calculated for the 5 RJF populations and a dendrogram was constructed using Unweighted Pair Group method with arithmetic mean (UPGMA) which showed RJF populations in India formed 3 clusters: (i) northern and eastern, (ii) central and southeastern, and (iii) northeastern. Correspondence analysis also showed the similar pattern of clustering RJF population in India. Genetic bottleneck hypothesis were also tested on the captive population of Northern India, suggesting that RJF has not experienced a genetic bottleneck in the recent past.

Key Words: Red Junglefowl, microsatellite markers, genotyping, genetic diversity, genetic bottleneck

19 Interspecies heterologous chicken microsatellites with their wide spectrum of applicability in different bird taxon. M. Thakur*[1,2], R. Javed[2,3], and S. Sambandham[1], *[1]Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, India, [2]Kurukshetra University, Kurukshetra, Haryana, India, [3]National Dairy Research Institute, Karnal, Haryana, India.*

Chicken microsatellite markers were tested for developing heterologous microsatellite markers for birds with their wide spectrum of applicability and use in studying genetic variation and relationship. We transferred and studied 15 chicken microsatellites to Himalayan monal (*Lophophorus impejanus*), 17 to mallard ducks (*Anas platyrhynchos*) and 18 to domestic pigeon (*Columba livia* var. *domestica*) for which previous genetic information was limited. Eight loci were commonly investigated in all the 3 species. Number of alleles per locus (Na) ranged from 8 (MCW0078) to 14(MCW0067) in ducks, 3 (ADL0268) to 12 (MCW0078) with exception of one monomorphic markers in pigeon and 2 (MCW0078, MCW0016) to 6 (MCW0295) in monal. Mean observed heterozygosity (±s.e.) was found 0.6318 (±0.2192), 0.7004 (±0.278) and 0.4997 (±0.1256) in ducks, pigeon and monal, respectively. Expected heterozygosity was higher than the observed heterozygosity in all 3 species. Using allelic frequencies, polymorphic information content (PIC), a measure of marker's informativeness and predicted null allele frequencies was calculated. PIC values ranged between 0.432 to 0.777, 0.01 to 0.837 and 0.346 to 0.605 in ducks, pigeon and monal, respectively. The mean PIC values was 0.6855 in ducks, 0.6399 in pigeon and 0.5249 in monal which was informative (PIC > 0.5). Hardy-Weinberg equilibrium test ($P > 0.05$), describes the expected frequencies of genotypes in a population under random mating was conducted for all 8 loci in these bird species. In conclusion, we have successfully applied chicken microsatellites in other bird species. In addition, existing genetic variability within and among species was assessed. Interspecies heterologous microsatellite primers for birds could play a major role in studies on bird evolution, phylogeny and genetic divergence of birds of different taxa.

Key Words: chicken microsatellite markers, cross-species application, *Anas platyrhynchos*, genotyping, genetic diversity

20 Study of phylogenetic relationship of three Indian chicken populations based on mitochondrial D-loop region. R. Javed*[1,2], B. Mishra[3], M. S. Tantia[1], and R. K. Vijh[1], *[1]National Bureau of Animal Genetic Resources, Karnal, Haryana, India, [2]KurukShetra University, Kurukshetra, Haryana, India, [3]Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India.*

We had drawn a phylogenetic relationship among 3 (Aseel, Daothigir and Punjab Brown) indigenous breeds of chicken based on D- loop region. D-loop region was amplified and multiple sequence alignment was done using Clustal W software. A sequence of 652 base pairs was taken for further analysis. In total, 17 different haplotypes were found, of which, 9 in Aseel, 3 in Daothigir and 5 different haplotypes were observed in Punjab Brown. Haplotype-5, 1 and haplotype 3 were shared among 3 breeds. Relative haplotype frequencies in the 3 populations ranged from 0.05 to 1.0 in Aseel, 0.05 to 0.35 in Daothigir and 0.0435 to 0.478 in Punjab Brown. Significant linkage disequilibrium was observed in 3, 2 and 1 pair of loci in Punjab brown, Daothigir and Aseel, respectively. The haplotype diversity was estimated to be 0.79474, 0.79474 and 0.74308 for Aseel, Daothigir and Punjab Brown. The number of migrants based on haplotype data information was Nm = 2.06 while a value of Nm = 1.27 was obtained using sequence data information. The effective number of migrants Nm based on the Fst estimator has been found to be 0.1890. The Fst values which is a parameter for the population differentiation revealed maximum genetic differentiation between Aseel and Punjab Brown and was 22.27% while the minimum population differentiation was between Daothigir and Punjab Brown (16.60%). The inter haplotypic distances were utilized for the preparation of trees using NJ and UPGMA algorithm. The results revealed that the Aseel population was the ancestral population and other population arose from it. The study of indigenous chicken populations is important for biodiversity analysis to identify the genetic structures, migration patterns and genetic relationship among these populations/breeds. The study of these chicken breeds also assumes importance for their increased utility in chicken improvement programs in terms of disease resistance and quality meat production.

Key Words: phylogenetic analysis, D-loop region, chicken, Aseel, Daothigir and Punjab Brown

21 Genome screening of native Egyptian chickens selected for increased body weights using microsatellite markers. E. A. El-Gendy[1], E. M. El-Komy*[2], A. A. El-Far[1], and A. A. El-Gamry[2], *[1]Department of Animal Production, Faculty of Agriculture, Cairo University, Giza, Egypt, [2]Department of Animal Production, National Research Center, Giza, Egypt.*

An experiment was conducted to study the molecular characteristics of a native Egyptian chicken line (CE1) that has been developed as a local broiler line by selection for increased 6-wk body weight for 7 generations. For genetic comparisons, the local genetic control line (CE2), a slow-growing commercial broiler strain (SGB) and a fast-growing commercial broiler strain (FGB) were used and the F1 reciprocal crosses CE1*SGB and SGB*CE1 were obtained. Twenty-seven microsatellite markers were used to screen the genomes of the different genetic stocks. The average numbers of detected allelic bands, over all markers, ranged from 4.93 in line CE2 to 6.07 in line CE1 in the parental generation and from 4.85 in the cross SGB*CE1 to 6.11 in line CE1. Polymorphism ranged from 57.2% of the total allelic bands in line CE2 to 65.2% in line CE1 in the parental generation, and from 52.9% in the cross CE1*SGB to 65.5% in line CE1 in F1 generation. The stock-specific alleles averaged 1.2% of the total number of detected alleles in line CE1 and 7.5% in line CE2 in the parental generation, versus 2.0% in line CE1 and 7.4% in line CE2 in F1 generation. The crosses CE1*SGB and SGB*CE1 had specific alleles of 1.2 and 3.1%, respectively. Similar percentages of monomorphic alleles were obtained for the genetic stocks and averaged 2.11%. Also, more genetic variation was observed for line CE1 compared with the control line CE2 and strains SGB and FGB. The cross CE1*SGB showed high similarity with the parental line CE1, however the cross SGB*CE1 showed high similarity with the parental strain SGB. The results indi-

cated that line CE1 has been genetically differed from its control line (CE2) as a result of the selection scheme.

Key Words: local chickens, microsatellite loci, polymorphism, reciprocal crosses

22 An approach to marker-assisted selection for increased body weights in local chickens in Egypt. E. A. El-Gendy and M. A. Helal*, *Department of Animal Production, Faculty of Agriculture, Cairo University, Giza, Egypt.*

A study was conducted to reveal the microsatellite loci that can be used to assist in selection for increased 6-wk BW in 2 local chicken lines in Egypt. The lines have been developed by selection for high 6-wk BW for 8 selected generations as normally feathered local broilers (Line CE1), and naked-neck local broilers (Line CE3). The screening of genomic microsatellite loci has been carried out on selected generations 6, 7 and 8, using 27 microsatellite markers. Six-wk BW were obtained on family basis for each line and generation. The selected high BW families of line CE1 have performed 6-wk BW of 1.14 to 1.96 folds of their genetic controls over the 3 selected generations, and the selected high body weight families of line CE3 have performed 6-wk body weight of 1.16 to 1.79 folds of their genetic controls. There have been several polymorphic and monomorphic loci detected by the microsatellite markers. The study revealed line-specific microsatellite allelic bands, among them several bands were family-specific. Significant associations between the family means and the appearance of several loci were observed. In line CE1, primer ADL0299 detected a band of 180 bp with increased frequency in subsequent generations and was associated with high 6-wk BW. In line CE3, primer ADL0299 detected a band of 200 bp with increased frequency in subsequent generations and was associated with high 6-, and 12-wk BW. In line CE1, primer ADL0022 detected a band of 180 bp with high frequency in generation 8 and was associated with 8-, and 12-wk BW. In line CE3, primer LEI0075 was detected a band of 280 bp with increased frequency in subsequent generations and was associated with high 6-wk BW. It is concluded that specific allelic bands can be combined to the phenotypic and genotypic data in a marker assisted selection (MAS) program for increased juvenile body weights of local chickens.

Key Words: body weight, local breeds, MAS, microsatellite loci

23 Productive performance and immunocompetence parameters of naked necks and normally feathered chicken genotypes issued from different maternal lines. A. Galal* and M. Mahrous, *Poultry Production Dept., Faculty of Agriculture, Ain Shams University, Cairo, Egypt.*

Productive performance, humoral, cell-mediated immunities and phagocytic ability were examined in naked neck (Nana) and normally feathered (nana) genotypes issued from different maternal lines (Brown and White Hy-line breeder hens). Cell-mediated immunity was examined by phytohemagglutinin-P (PHA-P) assay at 30 wk of age. At 32 and 34 wk of age, 20 birds from each genotype within dam line were injected sheep red blood cells (SRBCs), and blood samples were collected at 7 and 14 d post-primary injection (PPI) and post-secondary injection (PSI). Phagocytic ability was measured by carbon clearance assay at 35 d of age. Regarding adaptability, comb and wattle lengths were significantly increased by the naked neck gene allowing for increased heat dissipation. In the absence of interaction, the presence of Na gene significantly increased egg number compared with normally feathered counterparts. Also, the naked neck hens had a larger egg weight. With respect to immunocompetence parameters, the results showed that the naked neck genotype had significantly ($P < 0.05$) higher total antibody titers to SRBCs than their nana counterparts. In both dam lines, the naked neck genotype had significantly faster carbon clearance ability than the nana sibs.

Key Words: naked neck gene, immunity

24 Eggshell ultrastructure of naked neck, frizzle and normally feathered genotype chickens. M. Mahrous* and A. Galal, *Poultry Production Dept., Faculty of Agric., Ain Shams University, Cairo, Egypt.*

An experiment was conducted to evaluate mechanical and ultrastructural properties of eggshell in naked neck (Nanaff), frizzled (nanaFf), naked neck-frizzled (NanaFf) and normally feathered (nanaff) genotypes. To assess eggshell quality, a total of 200 eggs (50 each genotype) were randomly collected at 35 weeks of age. The eggs produced from birds carrying Na gene in a single manner or interact with F gene had owned better thickness and breaking strength of eggshell compared with other produced from nanaff sibs. The presence of Na gene in a single state or combined with F gene significantly increased relative palisade thickness compared with nana genotype. Opposite trend was noticed for relative mammillary thickness. Type B bodies, which are rounded and located among mammillary caps, were more frequent in eggshell of nanaff genotype resulting in poor eggshell quality. However, Nanaff and NanaFf genotypes had good rounded caps and early fusion as compared with nanaff ones. In conclusion, the birds carrying Na gene in a single state or combined with F gene had genetically not only better mechanical eggshell properties but also good ultrastructural formation of eggshell compared with normally feathered genotype.

Key Words: naked neck gene, frizzled gene, eggshell, ultrastructure

Physiology, Endocrinology, and Reproduction I

25 A comparative study on lipid profile in Egyptian local breed Fayoumi and commercial hybrid ISA-Brown. A. Abbas*, A.-R. Atta, and M. Sabry, *Cairo University, Giza, Cairo, Egypt.*

The present study was conducted to investigate the variation in the lipid profile between Egyptian breed Fayoumi and commercial strain ISA-Brown. Forty 32-wk-old ISA-Brown and thirty-five 36-wk-old Fayoumi were housed individually in separated layer cages in open-system housing. Four weeks later, Body weight was recorded and egg weight, number, and composition were measured. In addition, lipid profile was estimated in serum and liver in Fayoumi and ISA-Brown. ISA-brown was higher in body weight, egg weight and egg number by 29%, 37%, and 24% respectively compared with Fayoumi. The difference in egg weight mainly due to albumin weight, but there was no significant difference in yolk weight. Even though the concentration of serum HDL and liver cholesterol, and the activity of liver HMG-co-reductase were significantly higher in ISA-Brown by 50%, 100%, and 40% respectively compared with Fayoumi, there were no significance differences in serum triglyceride, serum total lipid, serum LDL, serum cholesterol, yolk cholesterol, and liver total lipid. On the other hand, plasma progesterone and estradiol concentrations were significantly higher in Fayoumi by 27% and 60% respectively compared with ISA-Brown. The results of the current investigation indicate that the lipid profile in Fayoumi native breed and Isa-Brown commercial hybrid could help to understand not only the mechanisms that regulate differences in gene expression, but also how genes interact.

Key Words: cholesterol, lipid profile, ISA-Brown, Fayoumi

26 Effects of in ovo injection of 25-hydroxycholecalciferol on post-hatch broiler performance. A. Bello*, W. Zhai, S. K. Womack, and E. D. Peebles, *Mississippi State University, Mississippi State, MS.*

The in ovo injection of 6, 12, 24, and 48 IU of 25-hydroxycholecalciferol [25(OH)D] in broiler hatching eggs on d 18 of incubation was previously shown in our laboratory to increase hatchability. However, only the 6 IU dose increased chick absolute BW and yolk free BW in proportion to egg weight at hatch. The effect of these same dosages on post-hatch broiler performance was investigated in the current study. Ross × Ross 708 broiler hatching eggs were individually weighed and set on 10 replicate tray levels of a single-stage incubator, with 21 eggs in each treatment group on each tray. Eggs were subjected to one of 6 treatments on d 18 of incubation using a commercial multi-egg injector. The 25(OH)D was dissolved in 100 μL of diluent to deliver either 6, 12, 24, or 48 IU of 25(OH)D to each egg. Non-injected control and 100 μL diluent-injected control groups were also included. Approximately 15 chicks from each treatment replicate group were later transferred to corresponding floor pens. Bird numbers, and body and feed weights were determined on a pen basis on d 0, 7, 14, and 21 post-hatch for the calculation of percentage mortality, BW gain, and feed conversion in the 0 to 7, 7 to 14, and 14 to 21 d age intervals. There were significant treatment effects for only BW gain ($P \leq 0.04$) and feed conversion ($P \leq 0.09$) between d 14 and 21. In the 14 to 21 d interval, BW gain was lower, whereas feed conversion was higher, in the 6 IU of 25(OH)D treatment group in comparison to the diluent-injected control and the 12, 24, and 48 IU of 25(OH)D treatments. Day 14 to 21 BW gain for the 6 IU treatment was also lower in comparison to the non-injected control. In conclusion, the in ovo injection of 25(OH)D at the dosages tested was capable of altering the growth pattern of Ross × Ross 708 broilers through d 21 post-hatch.

Key Words: 25-hydroxycholecalciferol, broiler, hatching egg, in ovo injection, performance

27 Sequencing and expression of trefoil factor 2 cDNA in chicken. Z. Jiang*, A. C. Lossie, and T. J. Applegate, *Purdue University, West Lafayette IN.*

The trefoil factors (TFFs), a family of small (7–12 kDa in mammals) secretory protease-resistant peptides, have a unique trefoil-like structure, and are crucial for epithelial restitution and wound healing, especially on mucosal surfaces. They have been characterized mostly from mammals and amphibians. Here, we report the full-sequence of chicken TFF2 (*ChTFF2*) cDNA and spatial expression of TFF2 transcripts. Computational analysis of *ChTFF2* cDNA, promoter sequence, deduced amino acid and TFF2 phylogenetic tree demonstrated conserved (83% identity among avian species; 61.9% pairwise identity of the trefoil domains to human and mouse) and unique characteristics of *ChTFF2*. The spatial expression of *ChTFF2* transcripts are found throughout the gastrointestinal tract with major expression sites in the glandular and muscular stomach. Expression in the colon, small intestine, cecal tonsil and crop were also observed by RT-PCR. This work provides a foundation for further investigation of the functionality of chicken TFF2 with further need to deduce the physiological and functional differences versus mammalian counterparts.

Key Words: chicken, trefoil factor, sequencing, expression

28 Cell bioenergetics in early and late passage chicken embryo fibroblasts (CEF) and immortalized CEF (DF-1) cells in response to 4-hydroxynonenal-induced oxidative stress. K. Lassiter*, J. Y. Lee, A. Piekarski, B.-W. Kong, B. M. Hargis, and W. G. Bottje, *Dept. of Poultry Science, Center of Excellence for Poultry Science, University of Arkansas, Fayetteville.*

We investigated effects of 4-hydroxynonenal (HNE), a secondary lipid peroxide, on bioenergetics of early and late passage (passage 7 and 18) CEF cells, and DF-1 cells. Cell viability decreased to ~20% in DF-1 cells with 20 and 30 μM HNE whereas CEF (early and late passage) cell viability approached ~50% only with 30 μM HNE. Mitochondrial and glycolytic activities were assessed by flux analysis of O_2 consumption rate (OCR) and extracellular acidification rate (ECAR) in response to 0 (Control), 5, 10, 20 and 30 μM HNE. Bioenergetic analyses were made 2 h post-HNE by monitoring OCR changes to oligomycin (ATP synthase inhibition), FCCP (to uncouple oxidative phosphorylation), and antimycin A (electron transport inhibition). This chemical sequence enables determination of O_2 consumption linked to ATP synthesis, to proton leak, and to non-mitochondrial mechanisms (electron leak and oxidase activity), as well as maximal O_2 consumption and O_2 reserve capacity. With 0 μM HNE, DF-1 cells exhibited greater ($P < 0.05$) ATP-linked OCR, O_2 reserve capacity, and non-mitochondrial linked OCR compared with the CEF cells but there were no differences in proton leak between all 3 cell types. In response to 20 and 30 μM HNE, both early and late passage CEF cells increased the ratio of mitochondrial to glycolytic capability to a greater extent ($P < 0.05$) than could DF-1 cells. Because mitochondrial activity would provide more ATP than glycolysis, we hypothesize a) that higher energy production from both mitochondrial and glycolytic activities in DF-1 cells under control conditions are responsible in part for faster growth rates of DF-1 cells, and b) the ability of both early and late passage CEF cells

to recruit relatively more mitochondrial energy in response to higher levels of 4-HNE may allow CEF cells to retain greater capacity to respond to oxidative stress compared with DF-1 cells. The results of these studies provide new insight into relationships between cell bioenergetics and ability of cells to respond to oxidative stress.

Key Words: cell bioenergetics, chicken embryo fibroblasts, 4-hydroxynonenal, oxidative stress

29 Molecular cloning and characterization of chicken serotonin receptor subtypes 2a and 2c. M. T. Leung*[1], A. H. Y. Kwok[1], J. C. W. Ho[1], Y. Wang[2], and F. C. Leung[1], *[1]The University of Hong Kong, Hong Kong, PR China, [2]Sichuan University, Chengdu, PR China.*

Serotonin (5-hydroxytrptamine; 5-HT) is a phylogenetically ancient monoamine neurotransmitter which modulates a wide range of neural and physiological processes through the cell surface receptors, serotonin receptors (5-HTRs). Among the 7 5-HTR subtypes, 5-HTR subtype 3 stands alone as gated ion channel, the rest are G-protein coupled receptor (GPCR) family A members. Though these receptors have been extensively investigated in mammals, much less is known about their expression and functionality in non-mammalian species. Likewise in avian species, the 5-HT actions were found to encompass various physiological processes, but the underlying molecular mechanism remains largely unexplored. In this study, the full length cDNAs of chicken 5-HTR subtypes 2a and 2c were first cloned from adult chicken brain. Both show high degrees of amino acid sequence identity—the average homology of 5-HTR subtypes 2a and 2c shared among human, mouse and rat gene homologs are 75% and 69%, respectively. RT-PCR assays revealed that 5-HTR 2a gene is widely expressed in adult chicken tissues, with abundant expression noted in brain, kidney and lung tissues; while the 5-HTR 2c expression is restricted in brain. Similar expression profiles are observed in mammalian species. Using a pGL3-NFAT luciferase reporter system, we demonstrated that 5-HT could activate 5-HTR2a and 5-HTR2c expressed in Chinese hamaster ovary cells (CHO) in a dose-dependent manner (EC50: ~1.0 nM), suggesting that both receptors may be functionally coupled to the Ca^{2+} signaling pathway, as reported in mammals. Together, this study establishes a basis to elucidate the physiological roles of 5-HTR2a and 5-HTR2c in chicken tissues.

Key Words: chicken, 5-hydroxytrptamine, 5-HTR2a, 5-HTR2c, characterization

30 Effects of turning frequency during higher incubation temperature on broiler embryonic development. Y. M. Lin*[1], J. Brake[1], S. Yahav[2], and O. Elibol[3], *[1]North Carolina State University, Dept. of Poultry Science, Raleigh, [2]Institute of Animal Science, ARO, The Volcani Center, Bet Dagan, Israel, [3]Department of Animal Science, Faculty of Agriculture, University of Ankara, Ankara, Turkey.*

The effects of turning broiler hatching eggs 24 (24X) or 96 (96X) times daily to E 18 of incubation was studied in 2 trials. Eggs were obtained from Ross 344 male x Ross 708 female broiler breeders at 34 and 59 wk of age in 2 experiments. Freshly laid eggs were weighed and randomly distributed in each turning treatment during the first experiment, but eggs were paired by initial weight in the second experiment to provide equal egg weights in each turning treatment. The eggs were then stored for 1–2 d at 16 C and 60% RH followed by preheating at 23.5 C for 12 h before setting. Each individually weighed egg in each turning treatment constituted a replicate. Incubators (Natureform NOM-45) were operated at an air temperature of 38.1 C and 53% RH until E 3 of incubation. From E 3 to E 15, the incubation air temperature was 37.5 C and then lowered to 37.4 C on E 16, to 37.3 C on E 18, and to 36.9 C during the hatching process. Eggs were transferred to individual pedigree bags at E 18 and hatched in the same machine. At E 14 of incubation, 30 embryos from each of the 2 treatments were necropsied to determine embryo length, and weights of the egg, embryo, yolk sac, and embryonic fluids. Chick BW and length were measured on all chicks at hatching, and then the chicks were killed and necropsied to measure yolk sac weight. A *t*-test was used to compare means and variances. In both trials, embryo weight at E 14 was greater ($P < 0.05$) in the 96X treatments. Further, chick length were greater ($P < 0.05$) in the 96X treatment at pull in both trials. These data indicated that more frequent turning before E 18 resulted in a longer chick but didn't increase the chick weight at pull. These data suggested that embryo growth and development was accelerated by 96X turning during incubation up to 14 d of incubation.

Key Words: broilers, incubation, turning frequency, chick length, chick weight

31 Baseline hematology and serum biochemistry values for farmed emus (*Dromaius novaehollandiae*). D. G. Menon*[1], D. C. Bennett[1], A. L. Schaefer[2], and K. M. Cheng[1], *[1]University of British Columbia, Vancouver, British Columbia, Canada, [2]Lacombe Research Centre, Agriculture and AgriFood Canada, Alberta, Canada.*

Emus, a ratite native to Australia, are being farmed around the world primarily for the oil obtained from its fat. Emus have a high total body fat content which, depending on the season, may reach up to 30%. Hematology and blood biochemistry is an important tool to evaluate the health and nutritional status of the bird, but baseline data are presently lacking. The current study was undertaken to determine the hematology and blood biochemistry of emus immediately before the beginning of the breeding season (December) and whether there exists any differences between the 2 sexes. Blood samples were collected from 24 farm emus between 3 and 4 years of age and evaluated using an autoanalyser (Siemens, Dimension RXL). Blood samples were collected in heparin coated tubes and blood smears stained using the Diff Quik method. Between sex differences was analyzed using Student-*t*-test (MYSTAT). The mean WBC count was 12.3 ± 0.7x10E9/L, while the PCV was 52.5 ± 2cL/L. The mean differential counts were 62.9 ± 1.7% (heterophils; H), 30.7 ± 1.3% (lymphocytes; L), 5.1 ± 0.5% (monocytes), 1.1 ± 0.3% (eosinophils) and 0.2 ± 0.1% (basophils), respectively. The H:L ratio was found to be 2.2 ± 0.1. The mean glucose, total protein, ALT, AST, CK, creatinine and uric acid levels were found to be 10.1 ± 0.2mmol/L, 51 ± 0.8g/L, 19.8 ± 1.5IU/L, 208.5 ± 9.6 IU/L, 387 ± 46.2 IU/L, 9.7 ± 0.9µmol/L and 136 ± 13.2 µmol/L respectively. Plasma triglyceride level in males was 1.9 ± 0.6 mmol/L and was significantly different ($P < 0.01$) from that of females (4.6 ± 1.1 mmol/L). These data should provide a useful diagnostic tool for veterinarians.

Key Words: emu, hematology, biochemistry, triglyceride, fat

32 Elevated testosterone stimulates female birds to produce more sons. S. E. Pinson*, J. L. Wilson, and K. J. Navara, *University of Georgia, Athens.*

Birds have demonstrated a remarkable ability to manipulate offspring sex. Previous studies suggest that treatment with hormones can stimulate females to manipulate the offspring sex before ovulation. Specifically, acute and chronic treatments with testosterone stimulated

significant skews toward male offspring. It has been suggested that hormones may act by influencing which sex chromosome is donated by the heterogametic female bird into the ovulated ovarian follicle. However, it is difficult to pinpoint when the effects of testosterone on offspring sex occurred because testosterone treatments did not target the critical period of chromosome segregation. We treated laying hens with testosterone injections 5h before ovulation to target this critical period and quantified the sexes of the subsequently ovulated eggs. We hypothesized that an injection of testosterone coincident with segregation of the sex chromosomes would stimulate hens to produce more male than female offspring. As hypothesized, hens injected with testosterone produced a significant bias toward male offspring, nearly 70%. These results suggest that acute testosterone elevation during meiotic segregation may mediate primary sex ratios in birds, potentially through non-random chromosome segregation. Results of this study provide further information regarding the timing of potential mechanisms of sex ratio manipulation in birds. The poultry industry would benefit financially if hens could be selectively manipulated to produce less of the undesired sex. Further research should be pursued so that a non-hormonal treatment can be found to influence offspring sex in a similar manner.

Key Words: primary sex ratio, offspring sex, maternal effects, testosterone

33 Validation of a polyclonal antibody against chicken arginine vasotocin receptor (VT4R) and distribution of VT4R in the brain of sexually mature chickens. R. Selvam*[1], A. Jurkevich[2], Y. Du[1], M. Mikhailova[3], L. E. Cornett[3], and W. J. Kuenzel[1], *[1]University of Arkansas, Fayetteville, [2]University of Missouri, Columbia, [3]University of Arkansas for Medical Sciences, Little Rock.*

The nonapeptide arginine vasotocin in birds is homologous to mammalian arginine vasopressin. Its actions are carried out through G protein coupled receptors that belong to vasotocin/mesotocin receptor family in birds. The present study focuses on 2 specific aims: (1) development and validation of a polyclonal antibody specific to VT4R and (2) investigation of the anatomical distribution of VT4R immunoreactivity (ir) in forebrain and diencephalon. Brains obtained from sexually mature male chickens were used for immunohistochemistry (IHC). Western blotting of brain extracts and the use of HeLa cells transfected with the VT4R have shown that the antibody is specific to the VT4R. A strong band at approximately 47Kda was detected in hypothalamic and lateral septal tissue and in HeLa cells transfected with VT4R. In addition, this band was specifically removed with pre-incubation of the antibody with VT4R peptide. Results using IHC showed ir in neurons located in the supraoptic, periventricular hypothalamic and paraventricular nucleus. Scattered immunostained perikarya were also noted in lateral forebrain bundle and globus pallidus. Distinct immunostaining of glial cells lining the lateral and third ventricles occurred particularly in circumventricular organs. Further research will be required to determine the distribution of VT4R in the cephalic and caudal lobes of anterior pituitary and its possible role in homeostasis and osmoregulation. Supported by NRI competitive grant # 2005–35203–15850 from USDA/NIFA and NSF grant 0842937.

Key Words: Western blotting, arginine vasotocin, immunohistochemistry, circumventricular organs, osmoregulation

34 Use of differential detergent fractionation methodology in the detailed proteomic analysis of pipping muscle tissue. A. O. Sokale*, E. D. Peebles, R. Pulikanti, W. Zhai, S. Burgess, and T. Pechan, *Mississippi State University, Mississippi State, MS.*

The identification of all proteins expressed within a cell, tissue, or organ system requires a pre-fractionation step before protein identification methods, to increase proteome coverage. Complex eukaryotic tissues contain proteins which are expressed across a wide dynamic range and are either present in low amounts or are difficult to isolate. Differential Detergent Fractionation (DDF) is a detergent based technique employed to sequentially solubilize proteins from eukaryote cells and tissues based on sub-cellular location. The early muscle development pattern in the broiler embryo on d 13 of incubation before lymph infiltration provides a true expression profile for muscle proteins of the pipping muscle. We examined the muscle proteins of the Ross × Ross 708 broiler embryo pipping muscle on d 13 of incubation, using DDF in conjunction with nano-HPLC MS/MS analysis, for protein identification. A total of 676 proteins were identified from all cellular compartments. The relative distribution of the DDF proteome based on cellular compartmentalization revealed abundant cytosolic proteins (33% of total identified proteins), membrane proteins (18%), nuclear proteins (11%), soluble proteins (13%), and 25% of proteins not common to a particular localization. All identified proteins were annotated to a GO biological process for functional classification. These were allocated as follows: 38% to metabolic processes, 8% to transport, 9% to cell communication, and 11% to various physiological processes. Approximately 7% of the proteins were annotated to a cellular physiological process function. Proteins annotated to unknown functions (27%), were proteins for which no experimental data was available. We demonstrated the ability of DDF to increase pipping muscle tissue proteome coverage, similar to previous reports on DDF fractionation of eukaryotic B-cells isolation. This study is the first proteomics analysis of the pipping muscle in broiler embryos.

Key Words: animal proteomics, broiler, embryo, nano-HPLC MS/MS, pipping muscle

35 Use of FOS immunohistochemistry for morphological identification of neuronal activation by acute and chronic stress in broilers. B. Tessaro*, S. W. Kang, and W. J. Kuenzel, *University of Arkansas, Fayetteville.*

Corticotrophin-releasing hormone (CRH) and arginine-vasotocin (AVT) releasing neurons are major components of the hypothalamic-pituitary-adrenal (HPA) axis and can be found in distinct groups. Following stress, the secretion of these hormones leads to the eventual release of corticosterone (CORT) from the adrenal cortex. This study examines whether these groups of neurons can be differentially activated by acute or chronic stress using FOS immunohistochemistry (IHC). Twenty 4 broilers (*Gallus gallus*) were raised from hatch on a diet fed ad libitum and exposed to a light (L) dark (D) schedule of LD16:8. Birds were randomly assigned to one of 4 groups: chronic stress (CS), chronic control (CC), acute stress (AS), and acute control (AC). Stress was induced via one hour immobilization; wherein, each was restrained from standing or moving their upper bodies and had access to water. CS received this treatment for 10 consecutive days and AS received only one treatment period before sampling. In addition, blood samples were drawn from the CS and CC on d 1, 4, 9, and 10 of stress; whereas, they were drawn one day prior and directly following stress from the AS and AC. Perfusion was performed with Zamboni's solution at 5 weeks of age. Brains were sectioned 40 μm thick and stained for FOS protein. The stained nuclei from selected areas were then quantified. Plasma CORT levels, measured by a radio-

immunioassay, confirmed that immobilization is an effective stressor. The paraventricular nucleus (PVN), bed nucleus of pallial commissure, and part of the nucleus accumbens shell were activated by AS. The PVN is a prime candidate for involvement with immobilization stress response as both AS and CS resulted in large increases in FOS expression. Results indicate that FOS IHC in the chicken brain serve as a useful method for morphological identification of the stress-induced neuronal activation. Supported in part by NSF grant #0842937.

Key Words: arginine vasotocin, corticotropin releasing hormone, paraventricular nucleus, hypothalamic-pituitary-adrenal axis

36 Differential expression of arginine vasotocin and corticotrophin-releasing hormone receptor subtypes by acute and repetitive restraint stress in the anterior pituitary of male broilers. S. W. Kang*, B. Tessaro, G. Nagarajan, and W. J. Kuenzel, *University of Arkansas, Fayetteville.*

In birds, stress induced adrenocorticotropic hormone (ACTH) release from the pituitary gland is controlled by corticotrophin-releasing hormone (CRH) and arginine-vasotocin (AVT). To date 4 subtypes of chicken vasotocin (VT) receptors have been cloned, characterized and designated VT1R, VT2R, VT3R, and VT4R. Two major subtypes of CRH receptor (CRH1R and CRH2R) mRNA are known to be expressed in the pituitary gland of chickens. To test the hypothesis that acute (1hr) or repetitive (1 h, 10 d) restraint stress causes differential expression of CRH and VT receptor subtypes in the anterior pituitary gland, gene expression levels were determined by qRT-PCR. Restraint for 1 h or 1 h restraint for 10 consecutive days was followed by a significant increase in plasma corticosterone (CORT) levels (3–4 fold). No significant change was observed in the pro-opiomelanocortin (POMC) mRNA by acute or repetitive stress. Acute stress decreased c-fos mRNA and repetitive stress further decreased levels to 47% of controls ($P < 0.05$). Acute stress induced significant down-regulation of CRH1R and VT4R mRNA, and repetitive stress made them more severely reduced ($P < 0.05$) implying high CORT levels induced suppression of the CRH/AVT-ACTH axis. In contrast, acute stress increased VT2R and CRH2R mRNA expression while expression level of VT2R mRNA was decreased by repetitive stress but still significantly higher than that of control ($P < 0.05$). VT1R and VT3R mRNA were increased 64% and 38% by acute stress, respectively ($P < 0.05$) and decreased by repetitive stress (less than those of controls, $P < 0.05$). The results of the present study suggest that restraint stress has the receptor subtype-specific consequences for the modulation of the CRH/AVT-ACTH axis and the differential and coincidental expression of receptor subtypes might be an important mechanism that accompanies vasotocinergic regulation of restraint stress responses. Supported by NSF Grant 0842937.

Key Words: stress, AVT, CRH, receptor, male broilers

37 Enhancement of the semen quality of the fowl by 655-nm diode laser irradiation. E. A. El-Gendy[1], M. M. A. Mohamed[2], M. M. Abdel-Fattah*[2], and M. S. Salama[3], *[1]Department of Animal Production, Faculty of Agriculture, Cairo University, Giza, Egypt, [2]Department of Laser Applications in Metrology, Photochemistry and Agriculture, National Institute of Laser Enhanced Sciences, Cairo University, Giza, Egypt, [3]Department of Entomology, Faculty of Sciences, Ain Shams University, Cairo, Egypt.*

An experiment was conducted to assess the enhancement of cock semen quality after the exposure to laser irradiation. Fresh semen samples were collected from a local fowl in Egypt, mixed and divided into 7 pooled aliquots for 7 treatments. Five aliquots were exposed to 655-nm continuous diode laser at energy doses of 2, 4, 6, 8, and 10 J/cm^2. Semen quality was assessed by spermatozoa motility index and viability. Spermatozoa capacity was also evaluated by the reduction of colorless tetrazolium dye MTT. All parameters were estimated at zero, 30, 60, 90 and 120 min after irradiation. Two aliquots served as fresh and untreated controls. The motility index was significantly improved by the exposure to 4 J/cm^2, where it reached 83.8, 81.1, 77.5, 73 and 68.3%, compared with 75.8, 63.3, 57.5, 46.6 and 36.0% for the untreated control at zero, 30, 60, 90 and 120 min. Higher powers than 4 J/cm^2 resulted in significant negative effects on motility index. The exposure to 10 J/cm^2 resulted in motility index of 57.5 and 25.8% at 0 and 120 min. The viability was significantly improved by the exposure to 4 J/cm^2 and was 89 and 78% at zero and 120 min. The sperm capacity was enhanced by 4% at 2 J/cm^2, and increased to 18% at 4 J/cm^2. The capacity was negatively affected by the increase of energy doses and reached −23 and −28% at 8 and 10 J/cm^2 respectively, compared with the control. It is concluded that laser irradiation at 4 J/cm2 enhances the semen quality for up to 90 min and maintains high semen quality for up to 120 min. This can be of significant consideration in the artificial insemination in the industry.

Key Words: fowl spermatozoa, laser irradiation, semen quality

38 The use of peGFP *E. coli* to establish that yolk sac infection occurs via the broiler chick navel. A. Ulmer-Franco*, L. M. McMullen, and G. M. Fasenko, *Department of Agricultural, Food and Nutritional Science, Poultry Research Centre, University of Alberta, Edmonton, AB, Canada.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

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39 The effect of canthaxanthin and hen age on chick innate immunity. M. L. Johnson*, J. L. Saunders-Blades, and D. R. Korver, *University of Alberta, Edmonton, AB Canada.*

Canthaxanthin (Cxn) is a fat-soluble red carotenoid pigment and is reported to be immunomodulatory. Broiler breeder hens were fed 0 ppm (Control), 6 ppm or 12 ppm Cxn to determine the effect of maternal dietary Cxn on chicks hatched from hens at 31 (Early), 45 (Mid) and 57 (Late) wk of age. Whole blood was obtained at 1 and 4 d of age to assess the number of cells able to engulf at least one *Escherichia coli* (% phagocytosis), average number of *E. coli*/cell (phagocytic capacity), and *E. coli* bactericidal capacity ex vivo. Egg and chick liver Cxn were determined. Eggs from 12 ppm hens had 40% more Cxn than eggs from 6 ppm hens, which in turn had 30% more Cxn than eggs from Control hens ($P < 0.0001$). Liver Cxn of 12 ppm chicks was 126% greater ($P < 0.0001$) than 6 ppm chicks; 6 ppm chicks had 67% more Cxn than Control chicks. Chick liver Cxn content decreased by 37% in 6 ppm chicks and 22% in 12 ppm chicks ($P < 0.01$) from Early to Mid with no subsequent changes; there was no age effect in Control chicks. There was a 22% reduction ($P < 0.03$) in phagocytic capacity at 1 d in 6 ppm chicks relative to Control and 12 ppm chicks. At 4 d of age, 12 ppm chicks had 20% lower ($P < 0.03$) *E. coli* bactericidal capacity than 0 or 6 ppm chicks. *E. coli* bactericidal capacity increased from 1 to 4 d in Control and 6 ppm chicks, but not in 12 ppm chicks ($P < 0.02$). Chicks from 6 ppm hens had the greatest *E. coli* bactericidal capacity among chicks hatched from Mid hens, even though they had the lowest *E. coli* bactericidal capacity among chicks from Early hens. Among Late hens, Control chicks had the greatest *E. coli* bactericidal capacity, while 12 ppm chicks had the lowest *E. coli* bactericidal capacity. Greater levels of dietary Cxn increased egg and chick liver Cxn, although liver Cxn content decreased as hens aged. Feeding hens 6 ppm Cxn appeared to increase early chick *E. coli* bactericidal capacity in d-old chicks, in spite of decreased phagocyte capacity, indicating an overall increase in innate immune function. However, this effect was dependent on hen age.

Key Words: canthaxanthin, broiler breeder, innate immunity, phagocytosis, egg

40 Effects of feeding functional oils on performance and jejunum morphology in turkey poults. R. D. Malheiros*[1], P. R. Ferket[1], J. L. Grimes[1], V. M. B. Moraes[2], I. B. Barasch[1], and J. Torrent[3], *[1]North Carolina State University, Raleigh, [2]Sao Paulo State University, Jaboticabal, Brazil, [3]Oligo Basics, Wilmington, DE.*

Functional oils from botanicals have been shown to have antimicrobial, anti-inflammatory or antioxidant activities, and may be used as alternatives to prophylactic or therapeutic pharmaceuticals to control gut health in animals. The feed additive Essential (Oligo Basics USA, Wilmington, DE), a blend of functional oils from cashews and castor bean, was evaluated as an alternative to monensin on the early performance and gut morphology of turkey poults. Male poults were randomly assigned to 3 treatments with 15 pens/treatment and 13 poults/pen. The 3 treatments consisted of a non-medicated control (Ct), dietary inclusion of 0.15% Essential (Es), and 66 ppm Monensin (Mn). Day-old poults were placed in a floor pens with soft-pine shavings contaminated with used litter from a previous flock to provide a natural microbial challenge. Feed and water were provided for ad libitum consumption. Body weights (BW) and feed intake (FI) were determined at 14, 28, and 42 d and feed/gain (FCR) was calculated. At 4, 11, and 21 d, 6 poults/treatment were sampled for jejunum histomorphometric analysis. Significant treatment effects were observed throughout the experiment. In comparison to Ct, Es and Mn significantly increased BW at 14d (353 vs. 381 and 373 g, $P < 0.01$), 28 d, and 42 d 2.127 vs. 2,226 and 2,317, $P < 0.01$), respectively. FCR from 1 to 42 d was 1.62, 1.68, and 1.50 for Ct, ES, and Mn, respectively ($P < 0.001$). In comparison to Ct at 21 d, jejunum villi height and crypt depth was greater among Es poults, whereas villi surface area was greater among Mn poults. Es yields similar positive growth performance and mucosal development of starting turkey poults as Mn, indicating that it could be a potential non-pharmaceutical alternative to an ionophore like monensin.

Key Words: cashew functional oil, monensin, growth performance, gut morphology, turkeys

41 Feeding plant extract to chickens reared on previously used litter: Effects on growth performance, metabolizable energy and nutrient digestibility. V. Pirgozliev*[1] and D. Bravo[2], *[1]SAC, Ayr, Scotland, UK, [2]Pancosma S.A., Geneva, Switzerland.*

A study was conducted to investigate the response of 21-d old male Ross 308 broiler chicks to dietary supplementation of a mixture of carvacrol, cinnamaldehyde and capsaicin (XT, Pancosma S.A.) using growth performance, apparent metabolizable energy corrected for N retention (AMEn) and the coefficients of dietary dry matter (DMD), nitrogen (ND) and fat digestibility (FD) as response criteria.. There were 4 treatments (including 2 wheat- (WC) or corn-based (MC) control diets formulated to be adequate in protein (215 g/kg diet) but marginal in AME (2890 kcal/kg) and slightly high in non-starch polysaccharides than the breeder's recommendation and the control diets supplemented with XT (100 g/tonne). The diets were provided in mash form ad libitum throughout the experiment. The treatments were allocated in a randomized complete block design with each treatment having 10 replicate floor pens with 10 birds per pen. The pens were bedded with used litter. Birds on maize-based diets had higher ($P < 0.05$) AMEn, feed intake ($P < 0.001$) and feed conversion ratio ($P < 0.05$). Irrespective of cereal type, XT supplementation improved ($P < 0.05$) daily feed intake and weight gain ($P < 0.001$) and reduced ($P < 0.05$) feed conversion ratio. There was also improvement in ($P < 0.05$) in dietary AMEn and FD in response to XT supplementation whereas the supplement tended ($P < 0.10$) to increase DMD. The lack ($P > 0.05$) of cereal source by XT interaction suggests that similar responses may be expected when XT is added to maize or wheat based diets. It is concluded that supplementing CP-adequate, marginally low-ME corn-or wheat-based diet with XT to chicks reared on previously used litter improves the nutritive value of the diets.

Key Words: plant extract, AME, digestibility, broilers

42 The effects of whole or large particle grains, Grobiotic-P, and lactose on *Eimeria acervulina* infection, growth performance, nutrient digestibility, and microbial populations in young chicks. C. M. Jacobs*[1], E. Jimenez-Moreno[2], M. C. Jenkins[3], P. L. Utterback[1], and C. M. Parsons[1], *[1]University of Illinois, Urbana, [2]Universidad Politecnica de Madrid, Spain, [3]USDA, Beltsville, MD.*

An experiment was conducted to evaluate the effects of fine and large particle corn, whole sorghum, and whole wheat in the presence and

absence of an acute *Eimeria acervulina* (EA) infection in chicks fed a corn–soybean meal diet. A second experiment was also conducted using Grobiotic (GB), Dairylac-80 (International Ingredient Corporation, St. Louis, MO), and lactose in the presence of an EA infection. Male commercial Ross 308 broiler chicks were orally gavaged with 1×10^6 sporulated oocysts at 8 d of age and growth performance was measured from 8 to 22 d of age. Metabolizable energy (ME_n), amino acid (AA) digestibility, and cecal microbial populations were also measured at 22 d of age. The EA infection significantly reduced chick growth performance, ME_n, and AA digestibility ($P \leq 0.05$). However, the addition of large ground corn, whole sorghum or wheat, GB, Dairylac–80, or lactose to the diet had no consistent effects on growth performance and did not ameliorate the negative effects of the coccidiosis infection. Chicks fed diets containing large ground corn, whole sorghum, or whole wheat had significantly increased ($P \leq 0.05$) relative gizzard weights when compared with chicks fed the fine ground corn. The addition of GB resulted in a significant increase ($P \leq 0.01$) in cecal lactobacilli populations, while the addition of the whole wheat, whole sorghum, and large ground corn and the presence of the EA infection all decreased ($P \leq 0.05$) *E. coli* populations. The results of this study indicated that feeding large ground corn, whole sorghum, or whole wheat in the presence or absence of a coccidiosis infection significantly increased relative gizzard weights and decreased *E. coli* populations, but none of the dietary feed additives had a consistent effect on overall growth performance or responses to the EA infection.

Key Words: whole grains, coccidiosis, lactose, chick, growth

43 Water plantain (*Alisma canaliculatum*) probiotics as an alternative feed additive for broiler. M. E. Hossain*[1], S. Y. Ko[1], G. M. Kim[1], J. D. Firman[2], and C. J. Yang[1], *[1]Department of Animal Science and Technology, Sunchon National University, Suncheon, Jeonnam, Korea, [2]Department of Animal Sciences, University of Missouri, Columbia.*

The present study was conducted to select proper probiotic strains for making water plantain (*Alisma canaliculatum*) probiotics and examine their effect on broiler performances. Sixteen strains of *L. acidophilus*, *L. plantarum*, *E. faecium*, *B. subtilis*, *B. coagulans* and *S. cerevisiae* from Korean Collection for Type Cultures (KCTC) were used in this experiment. The strains were first tested for acid and bile tolerance, then the higher tolerate strains were selected for heat tolerance. Among the tested strains, *L. acidophilus* KCTC 3111, *E. faecium* KCTC 2022, *B. subtilis* KCTC 3239 and *S. cerevisiae* KCTC 7928 which had higher tolerance in acid, bile and heat were selected for making fermented *A. canaliculatum* probiotics. Associative inoculation of *A. canaliculatum* probiotics with *E. coli* S93 F5 and S99 LT showed that the numbers of *E. coli* were gradually decreased after 6 h of inoculation. In the in vivo trial, one hundred 40 Ross broiler chicks had been arranged for a period of 5 weeks to 4 dietary groups: NC (basal diet), PC (basal diet+0.005% oxytetracycline), AC (basal diet+0.5% *A. canaliculatum* powder) and ACP (basal diet+0.5% *A. canaliculatum* probiotics). The results indicated that growth performances were not affected by the addition of AC or ACP into feed. Higher crude protein and lower crude fat content of breast meat were found in the ACP group whereas; additive groups showed lower crude protein content in thigh meat. Thiobarbituric acid value of breast meat in d 3 and thigh meat in d 5 were higher in the ACP group, but after 1 week of preservation no changes were observed. Among the fatty acid composition of breast and thigh meat, PUFA and n3 fatty acid were increased resulting in lower n6/n3 ratio in the ACP group. Proventriculus and kidney weight were decreased, and cecal *E. coli* numbers were reduced in the ACP group as same as in the PC group. It is concluded that *A. canaliculatum* probiotics exhibited a high tolerance to acid, bile and heat, inhibition effect on *E. coli* proliferation, no adverse effect on broiler performances, and would be incorporated to broiler diet as an alternative to antibiotics.

Key Words: water plantain, probiotics, *E. coli*, feed additive, broiler

44 Effect of *Bacillus subtilis* C-3102 on morphological characteristics and microbial status of 14-d-old chicks in conventional and germ-free environments. T. Hamaoka*[1], N. Otomo[1], B. Y. Lee[1], Y. Tadano[2], T. Marubashi[2], J. Marshall[3], and A. Van Kessel[3], *[1]Calpis U.S.A. Inc., Mt. Prospect, IL, [2]Calpis Co. Ltd., Tokyo, Japan, [3]University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

Bacillus subtilis C-3102 (BSC) is utilized in a direct-fed microbial or probiotic product Calsporin (Calpis Co. Ltd., Japan) and made available worldwide. To study mechanisms of action of BSC, a study was conducted using gnotobiotic birds. All birds (Ross308) were hatched as germ-free chicks in 4 gnotobiotic isolators (10 chicks/isolator) according to methods developed at the University of Saskatchewan. After hatching, birds in 2 isolators were conventionalized by mixing 2 g of fecal material into drinking water. All birds were fed *ad libitum* from day of hatch a diet sterilized by gamma irradiation and meeting nutrient requirements. In one of the germ-free and one of the conventionalized isolators, the diets were supplemented with 3×10^5 cfu/g of BSC throughout the trial. Results were analyzed employing a 2×2 factorial design of 4 treatments, germfree, BSC monoassociated, conventionalized and conventionalized plus BSC supplemented. At 14-d of age, all the birds were killed and organs, tissues and intestinal contents were collected for analyses. Microbial status were investigated by culture based methods and qPCR. Tissues were fixed and stained (H&E) for morphometric analyses. Culture based analysis indicated BSC reduced ($P < 0.05$) counts (log cfu/g) of total anaerobes and enterobacteria. Molecular enumeration demonstrated the same trends. Conventionalization resulted in several significant changes. Relative bursa weight ($P < 0.001$) and relative length of small intestine ($P < 0.08$), duodenum ($P < 0.001$) and cecum ($P < 0.05$) were less in conventionalized groups compared with the other treatment groups. Villus length and crypt depth in ileum were increased in conventionalized birds ($P < 0.0001$, $P < 0.05$). Supplementation with the BSC did not affect mucosal morphology but increased ($P < 0.05$) the thickness of muscularis. In conclusion, supplementation with the BSC increased the thickness of muscularis mucosa in both conventionalized and ex-germ-free monoassociated birds, suggesting a direct host response to BSC, possibly a mechanism not mediated by a change in ileal microbiota.

Key Words: *Bacillus subtilis* C-3102, germ-free, muscularis mucosa

45 Evaluation of Tasco-supplemented broiler diets as a candidate prebiotic. M. Arata*[1], D. Anderson[1], B. Rathgeber[1], and F. Evans[2], *[1]Nova Scotia Agricultural College, Truro, NS, Canada, [2]Acadian Seaplants Ltd., Dartmouth, NS, Canada.*

Tasco, made of dried brown seaweed (*Ascophyllum nodosum*) by Acadian Seaplants Ltd., is a candidate prebiotic. This study sought optimal levels of Tasco and compared its effects with Inulin, a known prebiotic. Male broiler chickens were studied in 2 trials. In trial 1 each room contained either pens with a 2:1 mix of previously used and new litter or pens with all new litter. Birds were raised to 35 d and fed 5 diets; 0, 0.5, 1.75, and 3% Tasco, and 2.5% Inulin. In trial 2 birds were raised to 45 d and fed 8 diets; 0%, 0% with ATB, 0.25, 0.5, 1, and 2% Tasco,

2% Tasco pulse fed for the first 2 weeks, and 2.5% Inulin. In both trials pH of the ceca and jejunum and weights of the ileum, ceca, bursa, and spleen were recorded on d 7, 21, and 35, and d 45 in trial 2. In trial 1, 1.75 and 0.5% Tasco increased body weight (BW) and gain (G) in g/bird over Inulin ($P < 0.05$)(1210 ± 7.1, 1191 ± 7.1, and 1117 ± 7.1 BW respectively (resp.) and 680 ± 5.5, 671 ± 5.5, and 630 ± 5.5 G resp.). Tasco at 1.75% improved feed intake (FI) in g/bird over Inulin ($P < 0.05$)(1199 ± 12.7 and 1131 ± 12.8 resp.). For feed:gain 0.5% Tasco clean litter outperformed 0% Tasco clean litter and 2.5% Inulin clean and dirty litter on d 24 ($P < 0.05$)(1.5 ± 0.03, 1.8 ± 0.03, 1.8 ± 0.03, and 1.8 ± 0.03 resp.) and 1.75 and 0% Tasco, 2.5% Inulin dirty litter and 0.5% Tasco clean and dirty litter outperformed 2.5% Inulin clean litter on d 35 ($P < 0.05$) (2.0 ± 0.03, 1.9 ± 0.03, 2.0 ± 0.03, 2.0 ± 0.03, and 2.0 ± 0.03 resp.). In trial 2 BW 0.5% Tasco improved over 2 and 0% Tasco on d 35 ($P < 0.05$)(2331 ± 45.7, 1854 ± 45.7, and 2080 ± 45.7 resp.) and 0.25% Tasco improved over 2, 2 pulse, and 0% Tasco on d 45 ($P < 0.05$)(3511 ± 45.8, 2965 ± 45.6, 3140 ± 45.6, and 3253 ± 45.6 resp.). For FI 1% Tasco outperformed 0.5, 0, and 0% ATB Tasco on d 35 ($P < 0.05$) (2224 ± 55.6, 1875 ± 55.6, 1740 ± 55.5, and 1813 ± 55.5 resp.) and 2.5% Inulin and 0% Tasco on d 45 ($P < 0.05$) (2479 ± 55.5, 2158 ± 55.5, and 2118 ± 55.5 resp.). Tasco at 0.25, 1, and 2% pulse showed increased G over 0% ($P < 0.05$)(849 ± 19.0, 835 ± 19.0, 823 ± 19.0, and 723 ± 19.0 resp.). Tasco was effective at levels as low as 0.25% and 0.5% and showed improvement over the control and inulin diets.

Key Words: Tasco, seaweed, prebiotic, broiler, inulin

46 Improving the production economics of broiler production by using *Bacillus* based growth promoter either on top of diet or by use of matrix value. I. Knap, A. B. Kehlet*, and A. M. Michelsen, *Chr. Hansen, Hørsholm, Denmark.*

Bacillus subtilis has been used as direct feed microbial (DFM) in broiler feed to improve intestinal health through microflora modulation and improving production performance (Knarreborg et al., 2008). Addition of *B. subtilis* to broilers diet improves ileal nutrient digestibility resulting in increased metabolizable energy by 70- 110 kcal/kg dry matter (Knap et al., 2010). To evaluate the consistency of GalliPro (*Bacillus subtilis*) performance in relation to diet composition and bird breed as well as the effect on FCR compared with breeders performance guideline, 30 production studies were investigated. The 30 trials were performed at independent trial facilities or research institutes using 2 treatments - a control group and control plus GalliPro 500 g/ton feed. The groups were compared with regards to effect on FCR measured at slaughter. Twenty-four of the 30 (80%) trials resulted in reduced FCR in the group added GalliPro compared with the control group (on average FCR was decreased by 2.6%). The effect of GalliPro was independent of breed (Ross vs. Cobb) and diet energy source (wheat vs. corn based diets). Based on 16 trials evaluated at d 42, (production trials running until d 42) comparing the FCR performance of the control birds with recommended FCR values given in breeders performance guideline, a clear pattern was seen; If control birds performed less efficient (higher FCR than breeders guideline) the effect of adding *Bacillus subtilis* was highest. If the control birds performed in accordance with or better (lower FCR) than the breeders guideline the effect of adding GalliPro was low. To be able to utilize the performance improving and increased nutrient utilization of adding GalliPro to broiler diets it is recommended for broiler producers at an elevated FCR level (FCR > breeders guideline at a given age) to add GalliPro on top of the diet, and if the broiler producers have a FCR equal or lower than the breeders guideline to use a matrix value to gain optimal economic out of the *Bacillus* based growth promoter.

Key Words: *Bacillus subtilis*, FCR, breed, matrix value, production

47 Effect of feeding diets containing a probiotic or antibiotic on broiler performance and litter water-soluble phosphorus. A. M. Amerah*[1], C. Jansen van Rensburg[2], and P. W. Plumstead[1], *[1]Danisco Animal Nutrition, Marlborough, UK, [2]University of Pretoria, South Africa.*

The aim of the present experiment was to examine the influence of feeding diets containing a probiotic (Enviva Pro 202 GT) based on 3 *Bacillus subtilis* strains or antibiotic (Zinc Bacitracin) on the performance, intestinal morphology and litter water-soluble phosphorus (WSP) of broilers fed corn based diets. Three treatments were employed: Control diet (C); Control diet supplemented with the probiotic at 7.5×10^4 cfu/g diet (T1); and Control diet supplemented with the Zinc Bacitracin (50g/t of feed) (T2). Diets were pelleted and fed *ad libitum* to 7 pens of 50 male broilers, each from d 1 to 35. Data were subjected to one way ANOVA using the JMP 8.0 software and means were separated by Student's *t*-test. Feed intake and weight gain were not influenced ($P > 0.05$) by dietary treatments. However, T1 improved ($P < 0.05$) FCR compared with control and T2 (1.40, 1.45 and 1.48 g/g; T1, T2 and C, respectively). Similarly, T1 improved ($P < 0.05$) production efficiency factor compared with control and T2 (466, 443 and 421; T1, T2 and C, respectively). Villus height and crypt depth in duodenum and jejunum were not influenced by dietary treatment. Probiotic and antibiotic supplementation had no effect ($P > 0.05$) on litter total P. However, T2 reduced ($P < 0.05$) litter WSP compared with control and T1 (0.69, 0.78 and 0.77g/ 100g DM; T2, T1 and C, respectively). This reduction in litter WSP in T2 may be explained by the effects of antibiotics on microbial population, reducing the degradation of phytate with concomitant reductions in WSP. In conclusion, probiotic supplementation had no effect on intestinal morphology or WSP but improved broiler performance compared with control or antibiotic supplemented diet.

Key Words: *Bacillus subtilis*, probiotic, antibiotic, water-soluble phosphorus, broilers

48 Potential of multispecies probiotic to reduce Necrotic enteritis and Gangrenous dermatitis in broilers. A. Jordan*[1], M. Mohnl[2], and G. Schatzmayr[3], *[1]Biomin USA, San Antonio, TX, [2]Biomin Holding GmBH, Herzogenburg, Austria, [3]Biomin Research Center, Tulln, Austria.*

Global animal production is ever changing, creating the necessity to conform to the needs and wants of the consumer. One product on the market is based on a well-defined, multispecies probiotic consisting of intestinal bacteria derived from the chicken gut belonging to the genera *Enterococcus*, *Pediococcus*, *Lactobacillus* and *Bifidobacterium* combined with a nutrient ingredient Fructooligosaccharide source. Using a co-cultivation in vitro model, each strain was evaluated for its ability to inhibit the growth of *Clostridium perfringens*. Necrotic enteritis (NE) is caused by the pathogen *C. perfringens* and continues to be a concern. Gangrenous dermatitis (GD) is also associated with this pathogen; thus, it was decided to evaluate the effect of the product in the course of a series of in vivo experiments. Study 1: The experimental group received the probiotic via drinking water (20g / 1000 birds /day), the birds of the probiotic group and the positive control

group were orally gavaged with *C. perfringens* once daily for 3 consecutive days starting on d 17 (10^6 cfu/mL in Exp 1 and 10^7 cfu/mL in Exp 2). Lesion scores and bacterial counts showed the probiotic was able to maintain lesion scores, mortality and bacterial counts to the level of the negative control birds or statistically below ($P < 0.05$) the positive control group. On both farms the probiotic treated house had ($P < 0.05$) lower mortality at disease onset, as well as an increase ($P < 0.05$) in body weight gain. Study 2: A subclinical necrotic enteritis model was used to reproduce the disease. The birds of the probiotic group (0.1% of product in feed) and the positive control group were challenged orally 3 times a day with approximately 4×10^8 cfu *C. perfringens* at d 17, 18, 19 and 20. Results showed that the probiotic group had a significant ($P < 0.05$) lower amount of birds with necrotic lesions compared with the positive control group. In conclusion these studies suggest that the multispecies probiotic may be beneficial in the control of poultry diseases which are related to *C. perfringens* like NE and GD.

Key Words: probiotic, multispecies, necrotic enteritis, gangrenous dermatitis, *Clostridium perfringens*

49 Effect of conditioning temperature and probiotic supplementation on growth performance of broilers fed corn/soy-based diets. A. Amerah[1], P. Medel*[2], C. Millán[2], and M. I. Gracia[2], *[1]Danisco Animal Nutrition, Marlborough, Wiltshire, United Kingdom, [2]Imasde Agroalimentaria, S.L., Madrid, Spain.*

The aim of the present experiment was to examine the effect of conditioning temperature and a probiotic (Enviva Pro 202 GT) supplementation based on 3 *Bacillus subtilis* strains on growth performance of broilers fed corn/soy-based diets. The experimental design was a 3 × 2 factorial arrangement of treatments evaluating 3 conditioning temperatures (75, 85 and 95°C) and 2 levels of probiotic supplementation (without or with 1.5×10^5 cfu/g feed). Each treatment was fed ad libitum to 8 pens of 22 male broilers, in both the starter (1–21 d) and the grower (21–42 d) phases. The performance data were analyzed by 2-way ANOVA using the GLM procedure of SAS (2002). During the starter phase (1–21d), conditioning temperature had no effect ($P > 0.05$) on broiler performance. Probiotic supplementation reduced feed intake (59.4 vs. 58.6 g/d; $P < 0.05$) compared with unsupplemented diets with no significant effect ($P > 0.05$) on weight gain or feed conversion. Over the entire period (1–42d), a positive quadratic response ($P < 0.05$) of conditioning temperature on bodyweight gain was observed. Probiotic supplementation significantly reduced feed intake by 2.1% (113.3 vs. 110.9 g/d; $P < 0.01$) and improved feed conversion by 2.3% (1.72 vs. 1.68 g feed/g gain; $P < 0.01$). No interactions ($P > 0.05$) were observed for any of the measured parameters during the overall period. It is concluded that diet supplementation with this probiotic at 1.5×10^5 cfu/g feed improves feed conversion ratio in broilers fed corn/soy diets, regardless of the conditioning temperature used.

Key Words: *Bacillus subtilis*, conditioning temperature, broilers, performance

50 Performance of layers fed Original XPC for 24 weeks. K. E. Anderson[1], J. N. Broomhead*[2], and W. Michael[2], *[1]North Carolina State University, Raleigh, [2]Diamond V, Cedar Rapids, IA.*

Laying hens from 11 white and 7 brown strains (approximately 17 weeks of age; n = 9594) were fed *Saccharomyces cerevisiae* fermentation product (Diamond V Original XPC) for 24 weeks and egg production, size and quality were measured. Hens were housed at 2 densities (497 or 471 sq cm with 5 or 7 hens/cage) within 2 production houses (approximately 13 replicates per dietary treatment per strain). Dietary treatments included 0 or 0.68 kg Original XPC/ton feed. Egg weights and sizes were recorded monthly from all eggs collected during a 24 h production period starting at 119 d of age. Percentages of eggs within each size category, average egg weight, and average egg mass were calculated. Egg quality was determined using USDA grades. Feed was provided ad libitum and was weighed back every 28 d by replicate group and feed intake was calculated. Data was analyzed separately for white and brown strains using a SPLIT-PLOT design and PROC MIXED procedure of SAS. For white and brown strains, hen day production, average egg weight and percentage of extra large plus large eggs was greater ($P < 0.05$) for hens supplemented with Original XPC. Percentage of medium size eggs were lower ($P < 0.05$) for white and brown hens supplemented with Original XPC. White strain hens supplemented with Original XPC had greater ($P < 0.05$) feed intake per bird per day and lower ($P < 0.05$) percentage of check eggs than the controls. When Original XPC was supplemented to the diets, brown strain hens had significantly greater ($P < 0.05$) hen housed production and percentage of grade A eggs. The white strain hens had numerically greater hen housed production ($P < 0.06$) and percentage of grade A eggs ($P < 0.09$). The results indicate that supplementation of Original XPC can improve egg production, size and quality in white and brown strains of laying hens.

Key Words: layers, *Saccharomyces cerevisiae* fermentation product, egg production, egg quality, egg size

51 Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of oregano essential oil for common livestock and poultry pathogens. M. A. Mellencamp*, J. Koppien-Fox, R. Lamb, and R. Dvorak, *Ralco Animal Health, Marshall, MN.*

Enteric health plays a key role in disease control, efficient feed utilization and maturation of the immune system. The poultry industry is investigating phytonutrients including oregano essential oil (OEO) because they exert potent antimicrobial and antioxidant activity in the gut. The antimicrobial and antioxidant activity of OEO is attributed to its most abundant polyphenols, carvacrol and thymol. Carvacrol and thymol have been shown to permeabilize and depolarize the bacterial cytoplasmic membrane, resulting in cell death. The objective of this study was to quantify the antimicrobial and antioxidant activities of OEO. Antibacterial activity was determined by testing for the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of OEO for common livestock and poultry pathogens. A standardized microtiter protocol was used. Several bacteria were tested including *Escherichia coli*, *Salmonella enteritidis*, *S. typhimurium*, *Klebsiella pneumoniae*, and *Staphylococcus aureus*. Antioxidant activity for OEO and vitamin E (positive control) was determined by the oxygen radical absorption capacity (ORAC) value against 5 oxygen radicals: peroxyl radical, hydroxyl radical, peroxynitrite, superoxide anion, and singlet oxygen. Results showed that MICs and MBCs for both gram-positive and gram-negative bacteria ranged from 1.25 to 10.0 µg/ml. MBCs were all equal to the MIC in all cases, demonstrating bactericidal activity. Antioxidant testing showed that OEO had much higher level of total antioxidant activity (2,520,600 trolox equivalents/100g) than natural vitamin E (48,200) and several other common antioxidants. These results demonstrate that OEO has high antimicrobial activity for pathogens that cause enteric disease

in poultry. The very high level of antioxidant activity of OEO may protect enterocytes against inflammatory damage caused by reactive oxygen molecules that are released during immune system activation.

Key Words: oregano essential oil, antimicrobial, gut health, antibiotic alternative, antioxidant

52 Carcass quality of broiler chicks under high stocking density fed α-tocopherol supplemented diet. O. A. Adebiyi*[1], M. D. Olumide[1], O. A. Ogunwole[1], and O. A. Adu[2], *[1]University of Ibadan, Ibadan, Ibadan, Oyo State, Nigeria, [2]Federal University of Technology, Akure, Akure, Ondo State, Nigeria.*

Two hundred and seventy, day-old Arbor Acre strain of broiler chicks were used for this research. The basal diet contained 23.00% crude protein and 3,000 kcal/ kg metabolizable energy. The premix used was a normal commercial broiler starter premix that contained 0.08kg Vit E / kg of premix. The basal diet was therefore supplemented with the different levels of Vit E (α-Tocopherol) to have the different diets (Treatment 1 contained 10 birds/m^2 without additional Vit E supplementation, Treatment 2 had 20 birds /m^2 without Vit E supplementation, Treatment 3 had 20 birds /m^2 but with additional 50.00 mg/kg Vit E supplementation, Treatment 4 contained 20 birds /m^2 with 100.00mg/kg Vit E supplementation, while Treatment 5 had 20 birds /m^2 with 150.00mg/kg Vit E supplementation). The Experimental design was a completely randomized design. While significant means were separated at 95% level of significance ($P < 0.05$). All treatments were replicated 3 times. At the end of the 4 weeks of experiment, carcass characteristics (Cold shortening (CS), Thermal shortening (TS), Cooking loss (CL), Shear force (SF) and Water Holding Capacity (WHC)) of the birds were determined. There were no significant changes in the weight gain and final weight of the birds fed the different dietary treatments. However, the feed conversion ratio (FCR) revealed that birds on dietary treatment 2 had the highest significant value of 3.29 compared with those on Vit E supplemented diets. No significant different was observed in the WCH of both raw (58.43% to 59.43%) and the cooked meat (59.02% to 59.51%) for all the treatments. Birds fed dietary treatment 2 (negative control) had the highest significant ($P < 0.05$) CS value of 3.50% compared with its counterparts on Vit E supplemented diets with values ranging from 2.45% to 2.55%. No significant difference was observed in the SF of the birds in all the treatment with mean value ranging from 3.35% to 3.60%. In conclusion, broiler chicks could be stocked up to 20 birds/m^2 only if the diet is supplemented with 100mg/kg Vit. E.

Key Words: stock density, vitamin E, carcass quality, broilers

53 Influence of NSP enzyme (Rovabio) on energy sparing and growth performance of broilers fed corn-based diets containing corn distillers dried grain with solubles. B. S. Lumpkins*[1], G. F. Mathis[1], S. K. Rao[2], and D. R. McIntyre[3], *[1]Southern Poultry Research Inc., Athens, GA, [2]Foster Farms, Delhi, CA, [3]Adisseo, Alpharetta, GA.*

The study was conducted to investigate the effects of a multi-enzyme complex (Rovabio Excel) containing carbohydrolase activities on the performance of broiler chickens. Test diets were formulated to include 12% corn distillers dried grain with solubles (DDGS). In total, 1200 Cobb 500 broiler males were randomly assigned to 8 replicate pens of 50 birds per treatment and grown to 45 d of age using one of 3 different dietary regimens. Birds in Treatment 1 received industry standard broiler feeds that served as the positive control (PC) program. Treatment 2 diets were adjusted to reduce Metabolizable Energy (ME) by 132 kcal/kg and were designated as the negative control (NC) group. Feeds in Treatment 3 were the same as NC but with the addition of a NSP enzyme, Rovabio (ROV). A 5 feed program was used to provide: starter (1–13d), grow 1 (13–21d), grow 2 (21–32 d), finisher (32–39d) and withdrawal (39–45d), respectively. Birds were weighed at 0, 21, 35 and 45d; feed conversion ration (FCR), feed intake and mortality were also determined at each weigh day. Calorie reduction in the NC treatment significantly reduced weight gain compared with the PC treatment at 45d (2.45 vs. 2.51 kg). FCR in the NC birds was higher than the PC (1.78 vs. 1.75). Adding the NSP enzyme (Rovabio) to the NC feeds restored both weight gain and feed conversion (2.54 kg and 1.75, respectively). No differences in mortality were observed.

Key Words: NSP-enzymes, DDGS, broiler

54 Effects of low oligosaccharide soybean meal and α-galactosidase supplementation on growth and meat yield responses of broilers during a 40 day production period. K. R. Perryman* and W. A. Dozier III, *Auburn University, Auburn, AL.*

This study examined the interactive effects of soybean meal (SBM) source and α-galactosidase supplementation on growth performance, meat yield, and physiological variables during a 40-d production period. Twelve hundred (25 per pen; 0.09 m^2 per bird) Ross × Ross 708 male chicks were randomly distributed to 48 floor pens (12 replicates per treatment). Birds were fed diets containing 2 SBM sources [conventional soybean meal (CSBM) or low oligosaccharide soybean meal (LOSBM)] and 2 concentrations of α-galactosidase (0 or 12,000 units/kg SBM) in a 2 × 2 factorial arrangement. In diet formulation, determined AME_n values were used for each SBM source from a previous energy balance assay. Overall, diets containing LOSBM had a 64% reduction in added fat due to its higher AME_n compared with diets formulated with CSBM. Dietary treatments were fed from 1 to 13, 14 to 28, and 29 to 40 d of age during starter, grower, and finisher periods respectively. Body weight gain, feed intake, feed conversion ratio (FCR), mortality, carcass yield, abdominal fat yield, breast meat yield, plasma glucose, plasma triglycerides, plasma free fatty acids, and intestinal viscosity were assessed. Broilers fed diets containing LOSBM increased ($P < 0.001$) BW gain from 1 to 13 d of age and decreased ($P \leq 0.012$) FCR from 1 to 13 and 1 to 40 d of age. α-Galactosidase supplementation reduced ($P \leq 0.033$) BW gain from 1 to 28 and 1 to 40 d of age and decreased ($P = 0.039$) feed intake from 1 to 40 d of age. Processing characteristics were unaffected by SBM source or enzyme addition with the exception of carcass yield being increased ($P < 0.044$) with broilers fed the LOSBM treatment, and lower ($P < 0.012$) breast yield was observed with birds fed diets with α-galactosidase. No differences ($P > 0.05$) were measured for physiological variables between treatments. These results indicated that LOSBM does not adversely affect growth performance and meat yield, but reduces fat supplementation due to its higher AME_n.

Key Words: α-galactosidase, broilers, oligosaccharide, soybean meal

55 Evaluation of feeding distillers dried grains with solubles and the effects of dietary enzymes on broiler performance and carcass characteristics. B. Jung*[1], M. Hoerler[1], A. B. Batal[1], and R. Mitchell[2], *[1]University of Georgia, Athens, [2]Perdue Farms Inc., Salisbury, MD.*

The use of distillers dried grains with solubles (DDGS) in poultry diets may be cost effective alternative for supplying energy and protein. However, the use of high levels of DDGS in broiler diets may be limiting due to negative effects on performance and carcass characteristics. The use of enzymes may overcome the nutritional challenges associated with feeding high levels of DDGS to broilers. An experiment was conducted to evaluate the use of 2 sources of DDGS and the effect of enzyme supplementation on performance and carcass characteristics of birds fed diets with high levels of DDGS inclusion. One thousand 4 hundred-40 1-d-old male Heritage broilers were randomly assigned to the 9 dietary treatments; 1) 0% DDGS(control); 2) a diet containing DDGS1; 3) a diet containing DDGS2; 4) a negative control diet (reduced in energy and protein) with DDGS1; 5) a negative control diet with DDGS2; 6) as diet 4 + enzyme 1; 7) as diet 5 + enzyme 1; 8) as diet 4 + enzyme 2; 9) as diet 5 + enzyme 2. The diets contained 9% DDGS during the starter period (0 to 21 d) and then 12% DDGS there after (15 to 49 d). Eight replicate pens containing 20 chicks were fed each experimental diet. The diets were formulated on a digestible amino acid basis for all periods. There was no difference in broiler performance for chicks that were fed DDGS1 or DDGS2. However the birds fed the diets containing 9% DDGS from either source were not ($P < 0.05$) as efficient (gain:feed) as the birds fed the control diet (with no DDGS inclusion) from 0 to 21 d of age. The supplementation of the enzymes to the 9% DDGS diets improved ($P < 0.05$) feed efficiency as compared with the 9% DDGS diets un-supplemented with enzyme from 0 to 21 d. Performance from 22 to 49 d and carcass characteristic data are currently being collected. Careful consideration should be given when 9% DDGS is fed to broilers for starter period (0 to 21 d) due to negative effects on feed efficiency. The supplementation of enzymes to broiler diets with high DDGS inclusions level (9%) may overcome the negative effects of DDGS.

Key Words: DDGS, broilers, enzymes, performance, carcass characteristics

56 Influence of exogenous celluloses, hemicelluloses, protease and α-amylase enzymes preparation at ensiling (ZADO-complex) in the diets on broiler performance and slaughter traits from 1 to 42 days of age. H. M. Safaa*, *Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt.*

A total of 480 Cobb-500 broiler chicks at one-day old was used to study the effect of exogenous celluloses, hemicelluloses, protease and α-amylase enzymes preparation at ensiling (ZADO-complex) on the productive performance and slaughter traits. Chicks were divided randomly into 4 treatments (diets supplemented with 0, 2, 4 and 6% with

ZADO-complex) and housed at deep litter in an open house system. Each treatment replicated 4 times (30 chicks per replicate). Basal diet contained 23.1% CP and 3,103 kcal AME/kg for the starter diet (0–21 d) and 20.0% CP and 3,207 kcal AME/kg for the finisher diet (21–42 d). Results indicated that body weight and body weight gain were improved in response to dietary 6% ZADO-complex comparing to the other treatments ($P = 0.0112$ and 0.0097, respectively). Moreover, feed intake and feed conversion were improved and mortality rate was decreased in response to dietary 4 and 6% of ZADO-complex comparing to 0 and 2%. Feed conversion ratio was 1.95, 1.90, 1.76 and 1.68 for birds fed diet supplemented with 0, 2, 4 and 6% ZADO-complex, respectively. In addition, birds fed diet supplemented with 6% ZADO-complex recorded higher dressing, internal organs and immune organs relative weights at 6 weeks of age than other treatments ($P \leq 0.05$). It could be recommended from this study to supplement 4% or more of ZADO-complex to broiler diet from 0 to 42 d of age for improving the productivity and slaughter traits

Key Words: ZADO-complex, broiler performance, slaughter traits

57 Effect of dietary protein and protease supplementation on performance and gut health of broiler chicks. F. Yan*, J. Dibner, C. D. Knight, M. Vazquez-Anon, N. Odetallah, and S. Carter, *Novus International Inc., St. Charles, MO.*

Effect of dietary protein level and protease supplementation on performance and gut health was evaluated in 2 studies. For study 1, 288 broilers were used to examine effect of normal crude protein (CP) vs. high CP (22% vs. 30%) without or with protease (CIBENZA DP100, Novus International Inc.) supplementation in a 2 × 2 factorial arrangement. Each test diet was fed to 9 replicate pens of 8 birds from 0 to 28 d. All diets contained 20% rye and 25% wheat, high CP diets had 14% poultry meal, and all birds were given a cocci challenge (10× immunizing dose) on d 7. In the absence of protease, increasing dietary CP increased ileal *Clostridium perfringens* (C.p) by 2 logs (2.35 vs 4.34) and with protease supplementation no CP effect was seen (2.09 and 2.30 for normal and high CP), accounting for a significant interaction. Protease was also associated with increased growth efficiency in the gut and reduced systemic inflammation demonstrated by improved crypt villus ratio and lower serum α-1 glycoprotein level. For study 2, 3 corn soy DDGS based diets - normal CP, low CP (7% less), and low CP + protease, were fed to birds under 2 stress conditions- normal (21 birds per pen) and stress (8-h feed outage on d 0 and d 14, 25 birds per pen). Each test diet was fed to 8 replicate pens. Under normal condition, body weight was not affected by dietary CP at d 14 and 27 whereas under stress condition, birds fed normal CP actually weighed less. Under normal condition, broilers on normal CP had better 0–14 d FCR than those on low CP, but under stress condition, no significant difference was observed. Protease improved FCR throughout the trial and the response tended to be greater under stress condition from 0 to 14 d. In summary, undigested protein in the gut either from excessive CP supply or comprised gut function by stress could cause gut dysbacteriosis by promoting C.p growth and reduce performance and protease can alleviate these negative effects through improving protein digestion in young broilers.

Key Words: protease, broiler, protein, gut health

58 New model for examining the energy release of exogenous enzymes in laying hen rations. G. R. Murugesan* and M. E. Persia, *Iowa State University, Ames.*

A 12-wk experiment was conducted with 90 Hy-line W-36 laying hens to investigate energy release of an exogenous enzyme cocktail (EE) with special attention to productive, maintenance and storage energy. The experiment was arranged as a 2x3 factorial design, with ad-libitum and fed restriction (90g/hen/day) groups and 3 dietary treatments (positive control; PC, negative control; NC, and NC with EE; NEE). The experiment unit (EU) was an individually housed hen (192 in2) resulting in 15 EU randomized in a complete block design for each of the 6 treatments. The PC was formulated to meet or exceed industry based requirements with 3150 kcal/kg, the NC diets were similar to the PC with the exception of a 100kcal/kg reduction in ME. Hens were secured from a local commercial facility at 22 weeks of age and were allowed to transition to the experimental facilities for 2 weeks before experimental diets were provided. Egg production and mortality data were collected daily, feed intake was measured weekly and hen body weight was determined monthly. Statistical analysis was carried out using ANOVA with protected LS means used to separate means. There were no interactions throughout the experiment, but feed restriction resulted in significant reductions in feed intake, egg production, ending body weight, feed conversion ratio and fat pad. Hens fed the NEE diet resulted in a slight, but significant increase in feed intake and feed conversion ratio in comparison to the PC fed birds. The reduction in energy between the PC and NC fed birds (100 kcal/kg) did not change productive energy (egg production and egg weights) or maintenance energy (body weight), but did result in a significant reduction in energy storage (reduced fat pad). The NEE diet resulted in no change in the productive or maintenance energy but significantly increased the energy storage (fat pad) and returned energy storage to the level of the PC fed birds. These results suggest that although productive and maintenance energy were minimally affected, in this experiment the EE did liberate energy from the diet that was stored as fat in the fat pad of the hens.

Key Words: layer, enzyme, energy metabolism

59 Effect of feeding several feed enzymes activities combinations and feed formulation matrix values on broiler growth performance. E. Avila-Gonzalez[1], J. Arce-Menocal[2], S. Chárraga[3], E. Rosales[3], and S. R. Fernández*[3], *[1]Universidad Nacional Autónoma de México, Mexico City, México, [2]Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Mich. México, [3]DSM Nutritional Products México S.A. de C.V., Guadalajara, Jal, México.*

To test the broiler performance when feeding different combinations of; phytase; Ronozyme P (P), non-starch carbohydrases; Ronozyme Blend 25 (B25), and protease; Ronozyme ProAct (PA) activities, 2,100 1-d-old-Ross 308 male broilers were randomly allocated to 6 treatments with 7 replicates of 50 chicks each. T1 (control) was a corn, SBM, DDGS (8%), canola meal (5%) MBM (3%) diet with no enzyme addition, formulated to fulfill the Ross 308 nutritional requirements. T2 was as T1 + P (100% amino acid (AA) matrix values) + B25 (100% AA matrix values, PB25–100), T3 was as T2 + PA, but 0% matrix AA values for P and B25 (PB25–0PA), T4 was as 3 but with 100% matrix AA values for P and B25 (PB25–100PA), T5 was as 4 but with 50% matrix AA values for P and B25 (PB25–50PA), T6 was as T1 + P + PA with 100% matrix AA values for P (P-100PA). Feed and water were provided *ad libitum*. The experimental period lasted 44 d. Data were analyzed as CRD. Results were as follows: Final body weight (kg/bird) ($P < 0.05$) T1, 2.836^{c}, T2, 2.846^{bc}, T3, 2.860^{abc}, T4, 2.900^{a}, T5, 2.824^{c}, T6, 2.892^{ab}. Feed intake (kg/bird) ($P < 0.001$); T1, 4.859^{b}, T2, 5.047^{a}, T3, 5.049^{a}, T4, $4,999^{a}$, T5, $5,053^{a}$, T6, $5,010^{a}$. Feed conversion ($P < 0.002$); T1, 1.737^{a}, T2, 1.797^{c}, T3, 1.789^{bc}, T4, 1.747^{a}, T5, 1.814^{c},

T6, 1.755[ab]. Anyone of the enzymatic combinations tested, yielded a better feed intake than control treatment (T1), this situation helped the chicks fed some of the treatments added with feed enzymes to get better body weights than the ones fed the control feed (T1), finding that the broilers fed T4 PB25–100PA were 64 g heavier ($P < 0.05$) than the broilers fed the control treatment (T1) with no enzymes.

Key Words: broiler, enzymes, phytase, carbohydrase, protease

60 Effect of xylanase on performance of starter broilers fed diets containing maize harvested in different regions. H. V. Masey O'Neill*[1] and N. Liu[2], *[1]AB Vista Feed Ingredients, Marlborough, Wiltshire, UK, [2]Henan University of Science and Technology, Luoyang, China.*

Maize composition and physical characteristics vary with geography, agronomic inputs, environment and variety. It is thought that this may affect the nutritional value and response to dietary enzyme addition. The objective of this study was to investigate the effect of a commercially available xylanase on the growth performance of starter broilers fed diets containing maize of one variety, harvested in different regions in China. Samples of the maize were harvested in 2010 from 5 geographically diverse regions: Heilongjiang, Henan, Sichuan, Xinjiang and Zhejiang. Each test maize was fed individually in a mash diet as follows. Diets were formulated as (g/kg) test maize 608.3; SBM 324.1; poultry fat 25.2; salt 4.6; met 2.6; lys 1.6; thr 0.5; limestone 9.7, dical 18.4; vit/min 5.0; CP 210 and ME (kCal/kg) 3085. Each maize diet was fed with or without xylanase at 16,000U/kg. The diets were fed to 720 Arbor Acres broilers with 6 replicates, each containing 12 birds, per treatment, from 0 to 18 d of age. Data was analyzed as a 5 (test maize) x 2 (□/− xylanase) factorial design. Pen was the experimental unit. The results showed that there was no effect of harvest region on the FI, BWG or FCR of the broilers over the 18 d period ($P = 0.959$, 0.926, 0.819 respectively). There was a significant improvement in all parameters with the addition of xylanase (FI $P = 0.011$; BWG and FCR $P < 0.001$ in each case). There was no interaction between harvest region and xylanase addition (FI $P = 0.629$; BWG $P = 0.482$; and FCR $P = 0.736$). The broilers performed well according to the breed guidelines, with slightly increased FI, increased BWG and similar FCR before the addition of xylanase. When FCR and BWG were analyzed with FI as a covariate, xylanase addition remained significant suggesting that the improvement in BWG and FCR was driven by an increase in digestibility and nutrient availability.

Key Words: broiler, maize, performance, xylanase

61 Interaction of heat-resistant β-mannanase feed enzymes with broiler chickens infected with Eimerian parasites. D. M. Anderson*[1], H.-Y. Hsiao[1], K. Schuster[1], T. Holder[3], J. Engel[1], S. Fitz-Coy[2], and L. Liu[1], *[1]ChemGen Corp., Gaithersburg, MD, [2]Intervet/Schering Plough, Millsboro, DE, [3]Allen Family Foods, Seaford, DE.*

A β-mannanase feed enzyme (Hemicell HT) has been developed with intrinsic heat, acid and protease resistance (Hsiao et al. JAM, Denver, July 15, 2010). This enzyme was further improved providing a half-life in solution of 15 min at 96.5°C while still retaining full activity at 40°C. In 2 separate cage experiments birds were infected with *Eimeria* sp. both with and without heat tolerant β-mannanase in the diets. The heat tolerant β-mannanases were heated at 75°C to inactivate other enzyme activities in the preparations before use. In one experiment using Ross 708 broilers (8 per cage and 8 replicate cages per treatment) were infected with either *E. tenella* or *E. maxima* at d 2 through the feed and water. Total feces were collected from each cage during d 8–10, blended, and the oocysts per gram feces were counted. In a second cage experiment with Cobb × Cobb broilers (6 per cage and 6 replicate cages per treatment) birds were infected by gavage at d 13 with a mixture of *E. acervulina*, *E. maxima*, and *E. tenella*. On d 18–20 total feces were collected from each cage and oocysts per gram feces were also measured. In this case an additional control with Salinomycin medicated feed was used, as well as comparison of 4 mannanase types including enzymes of bacterial and fungal origin. In both experiments with either the Ross 708 or Cobb × Cobb broilers, the average oocyst counts from the first replication cycle were reduced in the birds that received the heat resistant mannanase containing feed. Among the β-mannanase enzymes tested, the best growth parameters were observed with the most heat resistant version fed to the infected birds.

Key Words: β-mannanase, feed enzyme, heat resistant, *Eimeria* sp., infection

62 Energy contribution of digestible starch, fat, and protein in response to combinations of exogenous xylanase, amylase, and protease in corn-based broiler diets. L. F. Romero*[1], P. W. Plumstead[1], and V. Ravindran[2], *[1]Danisco Animal Nutrition, Marlborough, UK, [2]Massey University, Palmerston North, New Zealand.*

The contribution of substrates on the energy responses to exogenous enzymes in poultry diets is not entirely understood. One study with 21-d-old Ross-308 males was performed to evaluate starch, fat, and protein digestibility effects of xylanase and amylase without (XA) or with protease (XAP) in 2 broiler diets using a 3 × 2 factorial design with 6 replicate cages of 5 birds per treatment. Diets were based on corn and soybean meal (CS) or CS with 10% DDGS and 5% canola meal (mixed diet), and were fed from 0 to 12 d of age. At 12 d, 3 different enzyme treatments were applied to each diet: a negative control with 500 FTU/kg phytase (NC); NC with XA, or NC with XAP (Axtra XAP, Danisco Animal Nutrition). At 21 d, birds were euthanized. Ileal digesta was collected, pooled per cage, and analyzed to determine apparent digestibility of starch, fat, and protein. Data were analyzed with a generalized linear model. Significant differences were assessed at $P < 0.05$. Both XA (+2.1%) and XAP (+2.0%) increased starch digestibility compared with the control diets (94.6%) without a significant interaction between enzyme and diet. XA (+7.5%) and XAP (+7.3%) also increased fat digestibility compared with the control diets (85.4%) without a significant interaction. Protein digestibility increased gradually from the NC (82.0%) to the XA (+3.2%) and the XAP treatment (+5.2%) in both diets. In mixed diets, ileal energy digestibility improvements of enzymes were primarily provided by protein (XA: 40.1 kcal/kg; XAP: 62.2 kcal/kg), followed by fat (XA: 34.5 kcal/kg; XAP: 35.1 kcal/kg), and starch (XA: 24.6 kcal/kg; XAP: 18.2 kcal/kg). In CS diets, the relative energy contribution of starch (XA: 36.1 kcal/kg; XAP: 39.7 kcal/kg), fat (XA: 19.9 kcal/kg; XAP: 17.8 kcal/kg) or protein (XA: 27.2 kcal/kg; XAP: 48.6 kcal/kg) in response to enzymes depended on the enzyme combination, with a greater energy contribution from protein only when protease was present. Energy contribution from starch, fat and protein was clearly determined by differences on digestibility and substrate availability between diets.

Key Words: broiler, starch, fat, protein, enzyme

63 Evaluating the efficacy of enzymes under varying levels of dietary fat inclusion in broiler diets. J. D. Hamburg* and A. B. Batal, *University of Georgia, Athens.*

The objective of this study was to determine the efficacy of 2 different enzymes in diets with various levels of fat inclusion. A 4 × 3 factorial study was conducted in which a standard corn-SBM-DDGS diet was fed to broilers for 28 d for performance and AME determination and also to roosters for TME_N determination. There were 4 levels of supplemental fat: 0, 1, 2, and 3% and 3 levels of enzyme: no enzyme, a xylanase at 0.2lbs/ton, and a β-glucanase at 0.2lbs/ton. Diets were formulated to meet the birds digestible amino acid requirements; however the ME of the diets varied with fat inclusion. The calculated ME of the control diet (0% fat and no enzyme) was 2,900 kcal/kg and the ME increased 84 kcal/kg for every 1% inclusion of fat. The rooster assay was a traditional precision-fed rooster assay in which 8 birds per diet were fasted for 24 h then crop intubated with 35g of the test diets. Excreta was then collected for 48 h for AME determination. The broiler performance assay used 1152 Cobb 500 male chicks, obtained on day of hatch. They were placed in 72 floor pens and fed a standard broiler starter diet until d 14. At 14 d of age 6 replications of 16 chicks were weighed and assigned to one of the 12 dietary treatments. Body weight was measured at d 14, 21, and 28. Feed intake was measured and illeal contents were collected at d 21 and 28. The TME_N and AME values of the diets increased as fat inclusion in the diets increased. Body weight decreased with the addition of fat in all treatments until 3% fat inclusion where there was a slight increase. Feed intake decreased with the addition of fat to the diet in all treatment groups. Feed efficiency was variable but was not significantly different within or between treatments due to the decreased BW and FI. The efficacy of the enzymes on releasing energy and increasing the TME_N and AME values improved as the inclusion of fat increased. Based on the results of these studies, fat inclusion levels in the diet appear to have an effect on enzyme efficacy.

Key Words: broiler, fat, xylanase, beta glucanase

64 Effect of a protease on the digestibility of amino acids and the energy value of canola meal in starter broilers. S. Gómez*[1,2], M. L. Angeles[1], E. Ramírez[1,2], and S. Fernández[3], *[1]CENIDFyMA-INIFAP, Ajuchitlán, Querétaro, México., [2]FESC-UNAM, Ajuchitlán, Querétaro, México., [3]DSM Nutritional Products México SA de CV, El Salto, Jalisco, México.*

An experiment was carried out to evaluate the effect of a protease on the apparent ileal (AID) and apparent fecal (AFD) amino acid (AA) digestibility and the apparent metabolizable energy corrected to zero nitrogen retention (AMEn) of canola meal (CM) in broilers from 13 to 21 d of age. One hundred and 20 13 d old, male B308 Ross chicks, were randomly assigned to 4 treatments in a complete randomized design with a factorial arrangement of 2 dietary treatments x 2 levels of a protease (Ronozyme ProAct). The dietary treatments were as follows: 1. Basal diet: formulated with corn and soybean meal and nutrient content according to the recommendations of Ross for broilers from 15 to 28 d of age. The dietary nutrient content was as follows: 3141 kcal of ME/kg of feed, 1.05% of digestible lysine, 0.90% of Ca and 0.45% of available P; 2. As 1) plus 200 g/ton of protease; 3. 30% of the basal diet was replaced by 30% CM; and 4. As 3) plus 200 g/ton of protease The AMEn was calculated for the diets and CM and the ileal or fecal output of AA and the AID and AFD of AA were estimated using the substitution method. Results were subjected to ANOVA. The AID of Lys, Trp, Thr, Arg, Ile, Val, Leu and His were higher ($P < 0.05$) on the Basal than on the Basal + CM diet. Also, the AFD of Lys, Trp, Met, Val, Leu and His were higher ($P < 0.05$) on the Basal than on the Basal + CM diet. The AID of all AA on the Diets and CM was arithmetically improved by the addition of Protease. The average AFD of Lys was improved ($P < 0.05$) across all diets by Protease as well as the AFD of Lys in CM ($P < 0.05$). In addition, protease increased the AMEn of CM from 2181 to 2287 kcal/kg. In summary, the results suggest that the availability of amino acids and the energetic value of diets formulated with canola meal can be enhanced by the addition of a protease.

Key Words: starter chicks, canola meal, AA digestibility, protease

65 Effect of a protease on the digestibility of amino acids and the energy value of distillers dried grains with solubles in starter broilers. S. Gómez*[1,2], M. L. Angeles[1], E. Ramírez[1,2], and S. Fernández[3], *[1]CENIDFyMA-INIFAP, Ajuchitlán, Querétaro, México., [2]FESC-UNAM, Ajuchitlán, Querétaro,México., [3]DSM Nutritional Products México SA de CV, El Salto, Jalisco, México.*

An experiment was carried out to evaluate the effect of a protease on the apparent ileal (AID) and apparent fecal (AFD) amino acid (AA) digestibility and the apparent metabolizable energy corrected to zero nitrogen retention (AMEn) of distillers dried grains with solubles (DDGS) in broilers from 13 to 21 d of age. One hundred and 20 13 d old, male B308 Ross broilers were allocated in groups of 3 in individual crates. Broilers were randomly assigned to 4 treatments in a complete randomized design with a factorial arrangement of 2 dietary treatments x 2 levels of a protease (Ronozyme ProAct). The dietary treatments were as follows: 1. Basal diet: formulated with corn and soybean meal and nutrient content (3141 kcal of ME/kg of feed, 1.05% of digestible lysine, 0.90% of Ca and 0.45% available P) according to the recommendations of Ross for broilers from 15 to 28 d of age; 2. As 1) plus 200 g/ton of protease; 3. 30% of the basal diet was replaced by 30% DDGS; and 4. As 3) plus 200 g/ton of protease. Feed was offered ad libitum during 9 d and the last 4 d excreta was totally collected every 24 h. At the end, all birds were killed to collect the ileal content. The experimental unit was 2 adjacent crates with 6 chicks and there were 5 replicates per treatment. The AMEn was calculated for the diets and DDGS and the ileal or fecal output of AA and the AID and AFD of AA were estimated using the substitution method. Results were subjected to ANOVA. The AID of Lys, Thr, Arg, Ile, Val, Leu, His and Tyr was higher ($P < 0.05$) on the Basal than on the Basal + DDGS diet. Also, the AFD of Lys, Met, Trp, Val, Leu and His was higher ($P < 0.05$) on the Basal than on the Basal + DDGS diet. The AID of all AA on the Diets and DDGS was arithmetically improved by the addition of Protease. The average AFD of Lys was improved ($P < 0.05$) across diets by Protease. Protease improved the AMEn of DDGS from 2859 to 2948 kcal/kg. The results suggest that the availability of amino acids and the energetic value of diets formulated with DDGS could be enhanced by the addition of a protease.

Key Words: starter chicks, DDGS, AA digestibility, protease

66 Effect of pH of alkaline salts of fatty acids on the inhibition of bacteria associated with poultry processing. A. Hinton Jr.* and K. D. Ingram, *Russell Research Center, Athens, GA.*

The agar diffusion assay was used to examine the effect of pH on the ability of alkaline salts of 3 fatty acids (FA) to inhibit growth of bacteria associated with poultry processing. FA solutions were prepared by dissolving 0.5 M concentrations of caprylic, capric, or lauric acid in separate aliquots of 1.0 M potassium hydroxide (KOH). Citric acid was added to the FA-KOH mixtures to reduce the pH of separate portions of the solutions to 9.5, 10.5, 11.5, 12.5, or 13.5. Solutions were sterilized by passage through 0.2 µm filters. Agar media was then prepared, sterilized, tempered to 50°C, and inoculated with 10^6 colony-forming-units/ml of *Campylobacter jejuni, Escherichia coli*, or *Salmonella* Typhimurium. Inoculated agar was poured into Petri dishes and allowed to solidify. Wells were made in solidified agar, and 0.1 mL of FA-KOH solutions was added to separate wells. Inoculated agar plates were incubated, and zones of inhibition of bacterial growth around the wells filled with FA-KOH mixtures were measured. Results indicated that reducing the pH of caprylic acid-KOH to 13.5 and the pH of capric acid-KOH mixtures to 12.5 produced significant ($P < 0.05$) decreases in the size of zones of inhibition of *C. jejuni*, but reducing the pH of these solutions to 9.5 produced no differences in the size of zones of inhibition of *E. coli*. However, while lowering the pH of caprylic acid-KOH solutions to 13.5 produced a significant reduction in the size of zones of inhibition of *Salmonella* Typhimurium, decreasing the pH of capric acid-KOH mixtures did not result in changes in the size of zones of *Salmonella* Typhimurium. Lowering the pH of lauric acid-KOH solutions to 12.5 produced significant decreases in the size of the zones of inhibition of all 3 isolates. Findings demonstrated that the pH of solutions of alkaline salts of FA may play a role in the antibacterial activity of these surfactants toward bacteria associated with poultry processing. Therefore, the pH of FA-KOH mixtures should be considered when formulating these solutions for use as poultry processing sanitizers.

Key Words: caprylic acid, capric acid, lauric acid, potassium hydroxide, agar diffusion assay

67 Microbiological quality of water-immersion and air-chilled broilers. K. Janardhanan*, L. Zhang, J. Y. Jeong, E. T. Ryser, and I. Kang, *Michigan State University, East Lansing.*

Carcass chilling during broiler processing is a critical step in preventing growth of both pathogenic and spoilage bacteria. The objective of this study was to compare the microbiological quality of air- and water-chilled broiler carcasses processed at the same commercial facility. For each of 4 replications, 15 broilers were collected from the same commercial processing line after evisceration, after spraying with cetylpyridinium chloride (a cationic disinfectant), and after air chilling (AC) or water immersion chilling (WIC). All carcasses were quantitatively examined for mesophilic aerobic bacteria, *Escherichia coli*, coliforms, and *Campylobacter* as well as for the presence of *Salmonella* and *Campylobacter*. No significant differences ($P > 0.05$) were seen between air and water chilling for *E. coli* or coliforms, or for the incidence of *Salmonella* and *Campylobacter*. Lower numbers of *Campylobacter* were recovered from WIC as opposed to AC carcasses ($P < 0.05$), but the incidence of *Campylobacter* on WIC carcasses was similar, suggesting that some *Campylobacter* were injured rather than killed during WIC. In-line spraying with the disinfectant effectively decreased the incidence of *Salmonella* and *Campylobacter* on pre-chilled carcasses; however, cells presumably injured by the sanitizer recovered during chilling. Therefore, on-farm intervention strategies remain critically important in minimizing the spread of microbial contaminants during processing.

Key Words: poultry, air chill, water chill, *Salmonella*, *Campylobacter*

68 Effects of modified atmospheric packaging (MAP) on safety and quality of breast fillets and drumsticks. T. Yalamanchili*[1], V. K. Sunkara[2], L. D. Thmopson[2], and C. Z. Alvarado[1], *[1]Texas A&M University, College Station, [2]Texas Tech University, Lubbock.*

Packaging system of fresh meats may help restrict the growth of microorganisms and maintain the freshness. Two of the most commonly used packaging in retail are overwrap and vacuum pack. However, the use of mixed gases in MAP containing carbon monoxide, carbon dioxide or nitrogen has been less investigated. Therefore, the objective of this research is to determine the effect of the 3 gases on safety and quality of skinless boneless breast fillets (BF) and skin-on bone-in drums (DR) stored at 4C for 3, 7 and 14 d. Treatments included: (1) overwrap (control) (2) 0.4% CO/30% CO2/69.6% N2, (3) 30% CO2/70% N2, and (4) vacuum. Parameters observed were pH, color, peroxide value (PV), and TBARS for quality while APC on petrifilms, *E. coli*/coliforms and *Salmonella* for safety. Two-strain *Salmonella* cocktail was used to inoculate the sample to a concentration of 10^5 cfu/ml. The pH of CO and vacuum packaged fillets were significantly lower than all other treatments after 14d of storage. The PV for both cuts in MAP treatments were not significantly different on d 7 and 14. However, the TBARS values of the drumsticks on 14d for all treatments were significantly different with CO having the lowest value followed by vacuum and CO2:N2 . On the other hand, color was observed higher in L values on both cuts at 14d for CO and vacuum treatments while hue value of the CO treated packages was significantly lower giving a more red color than all other treatments. The chroma of DR in overwrap was higher than other treatments on 14d while CO and vacuum is higher on BF. The APC at 14d for BF was higher in overwrap than other treatments while DR was higher in APC for CO among treatments. The coliforms however, did not change in CO over time as compared with other treatments. As for *Salmonella*, the count was highest for vacuum and lowest for CO and overwrap for both BF and DR. These results indicate that MAP packaging may be beneficial in increasing the quality and safety of poultry products, and with the inclusion of 0.4% CO to the gas mixture, it may even be more beneficial to the producers and retailers.

Key Words: carbon monoxide, packaging, *Salmonella*, color, pH

69 Characterization of a commercial poultry chiller. J. C. Butler* and P. A. Curtis, *Auburn University, Auburn, AL.*

Poultry is the number one agriculture commodity in Alabama, with more than 1.07 billion chickens produced in 2007 (USDA-NASS, 2008). Over 55,000 Alabamians are currently employed by the poultry industry, allowing this industry to contribute approximately 10% to the state's economy (Alabama Poultry and Egg Association, 2008). Since the implementation of HACCP in 1998, water usage per bird has jumped from 5–6 gallons per bird to as much as 9 gallons. If a drought is severe enough, the plant could potentially face cutbacks and even

temporary closings. This research focuses on the potential extended use of chiller water past the typical 2 processing shifts while it retains the ability to be an effective food safety intervention step. It could also lead to a decrease in the amount of waste water a plant makes, which would also lower costs significantly. Chiller water samples were taken every 3 h for 15 h into a processing shift. Samples were then analyzed for *Enterobacteriaceae*, total plate count, chemical oxygen demand (COD), pH and temperature. Other data, such as flow rate and antimicrobial utilized, were also recorded. The sampling was further separated by prechill chiller and the actual chiller. Results show that microbial counts were not affected by time, but were affected by location within the chiller. The microbial counts were also highly correlated with one another. COD levels remained constant after hour 9. Further research is being performed on additional Alabama processing plants as a continuation of the study.

Key Words: chiller, *E. coli*, chemical oxygen demand, poultry

70 The microbial differences between male vs. female broiler litter environments. D. L. Everett*, C. D. McDaniel, and A. S. Kiess, *Mississippi State University, Mississippi State, MS.*

Few studies have tested the microflora of litter when male and female broilers are raised separately. If differences in the number of bacteria do exist, management strategies that improve the litter environment can be established. The objective of this study was to compare the level of bacteria, yeast and mold in litter where male, female, or straight-run broilers have been raised. A total of 216 sexed broilers were placed into 18 different pens (6 pens/3 treatments) filled with fresh pine shavings. A sample of litter (100 g) was collected on d 0, 21, 28 and 31. Ten grams of each pooled litter sample was diluted 1:10 in buffered peptone water and then serial diluted. One hundred microliters from each dilution was plated onto anaerobic agar, sarboraud dextrose agar, or MacConkey agar in duplicate to culture anaerobes, yeasts and molds, and total coliforms, respectively. Plates were incubated for 24 h at 37°C either aerobically or anaerobically. After 24 h of incubation, plates were counted. Data was analyzed using a randomized complete block design with a split plot over days and sex. Means were separated using Fishers protected least significant difference test. Statements of significance were based on $P < 0.05$. No microbial difference in the litter environments between the different broiler sexes was observed. Anaerobic counts from male, female, and straight-run treatment pens were 6.81, 6.86, and 6.58 mean log cfu, respectively. Yeast and mold growth for male, female and straight-run treatment pens were 6.68, 6.68, and 6.66 mean log cfu, respectively. Total coliform counts for male, female, and straight-run treatment pens were 6.21, 6.09, and 6.14 mean log cfu, respectively. In conclusion, raising straight-run broilers can provide broiler producers with a litter environment that is just as safe as a litter environment where male and female broilers are raised separately. Also, by placing straight-run broilers flocks, broiler producers are making a more economical choice since sexing broiler chick requires additional time and labor costs.

Key Words: male, female, straight-run, microflora, litter

71 Caprylic acid reduces *Salmonella* Enteritidis invasion of avian abdominal epithelial cells in vitro and down-regulates virulence gene expression. A. Kollanoor-Johny*[1], M. J. Darre[1], D. J. Donoghue[2], A. M. Donoghue[3], and K. Venkitanarayanan[1], *[1]University of Connecticut, Storrs, [2]University of Arkansas, Fayetteville, [3]USDA-ARS, Fayetteville, AR.*

Salmonella Enteritidis (SE) is a major food-borne pathogen transmitted through poultry products. Since chickens serve as the reservoir host of SE, reducing the cecal carriage of the bacterium in chickens would decrease contamination of meat and eggs with this pathogen. The first step in SE colonization of chickens involves bacterial invasion of intestinal epithelial cells. Reducing this critical step could decrease the carriage of SE in chickens and ultimately human illness caused by the pathogen. We previously found that the feed supplemented with caprylic acid (CA), a GRAS-status, natural, 8-carbon fatty acid reduced SE colonization in 18-d old and market-age commercial, broiler chickens. To elucidate the potential mechanism of antibacterial action of CA, we investigated the efficacy of sub-inhibitory concentration (SIC, concentration not inhibiting bacterial growth) of CA (10 mM) in reducing SE invasion of cultured avian abdominal epithelial cells. Confluent monolayers of budgerigar abdominal tumor (BAT) cells grown in 24-well tissue culture plates (~10^6 cells/well) were inoculated with SE (multiplicity of infection of ~1:10), followed by the addition of CA. The samples were incubated at 37°C with 5% CO_2 for 2 h and SE that invaded the epithelial cells was enumerated using gentamicin protection assay. In follow up studies, the effect of CA on the expression of SE invasion gene transcriptional activator, *hilA* and Salmonella Pathogenicity Island-1 regulator, *hilD* was investigated, using real-time quantitative PCR (RT-qPCR). All experiments were replicated 3 times. Caprylic acid significantly ($P < 0.05$) reduced SE invasion of BAT cells by 60–90%. RT-qPCR data revealed that CA significantly ($P < 0.05$) downregulated *hilA* and *hilD* expression, compared with controls. The results suggest that CA reduces the pathogen's ability to invade intestinal epithelial cells by downregulating key SE virulence genes, *hilA* and *hilD*.

Key Words: *Salmonella*, cell culture, invasion, hilA, hilD, gene expression

72 Effect of food-grade carvacrol on cecal *Salmonella* Enteritidis colonization and cloacal shedding in 19-day-old commercial broiler chicks. A. Kollanoor-Johny*[1], T. E. Mattson[1], S. A. Baskaran[1], M. A. R. Amalaradjou[1], M. J. Darre[1], M. I. Khan[1], D. J. Donoghue[2], A. M. Donoghue[3], and K. Venkitanarayanan[1], *[1]University of Connecticut, Storrs, [2]University of Arkansas, Fayetteville, [3]USDA-ARS, Fayetteville, AR.*

Salmonella Enteritidis (SE) is a major food-borne pathogen transmitted through poultry products. Chickens serve as the reservoir host of SE; reducing the cecal carriage and shedding of the bacterium in chickens would decrease contamination of meat and eggs. This study investigated the efficacy of feed supplemented with carvacrol (CR), a plant-derived, GRAS molecule, for reducing SE colonization in 19-d old broiler chicks. In 3 separate trials, day-old chicks (n = 65 per trial) were randomly assigned to 5 groups (n = 13 per group): CR control (no SE, 0.9% CR), positive control (SE, no CR), negative control (no SE, no CR), treatments (SE, 0.6 or 0.9% CR). Water and feed were provided *ad libitum*. At 9 d of age, birds were inoculated with ~8.0 $\log_{10}$ cfu of a 4-strain mixture of nalidixic acid resistant SE. After 24 h, 3 birds from each group were sacrificed to ensure colonization with SE. Ten birds from each group were euthanized 10 d after SE challenge, and pathogen populations in the cecum and cloaca were enumerated. CR at 0.9% reduced cecal and cloacal SE counts by ~4 $\log_{10}$ cfu/g in trial 1 ($P < 0.05$), and decreased SE by 1.4 $\log_{10}$ cfu/g of cloacal contents ($P < 0.05$) with no reduction in cecal SE in trial 2. In trial 3, 0.9% CR reduced cecal SE by 0.9 $\log_{10}$ cfu/g ($P < 0.05$) with no change in cloacal SE populations. Carvacrol at 0.6% decreased cecal SE counts by 1 $\log_{10}$ cfu/g and 2 $\log_{10}$ cfu/g in the first and second trials ($P <$

0.05), respectively. However, in trial 3, no reductions in cecal SE populations were observed. Feed intake and body weight were not significantly different ($P > 0.05$) between CR-treated and control groups. The results suggest that CR supplementation had an inconsistent effect on SE colonization in broiler chicks, and further studies in market-age broiler birds are underway.

Key Words: *Salmonella*, carvacrol, chicks, colonization, antibacterial

73 Hypothesis: A role for the mouse as an amplifier of *Salmonella enterica* on-farm. J. Guard*[1], R. Sanchez-Ingunza[1], B. Ahmer[2], M. McClelland[3], and D. Henzler[4], *[1]United States Department of Agriculture, Athens, GA, [2]The Ohio State University, Columbus, [3]The Vaccine Research Institute of San Diego, San Diego, CA, [4]Private practice, Fairmont, WV.*

The presence of the mouse in the environment of the hen has been consistently identified as a risk factor for the contamination of eggs by *Salmonella enterica* serovar Enteritidis (SE). To address how much risk the mouse poses for egg contamination, the spleens and intestines of mice caught on-farm from January 1999 to July 2002 were cultured for recovery of Salmonellae. Of the 933 mice that were caught in 42 hen houses, 1 of every 2.2 houses (45.2%) was positive for SE. More mice were recently collected in winter of 2010 from 15 houses spanning 2 states. These houses had not been reported as having problems with egg contamination. One (1) of 15 houses (6.7%) yielded one positive mouse of 31 total sampled. The positive mouse came from a house that had been already been identified by the producer as needing more aggressive rodent control, because it had been noticed that mice seemed to be increasing in the house. It was one of 11 captured and none of the other 14 houses yielded more than 3 mice during the capture period. Finally, an additional molecular biology experiment was conducted to see if chickens and mice had different patterns of infection. To do this, chickens and mice were experimentally infected with a library of mutants to compare the ability of each host to overcome founder population effects following oral infection with *Salmonella enterica*. This approach evaluates if statistically significant replication occurs post-exposure within a given host. Founder populations were surpassed within the mouse, but not in the chicken. Although the difficulties in comparing infection dynamics across time and across genera is admitted, evidence supports the hypothesis that the mouse, in contrast to the chicken, is a vector of amplification for *Salmonella enterica* on-farm. In addition, sampling of mice in 2 time frames nearly a decade apart provides some guidance as to how badly mice could contribute to the risk of egg contamination. Approaching the mouse as a vector that poses especially high risk for egg contamination facilitates improving the safety of eggs by guiding allocation of resources and application of best practices.

Key Words: *Salmonella*, epidemiology, chicken, egg, rodent

74 Impact of litter *Salmonella* on the recovered *Salmonella* from broiler crop and ceca following feed withdrawal. R. J. Buhr*, A. Hinton Jr., J. A. Cason, N. A. Cox, D. V. Bourassa, and L. L. Rigsby, *USDA-ARS Russell Research Center, Athens, GA.*

To evaluate the impact of litter *Salmonella* status during feed withdrawal, 2 pens of broilers (n = 10/pen) in separate rooms were challenged with marker strains of either *Salmonella* Montevideo (nalidixic acid resistant) or *Salmonella* Heidelberg (streptomycin resistant) by gavage. Three d post-challenge 1 pen of broilers for each *Salmonella* strain was switched and all pens subjected to a 12 h feed withdrawal. The litter surface of each pen was sampled by stepped-on drag swabs before switching broilers and after the feed withdrawal period. Broilers were euthanized and the crop and ceca were aseptically removed for *Salmonella* isolation following enrichment and streaking onto both Brilliant Green Sulfa (BGS)+nalidixic acid (200ppm) and BGS+streptomycin (200ppm). For broilers that remained in challenged pens, only the challenge *Salmonella* was recovered from the litter before and following feed withdrawal. For the switched broilers, *S.* Heidelberg was recovered from litter in each pen in both trials and *S.* Montevideo was recovered from both pens in one trial. Broilers challenged with *S.* Heidelberg that remained in their pens only had *S.* Heidelberg recovered from crops and ceca 20/20. From the broilers challenged with *S.* Montevideo that remained in their pens, only challenge *Salmonella* strain was recovered from crops 3/20 and ceca 13/20. Those broilers challenged with *S.* Heidelberg and switched to S. Montevideo pens had only *S.* Heidelberg recovered from the crops 20/20 and ceca 18/20. In contrast, for broilers challenged with *S.* Montevideo and switched into *S.* Heidelberg pens, their crops had either *S.* Montevideo or *S.* Heidelberg recovered from 4/20, but only *S.* Montevideo recovered from the ceca 16/20. *S.* Heidelberg remained colonized in 100% of challenged broiler crops and ceca and when exposed to *S.* Montevideo in the litter during feed withdrawal, *S.* Montevideo was unable to colonize. Colonization of the crop during feed withdrawal by *Salmonella* appears to depend on the challenge and litter *Salmonella* status. However, ceca *Salmonella* status following feed withdrawal appears only influenced by the challenge *Salmonella*.

Key Words: *Salmonella*, litter, feed withdrawal, crop, ceca

75 Prevalence of pathogens associated with eggs and the environment of conventional cage and free range egg production. D. R. Jones*[1], K. E. Anderson[2], and J. Y. Guard[1], *[1]USDA Agricultural Research Service, Egg Safety and Quality Research Unit, Athens, GA, [2]Department of Poultry Science, North Carolina State University, Raleigh.*

Alternative egg production methods are becoming more popular with US consumers. As the drive to expand the retail shell egg market to accommodate consumer shifts proceeds, a need arises for additional information to ensure processing methodologies result in safe eggs from all egg sources. A study was conducted to determine if there were differences in the prevalence of *Salmonella*, *Listeria*, and *Campylobacter* on and within eggs and in the environment of a sister flock of conventional cage and free range laying hens. Microbial sampling occurred approximately every 6 weeks between 20 and 79 wks of age. There was a significantly greater ($P < 0.0001$) prevalence of *Campylobacter* present in the free range nest boxes (NBS) compared with free range grass (FRG) and conventional cage swab (CS) samples (number of positives: 8 NBS; 1 FRG; 0 CS). Seven isolates of *Listeria innocua* were detected with no significant difference in prevalence between the treatments. Isolates were associated with egg shells (2 free range floor; 1 cage) and the free range environment (2 NBS; 2 FRG). There were 21 *Salmonella* isolates detected between all sample locations. There was no significant difference in the prevalence of *Salmonella* detection between the treatments. Additional studies are needed to fully understand the impact of alternative production methods on the prevalence of pathogens in nest run eggs.

Key Words: egg, microbiology, conventional cage, free range, environmental

76 Nicarbazin residues in commercially raised broilers. K. Bafundo*[1], P. Stayer[2], A. MacDonald[3], and R. Lee[1], *[1]Phibro Animal Health Corp., Ridgefield Park, NJ, [2]Sanderson Farms Inc., Laurel, MS, [3]Pharma Science Inc., North Caldwell, NJ.*

In the last year much discussion has taken place on the level of acceptable nicarbazin residues permitted in US broilers destined for export to Russia. While no official notification of residue limits has been published, US broiler producers have commonly discussed a residue limit of 1ng/g (1 ppb) for meat intended for this market. Due to limitations in assay technology, nicarbazin residues in the range of 1 ppb had never been measured before 2010. As a result of this situation, an experiment was conducted to determine the levels of nicarbazin residues in broiler meat when the drug was fed at 100 ppm (with bacitracin MD and roxarsone) for a 14-d period in a commercial environment. Nicarbazin residues were measured in leg quarter meat approximately every 4 d over a 50-d period following nicarbazin exposure. Leg quarter meat was sampled and analyzed for nicarbazin residues using HPLC MS/MS techniques. Results indicated that for the first 7 d following nicarbazin withdrawal, residues in muscle meat decreased from 1223 ppb at d 0 to 6.75 ppb at d 7. By 18 d post nicarbazin feeding, residues of 2.3 ppb were recorded. At 22 d withdrawal, residues below 1 ppb (0.736 ppb) were first observed. Subsequent residues values measured up to 46 d withdrawal were all in the approximate range of 1 ppb. At 2 time points (28 and 50 d post nicarbazin withdrawal) muscle residue values slightly exceeded the 1 ppb limit (1.1 and 2.3 ppb, respectively). The results of this test indicate that under commercial conditions nicarbazin residues of approximately 1 ppb can be achieved with an appropriate withdrawal period. Periodically however, it is possible that residue values can exceed the 1 ppb limitation. We suggest that consumption of nicarbazin-containing feed particles in the litter during the withdrawal period probably accounted for the slight increase in residue values at 28 and 50 d withdrawal.

Key Words: nicarbazin, residues, coccidiosis, anticoccidial

Case Reports

77 The toxicity effects of feeding 1-alpha hydroxy D3 to broiler breeding hens. B. Rings*, F. Hoerr, S. Gustin, and J. Halley, *Cobb-Vantress.*

AAAP abstract†

78 A natural outbreak of toxoplasmosis in a backyard flock of guinea fowl in Mississippi. K. Holloway Jones*, F. D. Wilson, S. D. Fitzgerald, and M. Kiupel, *Poultry Research and Diagnostic Laboratory, College of Veterinary Medicine, Mississippi State University, Pearl.*

AAAP abstract†

79 Increased mortality and lameness in male broiler breeders prior to peak production associated with *Staphylococcus aureus*. M. P. Martin*, A. McRee, K. M. Robbins, L. B. Borst, K. L. Anderson, P. Jay, and H. J. Barnes, *North Carolina State University, College of Veterinary Medicine, Raleigh.*

AAAP abstract†

80 Diagnosis: MG/MS in a backyard flock. Is control possible? P. S. Wakenell* and D. Wilson, *Purdue University Animal Disease Diagnostic Laboratory.*

AAAP abstract†

81 Necrotizing hepatitis in pigeons due to *Toxoplasma gondii*. R. Fulton* and M. Kiupel, *Michigan State University.*

AAAP abstract†

82 A good case for insomnia: Bedbug infestation in broiler breeders. S. A. Hubbard*, J. Cater, and D. L. Magee, *Mississippi State University Poultry Research & Diagnostic Laboratory.*

AAAP abstract†

83 Hemorrhagic proventriculitis and ventriculitis in layer pullet chicks. C. Gabriel Sentíes-Cué*, J. Kelly, and B. R. Charlton, *California Animal Health and Food Safety Laboratory System, Turlock, CA, School of Veterinary Medicine, University of California, Davis.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Current Regulatory Status and Use of Antibiotics in the Poultry Industry Symposium

84 Consumer costs in relation to alternative production systems. H. Thesmar*, *National Turkey Federation, Washington, DC.*

Changing the current policy and regulatory framework of antibiotic use in agriculture could have a major impact on the availability of animal proteins, and ultimately the cost to consumers. In this session, we will explore the potential immediate and long-term effects of changes to the regulations on antibiotic use in the poultry industry. We will look at cost differences of current products on the market. Questions that will be addressed include: What will proposed changes do to availability of poultry products? What will proposed changes do to the cost of products? What will happen to the premium product market?

Key Words: poultry, antibiotic, regulatory, cost

85 Used responsibly, roxarsone poses no threat. P. Twining*, *Paul Twining Associates Inc.*

Arsenic is an element that is widely distributed in the Earth's crust and in rock, soil, water and air, and is taken up by plants and ingested by animals and humans. It occurs in different forms, including organic and inorganic forms. While chemical compounds containing the inorganic form can be toxic, the organic form does not present such problems. It is normal to find low levels in food products, and these levels will vary in different parts of the country. Studies have shown that seafood has the highest levels of naturally occurring arsenic. It can also be found in meat, poultry, cereal products, fruits and vegetables. The US Food and Drug Administration sets strict limits on arsenic levels in food. Allowable levels in poultry are 0.5 ppm in uncooked muscle and 2 ppm in liver; typical levels are much lower to nondetectable. In contrast, shrimp, crab, lobster and scallops have about 40 ppm on average and an FDA limit of 50 ppm. Some chicken companies use animal health products such as roxarsone (which is not an antibiotic) that have organic arsenic-containing compounds in their makeup. FDA-approved arsenic-containing compounds, such as roxarsone, when used according to label directions, are safe. The purpose of these products is to prevent colonization coccidia, whose presence can cause lethargy, lack of growth, illness, or death in untreated flocks. Roxarsone is effective as an aid in the prevention of coccidiosis in chickens when used in combination with certain anticoccidials. Roxarsone has also been shown to significantly reduce salmonella levels in chickens. Traces of organic arsenic that are sometimes found in broiler meat are not necessarily related to use of animal health products and could be related to naturally occurring arsenic in food and water ingested by the animals. The FDA says the presence of arsenic at these trace levels is not harmful to human health. The facts show that compounds containing organic arsenic are used responsibly and safely by poultry producers. Poultry producers using these products to produce healthy birds are contributing to a healthful food supply for consumers in America and around the world.

Key Words: roxarsone, arsenic, coccidiosis, salmonella, chicken

86 Benefits of antibiotic use in animal agriculture. H. M. Cervantes*, *Phibro Animal Health, Watkinsville, GA.*

Many benefits come from using antibiotic feed additives (AFAs), such as: 1. Prevention of subclinical diseases, like necrotic enteritis (NE). When used to prevent subclinical disease AFAs are sometimes used at subtherapeutic levels. Subclinical NE depresses flock performance and increases condemnations. Research has shown that the effectiveness of an AFA to improve growth rate and feed conversion (FC) is directly related to its ability to control Clostridium perfringens, the causative agent of NE. In the EU the prevalence of enteric diseases and the use of therapeutic antibiotics in food animals have increased significantly since the ban of AFAs. 2. Reduction of human pathogens, by improving flock uniformity, enhancing intestinal strength, minimizing gastrointestinal ruptures during processing, and by reducing shedding of human pathogens, the use of AFAs enhances food safety. Chickens raised without AFAs had a prevalence of Campylobacter spp. much greater than that of chickens raised with AFAs. 3. Improved animal welfare, AFAs were shown to reduce immunologic stress in healthy chickens kept under optimal conditions, their use contributes to the welfare of birds. 4. Improved production efficiency, results from better enteric health and prevention of nutrient degradation by the intestinal microflora. Rather than "growth promoters" AFAs are "health promoters." 5. Preservation and less contamination of the environment, a 0.04 improvement in FC attributed to the use of AFAs in a commercial turkey operation eliminated the need for an additional 5525 tons of feed that without them would have been produced and delivered, and as a consequence, an additional amount of excreta corresponding to the increase in feed tonnage would have been produced and disposed of into the environment. An additional 11050 tons of water would have also been used taking more natural resources from the environment. This is why AFAs enhance the sustainability of animal agriculture and reduce its carbon footprint. 6. Lower prices for the consumer, the use of AFAs enhances production efficiency and the savings from the lower cost of production can be passed on to consumers.

Key Words: antibiotic feed additives, growth promoters

87 Global interventions on antimicrobial use in animal feeds. T. R. Shryock*, *Elanco Animal Health, Greenfield, IN.*

Globally, the administration of antibiotics (excluding ionophores and non-human use antibiotics) via feed to groups of food animals for the purpose of performance or disease prevention has been a contentious and complex food safety and public health issue for over 40 years as evidenced by numerous panels, reports and hearings. The WHO Global Principles document in 2000 provided the first comprehensive path forward for addressing antimicrobials used in food animals with the goal of minimizing the negative public health impact while providing for their safe and effective use in veterinary medicine. Regulatory and legislative interventions for antimicrobial use in animal feeds have been implemented in various ways, not all of which are aligned to the WHO document. The principles recommend that risk-based evaluations be undertaken for antimicrobial growth promoters that belong to antimicrobial classes used in humans. Prevention uses are to be justified and regularly assessed by veterinarians to ensure continued effectiveness and not as a substitute for good herd health management. The EU legislatively mandated discontinuation of performance indications, the US has ongoing regulatory reviews of 2 products, issued its own draft risk assessment for another, and has other initiatives underway. Other countries have risk-based evaluations pending or regulatory or legislative actions put in place to restrict feed antimicrobial use. Whether or not these interventions have actually reduced antimicrobial

resistance in humans attributed to the feed administration in food animals is debatable. It is known that discontinuation of use will result in the loss of the "benefits". Moving forward, it is expected that legislation that seeks to follow the EU example (i.e., remove indications) for feed antimicrobials will continue to be advocated in several countries. Regulation will continue to migrate toward veterinarian oversight of antimicrobial use, with modernization of antimicrobial feed administration practices and risk assessment for product label evaluations. Veterinarians and producers will likely be called upon to comply more fully with responsible use guidelines.

88 The results of Denmark's restriction on antibiotics. S. R. Clark*, *Pfizer Inc.*

In Europe where bans on antibiotic growth promoters in animal agriculture have been adopted to limit on farm antibiotic use, there has been little evidence of improvements in public health. There is global influence of Denmark on current thinking on antibiotic usage in food producing animals. Denmark's DANMAP annual report summarizes antibiotic resistance and volumes data.

Key Words: Europe, DANMAP, antibiotic, resistance

89 Concerns regarding antibiotics and antibiotic resistant bacteria in the environment. R. S. Singer*, *University of Minnesota, St. Paul.*

Development of resistance to antimicrobials is well-documented for some bacteria. To solve the complex problem of reducing resistance, it is necessary to identify activities that are major contributors to the emergence of resistance. The alteration or elimination of these activities could then slow the loss of antibiotic efficacy. Antibiotic use is likely the major selection pressure influencing changes in antibiotic resistance. It must be emphasized, that resistant bacteria can be resistant for reasons entirely independent antibiotic use, including the fact that resistance mechanisms have existed in bacteria long before humans started using antibiotics. The discharge of wastewater from animal agricultural facilities, human sewage treatment plants, hospitals and pharmaceutical plants has been associated with increased levels of zoonotic pathogens as well as increasingly resistant and virulent organisms. Antibiotics are often discharged from these sites. Once in the environment these antibiotics can act as a selection pressure, further influencing the acquisition of resistance genes. All of these possibilities must be considered to identify the causes of resistance and to subsequently estimate the amount of risk attributable to animal antibiotic use. One uncertainty that emerges is the biological significance of the low concentrations of antibiotics found in the water supply. Some studies have found a correlation between increased concentrations of antibiotics and higher levels of antibiotic resistant bacteria and antibiotic resistance genes. However, in a recent study conducted by our laboratory, low levels of chlortetracycline did not appear to select for resistance. Because the pressures that can select for antibiotic resistance in the environment have considerable spatial and temporal heterogeneity, studies that want to investigate the emergence and spread of antibiotic resistance must be carefully designed. In conclusion, there are many factors that affect antibiotic resistance in the water supply. An ecosystem-based approach to antibiotic resistance is the only way in which the myriad of selection pressures and other determinants can be taken into account.

Case Reports

90 Case report: Avian encephalomyelitis in pen-raised Bobwhite Quail. D. Anderson*, *Georgia Poultry Laboratory Network, Oakwood.*

AAAP abstract†

91 Infectious coryza in a commercial broiler breeder flock. G. D. Ritter*, *Mountaire Farms Inc., Millsboro, DE.*

AAAP abstract†

92 Ulcerative enteritis-like disease associated with *Clostridium sordellii* in quail. H. L. Shivaprasad*, M. Franca, and R. Crespo, *CAHFS-Tulare, Tulare, CA.*

AAAP abstract†

93 "Silent" histomoniasis on a brooder farm. M. E. Blakley*, *Butterball.*

AAAP abstract†

94 Otitis externa in chickens due to *Staphylococcus hyicus*? R. Fulton* and J. G. Hunchar, *Michigan State University.*

AAAP abstract†

95 Management procedures used to control ILT on commercial broiler farms. J. Giambrone*, S.-C. Ou, and K. S. Macklin, *Auburn University.*

AAAP abstract†

96 Detailed analysis of 2009-2011 ELISA serological data from the Georgia poultry industry. L. Dufour-Zavala*, L. Chappell, and B. Glidewell, *Ga Poultry Lab Network.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Environment and Management I

97 Effect of diatomaceous earth on bone mineralization in free-range organic laying hens. D. C. Bennett*[1], Y.-J. Rhee[1], D. R. Korver[2], and K. M. Cheng[1], *[1]University of British Columbia, Vancouver, BC, Canada, [2]University of Alberta, Edmonton, AB, Canada.*

Previously we showed that free-range hens fed diets supplemented with diatomaceous earth (DE) were significantly heavier, laid more eggs, and consumed more feed than hens fed the control diet, with no differences in feed efficiency. In the present study, we compared plasma calcium concentrations, and bone mineralization of the hens from our previous study to test the effect of DE on these parameters. Day old pullets of 2 commercial brown egg laying lines (Bovan Brown, Lohmann Brown) were reared indoors until 11 weeks of age, and then transferred to hen-houses with access to outdoor range. Birds were initially fed a certified organic grower mash, which was replaced with a certified organic layer mash at 18 weeks of age. Starting at 16 weeks of age, half the hens of each line began receiving these diets supplemented with 2% DE. Forty hens (10 hens/line/treatment) were sacrificed between 33 and 38 weeks of age, and one radius from each bird was analyzed for bone mineral density and cross-sectional area by quantitative CT. Laying status was assessed by inspection of the ovaries. The density, area and mineralization of the trabecular bone of the radius did not differ between the 2 lines and was unaffected by DE. However, density and mineralization of the cortical bone of the radius was significantly greater in hens consuming the DE diet. Trabecular bone density and mineralization was greater in layers than in non-layers, likely as a consequence of medullary bone inclusion in the trabecular space, while the reverse was true for cortical bone. Plasma calcium concentration did not differ between the treatments, but was greater in layers. The results of this experiment indicated DE increased mineralization of cortical structural bone.

Key Words: diatomaceous earth, bone mineralization, organic layer production

98 A meta-analysis of the effects of feeder space on broiler breeder performance. J. Brake* and N. Leksrisompong, *North Carolina State University, Dept. of Poultry Science, Raleigh.*

Four experiments were conducted with varied numbers of 132 cm circumference tube feeders and varied numbers of females in rearing and laying pens to study the effects of feeder space (FS) on broiler breeder female reproductive performance, uniformity, and mortality. In Experiment 1, a large increase (7.0–10.3 cm), large decrease (10.4–6.2), small decrease (7.0–6.2 cm), or no change (10.4–10.3 cm) in FS were compared and it was found that maintaining similar FS between the rearing and laying quarters improved egg production and decreased hen mortality (7.0–6.2 cm; 175 EHH, 6.6%) (10.4–10.3 cm; 181 EHH, 5.9%), while an increased FS increased hen mortality and decreased egg production (7.0–10.3 cm; 169 EHH, 10.9%). In a similar manner, eggs per hen housed was generally better in Experiments 1 and 2 (6.6–6.9 cm; 171 EHH) where FS was similar between growing and laying quarters as compared with Experiments 3 (5.3–8.8 or 7.0–8.8 cm; 162 EHH) and 4 (6.8–8.8 cm; 157 EHH). The increase in FS in Experiment 3 (5.3–8.8 or 7.0–8.8 cm) was equal to or greater than in Experiment 4 (6.8–8.8 cm) but the overall EHH was not reduced. This may be interpreted to mean that when the change in FS exceeded a certain point a threshold was passed where greater negative impacts were not evident. This was also evidenced by the similar hen mortality observed for the 2 FS changes (5.3–8.8 or 7.0–8.8 cm) in Experiment 3 (mean = 7.4%). By comparison, female mortality in Experiment 4 was 10.7% for a FS increase of 6.8–8.8 cm. The 7.0–10.3 cm combination of Experiment 1 also exhibited 10.9% hen mortality. It was concluded that not changing FS between the growing and laying periods at the time of movement and photostimulation improved egg production regardless of ambient temperatures while increasing or decreasing FS produced poorer results. Contrary to expectations, BW uniformity was not affected by FS. These data provide insight toward an explanation why broiler breeder performance has often been observed to be better in housing systems that do not require the flock to be moved at photostimulation.

Key Words: broiler breeders, feeder space, uniformity, egg production, mortality

99 Evaluation of size variation in commercial turkeys from a single breeder flock. II: Bacterial and viral profile. D. Karunakaran*, D. V. Rives, J. Benson, G. Siragusa, and J. M. Day, *Danisco Animal Nutrition.*

AAAP abstract†

100 Broiler breeder composition restriction: 2. Does altering dietary protein and energy to limit muscling affect egg production traits? E. T. Mba*, A. Pishnamazi, T. G. Moraes, M. J. Zuidhof, and and R. A. Renema, *University of Alberta, Edmonton, AB, Canada.*

The growth of modern broiler breeders is geared toward muscle growth. Shifting carcass composition away from muscle deposition could allow more maternal nutritional support for egg production. A 3 × 2 × 2 × 2 factorial arrangement of treatments was used. A total of 1,186 Ross 708 pullets were housed in floor pens and from 21d were fed 3 ME levels: high, standard, and low (2,950, HEr; 2,800, SEr; and 2,650, LEr, kcal/kg, respectively), combined with high (16%, HPr) or low (14%, LPr) CP levels. At 23 wk, 384 pullets were individually caged and from 25 wk fed breeder diets with high (2,900 kcal/kg, HEl), or low ME (2,800 kcal/kg, LEl) combined with high or low CP (15.5%, HPl; or 14.5%, LPl, respectively). Birds were maintained on a breeder recommended target BW. Feed allocation was adjusted twice/wk until 38 weeks of age and once/wk thereafter. Individual egg production records were kept and birds were artificially inseminated once/wk and incubated to determine hatchability. Results were assessed with the MIXED procedure of SAS ($P < 0.05$). Pullet and breeder phase growth was influenced primarily by ME intake. As a result, ME intakes were similar and differences in protein intake had the greatest effect on experimental parameters. At 25 wk, birds on LEl × HPl diet had smaller egg size (48.2g) compared with LEl × LPl (50.8g). The average egg weight ($P < 0.0001$) and total eggs laid ($P = 0.0017$) were significant between ME and CP combinations for the interaction between the rearing and breeding phases. For example, birds on SEr × LPr and LEl × HPl laid 40 more eggs compared with LEr x LPr and HEl × HPl and also had the highest number of settable eggs (178 eggs, $P = 0.0009$). The number of unsettable eggs was affected by breeding period feeding, where LEl × LPl had double the unsettable egg production (6.3/hen) of HEl × LPl hens. Hatchability in Hel × HPl hens was 3% higher than in other treatments. The study shows that several combinations of protein and energy positively affected production traits and that feeding programs during rearing influence production traits more than expected.

Key Words: broiler breeder, CP, ME, feed allocation, hatchability

101 Broiler breeder composition restriction: 3. Can carcass traits at the end of lay be used to judge the effectiveness of modifying dietary protein and energy levels during the rearing and breeding phases? R. A. Renema*, A. Pishnamazi, E. T. Mba, and M. J. Zuidhof, *University of Alberta, Edmonton, AB, Canada.*

The effectiveness of a composition restriction program to support egg production and limit breast muscling was assessed at 60 wk of age in 384 Ross 708 breeder hens. A 3 × 2 x 2 × 2 factorial arrangement of treatments was used. A total of 1,186 pullets were housed in floor pens and from 21 d were fed 3 ME levels: high, standard, and low (2,950, HEr; 2,800, SEr; and 2,650, LEr, kcal/kg, respectively), combined with high (16%, HPr) or low (14%, LPr) CP levels. At 23 wk, 384 pullets were individually caged and from 25 wk fed breeder diets with high (2,900 kcal/kg, HEl), or low ME (2,800 kcal/kg, LEl) combined with high or low CP (15.5%, HPl; or 14.5%, LPl, respectively). Birds were maintained on a breeder recommended target BW by weighing birds and adjusted feed allocation twice/wk until 38 weeks of age and once/wk thereafter. Individual egg production records were maintained throughout lay. At 60 wk of age, breast muscle, liver, fatpad, ovary and oviduct weights were recorded. Results were assessed using proc MIXED of SAS ($P < 0.05$). The analysis of the biological significance of egg production traits required inclusion of both rearing and breeding phase treatments. The up to 40 egg difference among treatments indicated birds cope best with a consistent feeding program through life. For carcass traits at 60 wk, reproductive support tissues (ovary, liver and abdominal fatpad) were affected by breeder phase dietary ME, with liver weight most affected (LEl = 67 g vs. HEl = 59 g). The impact of rearing treatments was indirect — affecting muscling instead. Rearing feeding program affected proportion of breast muscle, with both LEr and HPr birds carrying a higher % breast muscle than their HEr and LPr counterparts ($P = 0.04$). The highest Pectoralis major weight was 709 g in LEr:LEl:HPl birds, which was 9.4% higher than 4 other treatment combinations that included HEr or HEl as one of their feeding parameters ($P = 0.05$). Breast muscle is established in the rearing period and strategies to limit deposition must therefore start early.

Key Words: broiler breeder, CP, energy, breast muscle

102 Effects of broiler strain and antibiotics on innate immunity. K. Ton*, J. L. Saunders-Blades, D. R. Korver, and M. J. Zuidhof, *University of Alberta, Edmonton, AB, Canada.*

The poultry industry is facing consumer and legislative pressure to reduce the use of antibiotic growth promoters (AGP). This study was conducted to investigate the effects of strain and dietary AGP on innate immunity of broiler chicks. A 2 × 4 factorial arrangement of treatments was used with 2 commercial broiler strains (A and B), randomly assigned to one of 4 dietary AGP, control (no AGP), bacitracin methylene disalicylate (BMD), roxarsone (ROX) or virginiamycin (VIRG), added to feed at recommended doses. At d 13, 10 birds/treatment were injected intra-abdominally with bacterial lipopolysaccharide (LPS), while 10 birds/treatment were used as non-injected controls. Chick plasma was collected 6 h post-injection and nitric oxide (NO) concentration was measured. At d 16, whole blood was obtained from 10 chicks/treatment to assess: the number of cells able to engulf at least one *Escherichia coli* (% phagocytosis); average number of *E. coli*/cell (phagocytic capacity) and *E. coli* bactericidal capacity in vitro. There were no effects of strain or antibiotic treatment on NO concentration within the non-injected group. Birds fed antibiotics had a 16 to 41% lower NO concentration than control birds within LPS treatment ($P < 0.05$). Strain A had a greater % phagocytosis, mean phagocytic capacity and NO concentration than strain B (29.1, 25.8 and 28.8% higher, respectively; $P < 0.05$). There were no differences in % phagocytosis among AGP diets. Strain B on the ROX diet had the greatest % *E. coli* killing (65.9%, $P < 0.05$%) which was greater than all other treatments, except strain B on VIRG diet (61.4%). Strain A with no antibiotic had a lowest bactericidal capacity (45.8%, $P < 0.05$). Our findings show that there may be differences among broiler strains in disease susceptibility. Antibiotics increased bactericidal capability in chicks, and decreased NO concentration in LPS-injected birds. Understanding the mechanisms of action of growth promoting antibiotics is an important step in evaluating novel strategies to replace antibiotics in poultry diets.

Key Words: innate immune function, phagocytosis, nitric oxide

103 In vitro selection of aptamers against subtype H7 of avian influenza virus. J. Lum*, R. Wang, T. Jiang, and Y. Li, *University of Arkansas, Fayetteville.*

Avian influenza virus (AIV) is a medically and economically significant pathogen for both humans and poultry. Rapid and specific detection of AIV is needed for effective implementation of therapeutics or quarantines. Many current detection techniques rely on antibodies, which have the problem of having poor thermal stability. Aptamers are short oligonucleic acids which bind specific target molecules. They show higher affinity for their targets and have much better thermal stability, making their use advantageous over antibodies in detection applications in the poultry industry. The goal of this research was to develop aptamers specific against AIV hemagglutinin subtype H7 using Systematic Evolution of Ligands by Exponential enrichment (SELEX) for use in an impedance biosensor. H7-specific aptamers were selected by incubating H7 protein in a DNA library of 10^{14} molecules randomized at a central 40 nt site with conserved primer regions at both ends. Bound aptamers were separated using nitrocellulose filters, eluted and amplified by PCR. Dot ELISA and Dot Blot were used to test affinity and specificity of aptamers for H7. Results showed that the aptamers have strong affinity and specificity to H7 as compared with H5N1, H5N2, H5N3, H1N1, H9N2, and H2N2. Future research will include comparing aptamer affinity against monoclonal anti-H7 antibody and using the selected aptamer as the biological recognition element in a portable impedance biosensor.

Key Words: aptamer, influenza, detection

104 Relative performance in rural Uganda of two breeds of scavenging backyard chickens. J. Sharma*, H. R. Mwesigye, D. K. N. Semambo, E. Galunkande, D. Musinga, T. Aliro, and S. L. Sharma, *Arizona State University.*

AAAP abstract†

105 Evaluation of size variation in commercial turkeys from a single breeder flock. Part I. D. Rives*, *Prestage Farms Inc., Clinton, NC.*

AAAP abstract†

106 Effects of whole house brooding on broiler performance and footpad dermatitis prevalence. E. O. Oviedo-Rondan*, M. J. Wineland, M. R. Dalmagro, J. Ruiz, D. Ruiz, D. G. Valencia, and M. P. Serrano, *Department of Poultry Science, North Carolina State University, Raleigh.*

AAAP abstract†

107 Development of a biosecurity training program for poultry catch crews and drivers. E. Wallner-Pendleton*, L. Harlow, R. M. Hulet, G. Martin, P. Patterson, and C. Wood, *Animal Diagnostic Laboratory, Pennsylvania State University, University Park.*

AAAP abstract†

108 Influence of incubation temperature on turkey poult intestinal development and susceptibility to poult enteritis. J. R. Sottosanti*, J. S. Guy, F. W. Pierson, R. A. Dalloul, and A. P. McElroy, *Department of Animal and Poultry Sciences, Virginia Tech, Blacksburg.*

AAAP abstract†

109 A profile of *Aspergillus* spp. Dissemination into broiler hatching egg air cells via in ovo injection holes. R. Keirs*, *Mississippi State University.*

AAAP abstract†

110 Introduction and dissemination of a "new" *Salmonella* serotype throughout a commercial turkey company. R. Lippert* and D. C. Lauer, *Willmar Poultry Company.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

111 The evaluation of Topmax (ractopamine hydrochloride) in tom finishing turkeys administered at 4.6 g/ton at three different age periods: 15–17, 17–19, and 19–21 weeks of age. S. L. Noll[1], J. D. Trites*[2], J. Brannon[1], and W. Weber[1], *[1]University of Minnesota, St. Paul, [2]Elanco Animal Health, Greenfield, IN.*

A study was conducted to determine the clinical effects of 2% ractopamine hydrochloride (RAC) Type A Medicated Article on growth performance in tom finishing turkeys (576, Nicholas, Large White) during 3 different age periods: 15–17, 17–19, and 19–21 wks of age. After a one week acclimation period, turkey finisher toms were fed one of 2 treatments with and without RAC (4.6 g/ton) for the last 14 d before slaughter. The pen of turkeys (10 toms/pen) was the experimental unit and each treatment was replicated 8 times. Toms were allocated to pens one week before the start of the treatment based on body weight. Individual body weights were taken at the start and finish of the 14 d treatment phase. Feed intake was measured for the 2 week period. Data were analyzed using mixed model procedures (SAS). The model included diet treatment, age group and their interaction as a fixed effect with significant effects at $P < 0.05$. Turkeys fed RAC, on average, had 0.3 kg increased body weight. Average daily gain of turkeys fed Topmax was improved 9.2% (20.2 g/day) for all age groups. No differences were noted for feed intake among diet treatments. Feed efficiency (feed/gain) of turkeys fed RAC was improved by 6.75% (20 points) during the feeding period compared with the respective non-supplemented control treatments. Feeding of RAC to finisher toms for 2 weeks improved gain and feed efficiency regardless of market age.

Key Words: tom turkeys, ractopamine, performance, age

112 The evaluation of Topmax (ractopamine HCl) administered at 8.2 g/ton to finishing hen turkeys for the last 14 days prior to slaughter at 17 weeks of age. E. A. Heskett*[1] and K. K. Krueger[2], *[1]Elanco, A Division of Eli Lilly and Company, Greenfield, IN, [2]Diamond K Research, Marshville, NC.*

This study was conducted to determine the effects of ractopamine hydrochloride (RAC) Type A Medicated Article on finishing performance in hens (15–17 weeks of age, Hybrid Converter). Ractopamine (HCl) was fed at 8.2 g/ton in combination with Coban (monensin sodium) at 54 g/ton for the final 14 d before slaughter. The control diet contained monensin at 54 g/ton. Birds were weighed and randomized to produce equal weight pens 15 d (~13 weeks of age) before being placed on respective treatments. The pen (10 hens/pen) was the experimental unit with each treatment being replicated 8 times. Individual body weights and feed intake were measured at the start of treatment initiation, at 7 and 14 d on treatment. Birds were withdrawn from feed 10.5 h before slaughter then processed according to USDA regulations and air chilled. Carcass weight measurements included: intact carcass, standard trimmed carcass, front half (separation at T7-L1) and back half by subtraction. Turkeys fed RAC were 0.54 pounds heavier (2.3% improvement, $P = 0.084$) resulting in an average daily gain improvement of 0.038 pounds (11.9% improvement, $P = 0.014$). No increase in feed intake was observed resulting in a feed to gain (F:G) improvement of 33 points (10.9% improvement, $P = 0.003$). The increase in weight was also observed in the RAC treated birds' intact carcasses being 0.474 pounds heavier ($P = 0.044$) and standard trimmed carcass being 0.451 pounds heavier ($P = 0.056$). The use of RAC improved feed to gain ratio and average daily gain. This increased weight resulted in statistically heavier carcass weights.

Key Words: turkey, hen, ractopamine-HCl, finishing, carcass

113 Evaluation of the use of various feed additives administered in the withdrawal feed of broiler chickens vaccinated with a commercial coccidiosis vaccine at day of age. E. A. Heskett*[1] and K. K. Krueger[2], *[1]Elanco, A Division of Eli Lilly and Company, Greenfield, IN, [2]Diamond K Research, Greenfield, IN.*

Day-old straight run Cobb 500 broilers were commercially vaccinated for coccidiosis at the hatchery and assigned to 4 withdrawal diet (d 29–42) treatment groups: T1 - basal ration, T2 - Monteban 63 g/ton (narasin), T3 - Stafac 20g/ton (virginiamycin), and T4 treated with Monteban 72 g/ton in the grower phase (15–28 d) and 63 g/ton in the withdrawal phase. Birds were reared on used poultry house litter (4 grow-outs) and provided food and water ad-libitum. All birds received BMD 50 g/ton (bacitracin methylene disalicylate) in the starter and grower rations with the exception of T4 grower diet. Birds were randomized at placement (day of age). Each pen of birds was mass weighed at day of age, 14, 28 and 42 d of age. Feed intake was measured at d 14, 28 and 42. The pen was the experimental unit with each treatment being replicated 12 times. Birds were withdrawn from feed approximately 8 h before carcass measurement collection. For carcass evaluation, 2 males and 2 females from each pen were randomly selected. Broilers coccidiosis vaccinated at day of age and fed narasin in the grower and withdrawal (T4) or withdrawal only (T2) had improved feed to gain ratio of 4 and 3 points respectively as compared with T1 and T3 ($P = 0.02$). Final body weights (5.1 to 5.3 lbs.) were not statistically different. Carcass differences are reported by gender. Female birds in the T2 and T4 groups had 0.052 and 0.108 pounds more harvestable pectoralis major over T1, respectively, and 0.049 and 0.105 pounds more harvestable pectoralis major over T3, respectively ($P < 0.001$). Male birds in the T2 and T4 groups had 0.084 and 0.09 pounds more total white meat (front half) over T1, respectively, and 0.068 and 0.074 pounds more total white meat over T3, respectively ($P < 0.001$). In males, the back half (saddle) was lighter by 0.03 to 0.05 pounds ($P < 0.001$). This study demonstrated that the addition of narasin, for the prevention of coccidiosis, resulted in improved feed utilization and increased harvestable pounds of white meat.

Key Words: broiler, coccidiosis, growth, finishing, carcass

114 Changes in the heat stress response of laying hens following antioxidant supplementation. J. N. Felver-Gant*[1], S. D. Eicher[2], and H. W. Cheng[2], *[1]Purdue University, West Lafayette, IN, [2]Livestock Behavior Research Unit USDA-ARS, West Lafayette, IN.*

Heat stress (HS) is a major contributor to mortality and other welfare issues in the poultry industry. The objective of this study was to determine the benefits of an antioxidant supplement during HS. One hundred twenty White Leghorns at 32 wk of age were randomly transferred to 2 adjacent rooms. Hens were randomly pair-housed and assigned to a control feed (CF) or a feed including an antioxidant blend (ethoxyquin, propyl gallate, and propylene glycol; Agrado Ultra) at 160 ppm (AF) and then raised for 2 wks at a control climate (C) (24°C, 15.6% RH). Afterward, one room was subjected to a HS climate (H) (33°C, 23.7% RH) for 8 d. Physiological data were taken from 40 hens on d 1 and 8 respectively; and feed intake data were taken on d 1, 3, 6, and 8. Data were analyzed using a Proc Mixed model and slice adjustment. Compared with their controls, H-hens had higher core body temperatures ($P < 0.01$) on both d 1 and 8. Compared with their controls, H-CF hens but not H-AF hens had reduced liver wt on d 1 ($P < 0.05$; $P > 0.05$, respectively); and on d 8, liver wt was reduced in both H-CF and H-AF

hens ($P < 0.05$). However, on d 8, H-AF hens liver wt was greater than the liver wt of H-CF hens ($P < 0.05$). The ratio of ileum weight and length was reduced in both H-CF and H-AF hens compared with their controls ($P < 0.05$) on d 1; while H-CF hens tended to be different on d 8 ($P = 0.08$). H-CF hens ate less than C-CF hens during d 1, 3, 6, and 8 ($P < 0.01$) while H-AF hens ate less than controls during d 3 and 6 only ($P < 0.01$). Partial pressure CO2 (pCO2), $HCO3^{-}$, and total CO2 of cardiac blood of H-CF hens was lower than C-CF hens ($P < 0.05$) on d 8. However, only p CO2 was decreased in H-AF hens compared with controls ($P < 0.05$). Low pCO2, $HCO3^{-}$, and total CO2 are indicative of respiratory alkalosis or metabolic acidosis that can onset under HS through excess hyperventilation. These data suggest that hens exhibit a negative response under HS. Evidence is provided that hens fed AF have an improved coping capability to HS.

Key Words: heat stress, antioxidant, well being, laying hen, blood gas

115 Live performance and energy uplift of 0.5% Azomite Feed-Grit (versus 0%) were evaluated in broiler feeds in two series with increasing levels of metabolizable energy under disease stresses in floor pens. J. L. McNaughton[1], D. Fodge[2], W. W. Emerson[3], and D. M. Hooge*[4], *[1]AHPharma Research Inc., Salisbury, MD, [2]DF International Inc., Rockville, MD, [3]Azomite Mineral Products Inc., Kansas City, MO, [4]Hooge Consulting Service Inc., Eagle Mountain, UT.*

Azomite Feed-Grit (AZO; Azomite Mineral Products, Inc., Kansas City, MO) was included at 0 or 0.5% in broiler diets in 2 series with increasing metabolizable energy (ME) to study live performance and energy uplift effects. The AZO is a hydrated Na-Ca aluminosilicate, from a volcanic ash and an ancient seabed deposit in Utah, which has been shown to improve caloric conversion. Mash feeds were in 3 phases (starter 0–21 d, grower 21–35 d, and finisher 35–42 d) with respective ME levels of 3,086, 3,142, and 3,197 kcal ME/kg and +0, +22, +66, or +132 kcal ME/kg. In the 0.5% AZO series of diets, soybean oil was added to make formulas equicaloric with corresponding 0% control diets. A total of 4,320 straight-run broiler chicks were randomly allocated at 54 chicks/floor pen into 10 replicate pens for each of the 8 treatments (4 with 0% and 4 with 0.5% AZO). Stocking density was 0.0743 m^2 (0.8 ft^2)/bird on used litter. A live coccidia vaccine was given at hatch, and BMD (55 ppm) was used in all diets. *Eimeria acervulina* (100,000 oocysts/bird) and *maxima* (50,000 oocysts/bird) were given on d 5, *Clostridium perfringens* (10^4/bird) on d 8, and *E. coli* (10^6/bird), *Salmonella* spp. (10^4/bird), *Listeria monocytogenes* (10^6/bird), and *Campylobacter jejuni* (10^4/bird) by oral gavage on d 40. The 42-d BW was 2.545 kg for the 4 0% and 2.578 kg for the 4 0.5% AZO groups ($P = 0.056$). The 0–42 d feed conversion ratio (FCR) was 1.834 for 0% and 1.817 for 0.5% AZO groups ($P = 0.007$), and mortality-adjusted FCR was 1.831 for 0% and 1.813 for 0.5% AZO groups ($P = 0.002$). Mortalities were similar (1.71 vs 2.04%, respectively; $P = 0.494$). The AZO at 0.5% was estimated to have 7,910 kcal ME/kg (3,588 kcal/lb) 0–21 d, 10,194 kcal ME/kg (4,624 kcal/lb) 21–42 d, and 9,744 kcal ME/kg (4,420 kcal/lb) of product 0–42 d. The AZO (a noncaloric ingredient) at 0.5% of diets increased effective ME level by 48.72 kcal ME/kg (22.10 kcal/lb) feed from 0 to 42 d.

Key Words: Azomite, broiler, coccidia, metabolizable energy, pathogens

116 Growth response of broiler chickens to inclusion of hydrolyzed porcine mucosa (Palbio) in diets varying in total lysine content. M. Mohiti-Asli[1], M. Frikha[1], C. Jabbour[1], E. Borda[2], L. Cámara[1], and G. G. Mateos*[1], *[1]Departamento de Producción Animal, Universidad Politécnica de Madrid, 28040 Madrid, Spain, [2]I+D Nutrition and Health Care, Bioibérica S.A., Palafolls, Barcelona, Spain.*

The growth response of broiler chickens to the inclusion of hydrolyzed porcine intestinal mucosa (PAL, Palbio 50 RD; Biobérica, Spain) in diets varying in total lysine (Lys) content was studied in 2 experiments (Exp.). In Exp. 1, 1,200 one day-old, straight-run Ross 308 chicks were allotted randomly to 8 dietary treatments with 5 pen floor replicates of 30 chicks each. The design was completely randomized with treatments arranged as a 4 × 2 factorial with 4 inclusion levels of PAL (0, 2.5, 5.0, and 7.5%) and 2 levels of Lys (1.23 and 1.37%). Birds received their respective experimental diets from 1 to 21 d and then a common diet without PAL from 21 to 37 d of age. Lys level did not affect ADG in any of the periods considered but final BW tended to be higher (2,662 vs. 2,707 g; $P = 0.063$) for birds fed the higher Lys level. The inclusion of PAL tended to improve ADFI ($P = 0.08$) and improved BWG ($P \leq 0.05$) and FCR ($P \leq 0.001$) from 1 to 21 d of age. Previous treatment did not affect broiler performance from 21 to 37 d of age. Litter quality was not affected by diet. In Exp. 2, the same diets used from 1 to 21 d in the previous study were used from 1 to 37 d of age. For the entire experiment, birds were kept in cages and each of the 8 treatments was replicated 5 times (7 birds each). Birds fed 1.37% Lys had higher ADFI and ADG ($P \leq 0.01$) than birds fed 1.23% Lys. The inclusion of PAL improved ADFI and ADG from 1 to 21 d ($P \leq 0.01$) and from 1 to 37 d ($P \leq 0.05$) of age, with best results observed with 2.5 to 5.0% PAL. Moisture content of the excreta was not affected by dietary treatment. The results indicate that PAL inclusion improves growth performance of broilers and that the most efficient level of inclusion is between 2.5 and 5.0%, irrespective of dietary Lys level. Moreover, broilers respond better to diets with 1.37% Lys than to diets with 1.23% Lys.

Key Words: broiler performance, lysine, hydrolyzed porcine digestive mucosa

117 Impact of replacing canola meal with distillery yeast sludge on growth performance, haematology, histopathology and growth performance of broilers. J. I. Sultan*, I. Haider, A. Javaid, and M. Yaqoob, *University of Agriculture, Faisalabad, Faisalabad, Punjab, Pakistan,*

The intent of this study was to determine the chemical profile and to explore the impact of replacing canola meal with distillery yeast sludge (DYS) on hematology, histopathology, growth performance and economics of broiler chicks. Two hundred 40 (240) day-old broiler chicks were randomly divided into 20 experimental units in such a way that each diet was offered to 4 experimental units comprising 12 chicks. Five isonitrogenous (CP, 21%) and isocaloric (ME, 3000 Kcal/kg) broiler diets i.e., control, DYS5, DYS10, DYS15 and DYS20 were formulated having 0, 5, 10, 15 and 20% DYS replacing canola meal. The trial was 42 d long. Feed intake remained unaltered across all diets. Weight gain of chicks fed control diet was higher ($P < 0.05$) than those fed DYS20, however, it was similar to those fed other diets. Feed conversion ratio was lower ($P < 0.05$) in chicks fed control diet than those fed DYS20, however, it was similar across other diets. Red blood cells, white blood cells, packed cell volume and hemoglobin values remained unchanged with increasing the inclusion level of DYS in the diet. No pathological lesions on heart, kidney and liver were observed across any diet. Feed cost per kg live weight gain decreased ($P < 0.05$) as the level of DYS was increased in the diet. Based on the findings of the present study it was concluded that DYS is economical protein

source and can effectively replace canola meal up to 15% in broilers diet without any deleterious effect on broiler performance, hematology and histopathology

Key Words: distillery yeast sludge, canola meal, broilers, weight gain, feed conversion ratio, hematology, histopathology

118 Real-time antibiotic use in broiler production. T. Cummings*, *Mississippi State University.*

AAAP abstract†

119 Maximizing desired outcomes for therapeutic antimicrobials. H. Cervantes*, *Phibro Animal Health Corp.*

AAAP abstract†

120 Justifying longer duration uses of tetracyclines, penicillins and sulfonamides in feeds and water: A summary of US usage and resistance patterns. S. R. Clark* and J. J. Mathers, *Alpharma LLC, Bridgewater, NJ.*

AAAP abstract†

121 Analysis of changes in chicken gut microbial communities and metabolic potential in response to growth promoters. T. J. Johnson*, J. L. Thorsness-Danzeisen, H. Bum Kim, and R. E. Issacson, *University of Minnesota.*

AAAP abstract†

122 Assessment of egg quality characteristics of laying hen fed raw and enzyme treated cocoa bean shell based diet. M. D. Olumide*[1], O. A. Adebiyi[1], O. Abiola-Olagunju[1], and A. A. Mako[2], *[1]University of Ibadan, Ibadan, Ibadan, Oyo State, Nigeria, [2]Tai Solanrin University of Education, Ijebu Ode, Ogun State, Nigeria.*

The biggest constraint to poultry production in Nigeria has remained the cost of feed. The high cost of feed has been as a result of increased cost of ingredients especially the cereals protein ingredients; this is why there is need to investigate into some agro-industrial bye products that have potential as feed ingredients. Cocoa bean shell constitutes waste in cocoa industries in Nigeria. This study is focused on evaluating the egg quality characteristics of layers fed cocoa bean shell based diets. One hundred (100) 6-week-in-lay hens were used for this trial with 20 birds per treatment in a 2 × 2 factorial arrangement. These diets were: A (0% CBS control), B (5% raw CBS), C (10% raw CBS), D (5% CBS with enzyme) and treatment E (10% CBS with enzyme). The birds were offered feed and water ad-libitum throughout the experimental period. The egg quality characteristics external (egg weight, egg shell thickness, egg length, egg width, egg shape index, shell weight, shell thickness, shell percentage, shell surface area) and internal egg characteristics (yolk weight, yolk height, yolk width, albumen weight, albumen height, yolk color, Haugh unit, yolk percentage, albumen percentage and yolk index) were determined. The result revealed no significant ($P < 0.5$) difference in the values obtained for yolk height (1.25–1.30), yolk width (3.86–3.92), albumen weight (35.95- 37.92), Haugh unit and yolk percentages with values of 82.40–85.10 and 24.67–28.23% respectively for all treatments. However, albumen percentages vary significantly with birds on diet C having the highest percentage of 63.32% and treatment E with the least value of 57.89%. The egg quality characteristics (external) showed no significant changes in all the parameter measured among all the treatments. It can therefore be concluded that the feeding of CBS based diet with or without enzymes has no effect on both internal and external egg quality characteristics of laying birds.

Key Words: cocoa bean shell, enzymes, layer, egg quality

123 Performance, serum biochemistry and hematological characteristics of layers treated feed, differently cocoa bean shell based. A. O. Abkinsoyinu, M. D. Olumde*, O. A. Adebiyi, and A. D. Ologhobo, *University of Ibadan, Ibadan, Ibadan, Oyo State, Nigeria.*

Cost of feed has remained the biggest constraint to poultry industries in Nigeria. The high cost of feed ingredients results in increased cost of feed especially the cereals and protein ingredients, therefore is need to investigate some agro- industrial by- products like cocoa bean shell (CBS) that has potential as feed ingredients. Cocoa bean shell is an agro industrial waste that constitute disposal problem to the cocoa processing companies in Nigeria. This study is therefore focused on evaluating the performance, serum biochemistry and hematological parameters of birds feed differently treated cocoa bean shell-based diets. One hundred forty (140) 6 weeks in lay hens were used for this trial with 20 birds per treatment in a 2 × 3 factorial arrangement of a completely randomized design. Significant means were separated at 5% level of significant ($P < 0.05$). The basal diet contained 2631.06 kcal/kg ME and 16.05% Crude Protein, while the CBS is replacing maize at the different levels. These diets were: A (basal diet) (0% CBS control), B (5% raw CBS), C (10% raw CBS), D (5% Raw CBS with enzymes), E (10% CBS with enzymes), F (5% fermented CBS), G (10% fermented CBS). The birds were offered feed and water ad-libitum throughout the experimental period. The CBS is replacing maize at 5 and 10% levels of inclusion. The parameters studied were, feed intake, egg production, feed conversion ratio, mortality rate egg weight, cost of feed, total protein, albumin, globulin, albumin: globulin ratio, glucose, creatinine, cholesterol, red blood cell, white blood cells, packed cell volume and hemoglobin. Significant ($P < 0.05$) differences were observed in the feed intake of birds on diet D (5% Raw CBS with enzymes) having the mean value of 98.00g compared with birds fed diet G (10% fermented CBS) having a least feed intake of 89.40g. The same trend was observed in the egg weight with of birds fed diet D (65.56g) while the least was observed in birds fed diet B (60.06g).No significant ($P > 0.05$) difference was observed in most of the serum and hematological parameters, therefore cocoa bean shell can effectively be used in layers diet without any deleterious effect on the performance, blood, and serum indices.

Key Words: agro-industrial, cocoa bean shell, constraint, hematological, performance

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

124 Effects of temperature, pH, and pepsin on the stability of intrinsic phytase of rye, wheat, and barley. O. Esmaeilipour*[3,1], M. M. Van Krimpen[2], A. W. Jongbloed[2], L. H. De Jonge[1], and P. Bikker[2], *[1]Wageningen University, Wageningen, the Netherlands, [2]Wageningen UR, Livestock Research, Lelystad, the Netherlands, [3]University of Tehran, Karaj, Iran.*

An experiment was carried out to evaluate effects of temperature, pH, and incubation time on the stability of intrinsic phytases. The experiment was conducted as a 3*4*3*3 factorial arrangement with 3 feed ingredients (rye, wheat, and barley), 4 temperatures (T) (20, 38, 55, and 80°C), 3 pH levels (3, 5.5, and 8), and 3 incubation times (30, 60, and 120 min), with 2 replicates per treatment. After incubation at the destined conditions of T and pH, residual phytase activity of treatment groups as well as non-treated (reference) samples were measured. Stability was calculated as the ratio of the residual phytase activity of a treated sample to the reference sample times 100. Phytase activity of the reference samples of rye, wheat, and barley was 3.14, 1.77, and 0.66 FTU/g, respectively. Overall, rye showed the highest and barley the lowest stability (58% vs. 47%). Stability decreased with increasing T to 6.5% at 80°C. Stability of intrinsic phytase significantly decreased with increasing incubation time. Stability was highest at pH 3 and lowest at pH 8 (65% vs. 34%). Combinations of low pH (3 and 5.5) and low temperature values (20 and 38°C) resulted in the highest stability of intrinsic phytase (>90%). Wheat and rye phytases were stable at pH 3 (20 and 38°C) and 5.5 (20 and 38°C). Moreover, stability of intrinsic phytase of these feed ingredients was determined in different concentrations of pepsin (0, 5, and 10 mg/ml) at pH 2. Intrinsic phytases of wheat and rye were resistant to pepsin, but barley phytase was susceptible to pepsin and its stability decreased to 57% at 5 mg/ml pepsin concentration. It can be concluded that the effect of T on stability of intrinsic phytases was more destructive than the effect of pH or pepsin. Among the tested feed ingredients, rye had the highest overall stability. This knowledge may contribute to optimize within phytase activity, thereby reducing phosphorus excretion of monogastrics.

Key Words: intrinsic phytase, stability, temperature, pH, residual activity

125 Effect of NSP-enzymes and phytase combination on growth performance and bone mineralization in turkey fed wheat-corn-based diet. A. Preynat*[1], D. McIntyre[2], G. Uzu[1], and P. Dalibard[1], *[1]Adisseo France SAS, 92160 Antony, France, [2]Adisseo USA Inc., Alpharetta, GA.*

The present experiment was carried out to investigate the benefits of a multi-enzyme complex (Rovabio Max) containing carbohydrolases (*Penicillium funiculosum*) and 6-phytase (*Schizosaccharomyces pombe*) activities on the performance of turkeys. One thousand BUT 9 male turkeys were distributed into 5 experimental treatments (8 replicates, 25 birds per pen): one positive control (PC) diet formulated to be adequate in nutrient and 2 negative control (NC1 and NC2) diets with a decrease in available phosphorus (−1.5 g AvP /kg), calcium (−1.2 g Ca/kg) and a gradual decrease in apparent metabolizable energy (AME) (NC1, −80 kcal/kg and NC2, −120 kcal/kg). The 2 NC diets were supplemented or not with Rovabio Max supplying 1,100 visco units of endo-β-1,4-xylanase, 100 AGL units of endo-1,3(4)-β-glucanase, and 500 Phytase units of phytase per kg of feed. Body weight and feed intake were determined at 22, 35, 57, 77, 96 and 111 d. Phalanxes from 20 turkeys per treatment were collected for ash content determination at 111 d. During the total experimental period, animals fed NC1 and NC2 diets had the lowest weight gain and the highest feed conversion ratio ($P < 0.01$) with no effect on feed intake when compared with the PC group. Further reduction of AME in the NC2 diet did not significantly degrade more animal performances than NC1. Phosphorus and calcium deficiency significantly decreased bone mineralization of turkeys by 7% as compared with animals fed PC diet. Supplementation of the NC diets with the multi-enzyme complex significantly improved feed intake, weight gain and feed conversion ratio at the similar level of those obtained for the PC group. Moreover, the ash content was partially and fully compensated by enzyme addition for NC1 and NC2, respectively. These results confirm the efficiency of multi-enzyme complex containing NSP-enzymes and phytase to reduce the phosphorus, calcium and energy specifications of wheat-corn-based diets without performance losses.

Key Words: NSP-enzymes, phytase, turkeys, formulation matrix, growth and bone mineralization

126 Effects of phytase and xylanase supplementation of diets fed to male broilers on nutrient digestion from 28 to 32 days of age. C. K. Gehring*[1], M. R. Bedford[2], and W. A. Dozier III[1], *[1]Auburn University, Auburn, AL, [2]AB Vista Feed Ingredients, Marlborough, UK.*

This study evaluated 6 concentrations of phytase (0, 1,000, 2,000, 4,000, 8,000, and 16,000 U/kg) and 2 concentrations of xylanase (0 and 16,000 U/kg) on standardized ileal amino acid and energy digestibility in broilers. Enzymes were added to a corn-soybean meal-based basal diet formulated to contain adequate Ca (0.65%) and non-phytate P (0.33%). Eight hundred and 60 4 (12 per battery cage; 0.45 m^2 per bird) Ross × Ross 708 male broiler chicks were randomly distributed to 72 cages (6 replicates per treatment). From 1 to 28 d of age, broilers were fed common corn-soybean meal-based diets that were not supplemented with exogenous enzymes. Experimental diets (including 0.50% TiO_2) were provided from 28 to 32 d of age. On d 32, digesta from the distal ileum (a section spanning 4 to 30 cm upstream from the ileocecal junction) was collected from 8 birds per cage. Feed and digesta were analyzed for TiO_2, amino acid, and gross energy content. Only phytase main effects were observed on standardized ileal amino acid digestibility (SIAAD), and phytase and xylanase did not interact in their effects on any measured variable. The addition of 1,000 U/kg of phytase increased ($P < 0.010$) SIAAD of all amino acids with the exception of Ala ($P = 0.085$). Average SIAAD was increased by 1.74% with 1,000 U/kg of phytase. The response to phytase on SIAAD was more pronounced for Ser (3.0%) and Cys (2.5%) and less for Thr (1.5%), His (1.4%), and Met (0.7%). The addition of higher levels of phytase did not further increase SIAAD of any amino acid ($P > 0.05$) above the addition of 1,000 U/kg, although 2,000 U/kg significantly ($P = 0.024$) increased standardized Ala digestibility above the basal diet. Significant linear or quadratic effects of phytase ($P > 0.05$) were not observed. These results indicated that 1,000 U/kg of phytase increased amino acid utilization in corn-soybean meal-based diets formulated to contain adequate Ca and non-phytate P for broilers.

Key Words: phytase, xylanase, standardized ileal digestibility

127 Phytase affects the optimum calcium:phosphorus ratio in broilers. B. M. Nusairat*[1], P. W. Plumstead[2], P. Kwanyuen[3], A. B. Leytem[4], and J. Brake[1], *[1]Department of Poultry Science, North*

Carolina State University, Raleigh, [2]Danisco Animal Nutrition, Marlborough, UK, [3]USDA, Agricultural Research Service, Soybean and Nitrogen Fixation Research Unit, Raleigh, NC, [4]USDA, Agricultural Research Service, Northwest Irrigation and Soils Research Laboratory, Kimberly, ID.

This study was conducted to determine effects of calcium (Ca) on ileal phytate hydrolysis and if the optimum calcium:non-phytate phosphorus (Ca:NPP) ratio was altered when an *E. coli* phytase enzyme was added to broiler diets. A 2 × 4 factorial design was used with 4 dietary Ca levels from 0.36% to 1.16% and 2 levels of *E. coli* phytase (0 or 500 FTU/kg feed) with titanium dioxide as the marker. Male broiler chicks were fed a standard corn-soy starter diet to 15 d of age followed by 1 of 8 experimental diets with 4 replicate pens of 13 birds per interaction cell from 16 to 21 d of age. Excreta was collected from 19 to 20 d of age and distal ileal digesta was collected at 21 d and analyzed for phytate and phosphorus (P). *E. coli* phytase inclusion reduced ileal phytate concentration by 70%. Increasing dietary Ca decreased phytate hydrolysis in a step-wise manner when no phytase was added, but had much smaller effects on phytate hydrolysis in diets with *E. coli* phytase. Conversely, increasing dietary Ca resulted in a greater decline in ileal P digestibility when diets contained added phytase to the extent that there was no net increase in ileal P digestibility from phytase at the highest Ca level. Increasing dietary Ca increased P retention. The optimum Ca:NPP ratio that resulted in maximal P retention was determined by nonlinear regression to be reduced from 2.40:1 to 2.17:1 when diets contained phytase. In conclusion, high dietary Ca levels had a greater negative effect on ileal P digestibility when diets contained *E. coli* phytase. However, the adverse effect of high calcium on P retention can be avoided by reducing total dietary Ca or maintaining a lower Ca:NPP ratio when adding phytase to feed.

Key Words: broilers, phosphorus, calcium, phytase, non-phytate phosphorus

128 Influence of a highly soluble source of calcium and phytase on performance and bone ash of 21-day-old broiler chickens. C. L. Walk*[1], E. K. Addo-Chidie[2], M. R. Bedford[1], and O. Adeola[2], *[1]AB Vista Feed Ingredients, Marlborough, Wiltshire, United Kingdom, [2]Purdue University, West Lafayette, IN.*

Meeting the nutrient requirements of growing animals has yielded substantial research in regards to amino acids, metabolizable energy, and available P (aP). One area that requires further study is Ca solubility and digestion, especially in the presence of phytase. Previous in vitro research would suggest limestone is approximately 80% soluble in the acidic medium of the gastrointestinal tract, but decreased to 77% solubility in neutral conditions of the intestine, suggesting no further dissolution in the intestinal phase. Calcium must be soluble before it can be absorbed and an experiment was conducted to evaluate the influence of a highly soluble Ca source on performance and bone ash of broilers. Dietary Ca was supplied by Vistacal and monocalcium phosphate to provide 4 levels of Ca (0.45, 0.60, 0.75, or 0.90%). The dietary inclusion of Vistacal ranged from 0.5 to 2.0% and monocalcium phosphate was included at 1.09% to provide 0.32% aP. Each diet was supplemented with 0, 500, or 2500 FTU/kg phytase as a 4 × 3 factorial. An additional diet was formulated using 1.28% limestone and 1.76% monocalcium phosphate to contain 0.90% Ca and 0.45% aP (PC). Diets were fed to day-old Ross 708 birds for 21 d in 7 replicate cages of 8 birds per cage. Feed intake (FI) and body weight gain (BWG) were reduced ($P < 0.05$) in broilers fed 0.90% Ca from Vistacal compared with the PC and all other diets. Phytase increased ($P < 0.05$) FI and BWG in broilers fed 0.90% Ca from Vistacal to values comparable to the PC. There were no differences in FI or BWG among the broilers fed 0.45, 0.65, or 0.75% Ca from Vistacal or the PC. Phytase increased FI and BWG in broilers fed 0.45. 0.65, or 0.75% Ca from Vistacal, but this was not different from the PC. Tibia ash percent was reduced ($P < 0.05$) in broilers fed Vistacal without phytase at all Ca levels compared with the PC. Phytase increased ($P < 0.05$) tibia ash percent at all levels of Ca from Vistacal and this was comparable to the PC. In conclusion, feeding a highly soluble Ca source with phytase allows for significant reductions in dietary Ca while maintaining broiler performance and bone ash.

Key Words: calcium, phytase, broiler

129 The effects of feeding high concentrations of cholecalciferol and/or phytase on broiler chicks fed various concentrations of nonphytate phosphorus. J. Green* and M. E. Persia, *Iowa State University, Ames.*

Two experiments were conducted with Ross broiler chicks to investigate the effects of feeding high concentrations of cholecalciferol (D) and/or phytase (PHY) on performance variables when fed various concentrations of nonphytate phosphorus (nPP). Experiment 1 was arranged as a 5x3 factorial in a randomized design resulting in 5 dietary concentrations of nPP (0.20, 0.26, 0.33, 0.39 and 0.45%) and 3 of D (0, 7,500 and 15,000 IU/kg) fed for an 18 d period. The second experiment utilized a randomized design with a 4x2x2 factorial arrangement of treatments consisting of 4 dietary concentrations of nPP (0.15, 0.25, 0.35 and 0.45%), 2 of D (0 and 7,500 IU/kg) and 2 of PHY (0 and 1,000 FTU/kg) fed over a 15 d period. Chicks were housed in raised wire cages in an environmentally controlled room with *ad libitum* access to feed and water. Body weight gain (BWG), feed intake (FI) and feed efficiency (FE) were calculated over the duration of the each experiment. Tibia and excreta samples were collected at the end of each experiment to determine bone ash, expressed as total ash weight (AshW) and as a percentage of total tibia weight (AshP) and total tract P retention (TTPR). Vitamin D x nPP interactions were significant ($P < 0.05$) for BWG, FI, FE, AshW, AshP and TTPR for experiment 1. Increasing nPP increased performance and tibia ash without added D, but when 7,500 or 15,000 IU of D were added performance and tibia ash were similar among concentrations of dietary nPP. In experiment 2, there were main effects of PHY and nPP that resulted in significant ($P < 0.05$) increases in BWG, FI and FE. A significant ($P < 0.05$) PHY x nPP interaction was observed in both AshW and AshP. As expected, PHY was more efficient in improving tibia ash at lower dietary nPP than with higher dietary nPP. The supplementation of low nPP diets with cholecalciferol or phytase increased growth performance and tibia ash, although the response of chicks fed the cholecalciferol was inconsistent over the experiments.

Key Words: cholecalciferol, phytase, nonphytate phosphorus, broiler

130 Effect of phytase supplementation on growth performance, tibia characteristics, and phosphorus excretion in broilers. F. Yan*, M. Vazquez-Anon, N. Odetallah, and S. Carter, *Novus International Inc., St. Charles, MO.*

A total of 1440 male broilers were used in a floor pen study to test efficacy of a newly developed heat stable phytase (Cibenza Phos, Novus International Inc.) in improving P utilization in broilers. Corn

soybean meal based diets were formulated to reflect typical US poultry industry nutrients specifications except P for starter (0–14 d), grower (14–28 d) and finisher (28–42 d) periods. Starter diets were crumbled and grower, finisher diets were in pellet form. Positive control diet was formulated to contain 0.45%, 0.41%, and 0.35% non phytate P (nPP) for starter, grower, and finisher diets respectively. Two negative control diets were obtained by reducing nPP by 0.10% or 0.20% at each phase. To the 2 negative controls, phytase was added at 250, 500, and 1000 units/kg resulting in a total of 9 treatments. Each diet was fed to 8 replicate pens of 20 birds. Body weight, FCR, feed intake, and mortality were measured at d 14, 28 and 42. At d 43, 5 birds per pen were taken for tibia breaking strength, tibia ash, and 1 bird per pen for tibia minerals measurements. Litter samples were collected by pen for Ca and P determination at the end of the trial. A reduction of dietary nPP by 0.10% significantly decreased 42-d body weight, 0–42 d FCR, tibia ash percentage, tibia P and Ca level of broilers, and all these measurements were recovered to the positive control level by supplementation of 250 units/kg phytase. Reducing dietary nPP by 0.20% significantly impaired body, FCR, feed intake, tibia breaking strength, tibia ash percentage, tibia P, Ca, and Zn level; phytase supplementation was effective in improving all these parameters. The responses to phytase was dose dependent, either linear or quadratic depending on dietary nPP and measurement. Tibia Fe, Mn and litter Ca levels were not significantly affected by dietary treatments. P excretion can be reduced significantly by lowering dietary nPP along with phytase supplementation without compromising growth performance and bone characteristics of broilers.

Key Words: phytase, broiler, phosphorus, excretion

131 Effect of microbial phytase supplementation on phosphorus utilization, tibia bone-ash and performance in broilers fed corn-cowpea-soybean meal based diets. E. A. Iyayi*[1] and P. C. Aguihe[2], *[1]University of Ibadan, Ibadan, Oyo State, Nigeria, [2]Federal College of Wildlife and Management, New Busa, Niger State, Nigeria.*

A 56-d feeding trial was conducted with 96 1-d-old broiler chickens, which were fed diets based on corn, cowpea and soybean meal, to study the effect of microbial phytase enzyme supplementation on growth performance, phosphorus utilization, and tibia bone phosphorus and ash content in the birds. Four iso-nitrogenous and isocaloric diets were formulated to contain 4 different concentrations of microbial phytase concentrations of at 0, 250, 500, and 750 FTU/Kg diet. Each dietary treatment was offered ad libitum to 4 replicates of 6 birds each in a completely randomized design. Records of body weight and feed intake were obtained on weekly basis. On d 56, 3 birds from each replicate were selected for a 5-d nutrient digestibility study and 2 birds also were sacrificed for determination of tibia bone ash and phosphorus concentrations. Phytase supplementation significantly ($P < 0.05$) reduced feed intake and feed conversion ratio (FCR), and increased ($P < 0.05$) apparent phosphorus digestibility but had no significant effect on final weight, daily weight gain, tibia P, percent tibia ash and fecal P. The results suggest an improved growth performance and bone mineralization in broilers due to phytase supplementation.

Key Words: phytase, phosphorus digestibility, performance, broilers

132 Effects of calcium and phosphorus levels during the finisher phase on Heritage broilers: I. Performance and mineral retention. M. R. Dalmagro*[1], E. O. Oviedo-Rondón[1], P. L. Mente[1], A. Mitchell[2], H. Engster[3], and R. Mitchell[3], *[1]North Carolina State University, Raleigh, [2]USDA-ARS, Beltsville, MD, [3]Perdue Farms Inc., Salisbury, MD.*

One experiment was conducted to evaluate the effects of calcium (Ca) and phosphorus (P) levels during the finisher phase on performance and mineral retention of Heritage broilers. All diets were corn-soybean meal based with 10 to 12% of DDGS. Celite (1%) was used as a marker in the finisher phase. Common starter and grower diets were fed from 1 to 17 and 18 to 35 d of age, respectively. Broilers consumed the finisher diets from 36 to 49 d of age, which were formulated to contain combinations of 4 levels of Ca (0.38, 0.54, 0.70, 0.86%) and 4 levels of nPP (0.17, 0.25, 0.33, 0.41%). There were 6 replicate pens per treatment and each pen received 8 male and 8 female day-old chicks, individually identified and randomly assigned. Body weight (BW) gain, feed intake, and feed conversion ratio (FCR) were assessed at the end of each dietary phase, and all chickens were individually weighed at 35 and 49 d of age to determine flock uniformity. At 45 d of age, fresh fecal samples were collected and Ca and P retention evaluated. Data were analyzed as a completely randomized block design by response surface methodology using JMP. Results indicated that female BW gain increased linearly as P levels increased during the finisher phase ($P \leq 0.1$). No significant effects of Ca and P levels fed in finisher diets were observed on male BW gain or on feed intake. A quadratic effect ($P \leq 0.1$) of P levels was observed on FCR both during the finisher phase and from 0 to 49 d of age. Flock uniformity at 49 d was affected by the interaction between the levels of Ca and P ($P \leq 0.1$). Calcium and P retention, evaluated at 45 d of age, showed an interaction effect ($P \leq 0.05$) of Ca and P levels used in finisher diets. Taking into account these results, it was concluded that the levels of Ca and P fed to Heritage broilers in the finisher phase affect their live performance and also should be considered for minimizing mineral excretion.

Key Words: calcium, phosphorus, live performance, mineral retention

133 The influence of dietary calcium from limestone on broiler performance, bone ash, and crude protein digestibility. C. L. Walk*[1], A. P. McElroy[2], and M. R. Bedford[1], *[1]AB Vista Feed Ingredients, Marlborough, Wiltshire, United Kingdom, [2]Virginia Tech, Blacksburg.*

Previous research indicated dietary limestone increased gizzard pH in laying hens and urinary pH in grow/finisher pigs. An increase in gastric pH from limestone may reduce pepsin activity and reduce crude protein digestibility. An experiment was conducted to determine the influence of 2 levels of dietary Ca from limestone and 3 levels of phytase on broiler performance, bone ash, gastrointestinal pH, and Ca, P, and apparent ileal crude protein digestibility. Cobb 500 broilers were allowed ad libitum access to one of 6 corn/soy diets from 0 to 16 d. Experimental diets were formulated to contain 1.0% or 0.64% Ca from 1.21 or 0.43% limestone, respectively. Each diet was then supplemented with 0, 500, or 5000 FTU/kg phytase to create a 2 × 3 factorial. Dicalcium phosphate was added at 0.77% in all the diets to yield 0.61% total P. Broiler feed intake (FI), body weight gain (BWG), or mortality was not affected by dietary Ca or phytase. Feed efficiency was improved ($P < 0.05$) as dietary phytase increased. Tibia ash percent was reduced ($P < 0.05$) as dietary Ca decreased, but improved with phytase addition ($P < 0.05$). Gizzard and ileal pH were reduced ($P < 0.05$) in broilers fed 0.64% Ca compared with 1.0% Ca. Phytase at 5000 FTU/kg increased ($P < 0.05$) pH in the gizzard, duodenum, jejunum, and ileum. Gizzard Ca solubility and apparent ileal P digestibility

were increased ($P < 0.05$) in broilers fed 0.64% Ca compared with broilers fed 1.0% Ca. Apparent ileal Ca digestibility was increased ($P < 0.05$) in broilers fed 1.0% Ca compared with broilers fed 0.64% Ca. Apparent ileal crude protein digestibility was reduced in broilers fed 1.0% Ca. Phytase improved apparent ileal crude protein digestibility in broilers fed 1.0% Ca, but did not have an effect on broilers fed 0.64% Ca, which resulted in a Ca x phytase interaction ($P < 0.05$). In conclusion, a certain amount of Ca is necessary for adequate tibia ash formation. However, high dietary Ca from limestone increases gastric and ileal pH and reduces apparent ileal P and crude protein digestibility.

Key Words: calcium, phosphorus, phytase, broiler, digestibility

134 Productive performance of laying hens fed different Ca & available P levels. E. Avila-Gonzalez[1], C. Rámirez-Peña[2], S. Chárraga[3], E. Rosales[3], and S. R. Fernández*[3], *[1]Universidad Nacional Autónoma de México, Mexico City, Mexico, [2]GENA Agropecuaria, Acatic, Jalisco, Mexico, [3]DSM Nutritional Products México S.A. de C.V., Guadalajara, Jal, México.*

With the objective to evaluate the hen response to different Ca and P feed concentrations, 1,344 40-weeks-old-Hy Line W36 hens were randomly allocated to 4 treatments, with 8 replicates of 42 hens each (14 hen cages with 3 hens per cage). The birds were housed in an open hen house with curtains; feed and water were provided *ad libitum*. The trial lasted 20 weeks. The treatments were as follows (expressed by production phase; 40 to 50 and 50 to 60 weeks-old); T1, sorghum-SBM-15% DDGS diet; Ca 4.01, Av. P. 0.49 and Ca 4.35 and 0.46 Av. P g/h/d (Hy Line manual 2009, HL2009), T2 as T1 with Ca 3.84, Av. P. 0.39 and Ca 4.20 and 0.36 Av. P g/h/d (Hy Line manual 2003, HL2003), T3 as T2 minus 0.04% Ca and 0.04% Av. P, and T4 as T3 + 4 ppm Rovimix Hy D (50 ppb 25-OH-D_3). All other nutrients were formulated to fulfill the W36 hen nutritional requirements. Data were analyzed as a CRD. Following the results: egg production (%) ($P < 0.05$); T1, 82.7^{b}, T2, 84.8^{a}, T3, 82.4^{b}, T4, 83.5^{ab}. Feed conversion ($P < 0.03$); T1, 1.856^{b}, T2, 1.823^{a}, T3, 1.860^{b}, T4, 1.822^{a}. Egg mass (g/h/d) ($P < 0.01$); T1, 50.4^{b}, T2, 52.3^{a}, T3, 50.4^{b}, T4, 51.3^{ab}. The hens fed HL2009 Ca and P recommendations showed lower egg production and worse FC, than the hens fed HL2003 Ca and P recommendations. The hens fed T3 with the lowest Ca and P levels, showed a lower productive performance compared with T2 and similar to the hens on T1, however, hens fed T4, the diet with lowest Ca and P levels + Hy D showed a productive performance equal to the hens fed HL 2003 Ca and P values. These results suggested that Hy Line 2003 Ca and P recommendations for 40 to 60 weeks-old-hens are closer to the hen requirement than the ones published in 2009, also, Hy D supplementation helped the hens fed the lowest Ca and P treatment to show a productive performance comparable to hens fed the HL2003 feed.

Key Words: hens, calcium, phosphorus, vitamin D, egg production

135 The dynamics of trace elements (Cu, Zn, Mn and Fe) metabolism in the molted layers supplemented with protein, symbiotic and probiotic. H. Anwar* and Z. U. Rahman, *Department of Physiology and Pharmacology, University of Agriculture, Faisalabad, Pakistan.*

The current study was designed to seek the impact of protein, symbiotic and probiotic supplementation on the mineral profile of serum, eggs, muscle and organs (Brain, heart, kidney, liver and spleen). The dietary zinc (3g/kg of feed) was used to induce the molt in 180 white leg horn caged housing birds (70 week old) thereafter allocated to 4 groups 45 birds in each as G1 (control; CP16%, no supplement), G2 (CP18%, No other supplement), G3 (CP16%, Symbiotic @ 85mg/L drinking water) and G4 (CP16%, Probiotic @ 85mg/L in drinking water). Twenty birds were slaughtered from each group at 5% and peak egg production. Blood (to separate the serum), eggs, muscle and organs were collected to digest by the wet digestion method and mineral estimation (mg/L) by atomic absorption spectrophotometer was done. The serum Zn was found significantly high in G4 as compared with G1 and G2. The Zn in muscle and brain found high in G3 comparatively. The Mn of egg in G2 and brain in G3 found high from G1. The Mn level of kidney and liver decreased in G4 as compared with G1. The muscle and brain Fe concentration increased in G3 as compared with G1, while kidney and liver Fe was high in G3 and G1 as compared with other 2 groups. The liver Cu concentration decreased in G2 and G4 as compared with G1. The literature has various reports regarding the impact of mineral supplementation, their organic/inorganic status, different level of supplementation and binding efficacy of different supplemented substances with the minerals. There is no such report regarding the efficacy of probiotic and symbiotic supplementation in the molted layers on the dynamics of mineral metabolism and fate in the body. In current study an immense relationship was seen with the probiotics and serum zinc availability. The decreased level of liver and kidney minerals and enhanced concentration of brain and muscle in supplemented groups is showing their efficiency to conserve these minerals to play significant role in various body functions.

Key Words: molt, layers, trace minerals, protein, probiotics

136 Low inclusion of a blend of organic trace minerals (Zn, Cu, Fe, and Mn) to broiler chickens diet is able to regulate oxidative stress. H. Echeverry*, A. Yitbarek, P. Munyaka, M. A. Alizadeh, P. Wang, O. Karmin, J. C. Rodriguez-Lecompte, and G. Camelo-Jaimes, *University of Manitoba.*

AAAP abstract†

137 Effect of in ovo selenium injection of broiler breeder eggs at 10 days of incubation on tissue selenium concentration and embryo viability. L. M. Macalintal*, A. H. Cantor, A. J. Pescatore, K. A. Dawson, J. L. Pierce, M. J. Ford, T. Ao, H. D. Gillespie, and A. N. Meredith, *Alltech-University of Kentucky Nutrition Research Alliance, Lexington.*

The effect of injecting graded levels of selenium (Se) as seleno-L-methionine (Se-Met) or sodium selenite (Na_2SeO_3) in the yolk of fertile broiler breeder eggs at Day 10 of incubation on tissue Se concentration and embryo viability was investigated. Eggs were injected with 0.1 mL of a phosphate buffered saline solution containing 0, 2.5, 5, 10, 20 or 40 μg Se as either Se-Met or Na_2SeO_3. Two replicate groups of 25 fertile eggs were used for each treatment. After candling, the eggshell surface above the air cell was disinfected, a small hole was drilled, the Se solution was injected, the hole was sealed with glue, and the egg was returned to the incubator. Breast muscle, heart, liver and lung samples were taken from 5 viable embryos per replicate group on Day 20 for Se analysis. Embryo viability values on Day 18 (range = 78 to 98%) and on Day 20 (range = 71 to 90%) were not significantly affected by treatments. In addition, there was no significant effect of treatments on

hatchability. Injecting graded levels of Se resulted in linear increases in tissue Se concentration for both Se sources for all tissues. However, significantly higher ($P < 0.001$) linear regression coefficients were obtained with Se-Met, compared with Na_2SeO_3. The highest slope ratios for Se-Met:Na_2SeO_3 were observed with lung (2.9) and heart (3.6) tissues. The results of this study indicate that injecting broiler breeder eggs with Se as Se-Met or Na_2SeO_3 up to 40 µg Se/egg at Day 10 of incubation has little effect on embryo viability. Furthermore, injecting Se-Met results in greater Se tissue accumulation, compared with injecting the same amount of Se as Na_2SeO_3.

Key Words: in ovo injection, selenium, embryo viability, selenomethionine, broiler

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Food Safety Symposium: Awareness of New *Salmonella* Thresholds

138 Salmonella Risk Assessment on the Farm and in the Processing Plant. R. H. Bailey*[1], R. W. Wills[1], M. L. Rybolt[2], V. V. Volkova[3], J. A. Byrd[4], K. Dazo-Galarneau[1], A. K. Daniel[1], K. L. Hataway[1], T. P. Doler[1], S. A. Hubbard[1], and D. L. Magee[1], *[1]Mississippi State University, Mississippi State, [2]Perdue Farms, Salisbury, MD, [3]Cornell University, Ithaca, NY, [4]Southern Plains Area Research Center, College Station, TX.*

A series of studies was conducted to assist the poultry industry in understanding the risk factors involved in meeting FSIS *Salmonella* performance standards in broilers. Initially, a comparison was conducted of the isolation ability of *Salmonella*-specific protocols: tetrathionate (TT) broth, Rappaport-Vassiliadis R10 (RV) broth, and a secondary enrichment (TR) procedure. All methods were compared in litter and drag swab samples that were collected in broiler grow out houses. Although the number of samples identified as positive by TT and RV were not different, further analysis revealed that TT and RV were generally not in agreement. The TR protocol was shown to be the most sensitive isolation protocol and was subsequently used in a longitudinal field study. The relationships among *Salmonella* occurrence in various samples from broilers and their grow-out environment were investigated in 64 flocks in the southern United States. The increased likelihood of *Salmonella* contaminated carcasses entering the immersion chill tank was associated with higher contamination of the exteriors and crops of birds at plant arrival as well as house environmental samples at the time of harvest and before placement. The best predictors of post-chill broiler carcass *Salmonella* status were the frequencies of *Salmonella* in the litter on the day of harvest and before placement. Immersion chilling appeared to disrupt some of the relationships between *Salmonella* status in processing plant and preharvest samples. Therefore, a study was done to further investigate the prevalence of *Salmonella* at different points along the processing continuum and determine the relationship between the presence of *Salmonella* and *Campylobacter* on the same carcasses at the different points of processing. Carcasses were collected at 3 different points during processing: 1) at the re-hang station following de-feathering and removal of the feet, 2) following the final bird rinse cabinet, and 3) at the immersion chiller exit. The results of this work indicated that the prevalence of both pathogens decreased during processing and there was poor to slight agreement between *Salmonella* and *Campylobacter* status on carcasses.

Key Words: *Salmonella*, prevalence

139 Campylobacter risk assessment on the farm and in the processing plant. J. A. Byrd*[1], R. H. Bailey[2], R. W. Wills[2], M. L. Rybolt[3], V. V. Volkova[4], K. L. Hataway[2], T. P. Doler[2], S. A. Hubbard[2], and D. L. Magee[2], *[1]USDA-ARS-Food and Feed Safety Research Unit, College Station, TX, [2]Mississippi State University, Mississippi State, [3]Perdue Farms, Salisbury, MD, [4]Cornell University, Ithaca, NY.*

Poultry companies continue to produce safe and wholesome products, while facing increased regulatory pressure to control certain organisms indigenous to the production system. Although many risk factors that contribute to Campylobacter levels have been identified, precise identification of the most effective sites for intervention have not been established. A series of studies were conducted to assist the poultry industry in understanding the risk factors involved in meeting FSIS Salmonella performance standards in broilers. It has been established that contamination of the broiler carcass, when present, irrefutably begins on farms, with potential cross-contamination of non-contaminated carcasses during processing Increased carcass contamination has been observed during the transport and holding of live poultry before entering the processing plant, and may continue during processing. Although carcasses exiting the scald tank typically have reduced numbers of *Campylobacter*, contamination of broiler carcasses has been shown to increase during feather and viscera (including crop) removal. Identification of critical control points allows the selection of appropriate and effective intervention strategies to help reduce the number of pathogen contaminated carcasses. Present data strongly suggest that effective programs must incorporate an integrated farm-to-table strategy that begins before the animals are placed on the farm (breeders and hatcheries) and must continue through handling and preparation by the consumer.

Key Words: *Campylobacter*, prevalence

140 FSIS perspective on the public-health basis for new broiler and turkey carcass *Salmonella* and *Campylobacter* performance standards. D. L. Engeljohn*, *FSIS, USDA, Washington, DC.*

FSIS will present an overview of the public health objectives associated with implementing performance standards to reduce the presence of pathogens of public health concern in raw poultry carcasses. A summary of the results of a nationwide baseline study will be presented, identifying the presence and counts of *Salmonella* and *Campylobacter*, as well other microbial indicators of process control on carcasses both before and after evisceration. Results of an FSIS risk assessment and cost-benefit analysis will be used to convey the expected public health benefits and costs associated with reducing exposure of the public to these pathogens of public health concern. Federal goals for reducing illnesses will be identified, and progress associated with the contribution of poultry to the public health burden will be described.

141 *Campylobacter* numbers from the processing lines. J. A. Marcy*, *University of Arkansas, Fayetteville, AR.*

This presentation will include industry data provided to the presenter without plant location or identifiers for both broiler and turkey processors. Some data includes enumeration of *Campylobacter* and other information is only in terms of percent positive.

Key Words: *Campylobacter*, broiler, turkey, processing

142 New and traditional *Salmonella* and *Campylobacter* detection technology and surveillance techniques or, how do we protect the public health and make money for the poultry industry? N. Stern*, *American Academy of Microbiologists, Athens, GA.*

Salmonella and *Campylobacter* are pathogens causing numerous human cases/outbreaks repeatedly associated with poultry products. To enhance poultry microbiological safety, it is incumbent upon the poultry industry to produce commercial products with reduced levels of pathogens or, to eliminate these from poultry products. It is expected that the presently responsible regulatory agency (Food Safety Inspection Service; FSIS) will appropriately monitor and protect the public's safety associated with these products. Adequate methods for enumerating these pathogens (old-fashioned quantitative bacterial methods)

exist for limited numbers of samples and, DNA or immunoassay based technologies will continue to evolve to assess larger numbers of samples. The current approach prescribed by FSIS to monitor adequacy of processing plants for adherence to safety standards call for a single processed carcass among perhaps 100,000 to 1,000,000 carcasses per day to evaluate that plant for compliance. This qualitative standard is held despite large variations in *Campylobacter* numbers seen between individual processed carcasses. An alternative science-based quantitative pathogen assessment of entire process lots will be discussed and should be considered by FSIS and the industry. Currently, many US consumers and both Western Europe and Japan have proscriptions against the use of hyper-chlorination and other harsh chemical processes costing US poultry sales. To enhance market share, the US industry must institute effective on-farm interventions to reduce the need to apply controversial chemical disinfection of carcasses while protecting the public health.

Incubation and Effects Upon Embryo and Hatchling Performance Symposium

143 Egg alterations common to the breeder flock and emerging chick after incubation. E. T. Moran*, *Auburn University, Auburn, AL.*

Yolk relative to albumen is known to increase with average egg weight as the flock ages and to a lesser extent within the extremes at any one age. Increased dietary essential fatty acids with the breeder can improve yolk yield with small eggs provided by young breeder while reducing methionine moderates albumen in large eggs with old hens. Alterations in the amount of albumen can modify late embryonic body mass body mass of the late embryonic development while yolk modulates subsequent yolk sac and post-emergent success of the chick. Hatching eggs of progressive weight provided by mid-age hens encompasses extremes in weight through the entire production cycle. Such eggs having a common background and terms of incubation had similar incidence of non-viable germs and early dead as well as late dead, pips and culls. Chicks at hatch are expected to increase in weight with egg weight and the proportion of each sex to be equivalent, however, males have a wet mass advantage that continues through to hatch. Subsequent short-term holding loss increases with chicks derived from increasing egg weight while loss with males exceeds females. An examination of eggs from 4 commercial breeder sources at 37 weeks and identical terms of production revealed detectable differences in egg weight as well as relative amounts of yolk-albumen; however, each strain exhibited similar differences between the heavy and light weights within the population. Chicks at hatch had a weight that paralleled the egg of origin while their associated yolk sacs differed among strains and followed the amount of yolk. Effects of hatching egg weight on incubation and chick reserves within any one breeder flock at a prime age than can be detected among strain sources.

Key Words: breeder hen, chick weight, egg weight, incubation, post hatch loss

144 The synthesis and storage of glucose in the yolk sac as compared to the liver during chick embryonic development. L. Yadgary*, A. Cahaner, and Z. Uni, *Hebrew university, Rehovot, Israel.*

Toward the end of incubation, the high demand for energy to support the dramatic physiological changes of the hatching process drives the embryo toward catabolism of glucose. Previous studies determined that during chick embryonic development, the liver performs most of the essential processes involved in carbohydrates metabolism and in the supply of glucose to the tissues. Glycogen was detected in the yolk sac membrane (YSM), an extra-embryonic structure responsible for the transfer of nutrients from the contents of the yolk sac (YS) to the chick embryo. Therefore, the current study examined the role of the YSM in the supply of carbohydrates to the broiler embryo during incubation. The levels of glucose and glycogen were measured in the YS and liver from 11E to 21E (day of hatch). Eight fertile eggs were sampled on 0E (fresh eggs), 11E, 13E, 15E, 17E, 19E, 20E and 21E. Glycogen and glucose concentrations (mg/g tissue) in the YS and liver were determined, and absolute amounts (mg) of glycogen or glucose in the YS and liver were calculated. Results show that levels of glucose in the YS increased from 25 mg on 11E to 60 mg on 19E, and then decreased by nearly 30 mg on 21E. Only trace amounts of glycogen were found in the yolk of the fresh egg, whereas on 11E glycogen amount in the YS was 25 mg, and then increased by 10-fold reaching 250 mg on 19E. Between 19E to 21E, glycogen levels decreased by 100 mg. Liver carbohydrates amount had a similar pattern compared with the YS, yet the liver had significantly lower levels of glycogen (20–50 folds lower). Gene expression analysis (by real time PCR) of enzymes involved in carbohydrates metabolism confirmed the gluconeogenic and glycogenic abilities of the YSM. It can be concluded that during the last week of chick embryonic development, the major gluconeogenic and glycogenic tissue is the YS and not the liver. The YS stores most of the carbohydrates needed as an additional source of available energy during the hatching process and after hatch.

Key Words: yolk sac, glycogen, gluconeogenesis, embryo, broiler

145 Effect of applying short periods of incubation temperature during pre-incubation egg storage on the hatchability of broiler eggs. N. A. French*[1], D. Nicholson[1], V. Kretzschmar[2], D. Goyne[2], and J. Veal[2], *[1]Aviagen Ltd., Newbridge, Midlothian, UK, [2]Aviagen Inc., Huntsville, AL.*

This paper will report 2 experiments that investigated whether giving broiler eggs several short periods (4 h) of incubation at 37.5°C during pre-incubation storage improved hatchability compared with untreated eggs. In both trials all eggs were stored at 15.5 to 18.3°C and 60%RH. The short incubation treatment involved moving eggs directly from the egg store into a multistage setter operating at 37.5°C and 43%RH for 4 hours and then moving the eggs directly back into the egg store. In the first trial there were 5 treatment groups (n = 1944 eggs per group): 3d storage - no treatment, 21d storage - no treatment, 21d storage - treated 2x during storage, 21d storage - treated 4x during storage, 21d of storage - treated 5x during storage. The hatchability of all eggs incubated for the five treatment groups were 87.8%, 28.1%, 75.3%, 79.4% and 75.1% respectively. In all three groups where short periods of incubation temperature during storage was applied showed a significant ($P < 0.05$) hatch improvement compared to the 21 day stored controls. The best hatch was achieved when 4 treatments were applied during storage. In the second trial there were 7 treatments (n = 1944 eggs per group): 3d storage - no treatment, 7d storage - no treatment, 7d storage - treated 1x during storage, 14d storage - no treatment, 14d storage - treated 3x during storage, 21d storage - no treatment, 21d storage - treated 4x during storage. The hatchability of all eggs incubated for the seven treatment groups were 89.4%, 86.7%, 89.2%, 83.5%, 87.0%, 62.6% and 76.9% respectively. The treated eggs all hatch significantly better hatch ($P < 0.05$) than their respective controls with the same days of storage. The longer the storage period the greater the hatch benefit of the treatment. The two experiments show that applying 4 hours of incubation temperature (37.5°C) at regular intervals during pre-incubation egg storage significantly improves the hatch of broiler embryos. It is proposed that short periods of incubation during storage allow the embryo an opportunity to repair cell damage that occurs during long storage.

Key Words: egg storage, hatchability, incubation, broiler

146 The influence of incubation on chick quality and broiler performance. R. Meijerhof*, *Poultry Performance Plus, Voorst, the Netherlands.*

The efficiency of hatcheries is often measured in terms of hatchability. However, a non-optimal incubation process does not only result in a

loss of embryos, but also in a loss of chick quality. As chick quality is a driving force for final results, the economical impact of a loss of chick quality is often higher than the impact of a decrease in hatchability. The content of the egg supplies both the building stones for the chicken body and the energy that is needed to build up that body. Especially the temperature during incubation influences the process of development and how well the content of the egg is converted into a chicken. This makes temperature the most important climatic condition during incubation. Especially the energy utilization of the embryo is influenced by temperature. Too high temperatures does not only result in a poor hatchability due to more dead embryos at the end of the incubation process, but also results in a poor utilization of the yolk, less development of the embryo, and less viable chicks. High temperatures especially in the second half of the incubation process result in chicks with significantly smaller hearts at moment of hatch, poor growth and feed efficiency performance and more incidences of ascites at the end of the growing period. The important factor to control during incubation is the temperature inside the egg. This so-called embryo temperature is the result of the balance between heat production and heat loss. As heat loss is influenced by air temperature, but also by air velocity, heat capacity of the air and evaporation of water, embryo temperature and air temperature are not identical, and are even not fully related. A complicating factor in this respect is that an embryo of modern high yielding strains seems to produce more heat during incubation than the more classical type of birds The consequence of this is that the internal egg temperature (embryo temperature) of modern high yielding strains will be higher than of classical strains, if incubator conditions are not adjusted.

Key Words: incubation, chick quality, embryo development

147 Embryological development and diagnostic review of hatch residue. R. M. Hulet*, *The Pennsylvania State University, University Park.*

Research in the area of incubation and hatchery management has increased significantly in the past 5 years. Information on pre-incubation, incubation, and perinatal factors that affect embryonic development, mortality and post-hatch performance have been documented in the literature. Application of this research has been adopted by hatchery manufactures and managers to improve hatchability as well as chick performance in the field. Diagnostic reviews of hatch residue relate back to the effect of these factors on embryological development and mortality. Currently, the use of single stage incubation has increased the precision of embryo growth and development because research has shown this system more accurately meets the demands of the embryos. Recent research has focused on multi- and single-stage hatcheries to determine the proper hatch conditions necessary to optimize embryonic development, chick quality, and subsequent effects on post-hatch performance. Residue analysis can show how increases in shell temperature, independent of machine temperature, can result in increases in embryonic mortality, decreased heart weight as a percentage of chick weight, decreased yolk-free body weight, and increased yolk weight. Some embryological lesions such as malpositions, red hocks, exposed brain, etc. as well as post-hatch ascites has recently been identified with incubator operations. Other factors that contribute to the increase in heat stress on developing embryos include egg size, air flow, age of the embryo, sanitation, and breeder flock fertility. Variation in chick performance in the field can be partially explained by factors affecting growth and development in the hatchery. Therefore, the symposium presentation will show how improvements in our knowledge of the requirements of the developing avian embryo can help improve diagnosis of hatch residue as well as embryonic viability and hatchling performance.

Key Words: hatch residue, embryological development, embryonic temperature, post-hatch performance

148 Review of the Animal Welfare Judging & Assessment Competition (AWJAC) through 2010. C. Heleski[1], G. Golab[2], S. Millman[3], R. Reynnells*[4], J. Siegford[3], and J. Swanson[3], *[1]Michigan State University, East Lansing, MI, [2]American Veterinary Medical Association, Schaumburg, IL, [3]Iowa State University, Ames, [4]United States Department of Agriculture, Washington, DC.*

The concept of an animal welfare (AW) judging contest was presented at the 2001 International Society of Applied Ethology by Heleski, Zanella, and Pajor. The purpose was (and is) to promote concepts of AW science and behavior to undergraduate students using the model of traditional livestock judging. The first AWJAC was held at MSU in 2002 (18 participants, 4 teams, 4 universities). The 2010 contest had 78 participants (18 teams, 9 universities), and now has 3 divisions: undergraduate, veterinary, and graduate students. The AWJAC originally evaluated AW of food animal species but now includes companion, laboratory and exotic animals. The AWJAC includes a team assessment, usually of live animals, and individual assessments of animals in realistic hypothetical situations. Students evaluate and place live animals, or animals in scenarios, relative to the better AW (e.g., health, behavior), then provide oral reasons. For each category, judges evaluate reasoning and placing of animals. Scenarios provide good talking points regarding various aspects of AW, with all students viewing the slides at one time. All students provide qualitative judgments on the AW continuum regarding preferred, acceptable, or unacceptable components. Students integrate quantifiable science-based information with qualitative ethical concerns in this interdisciplinary problem solving exercise. Judges have expertise in AW science and/or knowledge of evaluated species. Teams are composed of 3–5 students, who all participate in the evaluation and recommendations. Guidelines for teams, rules, references and sample scenarios are on the AWJAC Web site. Over 95% of participants (345 students) believe the AWJAC is valuable; they increased their knowledge about AW science, and would recommend participation to peers. Based on recommendations, the contest moved to a 2 d format, added speaker and poster programs and the veterinary and graduate student categories, and is now held in November.

Key Words: animal welfare, behavior, bioethics, judging, assessment

149 Subjective welfare assessments in the hatchery. J. Barton*, *The Poultry Federation Lab.*

AAAP abstract†

150 The effect of perches installed in conventional cages on White Leghorn pullets. S. A. Enneking*[1], H. W. Cheng[2], J. P. Garner[1], P. S. Wakenell[1], D. A. Rubin[3], K. Y. Jefferson-Moore[4], and P. Y. Hester[1], *[1]Purdue University, West Lafayette, IN, [2]USDA Agricultural Research Service, West Lafayette, IN, [3]Illinois State University, Normal, [4]North Carolina A&T State University, Greensboro.*

Enrichments for laying cages are receiving increasing attention by egg producers as a means of meeting the behavioral needs of laying hens. Pullet cage enrichments have received less attention and study. Adapting pullets to perches before placement in enriched laying cages may offer health and welfare advantages over pullets raised without perches. Thus, the objective of this study was to assess the response of Hy-Line W36 White Leghorn pullets to the presence of perches placed in conventional cages. Prior to hatch, 2 round steel Big Dutchman perches were installed in each of 14 cages in parallel arrangement with respect to the feed trough at a height of 8.9 cm from the cage floor resulting in 3.2, 5.1, 7.6, and 10.2 cm of perch space/pullet at hatch, 3, 6, and 12 wk of age, respectively. An additional 14 cages without perches served as controls. Floor space allowances for pullets of all cages were 98, 155, 233, and 310 sq cm/bird and the numbers of pullets/cage were 38, 24, 16, and 12 at hatch, 3, 6, and 12 wk of age, respectively. A sample of pullets from each cage was evaluated for foot health, BW, right adrenal weight, and packed cell volume (PCV) at 3 (PCV at 4.4 wk), 6, and 12 wk of age. Data were analyzed using an ANOVA. Behavioral observations indicated that pullets began using perches as early as 2 wk of age. Pullets with perches showed an increase in BW at 12 wk of age as compared with 12 wk old pullets without perches, with no effect on BW at 3 and 6 wk of age (treatment by age interaction, $P < 0.03$). The gross right adrenal weight was not affected by the perch treatment, but the relative right adrenal weighed less ($P = 0.06$) for pullets given access to perches as compared with controls, an indicator that pullets with perches were less stressed. Pullets showed little to no hyperkeratosis of the foot-pads and toes to 12 wk of age. The incidence of hyperkeratosis and PCV were similar between pullets reared in cages with perches as compared with those in cages without perches. In conclusion, these results to 12 wk of age indicate that the presence of perches in a conventional cage did not detrimentally affect pullet performance and well-being.

Key Words: perch, White Leghorn, body wt, adrenal, PCV

151 Neuroanatomical characterization of the lower spinal cord and its possible influence on gait in chickens, *Gallus gallus*. G. Nagarajan*, S. W. Kang, R. F. Wideman, and W. J. Kuenzel, *University of Arkansas, Fayetteville.*

Rapid growth of broiler chickens can cause leg weakness and abnormal walking behavior or gait. This study focuses on the anatomical characterization of motor neurons in the spinal cord involved in motor movement of the legs. Broilers were raised from hatch to 5 weeks of age in floor pens. Feed and water were provided ad libitum and birds given a photoperiod of 20h of light and 4h of dark. Body weight was recorded weekly and each bird was given a numerical gait score described by Kestin et al. (Vet Rec. 131:190–194; 1992) that ranged from 0 (completely normal) to 5 (unable to stand). Three groups of birds (controls, high gait score and normal leg bones, high gait score and femoral head separation) were sampled at 30 d of age. Blood samples were taken followed by sampling the synsacral region that was dissected to expose the spinal cord and placed in 4% paraformaldehyde. Lower spinal cord segments were sectioned and nissl stained. Plasma corticosterone level, an indicator of stress, was determined by RIA and 3–4 fold increase was found in 2 experimental groups with high gait scores compared with controls ($P < 0.08$ and $P < 0.02$ respectively). Motor neurons in the ventrolateral motor column of the lumbosacral region (LS1-LS6) of birds with a gait problem and normal femoral bones were shown to have changes in the cell bodies of neurons. Specifically, the perikarya of motor neurons were more globular in appearance with fewer projections. In contrast, the motor neurons in controls and those with high gait scores and femoral head separation had normal star shaped characteristics of the motor neurons in the ventral horn. Cell Surface

Index (circumference/cell diameter) of motor neurons from birds with the high gait score and normal leg bones was decreased 7.04% when compared with controls ($P < 0.05$). Results of this study indicate that this particular gait problem that occurs infrequently, is independent of the one reported from femoral head separation and necrosis in broilers.

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Key Words: lumbosacral region, gait score, lateral motor column, corticosterone, femoral head

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Extension and Instruction

152 Development of a comprehensive and integrated educational program for beginning farmers and ranchers. I. Reyes-Herrera*[1], A. M. Donoghue[2], J. R. Moyle[2], H. L. Goodwin[1], J. M. Burke[3], D. M. Burner[3], R. L. Raper[3], A. C. Fanatico[4], O. J. Gekara[5], G. Kuepper[6], A. Wells[6], T. Spencer[7], M. Hale[7], and D. J. Donoghue[1], *[1]Dept. Poultry Science, University of Arkansas, Fayetteville, [2]Poultry Production and Product Safety Research Unit, USDA-ARS, Fayetteville, AR, [3]Dale Bumpers Small Farms Research Center, USDA-ARS, Booneville, AR, [4]The Goodnight Family Sustainable Development Program, Appalachian State University, Boone, NC, [5]Dept. Agriculture, University of Arkansas at Pine Bluff, Pine Bluff, [6]The Kerr Center for Sustainable Agriculture, Poteau, OK, [7]National Center for Appropriate Technology, NCAT, Fayetteville, AR.*

Agriculture is one of the most important economic sectors of the country, particularly in the South. Unfortunately, a vast majority of farm operators are reaching retiring age (60+ years), while the number of young rural people interested in agriculture continues to decline. In contrast, the latest Agricultural Census showed an increase in the number of middle aged people who want to get into agriculture, with nearly 300,000 new farms beginning operation since the last census in 2002. Most of these new and beginning farmers and ranchers come from urban or suburban origins and have worked in a different career for several years. Few of these new farmers have the adequate training to be successful in their agricultural operations. To support the success of new and beginning farmers, timely and effective training and learning programs are greatly needed. We are creating a unique learning and production program that uses elements and strategies that are easy and inexpensive to implement and manage (poultry, small ruminants and agroforestry), while providing quick returns and multiple marketing opportunities. Our specific goals are to: 1) develop a comprehensive modular outreach/training program that provides beginning farmers with relevant knowledge and tools to operate ecologically and financially sustainable farms, focused primarily on integrated poultry, livestock and agroforestry systems; 2) implement various delivery strategies for our programs including an eLearning system and farmer friendly publications; 3) offer unique experiential learning opportunities such as workshops and internships for beginning farmers at production farms; and 4) create and offer custom mentoring strategies to provide an effective support system for farmers. This dynamic program is generating specific training and learning opportunities and networking systems for new and beginning farmers and ranchers. This program is funded by the USDA-NIFA-BFRDP 2010–03143.

Key Words: educational program, beginning farmers and ranchers

153 Carbon footprint of poultry production farms in south Georgia. C. Dunkley*[1], B. Fairchild[2], C. Ritz[2], B. Kiepper[2], and M. Lacy[2], *[1]University of Georgia, Tifton, [2]University of Georgia, Athens.*

A study was conducted in south Georgia to determine the Green House Gas (GHG) emissions from poultry production farms. The study included; broiler grow-out farms, pullet farms and breeder farms from one commercial broiler complex. Data collection included activity data from each farm (in the form of fuel bills and electricity bills), house size and age, flock size and number of flocks per year and manure management. Emissions were calculated using a GHG calculation tool. The carbon dioxide, nitrous oxide and methane emissions were computed and a carbon footprint was determined. Emission from each of the production systems was assessed and comparisons were made based on house construction and age of the house. The results from the study showed that about 68% of the emissions from the broiler and pullet farms were from propane use while only 0.3% of the total emissions from breeder farms were from propane use. On breeder farms, about 85% of GHG emissions were the result of electricity use while the pullet and broiler grow-out farms had 30% and 29% emissions respectively from electricity use. The study showed that emissions increased with increased house age. Even though the GHG emissions from poultry production farms were small, the study showed that there was still room for improvements and modifications such as replacing old inefficient fans and installing attic inlets on these farms to reduce emissions. The improvements or modifications will have to be done on a farm by farm basis because no 2 farms have the same physical conditions.

Key Words: carbon footprint, poultry, green house gases

154 Climate change and poultry production: Training and research options. J.A. Olupona*, O.A. Owosibo, and O.O. Adejinmi, *Federal College of Animal Health and Production Technology, Ibadan, Oyo, Nigeria.*

Livestock production contributes significantly to green house (GHG) emissions which have been implicated in climate change. Though the impact of poultry production is significantly less compared with other livestock species, there is need to reduce the high proportion of poultry's share in global GHG emission which stems from the feed supply chain with the adoption of highly feed efficient and resilient strains. However, according to feedstuffs weekly newspaper report, most college students in United States of America do not grasp the scientific basis of the carbon cycle which is an essential skill in understanding the causes and consequences of climate change. A similar study was therefore carried out in Nigeria to assess the fundamental scientific knowledge of college students on the issue of climate change. About 25 students from 4 secondary schools in South western part of Nigeria which were initially assembled for an annual quiz competition program organized by the World Poultry Science Association Nigeria branch (WPSA-NB) during the African international poultry summit held in University of Abeokuta, Nigeria on 22–25 February 2011. The students were interviewed on their level of awareness of this important environmental issue using a one-on-one approach. Though, 95% of the students initially put up an impressive performance in the college quiz program on their level of understanding in the area of poultry production, their level of awareness on climate change was low since 52% of the students did not understand the process that lead to climate change. Therefore, improving students understanding of the biological principles could make them better prepared to deal with environmental issues such as global climate change. Also, the need for a new way of teaching these scientific principles cannot be overemphasized. This can be done through training the trainer program. Also, there is need to sustain a program such as the college quiz competition and even extend a training like this to local farmers. Moreover, climate change volunteers should be established in our schools and colleges.

Key Words: climate change, college students, training

155 Poultry farm management programs for new and existing growers. J. R. Timmons*[1], J. L. Rhodes[2], and J. R. Nottingham[3], *[1]University of Maryland, Salisbury, [2]University of Maryland, Centreville, [3]University of Maryland, Princess Anne.*

Broiler production is the largest agricultural revenue generator in Maryland (MD). The University of Maryland Extension (UME) has developed several educational programs for MD poultry growers. The first program was developed to address production and environmental issues. A series of workshops were conducted quarterly in 2 MD locations. Some of the topics discussed were energy efficiency, environmental regulations, avian diseases, and manure handling. Over 250 producers have been educated by this program. Some results of this program are 55% of participants would implement one of the disaster preparation steps discussed, and 55% had a better understanding of Environmental Protection Agency (EPA) expectations regarding Concentrated Animal Feeding Operation (CAFO) inspections. A second UME program, Poultry Farm Management Training & Certification for New Growers, was developed for potential poultry growers as part of the New Source Performance Standard for EPA CAFOs. This workshop is a required component of the MD Department of Environment New Source Performance Design Criteria for Poultry Operations. All new growers in MD must attend this class before receiving their National Pollutant Discharge Elimination System CAFO permit. This workshop was designed to teach new poultry growers the various aspects of poultry production. Three workshops have certified over 70 participants. Some results of this program include 50% rated the workshop excellent and 89% had a better understanding of a broiler operation. A third program was developed for Vietnamese and Korean poultry producers. There are approximately 100 Korean and Vietnamese growers on MD's Eastern Shore and Delaware. These growers have the potential to constitute a significant impact on MD's poultry industry and the environment. Critical information on CAFOs, best management practice installation, and related water quality information was presented by translating workshop materials into Korean and Vietnamese. Maryland Poultry Educational programs provide farm families with educational resources to assist with management decisions as they develop and operate economically viable and environmentally responsible poultry operations

Key Words: broiler, CAFO, environment

156 Performance characteristics and cost benefits of village chicken fed compounded ration under intensive and semi- intensive system of management. J. A. Olupona*, O. A. Owosibo, O. O. Adejinmi, and A. M. Raji, *Federal College of Animal Health and Production Technology, Ibadan, Oyo, Nigeria.*

The growth potential of village chickens in Nigeria was evaluated by comparing their growth performance under intensive and semi-intensive systems of management. Fifty-two chicks of 8 weeks old were collected from villages in Ibadan South West local government and individually raised in cages. Hatch mates of cage-raised chicks (n – 56) remained with the farmers and were raised under semi-scavenging conditions. On-farm made grower mash (18% CP) was fed for chicks raised under intensive conditions and the birds were treated against common diseases and parasites. Data were collected on feed intake, weight gain and growth efficiency. Feed costs (FC) were calculated by multiplying total feed intake by price per kg feed. Revenue (RV) was calculated by multiplying final weight per bird by price per kg live weight of chicken. Gross margin over feed cost was calculated by subtracting FC from RV. Village and systems of management significantly ($P < 0.05$) influenced growth rates. The values for bird under intensive conditions were significantly ($P < 0.05$) higher than for birds under semi-scavenging conditions for feed intake, weight gain and growth efficiency. Economic evaluation showed a positive mean gross margin with a wide variation. Similarly, both rate of return on feed costs and bird costs showed wide variation. It is concluded that growth potential of village chicken can be enhanced by providing enough feed under semi-scavenging condition; however, It may not be economically justifiable when other costs such as labor cost are taken into consideration to improve feeding of local chicken except with farm waste.

Key Words: village chicken, semi-scavenging, feed cost, revenue, growth potential

157 Transforming bird health and managerial considerations into caloric costs in the production environment. R. Teeter*, L. Newman, A. Beker, and C. Broussard, *Department of Animal Science, Oklahoma State University, Stillwater.*

AAAP abstract†

158 Pathology associated with a chicken astrovirus isolated from broiler chickens with runting and stunting syndrome. G. Zavala*, S. Cheng, C. Brown, and J. Zhang, *Department Of Population Health, University of Georgia, Athens.*

AAAP abstract†

159 Comparative pathology of diseases of tendons in broilers and broiler breeders. F. Hoerr*, *Thompson-Bishop-Sparks State Diagnostic Laboratory, Auburn, AL.*

AAAP abstract†

160 Histopathological changes associated with white striping in broiler breast muscles. V. A. Kuttappan*[1], H. L. Shivaprasad[2], B. M. Hargis[1], F. D. Clark[1], S. R. McKee[3], and C. M. Owens[1], *[1]University of Arkansas, Fayetteville, [2]University of California, Davis, [3]Auburn University, Auburn, AL.*

White striping is a characterized grossly by the occurrence of white striations, seen parallel to the direction of muscle fibers, on broiler breast fillets and thighs. Based on visual evaluation of the intensity of white striping, breast fillets can be categorized into normal (NORM), moderate (MOD) and severe (SEV) categories. A detailed microscopic evaluation of the fillet samples could provide information regarding the structural and compositional changes associated with the occurrence of white striping. The present study was undertaken to evaluate the details of histological changes occurring in the fillets with respect to the 3 degrees of white striping. Representative breast fillets, for each degree of white striping (n = 20), were collected from 45-d-old broilers, around 2 h post mortem. From each fillet, 2 tissue samples were obtained and fixed in 10% neutral buffered formalin. To identify and differentiate the histological changes, slides were prepared and stained using Hematoxylin and Eosin and Masson's Trichrome stains. Major changes observed in the MOD and SEV samples consisted of loss of cross striations, variability in fiber size, increased eosinophilia, floccular/vacuolar degeneration and lysis of fibers, mild mineralization, occasional regeneration (nuclear rowing and multinucleated cells), mononuclear cell infiltration, lipidosis and interstitial inflammation and fibrosis. Lesions were visually scored mainly for degeneration and necrosis, fibrosis and lipidosis in the samples. The scale used to score the samples ranged from 0 (normal) to 3 (severe). There was a significant ($P < 0.05$) increase in mean scores for degenerative or necrotic lesions, fibrosis and lipidosis as the degree of white striping increased from NORM to SEV. The histopathological findings from the present study show that the changes occurring in white striping are similar to muscular dystrophy of unknown cause.

Key Words: white striping, broiler breast fillets, histopathological changes, fibrosis and lipidosis, muscular dystrophy

161 The efficacy of two *Mycoplasma gallisepticum* vaccines in laying hens. N. Ferguson-Noel*, S. Williams, and V. Laibinis, *University of Georgia, Athens.*

AAAP abstract†

162 Tracking infectious laryngotracheitis CEO vaccine: Field to processing. D. L. Brinson*, M. Garcia, G. Zavala, S. Riblet, L. Chappell, L. Dufour-Zavala, A. Vagnozzi, P. O'Kane, and R. Espinosa, *Poultry Diagnostic And Research Center, Department of Population Health, College of Veterinary Medicine, The University of Georgia, Athens.*

AAAP abstract†

163 The effect of vectored HVT+IBD (Vaxxitek HVT + IBD) vaccination on body weights, uniformity and virus shedding in commercial broilers. A. T. Garritty*, *Merial Select Inc., Gainesville, GA.*

AAAP abstract†

164 Protection and virus shedding after challenge with various infectious bursal disease virus isolates in commercial broilers vaccinated with a vector HVT + IBD vaccine. E. Montiel*, N. Pritchard, and D. Smith, *Merial Select Inc.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Marek's Disease

165 Use of CVI988 in optimizing revaccination protocols against Marek's disease. A. K. Pandiri*, A. L. Cortes, and I. M. Gimeno, *Experimental Pathology Laboratories Inc., Research Triangle Park, NC.*

AAAP abstract†

166 Alteration of a single amino acid in the basic domain of Marek's disease virus Meq oncoprotein plays an important role in T-cell transformation. S. Reddy*, A. Sun, O. Khan, L. F. Lee, and B. Lupiani, *Texas A&M University, College Station.*

AAAP abstract†

167 Correlation between Marek's disease virus replication rates and pathotype based on fifteen virus strains. J. Dunn*, *USDA-ARS-ADOL.*

AAAP abstract†

168 Attenuation of Marek's disease virus lacking the meq oncogene in cell culture. L. Lee*, *USDA, Avian Disease and Oncology Lab.*

AAAP abstract†

169 Marek's disease virus induced transient paralysis—A closer look. M. Heidari*, M. Xu, H. Zhang, and L. Lee, *USDA-ARS-Avian Disease and Oncology Laboratory.*

AAAP abstract†

170 Appraisal of experimental and commercial Marek's disease vaccines to induce bursal and thymic atrophy. R. Silva* and J. R. Dunn, *USDA/Agricultural Research Service, Avian Disease and Oncology Laboratory, East Lansing, MI.*

AAAP abstract†

171 Chronological study of the pathogenesis of oncogenic and attenuated Marek's disease virus strains in the lung. I. Gimeno*, A. L. Cortes, O. J. Fletcher, and A. R. Pandiri, *Department of Population Health and Pathobiology, College of Veterinary Medicine, North Carolina State University, Raleigh.*

AAAP abstract†

172 Measurement of CD4, CD8, class II, and macrophage antigen expression in chicken lungs. O. J. Fletcher*, X. Tan, L. Cortes, and I. Gimeno, *College of Veterinary Medicine, North Carolina State University, Raleigh.*

AAAP abstract†

173 Replication of recombinant herpesvirus of turkey expressing genes of infectious laryngotracheitis virus (LT-rHVT) following in ovo and subcutaneous vaccination. A. L. Cortes*, E. Turpin, C. Williams, and I. M. Gimeno, *Population Health and Pathobiology Department, College of Veterinary Medicine, North Carolina State University, Raleigh.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Monday, July 18
SYMPOSIA AND ORAL SESSIONS

Coccidiosis I

174 A new species of *Eimeria* (Apicomplexa: Eimeriidae) of turkeys (*Meleagris gallopavo*). S. Fitz-coy*, *Merck And Co., Salisbury, MD.*

AAAP abstract†

175 Nicarbazin: Field experiences improving intestinal health. J. Ruiz*, H. Cervantes, and K. Bafundo, *Phibro Animal Health, Fayetteville, AR.*

AAAP abstract†

176 Economic consequences of weather and coccidiosis in one U.S. broiler integration. L. J. Newman* and R. Teeter, *Intervet/Schering-Plough Animal Health.*

AAAP abstract†

177 Working with Coccivac D in a dry climate. J. Fricke* and T. E. Inglis, *Poultry Health Services Ltd., Airdrie, Alberta, Canada.*

AAAP abstract†

178 An alternative method of delivering *Eimeria* oocyst vaccines to protect against avian coccidiosis. M. Jenkins*, S. Klopp, D. Ritter, R. Fetterer, and K. Miska, *Agricultural Research Service, USDA, Beltsville, MD.*

AAAP abstract†

179 Attenuation of development of *Eimeria maxima* following gamma irradiation. R. Fetterer*, M. C. Jenkins, and R. C. Barfield, *Animal Parasitic Diseaes Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

AAAP abstract†

180 Oocyst shedding patterns and immune response of turkeys following coccidiosis vaccination. M. Behl*[1,2], D. Caldwell[2], H. He[3], M. Kogut[3], R. Spasojevic[1], and M. Farnell[2], *[1]Willmar Poultry Company d.b.a. Ag Forte, Willmar, MN, [2]Texas AgriLife Research and Extension, College Station, [3]USDA-ARS, College Station, TX.*

Coccidiosis causes considerable economic damage to the turkey industry. Field strains of *Eimeria* easily develop resistance to anticoccidials making them less effective for long-term use. The objective of the current study was to assess coccidiosis vaccine-associated oocyst shedding patterns and mucosal gene expression in turkeys. In Trial 1, poults were vaccinated via oral gavage with approximately 500 oocysts obtained from a commercially available vaccine at day of hatch. Fecal samples were obtained daily and diluted in water. Oocysts were counted using a hemocyometer. In Trial 2, poults were orally gavaged with water or with approximately 1,000 oocysts on day of hatch and killed at 5, 10, 13, 17, and 20 d post vaccination. Oocyst shedding was determined by shedding patterns observed in Trial 1. Intestinal sections adjacent to Meckel′s diverticulum, the ileocecal junction, and midpoint of the cecum were collected. These tissues were evaluated for mRNA expression of IL-10, IL-1β, and GAPDH. In Trial 1, peaks in oocyst shedding occurred on 5–6, 13–17, and 19–20 d post vaccination. Shedding ceased at approximately 20 d post vaccination. In Trial 2, no significant changes in gene expression of either IL-10 or IL-1β were detected in the tissue adjacent to Meckel′s diverticulum. At the ileocecal junction, IL-10 was significantly upregulatated on d 5 and 17, and IL-1β was significantly ($P < 0.05$) downregulated on d 20 post vaccination. In the ceca, both IL-10 and IL-1β were significantly upregulated on d 5, 10, and 13. On d 17, IL-10 was significantly upregulated and later downregulated on d 20. The upregulation of IL-10 and downregulation of IL-1β typically indicates a reduction of immune functionality which is typically seen after clearance of a pathogen. Further research needs to be conducted to elucidate the overall immune response of turkeys during an *Eimeria* infection.

Key Words: turkey, coccidiosis, vaccine, IL-10, IL-1β

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Infectious Bursal Disease

181 Immunopathogenesis of infectious bursal disease virus in chickens. A. Rauf*, M. Khatri, M. V. Murgia, and Y. M. Saif, *The Ohio State University.*

AAAP abstract†

182 Detection and differentiation of high and low pathogenic strains and reassortant infectious bursal disease viruses by a multiplex RT-PCR/RFLP assay that simultaneously analyze both genomic segments. A. Banda*, M. Hernandez, G. Tomas, D. Hernandez, P. Villegas, L. Maya, Y. Panzera, and R. Perez, *Poultry Research and Diag. Lab., College Of Veterinary Medicine, Mississippi State University, Pearl.*

AAAP abstract†

183 Massively parallel cDNA sequencing (RNA-seq) analysis of immune tissues from IBDV-infected birds. C. L. Keeler Jr.*, C. Boettger, M. N. Maughan, J. K. Rosenberger, and C. Schmidt, *Department of Animal and Food Sciences, University of Delaware, Newark.*

AAAP abstract†

184 Natural reassortants of very virulent infectious bursal disease virus (vvIBDV) containing genetic elements from both serotype 1 and 2 viruses. D. Jackwood*, S. E. Sommer-Wagner, B. M. Crossley, S. T. Stoute, P. R. Woolcock, and B. R. Charlton, *Food Animal Health Research Program, The Ohio State University/OARDC, Wooster.*

AAAP abstract†

185 Combining FTA card with reverse genetics allows characterization of the antigenicity of infectious bursal disease viruses on a global scale. V. Durairaj*, H. S. Sellers, and E. Mundt, *Poultry Diagnostic and Research Center, Department of Population Health, College of Veterinary Medicine, University of Georgia, Athens.*

AAAP abstract†

186 A prime-boost approach for DNA-mediated vaccination against infectious bursal disease in broiler chickens with maternal antibody. C. C. Wu*, M. Hsieh, and T. L. Lin, *Department of Comparative Pathobiology, Purdue University, West Lafayette, IN.*

AAAP abstract†

187 Biological monitoring of vaccine take and productive parameters in broilers vaccinated with immune complex and recombinant vector vaccines against infectious bursal disease (IBD). L. Sesti*, C. Kneipp, Y. Gardin, and B. Alva, *Ceva Saúde Animal Ltda., Rua Moanoel Joaquim Filho 303, Paulínia, Brazil.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

188 Choice feeding of organic meat chickens. A. C. Fanatico*[1], V. B. Brewer[2], C. M. Owens[2], and A. M. Donoghue[3], *[1]Appalachian State University, Boone, NC, [2]University of Arkansas, Fayetteville, [3]USDA Agricultural Research Service, Fayetteville, AR.*

Specialty poultry production is growing, including free-range, organic, and small flocks; however, feed cost is high. Choice feeding, using a high-protein feed with mineral/vitamin supplements provided separately from a grain feed, may allow birds raised in relatively open housing with largely uncontrolled environmental conditions to more precisely meet their nutritional requirements by self-selection compared with feeding a fully-formulated diet. Choice feeding may also allow producers to use feed grains produced on their own farms to reduce transportation and milling. A study was conducted to determine the impact of choice feeding on performance in organic meat chickens. Pens of medium-growing chickens (20 birds per pen) were randomly assigned to one of 2 treatments: fully formulated diet (F) or choice (C) diet. There were 4 replications of these treatments. Birds were raised in floor pens in a naturally ventilated house; popholes provided access to grassy yards during the day. During the starter period (0–27 d), the C treatment received formulated feed as well as high-protein feed and grain, but during the grower/finisher period (28–64 d), only high-protein feed and grain. Birds were commercially processed at 64 d. The organic formulated diet had 21% CP, while the choice diet selected by birds from 28 to 34 d had 13.2% CP and the choice diet at 57–64 d was 12% CP. Performance data were subjected to a *t*-test. There was no difference between treatments in weight gain during the grower/finisher period, but overall weight gain was higher for F birds ($P < 0.05$). However, feed intake was higher and feed efficiency was inferior for F birds compared with C ($P < 0.05$). Although carcass weights and breast fillet weights were heavier in F birds, there was no difference in yields (carcass, breast, wing, or leg) between treatments ($P > 0.05$). The Choice diet was less expensive than the Fully Formulated diet ($0.58/kg based on the diet selected the last week of production vs. $0.66/kg). These data indicate that while F birds gained more weight than C, feed efficiency was poor and the opportunity for organic chickens to self-select feeds may be more efficient and save costs.

Key Words: organic, feeding, self-selection, meat chickens

189 Cage design and management effects on ammonia levels in laying hen houses. J. A. Mench*[1], A. S. Keiss[2], P. Y. Hester[3], R. C. Newberry[4], and J. P. Garner[3], *[1]University of California, Davis, CA, [2]Mississippi State University, Mississippi State, MS, [3]Purdue University, West Lafayette, IN, [4]Washington State University, Pullman.*

Excessive ammonia levels in commercial laying hen houses can negatively affect hen health and performance. However, ammonia may be difficult to manage because levels are influenced by a complex interaction of factors. This interaction is difficult to study in a conventional experiment where only a few factors can be manipulated. Epidemiological approaches, which use the variation between houses and producers to study outcomes, provide a a approach to this problem. The objective of this study was to use such an approach to identify features of cage design and house management influencing indoor ammonia levels both within producers (across houses) and between producers. A universal cage measurement system and a management survey were developed in consultation with industry. Commercial houses (n = 188) were then visited. Atmospheric ammonia was recorded from 9 standardized locations per house using a Dräger Pac III ammonia meter. For analysis, variables without sufficient variation were removed. Highly correlated variables were condensed into single summary variables, and the GLM was used to identify a model that best described variance in ammonia. Overall the resulting analysis explained 90% of the variation in ammonia levels within and between producers. The mean ammonia level found was 13.7 ppm, but 25% of houses had levels exceeding 25 ppm. Within producers, ammonia was higher in vertical than A-frame cages ($P = 0.004$). Between producers, cooled houses had less ammonia ($P < 0.001$). Both within and between producers, nipple drinkers ($P < 0.001$) and drinkers placed at the back of A-frame cages ($P = 0.002$) were associated with increased ammonia, and ammonia decreased with increasing house area ($P = 0.001$). Although removing manure from the house decreased ammonia, particularly between producers for vertical cages ($P = 0.007$), drinker design and placement had a greater influence than manure handling (e.g., within a producer, drinker type explained over 3 times more variation in ammonia than manure handling). Together, these results suggest that ammonia release from manure under warm conditions can be most effectively minimized through drinker design and placement to avoid moisture build-up.

Key Words: ammonia, drinker, manure management

190 Bacterial community dynamics in poultry litter treated with LitterGuard studied by DGGE and 454 pyrosequencing. A. K. Kaushik*, A. Nalian, J. Bray, and A. M. Van-Kley, *Stephen F. Austin State University, Nacogdoches, TX.*

Bird performance is largely affected by intestinal and litter bacterial communities in poultry houses. Poultry litter, a mixture of sawdust and manure, provides a baseline to analyze the bacterial communities found in the poultry houses. LitterGuard is designed to reduce the presence of pathogenic bacteria and lower ammonia production in litter. LitterGuard was studied using denaturing gradient gel electrophoresis (DGGE) and pyrosequencing. DNA was extracted from samples collected at 8 different time points from 4 broiler houses during 2 flock rotations. A total of 128 samples were analyzed with DGGE and 40 samples with pyrosequencing. Overall, we found an average of 250 taxa in each sample from DGGE results. However, there were no significant differences in richness or composition of the bacterial communities between the houses. Pyrosequencing analysis resulted ~300,000 genomic sequences and we were able to identify a total of 188 taxa in the pretreated samples and 199 taxa in the post treated samples. It was found that *Cornybacterium* spp., *Stapylococcus* spp., *Lactobacillus* spp., *Salinicoccus* spp., *Nocardiopsaceae* spp. and *Yania* spp. were highly abundant in both the pre-treated and post-treated samples. Using multivariate analysis we found that the bacterial structure before treatment was significantly different than after treatment. However, no significant difference was found in the composition and relative abundance of bacterial communities between the treated and untreated houses. There was no difference found in bird performance between the treated and non-treated houses. Pyrosequencing can be used with DGGE for in-depth analysis of patterns of bacterial communities in a variety of habitat.

Key Words: poultry litter, bacterial communities, DGGE, pyrosequencing, multivariate analysis

191 Development of a novel polymer plenum floor for broilers to replace litter and reduce house/environmental ammonia. M. Dekich* and J. Harter-Dennis, *Avihome LLC, Salisbury, MD.*

AAAP abstract†

192 Alternative fuel for brooding turkey poults: Bird and environmental impacts. A. J. Bardella*, P. H. Patterson, R. M. Hulet, and T. L. Cravener, *Penn State University, University Park.*

Greater energy costs and nutrient management concerns are motivating Pennsylvania poultry producers to consider cost saving, energy efficient heating alternatives and management options to stabilize waste nutrients. This field study compared a conventional propane-fueled (P) brooder/heating system for turkey poults to one fueled by spent turkey litter (L) which could potentially address both energy efficiency and waste management problems. On 2 farms L and P fueled houses were monitored for propane and litter consumption, ash production, temperature, relative humidity, air quality (NH3 and CO2, ppm) and litter score (0 as highest quality and 5 as lowest). One farm had a single house with a conventional P brooding/heating system. The second farm had 2 houses utilizing a 586kW (2 mill BTU/hr) L fueled boiler to produce heat for brooding and rearing and 7 ceiling mounted heat exchangers per house for distribution. The houses were 15.2 × 183 m with approximately 8,450 birds/house. The L fueled furnace consumed 309 t of litter and produced 13.7 t of ash, which reduced propane usage by 90%. House levels of CO2 were significantly lower for the 2 L fueled houses (2140, and 2085 ppm) compared with the P house (3570 ppm). House NH3 levels and litter quality were not significantly different between treatments, with values ranging from 0.80 to 49 ppm NH_3 and litter scores between 0 and 4.33 corresponding with low values at placement on new litter and higher values at the conclusion of the brooding phase. House temperatures were similar in both systems and not significantly different averaging 25.4 C for the P, and 27.3 and 26.7 C for the L houses during the brooding phase. However, average relative humidity was reduced by 18% utilizing L fuel (59.4 and 59.3%) vs. 71.6% for P fuel. Overall, lower humidity and CO2 levels were an environmental benefit to the birds. Grower propane usage was reduced 90% and litter tonnage was reduced 20-fold. The residual ash is a nutrient dense, stable by-product with potential value as a fertilizer (26.5% P_2O_5, 13.8% K_2O) or feed phosphate (11.6% P, 19.4% Ca).

Key Words: turkey, alternative fuel, relative humidity, carbon dioxide, ammonia

193 The effects of GalliPro Max on broiler live performance, footpad lesions, and litter quality. M. A. Bailey*, Z. T. Williams, J. B. Hess, and K. S. Macklin, *Auburn University, Auburn, AL.*

In recent years, pressure from consumers and government regulation has driven an interest in eliminating the use of antibiotics in commercial poultry feeds. Probiotics have shown the potential to replace growth promoting antibiotics in that they improve feed conversion and weight gain. In this experiment the competitive exclusion product GalliPro Max (containing *B. subtilis*) was evaluated for its effect on live bird performance, footpad lesions, and litter scoring when fed in a corn-soy diet. In this study 1,000 Ross males were raised to 42 d under commercial conditions. Four treatments were added to standard diets and randomly assigned to 10 pens: negative control (NEG), virginiamycin at 5g/ton (POS), GalliPro Max (GPM) and GalliPro Max with virginiamycin (GPM-V). Pen body weights, feed consumption, feed conversion, percent mortality, footpad lesion scores and indexing of caked litter were measured on d 0, 21, 35, and 42. No statistical significance ($P < 0.05$) was found between the 4 treatments for pen body weights, foot pad lesion scores, caked litter indexing and mortality. Feed consumption and adjusted feed conversion were significantly higher in NEG at d 21 compared with the other 3 treatments, but no significance was observed on subsequent days. Contrast analysis showed that treatment GPM-V had better feed conversion at both d 35 and 42 compared with NEG. Although not significant, the treatments containing GPM improved bird live performance over the controls. GPM and GPM-V had 4 and 6 point improvements in adjusted feed conversion over the controls and these 2 improved bird average final weight by 0.21 and 0.20 lb over the controls. POS had more footpad lesions than the 2 groups containing GalliPro Max. Mortality was lower in the 2 treatments containing GalliPro Max compared with NEG and POS. Caked litter was higher in the 2 treatments that contained virginiamycin compared with NEG and GPM. According to our results GalliPro Max was effective in improving overall bird live performance either with or without the addition of virginiamycin.

Key Words: broiler, probiotic, virginiamycin

194 Evaluation of air and litter quality with microbiological fluctuations in commercial broiler facilities using a biological and a chemical litter treatment. D. B. Gholap*, K. S. Macklin, J. P. Blake, and S. F. Bilgili, *Department of Poultry Science, Auburn University, Auburn, AL.*

For 6 commercial broiler houses (12.2 × 152.4 m), 3 were treated with Litter Guard (LG) 7 d before placement; 18.9 L of LG was mixed into 378.5 L water. Three others had Poultry Litter Treatment (PLT) applied to the center brooding area 1 d before placement at a rate of 24.4kg/100 m^2. Two houses each contained 2, 3, or 6 flock old litter. Litter samples were obtained before litter treatment application and at 1, 8, 15, 22, 29, 36 and 42 d of age at 4 equidistant locations in each house for microbiological analyses, moisture, pH and water activity. Microbiological analyses included total aerobic, anaerobic, and enteric bacteria, and Clostridium *perfringens* and E. *coli*. Ammonia measurements were obtained on the same days using a Drager CSM Analyzer with an air sampling pump connected to a closed container inverted over the litter bed. At processing, 500 paws were collected from each house and visually scored for quality. PLT effectively ($P < 0.10$) reduced ammonia levels during the first week, while LG reduced ammonia on d 22 ($P < 0.10$). Differences ($P < 0.10$) between and within houses were also noted with 6 flock houses exhibiting higher ammonia levels. Decreases ($P < 0.10$) in litter pH occurred the first week in PLT treated houses (8.45 vs. 7.96) and on d 36 in LG treated houses (8.24 vs. 8.40). There were no differences ($P > 0.05$) in litter moisture while a lower ($P < 0.05$) water activity (0.902 vs. 0.983) occurred with the LG treatment on d 36. There were no significant differences ($P > 0.05$) in microbial counts (cfu/g) for the entire experiment except for total enterobacteria, which showed a gradual increase in counts. Birds in one of the PLT houses exhibited a high incidence of foot pad dermatitis where 43% were scored as a 1 (moderate lesions) and 15% scored as 2 (severe lesions); whereas, the other 5 houses exhibited < 3% foot pad lesions.

Key Words: ammonia, paw quality, litter treatment

195 Evaluation of a compressed air foam system for euthanasia of caged layer chickens. K. Stringfellow*[1], D. Caldwell[1], J. Byrd[2], D. Abi-Ghanem[1], L. Berghman[1], J. Hoffman[1], J. Lee[1], and M. Farnell[1],

[1]Department of Poultry Science, Texas AgriLife Research and Extension, College Station, [2]USDA-ARS-SPARC, College Station, TX.

The USDA Veterinary Services and AVMA have conditionally approved the use of water-based firefighting foam as a means of mass depopulation for poultry during a disease outbreak. The technique works well with floor reared poultry, but it has not been adapted for poultry reared in cages. The objective of this study was to develop a thicker foam produced by utilizing a compressed air foam system (CAFS). The hypothesis of this study was that CAFS can be used to humanely euthanize caged layers similarly to the aspirated foams used for broiler and turkey depopulations. Treatment groups (n = 8/treatment) consisted of a negative control (no treatment other than venipuncture), carbon dioxide, aspirated foam (1% foam concentrate) and CAFS (3.5% foam concentrate). This study was replicated 3 times. Blood was collected from the jugular vein in the negative control birds and from the femoral artery in the euthanized birds. Blood was allowed to clot overnight at 4°C and the serum was removed and frozen for later use in a commercially available corticosterone assay. The respiratory tract was immediately evaluated post euthanasia for signs of trauma or drowning. We observed no significant differences ($P < 0.05$) in corticosterone levels among any of the treatments, and following examination of the trachea there were no signs of tissue damage. Foam was present in the upper respiratory tract but did not enter the lung which indicates that the foam did not drown the birds. These data demonstrate that CAFS may be used to humanely euthanize layers during a reportable disease outbreak.

Key Words: foam, depopulation, stress, euthanasia, layer

196 Evaluation of compressed air foam to clean and disinfect poultry rearing facilities. M. Ross*[1], D. Caldwell[1], J. Byrd[2], J. Lee[1], K. Stringfelllow[1], S. Anderson[1], and M. Farnell[1], *[1]Department of Poultry Science, Texas AgriLife Research and Extension, College Station, [2]USDA, Agricultural Research Service, Southern Plains Agricultural Research Center, College Station, TX.*

Foaming disinfectants and cleaners are a common component of poultry hatchery and processing plant sanitation programs. These techniques may also provide a practical means of cleaning and disinfecting poultry rearing facilities. Two studies were conducted to evaluate the effects of commercially available firefighting foam and a foaming cleaner on a floor pen and a caged quail rearing facility. These 2 barns were located on the same farm and had a significant load of organic matter. Environmental samples were collected before and post treatment throughout the facilities utilizing a sterile 2" × 2" stainless steel template and a gauze swab pre-enriched with buffered peptone water. A bioluminescent ATP test was conducted concurrently. Foaming agents were mixed to manufacturer recommended concentrations and applied with a custom made compressed air foam system, typically used by firefighters. All swabs were incubated for 24 h at 37 C before direct plating onto tryptic soy agar plates to enumerate total aerobic bacteria. The foaming cleaner reduced ($P < 0.05$) aerobic plate counts from a log of 6.41 to 4.85 and 3.52 to 2.41 cfu/in^2, for the floor pen and caged rearing facilities, respectively. The foaming cleaner decreased ($P < 0.05$) ATP bioluminescence from 4,546 to 1,675 and 3,651 to 976 relative light units (RLU), in the floor pen and caged rearing facilities, respectively. The firefighting foam in the floor pen and caged facilities significantly reduced aerobic plate counts from a log of 6.01 to 5.64 and 4.23 to 3.83 cfu/in^2 and ATP bioluminescence from 4,894 to 693 and 4,087 to 627 RLU, respectively. These data suggest that commercially available compressed air foam systems and foaming agents may be a practical means to rapidly clean and disinfect poultry facilities.

Key Words: cleaning and disinfection, foaming agents, compressed foam air, poultry

197 Evaluation of foaming agents for improved cleaning and disinfection within poultry premises. M. Ross*[1], D. Caldwell[1], J. Byrd[2], S. Anderson[1], K. Stringfelllow[1], J. Lee[1], and M. Farnell[1], *[1]Department of Poultry Science, Texas AgriLife Research and Extension, College Station, [2]USDA, Agricultural Research Service, Southern Plains Agricultural Research Center, College Station, TX.*

The use of foaming agents to rapidly clean and disinfect poultry processing facilities and hatcheries is a common practice. The objective of this study was to evaluate the effects of foaming agents on *Salmonella* Typhimurium (ST) and *Campylobacter jejuni* (CJ) contaminated surfaces in a poultry rearing facility. A 21-d broiler grow out trial was conducted to uniformly contaminate plastic rearing panels with organic matter from broilers challenged with ST and CJ. Four BSL-2 rooms were utilized to challenge day-of-hatch broiler chicks with ST and CJ using a horizontal transmission challenge model. On Day 21, all birds were removed from the premises and pens were disassembled for treatment application. Water alone, foam concentrate alone, 1% peracetic acid (PAA) with a foam concentrate, and a foaming cleaner were applied individually to each treatment room. Environmental samples for bacterial recovery were collected before and post treatment application. A bioluminescence ATP test was concurrently conducted for each sample. All treatments were left on the panels for 30 min of contact time and then gently rinsed. Despite good colonization of broilers, levels of ST and CJ were low and variable on pen materials. However, total aerobes and ATP tests yielded viable data. The water, foam concentrate, PAA and foam cleaner treatments reduced ($P < 0.05$) aerobic bacteria from a log of 6.19 to 4.33, 6.14 to 4.03, 5.68 to 3.04 and 5.65 to 2.74 cfu/in^2, respectively. ATP bioluminescence was reduced ($P < 0.05$) from 2,098 relative light units (RLU) to 784, 3,139 to 653, 2,098 to 345, and 2,129 to 104, respectively. These studies demonstrate that foaming agents may be an effective means to clean and disinfect poultry facilities.

Key Words: *Salmonella* Typhimurium, *Campylobacter jejuni*, disinfectants, foaming agents, aerobic bacteria

198 Reducing litter ammonia emission and *Salmonella* concentration using two *Bacillus subtilis* strains. Z. Williams*, M. Bailey, M. Liles, and K. Macklin, *Auburn University, Auburn, AL.*

Control of ammonia emissions from commercial poultry houses has become increasingly important with recently proposed environmental regulations. Litter amendments have been developed that reduce ammonia production; however, many of these amendments are chemical and only work for a short time period. Bacterial amendments have the capability to last indefinitely, if bacteria can be isolated that reduce ammonia and persist in the litter environment, and furthermore many bacteria produce antibacterial compounds that may inhibit the growth of bacterial pathogens. Two *Bacillus subtilis* strains (01 and 301) were isolated that could reduce ammonia and exhibited antibacterial effects to several *Salmonella* species in vitro. A trial was performed consisting of 6 treatments. Treatments consisted of 01 and 301 at rates of 10^7 or 10^9 cfu/g, sodium bisulfate at 45.4 kg/92.9 m[2, and a negative control. In addition a cocktail of 5 *Salmonella* species was added with each

treatment. Ammonia measurements were taken at 0, 24, 48, 72 and 96 h post treatment. Additionally litter pH, moisture, water activity measurements and bacterial counts for total aerobes, total anaerobes, *E. coli* and *Salmonella* were taken at 0, 24 and 96 h. Ammonia measurements were significantly lower for the *B. subtilis* treatments from 0 to 24 h but these ammonia levels were not significantly different than the control and were significantly higher than sodium bisulfate ($P < 0.0001$). Bacteria concentrations were not affected by any treatment ($P < 0.05$). Litter pH was significantly reduced by sodium bisulfate ($P < 0.0001$). Litter water activity, moisture and pH were significantly affected by time, and were decreased at 72 and 96 h sampling time ($P < 0.0001$). Even though these 2 *B. subtilis* strains performed well in vitro at reducing ammonia and *Salmonella*, the complexity of the litter environment and competition with other bacteria led to decreased efficacy when applied to litter.

Key Words: *Salmonella*, ammonia, litter management, *Bacillus subtilis*

199 Histology of early footpad dermatitis lesions in broilers. E. M. Shepherd, S. M. Williams, and B. D. Fairchild*, *University of Georgia, Athens.*

Footpad dermatitis (FPD) is a skin condition that affects the plantar surface of the footpad in broilers and turkeys. This condition is an issue for the poultry industry with concerns from animal welfare, food safety, and economic loss standpoints. Previous histopathological examinations of this condition have centered on existing lesions. It may be more useful to understand the early progression of these lesions to better understand the causes and possible methods of prevention. In this study, microscopic changes in early lesion development associated with FPD were examined. Samples of the plantar surface of the footpad from 14d broilers were stained with routine hematoxylin and eosin. The samples were then examined at a magnification of 100x. Upon examination, it appears that the keratin layers became degenerate, possibly due to moisture, and began to shear. The shearing led to a rapid turnover of keratinocytes. The type of keratin changed from compact to basket weave which weakened the keratin layer. When these layers sheared off completely, heterophils infiltrated the area, and lesions developed. The progression of these lesions occurs long before any changes in the skin structure can be observed by the naked eye.

Key Words: broiler, footpad dermatitis, lesion, histology

200 Evaluation of three commercial drinker systems for hen turkeys to 98 days of age. R. M. Hulet* and T. L. Cravener, *Pennsylvania State University, University Park.*

The performance of 1104 turkey hens was evaluated when 3 types of commercial drinker systems were provided: Control bell drinker (Plasson), and 2 nipple drinkers (Lubing and Roxell). Control drinker (A) was compared with the 2 nipple drinkers (B and C). Hybrid Converter poults were randomly placed in 12 pens (11 birds/m^2), brooded until 14 d, and spread out to 24 pens (5.5 bird/m^2) until 98 d. Birds were fed commercial feed through out the study. Birds and feed were measured at placement, 14, 42, 70 and 98 d. Water consumption (WC) was measured weekly from 2 to 13 wks. BW was significantly affected ($P < 0.05$) at 70 and 98 d, with drinker A (9.79 kg) being similar to B (9.71) and significantly greater (SG) than C (9.47) at 98 d. BW gain was significantly different (SD) from 42 to 70 d, and 14–98 d, with A being similar to B and both SG than C. Feed intake (FI) was similar for A (21.36 kg) and B (20.94), and SG than C (20.28) from 14 to 98 d. Feed conversion was SD only from 70 to 98 d, with A being higher (2.959) than either B (2.813) or C (2.825). Percent mortality from 14 to 98 d was SG for A (2.46) and B (2.18,) versus C (0.28). In 9 of 13 weekly measurements, WC was significantly affected by drinker type. By 13 wk, drinker A WI (0.032kg/bird/hr) was SG than either B (0.028) or C (0.024). Nipple drinker B was equal in performance for growth and feed intake to the Control bell drinker A. Nipple drinker C resulted in overall lower performance than either drinker A or B. Evaluation of 3 commercial drinker systems for hen turkeys to 98 d of age found a nipple drinker equal in growth performance to the standard bell drinker system.

Key Words: turkey hens, nipple drinker, water consumption

201 Distillers dried grains with solubles (DDGS) and its effects on necrotic enteritis development in broiler chickens. K. S. Macklin*, L. N. Rose, and W. A. Dozier, *Auburn University, Auburn, AL.*

There has been an increase in availability of DDGS for use in animal feeds. The effect DDGS has on poultry gut health is relatively unknown. Previous work by our labs had shown a negative impact of increasing levels of DDGS on necrotic enteritis (NE) development. The objective of this study was to determine if the previously observed effects can be mitigated by the addition bacitracin and monensin into the diets. In this experiment 360 straight run broilers were evenly distributed into 36 battery pens (10/pen). These pens were then randomly assigned to one of 4 dietary treatments (9 replicates/treatment). The diets were: basal (Con), basal with monensin and bacitracin (Con-Ab), 15% DDGS and 15% DDGS with monensin and bacitracin (DDGS-Ab). On d 18 all of the birds were given a mixed *Eimeria* challenge. On d 21–23 all of the birds were administered *C. perfringens* via oral gavage. Pen fecal scoring was performed on d 22–28. On d 28 all of the birds were euthanized and intestinal lesion scoring was performed. Collected data was analyzed using GLM and any significant differences ($P < 0.05$) were further separated using Tukey's Multiple Comparison Test. There were statistically significant different fecal scores on d 23–25. On 2 of those days (23 and 24) the Con group had higher fecal scores than Con-Ab. By d 25 DDGS had higher fecal scores than Con-Ab. On all 3 d the other 2 diets gave intermediate results. An observable trend was that on the final 3 d (26–28) the 2 diets not containing antibiotics (AB) had higher fecal scores than the 2 diets that did contain them. There was no significant difference in the intestinal NE lesion scores between treatments; however there was the trend that the 2 diets not containing AB (0.47 and 0.51 for DDGS and Con, respectively) had higher NE lesion scores compared with the diets containing AB (0.39 and 0.43, for Con-Ab and DDGS-Ab, respectively). The results from this experiment imply that DDGS may influence severity of NE development; however the addition of AB (bacitracin and monensin) reduced the severity of both fecal scores and intestinal lesions.

Key Words: DDGS, necrotic enteritis, antibiotics

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202 Performance and oxidative stability effects of synthetic antioxidant in broilers fed diets containing either oxidized or non-oxidized fat. M. K. Manangi*[1], M. Vazquez-Anon[1], T. Wineman[1], M. Wehmeyer[1], J. D. Richards[1], S. Carter[1], and C. Owens[2], *[1]Novus International Inc., St. Charles, MO, [2]University of Arkansas, Fayetteville.*

A 42d study was conducted to determine the performance and oxidative stability effects of synthetic antioxidant {Santoquin M6 containing 66.6% Ethoxyquin (AOX)} in broilers fed diets containing either oxidized or non-oxidized fat. A total of 640 Ross-708 male chicks were assigned to 4 treatments with 8 pens/treatment and 20 chicks/pen. The study was carried out as 2 × 2 factorial design with 2 sources (oxidized vs. non-oxidized) of fat and 2 levels (0 vs. 125ppm) of AOX. The treatments consisted of: non-oxidized fat with no AOX, T1; non-oxidized fat with AOX; T2, oxidized fat with no AOX, T3; oxidized fat with AOX, T4. Soybean oil was used as a source of fat. For T3 and T4 diets, soy oil was oxidized to contribute 5mEq peroxide/kg in the starter and 7mEq peroxide/kg in the grower and finisher diets. Thiobarbituric acid reactive substances (TBARS, a measure of lipid peroxidation) were assayed in breast meat from 4 birds per pen as a measure of meat oxidative stability. No interaction ($P > 0.05$) was observed for source and level on performance variables, and breast meat TBARS. Main effects (source and level) indicate that feeding oxidized fat reduced feed intake by 200g ($P < 0.01$) and weight gain by 140g ($P < 0.01$), and increased TBARS in 10d old refrigerated pre-cooked meat by 1.7µmole malondialdehyde (MDA)/kg meat ($P = 0.07$)) and in 1d old refrigerated cooked meat by 20.4µmole MDA/kg meat ($P < 0.01$) compared with birds fed non-oxidized fat. Supplementing 125ppm synthetic AOX improved feed intake by 140g ($P = 0.02$) and weight gain by 70 g ($P = 0.07$), and decreased TBARS in 10d old refrigerated pre-cooked meat by 2.0µmole MDA/kg meat ($P = 0.04$) and in 1d old refrigerated cooked meat by 19.6µmole MDA/kg meat ($P < 0.01$) compared with birds fed zero synthetic AOX. Overall, the AOX effectively improved the broiler performance, and also the oxidative stability of the precooked and cooked meat compared with chicks fed no synthetic AOX.

Key Words: antioxidant, TBARS, Santoquin, breast meat

203 Differences among origins on nutritional and quality parameters of soybean meal. G. G. Mateos*[1], M. González[2], S. Sueiro[2], M. Hermida[2], J. Fickler[3], P. G. Rebollar[1], M. P. Serrano[1], and R. P. Lázaro[1], *[1]Universidad Politécnica de Madrid, Madrid, Spain, [2]Laboratorio Mouriscade, lalín, Pontevedra, Spain, [3]Evonik, Hanau, Germany.*

Soybean meal (SBM) is the main protein source in livestock feeds. United States (USA), Brazil (BRA), and Argentine (ARG) are the major SBM exporter countries. The nutritive value of SBM varies because genetics, environment, farming conditions, and processing of the beans influence strongly the content and availability of major nutrients. The present research was conducted to determine the influence of origin (USA, BRA and ARG) on nutritive value and protein quality of SBM. Samples (n = 385) were collected during a 4-yr period and analyzed for major dietary components, at the same laboratory and by the same technician, following AOAC procedures (Mouriscade, Spain). Amino acids (AA) were analyzed by NIR technology (Evonik, Hanau, Germany). On DM bases, USA meals (n = 148) had more CP (53.9 vs. 51.6 vs. 52.7%; $P \leq 0.001$) and less NDF (8.8 vs. 10.7 vs. 12.0%; $P \leq 0.001$) than ARG (n = 126) and BRA meals (n = 110). Sucrose and stachyose content was higher, and raffinose lower, for USA than for ARG and BRA meals (8.1 vs. 7.6 vs. 6.5%; 6.4 vs. 5.6 vs. 5.3% and 1.09 vs. 1.31 vs. 1.57%, respectively; $P \leq 0.001$). The USA meals had more P (0.79 vs. 0.69 vs. 0.74%; $P \leq 0.001$) than the BRA with ARG being intermediate. Also, BRA meals had more Fe (201 vs. 127 and 133 mg/kg; $P \leq 0.001$) but less K (2.3 vs. 2.6 and 2.5%; $P \leq 0.001$) than ARG and USA. The USA meals had higher KOH solubility (87.3 vs. 82.5 and 83.6%; $P \leq 0.001$), protein dispersibility index (19.9 vs. 17.1 and 15.3%; $P \leq 0.001$), and trypsin inhibitor activity (3.9 vs. 3.0 and 3.0 mg/g; $P \leq 0.001$) than ARG or BRA SBM. The amino acid profile (% CP) varied with the origin. Lysine (6.15 vs. 6.09 vs. 6.05%), met+cys (2.86 and 2.86 vs. 2.80%), thr (3.91 and 3.93 vs. 3.88%), trp (1.36 vs. 1.37 vs. 1.34%) and the content of these 5 key AA was higher ($P \leq 0.001$) for USA and ARG than for BRA, respectively. It is concluded that SBM of USA origin have a higher feeding value (protein quality indicators, less fiber and more sucrose, phosphorus, CP, and indispensable AA content) than South American meals. Thus, the origin of the beans should be specified in feed tables for accurate and precise formulation of diets by the feed industry.

Key Words: soybean meal, protein quality, nutritive value

204 Effects of the main cereal and type of fat of the diet on productive performance and egg quality of brown egg-laying hens from twenty-two to fifty-four weeks of age. A. Pérez-Bonilla[1], M. Frikha[2], C. Jabbour[2], S. Mirzaie[2], H. Irandoust[2], J. García[1], and G. G. Mateos*[2], *[1]Camar Agroalimentaria S.L., Toledo, Spain, [2]Universidad Politécnica de Madrid, Madrid, Spain.*

The influence of the main cereal and supplemental fat of the diet on productive performance and egg quality was studied in 756 brown-egg laying hens from 22 to 54 weeks of age. The experiment was conducted as a completely randomized design with 9 treatments arranged factorially with 3 cereals (dented corn, soft wheat, and barley) and 3 types of fat [soy oil (SBO), acidulated soapstocks (AOS), and lard]. Each treatment was replicated 4 times (21 hens per replicate). All diets were formulated to have similar nutrient content except for linoleic acid that ranged from 0.76 to 3.4% depending on the combination of cereal and fat source used (wheat and lard vs. corn and SBO). Productive performance and egg quality traits were recorded every 4-wks and BW was measured at the beginning and at the end of the experiment. For the entire experimental period egg production (92.9 vs. 92.1 vs. 91.5%), egg weight (64.5 vs. 64.1 vs. 63.6%), and egg mass (59.9 vs. 59.1 vs. 58.2) were similar for all treatments. Hens fed the wheat and lard diet showed the lowest numerical values (62.8 vs. 64.0, for the mean of the other treatments). Body weight gain was higher for hens fed corn and wheat than for hens fed barley (238 vs. 243 and 202 g; $P \leq 0.05$). Mortality was not influenced by diet. Source of fat did not affect any of the performance variables studied, except for BW gain that was higher for hens fed lard than for hens fed SBO and AOS (251 vs. 221 and 210 g; $P \leq 0.05$). Egg quality variables were not influenced by diet except for yolk color that was higher for hens fed corn than for hens fed wheat or barley (9.0 vs. 8.3 and 8.3; $P \leq 0.001$) and for hens fed lard than for hens fed SBO or AOS (8.9 vs. 8.5 and 8.2; $P \leq 0.001$). It is concluded that the 3 cereals and the 3 fat sources tested can be used indistinctly in diets for laying hens provided that a minimum amount of linoleic acid is used. The results indicate that brown egg laying hens do not need more than 1.0% linoleic acid in the diet to maximize egg size and egg production.

Key Words: cereal, fat source, linoleic acid, hen performance, egg weight

205 Evaluation of feeding various sources of distillers dried grains with solubles (DDGS) in non-feed withdrawal molt programs for laying hens. K. A. Bland*, C. M. Parsons, S. A. dePersio, P. L. Utterback, and K. W. Koelkebeck, *University of Illinois at Urbana-Champaign, Urbana.*

An experiment was conducted using 588 Hy-Line W-36 hens (68 wks of age) to evaluate if laying hens can be successfully molted by ad-libitum feeding various levels and sources of DDGS. The 3 sources of DDGS varied greatly in color. Treatment 1 consisted of a 47% corn (C):47% soy hulls (SH) molt diet (C:SH) fed for 28 d (positive control). Treatments 2, 3 and 4 were molt diets containing 94% DDGS from various sources fed for 28 d. Treatments 5, 6 and 7 were 32% C: 42% SH: 20% DDGS, also fed for 28 d. At the end of the 28 d molt period, all hens were fed a 16% CP corn- soybean meal layer diet. Body weight (BW) loss during the molt period was greatest for hens fed the C:SH diet (26%). The BW loss was greater for hens fed the C:SH:DDGS diets (12%) than for the hens fed the 94% DDGS diets (2%) and the reduction in BW loss varied among DDGS sources. Feed consumption was lower for hens fed the C:SH control diet compared with hens fed the DDGS diets. Hens fed the C:SH diet had egg production near 0% during the last 3 weeks of the molt period. Hens on the other treatments did not have egg production below 8–10% during the molt period, and the reduction in egg production varied among DDGS sources. The darkest brown DDGS resulted in the greatest reduction in egg production. During the first 8 weeks of the post molt period, egg production of hens that had been fed the C:SH diet during the molt period was generally lower than that of hens fed the other molt diets. This study showed that responses varied among DDGS sources; however, none of the molt diets containing 20–94% DDGS resulted in satisfactory reductions in BW or egg production.

Key Words: DDGS, molting, laying hens

206 The effect of distillers dried grains with solubles (DDGS) and yeast-derived products on growth performance and gut morphology of broiler chickens fed corn/soybean meal-based diets. M. Alizadeh*, A. Rogiewicz, H. Echeverry, J. C. Rodriguez-Lacompte, and B. A. Slominski, *University of Manitoba, Winnipeg, MB, Canada.*

This study was carried out to investigate the effect of DDGS and yeast-derived products on growth performance, small intestinal morphology and gut development in broiler chickens from 1 to 21 d of age. In addition to DDGS, the yeast products used in the study contained different levels of potentially active components including mannan polysaccharides, β1,3 and β1,6-glucans and nucleotides. The brewer's yeast contained 0.32% nucleotides and 18.9% cell wall polysaccharides (CWP) with the component sugars mannose and glucose accounting for 99.0%. Such amounts would reflect the composition of yeast biomass present in DDGS. Other products investigated included a yeast cell wall product containing 43.3% CWP with mannose and glucose accounting for 99% and a commercial product containing the processed baker's yeast with 21.6% CWP and 1.13% nucleotides. The nucleotide product contained 9.3% nucleotides and very little CWP. It contained, however, 6.8% mannose derived from yeast cell walls with very little glucose, indicating the presence of free mannans but not β1,3 and β1,6-glucans. One-day-old male broiler chickens were assigned to 8 dietary treatments of 9 replicates of 5 chicks per pen from 1 to 21 d of age. The dietary treatments included: a positive control, a negative control with no antibiotics and coccidiostat (NC) and NC diets containing DDGS (10%), brewer's yeast (0.5%), yeast cell wall (0.25%), a commercial product (0.2%) and the nucleotide product at 2 levels 0.025% and 0.05%. The addition of brewer's yeast decreased ($P < 0.05$) BWG and resulted in the highest FCR compared with other treatments. Relative bursa and spleen weights were unaffected by dietary treatments. The addition of brewer's yeast and yeast cell wall reduced crypt depth. Diet supplemented with the nucleotides had the highest villus height/crypt depth ratio (VCR), while diet supplemented with the yeast cell walls had the lowest VCR. Diets containing the nucleotide product increased the number of goblet cells in the ileum from 827 to 2016.

Key Words: DDGS, yeast products, gut morphology, goblet cells, broiler

207 Effects of ingredient composition on rate of passage in broiler chicks. S. J. Rochell*[1], T. J. Applegate[2], E. J. Kim[3], and W. A. Dozier, III[1], *[1]Auburn University, Auburn, AL, [2]Purdue University, West Lafayette, IN, [3]USDA-ARS Poultry Research Unit, Mississippi State, MS.*

This study examined the rate of passage in broiler chicks fed 4 diets varying in ingredient composition. Two hundred eighty-eight male Ross × Ross 708 chicks (12 birds per pen; 0.45 m^2 per bird) were randomly assigned to 24 pens (6 replicate pens per treatment) at 1 d of age. Experimental diets consisted of: 1) corn-soybean meal-based (CSM) diet containing bovine meat and bone meal (MBM) (5% inclusion), 2) CSM diet containing distillers dried grains with solubles (DDGS) (5% inclusion), 3) semi-purified (SP) diet containing MBM (40% inclusion), and 4) SP diet containing DDGS (76% inclusion). All diets were formulated to contain 20% CP and were adequate for Na, Ca, P, trace minerals, and vitamins. Birds received a common starter diet until 13 d of age and experimental treatments were provided from 14 to 18 d of age. On d 18, 4 identical diets containing titanium dioxide (0.5% inclusion) as an inert marker were provided for 2 h. All excreta were then collected every h for a 12 h period after birds were given access to the diets for 1 h. Cumulative excretion curves were determined for each pen using the Weibull model. From the total excretion curves, time of 1% titanium excretion (T1), 50% titanium excretion (T50), and mean retention time (MRT) were assessed. Faster ($P \leq 0.001$) rate of passage was determined for broilers fed 2 SP diets when compared with the 2 CSM-based diets, as indicated by T1 (0.94 vs. 1.35 h), T50 (4.58 vs. 4.96 h), and MRT (5.31 vs. 5.60 h). Feeding broilers SP diets containing MBM had shorter ($P \leq 0.02$) T1 and T50 than birds fed CSM diets containing MBM. Broilers fed SP diet with DDGS displayed shorter ($P \leq 0.02$) T1, T50, and MRT than CSM diet formulated with DDGS. Broilers fed SP diet containing DDGS had shorter ($P \leq 0.04$) T50 and MRT compared with the SP diet containing MBM. These data indicate that broilers fed SP diets had a faster rate of passage than birds provided practical diets, and ingredients in SP diets can influence rate of passage.

Key Words: rate of passage, ingredients, broilers

208 A comparison of nutrient digestibility in wheat distillers dried grains with solubles (DDGS) and 3 wheat DDGS fractions produced using a 2-step dry fractionation process for broilers. M. Oryschak*[1], D. Korver[2], and E. Beltranena[1,2], *[1]Alberta Agriculture and Rural Development, Edmonton, AB, Canada, [2]University of Alberta, Edmonton, AB, Canada.*

High fiber content is believed to limit usefulness of wheat DDGS produced by Western Canadian ethanol plants as a protein feed for monogastrics. Reducing fiber content through fractionation may enhance the nutritive value of wheat DDGS for poultry. Several wheat DDGS

fractions (varying in fiber and protein content) were produced using a 2-step technique where DDGS were first separated by particle size and then by weight. Nutrient digestibility of wheat DDGS was then compared with that in 3 of the resulting wheat DDGS fractions. Ross 308 broilers (1-d old; n = 390) were distributed equally among 30 test cages and received a commercial starter diet for 14 d. On d 14 broilers were then offered ad libitum access to either a basal diet or one of 4 test diets (70% basal diet: 30% wheat DDGS or one of 3 wheat DDGS fractions), all of which included 0.5% chromic oxide as a marker. Each treatment appeared once per block for a randomized complete block design with 6 replicate cages per treatment. Excreta were collected for 24 h before all birds being sampled for ileal digesta on d 21. Excreta and digesta were pooled to produce a single specimen of each for each test cage. Diets, digesta and excreta were then analyzed for nutrient content and digestibility coefficients calculated for each. Apparent and standardized ileal digestibility coefficients for DM, CP and all AA did not differ among test ingredients. Our results suggest that the major benefit of dry fractionation of wheat DDGS is reducing the diluting effect of fiber thereby the concentration of protein. Given the range in fiber content among DDGS and the fractions tested, our data further suggest that factors other than fiber content affect nutrient digestibility of wheat DDGS for broilers.

Key Words: wheat DDGS, dry fractionation, nutrient digestibility, broiler

209 Bioassay of diverse feed ingredients for AME, TME, TMEN and their evaluation in broiler chicks. J. I. Sultan*, S. Minhas, A. Javaid, and H. Nawaz, *University of Agriculture, Faisalabad, Faisalabad, Punjab, Pakistan,*

One metabolic and one performance trial was simultaneously conducted. In metabolic trail, 60 6 adult White Leghorn cockerels were used to explore baseline information regarding apparent metabolizable energy (AME), true metabolizable energy (TME) and true metabolizable energy corrected for nitrogen (TMEn) for indigenous energy and protein sources and subsequently using same TMEn values on the performance of broilers. In performance trial, 480 d-old broiler chicks were divided into 3 groups and fed 3 isonitrogenous (20% CP) diets varying in energy i.e., low, (11.30 MJ/kg), medium (11.72MJ/kg) and high TMEn (12.13MJ/kg), formulated on the basis of TMEn determined in trial I. Feed intake decreased ($P < 0.01$) linearly with increasing the level of TMEn. Weight gain in broilers fed medium and high level of TMEn was higher ($P < 0.01$) than those fed low level of TMEn. Feed conversion ratio and dressing percentage were improved ($P < 0.01$) with increasing the dietary level of TMEn. Cost effective weight gain was attained in broilers fed medium TMEn.

Key Words: energy, protein sources, broiler chicks, AME, TME, TMEn

210 Prediction of nitrogen-corrected apparent metabolizable energy values of different wheat samples in broiler chicks by an in vitro digestibility technique. M. Yegani*[1], M. Swift[2], and D. R. Korver[1], *[1]University of Alberta, Edmonton, AB Canada, [2]Alberta Agriculture & Rural Development, Lacombe, AB Canada.*

Wheat is a common feedstuff in broiler chicken rations in many parts of the world. Variations in physical, chemical and digestibility characteristics, especially apparent metabolizable energy (AME) of wheat samples are of particular concern to the poultry industry. Accurate and timely prediction of AME value of wheat would allow increased accuracy of broiler diet formulation, increased productivity and reduced feed cost. Nitrogen-corrected AME (AMEn) values were determined using a chick bioassay for 8 samples of wheat. The AMEn values of the wheat samples ranged from 2,969 to 3,471 Kcal/Kg (DM basis). Subsequently, a 2-step in vitro digestibility technique was used to mimic pre-cecal digestion in broiler chicks. Commercially available pepsin and pancreatin were used in consecutive incubation stages (2 h with pepsin at pH 2 and 4 h with pancreatin at pH 6.8). The gross energy (GE) of wheat samples and residues from the in vitro digestion were measured to determine the in vitro GE digestibility and to calculate the in vitro AME. The in vitro AME and in vivo AMEn were analyzed by the Regression procedure of SAS. The predicted AMEn values ranged from 2,908 to 3,418 Kcal/Kg (adjusted $R^2 = 0.80$, SE of prediction = 65.97, $P = 0.0016$). Considering the cost and time required to conduct in vivo digestibility studies, in vitro digestibility techniques are necessary and becoming more common in feed quality evaluation programs. Accurate and precise data generated by in vitro methodology can be efficiently used to create and continually expand calibration databases for near infrared reflectance spectroscopy (NIRS) technology. Based on the results of the present study, this in vitro digestibility method can be used to reliably predict AMEn of wheat samples in broiler chicks. Such data will be of use for maintaining and continuous updating of "real-time" feed quality evaluation techniques such as NIRS.

Key Words: in vitro digestibility, AME prediction, broiler chick, wheat

211 Nutrient digestibility in canola meal for broilers: Effects of oil extraction method and fractionation by air classification. M. Oryschak*[1], D. Korver[2], and E. Beltranena[1,2], *[1]Alberta Agriculture and Rural Development, Edmonton, AB, Canada, [2]University of Alberta, Edmonton, AB, Canada.*

Fiber content of canola meal reduces AME content and may impair nutrient digestibility. Air classification may allow fiber to be removed from the meal, thereby potentially reducing antinutritional effects of fiber. Differences between expeller- and extruder-pressing of canola together with omitting the solvent extraction step may impact digestible nutrient and energy content in the resulting meal. The nutrient digestibility of a conventional, solvent-extracted canola meal (CM) was compared with that of 2 air classified CM fractions (AC1, AC2) and samples of expeller-pressed (EXP) and extruder-pressed CM (EXT). Ross 308 broilers (1-d old; n = 468) received a commercial starter diet until 14 d of age. On d 14 broilers were then offered ad libitum access to either a basal diet or one of 5 test diets (70% basal diet: 30% CM, AC1, AC2, EXP or EXT), all of which included 0.5% chromic oxide as a marker. Each treatment appeared once in each block for a randomized complete block design with 6 replicate cages per treatment. Excreta were collected for 24 h before all birds being sampled for ileal digesta on d 21. Excreta and digesta were pooled to produce a single specimen of each for each test cage. With the exception of LYS, AID and SID of AA was highest for CM. Digestibility of most AA was similar between CM and AC1. Coefficients for MET, THR, ILE, LEU, VAL and PHE were 6% lower for AC2 compared with CM. No differences in nutrient digestibility were observed between AC1 and AC2. Digestibility of most AA was between 10 to 15% higher in EXT compared with EXP. Digestibility of LYS was higher for EXT compared with CM, while coefficients for ARG, HIS, THR and TRP were similar between EXT and CM. In conclusion, air classification did not improve nutrient digestibility of conventional canola meal. Differences observed between the samples of expeller- and extruder-pressed canola meal suggest that different nutrient digestibility coefficients should be assumed for each when formulating diets for broilers.

Key Words: canola meal, air classification, nutrient digestibility, broiler

212 Nutrient digestibility of 4 varieties of triticale compared to that of Canadian Prairie Spring wheat for broilers. M. Oryschak*[1], D. Korver[2], and E. Beltranena[1,2], *[1]Alberta Agriculture and Rural Development, Edmonton, AB, Canada, [2]University of Alberta, Edmonton, AB, Canada.*

Increasing pressure on global wheat supplies has negative implications for Western Canadian broiler production which uses wheat as its major energy source in diets. Triticale (x Triticosecale) is reported to have several agronomic advantages over wheat and similar nutritional value for poultry. Due to limited production in Western Canada, it is also less sought after than wheat by local ethanol producers. To compare the feeding value of triticale to that of wheat, nutrient digestibility of single samples of Bunker (BUN), Alta (ALT), Pronghorn (PRO) and Tyndal (TYN) varieties of triticale were compared with 2 random, mixed-source samples of Canadian Prairie Spring wheat (CPS1, CPS2). Ross 308 broilers (1-d old; n = 468) were distributed equally among 36 test cages and received a commercial starter diet for 14 d. On d 14 broilers were then offered ad libitum access to one of 6 test diets (8% premix, 92% test grain), all of which included 0.5% chromic oxide as a marker. Each treatment appeared once in each block for a randomized complete block design with 6 replicate cages per treatment. Excreta and digesta were pooled to produce a single specimen of each for each test cage. Diets, digesta and excreta were then analyzed for nutrient content and digestibility coefficients calculated for each. There were no differences in AA digestibility among the triticale samples, but AME was lower in BUN compared with the other triticale varieties. In contrast, digestibility of most AA and AME was higher for CPS2 compared with CPS1. Digestibility of AA was similar between all triticale varieties and CPS2. In conclusion, our data suggest that triticale has similar nutrient digestibility to Canadian Prairie Spring wheat and is a viable alternative feed grain for broilers.

Key Words: triticale, wheat, nutrient digestibility, broiler

213 Preliminary assessment of Garcinia kola seed meal on performance, serum enzymes and haematology of broilers. O. A. Ogunwole*, E. A. Iyayi, O. O. Arinola, M. D. Olumide, A. O. Akinsoyinu, O. A. Adebiyi, and O. Abiola-Olagunju, *University of Ibadan, Ibadan, Oyo State, Nigeria.*

A preliminary assessment of incorporating varying levels of Garcinia kola seed meal and a commercial symbiotic Biovet-YC on performance, serum enzymes,hematology and organ weights of broilers was undertaken in a trial lasting 6 weeks. One hundred and 50 chicks of Arbor acre strain were randomly assigned to 6 treatments comprising 25 birds per treatment and 5 birds per replicate. Diets containing Garcinia kola meal at 0, 2.5, 5.0, 7.5 and 10.0g/100g of feed and the sixth diet, Biovet-YC at 0.1/100g of feed were formulated. Routine antiviral vaccinations were administered on the birds but without any medication throughout the course of the trial. Feed intake and weight gain were significantly lowered by Garcinia kola inclusion above 2.5g/100g in the feed. Values obtained for serum alkaline phosphatase (19.82, 21.40, 21.20, 21.05,20.82 and 22.90 ug/L for birds on treatments 1, 2, 3, 4, 5 and 6 respectively) were significantly ($P < 0.05$) higher with increasing inclusion of test ingredient. The red blood cell counts and the weight of kidney were significantly ($P < 0.05$) higher for birds on treatment 5.Garcinia kola meal should be incorporated at lower levels below 2.5g/100g in broilers diet. The bioactive component of Garcinia kola could be extracted, characterized and explioted for poultry production.

Key Words: Garcinia kola meal, serum indices, organ weight, symbiosis, hematology

214 Growth and performance of broiler starters fed rations supplemented with *Telfaria occidentalis* leaf meal (TOLM) (Ugu leaves). A. H. Ekeocha*, *University of Ibadan, Ibadan, Oyo, Nigeria.*

One hundred and 50 d old Abor acre broiler chicks were randomly allotted to 5 experimental rations of 30 birds per treatment such that each treatment had 2 replicates of 15 birds. The first ration was the standard (basal) starter ration and served as control. The other rations contained 2.5%, 5.0%, 7.5% and 10.0% TOLM respectively as graded replacement (w/w) for wheat bran. The study investigated the performance and nutrient metabolism of the birds to the diets. *Telfaria occidentalis* leaf meal supplementation improved performance characteristics over basal diets but did not significantly ($P < 0.05$) enhanced feed intake, crude protein retention, feed conversion and growth rate. Inclusion levels above 7.5% (TOLM) lead to higher wet droppings fecal moisture. On the whole, *Telfaria occidentalis* leaf meal supplementation at 7.5% was more effective and produced better growth indices than the 2.5%, 5.0% and 10.0% supplementation.

Key Words: growth, performance, broiler starters, *Telfaria occidentalis* leaf meal

215 Response of broiler finishers fed rations supplemented with *Vernonia amygdalina* leaf meal (VALM) (Bitter leaf). A. H. Ekeocha*, *University of Ibadan, Ibadan, Oyo, Nigeria.*

One hundred and 50 d old Abor acre broiler chicks were randomly allotted to 5 experimental rations of 30 birds per treatment such that each treatment had 3 replicates of 10 birds. The first ration was the standard (basal) finisher ration and served as the control. The other rations contained 2.5%, 5.0%, 7.5% and 10.0% VALM respectively as graded replacement (w/w) for wheat bran. The study investigated the performance, digestibility and blood glucose levels of the birds to the diets. The average final body weight, daily weight gain, daily feed intake and feed conversion ratio were significantly ($P < 0.05$) influenced by the diets. The average final body weight decreased as the levels of VALM increased in the diets with highest value of 2735.56g and those on the 10% VALM diet having the least value of 1845.23g. There were no significant ($P > 0.05$) difference in the average daily weight gain between broilers fed control 0% (VALM) and 5.0% (VALM) diets which were significantly ($P < 0.05$) higher than the values recorded in the other diets. The dry matter, crude protein and crude fiber digestibility of broilers fed the control diet were significantly ($P < 0.05$) higher than those of broilers fed the treated diets. The blood glucose level significantly ($P < 0.05$) reduced as the levels of VALM inclusion increased in the diets while hematological parameters were largely unaffected except for an increase in the hemoglobin concentration of VALM fed broilers. Invariably, the study suggests that *Vernonia amygdalina* leaf meal could be safely incorporated into poultry finisher rations up to 7.5% inclusion level without adverse effects. However, from the data presented here, an inclusion level of 5.0% appears to be adequate.

Key Words: broiler finishers, *Vernonia amygdalina* leaf meal

Food Safety II

216 Osteomyelitis in tom turkeys with green discolored livers. A. Hoffman*, M. Slater, D. Rives, M. P. Martin, and H. Barnes, *North Carolina State University, Poultry Health Management.*

AAAP abstract†

217 This turkey is not a Sept/Tox; this turkey is not a cadaver; this turkey does not have TOC. E. Gonder*, *Butterball LLC.*

AAAP abstract†

218 Sampling unhatched embryos as a method of salmonella detection in a turkey hatchery. D. Fernandez* and D. C. Mills, *Agforte.*

AAAP abstract†

219 Relationship between *Salmonella* culture findings from poultry and their environment. D. Waltman*, *Georgia Poultry Lab Network.*

AAAP abstract†

220 Rapid and cost-effective molecular *Salmonella* serotyping assay utilizing Luminex multiplexing technology. G. Rana*, B. Mire, D. Waltman, and M. R. Hoffmeyer, *Luminex Corp.*

AAAP abstract†

221 Monitoring on *Salmonella* infections in turkey flocks in Germany and European Union control measures. Hafez Mohamed Hafez*, *Institute of Poultry Diseases, Free University Berlin.*

AAAP abstract†

222 Implementation of MSRV methodology for *Salmonella* monitoring—Customer service and economic effects. K. Smith*, *Georgia Poultry Laboratory Network.*

AAAP abstract†

223 Effects of Salmonella Enteritidis bacterins vaccination on layers' protection and immune response. M. Boulianne*, T. Q. L. Tran, S. Quessy, A. Letellier, A. Desrosiers, and A. Thibodeau, *Department of Clinical Sciences, Faculty of Veterinary Medicine, Montreal University, Quebec, Canada.*

AAAP abstract†

224 Highly pathogenic strains of *Salmonella* Enteritidis show enhanced tolerance to acid, oxidative stress and better survival in egg albumen. Q. Hawley*, C. Casavant, T. Addwebi, and D. H. Shah, *NC State University CVM.*

AAAP abstract†

225 Method validation for the rapid detection of *Salmonella* Enteritidis from poultry houses and eggs. R. Crespo* and D. Shah, *AHFSL-WADDL, Washington State University.*

AAAP abstract†

226 Detection of natural campylobacter colonization in experimentally reared broiler chickens from a- positive commercial breeder flocks. P. O'Kane*, S. G. Thayer, D. L. Brinson, R. A. Espinosa, N. A. Cox, R. Berghaus, M. D. Lee, and C. L. Hofacre, *University of Georgia, Athens*.

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

National Extension Workshop: The Impact of Major Policy Shifts on the U.S. Food Supply and Producers: Environmental Issues

227 Washington update. R. Reynnells*, *United States Department of Agriculture.*

The 2011 Extension Special Recognition Award is presented to Ken Anderson, North Carolina State University. Ken has provided significant leadership for the Quadrennial (formerly Triennial) National Poultry Extension Workshop, Poultry Science Association National Extension Workshop, and other state, regional and national Extension activities. He has conducted important research in the areas of animal welfare and egg processing, and provided related Extension programs. The National Institute of Food and Agriculture was reorganized internally, both administratively and the physical location of personnel, in late 2010 to finalize the conversion from the Cooperative State Research, Education and Extension Service, and we are in the final stages of adding administrative personnel. Areas of primary responsibility are now: (Knowledge Area (KA) 306, Environmental Stress in Animals; and KA 315, Animal Welfare) along with previous multi-state liaison and other duties. Edgar Oviedo (NC) coordinated the 2010 National Poultry Waste Management Symposium, and Theresia Lavergne, Louisiana State University will coordinate the 2012 symposium, which will again include waste management for swine producers. The 2010 Future Trends in Animal Agriculture symposium provided a balanced discussion of: Legislation to Address Animal Welfare Issues: Is this the Best Approach?; the 2011 title is: The Polarization of Animal Welfare and Animal Rights Issues: Good or Bad for the Animals?. The Council for Agricultural Science and Technology's Food Animal Agriculture symposium was held in June, 2010, with hard copy and CD proceedings provided by the Animal and Plant Health Inspection Service, and which are available at www.castscience.org, and www.nal.usda.gov. The annual Animal Welfare Judging & Assessment Competition continues to be open to undergraduate, graduate and veterinary students, and focuses on animal welfare (AW) and animal behavior areas, and includes bioethics concerns. The contest emphasizes the importance of collaboration between disciplines and commodities to address AW issues. Bioethics remains an important component of discussions about AW and animal rights issues.

Key Words: recognition award, animal welfare, bioethics

228 Antibiotic residue avoidance in watersheds. E. C. Gonder*, *Butterball LLC, Goldsboro, NC.*

This is a multi-faceted issue with scientific, human, veterinary, production and political overtones. Consequently, it raises issues of prioritization involving (1) With which antibiotics are we concerned? (2) What are the sources of the antibiotics of concern? (3) What levels of the antibiotics of concern influence the bacteria of concern? Chemical methods may detect antibiotics at levels much lower than those to which bacteria may respond - what does detecting those levels mean in terms of antibiotic resistance development? (4) Where should such testing be conducted? From a usage standpoint, downstream of hospitals would be most appropriate. From evaluation of USDA FSIS residue violation data, it would be most appropriate to target dairy/veal operations. After a discussion of these questions, it is appropriate to address what steps can be taken to reduce the presence of antibiotics in watersheds, including (1) Proper disposal of unused antibiotics. They should not be flushed into the sewer or storm sewage systems. (2) Judicious use of antibiotics. Is there a good reason? (3) Proper control of application of animal and human waste within watersheds. Application systems adequately controlling nitrogen/phosphorus runoffs are an excellent starting point until more is known. (4) Consideration of various factors influencing environmental degradation of antibiotics of concern, if widely known. Some are quite labile to heat and light - others are quite stabile. Composting results in significant degradation of some. Filtration through simple carbon filters reduces the presence of antibiotics as well as other classes of pharmaceuticals.

Key Words: antibiotics, watersheds, residue

229 Developing effective risk and crisis communication approaches in the food industry. R. R. Ulmer*, *University of Arkansas at Little Rock, Little Rock.*

Over the past 10 years, the United States food system suppliers and producers have been called upon to respond to a wide variety of crises. A central component of managing and recovering from a crisis under public scrutiny is effective communication. This paper identifies effective risk and crisis communication strategies for use by United States food suppliers and producers. Key risk and crisis communication approaches are based upon extensive research in the food industry. The paper provides guidance on how to prepare for and respond to a crisis in the food industry. Special attention will be paid to managing diverse stakeholder groups and interests. Case study examples will illustrate the consequences for food suppliers and producers on enacting effective and ineffective risk and crisis communication strategies. Particular attention will be paid to communication strategies and approaches that create opportunities for food suppliers and producers to renew and grow following the crisis event. Ultimately, key counter intuitive approaches for preparation and response to a wide variety of crises are provided.

Key Words: crisis, risk, communication, renewal

Coccidiosis II

230 Effect of Montanide ISA 71 VG on recombinant coccidia antigen vaccination. S. Deville*, L. Dupuis, F. Bertrand, E. P. Lillehoj, S. H. Lee, K. W. Lee, M. S. Park, S. I. Jang, and H. S. Lillehoj, *Seppic, Puteaux, France.*

AAAP abstract†

231 The synergistic effects of plant-derived nutritional mixtures on recombinant antigen vaccination against avian coccidiosis. H. Lillehoj*[1], S. H. Lee[1], S. I. Jang[1], K. W. Lee[1], M. S. Park[1], and D. Bravo[2], *[1]Animal Parasitic Diseases Laboratory, Animal and Natural Resources Institute, Agricultural Research Service-U.S. Department of Agriculture, Beltsville, MD, [2]Pancosma S.A., Geneva, Switzerland.*

AAAP abstract†

232 Cellular immune responses, chemokine, and cytokine profiles in turkey poults following infection with the intestinal parasite *Eimeria adenoeides*. U. Gadde*, H. D. Chapman, T. Rathinam, and G. F. Erf, *University of Arkansas, Fayetteville.*

Cellular immune responses, chemokine, and cytokine profiles were investigated in 20 d old turkey poults following an oral infection with 12.5×10^3 oocysts of *E. adenoeides*, a protozoan parasite of the genus *Eimeria* that develops in the ceca. Large numbers of oocysts were produced in the feces of infected birds from d 5 after infection followed by a rapid decline by d 7. Local immune activities were characterized by observing the extent of leukocyte infiltration in the ceca by histology, measuring subsets of the lymphocyte population by immunohistochemistry, and determining the relative expression of cytokines by real-time RT-PCR. Inflammation, assessed by scoring the extent of cellular infiltration of leukocytes in sections of ceca, was significantly higher in infected poults compared with uninfected poults on d 4, 7, 9 and 11 following infection. The percent area occupied by CD4+ and CD8+ cells in the ceca was significantly greater on d 9 and 11 for CD4+ cells and d 11 for CD8+ cells in infected poults compared with uninfected controls. The relative expression of the chemokine CXCLi2 and the cytokines IL1β, IFNγ, IL13 and IL10 was investigated in tissue samples taken from the ceca. Increased expression of CXCLi2 occurred on d 4 and d 7. Increased expression of IL10 and IFNγ occurred on d 4, and IL1β and IL13 on d 7 post-infection. The increased leukocyte infiltration in the ceca, alterations in the lymphocyte subpopulations, and changes in expression of chemokines and cytokines are an indication of the cell and humoral immune activities occurring in the host as a result of exposure to *E. adenoeides*.

Key Words: *Eimeria*, turkey, immunity, CD4+, CD8+ lymphocyte, cytokine

233 Probiotic strains alleviating coccidiosis. K. Teichmann*[1], S. Henikl[1], I. Giannenas[2], and G. Schatzmayr[1], *[1]Biomin Research Center, Tulln, Austria, [2]University of Thessaly, Karditsa, Greece.*

In search for alternative ways to control chicken coccidiosis, probiotics are currently investigated for their potential in reducing the disease's impact on animal health and productivity. Probiotic strains from the BIOMIN culture collection were assessed for their ability to counteract coccidiosis in a stepwise procedure. In previous studies distinct strains of *Enterococcus faecium, Bifidobacterium animalis* and *Lactobacillus salivarius* isolated from chicken gut reproducibly inhibited in vitro parasite invasion by > 50% ($P < 0.05$). In a subsequent challenge trial with *E. tenella* body weights of broilers fed a mixture of the same probiotic strains (PS) were significantly higher ($P < 0.05$) than bird weights of an infected control group, but not significantly different from a group fed a conventional anticoccidial drug. Parasite impact on gut health parameters was markedly reduced. A vaccine challenge experiment employing a 10-fold dosage of a commercial vaccine confirmed the beneficial effects of the probiotic combination on performance parameters. Consequently, a challenge trial including *E. acervulina, E. maxima* and *E. tenella* was conducted to examine effects of feeding PS to broilers during a mixed parasite infection. PS protected weight gain, gut integrity and reduced parasite shedding ($P < 0.05$) in birds challenged with *Eimeria* species inhabiting different sections of the intestinal tract. Thus, previous findings on beneficial effects of a combination of probiotic strains (PS) during coccidiosis were confirmed in an experiment using a mixed infection with 3 *Eimeria* species. Probiotics have shown a great potential in alleviating coccidiosis and should be further investigated as a serious alternative to anticoccidial drugs.

Key Words: *Eimeria*, coccidiosis, direct-fed microbials, probiotics, vaccine

234 Effects of direct fed microbials supplementation on broiler performance under simulated coccidial infection. G. R. Murugesan* and M. E. Persia, *Iowa State University, Ames.*

A broiler coccidial challenge model was used to evaluate the effects of direct fed microbials (DFM; *Aspergillus oryzae* and *Bacillus subtilis*) supplementation on broiler performance under disease stress. Male Ross 308 chicks were brooded in 3 environmentally controlled (EC) chambers on 3 experimental diets. On d 7, the chicks were divided into 4'x4' floor pens located within 8 EC chambers arranged in a 2 × 3 factorial. The treatments consisted of 2 health status groups (control and cocci infected) and 3 dietary groups with a corn-soybean meal control diet (C), C with DFM, and C with antibiotic growth promoter (AGP). Each treatment consisted of 5 experimental units (EU) with 10 chicks per EU resulting in total of 300 chicks raised in a deep litter system (230 in2/chick). Four of the EC chambers served as controls (sham inoculation) and the rest housed challenged birds. The EC chambers were chosen to allow the bird's access to the floor and litter for possible re-infection, but to maintain biosecurity between the control and challenged groups. The challenge consisted of a 10x oral vaccination dose of a live-modified commercially available coccidiosis vaccine that contained a combination of Eimeria sp that was administered on d 9. Feed intake and body weight were recorded on d 7, 21 and 28 and feed conversion was calculated between 7 to 28 d. On d 21, 2 chicks from each EU were euthanized to collect ileal samples and the nutrient transport was measured by a modified Ussing chamber method. There were no significant interactions between coccidiosis challenge and the dietary treatments on bird performance. Dietary treatment, either DFM or AGP, had no significant effect on chick performance, regardless of coccidial status of the birds. Coccidiosis challenge resulted in a significant reduction in feed intake (4.5%), body weight gain (7.4%) and feed efficiency (15.7%) over the 7 to 28 d period. These data indicate that a successful coccidiosis model has been established with a 10× vaccination dose and floor rearing of commercial broiler chicks.

Key Words: broiler, DFM, coccidiosis, performance

235 Statistical handling of ordered categorical data (coccidial lesion scores). L. P. Taylor* and C. D. Smothers, *Pfizer Animal Health, Kalamazoo, MI.*

Scoring assessments for coccidial lesions have been established for decades and are widely used in the poultry industry. The scoring system for coccidial lesions (0,1,2,3,4) is commonly known in statistical terms as an ordered categorical system. An increase in the number is associated with an increase in the severity. Verbal descriptions are given to each category that describe the severity of the lesion. Ordered categorical scales are seen in many other disciplines and have been very useful in describing subjective outcomes for various disease states. Proper statistical analysis techniques that produce results with a high level of confidence have not always been the method of choice when analyzing such data. It is common to see such data subjected to mathematical calculations that are properly suited for continuous data such as body weights or body temperatures. The temptation to employ such analysis techniques and subsequent presentation of results should be avoided. Although ordered categorical scoring systems reflect degrees of severity, they are not additive or equally spaced. Summing or calculating averages of such data has no real meaning as the ordered numerical scores could just as easily be replaced by other notation, such as letters or colors, to convey the same meaning. Statistical methodologies for ordered categorical data have not advanced as quickly as those for continuous data, but categorical data analysis using mixed model methods are now readily available and being used to support efficacy and safety outcomes. These methods are based in practicality, have strong statistical support and are more reflective of the true nature of ordered categorical outcomes. Proper statistical methods of analyzing and presenting results from ordered categorical data are required by a growing number of regulatory agencies and scientific journals. Examples of these techniques and real world outcomes will be presented and discussed.

Key Words: lesions, ordered categorical, statistical method, scoring, coccida

236 Effect of probiotic administration on avian beta-defensin expression in coccidiosis vaccinated broilers. K. Stringfellow*[1], Y. Wang[1], H. Zhou[1], Y. Farnell[2], D. Caldwell[1], J. Lee[1], S. Anderson[1], M. Mohnl[3], R. Beltran[3], G. Schatzmayr[3], S. Fitz-Coy[4], C. Broussard[4], and M. Farnell[1], *[1]Department of Poultry Science, Texas AgriLife Research and Extension, College Station, [2]Department of Neuroscience and Experimental Therapeutics, Texas A&M University Health Science Center, College Station, [3]Biomin GmbH, Herzogenburg, Austria, [4]Intervet/Schering-Plough Animal Health, Summit, NJ.*

Defensins are a family of cysteine-rich antimicrobial peptides that play important roles in the innate immune system. In addition to their defense mechanisms against a variety of microorganisms, they have been demonstrated to play a significant role in the regulation of host adaptive immunity. Probiotic administration has a myriad of physiological effects on the host immune system and has been demonstrated to induce defensin gene expression in mammals. To understand the effect of probiotics on defensin expression in chickens, we used TaqMan® real-time PCR to examine mRNA expression of avian-beta defensins (AVBD) 2 and 9 in the liver of coccidiosis vaccinated broilers. The hypothesis of this study was that probiotic administration would modulate the expression of AVBDs in vaccinated broilers. Treatments consisted of a negative control, probiotic alone, vaccine alone, or a probiotic + vaccine group. Probiotic was administered through the drinking water and coccidiosis vaccination was performed on day-of-hatch by oral gavage. Probiotic was administered on days 0-3, 9-11 and 16-18 to respective groups. On day 21, liver tissue was collected and stored in RNAlater for subsequent RNA extraction. The results showed that AVBD2 expression increased ($P \leq 0.05$) in the probiotic + vaccine group relative to the probiotic alone group. Avian beta-defensin 9 was demonstrated to have an increased ($P \leq 0.05$) expression in the vaccine group when compared to the control birds. These findings indicate that increased AVBD2 and AVBD9 expression may be associated with a host immune response to probiotic and vaccine administration in broilers.

Key Words: defensins, probiotic, broilers, vaccine, coccidiosis

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Chicken Infectious Anemia Virus and Runting Stunting Syndrome

237 Pathogenicity and molecular detection of chicken anaemia virus in commercial broiler farms in Venezuela. L. Garcia*, A. E. Valera, V. Bermudez, M. Salem, and M. Brett, *Agroservices Luzvill.*

AAAP abstract†

238 Detection of chicken infectious anemia virus (CIAV) infection in broiler breeder pullets by non-conventional methods. R. Espinosa*, S. Cheng, G. Zavala, D. Brinson, and P. O'Kane, *Department of Population Health, Poultry Diagnostic and Research Center, The University of Georgia, Athens.*

AAAP abstract†

239 Quantitative analytical technique applied to histopathology of birds infected experimentally by chicken anemia virus. L. Garcia*, A. E. Valera, M. Brett, L. Peroza, K. C. Garcia, and J. Fragozo, *Agroservices Luzvill.*

AAAP abstract†

240 Investigations about the etiology of runting stunting syndrome affected chickens by in situ hybridization. K.-I. Kang*, H. S. Sellers, E. Linneman, T. Kim, and E. Mundt, *Poultry Diagnostic and Research Center, Department of Population Health, The University of Georgia, Athens.*

AAAP abstract†

241 Characterization of a novel chicken astrovirus isolated from intestinal homogenates of RSS-affected chickens. E. Mundt*, T. Kim, K.-I. Kang, E. Linnemann, and H. S. Sellers, *Poultry Diagnostic and Research Center, Department of Population Health, College of Veterinary Medicine, University of Georgia, Athens.*

AAAP abstract†

242 Role of maternal antibodies in protection against chicken parvovirus-induced runting-stunting syndrome. L. Zsak*, R. M. Cha, and J. M. Day, *Southeast Poultry Research Laboratory, USDA, ARS, SAA, Athens, GA.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Tuesday, July 19
SYMPOSIA AND ORAL SESSIONS

Coccidiosis Symposium

243 Anticoccidial drugs successes. H. M. Cervantes*, *Phibro Animal Health, Watkinsville, GA.*

The US produced 8550 MM chickens and 242 MM turkeys in 2010. This impressive production of poultry was almost entirely done under confinement. This level of production could not be achieved without coccidiosis control. The first anticoccidial added to poultry feed that proved to be effective and was approved by FDA in 1948 was sulfaquinoxaline. This was the start of the chemoprophylatic era and paved the way for the initial expansion of the industry and the development of a multitude of new anticoccidials. Some are still successfully used today, among them; nicarbazin approved in 1955 and arsanilic acid, approved in 1949 (now replaced by roxarsone). Up to the early 1970s the chemoprophylactic control of coccidiosis was based on the use of synthetic anticoccidials. Pharmaceutical companies employed scientists responsible for screening a variety of chemical compounds synthesized in their laboratories for their effectiveness as anticoccidials. The ones that were effective and well tolerated by poultry were further developed until an approval for marketing was secured. With a few exceptions, such as nicarbazin, the problem with these "chemicals" was that most of them had very strong anticoccidial activity and this lead to selective pressure upon the Eimeria spp. that in most cases resulted in complete resistance to the drug within a few years. Pharmaceutical companies had to be discovering, testing and approving new anticoccidials every few years. This changed in 1971 with the approval of monensin, the first ionophore. The main difference was that due to its different mode of action a fast development of resistance did not occur. This lead to the development and introduction of other ionophores; lasalocid (1976), salinomycin (1986), narasin (1988), maduramicin (1989) and semduramicin (1996). Since then, prevention of coccidiosis by in-feed anticoccidials has remained the backbone of control programs. It is remarkable that in spite of over 55 years of use, "chemical" anticoccidials like nicarbazin continue to be effective, and after more than 40 years of the introduction of the first ionophore, these drugs continue to be effective in chickens, and some (monensin and lasalocid) also in turkeys.

Key Words: coccidiosis, anticoccidials

244 Anticoccidial drugs and vaccines used in prevention of coccidiosis in poultry: A worldwide perspective. M. S. De Gussem*, *Vetworks, Poeke, Flanders, Belgium.*

Coccidiosis in poultry is still considered as one of the main diseases affecting performance of poultry reared under intensive production systems. With currently practically available diagnostic methods such as oocyst counts and lesion scoring, an interpretation of the impact of (subclinical) coccidiosis is not easy. Another problem difficult to address to date, is the interpretation of the efficacy of an anticoccidial program. Anticoccidial sensitivity testing of the different anticoccidial drugs available is the only reproducible method available today, but interpretation is far from easy. The result of all this is that coccidiosis is, all over the world, underestimated as a health hazard and thus also remains an important economic threat. Continuous optimization of anticoccidial programmes is therefore thought to be advantageous to the broiler industry. In addition to this, a link between subclinical coccidiosis and bacterial enteritis complicates choosing the right tools and strategy for poultry producers mainly in countries producing poultry meat without growth promotors and/or with vegetable diets only. Implementing sound shuttle and rotation programs, making use of all available and validated preventive tools (anticoccidials and live vaccines) is essential to not only control clinical, but mainly also subclinical coccidiosis. While basic rules for preventive programs are applicable all over the globe, regional differences (poultry meat organoleptic requirements, legislation in and availability of anticoccidial drugs and vaccines, management and impact of climatic conditions on coccidiosis challenge) make that designing anticoccidial prevention programs are per definition tailor made and solutions should continuously be evaluated.

Key Words: *Eimeria*, poultry, prevention, anticoccidial, vaccine

245 Coccidiosis mediated effects on energy cost at 5 age intervals throughout the broiler growth curve to 48 days. R. G. Teeter*[1], A. Beker[1], C. Brown[1], C. Broussard[2], S. Fitz-Coy[2], J. Radu[2], and L. Newman[2], *[1]Oklahoma State University, Stillwater, [2]Intervet Schering Plough Animal Health, Union, NJ.*

A metabolic chamber experiment was conducted utilizing Cobb x Cobb males to evaluate coccidiosis impact and calorific costs. Two groups of birds were reared in cocci free environments with one vaccinated at hatch (Coccivac-B) and the other maintained as naive to cocci. Birds were selected from the 2 backgrounds at 5 weekly intervals for chamber placement. The 5 challenge periods consisted of an oral dose of sterile saline or a mixture of 3 Eimeria species administered as oocysts to naïve birds at 14, 21, 28, 35, and 42 d. Variables examined 6 d post challenge included live weight, FE, gross lesion scores (upper small intestine: USI; mid small intestine: MSI; ceca: C), heat production (HP) and body composition. Metabolic costs of cocci challenge included appetite suppression, maintenance energy elevation, excreta calorie elevation and reduced live weight gain, FE and ration net energy ($P < 0.05$). Though coccidiosis challenge occurring early in the production cycle had energy cost, birds exposed late (35, 42 d) exhibited higher costs ($P < 0.05$). Effective caloric value (ECV) places caloric density equivalents upon nutritional and nonnutritional factors. In this study coccidiosis mediated lesion scores 6 d post oocysts challenge exhibited marked ($P < 0.01$) deleterious impact upon ECV. Lesion score 1 and 2 reduced the dietary energy value from an initial 3,200 Kcal/Kg ration by 125 and 596 Kcal for 800 g broilers and by 625 and 2,277 Kcal/Kg for 3000 g birds, respectively. Lesion score cost far exceeded consequences for inadequate lighting program and poor pellet quality. Calorimetry data substantiated the lesion consequence with increased maintenance energy need, heat production and malabsorption. Results demonstrate the importance of time dependency on coccidiosis control and calorific cost associated with lesions score.

Key Words: coccidiosis, broiler, energy, malabsorption

246 Practical aspects and field experiences in coccidiosis. L. J. Newman*[1], C. T. Broussard[1], A. Smykot[2], and D. Detzler[3], *[1]Intervet/Schering-Plough Animal Health, DeSoto, KS, [2]Intervet/Schering-Plough Animal Health, Pointe Claire, QC, Canada, [3]Fischer Feeds Inc., Listowel, ON, Canada.*

A quarter of a century ago, broiler coccidiosis control using in-feed anticoccidial medication was highly effective. Rotation and shuttle programs maximized efficacy, and control could be maintained with minimum flock-to-flock variation regardless of environmental conditions. But as sensitivity of the field coccidia decline, we must accept that farms will be subjected to some degree of *Eimeria* challenge or "coccidiasis" during the life of the flock. The genetics of the modern high-yield broiler allow slaughter by 30 to 36 d in many markets, and slaughter age will often coincide with the peak of *Eimeria* challenge. Coccidiosis or coccidiasis is no longer just a disease of a single bird or a single flock. It is a dynamic population that produces different clinical or economic outcomes depending upon many field factors such as stocking density, environmental humidity, slaughter age and the influence of the coccidiosis control program of the previous flock. Studies utilizing gross lesion scores, microscopic lesion scores, and sequential oocyst counts can be used to examine the influence of each of these factors on the behavior of the *Eimeria* challenge population on the farm. *Eimeria* reproduction is slowed by in-feed anticoccidial medication, low stocking density and low environmental humidity. This results in populations that peak at 28 d of age or later. When this peak corresponds to the final 2 weeks before slaughter, negative economic impact is maximized (Teeter et. al.). A peak in *Eimeria* shedding immediately before slaughter appears to result in the carryover of a higher challenge to the subsequent flock, even when cleaning and disinfection are employed. This early challenge may alter the clinical and economic outcome of the *Eimeria* population dynamics in that flock, which may, in turn, influence the next flock in sequence. Understanding coccidiosis population dynamics will help producers to develop coccidiosis and environmental management strategies to maximize broiler economic return as the broiler growth rate continues to increase and sensitivity to in-feed anticoccidials continues to decline.

Key Words: *Eimeria*, economics, coccidiosis, population, environment

247 The role of nutrition in maintaining gut health in the presence of coccidial cycling. J. J. Dibner*, F. Yan, and C. D. Knight, *Novus International Inc., St. Charles, MO.*

The move toward drug-free poultry feeds has increased use of coccidial vaccines, however, the curtailing of feed and therapeutic antibiotic use worldwide has increased enteric diseases, including necrotic enteritis (NE). NE, caused by *Clostridium perfringens* (Cp) is one of the most economically important enteric diseases of broilers. Coccidial vaccination may predispose birds to NE. The purpose of this presentation is to place necrotic enteritis within the context of digestive health and microbial ecology by testing the hypothesis that coccidial vaccination alone does not lead to Cp overgrowth. The studies were designed to test whether diet and dietary additives also play a role in Cp overgrowth. To study the role of diet in the development of dysbacteriosis, a model has been developed that does not include a Cp challenge. Rather, the model uses a high viscosity diet that has been associated with Cp dysbacteriosis. Using this model, a series of experiments was conducted to study factors that can contribute to or mitigate the effects of subclinical enteritis. In a proof of principle experiment broilers were fed a 22% CP, 1.21%/1.07% total/digestible lysine mash diet was fed that contained 33% rye, 25% wheat, and 31% soybean meal. A 3x overdose of a live oocyst vaccine and an antibiotic or an NSP enzyme mixture were compared with unchallenged and/or untreated controls. Results indicated that diet played a significant role in Cp growth while coccidiosis challenge had no significant effect. This model is being used to test novel feed additives. Determining the dietary and enteric conditions that precede clinical NE are essential in the development of dietary and feed solutions for sustainable drug free agriculture. The purpose of the research described here is to examine the relationship between coccidial cycling and dysbacteriosis involving C. perfringens in broiler chickens with the goal of identifying nutrition guidelines and feed additives that reduce the incidence of Cp overgrowth in the distal ileum of broiler chicks.

Key Words: coccidiosis, necrotic enteritis, vaccination, dysbacteriosis

248 Immune responses to coccidiosis in poultry: An update. R. A. Dalloul*, *Virginia Tech, Blacksburg.*

Considering the complex life cycle of *Eimeria* parasites, the interactions of this pathogen with the host have been historically difficult to track at the molecular level. Particularly, immune responses are diverse with the belief that cell-mediated immunity plays the predominant role against this intracellular pathogen. Over the past decade however, especially since the description of the highly conserved pattern recognition receptors, scientists have shown a much greater role of the innate arm of the host immune system. Traditionally regarded as an ancient scavenger system that immediately responds to slow down infection until adaptive immunity kicks in, components of the innate system have proven to perform more duties in orchestrating subsequent immune responses. In recent years, a plethora of publications has characterized both innate and acquired immune responses during *Eimeria* infections. These include the involvement of numerous immune elements like Toll-like receptors, antimicrobial peptides (e.g., LEAP-2), cytokines, and others engaged in inducing inflammation, activation of immune cells, and production of effector molecules. It has become evident that initial encounter of pathogens with the innate system leads not only to impeding the infectious process, but also to recruitment of various immune components, as well as induction and modulation of the adaptive immune system. As part of innate defenses, cells of the epithelial linings also contribute to such processes by secreting their own defense molecules. Overall, significant progress has been accomplished for better interpretation of the complex immune responses to coccidiosis, yet much remains to be explored. Current advanced tools of genomics, proteomics, and next generation sequencing technologies have become readily available and more economical for scientists to delve deeper into the intricate world of coccidiosis and the parasite interactions with its host.

Key Words: innate immunity, adaptive immunity, coccidiosis, *Eimeria*, poultry

249 Oocyst vaccine delivery and tracking. M. Jenkins*, *Agricultural Research Service, Beltsville, MD.*

The 2 predominant means by which producers control avian coccidiosis are medication of feed with anticoccidial compounds and administration of live *Eimeria* oocysts vaccines. While these approaches are sufficient to prevent major coccidiosis outbreaks, there is need for improvement in application of both control strategies. One improvement would be a rapid, inexpensive method for identifying species and strains of *Eimeria* present in a poultry house. This information would be useful for identifying drug-resistant or immunovariant strains, and

may guide producers on adopting alternative control strategies (e.g., switching between different drugs or vaccines). At present, there are several molecular methods based on PCR amplification of specific gene sequences, followed by analysis using gel- or capillary-electrophoresis or by real-time PCR to detect a particular *Eimeria* species. Efforts are underway to develop assays based on microsatellite markers for differentiating *Eimeria* strains, but no methods are available at present to discriminate *Eimeria* oocysts beyond the species level. The second area that needs improvement is live oocysts vaccine delivery. It is well established that chicks given *Eimeria* oocysts by oral gavage at hatch acquire immunity sufficient to resist a challenge infection by 2 weeks of age. Several commercial vaccines are available based on virulent or precocious *Eimeria* strains, and the 2 most often used methods of vaccine delivery are spray vaccination at hatch or inoculation into 18d embryos. Anecdotal evidence suggests that vaccination is neither efficient nor uniform, and that "cycling" of oocysts by chickens once inside the poultry house is required to achieve complete immunity. Our research is directed at improving the delivery of live vaccines by incorporating *Eimeria* oocysts inside gelatin-beads, and subsequent application onto feed for consumption by day-old chicks. Our preliminary data indicates that this method has promise for achieving uniform immunity against coccidiosis challenge infection. Comparison of gel-bead delivery to other immunization methods and obstacles for practical application will be a topic of discussion.

Key Words: coccidiosis, *Eimeria*, detection, vaccination, delivery

250 Precocious lines and attenuated coccidia. R. H. Fetterer*, *Animal Parasitic Diseases Lab, USDA/ARS, Beltsville, MD.*

Poultry coccidiosis caused by several species of *Eimeria* remains an important disease of chickens raised in intensive production systems. The biology of *Eimeria* is characterized by a direct life cycle with 3 or more meront stages which allow for asexual expansion of the parasite resulting in sexual stages leading to production of oocysts. The duration of the life cycle stages and the prepatent period were originally considered to be fixed characteristics. However, seminal studies by T. K. Jeffers and others demonstrated that the prepatent period could be shortened by selecting strains of parasites derived from the earliest produced oocysts. This selection for precocious development is a result of one or more meront stages being eliminated with the resultant attenuation of the life cycle. The precocious strains are desirable for use in live vaccines since they lack the virulence and fecundity of natural strains but retain the ability to illicit protective immunity. Considerable research effort has led to the development of commercially successful vaccines containing precocious strains. In addition to precocious strains there has been some interest in attenuation of *Eimeria* development by gamma irradiation of sporulated oocysts. Using the appropriate radiation dose it may be possible to limit parasite development to the trophozoite or early meront stages thus preventing pathology, eliminating oocysts production and inducing acquired immunity. A vaccine consisting of irradiated oocysts would not require genetic selection and production would not be limited by the reduced fecundity observed in precocious strains. Development of new methods to attenuate the life cycle of *Eimeria* will require an increased knowledge of the regulation of parasite development. The selective knock out of genes controlling developmental stages (genetic attenuated development, GAD) has been achieved in other Apicomplexan parasites but the ability to genetically manipulate genes of *Eimeria* is lacking. In the future, GAD may be the key to understanding the role of developmental stages in the acquisition of immunity to avian coccidiosis.

Key Words: coccidiosis, *Eimeria*, poultry, disease

251 Using immunology and genomics as tools to investigate innate immunity to *Eimeria* with the goal of developing antibiotic-free, disease control strategies against avian coccidiosis. H. Lillehoj*, *Animal and Natural Resources Institute, US Department of Agriculture, Agricultural Research Service, Beltsville, MD.*

Host-pathogen interactions in avian coccidiosis are complex. At the level of the host, a multitude of defense effector mechanisms are mounted against Eimeria parasties, including innate and acquired components of intestinal immunity. At the pathogen level, virulence is manifested through diverse and multifaceted genes and gene products. Although the underlying host immune response against Eimeria, and the counteracting response by parasites, are governed by genetically-controlled traits, recent evidence also highlights an important role for environmental factors affecting the outcome of this host-pathogen interaction. This complexity is further magnified by the microbiota of commensal bacteria which naturally inhabit the gut and influence the nutritional and metabolic states of both host and parasite. Therefore, a large array of management strategies to enhance gut health and increase disease resistance need to be considered if avian coccidiosis is to be effectively controlled. This talk will underscore resent basic research findings on poultry immunity and genetics that may prove beneficial for future development of novel alternative disease control strategies, thereby mitigating the use of anti-coccidial drugs.

Key Words: avian, coccidiosis, immunology, genomics, *Eimeria*

252 Coccidiosis control programs: Effects on gastrointestinal microbiota and incidence of clostridial infections in broiler chickens. G. D. Ritter*[1] and A. P. Neumann[2], [1]*Mountaire Farms Inc., Millsboro, DE,* [2]*Danisco USA Inc., Waukesha, WI.*

Coccidiosis is a ubiquitous disease of economic importance in commercial broiler production. Prophylaxis treatment to prevent or minimize economic losses due to reduced absorption of feed nutrients is typically achieved using ionophoric compounds, other classes of anticoccidial chemicals, and live oocyst vaccines. While interventions have been successful at reducing the impact of coccidia, they can have other unintended consequences on the natural communities of beneficial microbes in the GI tract. Disruptions in these communities can lead to reduced performance and disease. Commercial broiler production data over a 6 year period from a large broiler integrator located on the Delmarva Peninsula will be presented relating incidence of Clostridial gangrenous dermatitis (GD) to various coccidial control programs. Based on this field data a pen research study was completed to investigate the effects of anticoccidial feed additives on the composition of the gastrointestinal microbiota. Interventions evaluated included in-ovo vaccination using a live oocyst coccidial vaccine, the ionophores; monensin and salinomycin, the chemical products; Clinacox, Deccox, and Maxiban, a chemical ionophore shuttle program (nicarbazin/salinomycin), and a non-medicated control. Intestinal mucosa samples and cecal contents were collected periodically during the rearing period for microbial community profiling using molecular analysis techniques DGGE, T-RFLP and cloning and sequencing of select samples. Research results and associations/correlations with field data will be discussed.

Key Words: microbiota, ionophore, coccidiosis, gangrenous, dermatitis

253 Prevalence of *Eimeria* spp. in European broiler farms. M. Pages*[1], M. Dardi[1], J. Rubio-Perez[1], D. Blake[2], and E. Del Cacho[3],

[1]HIPRA, Amer, Spain, [2]Institute of Animal Health, IAH, Compton, England, [3]Faculty of Veterinary Medicine, Zaragoza, Spain.

Avian coccidiosis is one of the most important diseases affecting the intensive poultry industry worldwide. Despite its outstanding importance and well-known relation with other factors that may influence health status of the birds and commercial performance few studies are available on the distribution of species in the field. In Europe few field surveys of *Eimeria* species are available. Commonly, the published studies have been focused on identifying the 7 species of *Eimeria* which affect *Gallus gallus* in a European country. The studies available in Europe until the present date are, Czech Republic (KuÄ era, 1990), France (Williams, 1996), UK (Chapman, 1982, Shirley 1995, Shirley 1997, Williams 2006, Eckert 1995), Norway (Haug, 2008) and Sweden (Thebo, 1998). The number of studies that have been done using samples from broiler farms is scarce and only the study by Haug 2008 has been done exclusively with samples from broilers. In the present study litter samples obtained in broiler farms from Spain, Belgium, Italy and France were evaluated for the presence of *Eimeria* species. The evaluation was done using a polymerase chain reaction (PCR) developed at IAH to specifically detect *E. acervulina*, *E. maxima*, *E. mitis*, *E. praecox* and *E. tenella*. Together with this molecular tool for detection of *Eimeria* species in litter samples, oocyst counts and evaluation of percentage of species by using a morphometry test was also done to further evaluate the samples. Results obtained provide interesting data on the prevalence of species which affect the broiler birds in Europe as well as the percentage of farms with each species. Summary of data collected from litter samples in broiler farms using the PCR.

Key Words: *Eimeria*, PCR, broiler, coccidiosis

254 Pathologenicity and prevalence of the lesser species of chicken *Eimeria*. S. H. Fitz-Coy*, *Intervet/Schering-Plough, Millsboro, DE.*

Five of the chickens *Eimeria* are regarded as lesser species (*E. mitis*, *E. praecox*, *E. mivati*, *E. hagani* and *E. acervulina*). These are considered "lesser species" due to the perceived less pathogenic impact on the host. There is scant documentation on research with *E. hagani*, *E. praecox* and *E. mitis*; however, *E. acervulina* and *E. mivati* have had a reasonable share of scientific investigations. *E. acervulina* may cause severe growth depression, impairment in feed efficiency and cessation in egg production. Clinical signs are watery, viscid and mucoid droppings. Gross lesions are white transverse bands which may coalesce in severe infections in the upper third of the small intestines. *E. acervulina* is one of the most prevalent species of chicken. The description of *E. hagani* was brief, but was recently re-described. Infection confined to the upper half of the small intestine. *E. hagani* produces hemorrhagic spots and watery intestinal contents. Recent samples have had organisms identified as *E. hagani*. *E. mitis* produces no lesions but cause growth suppression and cessation in egg production. The prevalence of *E. mitis* is less than 15%. *E. mivati* is the most pathogenic, infections cause growth depression in broiler chickens, cessation in egg production and mortality in susceptible chickens. Signs are watery and mucoid droppings with a tinge of blood and gross lesions are white spots "a star burst appearance" throughout the small intestines with higher intensity in the upper half. Mortality can occur and may vary from 10% to 40%. The prevalence of *E. mivati* in the US is estimated to be 20–30%. *E. praecox*, has a shortened pre-patent period, the pathogenicity is often overlooked due to the lack of gross lesions. The prevalence is less than 15%. Although these 5 species of chicken *Eimeria* are referred to as the lesser species, some members of this group may be moderately pathogenic even causing mortality.

Key Words: *Eimeria*, lesser species, pathogenicity, chickens

255 *Eimeria* in gamebirds: Development of PCR-based diagnosis and tests of immunity and drug efficacy. L. R. McDougald*, R. Gerhold, and R. B. Beckstead, *University of Georgia, Athens.*

Outbreaks of coccidiosis are common and severe in gamebirds raised commercially. In cooperation with the North American Gamebird Association we conducted a limited survey of chukars, pheasants and bobwhite quail. Samples received from the field in 2% potassium dichromate were examined microscopically, then passaged in young cage-reared birds. Oocysts were collected from the droppings and the lesions examined by microscopy at necropsy. Single-oocyst-isolates of these cultures were used to prepare species-specific PCR primers. Genus-wide *Eimeria* PCR primers were used to amplify the internal transcribed spacer region 1 (ITS-1) of the ribosomal RNA of each species. PCR products were cloned, sequenced, and aligned for phylogenetic analyses. In the Chinese ringnecked pheasant, the most predominant and pathogenic species were *E. phasiani, E. colchici. E. duodenalis. E. pacifica* and *E. tetartoomia* were also identified. In the Chukar partridge, the predominant species was *E. kofoidi* (18 isolates). *E. legionensis* was identified in 3 isolates. Another species, identified only by PCR in one isolate, was unidentified. Bobwhite quail had 3 species common in most isolates. The most pathogenic and prominent were *E. lettyae* and *E. dispersa*. The 3rd species was probably *E. colini*, although the description of this species is incomplete. Tests were also conducted to evaluate the potential vaccination against these coccidia in each bird species. Several anticoccidial drugs were tested for efficacy against selected isolates.

Key Words: coccidiosis, *Eimeria*, PCR, gamebirds

256 Tom Jeffers: Pioneer of coccidiosis research. H. D. Chapman*, *University of Arkansas.*

For much of his career Dr T. K. (Tom) Jeffers was involved in animal health research and administration for one of the largest pharmaceutical Companies in the world. In 1963, as a student at Cornell University, he co-authored a paper on the genetics of allelism in the fowl which was published in Nature. During the 1970s, at Hess and Clark and Elanco, he made several unique contributions to our understanding of the disease coccidiosis in poultry. These included the most comprehensive set of data concerned with resistance to anticoccidial drugs ever published, the phenomenon of synergism and collateral sensitivity to certain drugs, and genetic recombination between them. Jeffers was the first to show that it was possible to develop resistance to an ionophore, the most widely used drugs for the control of coccidiosis. He co-invented a novel anticoccidial drug combination now widely used to control coccidiosis. His most significant contribution, however, was the demonstration that it was possible to attenuate a coccidian by selection for precociousness in the chicken. This eventually led to the development of live, attenuated vaccines for the control of coccidiosis. He proposed that alternating cycles of immunization using drug sensitive strains and chemotherapy could provide effective long-term control of coccidia in commercial poultry production. Tom Jeffers was a true pioneer of coccidiosis research.

Key Words: Jeffers, coccidiosis, drugs, vaccines

Immunology

257 Complement and natural antibody in pre-market commercial ducks and turkeys. P. Cotter*[1], T. Applegate[2], R. Murdoch[3], K. Daughtery[3], and L. Tusing[3], *[1]Cotter Laboratory, Arlington, MA, [2]Purdue University, West Lafayette, IN, [3]Maple Leaf Farms, Milford, IN.*

Our purpose was to compare complement and natural antibody levels of pre-market commercial duck and turkey sera using lysis and agglutination of horse (Ho), human (HuO), and rabbit erythrocytes (Rb). Day 35 duck samples (n = 97) and d 25 turkey samples (n = 66) represented 1 and 18 wks pre market age respectively. Sera were diluted in PBS supplemented with Ca and Mg, and tested using the same lots of erythrocytes. Microtiter end-points (log_2) were L_{100} and L_{50} indicating complete and partial lysis; HA_1, HA_2, and HA_{45}, represented stronger or weaker agglutinations. In both species, lysis titers were highest for rabbit cells and all duck sera were reactive. L_{100} and L_{50} values were 4.4 and 6.5. Strong Rb agglutinins (HA_1) were present in 67/97 (69%) of ducks, weak agglutinins (HA_2) were present in 36/97 (37%). All turkey sera lysed Rb cells (L_{50} titer = 3.9, L_{100} titer = 2.3), but L_{100} lysis was absent in 4 samples. Rb agglutinins of the HA_1 type were present in 21/66 (32%) and HA_2in 18/66 (27%) of turkeys. Ho cells were lysed by 52% (L_{100}) and 12% (L_{50}) of the duck sera; but agglutinins could not be differentiated into HA_1 or HA_2types due to low titer (1.9). Ho cells were lysed by 25/66 (38%) of the turkey samples; however the L_{100} - L_{50} differentiation could not be made with confidence. Weak Ho agglutinins (HA_{45}) were found in all turkeys, and in a minority (16/66, 24%) a pattern resembling HA_1 could also be detected. HuO agglutinins were absent from ducks but these cells were lysed; titers were L_{100} = 3 and L_{50} = 4.4. A minority of turkeys 15/66 (23%) lysed Ho but only by those sera also containing (HA_1) agglutinins. The latter was a surprising observation since turkeys were reported to lyse Ho independent of antibody. Collectively these observations indicate the utility of natural lysins and agglutinins as indicators of immunologic maturity in these species. They also show the degree of heterogeneity among similarly aged ducks and turkeys.

Key Words: complement, natural antibody, ducks, turkeys

258 Innate immune function in autoimmune vitiligo-prone Smyth line and control chickens. K. A. Byrne*, L. Dong, N. Stepicheva, F. Shi, and G. F. Erf, *University of Arkansas, Division of Agriculture, Department of Poultry Science, Fayetteville.*

Innate immunity, while not self-reactive, has been shown to play a role in the development of autoimmune diseases. Smyth line (SL) chickens develop autoimmune loss of pigment cells (vitiligo) in feathers. To examine innate immunity in autoimmune vitiligo-prone SL chickens and parental Brown Line (BL) and Light Brown Leghorn (LBL) controls, blood was collected from 16 SL, 8 BL and 8 LBL chickens at 6 wks of age before SL vitiligo (SLV) and again at 14 wks when 50% of the SL chicken had developed SLV. Blood was used to conduct differential leukocyte (WBC) counts and for isolation of peripheral blood mononuclear cells (PBMC). PBMC were immunofluorescently stained to determine the percentages of lymphocytes and various lymphocyte subsets, monocytes and thrombocytes by flow cytometry. The production of nitric oxide (NO) and reactive oxygen species (ROS) by PBMC with and without lipopolysaccharide (LPS) stimulation was also examined. Independent of age or vitiligo state, there were no differences in the proportions and numbers of WBC. At 6 wks of age, there were also no line differences in the proportions of thrombocytes, lymphocytes, and lymphocyte subsets in the isolated PBMC population. Interestingly, while ROS production by PBMC was similar for all chicks at 6 wks, PBMC from 6-wk-old SL chickens that later developed SLV had 2.5 times more ($P < 0.05$) KUL01-positive cells (monocytes) and produced higher ($P < 0.05$) levels of NO compared with SL chicks that never developed SLV. This line difference in NO production disappeared however when NO production was adjusted to the number of KUL01+ cells in the PBMC suspension. The same trends were observed when the chickens were 14 wks old, with the addition of heightened ROS production, increased proportions of CD8+ (cytotoxic) lymphocytes and decreased proportions of gamma-delta T cells in PBMC cultures of SL chickens with active SLV compared with SL without SLV, BL and LBL controls. These results suggest that NO production or the proportions of KUL01+ cells in PBMC suspensions may serve as a biomarker to identify SL chickens that will develop SLV. Support: State Undergraduate Research (SURF) grant.

Key Words: leukocyte, autoimmunity, nitric oxide, ROS, chicken

259 An essential role of avian Nod1 in host innate immunity. S. Kim*, C. L. Keeler Jr., E. A. Wong, C. M. Cox, L. H. Sumners, and R. A. Dalloul, *Avian Immunobiology Laboratory, Animal & Poultry Sciences, Virginia Tech, Blacksburg.*

AAAP abstract†

260 Supplementation of broiler diets with functional yeast-derivate macromolecules on local and systemic toll-like receptors and cytokines profiles. A. Yitbarek*[1], H. M. Echeverry[1], P. Munyaka[1], G. Carmelo-Jaimes[1], S. Sharif[2], W. Guenter[1], J. D. House[1], and J. C. Rodriguez-Lecompte[1], *[1]University of Manitoba, Winnipeg, MB, Canada, [2]University of Guelph, Guelph, ON, Canada.*

The turnover of intestinal epithelial cells is a dynamic process that includes the adequate cell proliferation and maturation in early gut development in chickens. We studied the effect of yeast-derived macromolecules (YDM, NuPro, Alltech Inc.) on performance and gut immunity of broiler chickens. One thousand and 80 1-d-old birds, 60 birds per pen and 6 pens per treatment were randomly assigned to treatment diets for 2 week at the starter phase. Treatments were a diet containing Monensin (T1), T1 supplemented with Bacitracin methylene disalycylate and T1 supplemented with YDM (T3). Feed intake, feed conversion efficiency, mortality, and gene expressions of toll-like receptors (TLRs 2 and 4) and cytokines (IFN-γ, interleukin 6 (IL-6), IL-10 and IL-12) in the Ileum, cecal tonsil, spleen and bursa were assessed. Feed intake and conversion efficiency were significantly lower in T3 ($P < 0.05$) than T1. Mortalities were 40 and 48% lower in T3 compared with T1 and T2, respectively. T3 showed a significant upregulation of TLR-4 in the bursa and spleen ($P < 0.05$) while no up/downregulation of both receptors was observed in the ileum and cecal tonsil ($P > 0.05$). A significant upregulation of IL-10 and IL-12 in T3 in the ileum was observed ($P < 0.05$), while no significant difference was observed in the other tissues. There was a significantly higher heterophils to lymphocytes ratio in T3 ($P < 0.05$). No up/downregulation of IL-6 and IFN-γ was observed in all tissues ($P > 0.05$). Our results suggest that feeding YDM in the first 2 weeks of the bird's age could have an immune regulatory effect via local and systemic responses involving TLRs and cytokines.

Key Words: toll-like receptors, cytokines, monensin, yeast-derived macromolecules, BMD

261 Performance and innate immune system responses of chickens fed with yeast-derivate carbohydrates. P. Munyaka*[1], H. M. Echeverry[1], A. Yitbarek[1], G. Carmelo-Jaimes[1], S. Sharif[2], W.Guenter[1], J. D. House[1], and J. C. Rodriguez-Lecompte[1], *[1]University of Manitoba, Winnipeg, MB, Canada, [2]University of Guelph, Guelph, ON, Canada.*

With the ban of antibiotic growth promoters (AGPs) there is a higher risk of chickens to necrotic enteritis and other diseases. Yeast-derived carbohydrates (YDC, Actigen, Alltech Inc.) may be used as an alternative to replace AGPs. We studied the effect of YDC on performance and gut immune system of broiler chickens. One thousand and 80 1-d-old birds, 60 birds per pen and 6 pens per treatment were randomly assigned to receive one of 3 dietary treatments. Treatments were a diet containing Monensin (T1), T1 supplemented with Bacitracin methylene disalycylate (T2) and T1 supplemented with YDC at 0.8, 0.4 and 0.02% for starter, grower and finisher, respectively (T3). Body weight, feed intake, feed conversion efficiency (FCR), mortality, and gene expression of toll-like receptors (TLRs 2 and 4) and cytokines (IFN-γ, interleukin 6 (IL-6), IL-10 and IL-12) were assessed. Final body weight was significantly higher while FCR was significantly lower in T3 than T1 ($P < 0.05$), and no significant difference was observed with T2 ($P > 0.05$). Mortality was 30 and 39% lower in T3 compared with T1 and T2, respectively. Heterophils to lymphocytes ratio was significantly higher in T3 ($P < 0.05$). Relative expression of TLR-4 in the ileum was significantly lower in T3 ($P < 0.05$) while it was not significant in the cecal tonsil. There was no significant difference in the expression of TLR-2 and cytokines (IFN-γ, IL-6, IL-10, and IL-12) in both ileum and cecal tonsil in all treatments. In conclusion, our results show that YDC supplementation could have a beneficial effect on the overall performance of birds as well as on the immune sysytem via microbiota control and immune regulator effects.

Key Words: necrotic enteritis, mannan-oligosaccharides, toll-like receptors, cytokines, broilers

262 Effects of dietary folic acid supplementation and lipopolysaccharide on systemic acute immune response of young laying hens. P. Munyaka*[1], G. Tactaman[1], K. O[1,2], J. D. House[1,3], and J. C. Rodriguez-Lecompte[1], *[1]Departments of Animal Science, [2]Physiology, [3]and Human Nutritional Sciences, University of Manitoba, Winnipeg, MB, Canada.*

Folic acid plays a central role in nucleic acid and protein synthesis and hence, poor folate status significantly alters the immune response. In addition to influencing cell-mediated immunity, folic acid deficiency affects the immune competence and resistance to infections. We studied the effect of *Escherichia coli* derived lipopolysaccharide (LPS) and folic acid supplementation on the immune response of young laying hens. Forty-eight Shaver White laying hens were used and water and feed were provided ad libitum. Two treatment diets, differing only in folic acid content, were mixed to provide either 0 mg, or 4mg folic acid per kg of diet. After 6 weeks, 6 birds from each treatment were selected randomly and subjected to an acute challenge via intravenous injection with 8 mg/Kg body weight of LPS and the birds were observed for 4 h before sample collection. Flow cytometry analysis for CD4, and CD3 in the blood and spleen, and serum biochemical constituents (fibrinogen, sodium, potassium, chloride, creatinine, glucose, albumin, globulin, phosphorus, and calcium) was assessed. LPS significantly decreased ($P < 0.05$) the levels of CD4+ and CD3+ cells in the blood compared with the control but did not cause significant effects in the spleen. Effects of diet were not significant in both blood and spleen. LPS significantly increased the levels of electrolytes: sodium, and chloride but not potassium ($P = 0.0273$, $P = 0.002$) while diet had no significant effect ($P > 0.05$). Folic acid supplementation slightly increased the level of calcium ($P = 0.052$), while LPS significantly lowered the levels of both calcium and phosphorus. The ratio of albumin/globulin was significantly higher in LPS injected hens compared with the control but the diet had no significant effect. Both LPS and diet did not have any significant effects on the levels of fibrinogen and glucose. In conclusion, this study shows that folic acid supplementation may not cause differences in the immune system of young hens while LPS challenge may have systemic effects in the immune response of young laying hens.

Key Words: folic acid, LPS, flow cytometry, innate immunity

263 Modulation of embryonic bursal gene expression after exposing high and low antibody response lines to testosterone. R. L. Taylor Jr.*[1], T. A. Burks[1], P. B. Siegel[2], and C. M. Ashwell[3], *[1]University of New Hampshire, Durham, [2]Virginia Tech, Blacksburg, [3]NC State University, Raleigh.*

Divergent selection from a common founder population has produced high (HAS) or low (LAS) White Leghorn lines that differ by more than 5-fold in their 5 d anti-SRBC antibody titer following intravenous injection of 0.1 mL 0.25% SRBC in saline. Exogenous hormone exposure, particularly testosterone, during embryonic development impairs the bursa of Fabricius (BF) microenvironment for chicken B cell maturation. We exposed fertile eggs from the 34th selected generation of each line to testosterone propionate (TP) on incubation d 3. Eggs were dipped in either a 2% TP ethanol solution for HAS TP and LAS TP treatments or ethanol alone for HAS and LAS controls. At 15, 18, and 21 d of incubation, bursal tissue RNA was extracted from 4 individual embryos of each group. Reverse transcription of the extracted RNA produced cDNA which was labeled indirectly with fluorescent dyes, Cy3 or Cy5. We examined the TP exposure impact on bursal gene expression by hybridizing individual cDNA to an immune-focused microarray comprised of 70-mer oligonucleotides representing 320 genes. A dye swap was included. This array exhibits increased sensitivity to detect sample differences because each gene is spotted 12 times. Mixed-model ANOVA was applied to log2 transformed fluorescent intensity data that were normalized through weighted regression. At d18, Line LAS controls had higher expression of genes associated with the immune response (iNOS, CD4, IL-2), transcription factors (HOXA3, c-FOS), and growth (IGF1) than did Line HAS controls. The elevated IGF1 is likely a downstream consequence of higher GH and GH-receptor at d15 in Line LAS. TP treatment of Line LAS raised metabolic and signal transduction (JAK3, IRF1) genes whereas Line LAS controls had a broader range of higher expressed genes including iNOS, CD4, IL-2, IL-8, IL-13, IGF1, HOXA3, and c-FOS, many of which were found in the prior comparison with Line HAS. Increased gene expression related to differential immune responses and growth correlates with physiological observations between the selected lines.

Key Words: bursa of Fabricius, microarray, immune response

264 A single immunization with a monoclonal anti-CD40-conjugated C. perfringens α-toxin-derived peptide elicits fast and strong IgG responses in chickens. C.-H. Chen*[1], D. Abi-Ghanem[1], J. Bray[2], W. Mwangi[2], S. Waghela[2], and L. Berghman[1,2], *[1]Department of Poultry Science, Texas A&M University, College Station, [2]Department of Veterinary Pathobiology, Texas A&M University, College Station.*

Necrotic enteritis (NE) is a devastating disease of modern broilers, caused mainly by *Clostridium perfringens* (Cp) type A. Cp α toxin (α-toxin) has been implicated in the pathogenesis of NE. Because of the concern for antimicrobial resistance, vaccination is considered the most promising avenue for prevention of NE. However, subunit vaccines that elicit quick and strong immune responses against NE are currently unavailable. CD40, a costimulatory molecule expressed mainly on antigen presenting cells (APCs), is crucial in regulation of cellular and adaptive immunity. The engagement of CD40 with CD154 on Th2 cells causes activation of APCs, especially antigen-specific B-cells. We have recently generated a monoclonal anti-chicken CD40 antibody 2C5 and demonstrated that it mimics biological functions of chicken CD154, and thus has great potential as an immunological adjuvant. In this study, we assessed the potential of 2C5 as potentiator of a subunit vaccine consisting of a Cp α-toxin-derived peptide in 5-week old chicks. This vaccine complex was prepared by complexing biotinylated 2C5, streptavidin, and biotinylated peptide at a stoichiometric ratio of 2:1:2. Chicks (7 chicks/group) were immunized subcutaneously with 2C5-Cp peptide complex or mouse immunoglobulin control at 3 dose levels (10μg, 30μg, 90μg) in the nape of the neck. Immunization of a group of 7 chicks was carried out via the same route with 3 dose levels (1.7μg, 5.1μg, 15.3μg) of streptavidin-Cp peptide (1:2) conjugate precipitated with alum. Blood was collected from the wing vein of each chick on d 4, 7, 10, and 14 post-immunization for detection of antigen-specific IgG by ELISA. Our data showed that a single subcutaneous immunization with 10μg of 2C5-based vaccine was able to generate significant Cp peptide-specific antibody responses as soon as 4 d post-immunization, ($P < 0.001$). This study suggests that CD40-targeted antigen delivery is an effective strategy to improve the kinetics of adaptive immunity of subunit vaccines in chickens.

Key Words: *Clostridium perfringens*, necrotic enteritis, α-toxin, vaccine, CD40

265 In vivo regulatory T cell depletion using anti-chicken CD25 monoclonal antibody. R. Shanmugasundaram and R. K. Selvaraj*, *Ohio Agricultural Research and Development Center, Wooster.*

$CD4^+CD25^+$ cells in chickens have regulatory T cells (Tregs) properties. Experimental depletion of Treg population, using anti-CD25 antibodies, has been shown in mammals. The objective of this study is to deplete Tregs in vivo using anti-chicken CD25 monoclonal antibody. Anti-chicken CD25 antibody or anti-rat CD25 antibody (isotype control) (1mg/bird) were injected intraperitoneally into 3 week old layer chickens. Peripheral blood was analyzed for $CD4^+CD25^+$, $CD4^+$, and $CD8^+$ cells at 0, 2, 4, 6, 8, 9, 10, 11, 12, 15, 18, and 21d post-anti-CD25 injection. $CD4^+CD25^+$ cells were depleted only in the group injected with anti-chicken CD25, but not in the isotype control injected groups. $CD4^+CD25^+$ cell percentage started to decrease at 4d post injection. Depletion of $CD4^+CD25^+$ reached its peak at 9d post-injection. At 9d post-injection 81% of $CD4^+CD25^+$ cells were depleted in the peripheral blood. $CD4^+CD25^+$ cell percentages started to increase at 12d post-injection and reached normal levels at 21d post-injection. $CD4^+$ and $CD8^+$ cell percentages did not differ between any of the treatment groups. A second experiment was conducted to confirm whether the Treg depletion observed in the peripheral blood occurred in the spleen. Injecting anti-chicken CD25 depleted 78% of $CD4^+CD25^+$ cells at 9d post-injection. It could be concluded that a single dose of anti-chicken CD25 injection could transiently deplete the $CD4^+CD25^+$ cell population in vivo. In vivo depletion of Tregs will facilitate future research to identify the role of Tregs during a pathogen challenge.

Key Words: regulatory T cell, Tregs, depletion

266 Identification and characterization of pheasant and quail avian beta defensin 2. N. C. Rath*[1], L. Kannan[1,2], R. Liyanage[2], J. O. Lay Jr.[2], and N. B. Anthony[2], *[1]USDA/ARS, Fayetteville, AR, [2]University of Arkansas, Fayetteville.*

Peptides play significant roles in physiology as hormones, neurotransmitters, growth, antimicrobial, and signal transducing factors. Identification of their tissue specific occurrence and abundance may lead to a better understanding of their physiological significance. Previously, we identified mature forms of defensins and thymosin β peptides from chicken and turkey white blood cells by direct MALDI-TOF-MS (matrix assisted laser desorption ionization-time-of-flight mass spectrometry). This reinforces the contention that MS approach may be a suitable platform to identify other cell and tissue associated peptides in their mature forms. As a proof of concept, we sought to find homologous avian β defensin 2 (AvBD2) peptides from pheasant and quail using purified heterophils and the methanol/ acetic acid extract of bone marrow. Based on the pattern of their spectra and comparisons with chicken and turkey tissue profiles, the spectra corresponding to m/z 4114 and 4164 were tentatively identified as possible defensins of pheasant and quail respectively. MALDI-TOF-MS spectra obtained after reducing and alkylating with iodoacetamide confirmed them as AvBD due to the exact mass shift by 348 Da indicative of 3 disulfide bonds that are characteristics of β defensins. The carbamidomethylated products were purified by reverse phase HPLC and subjected to trypsin digestion. In Source-, and Post Source Decay fragmentations were done to establish structural information by comparing them with known sequences of chicken and turkey AvBD2 from GenBank data. These results suggest that MS based approach can be extended to identify and characterize not only the homologous but also other novel peptides and understand their significance.

Key Words: avian defensin, pheasant, quail, mass spectrometry, peptidomics

267 Development and characterization of novel monoclonal antibodies against chicken monocyte-derived cells. W. K. Chou*, C. H. Chen, D. Abi-Ghanem, and L. R. Berghman, *Texas A&M University, College Station.*

The mononuclear phagocyte system (MPS) is defined as a group of cells that arises from hematopoietic progenitors in the bone marrow, circulating blood monocytes, and tissue macrophages in most of the organs in the body, and plays a critical role in host defense. The heterogeneity of macrophage subpopulations is defined based on expression of cell surface markers. Compared with mammalian species, relatively few chicken macrophage-specific surface markers have been identified and commercialized. Because chickens lack a significant number of harvestable resident macrophages, macrophages from the peritoneal cavity following Sephadex injection are the common source of primary macrophage cell populations. To further elucidate the unique properties of peritoneal macrophages, monoclonal antibodies were raised against chicken peritoneal recruited macrophages and used to characterize peritoneal recruited macrophage cell surface receptors. Peritoneal exudate cells (PECs) were harvested 42 h after a single injection of 3% Sephadex suspension. Peritoneal exudate macrophages (PEMs) were purified by the glass adherence method and used as immunogen for monoclonal antibody (mAb) production. Ten out of 52 hybridomas were selected by immunocytochemistry. Three of the mAbs triggered detectable NO production by chicken HD11 macrophages with maximal activity at 50 μg/ml ($P < 0.01$). None of the mAbs recognized recombinant chicken CD40 protein, suggesting

that the agonistic effects did not occur via the CD40-CD40L signaling pathway. Flow cytometric analysis of these mAbs showed no cross-reaction with chicken HD11 cells, suggesting that the antigens recognized by our mAbs might not be expressed or expressed at low intensity on the HD11 cell line. Future studies will attempt to elucidate the role of PEMs in chickens by examining the effects of selected mAbs in antigen presentation and the specific binding of monocyte-derived cell subpopulations.

Key Words: peritoneal recruited macrophages, antigen-presenting cells, monoclonal antibodies, CD40-CD40L signaling pathway, monocyte-derived cell

268 Production and characterization of an agonistic single-chain antibody against chicken CD40. D. Abi-Ghanem*, C.-H. Chen, J. Bray, W. Mwangi, S. D. Waghela, and L. R. Berghman, *Texas A&M University, College Station.*

CD40, a membrane glycoprotein of the TNF-receptor super family, is mainly expressed on antigen-presenting cells (APCs), including B-cells, macrophages, and dendritic cells. The interaction between CD40 and its ligand CD154 (CD40L) is critical for optimal activation of APCs, and provides crucial signals for optimal priming and expansion of antigen-specific T-cells, as well as heightened antibody production and immunoglobulin class switching in B-cells. In contrast to the extensive characterization of mammalian CD40, there is a dearth of information regarding the biological activities of chicken CD40 (cCD40). To address that deficiency, an immune antibody library against cCD40 was constructed by phage display, and was used to produce a dimeric anti-cCD40 single-chain antibody fragment (scFv). This scFv, designated DAG1, was then cloned into the mammalian expression vector pCMV, and was transfected into HEK 293 Free-Style cells, purified using anti-HA-agarose affinity chromatography, and characterized by immunoblotting. Purified DAG1 recognized cCD40 in ELISA and induced the production of nitric oxide by HD11 macrophages. Stimulation of proliferation of bursal B-cells by DAG1 will also be examined to further investigate the agonistic activities of DAG1. These activities will demonstrate that the anti-cCD40 scFv can mimic the effects of CD40L, providing the signals needed to induce activation of chicken APCs in vitro. Attached to a vaccine, such an agonistic anti-CD40 scFv will specifically target and activate antigen-presenting cells, thus eliminating the need for adjuvant use, and resulting in fewer applications needed and longer protection.

Key Words: chicken CD40, single-chain antibody fragment, co-stimulation, vaccine

269 Development of a transfer plasmid for expression of foreign genes in meleagrid herpesvirus type 1. S. Spatz* and L. Zsak, *Southeast Poultry Laboratory, Athens, GA.*

AAAP abstract†

270 Development of the immune system in broiler breeder pullets receiving various vaccination programs and feeding systems in controlled and field conditions. E. Montiel*, J. Buhr, N. Cox, B. Wills, C. Hofacre, and J. Wilson, *Merial Select Inc.*

AAAP abstract†

271 Suppression of cellular immune activity of chickens following in vivo and in vitro heat stress. A. M. Atta*, A. Abbas, and A. Desoky, *Cairo University, Giza, Cairo, Egypt.*

Two experiments were conducted to study the effect of heat stress in vivo and in vitro on lymphocyte proliferation of 6-week-old Arbor Acres chicks. In the first experiment, the heat stressed birds were exposed to 42°C for 2h vs. 24°C for control group. At 6 wk of age, splenic lymphocyte activities were tested at 0, 3, and 24h post heat stress by performing a mitogen cell proliferation assay with a polyclonal T-cell mitogen, concanavalin A (Con A), and B-cell mitogen, pokweed mitogen (PWM). In general, heat stress caused a decline in proliferation of T and B lymphocytes at all times post heat stress exposure. At 3h post exposure, the proliferation of B and T lymphocytes declined significantly ($P < 0.01$). Furthermore, at 24h, only the T-cells in stressed group had significantly ($P < 0.05$) lower activity than those of the control group. In the second experiment, 10 male and 10 female chickens were slaughtered at 6 wk of age, then splenic lymphocytes were collected, and mitogen stimulation was carried out by incubating the cells with Con-A or PWM. The lymphocytes were divided into 4 groups, the first group served as a control and was exposed to 41°C, while the other 3 groups were exposed to 45°C for 1, 3 or 6h respectively. The proliferation of lymphocytes decreased as the period of in vitro heat exposure increased. The proliferation of T-lymphocytes in males and B-lymphocyte in females were reduced significantly by exposure to 45°C for 6h compared with the control. Our results re-emphasize the immunosuppressive effect of heat stress. This phenomenon could be attributed to the increase of corticosteroid hormone and pro-inflammatory cytokines.

Key Words: heat stress, lymphocyte, immune response, broiler

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Bacteriology and Diagnostics

272 Development of a molecular typing method for *Enterococcus cecorum*. D. S. Wijetunge*, J. Blair, P. Dunn, E. Wallner-Pendleton, V. Lintner, and S. Kariyawasam, *Pennsylvania State University, University Park.*

AAAP abstract†

273 Genotypic and phenotypic comparison of field isolates of *Enterococcus cecorum* in outbreaks of spondylitis. K. M. Robbins*, M. P. Martin, P. C. Jay, M. M. Suyemoto, H. J. Barnes, and L. B. Borst, *Department of Population Health and Pathobiology, North Carolina State University College of Veterinary Medicine, Raleigh.*

AAAP abstract†

274 Multiplexed microsphere-based diagnostic assay for simultaneous detection of avian influenza, *Mycoplasma gallisepticum*, and *Mycoplasma synoviae* infection. M. Hoffmeyer*, J. L. Hale, and M. M. Bush, *Luminex Corporation, Austin, TX.*

AAAP abstract†

275 An evaluation of optimal methods for avian influenza virus sample collection. E. Spackman* and E. T. McKinley, *Southeast Poultry Research Laboratory, USDA, ARS.*

AAAP abstract†

276 New approaches to develop improved molecular diagnostic assays for infectious diseases (assay design]. H. Abbassi*, *University of Minnesota, Department of Animal Science, St. Paul.*

AAAP abstract†

277 New approaches to develop improved molecular diagnostic assays for infectious diseases (optimization and validation). H. Abbassi*, *University of Minnesota, Department of Animal Science, St. Paul.*

AAAP abstract†

278 Fowl cholera vaccination of pen-raised ring-necked pheasants with commercially available vaccines. D. A. Anderson*, *Georgia Poultry Laboratory Network, Oakwood.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Infectious Bronchitis

279 Infectious bronchitis virus in California 2003–2010: A review. P. R. Woolcock*, *University of California, Davis.*

AAAP abstract†

280 Characterization of infectious bronchitis virus isolates from backyard flocks. A. Kulkarni*, D. A. Hilt, and M. W. Jackwood, *Georgia Poultry Laboratory Network, Oakwood.*

AAAP abstract†

281 Recombination in avian gamma-coronavirus infectious bronchitis virus (IBV). S. W. Thor*, J. E. Phillips, D. A. Hilt, J. Kissinger, A. Paterson, and Mark W. Jackwood, *The University Of Georgia, Poultry Diagnostic And Research Center.*

AAAP abstract†

282 Evaluation of possible interference between Arkansas and Massachusetts vaccine serotypes. E. Ndegwa*, S. Bartlett, and V. L. van Santen, *Auburn University.*

AAAP abstract†

283 Interactions between multivalent attenuated live infectious bronchitis virus (IBV) vaccines in one-day-old chickens. H.-J. Roh*, D. A. Hilt, and M. W. Jackwood, *Department of Population Health, Poultry Diagnostic and Research Center, The University of Georgia, Athens.*

AAAP abstract†

284 The pathogenicity of avian metapneumovirus subtype C (aMPV/C) isolates from wild birds in domestic turkeys. R. M. Cha*, Q. Yu, and L. Zsak, *Southeast Poultry Research Laboratory, United States Department of Agriculture, Agricultural Research Service, Athens, GA.*

AAAP abstract†

285 Reverse genetic studies of avian paramyxovirus type-3. S. Kumar*, B. Nayak, P. L. Collins, and S. K. Samal, *Virginia-Maryland Regional College of Veterinary Medicine, University of Maryland, College Par.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

286 Impact of environmental temperature on core body temperature and performance of broiler breeder hens. D. C. Paul*, M. J. Zuidhof, R. A. Renema, and A. Pishnamazi, *University of Alberta, Edmonton, AB, Canada.*

The effects of environmental temperature (ET) and dietary ME on core body temperature (CBT) and production efficiency were evaluated in broiler breeder hens. A total of 192 Ross 708 broiler breeder hens were individually caged in one of 6 temperature-controlled chambers (32/room) at 20 wk of age. A biotelemetry sensor was surgically implanted abdominally to measure CBT of 8 birds/tmt every 10 min. The experiment was a 4 × 2 factorial arrangement, with 4 ET treatments (15, 19, 23, and 27 C) and 2 dietary ME levels (HE, 2,900; LE, 2,700 kcal/kg). The ET were randomly assigned to the chambers for 2 wk periods with the constraint that each treatment was represented at least once per period and each chamber had equal exposure to all treatments. Standard breeder BW targets were maintained by daily feed restriction. Individual BW was measured twice/wk for adjustment of feed allocation. Daily feed intake, egg production and egg weight were recorded. Data were analyzed using ANOVA and difference between treatment means were considered significant at $P < 0.05$. Mean CBT was the highest (40.84 C) in the 27 C treatment. Mean CBT in the 23 C treatment (40.63 C) was higher than in the 19 C and 15 C treatments (40.51 C), which did not differ. Similar trends were observed for average daily maximum and minimum CBTs in the ET treatments, while the mean CBT in the LE hens was 0.02 C higher than in the HE hens. Feed intake was higher in the LE compared with the HE hens (141 and 133g/d, respectively). The LE hens consumed significantly more energy (9.35 kcal) and CP (0.540 g) per g of egg compared with the HE hens (8.79 kcal and 0.494 g CP), which likely contributed to the difference in egg weight (58.9 vs. 58.2g in LE vs. HE). As long as target BW gain is maintained, changing environmental temperatures (15 to 27 C) will not affect production traits in breeder hens.

Key Words: broiler breeder, dietary ME, environmental temperature, core body temperature, egg production

287 Efficacy of feed additives to reduce the biological effect of naturally occurring mycotoxins fed to turkey poults reared to 20 weeks of age. J. E. Nixon*[1], J. L. Grimes[1], M. D. Koci[1], P. Nighot[1], C. Stark[1], and T. Middleton[2], *[1]North Carolina State University, Raleigh, [2]Ag ProVision, LLC, Kenansville, NC.*

In this study 576 LW tom turkey poults were raised to 20 wk in 48 pens (6 m^2, 12 birds/pen). These birds were randomly assigned to one of 2 diet groups. These 2 diets were then mixed with various feed additives (FA, Table 1) to produce 8 treatment groups (6 replicate pens per treatment). Typical turkey diets (1–7) were mixed using a common basal and either corn containing 11ppb aflatoxin (AF) and wheat containing no detectible levels of deoxnivalenol (DON) for control (C) or corn and wheat containing naturally occurring AF (620ppb) and DON (9.2 ppm), respectively, for mycotoxin (M) diets. The FA are described as: A - yeast cell culture and diatomaceous earth, B - aluminosilicate and mineral oil, D - clays and yeast cell products. The 7 feeds (2 starter, 3 grower, 2 finisher) for C diets contained from 0 to 14 ppb AF and 0.1–0.55 ppm DON and for the M diets: 54 (starter) to 275 (grower/finisher) ppb AF and 0.53 (starter) to 6.4 ppm DON (grower/finisher). Data were analyzed using GLM ($P < 0.05$). From 9 to 20 wk, the M fed birds (4.47kg, 8.04, 12.77, 17.61, 20.55) had lower BW than C fed birds (4.61kg, 8.45, 13.23, 18.11, 20.91). Feed consumption was reduced for M fed birds at 3, 9, and 15 wk. The M fed birds had a higher feed conversion than the C fed birds at 12 weeks. At 5 wk, M fed birds had increased relative (R) gizzard (M:2.84 to C:2.63g/100gBW) and pancreas wt (M:0.23 to C:0.20g/100gBW) and reduced serum albumin (M:3.99 g/dL to C:4.70) and R liver wt (C:2.07 to M:2.27g/100gBW) compared with C fed birds. At 20 wk, R kidney wt was increased for M fed birds (M:0.40 to C:0.37g/100gBW). At 5 and 20 wk there were no differences for aspartate aminotransferase (AST) and creatine kinase (CK) for M fed birds compared with C fed birds. Prolonged consumption of low levels of naturally occurring AF and DON has a significant negative effect on turkey growth and performance. There was no observed effect due to the feed additives under the conditions of this study.

Table 1. Dietary treatment groups

	Feed Additives			
Diet	Control	A	B	D
Control	CC	CA	CB	CD
Mycotoxin	MC	MA	MB	MD

288 Evaluation of a fermented rice/soy product on volatilization of odor compounds from fresh fecal material and growth parameters when included in broiler diets. M. P. Williams*[1], C. Coufal[1], E. Caraway[2], R. Carpenter[3], I. Smith[3], and J. T. Lee[1], *[1]Poultry Science Department, AgriLife Research, Texas A&M System, College Station, [2]Olfactory Laboratory, West Texas A&M University, Canyon, [3]BiOWiSH Technologies, Chicago, IL.*

An experiment was conducted to determine the effect of feeding 2 fermented rice/soy products (BiOWiSH-Odor and BiOWiSH-Aqua) on ammonia and manure odor volatilization from fecal material of battery-reared broilers. Mortality corrected feed conversion ratio, feed consumption, and body weight were also determined. The design consisted of 5 dietary treatment groups: control, BiOWiSH-Odor supplemented at 300, 600, and 900 g/ton, and BiOWiSH-Aqua included at 900 g/ton. Each treatment consisted of 6 replicate pens containing 12 d old male broilers per replicate (360 total broilers). Broilers were reared in battery brooders through 21 d of age. To characterize fecal odor profiles, feces were collected for a 24 h period beginning on d 20. One kg of fresh feces were removed and placed in a dynamic flux chamber for manure odor collection and then placed in a static flux chamber for a 24 min period. Ammonia concentration measurements were taken every 6 min, and hydrogen sulfide concentration was determined after 20 min in the static chamber. Additionally, fecal pH, moisture, and carbon/nitrogen ratios were determined on the fresh fecal material. Manure odor concentrations were determined by GC/MS, and carbon/nitrogen ratios were determined by combustion analysis. The addition of BiOWiSH-Aqua at 900 g/ton increased ($P < 0.05$) body weight at 21 d of age. Inclusion of both products at all levels decreased ($P < 0.05$) multiple volatile organic compounds that have been associated with manure odor, including 4-ethyl phenol, para-cresol, indole, skatole, valeric acid, isovaleric acid, and hexanoic acid. No significant differences were observed with regard to feed conversion ratio, feed consumption, mortality, carbon/nitrogen ratios, fecal pH, fecal moisture, or ammonia and hydrogen sulfide volatilization. These data indicate that inclusion of fermented rice/soy products can reduce fecal odorant volatilization and can increase growth rate in young battery-reared broilers.

Key Words: ammonia, odor, broiler, performance

289 Reduction of *Salmonella* Typhimurium on eggshell surfaces using ultraviolet light and hydrogen peroxide. S. Gottselig*, T. Duong, S. Horrocks, K. Woodring, and C. Coufal, *Texas A&M University, College Station.*

Salmonella is an important pathogen affecting the poultry industry. An experiment was conducted to evaluate the effectiveness of UV light (UV) and hydrogen peroxide application on eggshell surfaces to reduce *Salmonella*. Eggs were challenged with a *Salmonella* Typhimurium culture that was novobiocin (NO) and nalidixic acid (NA) resistant. Tryptic soy broth (TSB) with 0.25 mg/L NO and 0.20 mg/L NA was inoculated with the *Salmonella* starter culture and incubated for 24 h at 37 C. The culture was then centrifuged and resuspended in TSB resulting in an average concentration of 9 $\log_{10}$ cfu/ml. The eggshell surface was inoculated by placing the egg in a sterile plastic bag and adding 10 mL of the concentrated culture. After massaging for 1 min, eggs were removed and allowed to dry on an egg flat. Over 4 trials, 104 eggs were inoculated with *Salmonella*. Half of the eggs were sprayed with hydrogen peroxide (3%) followed by exposure to UV for approximately 5 s in a chamber equipped with UV-C lamps (254nm). The other half served as untreated controls. Enumeration was accomplished by rinsing eggs in phosphate buffered saline (PBS) and plating the rinsate onto xilose lisina tergitol-4 (XLT-4) agar with NO and NA. Plates were incubated for 24 h at 37 C. In each trial, an average reduction of greater than 5 $\log_{10}$ cfu/egg was observed between untreated and treated eggs. In trials 3 and 4, a crush and rub enumeration methodology was performed following the PBS rinse. Thirty control and 30 treated eggs were placed into a second rinsate bag containing PBS. Following a second rinse step, eggshells with membranes were placed into individual conical tubes with PBS and crushed with a sterile glass wand. The second rinse bag and conical tube solutions were also plated on XLT-4 agar. Results from this experiment demonstrate that UV and hydrogen peroxide treatment of eggshells can significantly reduce *Salmonella* on eggshell surfaces, but has no effect on *Salmonella* found below the eggshell surface. This methodology could be applied to the poultry industry where *Salmonella* reduction is important.

Key Words: ultraviolet light, hydrogen peroxide, eggshell, disinfection, *Salmonella*

290 Effect of range, cage-free, and cage environments on egg production and quality in two brown egg layer strains. M. M. Evans* and K. E. Anderson, *North Carolina State University, Raleigh.*

Growing public consumer awareness concerning layer hen welfare has caused the egg industry to look to alternative environments for egg laying hens. This experiment evaluated the effect of 3 different environments, including a free range system (R), cage-free (CF), and cage system (C) on Silver Brown Hy-Line (SBH) and Hy-Line Brown (HB) production and egg quality. All birds were raised within the environment they were going to be laying in and were placed in their respective environments at 17 weeks of age, with the exception of the range birds; they were placed in the range huts at 12 weeks of age. The experiment was a 2 by 3 factorial design with 2 replicates for each strain in the range and cage-free production environments and 8 replicates per strain in cage environment. The experimental populations were as follows: range contained 75 birds per replicate; cage-free contained 216 birds per replicate; and cages contained 20 hens per replicate for a total of 1,484 birds in the study. All diets were provided ad libitum, based upon the caged birds' consumption and productivity. Eggs and mortality were recorded daily. One day's eggs were sampled every 4 weeks for a total of 10 periods to determine the USDA grades as well as egg size distribution. All data was analyzed using PROC GLM in SAS®. The SBH had better ($P < 0.05$) HD production and feed conversion than the HB. The R birds had the highest ($P < 0.05$) HD production, consumption, and mortality, with the means being 91.0%, 11.51 kg/100 birds, and 18.4%, respectively. The C birds had the lowest HD production, consumption, and mortality, with the means being 83.06%, 10.40 kg/100 birds, and 2.7%, respectively with the CF hen performance being intermediate. The R birds also produced more ($P < 0.05$) B grade eggs than the C birds. Although the R hens appeared to have superior HD production, due to the R hens higher mortality their overall HH eggs produced was inferior to the CF and C hens, with their means being 79, 85, and 82 eggs, respectively.

Key Words: layer, range, cage-free, environment, production

291 Effect of maternal energy and protein and egg storage on egg quality, broiler embryonic development, residual yolk sac and early growth. P. O. Elaho*, R. A. Renema, A. Pishnamazi, and M. Z. Zuidhof, *University of Alberta, Edmonton, Alberta, Canada.*

Maternal protein and energy intake could alter broiler offspring development and response to egg storage. This study examines the effect of different ME and CP levels in broiler breeder diets during rearing and lay on broiler embryonic development and early growth in fresh or stored eggs. The base experiment was a 3 × 2 × 2 × 2 factorial arrangement of treatments. From 21d of age, Ross 708 broiler breeder pullets were fed 3 ME levels: high, standard, and low (2,950, HEr; 2,800, SEr; and 2,650, LEr, kcal/kg, respectively), combined with high (16%, HPr) or low (14%, LPr) CP levels. A total of 384 birds were photostimulated at 23 wk and layer rations had high (2,900 kcal/kg, HEl), or low ME (2,800 kcal/kg, LEl) combined with high or low CP (15.5%, HPl; or 14.5%, LPl, respectively). Fertile eggs were collected over 4d at 46, 47, and 48 wk of age (Total = 447) from birds raised on the HE:LP and LE:HP treatments in either the rearing or breeder phases, and compared as a 2 × 2 × 3 factorial with rearing, breeding and storage treatments. Eggs traits and yolk membrane strength were recorded. Embryo weight at E14 was measured and BW, residual yolk, liver and heart weights recorded at hatch or at 7d. Results were assessed with the MIXED procedure of SAS ($P < 0.05$). Feeding treatments did not affect egg, incubation, growth or yield traits. At E14, embryos from 7 and 14d stored eggs weighed 6.0 and 10.5% less than unstored eggs, respectively. Late incubation mortality doubled in 14d vs. 0d stored eggs. Hatch weight was not affected, although residual yolk sac weight increased from 4.8g in unstored eggs to 5.6g in 7 and 14d eggs. By 7d, chicks from 14d eggs weighed 10.8% less than chicks from 0 or 7d treatments, and breast muscle as a % of BW lagged 6.9% compared with 8.2 in 0d and 7d chicks. Yolk weight rose by 8.0% in eggs stored 14d, at the expense of albumen weight. Yolk rupture force in 14d eggs was 32% less than that of the fresh eggs. Lower yolk membrane strength in stored eggs likely contributed to reduced development and yield traits in 14d stored eggs.

Key Words: broiler breeder, egg storage, embryo development, growth, dietary protein

292 Quantification of *Eimeria* species in coccidia challenged broilers with real-time PCR. R. F. Khamadaliev*, A. Nalian, J. L. Bray, and A. M. Van-Kley, *Stephen F. Austin State University, Nacogdoches, TX.*

Coccidiosis is an economically important parasitic disease which affects poultry production worldwide. It is caused by obligatory intracellular protozoa from the genus *Eimeria*. Coccidia damage cells of the

intestinal wall which leads to weight loss and overall deterioration of poultry health. Currently, lesion scoring is used to diagnose and monitor coccidiosis. However, this method does not allow precise species identification or quantification. This study evaluated real-time PCR to identify and quantify Eimeria species present in coccidia challenged broilers. TaqMan real-time PCR assay was used to determine the effect of an ionophore coccidiostat on challenged and non-challenged birds by monitoring the presence of 3 species of *Eimeria* (*E. acervulina*, *E. maxima* and *E. tenella*). Samples were collected weekly for a total of 7 weeks from 4 groups: 2 control groups (challenged and non-challenged) and 2 experimental groups fed Salinomycin (challenged and non-challenged). Lesion scoring and body weight was determined for each individual bird and feed conversion ratio was calculated per group. Real-time PCR assay detected a higher number of infected birds than the lesion scoring method in all the groups: control challenged group 57% vs. 34%, experimental challenged 45% vs. 40%, control non-challenged 14% vs. 10%, experimental non-challenged 24% vs. 8.5%. The most common species detected by both methods was *E. acervulina*. In addition, the determined amount of oocysts was correlated to body weight and food conversion ratios. These results suggest that the real-time PCR assay can be used to monitor coccidiosis in industrial poultry production.

Key Words: coccidia, *Eimeria*, real-time PCR, lesion scoring, ionophore

293 No evidence for temperature-dependent sex determination in chickens. K. Collins*, S. Pinson, K. Navara, and J. Wilson, *The University of Georgia, Athens.*

A study was performed to determine if temperature–dependent sex determination exists in the chicken by examining if small incubation temperature deviations influence offspring sex in 2 strains of broilers. In the first trial, Cobb 500 broiler eggs from a 42 week old flock were placed in one of 3 Natureform incubators at standard temperature, 37.7°C, below standard, 37.4°C, or above standard temperatures, 37.9°C. Air temperatures throughout the top, middle, and bottom sections of each incubator were monitored. Hatched chicks from each treatment were vent sexed, and one tray from each treatment were sex separate reared to 31 d and necropsied to assess the presence of male or female gonads to determine the accuracy of the sexer. The vent sexer was 98.4% accurate. The sexed male ratios were not significantly different (52% in the below standard temperature treatment, 49.8% in the standard treatment, and 50.4% in the above standard treatment). A second trial of this experiment was conducted using Cobb 700 broilers from a 43 week old flock. Similar incubation temperatures were used, and the chicks were vent sexed and a subset was dissected to check the vent sexer accuracy. The vent sexer was determined to have 98.5% accuracy. No differences in male sex ratios were observed (50.6% in the below standard temperature treatment, 52.1% in the standard treatment, and 45.3% in the above standard treatment). Within the incubation temperature deviations of these studies, there was no evidence that temperature influences offspring sex in chickens.

Key Words: sex, incubation temperature, broiler, vent sexing, temperature-dependent sex determination (TSD)

294 Effect of environmental enrichment strategies on behavior and physiology of broiler breeders reared under thermoneutral and heat stress condition. O. B. Adeniji*, M. O. Smith, and H. G. Kattesh, *University of Tennessee, Knoxville.*

Environmental enrichment practices are thought to improve animal health and well being but there is a need to evaluate the effect of various forms of enrichment strategies on behavior and stress hormone levels of meat type birds. The objective of this study was to evaluate the effect of simple practical forms of environmental enrichment on behavior and corticosterone (stress hormone) levels of broiler breeder chickens reared in thermoneutral and heat stress environments. Two hundred and 88 21-week-old broiler breeder females and 48 males (Cobb 500) were randomly assigned to 24 pens in 2 separate temperature controlled rooms and placed on 4 environmental enrichment treatments. One room was maintained at 23 C to mimic a thermoneutral environment while the other room cycled between 23 C and 30 C to mimic heat stressed environment. The 4 treatments in each room were (1) no enrichment (2) sand box (3) perch and (4) combination of sand box and perch. Each treatment was replicated 3 times with 12 females and 2 males per replicate. Behavior and corticosterone levels were determined. All data were analyzed using the mixed model ANOVA procedure of SAS 9.2 (SAS Institute, Cary, NC, USA), and least squares means to determine significance. Results indicate that inclusion of perch in the housing environments of meat type bird parent stock, raised in either heat stress or thermoneutral conditions, tended ($P < 0.08$) to increase corticosterone level while other forms of enrichment did not affect performance. Use of enrichment structure was similar across temperatures.

Key Words: environmental enrichment, broiler breeders, heat stress, corticosterone, behavior

295 New perspective in egg storage: Cellular and molecular implications on embryo quality. J. A. Hamidu*, D. R. Barreda, and L. L. Guan, *University of Alberta, Edmonton, Alberta, Canada.*

Environmental factors such as cold storage influence the phenotype expression and quality of embryo. In poultry the fundamental reasons for reduced embryonic performance due to egg storage remains unclear. The objectives of this study were to investigate cellular and molecular changes induced by egg storage on embryonic cell viability and gene expression. To assess impact of egg storage on the cell viability, blastoderms from layer and broiler stored eggs (4d and 14d) were isolated, dissociated into single cells, stained with fluorescent dyes and subjected to flow cytometry analysis to differentiate between viable (live), apoptotic and necrotic cell populations. The data was analyzed by the MIXED model of SAS at $P \leq 0.05$. The results showed that a percentage decreased in viable blastodermal cells was associated with increased percentage of 'unregulated' apoptosis as storage duration increased in both layer and broiler breeder eggs ($P < 0.005$). In layer eggs the percentages of viable cells were (4d = 83.58 ± 2.15%; 14d = 71.42 ± 3.36%) while the percentage of significant apoptotic cells were (4d = 2.31 ± 1.52%; 14d = 7.36 ± 1.53%). Similar results recorded in broiler breeder eggs were: viable cells (4d = 81.17 ± 2.15%; 14d = 68.18 ± 2.13%) and significant early apoptosis (14d = 17.88 ± 1.87%; 4d = 4.32 ± 1.89%). Based on our results of cell death and survival, quantitative real time PCR analysis was then used to compare the expression of selected apoptotic genes (Bak, Bax, Bok, Bcl-2, Bcl-xL) in broiler blastoderms and embryos from 6d incubated eggs. Expression of pro-apoptotic genes were (*Bak* = 20.1, *Bax* = 3.5, and *Bok* = 7.1) folds in 14d stored eggs compared with 4d stored eggs at the blastodermal level but all genes (pro- and anti-apoptotic) were downregulated after 6d of incubation. While increment in egg storage duration caused activation of apoptotic cell deaths at the blastodermal level, the mechanism appeared suppressed with the application of heat

of incubation. Identification of cellular and molecular implications of egg storage may be effective to manage impact of cold storage of eggs.

Key Words: egg storage, layer eggs, broiler eggs, cell viability, cell death

296 Effect of egg storage temperature, storage period, and flock age on hatchability of broiler hatching eggs. M. Güçbilmez[2], S. Özlü[2], O. Elibol[2], and J. Brake*[1], *[1]North Carolina State University, Dept. of Poultry Science, Raleigh, [2]Ankara University, Faculty of Agriculture, Department of Animal Science, Ankara, Turkey.*

This study investigated the effect of storage temperature, storage period, and broiler breeder flock age on fertile hatchability. Experiment 1 was conducted in 3 trials and hatching eggs were obtained from 3 Ross 344 male x Ross 308 female broiler breeder flocks at young (27, 28, 28 wk), prime (39, 41, 47 wk) and old (51, 52, 57 wk) ages in each trial. Eggs were stored for 1, 3, and 7 d at either 18C or 21C. Hatching eggs also came from 3 breeder flocks at young (27, 28, 29 wk), prime (41, 42, 43 wk) and old (52, 53, 57 wk) ages in the 3 trials of Experiment 2. Eggs were stored for 3, 7, and 12 d at either 15C or 18C. Hatching eggs obtained from 2 prime (37, 41 wk) and 2 old (58, 63 wk) breeder flocks were used in the 2 trials of Experiment 3. Eggs were stored for 3, 7, and 12 d at either 12C or 18C. In all experiments each tray of 150 eggs constituted a replicate and a total of 15 (2250 eggs), 13 (1950 eggs), and 10 (1500 eggs) replicate trays were set per storage temperature at each flock age and storage period in Experiments 1, 2, and 3, respectively. As expected, fertile hatchability was significantly better for the prime flocks compared with young and old flocks and fertile hatchability was significantly decreased when the storage period was longer in the 3 experiments. In Experiment 1, fertile hatchability was increased (90.6 vs 89.1%) by storing eggs at 18C compared with 21C. However, in Experiments 2 (87.9 vs 86.0%) and 3 (88.5 vs 87.0%) lower egg temperature (15C or 12C, respectively) produced better fertile hatchability than did 18C. There were significant interactions of storage temperature × storage period for fertile hatchability in Experiments 1 and 2, which suggested that a lower storage temperature produced better results during an extended period of storage. There were significant interactions of flock age × storage period for fertile hatchability in Experiments 2 and 3 because it was only the young (Experiment2) and old (Experiments 2 and 3) flocks that responded in a significantly negative manner to the extended storage period as compared with prime flocks.

Key Words: broiler hatching eggs, flock age, hatchability

297 Impact of beak trimming versus no beak trimming on range and cage free brown egg layers 17 to 53 wks of age. K. E. Anderson*, *North Carolina State University, Raleigh.*

Beak trimming remains the primary method to control cannibalism, mortality, and feather pecking in egg layers. Beak trimming is criticized as inhumane by welfare groups, who suggest that for range and cage free birds it may be unnecessary. Therefore, this study was initiated to compare the performance of trimmed and non-trimmed hens in the range and cage free setting. Hy-Line Brown chicks were hatched and divided into 4 groups of 300 chicks and were reared on litter as described in the 38th NCLP&MT Grow report. Two groups were selected at 6 d of age and trimmed using the Lyons hot blade precision beak trimmer using a 7/64" guide hole. All other management and vaccinations were the same for all groups, except at 12 wks the range birds were moved to the range facility to complete the grow period 12–17 wk. At 17 wks of age both the 2 trimmed and 2 non-trimmed flock populations were set at 75 pullets/paddock and the complimentary cage free flocks were set at 216 pullets/pen. Beak trimmed hens had 4.2 more ($P < 0.001$) HH eggs than the non-trimmed hens and consumed 2.9 g/hen/d less ($P < 0.05$) feed. Non-trimmed hens had heavier ($P < 0.05$) eggs but there was no difference in egg size distribution. Production environment had the greatest impact on HD and HH production in opposite ways due to the mortality effects. The HD production is higher ($P < 0.0001$) in the range hens, however HH production was higher ($P < 0.05$) in the cage free system. Feed consumption was increased ($P < 0.01$) by 3.6% in the range hens. Mortality was 1.1% higher ($P < 0.02$) in the range system, primarily due to predation. Beak trimming appears to positively impact production characteristics which favor the continued use of beak trimming. However, the performance of range birds appears to be better than the cage free counterpart. The HH production shows the impact of a significantly higher mortality in the range system.

Key Words: chicken, range, cage-free

298 The effect of litter versus raised plastic flooring on environmental and well-being traits in commercial Pekin ducks. M. S. Lilburn*[1], G. S. Fraley[2], D. Karcher[3], M. Makagon[3], and R. Sommers[4], *[1]Ohio State University/OARDC, Wooster, [2]Hope College, Holland, MI, [3]Michigan State University, East Lansing, [4]Maple Leaf Farms, Milford, IN.*

In the US, the predominant litter source used in rearing commercial ducks has been fine wood shavings with a recent trend toward using raised plastic floors. There have been no definitive studies, however, designed to compare ducklings reared on these 2 flooring types. Eighteen commercial facilities (n = 7 litter; n = 11 raised floor; Maple Leaf Farms, Milford, IN) were identified. These facilities were in northern Indiana or southern Wisconsin. Flock measurements were made at 7–8, 21–24, or 31–33 d. Each individual house was an experimental unit and each duckling assessment variable was the average of 20 individual observations at each of 5 predetermined points (n = 100). Individual assessments at each age were eye score (0,1,2), feather quality (0,1,2), feather cleanliness (0,1), nostril (0,1), foot pad lesions (0,1,2) and gait (0,1). There were no main effects or interactions due to location so only the main effects of flooring type will be presented. Eye scores were low at all ages and in each flooring type. At 31–33 d, however, the mean eye score in ducklings reared on the raised plastic floors (0.25) was greater than litter (0.05). Nostril scores were higher at 21–24 and 31–33 d in ducks reared on raised plastic floors. There were no differences in feather cleanliness at the 2 earliest ages but at 31–33 d, mean feather cleanliness was significantly lower in ducks reared on raised plastic floors. Foot quality scores decreased with age in both flooring types but the only significant difference was at 21–24 d where the ducks on raised plastic had significantly lower foot pad scores than those reared on litter. There were no consistent or significant age or floor type effects on gait. The results of this field study suggest that raised plastic floors do not compromise the well-being of commercial ducks. It should be pointed out that while differences in some traits (i.e., nostril, eye score) were evident at selected ages, the overall scores were extremely low and the incidence of birds with scores greater than 0 need to be incorporated into the overall interpretation of the data.

Key Words: Pekin duck, litter, foot pad, feathers, eyes

299 Effects of removable chicken house on growth performance in broilers and excreta yield and fertility. A. G. Chen*, J. Feng, F. Y. Deng, C. M. Yang, and Q. H. Hong, *Zhejiang University, Hangzhou, Zhejiang, China.*

A total of 680 one-day-old Ling-nan broilers were selected to study the effects of the removable chicken house (RCH) on growth performance and excreta yield and fertility. The chickens were divided randomly into 2 groups, each with 4 replications, and raised in the RCH and the traditional fixed house (TFH), respectively. All broilers received the same basal corn-soybean meal diets, including a starter from 1d to 21d and then a grower until 63 d. The yields of excreta produced by the trial chickens were determined weekly by collecting all excreta and the indicators of excreta fertility were analyzed at every stage. Results indicated that the average final weight (AFW) and average daily gain (ADG) in RCH group were significantly higher ($P < 0.05$) than those in TFH group during the whole experiment. AFW and ADG of the chickens in RCH during 21–42d period were 5.88% ($P < 0.05$) and 7.25% ($P < 0.05$) higher than those in TFH respectively, while feed/gain (F/G) in RCH was 2.71% ($P < 0.01$) lower. During 42–63d phase, AFW of RCH group was 3.78% ($P < 0.05$) higher than that of TFH group, but the differences of ADG and F/G between 2 groups were not significant ($P > 0.05$) The results of excreta tests showed that the chickens in RCH and in TFH produced 1.93 kg and 1.98 kg excreta per kg body weight (BW), respectively. No differences of excreta yield were found between 2 types of the housing. The indicators of excreta fertility including organic matter (OM) content, total nitrogen (TN), total phosphorus (TP), total potassium (TK), hydrolyzable nitrogen (HN), available phosphorus (AP) and available potassium (AK) in both groups were similar ($P > 0.05$), but except for TK, most of the indicators were significant differences ($P < 0.05$) among 1–21d, 21–42d and 42–63d stages. In conclusion, compared with TFH, RCH could improve growth performance of Ling-nan broilers. Average excreta yield per kg BW and indicators of excreta fertility were not affected by type of housing, while OM, TN, TP, HN, AP and AK were affected by different stages.

Key Words: Ling-nan broilers, removable chicken house, growth performance, excreta yield, excreta fertility

Metabolism and Nutrition: Minerals and Vitamins

300 Implications of dietary potassium and potassium salts on production performance, carcass characteristics and serum mineral chemistry of broiler chickens reared under phase feeding system. M. M. H. Mushtaq*, *University of Agriculture, Faisalab, Punjab, Pakistan.*

Response of one-day-old straight-run Hubbard broiler chicks (n = 1656) to 4 dietary potassium (dK) levels (0.86, 1.02, 1.18 and 1.34%) and 2 sources of potassium salts (K2CO3 and K2SO4) with the concept of dietary electrolyte balances (DEB) were evaluated in 4 × 2 factorial arrangement. The 4 dK levels corresponded to DEB values of 200, 240, 280 and 320 mEq/kg, respectively. Each of the 9 dietary treatments (one basal diet without dK supplementation along with 8 experimental diets) was randomly allocated to 4 replicates each having 46 birds. Body weight gain ($P < 0.03$) and feed:gain ($P < 0.05$) was improved at 1.20% dK during 32 to 42 d of age. Feed intake during 1 to 10 d ($P < 0.05$) and water intake during 34 to 42 d ($P < 0.04$) and during 1 to 42 d ($P < 0.03$) was increased in K2SO4 supplemented diets. Water intake was increased linearly with increasing dK when supplemented by K2CO3 whereas these were decreased linearly with increasing dK with that of K2SO4 during 11 to 20 d (Pâ < 0.002) and 1 to 42 d (Pâ < 0.04). The K2SO4 supplemented diets increased the mortality during 1 to 42 d ($P < 0.02$), and lowered blood pH ($P < 0.001$), dressing ($P < 0.04$), abdominal fat ($P < 0.03$) weights and shank length ($P < 0.02$). A significant salt × dK effect was observed where low levels of dK with K2CO3 and high levels with K2SO4 exhibited lower litter moisture during all phases. Increasing serum cations is compensated by increased concentration of serum anions at the end of the experiment. The results of the experiments depicted the importance of dK for better BW gain and feed efficiency in later stages of production. K2CO3 increased survivability and dressing responses but both dk levels and salts played important role for water intake, litter condition and carcass characteristics.

Key Words: potassium, dietary electrolyte balance, salt, broiler, phase feeding

301 Evaluation of stabilized gelatin cholecalciferol beadlets on broiler performance. J. Fowler*, R. Kakani, A. Haq, and C. A. Bailey, *Department of Poultry Science, Texas A&M University System, College Station.*

In this study, 2 dietary sources of cholecalciferol (vitamin D_3) in the form of stabilized gelatin beadlets were evaluated for their effect on broiler growth performance and bone strength characteristics. A total of 250 one-day old Ross x Cobb broiler chickens were fed a commercial-type corn soy broiler starter diet for a 3-week rearing period. A custom vitamin premix containing no vitamin D_3 was used to formulate a single mash basal diet for all treatment diets, with vitamin D_3 supplemented at 0, 50, 100, 200, 400 and 800 IU D_3/kg after the diets were sub-divided into each separate treatment. All birds were fed 0 IU D_3/kg treatment diet for the first 7 d to deplete vitamin D_3 stores and were then fed the various treatment diets for 14 d. On d 21, the birds were killed and the right leg from each chick was removed at the tibia-femur joint. Feet were removed at the tibia-metatarsal joint distal to the spur for ashing. Muscle tissue and fibula were dissected from tibia bones, which were analyzed for breaking strength using an Instron machine. After breaking, tibias were also ashed. Data were analyzed as a 2 × 6 factorial design using GLM procedure of SPSS with means separated using Duncan′s Multiple Range Tests. Outliers were identified and excluded from the statistical analysis using the Outlier Box Plot procedure of JMP statistical software. There were no significant differences ($P \leq 0.05$) between the 2 dietary sources of vitamin D_3 stabilized gelatin beadlets for any of the variables measured. Treatment level had a significant effect on average body weight per bird, productivity index, foot ash and tibia bone ash (as both a percent of dry bone weight and as total mg of ash), and tibia breaking strength, which were all of the variables measured except for feed conversion ratios. For none of the variables measured was there a significantly greater response than in the 200 IU D_3/kg treatment level. This clearly confirms the NRC 1994 vitamin D_3 requirement of 200 IU D_3/kg.

Key Words: vitamin D3, tibia ash, foot ash, broiler

302 Iron bioavailability in lentil based diets: Studies in poultry and in vitro digestion/Caco-2 model. E. Tako*[1], A. Vandenberg[2], D. Thavarajah[2], P. Thavarajah[2], and R. Glahn[1], *[1]USDA/ARS, Robert W. Holley Center for Agriculture and Health, Cornell University, Ithaca, NY, [2]University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

Lentils (*Lens culinaris*) are a pulse crop that is relatively high in Fe concentration (50–100 ppm) and consumed worldwide. As such lentils are an excellent candidate for Fe biofortification. We measured Fe bioavailability and Fe concentration of 20 commercial lines of lentils from a major lentil production region in Saskatchewan, Canada. Using an in vitro digestion/Caco-2 cell model for Fe bioavailability screening, we found that significant differences in Fe bioavailability exist within the commercial lines. Fe concentration was also found to differ, ranging from 55 to 95 ppm. Therefore, we selected 3 lentil varieties to determine if the high-Fe lentils would improve the Fe status of our animal model (broiler chickens) when fed over a 30 d period. We formulated diets containing 50% lentils, broiler hatchlings were divided into 3 groups (n = 10), and were fed the following: lentil 1 (“Red berry” ,95ppm Fe), lentil 2 (“Red berry,”75ppm Fe) or lentil 3 (“Milestone,”55ppm Fe). Diets had no supplemental Fe and were differerent in Fe content (65, 55, 45 ppm Fe, respectively). For 4 wks, hemoglobin (Hb), feed consumption and body weights were measured. Results showed higher hemoglobin values and total body Hb-Fe values in “Lentil 1” group vs. “Lentil 3” ($P \leq 0.05$). We conclude that the in vivo results support the in vitro observations, ie. the 40ppm difference in lentil Fe provides significantly more bioavailable Fe.

Key Words: lentil, iron bioavailability, broiler, Caco2 model

303 Intra amniotic administration and dietary inulin affect the iron status and intestinal functionality of iron-deficient broiler chickens. E. Tako* and R. Glahn, *USDA/ARS, Robert W. Holley Center for Agriculture and Health, Cornell University, Ithaca, NY.*

Inulin, a linear β fructan, is present in a variety of plants. It exhibits prebiotic properties and enhances mineral absorption and beneficial bacteria in the colon. Our objective was to assess the effect of intra amniotic administration and dietary inulin on selected intestinal iron transporters and binding proteins gene expression and on intestinal iron uptake. In this study, inulin solution (4% inulin in 0.85% saline) vs. saline solution as control (0.85% saline) were injected into the naturally consumed amniotic fluid of 17d old chicken embryos (n = 60). Upon hatch, and from each treatment group 10 chicks were killed and their small intestine, liver and cecum were removed for mRNA abun-

dance of intestinal Fe related transporters, liver ferritin amounts and bacterial analysis of cecal content. In addition, chicks were allocated to a standard corn-soybean based diet (+/− iron/4% inulin, n = 8). At wk 6, birds were anesthetized and their duodenal loops were exposed. A non-occlusive catheter was inserted into the duodenal vein for blood sampling. A solution containing 58Fe (0.1mg Fe in 10mM ascorbic acid) and the digested relevant diet sample was injected into the loop. Blood samples were collected every 5min and for 90min post injection and analyzed by ICP-MS for 58Fe concentrations. At the end of the procedure, animals were killed and cecum contents and duodenum and liver samples were taken. DMT1, Dcytb and ferroportin mRNA levels and liver ferritin amounts ($P < 0.05$) were elevated in the inulin injected birds compared with the controls. Also, body weights and hemoglobin concentrations were higher in the inulin injected groups vs. control (as from d 14 post hatch, $P < 0.05$). In addition, the cecal content microflora was examined using 16S ribosomal DNA (rDNA) targeted probes from bacterial DNA. The *Bifidobacterium* population was increased in the inulin groups ($P \leq 0.05$) vs. the control group. These results indicate that dietary inulin might trigger an upregulation of genes encoding for iron transporters in the enterocyte. Thus providing a greater and overall health advantage to the broiler.

Key Words: broiler, intestine, iron, inulin

304 Mineral nutrition and bone development of broiler embryos: Effect of in ovo enrichment. R. Yair*, R. Shahar, and Z. Uni, *The Hebrew University of Jerusalem, Rehovot, Israel.*

The skeletal system is dependent upon minerals such as Ca, P, Cu, Mn or Zn for its proper development. Research in our lab showed that on 19E the levels of Zn, Cu, Mn, and P in the yolk (The major mineral reserve) decreased significantly; to 3.17, 5.68, 10.61 and 13.46% of their levels at day of set. This leaves the embryo with low mineral reserves. Respectively, the uptake of Zn, Cu, Mn, and P between 19E and day of hatch was low. The purpose of this study was to examine the effect of in ovo enrichment on yolk mineral levels and uptake and on bone mechanical and structural properties. For that purpose, 300 eggs were incubated and divided to 2 groups: Enriched (on 17E with a solution containing minerals, vitamins and carbohydrates using the in ovo Feeding method) and control. Eight eggs from each group were randomly selected on 18E, 19E and 21E. Their yolk was examined for its mineral content using ICP-AES and tibia bone was taken for further analysis. Hatchlings were raised and tibiae from 8 chicks from both groups were taken on 7d, 14d, and 28d for biomechanical testing using a micromechanical testing device. Additionally, for structural analysis, cortical and cancellous bone of tibiae were scanned in a high-resolution micro-CT, reconstructed and analyzed. Results show that the enriched groups had higher yolk P, Cu, Mn and Zn and exhibited higher uptake than the control. Tibia analysis show that on day of hatch, the enriched group tibia's had higher stiffness, load-to-fracture and ultimate load than the control group. On 7d the Tibiae trabecular bone of the enriched group had higher trabecular thickness and bone percent than the control. On 14d, the enriched group had higher load-to-fracture and ultimate load than the control group, additionally; the cortical bone medullary area was higher than the control. On 28 d the enriched group showed higher bone mineral density than the control. This study demonstrates that in ovo enrichment with minerals, vitamins and carbohydrates elevated the mineral content and uptake in the yolk of broiler embryos and can influence and improve bone properties at least until 28d.

Key Words: mineral, bone, tibia, in ovo

305 Effect of dietary 25-OH-D_3 on commercial turkeys. 1: Production, innate immunity and bone quality to 12 weeks of age. J. L. Saunders-Blades*, K. L. Nadeau, and D. R. Korver, *University of Alberta, Edmonton, AB, Canada.*

The effects dietary 25-OH vitamin D_3 ($25D_3$) on male turkey live performance, breast yield, innate immunity and bone quality to 12 weeks of age were studied. Hybrid Converter male turkey poults were placed in 42 floor pens at d of hatch (n = 6 pens per treatment; 32 turkeys/pen). Each pen was randomly assigned to 1 of 5 dietary treatments to 12 wk of age: 1. Control (3,680 IU vitamin D_3/kg feed); 2. $25D_3$ (92 μg/kg $25D_3$); 3. D_3+$25D_3$ (Control + 92 μg/kg $25D_3$); 4. D_3X2 (Control + 3,680 IU vitamin D_3/kg); 5. $25D_3$ Early (Control + 92 μg/kg $25D_3$ for 6 wk; Control thereafter). BW gain, feed consumption, and feed conversion ratio were assessed for each of the 4 dietary phases to 12 wk of age. Whole blood was obtained at 8, 29 and 43 d of age to assess the number of cells able to engulf at least one *Escherichia coli* (% phagocytosis), average number of *E. coli*/cell (phagocytic capacity), and *E. coli* bactericidal capacity in vitro. At 9 and 12 wk, breast yield was determined, and femur quality assessed using quantitative CT. There were no effects of diet on turkey performance to 12 wk of age, or on breast yield at 9 or 12 wk of age ($P > 0.05$). Turkeys fed the D_3+$25D_3$ treatment had among the greatest % phagocytosis ($P = 0.06$) and phagocytic capacity ($P = 0.07$) at 8 d of age, whereas the turkeys on the $25D_3$ treatment had a lower % phagocytosis than the turkeys on the D_3+$25D_3$ treatment ($P = 0.06$), and among the highest mean phagocytic capacity (0.07). At 43 d, the turkeys from the $25D_3$ treatment had among the greatest % phagocytosis ($P = 0.04$), although lower phagocytic capacity ($P = 0.02$). There was no effect of diet on *E. coli* killing ($P > 0.05$). There were no effects of diet on femur bone mineral density or cross-sectional area at 9 wk ($P > 0.05$). Dietary $25D_3$ supported equivalent turkey performance to the control treatment. The combination of D_3+$25D_3$ or 25D3 alone in the young turkey promoted a stronger innate immune response and indicates the ability of vitamin D_3 and $25D_3$ to alter the bird's immune function.

Key Words: turkey, 25-hydroxy vitamin D, vitamin D, innate immune function, growth

306 Effect of dietary 25-OH-D_3 on commercial turkeys. 2: Production, carcass yield and bone quality from 14 to 22 weeks of age. J. L. Saunders-Blades, K. L. Nadeau, and D. R. Korver*, *University of Alberta, Edmonton, AB, Canada.*

The effects dietary 25-OH vitamin D_3 ($25D_3$) on male turkey live performance, leg and bone quality and carcass composition from 14 to 22 wk of age were studied. Hybrid male turkey poults were randomly placed at day of hatch in 42 floor pens (n = 6 pens per treatment; 32 turkeys/pen). Each pen was randomly assigned 1 of 7 dietary treatments to 22 wk of age: 1. Control (3,680 IU Vitamin D_3/kg feed); 2. $25D_3$ (92 μg/kg $25D_3$); 3. D_3 + $25D_3$ (Control + 92 μg/kg $25D_3$); 4. D_3X2 (Control + 3,680 IU vitamin D_3/kg); 5. $25D_3$ Early (Control + 92 μg/kg $25D_3$ for 6 wks; Control thereafter); 6. $25D_3$ Recommended (Control + 92 μg/kg $25D_3$ for 12 wks; Control thereafter); 7. $25D_3$ Reduced (Control + 92 μg/kg $25D_3$ to 12 wks; Control + 46 μg/kg $25D_3$ from 13 to 22 wk). BW gain, feed consumption, and FCR were assessed for each of the 4 dietary phases from 14 to 22 wk. At 14, 16, 19 and 22 wk, carcass and portion yields were assessed. At each processing age, bone mineral density of the right femur was assessed by quantitative CT. A subjective gait analysis was performed at 17 and 22 wk. Neither dietary vitamin D form nor level affected turkey performance. At 14 wk, Control, $25D_3$ and $25D_3$ Reduced birds had the greatest % whole

carcass weight ($P = 0.05$) and the $25D_3$ Reduced birds had the greatest % of thighs ($P = 0.09$). At 16 wk, the $25D_3$ and $25D_3$ Reduced turkeys consistently had the greatest or among the greatest absolute weight of the P. major, P. minor, thighs and drums ($P < 0.05$). The $25D_3$ birds also had the greatest % P. minor ($P < 0.05$). At 22 wk, the $25D_3$ birds had the greatest % drum yield ($P = 0.07$). Turkeys fed the $25D_3$ recommended and the $25D_3$ Reduced diets had increased walking ability at 22 wk of age ($P = 0.07$). There were no effects of diet on femur bone mineral density or cross-sectional area at 19 or 22 wk ($P > 0.05$). Although $25D_3$ in the diet throughout the growing period affected turkey carcass traits, it was not necessary to have a full dose (92 µg/kg of feed) throughout life, as similar processing results were observed for the $25D_3$ Reduced treatment.

Key Words: turkey, vitamin D, 25-hydroxy vitamin D, growth, carcass yield

307 Evaluation of five proprietary vitamin-mineral premixes in Ibadan, Nigeria for broiler production. O. A. Ogunwole*[1], E. O. Kolade[1], M. O. Olumide[1], A. O. Akinsoyinu[1], A. A. Mako[2], O. Abiola-Olagunju[1], and O. A. Adebiyi[1], *[1]Department of Animal Science, University of Ibadan, Ibadan, Nigeria, [2]Tai Solarin University of Education, Ijebu-Ode, Nigeria.*

The relative efficacy of 5 common commercial vitamin-mineral premixes in Ibadan, Nigeria was evaluated using 280 d old Arbor acre strain. The chicks were randomly allotted to 6 treatments comprising 48 chicks and each treatment- a triplicate of 16 chicks. They were brooded on a partitioned deep litter house at the Teaching and Research Farm, University of Ibadan, Ibadan. Six isocaloric and isonitrogenous diets were formulated. Diet 1 was the control without any vitamin-mineral premix while diets 2, 3, 4, 5 and 6 each had Daramvita, Biorganic, Hinutrient, Optimix and DSM-Nutripoult broiler vitamin-mineral premixes respectively added at 0.25%. The design of the experiment was a completely randomized design. There were significant variations ($P < 0.05$) in the values obtained for feed intake and weight gain. So also, the feed conversion ratio values of 3.62, 3.35, 2.64, 2.58, 2.61, and 2.57 for birds on diets 1, 2, 3, 4, 5 and 6 respectively varied significantly ($P < 0.05$). Haematological indices of the chickens both at the starter and finishers phases were within the reference range for broilers. Serum total proteins (g/dl) varied and increased significantly ($P < 0.05$) from 5.45 in birds on diet 1 to 6.80 for birds on diet 6. The serum high density lipoproteins (mg/dl) values (81.11, 88.16, 90.40, 86.52, 85.35, and 154.63 for birds on diets 1, 2, 3, 4, 5 and 6 respectively) were significantly different ($P < 0.05$) depending on the type of vitamin-mineral premix used which indicated variable potency and efficacy.

Key Words: vitamin-mineral potency, isonitrogenous diets, vitamin-mineral premixes, broiler serum indices, high density lipoproteins

308 Relative bioavailability of tribasic manganese chloride for broiler chickens. R. Poureslami*[1], L. Koutsos[2], and A. B.Batal[1], *[1]University of Georgia, Athens, [2]Micronutrients, Indianapolis, IN.*

Manganese (Mn) is an essential micronutrient for birds. Manganese is involved in different metabolic pathways as an enzyme activator and as an essential part of metalloenzymes. According to NRC (1994), the broiler Mn requirement is 60 mg/kg. Based on the recent studies on heart MnSOD gene expression, dietary Mn requirement is proposed as 130 mg/kg. Corn-soybean meal diet is deficient in Mn and needs to be supplemented with a source of Mn. Two commercial sources of Mn, organic and inorganic sources are available in the market. A new hydroxy source of Mn (tribasic manganese chloride; TBMC; Mn2(OH)3CL) has been recently developed. The objective of the present study was to investigate the relative bioavailability of TBMC for broiler chickens. At hatch, Cobb 500 male broiler chicks were placed in battery cages. During the first week, birds were fed a corn-soybean meal basal diet without Mn supplementation. The diet was formulated to meet or exceed the requirements of broilers except for Mn. At d 8 of age, a total of 448 chicks were randomly divided into 8 treatment groups with 8 replicate cages (7 birds/cage) for each treatment in a completely randomized design involving a 2 × 4 (source × level) factorial arrangement of treatments. Test sources of Mn (TBMC and MnSO4.H2O) were fed at 60, 120, 180 and 240 mg/kg diet. At d 21 of age, birds were weighed and one bird per cage was euthanized. The heart was immediately excised, a sub-sample was immediately placed into RNA stabilization solution for MnSOD gene expression study. A second sub-sample was snap frozen in N for determination of protein concentration. Body weight gain and gain:feed ratio of broiler chicks were not significantly influenced by supplemental Mn source, level of inclusion or their interaction. However, birds fed TBMC (120 mg/kg) recorded a relatively higher feed intake, body weight and lower gain:feed ratio when compared with the other dietary groups. Several markers of Mn bioavailability including heart MnSOD activity, MnSOD gene expression and protein concentration will be determined in the next step of this project.

Key Words: tribasic manganese chloride, bioavailability, broilers

309 Maternal broiler breeder flock age and dietary Cu, Zn and Mn form affect embryonic bone development. C. A. Torres* and D. R. Korver, *University of Alberta, Edmonton, AB, Canada.*

Copper, Zn and Mn are important for skeletal development. Organic trace minerals (OTM) in the hen diet can have higher bioavailability than inorganic (ITM) sources and may influence embryo growth. We investigated the effects of maternal dietary Cu, Zn and Mn form and level on embryo bone traits at 15 (E15), 17 (E17) and 20 (E20) days of incubation from Early (32 wk), Mid (45 wk) and Late (59 wk) hen ages. Broiler breeder hens (n = 18/diet) were individually housed and fed a basal diet low in Cu, Zn and Mn to which minerals were added as either: 1) Control: ITM; mineral sulfates at industry levels (100 ppm Zn, 120 Mn, 10 Cu); 2) OTM: Zn, Mn and Cu chelated by 2-hydroxy-4-(methylthio) butanoic acid (HMTBA) at NRC (1994) levels (50 ppm Zn, 60 Mn, 10 Cu); 3) OTM+ITM: Diet 1 plus an additional 40 ppm Zn, 40 Mn and 20 Cu as OTM; 4) High ITM: Diet 1 plus 40 ppm Zn, 40 Mn and 20 Cu as ITM. At each embryonic age (except E15 from Early hens), egg and embryo weights were recorded and the right tibia and femur dissected (n = 10 embryos/hen age per diet). Bone length, width and mineralization ((calcified tissue/whole bone)*100)) were measured from bones stained with Alcian Blue and Alizarin Red S for collagen and mineralized tissue, respectively. Weekly egg production and bone traits were analyzed using repeated measures of SAS at a significance level of $P < 0.05$. Embryo weight was used as a covariate for bone traits. Maternal diet did not affect total or settable egg production to 60 wk of age. At E15, OTM and OTM+ITM embryos had 1.8 and 3.3% longer femurs than High ITM embryos, regardless of hen age. At E17, embryos from Mid hens fed OTM+ITM had 6% thicker tibias than embryos from Control hens. Bone mineralization was not affected by mineral form or level at any embryonic age. We previously reported that the maternal OTM treatment increased tibia and femur thickness in newly hatched chicks from Early and Mid hens. In spite having lower levels of Cu, Mn and Zn than the other groups, the OTM

group, as well as the OTM+ITM group, appeared to increase embryonic bone development.

Key Words: embryo, organic trace minerals, broiler breeder, bone development, 2-hydroxy-4-(methylthio) butanoic acid

310 Effects of calcium and phosphorus levels during the finisher phase on Heritage broilers: II. Leg health and bone characteristics. M. R. Dalmagro*[1], E. O. Oviedo-Rondón[1], P. L. Mente[1], A. Mitchell[2], H. Engster[3], and R. Mitchell[3], *[1]North Carolina State University, Raleigh, [2]USDA-ARS, Beltsville, MD, [3]Perdue Farms Inc., Salisbury, MD.*

One experiment was conducted to evaluate the effects of Ca and P levels during the finisher phase on leg abnormalities and bone traits of Heritage broilers. Common starter and grower diets were fed from 1 to 17 and 18–35 d of age, respectively. The experimental finisher diets (35–49 d of age) were formulated to contain combinations of 4 levels of Ca (0.38, 0.54, 0.70, 0.86%) and 4 levels of nPP (0.17, 0.25, 0.33, 0.41%). There were 6 replicate pens per treatment and each pen received 8 male and 8 female chicks. At 35 d of age, before initiate the experimental period, broilers with leg problems were culled and the lack of differences in BW among treatments verified. Pens were adjusted to have 7 males and 7 females at the beginning of the finisher phase. Leg abnormalities were evaluated at 49 d of age by assessing the prevalence of valgus/varus, crooked toes, and twisted legs. Legs were collected and shanks used for bone mineral content and density (BMC and BMD). Bone strength in 3-point bending test and dyschondroplasia (TD) score were performed using tibias. Thighs were mechanical deboned. Data were analyzed as a CRBD by response surface methodology. The log odds of probabilities were modeled within factorial effects to obtain the likelihood of observing each leg or bone condition using GLIMMIX of SAS. Male BMC and BMD were affected linearly by Ca ($P \leq 0.05$). There was an interaction effect of Ca and P on female BMD ($P \leq 0.1$). Levels of Ca had a quadratic effect on the occurrence of crooked toes and valgus ($P \leq 0.05$). Varus prevalence was affected quadratically by P levels ($P \leq 0.1$). The interaction between Ca and P levels affected the probability of occurring TD ($P \leq 0.1$). Bone breakage during mechanical deboning was affected quadratically by P levels ($P \leq 0.1$). Bone strength results indicated a linear effect of Ca in males only ($P \leq 0.05$). It was concluded that levels of Ca and P in finisher diets affect the prevalence of leg problems and also the bone biomechanical parameters of Heritage broilers.

Key Words: calcium, phosphorus, leg health, bone strength

311 Zinc's impact on growth and barrier function during coccidial challenge. C. Troche* and T. A. Applegate, *Purdue University, West Lafayette, IN.*

A study was designed to evaluate the effects of Zn supplementation on growth and intestinal function. Three dietary treatments were formulated: a basal diet with no supplemental Zn (Basal), and 2 Zn diets formulated to provide 100ppm total dietary Zn from either zinc sulfate (ZnSO4), or a 50:50blend of ZnSO4 and a Zn-AA complex (AvailaZn100; Blend). An oral gavage of a coccidial vaccine was administered weekly at 10 times the recommended dosage (10XCV) to determine the effects of Zn status to challenge (6 replicate cages per diet and challenge status; 6 chicks/cage). From 0 to 14d broilers consuming ZnSO4 and Blend had improved body weight gain (BWG) and feed intake (FI; $P < 0.0001$) over broilers consuming Basal. Administering 10XCV significantly reduced BWG and FI ($P < 0.0001$) and negatively impacted feed conversion ratio ($P = 0.0043$). Challenge depressed BWG in both ZnSO4 and Blend fed groups. However, BWG of challenged ZnSO4 or Blend birds was equal to un-challenged Basal treatments. The same was true for FI from 0 to 14d, with challenged ZnSO4 birds having improved FI over challenged Basal birds. From 14 to 28d the effect of challenge did not significantly affect BWG or FI. Both BWG and FI were greater in ZnSO4 broilers versus Basal ($P < 0.002$). On d 27 through 29 Ussing chamber analysis was performed to determine the effects of Zn treatment on active nutrient transport (Isc) and membrane integrity (Rt). Jejunal tissues ISC of birds consuming Basal were 10 times more responsive (0.349 vs. 0.0355, respectively $P < 0.0001$) to the addition of a Zn nutrient spike than either ZnSO4 or Blend. Challenged tissues were 5 times less responsive to the nutrient addition than unchallenged tissues (0.148 vs. 0.028 ISC, respectively; $P < 0.0001$). Jejunal cells were evaluated for intracellular Zn and phagocytic response on d 30 and 31. Intracellular Zn levels were increased 3 fold (30.96% positive for marker vs. 11.6% positive, respectively $P = 0.0004$) with 10XCV. Phagocytic response was 1% lower in birds consuming ZnSO4 compared with Blend or Basal levels (98.25% positive for marker vs. 99.24% positive; $P = 0.008$). Dietary inclusion of Zn and supplemental Zn source can impact growth and immune response.

Key Words: zinc, coccicia, broilers

312 Mutual antagonism of feeding organic zinc and organic copper in broiler chickens. S. D. Bun* and Y. M. Guo, *China Agricultural University, Beijing, China.*

An experiment was conducted to determine whether the antagonism occurs between organic Zn and organic Cu. Growth performance (0 to 42 d post-hatch) and mineral status on d 42 were measured during the 6-wk study. A total of 168 one-d-old female broilers were assigned to 4 treatments consisting of 7 replicates of 6 chicks each in a 2 × 2 factorial arrangement. The levels of zinc (methionine hydroxyl analog-Zn chelate) used were 20 and 200 mg/kg and those of copper (methionine hydroxyl analog-Cu chelate) were 4 and 100 mg/kg of diet. Dietary zinc and Cu levels had no effect on feed intake ($P > 0.05$). Weight gain tended to increase at zinc inclusion of 200 mg/kg of diet ($P = 0.06$) and feed per gain was significantly improved at Cu inclusion of 100 mg/kg of diet ($P < 0.05$). Metallothionein (MT) concentration in the mucosa of the duodenum was induced with increasing dietary Zn or copper levels, but it was decreased when both high zinc and high Cu levels were included ($P < 0.01$). Liver MT concentration ($P < 0.01$) and liver MT mRNA ($P < 0.001$) were significantly increased with increasing dietary zinc levels. Copper dietary supplementation at 100 mg/kg of diet did not influence liver MT content ($P > 0.05$), but it significantly inhibited liver MT mRNA expression ($P < 0.01$). Similarly, liver ceruloplasmin (CP) and liver CP mRNA were significantly reduced when dietary zinc level was increased and those tendencies were further decreased when both high zinc and copper inclusions were added ($P < 0.01$). The data suggest that mutual antagonism occurred when high organic Zn or high organic Cu levels were included in diet of broiler chickens.

Key Words: antagonism, growth performance, broilers, organic zn, organic cu

313 Ileal digestibility of amino acids in fish meal-based diets for broiler starters using regression technique. A. . F. Agboola* and E. A. Iyayi, *Department of Animal Science, University of Ibadan, Ibadan, Nigeria.*

An experiment was conducted to determine apparent ileal digestibility of amino acids in fish meal-based diets for broiler chickens using regression technique. The ileal amino acid digestibility of fish meal at varying levels of inclusion (0, 1, 2, and 3 percent) was determined for broiler chicks in a 7-d experiment. Fish meal (FM) served as the sole source of protein and amino acids, as other feed ingredients were fixed. The birds were fed a commercial broiler starter diet during the first 14 d posthatch. On d 14, birds were sorted by body weight and randomly alloted into 4 treatments in a completely randomized design. Each diet comprised 4 replicates of 5 birds each from d 14 to 21 posthatch. Titanium dioxide was included as dietary marker. On d 21, birds were asphyxiated with CO2 and digesta samples from the terminal ileum were collected. The concentrations of essential amino acids (AAs) of FM in overall, increased as the FM levels of the dietary treatments increases and lowered in birds fed diet 4 (3 percent FM) except for lysine and methionine. The amount of AA digested at the terminal ileum was linearly regressed against its intake. The amount of crude protein (CP) and AAs digested up to the terminal ileum consistently increased with CP and AA intake over the entire range of intakes. The digestibilities of all the essential AAs in birds were significantly ($P <$ 0.05) improved across the dietary treatments. The ileal digestibility of FM at varied levels in the experimental diets was greater than 90 percent except for valine and threonine in the control diet. Amino acid digestibility was significantly ($P < 0.05$) lowered in birds fed diet 4 (3 percent FM) when compared with other diets. In conclusion, the data from the present study showed that there were considerable differences in varying levels of FM in the digestibility of their amino acids for broiler starters. Therefore, for least cost feeding in broiler production, it is imperative to consider lower level of FM inclusion, as level above 2 percent resulted in decreased digestibility of the amino acids.

Key Words: ileal digestibility, amino acids, fish meal, broiler starters, regression technique

314 Determination of Ileal digestibility of amino acids from feed ingredients for laying hens and broilers. S. A. Adedokun*[1], P. Jaynes[1], R. L. Payne[2], and T. J. Applegate[1], *[1]Purdue University, West Lafayette, IN, [2]Evonik Degussa Corp., Kennesaw, GA.*

The objective of this study was to determine apparent and standardized ileal amino acid digestibility of 7 meat and bone meal (MBM) and 5 distillers dried grain with solubles (DDGS) in 21 d-old broilers and 30 wk-old laying hens (Hy-line W36). Standardization was by correcting for basal endogenous amino acid (EAA) losses using a nitrogen-free diet (NFD). Broilers were reared in cages from d 0 to 16 on a standard broiler starter diet after which they were randomized to treatments using a randomized complete design with 6 replicate cages of 8 birds/cage per diet. There were 6 replicate cages of 5 birds/replicate for the laying hens. Each feed ingredient was the sole source of amino acids in each semi-purified diet which was fed for 5 d. Results show that the same feed ingredient (MBM or DDGS) from different locations (or processing techniques) varied widely in digestibility. Apparent ileal digestibility of MBM in broiler chickens range from 73.5 to 85.7% (Met), 74.3–85.9% (Lys), and 66.1–78.6% (Thr). Similar trends were seen after standardization (Met, 76–88.4%; Lys, 76.6–88.3%, and Thr, 72.4–82.7%). In comparisons between ingredient use between broilers and hens, considerable differences were noted. Generally, hens had 7.2%-units less CP digestibility of all DDGS samples after standardization. For MBM samples, 4 of the 7 had lower digestibilities of CP by hens when compared with broilers (7.4%-units on average). In conclusion, this study suggests there are differences in the digestibility of these ingredients when fed to broilers or laying hens, which may justify the need for separate amino acid digestibility data for laying hens and broiler chicks.

Key Words: amino acid digestibility, broiler, DDGS, laying hen, meat and bone meal

315 Determination of standardized amino acid digestibility in soybean meal (SBM), distillers dried grains with solubles (DDGS), and meat and bone meal (MBM) using different methods. W. A. Walbaum*, P. L. Utterback, and C. M. Parsons, *University of Illinois at Urbana-Champaign, Urbana.*

The objective of this study was to evaluate and compare the standardized amino acid digestibility (SAAD) of 3 different feedstuffs using different methods; precision-fed cecectomized rooster excreta assay (PFR), precision-fed rooster ileal digestibility assay, precision-fed chick ileal digestibility assay (PFC), and standardized ileal amino acid digestibility assay (SIAAD). In the 2 rooster assays, birds were tube-fed 30 g of the feed ingredients and excreta were collected for 48 h (PFR) or ileal digesta were collected at 6 h postfeeding. For the PFC, commercial broiler chicks (21 d of age) were fasted for 10 h and then tube-fed 10 g of the feed ingredients. Ileal digesta were then collected at 4 h postfeeding. In the SIAAD, broiler chicks were fed semi-purified diets containing 20% protein (from only the test ingredient) for 17–21 d of age and ileal digesta were collected on Day 21. Three different feedstuffs were obtained and evaluated. These samples were soybean meal (SBM), a dark-brown DDGS, and meat and bone meal (MBM). When comparing amino acid digestibility values among the 3 ingredients, values for SBM were highest and values for DDGS were lowest, with MBM being intermediate. The rooster ileal digestibility assay yielded highly variable and inconsistent results. Comparison of the other 3 methods showed that amino acid digestibility values for SBM were in general agreement among the methods. The amino acid digestibility values for DDGS and MBM, however, were generally lower for the PFC and SIAAD assays when compared with the PFR assay.

Key Words: amino acid digestibility methods, poultry, soybean meal, distillers grains, meat and bone meal

316 Evaluation of the pepsin digestibility assay for predicting amino acid digestibility of meat and bone meals. T. M. Davis*[1], C. M. Parsons[1], P. L. Utterback[1], and D. Kirstein[2], *[1]University of Illinois at Urbana-Champaign, Urbana, [2]Darling International Inc., Irving, TX.*

Sixteen meat and bone meal (MBM) samples were obtained and selected from various company plants to provide a wide range in pepsin digestibility values. Pepsin digestibility was determined using either 0.02 or 0.002% pepsin. Amino acid digestibility of the 16 MBM samples was then determined using precision-fed cecectomized rooster assay. As expected, the 0.02% pepsin digestibility values were higher than the 0.002% pepsin values. The values varied from 77 to

93% for 0.02% pepsin and from 67 to 91% for 0.002% pepsin. The rooster amino acid digestibility results showed a wide range of values mostly due to the samples with the 2 lowest values and the 2 highest values. The amino acid digestibility values for the other 12 samples were intermediate and generally similar among samples. Correlation statistical analyses between pepsin and amino acid digestibility values showed that the correlation values (r) were generally high and significant for all amino acids when all 16 MBM samples were included in the analysis. However, when the MBM samples with the 2 lowest and the 2 highest rooster digestibility values were not used in the correlation analyses, the correlation coefficient values (r) were generally very low and not significant ($P > 0.05$). The results indicated that the pepsin digestibility assay is only useful for detecting large differences in protein quality among MBM. The pepsin assay was not useful for predicting differences in quality among MBM samples of average or intermediate quality. For example, rooster amino acid digestibility was similar for MBM samples having 0.02% pepsin digestibility values of 80 to 90% and 0.002% pepsin values of 72 to 86%. There also was no clear advantage for using 0.02 versus 0.002% pepsin since the correlation values were similar for both.

Key Words: pepsin digestibility, amino acid digestibility, meat and bone meal, poultry

317 Amino acid digestibility of different soy products. T. Loeffler* and A. B. Batal, *University of Georgia, Athens.*

To determine the digestibility of 8 soy products, a precision-fed rooster TAA assay and a chick AA digestibility assay were conducted. The soybean (SB) products can be grouped into 3 categories: cold pressed soybean meal (SBM), defatted SB, and full-fat SB. Of the cold pressed varieties (unheated), there was an ultra-low trypsin SBM, a low-trypsin SBM, and both a heated and unheated commodity SBM. The defatted SBM was a heated commodity blend. In full-fat SB varieties, there was a high protein ultra-low oligosaccharide, a high-protein and a commodity SB. Semi-purified diets containing dextrose as the main energy source were formulated to meet the bird's nutrient requirements, with each diet containing a different SB product. The TAA rooster assays were traditional precision-fed rooster assays in which 5 cecectomized birds per diet were fasted for 24 h, crop intubated with 35 g of the test diet containing 46.58% cold-pressed or defatted SBM, or 75% full-fat SB, and excreta was then collected for 48 h. For the chick assay, 480 one-day-old chicks were fed a standard corn-SBM starter diet until 17 d of age, and on d 18, the chicks were allowed ad libitum access to the SB-dextrose diets. There were 6 pens of 10 chicks per replication assigned to the 8 SB-dextrose diets. Ileal contents were collected on d 22, dried, ground and analyzed for amino acid contents. Excreta, ileal contents, and diets were analyzed for AA concentration to calculate the amino acid digestibility coefficients. The SBM samples that were genetically modified to have lower trypsin levels had higher AA digestibilities than the commodity cold pressed SBM samples. Heating the SBM negatively impacted the AA digestibility. The high protein SB sample was higher in total AA but there was little difference in the AA digestibility as compared with the commodity control. However, the genetic reduction in the oligosaccharide content of the SB increased the AA digestibility of the SB. Genetic modification of SB can have positive effects on the AA digestibility.

Key Words: TAA, broilers, roosters

318 Effect of crude protein and fat content of diets with similar indispensable amino acid profile on productive performance and egg quality of brown egg laying hens differing in initial body weight. C. Jabbour[1], A. Perez-Bonilla[2], M. Frikha[1], S. Mirzaie[1], J. Berrocoso[1], J. Garcia[2], and G. G. Mateos*[1], *[1]Departamento de Producción Animal, Universidad Politécnica de Madrid, Madrid, Spain, [2]Camar Agroalimentaria S.L, Cedillo del Condado, Toledo, Spain.*

In total of 504 Lohmann Brown hens were used to study the influence of the initial BW of the birds and the crude protein (CP) and fat content of the diet on performance and egg quality traits from 22 to 49 weeks of age. The experiment was completely randomized with 8 treatments arranged factorially with 2 initial BW (1,726 vs. 1,987g) and 4 diets with similar AMEn (2,750 kcal AMEn/ kg) and indispensable (lys, Met+Cys, Thr, and Trp) amino acid contents. Three of these diets differed in the CP level (16.5, 17.5, and 18.5%) otherwise having similar nutrient profile. The fourth diet contained also 18.5% CP but included 3.5% supplemental fat rather than 1.9%. Each treatment was replicated 4 times and the experimental unit was constituted by 21 hens (3 adjacent cages with 7 hens each). Diet did not affect any of the productive performance traits studied. For the entire experimental period egg production (93.2 vs. 90.6; $P \leq 0.05$), egg weight (64.9 vs. 62.4; $P \leq 0.001$), egg mass (59.3 vs. 55.4; $P \leq 0.05$), and average daily feed intake (122 vs.114 g; $P \leq 0.001$) were higher for the heavier than for the lighter pullets. In contrast, BW gain was higher for the lighter pullets (233 vs. 289; $P \leq 0.05$). Hen mortality and FCR (kg/kg) were not affected by initial BW of the pullets. Similarly, shell quality and HU were not affected by dietary treatment or BW of the pullets. In conclusion, CP and fat content of the diet did not affect hen performance or egg quality. Heavier pullets had better egg production and bigger egg size than lighter pullets but feed efficiency was not affected by initial BW. It is concluded that brown laying hens do not need more than 16.5% CP provided that the diets are balanced for key indispensable amino acids. Initial BW of the pullets is important when the market penalizes small egg size.

Key Words: crude protein, fat content, initial body weight, laying hen performance

319 Effect of dietary amino acid density on the global gene expression profile of the chicken intestine. R. Poureslami*, R. Beckstead, and A. B. Batal, *University of Georgia, Athens.*

Protein (namely amino acids; AA) is one of most expensive nutrients thus, establishment of a low-AA dense diet supporting the maximum performance will considerably affect economics of poultry production. Large numbers of attempts have been made to investigate the feasibility of low-AA dense diets. Unfortunately, the data from these studies appears to be contradictory and there is no standard tool available to normalize the data obtained from different strains, ages and experimental conditions. Given that genes and cellular functions are identical in different strains of chickens, a genomic-based tool might be developed to evaluate bird's response to AA density of diet. The objective of this study was to gain insight into the gene-regulation processes of broiler's response to low-AA dense diets. At hatch, Cobb 500 male broiler chicks were obtained from a local hatchery and placed in battery brooders. Birds were fed a starter diet for 3 d. On d 3 of age, birds were weighed and 80 birds were selected and allocated into 20 pens of 4 birds each (10 replicate pens/treatment). Birds were fed either one of the 2 experimental diets from d 4 to d 15 of age, suboptimal diet

(19.89% CP) and optimal diet (21% CP). At d 15, birds were killed and carcass was dissected. About 1 cm of the jejunum was cut and immediately placed into RNAlater solution. Using TriPure isolation reagent, total RNA was isolated for microarray-based gene expression profiling (8 birds/ treatment). Affymetrix GeneChips was used for microarray assay. Analysis of gene expression profiles indicated that among 21,366 genes/transcripts detected in jejunum tissue, expression of 262 genes were altered ($P < 0.05$, fold change > 1.50) by dietary treatments. Gene ontology analysis indicated the involvement of dietary AA density in different functions including, AA and energy metabolism, growth, cell differentiation, immune response, oxygen binding capacity and oxygen transport, metal binding and lipid storage. In the next step of this project, qPCR will be used to validate the microarray data for the most affected genes.

Key Words: amino acid, gene expression, broilers

320 Lysine stable isotope partitioning in broiler breeders as affected by protein and energy intake. R. D. Ekmay*, C. Salas, S. Cerrate, J. England, and C. N. Coon, *University of Arkansas, Fayetteville.*

A study was conducted to determine the partitioning of lysine stable isotopes in broiler breeder hens. Hens were arranged in a 2x3 factorial fashion with 2 levels of energy (390, 450 kcal) and 3 levels of protein (22, 24, 26g @ peak). Starting at wk 23, 6 hens per treatment were given a daily 15 mg dose of ^{15}N-Lys until the hen's first egg was laid. At first egg, the ^{15}N-Lys dosing ceased and a daily 15 mg $^{2}D_4$-Lys dose began. The ^{15}N-Lys served as a skeletal muscle marker, whereas $^{2}D_4$-Lys served as a dietary marker. Two hens per treatment were slaughtered after the second, third and fourth eggs were laid, respectively. Six additional non-enriched hens served as controls. Breast, yolk and albumen were sampled and frozen. The procedure was repeated at wk 27 and 43 with minor changes. ^{15}N-Lys dosing was given for a 2-week period after which there was a 2-d rest period in which no isotopes were given. After this period, $^{2}D_4$-Lys began and sampling was as described. Breast, albumen, and yolk were analyzed by GC/MS to determine molar percent excess and lysine quantification. The highest deposition of the cumulative dietary marker into the egg occurred during the 27–29 wk period at 32%, whereas the highest deposition of the cumulative breast marker into the egg occurred during the 23–25 wk period. Protein or energy level did not impact partitioning of lysine. Of the markers found within the egg, albumen consisted of 76% breast marker and 24% dietary marker at the 23–25 wk period. By peak production, albumen consisted of 61% breast marker and 39% dietary marker. Yolk showed a similar drop in breast muscle contribution and an increase in diet at peak. The 43–45 wk period continued this trend. Data shows that during the early lay period, there is a higher reliance on skeletal muscle reserves than on dietary protein for egg formation. However, utilization of dietary protein increases with age although skeletal muscle remains an important contributor. The majority of lysine is partitioned toward skeletal muscle: which suggests that skeletal muscle may act as an intermediary organ that partitions lysine as needed.

Key Words: lysine partitioning, broiler breeder, protein, energy

321 The effects of early feed amino acid and late feed non-phytate phosphorus levels on large tom performance, yield, and litter composition. L. K. Shires*, B. N. Swiger, K. G. S. Lilly, and J. S. Moritz, *West Virginia University.*

Decreasing diet cost, improving performance, and implementing sustainable production practices are essential to successful large tom production. The objectives of this study were 2-fold: 1) assess the effects of increasing amino acid density (4%) in a starter phase diet (d10–42) on performance and yield and 2) assess the effects of decreasing nonphytate phosphorus (NPP) (6%) in grower and finisher diets (d63–126) on performance, yield, and litter composition of Hybrid Converter toms during an 18wk production period. Treatments were arranged in a 2x2 factorial design utilizing 2 amino acid levels (normal industry level and high) and 2 phosphorus levels (low and normal industry level) fed during specific phases. All birds were reared at the West Virginia University turkey research facility and diets were manufactured at a commercial feedmill. Male poults were randomly placed into one of 16 pens, so that each experimental unit contained 110 poults. Treatments were randomly assigned to areas within the house or blocks. Live weight gain, feed intake, and feed conversion ratio (FCR), were recorded weekly throughout the 126d production period. Breast accretion was determined during wk 6 and included processing 25 poults per experimental unit. High amino acid levels tended to increase pectoralis major and total breast weight ($P = 0.0853$, and 0.0896 respectively), without any effects on performance ($P > 0.05$). High amino acid level trends did not carry over to finishing tom breast accretion or canner weight. However, carryover amino acid effects interacted with NPP effects ($P = 0.0153$) so that d1–126 FCR was most improved with the combination of high amino acid starter treatments, and normal NPP grower and finisher treatments. Low NPP treatments decreased total and soluble phosphorus levels of litter by approximately 8 percent ($P = 0.0001$, and 0.0001 respectively). These data show that amino acid increases and NPP decreases may not be economically feasible due to effects or lack of effects on performance and yield; however, low NPP treatments showed potential to reduce environmental impact.

Key Words: turkey, breast yield, FCR, NPP

322 Digestible Lys requirements of female broilers from 1 to 15 days of age. W. A. Dozier III*[1] and R. L. Payne[2], *[1]Auburn University, Auburn, AL, [2]Evonik-Degussa Corp., Kennesaw, GA.*

Two experiments were conducted to ascertain digestible (dig) Lys requirements of female broilers from 1 to 7 and 1 to 15 d of age. In each experiment, 1,600 female broilers (experiment 1 = Ross × Ross 708; experiment 2 = Hubbard × Cobb 500) were randomly distributed into 64 floor pens (25 birds per pen; 0.09 m^2/bird) at 1 d of age and fed experimental diets until 15 d of age. A basal diet consisting of corn, soybean meal, poultry by-product meal, and peanut meal was formulated to be adequate in all other amino acids except Lys. The basal diet was supplemented with L-Lys to create 7 titration diets, and then a control diet containing adequate dig Lys was used for comparison with the titration diets. Each treatment was represented by 8 replicate pens. Body weight gain, feed intake, dig Lys intake, dig Lys intake/BW gain, feed conversion, and mortality were assessed at 7 and 14 d of age. On d 15, blood was collected from 2 birds per pen via ulnar vein for the determination of blood urea nitrogen and uric acid plasma concentrations. In both experiments, female broilers fed gradient concentrations of dig Lys displayed significant ($P \leq 0.05$) quadratic responses for BW gain and feed conversion from 1 to 7 and 1 to 14 d of age. Digestible Lys requirements were estimated using a quadratic broken-line model. In experiment 1, dig Lys requirement for Ross × Ross 708 female broilers were estimated at 1.38 and 1.35%, for BW gain and feed conversion, respectively, from 1 to 7 d of age and 1.27% for BW gain from 1 to 14 d of age. In experiment 2, dig Lys requirement for female Hubbard × Cobb broilers was estimated at 1.26% and 1.18%,

for BW gain from 1 to 7 and 1 to 14 d of age, respectively. Digestible Lys requirement was 1.26% for 1 to 14 d feed conversion as a requirement was not estimated for feed conversion from 1 to 7 d of age. These data indicate that dig Lys requirements for modern broilers are higher based on growth performance than previously reported.

Key Words: amino acid, broiler, lysine

323 Effect of dietary methionine sources on broilers oxidative status in heat stress condition. H. Willemsen[1], Q. Swennen[1], N. Everaert[1], P. A. Geraert[2], Y. Mercier*[2], A. Stinckens[1], E. Decuypere[1], and J. Buyse[1], *[1]Laboratory for Livestock Phyiology, K.U. Leuven., Belgium, [2]Adisseo France S.A.S., France.*

Many works comparing methionine sources in heat stress condition had been published with emphasis on growth performance and relative efficacy. This work focused on the compared effect of methionine sources: DL-Methionine (DLM) and DL-hydroxy-metyl(thio)butanoic acid (HMTBA) on the redox status of birds in different environmental conditions. The experimental design allowed comparing methionine sources in thermo neutral (from 25°C at 2 weeks to 18°C at 6 weeks) and heat-stress (enhanced from 25 to 32°C and kept at 32°C until 42 d of age) condition form 2 to 6 weeks of age. As expected, comparison of growth performances between conditions showed significant differences on final body weight ($P < 0.05$) and feed intake ($P < 0.05$). Interestingly, heat stressed broilers fed with hydroxyl-analog exhibited significantly higher body weight ($P < 0.05$) at 6 weeks old compared with DLM fed birds. Oxidative parameters such as plasma TBARS in DLM fed birds showed a significant increase ($P < 0.05$) from thermo-neutral to heat stress condition meaning that, as expected, heat stress induce oxidative processes. However, no significant increase of plasma TBARS was observed with HMTBA fed birds concluding of lower differences between conditions. The analysis of liver glutathione indicated that high temperature condition increased ($P = 0.005$) the total glutathione pool meaning that more oxidative condition force to adapt cellular defenses leading to increase cysteine demand for glutathione synthesis. The comparison between methionine sources in heat stress condition demonstrated significant differences on reduced GSH/ total GSH ratio ($P = 0.005$) and on reduce GSH/ oxidized GSSG ($P = 0.04$) with higher ratio obtained when birds were fed with HMTBA. As GSH/total GSH is thought to be a good indicator of cellular redox status, this experiment demonstrated that HMTBA appeared as better solution than DLM to maintain hepatic redox status allowing at least better health status.

Key Words: heat stress, methionine, oxidation, glutatathione

324 Ileal endogenous amino acid losses determined using the regression method in 26-d-old broiler chickens fed two levels of fiber with or without mild coccidial vaccine challenge. S. A. Adedokun*[1], K. M. Ajuwon[1], L. F. Romero[2], and O. Adeola[1], *[1]Purdue University, West Lafayette, IN, [2]Danisco Animal Nutrition, Marlborough, Wiltshire, UK.*

The objective of this study was to determine, in 26-d-old broiler chickens, the effects of mild coccidial vaccine (5X) challenge and insoluble fiber (cellulose) levels on ileal endogenous amino acid (EAA) losses determined using the regression method. Birds were fed semi-purified diets containing 3 levels of casein (40, 80, or 120 g/kg diet) as the only source of dietary protein at 2 levels of fiber (25 or 75 g/kg diet) with or without mild coccidial vaccine challenge on d 20. The 3 levels of casein were used to determine EAA losses for each replicate cage of birds using the regression method. The design of the study was a randomized complete block employing a factorial arrangement of treatments with 2 levels of treatment (challenged (C) or not challenged (NC)) and 2 fiber levels (25 and 75 g/kg diet). Titanium dioxide was added at 5 g/kg as an indigestible marker. Each treatment was offered for 5 d to 6 cages with 8 birds per cage. On d 26 post-hatch, contents from the entire ileum was flushed with distilled water and stored at −20°C until processed. Ileal EAA losses were determined from the ordinate intercept, at zero amino acid intake, of the regression of ileal digesta amino acid concentration in mg/kg dry matter intake (DMI) against dietary amino acid intake in mg/kg dry matter. The effect of fiber level on EAA losses, expressed as mg/kg DMI, were higher ($P < 0.05$) for most of the amino acids in birds fed 25 g fiber/kg diet. Mild coccidial vaccine challenge affected ($P < 0.05$) EAA losses for 8 of the 20 amino acids. Significant interaction between fiber level and coccidial vaccine challenge was obtained for all the amino acid except His and Lys. Amino acids with the greatest endogenous losses were Glu, Ser, Val, Ile, Asp, and Thr. Tryptophan and Met were the amino acids with the lowest losses. The results suggest that ileal EAA loss is higher in challenged birds fed diet containing 25 g fiber/kg diet. Data from this study show the role of different levels of insoluble fiber in EAA flow in 26-d-old broiler chickens.

Key Words: broiler, challenge, endogenous amino acid, fiber, regression method

Processing and Products

325 Effect of various processing techniques and antioxidant levels on the storage stability of hatchery waste meal. A. Mahmud*, Saima, T. N. Pasha, M. Nasir, M. A. Jabbar, A. W. Sahota, and Z. Nasir, *University of Veterinary & Animal Sciences, Lahore, Punjab, Pakistan.*

The scarcity of conventional feed resources and their high price has necessitated exploring cost effective non-conventional ingredients to be utilized to replace the conventional ones like hatchery waste (HW). The chemical composition of HW has revealed its nutrient composition especially higher level of fat (18- 21%), which pose threat to spoil the quality of of product through rancidity. Hatchery waste was processed by simple cooking, autoclaving, extrusion cooking. Four different levels of antioxidant (Oxygun) at 0, 100, 200 and 300 mg/kg were added to all the processed and raw hatchery waste. The samples were stored for 50 d and analyzed for peroxide value (PV), thiobarbituric acid value (TBA) and free fatty acids (FFA) contents with the interval of 10 d to evaluate the fat storage stability of HW. There was a linear increase in PV, FFA and TBA values of all the treatments throughout the storage period. Comparison within the raw hatchery waste and processed HW revealed that extrusion cooking was the most effective processing technique to check fat oxidation followed by autoclaving and simple cooking, whereas unprocessed (raw) hatchery waste showed maximum fat deterioration. PV, FFA and TBA decreased with all the levels of antioxidant addition when compared with samples without antioxidant fortification. At the end of storage period the significantly highest ($P \leq 0.05$) levels of PV, FFA and TBA were observed in unprocessed samples without antioxidant addition, while the least degradation of fat was observed in extruded samples with 300 mg/kg of antioxidant addition. In general, all the processing techniques as well as antioxidant addition checked the fat rancidity throughout the storage period as compared with raw samples without antioxidant addition, however synergistic effect of extrusion cooking and 300 mg/kg of antioxidant addition was found to be most appropriate to keep the samples highly acceptable for 50 d of storage period.

Key Words: hatchery waste, antioxidant, processing, oxidative stability

326 Effects of physical form of ration on performance of broiler chickens. J. H. Vilar Da Silva*[1], P. B. Lacerda[1], F. G. P. Costa[1], F. H. G. Oliveira[1], R. A. Santos[1], E. L. Silva[1], P. H. Watanabe[1], S. R. R. Ferreira[2], and M. R. Lima[1], *[1]Universidade Federal da Paraiba, Bananeiras, Paraíba, Brazil, [2]Guaraves - Foods, Guarabira, Paraíba, Brazil.*

An experiment was carried out to evaluate the effects of physical form of corn and soybean meal based diet on performance of broiler chickens. One thousand 2 hundred and 60 d-old Cobb 500 broiler male chicks were used during the 42 d of trial, following a completely randomized design of 3 treatments with 6 replicates of 70 birds each: 3 physical forms of rations (mash, pellet and expanded-pellet). Broilers fed expanded-pellet diet grew faster than broilers fed pellet diet, but these birds performed better as compared with birds fed with unprocessed diet. The body weights, weight gain and feed conversion improved with processed rations as compared with mash diet. The results of body weight, weight gain and feed conversion of birds fed expanded-pellet, pellet and mash were, respectively, 180.6, 171.1 and 168.4 g of BW; 132.9, 123.6 and 120.81 g of WG; 1.075, 1.154 and 1.141 kg/kg of FC (1 to 7 d); 1.069, 1.052 and 0.960 kg BW; 1.024, 1.003 and 0.913 kg WG; 1.254, 1.271 and 1.305 kg/kg FC (1 to 21 d); 2.488, 2.455 and 2.252 kg of BW; 2.994, 2.950 and 2.714 kg of WG; 1.192, 1.222 and 1.242 kg/kg of FC (1 to 35 d); 3.076, 3.052 and 2.834 kg of BW; 3.031, 3.003 and 2.788 kg of WG; 1.498, 1.528 and 1.598 kg/kg of FC (1 to 42 d). Broiler fed expanded-pellet and pellet diets had higher feed intake than those fed mash diet but among them was no differences. Feed intake (1 to 42 d) were 4.542, 4.587 and 4.457 kg for expanded-pellet, pellet and mash rations, respectively. The viability was the same among the expanded-pellet and pellet rations, but were lower as compared with mash ration (93.1, 92.8 and 95.2%). The carcass, breast, thigh and drumstick weights were 2.529, 2.550 and 2.384 kg; 916, 893 and 794 g; 289, 299 and 271 g; 386, 396 and 350 g of bird fed expanded-pellet, pellet and mash respectively. The feed costs per kilogram of live weight were USD 0.76, 0.77 and 0.80 of bird fed expanded-pellet, pellet and mash, respectively. It is concluded that heat-treatment of corn and soybean meal based diet improves performance and reduces the cost of feeding broiler.

Key Words: broiler, physical form, pellet, mash, expanded-pellet

327 Impact of feeder and water placement on broiler meat yield. R. K. Gilcrease*, G. Casco, T. Yalamanchili, C. Ruiz, and C. Z. Alvarado, *Texas A&M University, College Station.*

Bone weakness can constitute issues with animal welfare and uniformity due to inability to eat or drink. Bone strength in broilers can be improved through physical activity. However, there is little research on the effect of physical activity on meat yield. The objective of this study was to determine the effect of increased physical activity on yield of broilers. A total of 432 birds (216 males and 216 females) in 2 trials were divided into the following treatments based upon feeder/water placements: 3 ft apart (control), 6 ft (T6), and 10 ft (T10). Treatments were imposed on 1d of age through slaughter. The broilers were raised for either 42 d or 52 d of age and conventionally processed by stunning, slaughter, bleeding, scalding, defeathering, eviscerating, chilling, and deboning. Yield analyses included percentages for the following: WOG, chilled carcass, wing, breast, skinless boneless breast, tender, thigh, and drum. Data was analyzed using the GLM procedure of SAS and the means were separated using Duncan's Linear Model with a *P*-value of <0.05 to determine significance. Males and female were reported separately. No significant differences were observed in male or female yield data slaughtered at 42d. However, by 52d of age, females had significantly higher breast meat yield (bone-in, skin-on and boneless skinless breast) in the controls (30.18) and T6 (30.09) compared with T10 (28.68). T10 females at 52 d had significantly higher drum yield (12.65) when compared with the other treatments (12.30). In the data collected from males at 52d, the WOG yield was significantly higher in the control (74.24) and T6 (73.80) treatments compared with the T10 (72.75). Therefore, it can be concluded that the different distances between feeders made no difference in either male or female birds at 42d, but by 52d, significant differences were observed.

Key Words: animal welfare, broilers, yield, physical activity, exercise

328 Lipid oxidation stability of cooked chicken meat using dietary supplemented and meat-added antioxidants. F. Avila-Ramos*[1], C. Narciso-Gaytán[2], A. Pró-Martínez[1], E. Sosa-Montes[3], J. M. Cuca-García[1], C. M. Becerril-Pérez[2], and J. L. Figueroa-Velasco[1],

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The antioxidant effect of natural and synthetic compounds on cooked chicken meat was assessed. The lipid oxidation stability of refrigerated cooked breast meat was estimated using dietary supplemented antioxidants: vitamin E (VE 10 and 100 mg) and oregano essential oil (OR 100 mg) per kg of feed, and meat-added antioxidants: honey (3%) and BHT (0.02%). Broilers were fed with a basal corn-soybean meal diet during 6 weeks of feeding period. Honey and BHT were added to the meat from the VE10 treatment. The meat was cooked on an electric grill up to an internal temperature of 74°C, cooled at room temperature, placed on trays and covered with packaging film, and refrigerator stored (4°C) during 0, 3, 6, and 9 d. TBARS (2-thiobarbituric reactant substances analysis) was conducted at each storage day to quantify the malondialdehyde (MDA) values. Data were analyzed using a completely randomized design; each treatment had 12 repetitions and the least squares means were compared using orthogonal contrasts. The results showed that the VE10 treatment had higher MDA values than the other ones ($P < 0.001$). No differences ($P > 0.05$) in MDA values were detected between the dietary supplemented (VE100 and OR100) and the meat-added antioxidants (honey and BHT). Addition of honey to the meat resulted in lower MDA values than the BHT treatment ($P < 0.05$). The VE100 treatment showed lower MDA values than the OR100 one ($P < 0.05$). In conclusion, the supplementation of only 10 mg/kg of vitamin E results in higher lipid oxidation development of the meat. The use of dietary supplemented or meat-added antioxidants has a similar effect on the lipid oxidation stability of the meat. Dietary supplementation of vitamin E exerts a higher antioxidant effect of the meat than oregano essential oil, at a same level of inclusion. Finally, the addition of honey to the meat is more effective at inhibiting the lipid oxidation development than the synthetic BHT antioxidant.

Key Words: meat lipid oxidation stability, natural antioxidants, synthetic antioxidants

329 Meat quality evaluation of a commercial and a heritage broiler strain. D. P. Smith*[1], J. K. Northcutt[2], and E. L. Steinberg[2], *[1]Depatment of Poultry Science, Raleigh, NC, [2]Department of Food, Nutrition, and Packaging Science, Clemson, SC.*

Some consumers have reported that meat from heritage broiler strains (HS) is preferred to commercial broiler strains (CS) in regard to meat quality attributes, but relatively few objective measurements have been conducted on most heritage strains. To directly compare meat quality from a heritage and a commercial broiler strain, 5 ready-to-cook carcasses from each strain were obtained from the processing plant or retail store on each of 5 d. Boneless skinless breast fillets and boneless thighs were taken from each carcass, weighed, and assigned to different testing lots for cooking to determine yield, objective texture (razor blade shear), or sensory panel evaluation (experienced untrained), or, raw parts pooled for proximate composition analysis (percent protein, moisture, fat, and ash). The CS breast fillets were significantly ($P < 0.05$) heavier than HS fillets (168 vs. 103 g) but there was no difference for thigh weight (82 vs. 77 g, respectively). HS breast cook yield was higher than CS breast (82 vs. 76%), but there was no difference in strains for thigh meat. Objective texture results showed no significant differences for breast or thigh meat due to strain. No significant differences were observed for breast meat by sensory panel due to strain; HS strain thigh meat had lower values than CS for appearance (5.2 vs. 7.6), juiciness (8.3 vs. 9.4) and tenderness (8.7 vs. 10.5). There were no significant differences due to strain for percent protein, moisture, fat, and ash, for either breast or thigh meat. Few differences between strains were observed for breast meat quality attributes, while sensory panel attributes for thigh meat ranked higher for the commercial strain than the heritage strain.

Key Words: broiler, heritage strain, meat quality, sensory analysis, proximate composition

330 Quality of chicken meat as influenced by heat stress and post slaughter chilling. G. A. Veluz*[1], C. M. Owens[2], and C. Z. Alvarado[1], *[1]Poultry Science Department, Texas A&M University, College Station, [2]Poultry Science Department, University of Arkansas, Fayetteville.*

Poor meat quality is a growing problem in poultry and can be attributed to heat stress as well as improper chilling of the carcass. This study was conducted to determine the relationship between prechilling and chilling in control and heat-stressed birds. A total of 300 broilers in 2 trials were raised in control or heat-stressed environments. At 49 d of age, heat stressed and control broilers were conventionally processed, and either prechilled at 55F for 15 min and chilled at 34F for 60 min or chilled only (34F for 60 min). Analyses of quality attributes included pH (0.25 h, 1.25 h, 3 h and 24 h PM), color (L*, a*, and b*), tenderness (allo-kramer shear), cook loss, and cooked meat moisture. Data was analyzed by GLM in SAS and means were separated using Duncan's Multiple Range test ($P < 0.05$). Data was analyzed by control and heat stressed birds with chilling as the treatment. Results indicated that the meat quality from the control and heat stressed birds subjected to prechilling and chilling was the same as those birds that were only chilled. There were no significant differences in meat quality (moisture content, cook loss, color, pH and tenderness) from either the heat-stressed (chilled/pre-chilled) and control birds (chilled/prechilled). In the control birds, the development of rigor mortis as indicated by pH decline (0.25 h to 24 h) was 6.61 to 5.82 for the chilled birds which was not significantly different from the prechilled/chilled birds (6..62 and 5.78). Likewise, similar pH decline values from heat-stressed birds chilled (6.67 to 5.81) and heat stressed birds treated with prechill/chill (6.69 to 5.82) were noted. Although cook loss was slightly lower for the chilled birds as compare with prechilled/chilled treatment for both control and heat-stressed birds, there was no significant difference ($P > 0.05$). Therefore, prechilling for 15 min (55F) does not negatively affect meat quality in control or heat stressed birds.

Key Words: prechilling, chilling, heat stress, broilers, tenderness

331 Postmortem aging can significantly enhance water-holding capacity of broiler pectoralis major muscle measured by the salt-induced swelling/centrifuge method. H. Zhuang* and E. Savage, *USDA-ARS, Athens, GA.*

Water-holding capacity (WHC) is one of the most important functional properties of fresh meat and can be significantly affected by postmortem muscle changes. Two experiments were carried out to evaluate the effects of postmortem aging on WHC of broiler pectoralis (p.) major muscle indicated with % salt-induced water gain (swelling/centrifugation method). The first experiment was to determine the effect of postmortem aging on WHC of broiler p. major with different color lightness. The p major muscle was deboned 6–8 h postmortem and categorized based on CIELAB L* value. The muscle WHC was measured either after deboning or after being aged at refrigerated tempera-

ture for 24 h. Regardless of muscle color lightness, the salt-induced water gain by the broiler p. major aged 24 h post-deboning was at least 50% higher than the samples without post-deboning aging, indicating that post-deboning aging could enhance WHC of broiler breast meat. The second experiment was to determine effects of deboning time and post-deboning aging time on the WHC. The p. major muscle was deboned at either 2 h or 24 h postmortem, and the 2-h deboned p. major was aged for either 22 h or 7 d at refrigerated temperature before WHC were measured. Regardless of aging methods (on or off the carcass) and aging time (22 h or 7 d), the salt-induced water gain by the aged p. major was more than 80% higher than that by the 2-h deboned samples. There was no difference in the WHC between the muscle deboned 24 h postmortem and the muscle deboned 2 h and aged 22 h post-deboning. There was no difference between the 22-h post-deboning aging and 7-d post-deboning aging. These results suggest that the first 24 h postmortem aging after slaughtering could enhance WHC of broiler p. major muscle.

Key Words: postmortem aging, water-holding capacity, pectoralis major muscle, broiler, deboning time

332 Quality and sensory attributes of shell eggs sanitized with a combination of hydrogen peroxide and ultraviolet light. K. Woodring*, S. M. Gottselig, C. Alvarado, L. Hirschler, J. T. Lee, and C. D. Coufal, *Texas A&M University, College Station.*

An experiment was conducted to evaluate the combination of hydrogen peroxide and UV light (UV) as an alternative eggshell sanitization procedure for shell egg processing. Two cases of eggs (720 total) were collected at a commercial inline egg production facility. To assure egg uniformity, only eggs between 57 and 62 g were collected from a single hen house. Half of the eggs (360) were commercially processed (washer and sanitizing rinse) following normal procedures outlined by the USDA for shell egg processing. These eggs were designated as the control group. The other half of the eggs (360) were washed as normal but without the sanitizing rinse. These eggs were then treated with the hydrogen peroxide and UV treatment (treated group). The treatment consisted of spraying the eggs with 3% hydrogen peroxide over the entire shell surface followed immediately by exposure to UV for 5 s in an enclosed chamber equipped with germicidal lamps (UV-C). This treatment was performed twice. Following washing and treatment, all eggs were packaged in clean styrofoam cartons and transported to the lab and stored in a refrigerator at 5 C. Eggshell aerobic plate counts (APC), breaking strength, and thickness, albumen height and pH, haugh units, and yolk color were measured on d 1 and 15 of storage. On d 15, sensory evaluation of scrambled egg samples was conducted to determine if consumers could detect a difference between treatment groups using a triangle test. Results indicate that treated APC were significantly lower than the control eggs for d 1 and 15. On each day, only 25% of treated eggs were positive for APC by rinse and plate method. No differences were found for all other egg quality parameters measured. In the sensory evaluation, only 28% of the participants correctly differentiated between the control and treated eggs. Data from this experiment suggests that hydrogen peroxide and UV can be used as an alternative eggshell sanitizing procedure without impacting eggshell or internal egg quality.

Key Words: eggs, sanitization, ultraviolet, hydrogen peroxide, sensory

333 The impact of marination on the quality of frozen broiler breast fillets. A. G. Sanchez Pena* and C. Z. Alvarado, *Texas A&M University, College Station.*

Eighty-three percent of consumers purchase fresh poultry and freeze it for future use. The objective of this study was to evaluate the effects of marination (M) on the quality of chicken breast fillets after 2wk storage in a home freezer (−18C). A total of 240 fillets (24hr PM) in 2 reps were used in the following treatments: non-marinated fresh non-frozen (NM-NF), non-marinated frozen (NM-F), marinated fresh not frozen (M-NF), and marinated frozen (M-F). The M fillets were vacuum-tumbled (25mm Hg, 14 RPM, 30min, 4C) with a 10% solution (0.45% STP and 1.25% salt). Samples subjected to frozen storage were randomly placed in freezer bags and frozen for 2 wk in a home freezer. The frozen samples were compared with the non-frozen fresh (24 h PM) fillets to determine ability to withstand freshness in a home freezer. Raw samples were analyzed for color (L*, hue, chroma), TBARS, and freezing loss. Cook loss, texture, moisture and sensory attributes (color, juiciness, tenderness, overall flavor and preference) were analyzed in the cooked samples at wk 2. Data was analyzed using the GLM procedure of SAS and the means were separated using Duncan's Linear Model (P value of <0.05). M-F had a significantly lower freezing loss compared with NM-F (1.75, 9.44). The NM samples (fresh and frozen) had significantly higher TBARS values when compared with the M samples indicating that marination resulted in antioxidant properties. All M samples had significantly lower cook loss, shear value, and higher moisture, preference, overall flavor and tenderness (sensory) than the NM ones. The M-F fillets samples had the lowest cook loss, shear force, and highest moisture of the 4 treatments. In addition, the M-F and the M-NF samples had the highest sensory ratings for color, juiciness, tenderness, overall flavor and preference. Therefore, consumers preferred the marinated samples more than the non-marinated samples. In addition, freezing in a home freezer for 2wk did not negatively impact the quality in the marinated fillets but did decrease quality in the non-marinated fillets.

Key Words: marination, quality, breast fillets, freezing

334 Yield Improvements in water and oil based marinades with a natural non-phosphate blend. G. Casco* and C. Z. Alvarado, *Texas A&M University, College Station.*

As consumer demand for natural marinades increases, the need to replace phosphate with a natural product that can produce equivalent or improved yield in products such as but not limited to rotisserie chickens is a challenge for processors. The objective of this research is to determine marination yield in water-based (W) and oil-based (O) marinades using a natural non-phosphate blend (SavorPhos-200). Two commercial phosphates used in water-based (PW) and oil-based (PO) injection brines for rotisserie chickens were compared with SavorPhos-200. The treatments included water control (water, 0.4% phosphate, 0.7% salt), WSF (water, 0.5% SavorPhos-200, 0.7% salt), oil control (water, 3% oil, 0.4% phosphate, 0.7% salt), and OSF (water, 3% oil, 0.5% SavorPhos-200, 0.7% salt). Whole birds were injected with a multi-needle injector to 20% (wt/wt) pick-up at a constant pressure (15–20psi). The parameters measured were marinade pick-up %, marinade retention %, and cook loss %. Data (2 trials, n = 20) was analyzed using a single-way ANOVA using SigmaStat software. Means were separated using a *t*-test ($P < 0.05$). Data was analyzed within marination type (W and O). Results for the W marinated sam-

ples indicate no significant difference ($P > 0.57$) between water control and WSF for marinade pick up (22.75, 21.55, respectively), retention (87.89, 91.62, respectively) and cook loss (31.86, 29.20, respectively). The oil-base injection indicated significantly higher marinade pick up with SavorPhos-200 (25.25) compared with the oil control phosphate (19.72). There were no significant differences in retention and cook loss with Savorphos-200 in the oil-based marinades. Therefore, SavorPhos-200 can be used as a natural non-phosphate blend in water based marinades with no detriment to yield. In addition, SavorPhos-200 can be used as a natural non-phosphate blend in oil-based marinades with yield improvements.

Key Words: natural marinade, non-phosphate blend, rotisserie chicken, oil-based marinade, Savorphos-200

335 Impact of water-flume transport of feather and viscera offal on poultry processing wastewater. H. S. Plumber*, B. H. Kiepper, E. Abboah-Afari, and C. W. Ritz, *University of Georgia, Athens.*

An experiment was conducted to measure the impact of water-fluming transport of broiler carcass feathers and viscera offal on poultry processing wastewater (PPW). Twenty-four 8-wk old male broilers were randomly assigned to 4 treatment groups (n = 6): SS (short-bleed/soft-scald), SH (short-bleed/hard-scald), LS (long-bleed/soft-scald), and LH (long-bleed/hard-scald). Short-bleed = 60 s, long-bleed = 120 s. Soft-scald = 50°C, hard-scald = 60°C. Birds were electrically stunned, simultaneously decapitated and bled for either 60 s (S) or 120 s (L). Carcasses were then scalded for 2 min in individual scald tanks containing 16L of water heated to either 50°C or 60°C. Representative samples of 100g of feathers were removed from each carcass and agitated in 2L of potable water for 2 min. Feathers were coarse sceened and rinse water was retained for analysis. Carcasses were eviscerated. Viscera were weighed and agitated in 4L of potable water for 1 min. 2L of coarse screened rinse water were retained for analysis. Viscera were agitated for an additional 2 min (3 min total) and remaining 2L of rinse water were retained for analysis. Samples of feather (24) and viscera (48) rinse water were analyzed for chemical oxygen demand (COD), total solids (TS), total suspended solids (TSS), total volatile solids (TVS), and total Kjeldahl nitrogen (TKN) concentration (mg/L). A PPW load (g/carcass) was calculated for each concentration (mg/L) data point using the associated volume of rinse water and statistically analyzed. Results showed feather rinse water mean loadings (g/carcass) were COD 1.23, TS 0.86, TVS 0.69, TSS 0.40, and TKN 0.11, with no significant differences between treatments. Viscera rinse water mean loadings (g/carcass) at 1 min agitation were COD 1.12, TS 0.58, TVS 0.58, TSS 0.23, TKN 0.07, with no significant differences between treatments. Viscera rinse water mean loadings (g/carcass) at 3 min agitation were COD 1.88, TS 1.03, TVS 1.02, TSS 0.44, TKN 0.11, with no significant differences between treatments. The additional 2 min of viscera agitation resulted in increased mean loadings of COD 40%, TS 44%, TVS 45%, TSS 49%, and TKN 33% in PPW.

Key Words: poultry processing, wastewater, offal, COD, TSS

336 Market profile of the duck and quail egg products in Vancouver Canada: Chinese-Canadian buyers and non-buyers. J. A. Arthur*, K. Wiseman, and K. M. Cheng, *University of British Columbia, Vancouver, BC, Canada.*

With the increasing ethnic diversity in the metropolises of North America, niche markets for ethnic foods may provide promising opportunities for local producers and processors. However, ethnic food market information is often scarce and it is often unknown to what extent acculturation and demographic indicators affect consumption. Nineteen percent of the population in the Greater Vancouver Area (Canada) is ethnic Chinese. The objectives of this study were to profile consumption and how demographic and acculturation indicators may impact purchase. Products studied included salted and preserved duck eggs, and fresh and processed quail eggs. The mixed method design consisted of exploratory focus groups followed by a mixed mode (mail–internet) survey of randomly selected Vancouver households with Chinese surnames. All documents were provided in English and Chinese. The adult most responsible for grocery shopping for the household was asked to complete the survey. Four hundred and 10 completed surveys (28% return) were processed and different statistics were applied (e.g., Chi-squared, Cramer's V). Results indicate that 73% of respondents were purchasers of at least one egg type. Salted duck eggs were most likely to be purchased (63%), followed by preserved duck eggs (58%), fresh quail eggs (13%), and processed quail eggs (2%). Products appear to be infrequently purchased: 43% purchased salted duck eggs 1–2 times/yr versus 4% every 1–2 wks. This pattern was consistent for all egg types. Approximately 32% reported purchases declined year over year for all egg types; 54–64% reported stable consumption. Indicators of acculturation, such as reading ability and dietary preferences showed stronger significant associations with product purchase/non purchase than demographic characteristics such as education and income. Age had no significant association. Our results provide an informed portrait of Chinese-Canadian consumers of duck and quail egg products and will allow producers and retailers the opportunity to make better product and marketing decisions.

Key Words: duck and quail eggs, Chinese consumers, survey, demographics and acculturation

337 Egg shells and cracked eggs of six pure lines compared to commercial white- and brown-egg layers. F. G. Silversides* and M. C. Robertson, *Agriculture and Agri-Food Canada, Agassiz, British Columbia, Canada.*

Egg production was measured over a 4-year period for 6 lines of layers kept at the Agassiz Research Centre along with that of Lohmann White (LW) and Brown (LB) hens. Egg and shell wt were measured on individual eggs at approximately 30, 40, and 60 wk of age and production of eggs and cracked eggs of the 3-hen cages was recorded in the 4-wk periods surrounding egg quality measurements. The LW and LB hens produced the most eggs and the Agassiz White Leghorns (BLK, BLU, BUR) and Rhode Island Reds (RIR) produced more than Barred Plymouth Rocks (BR) and Columbian Rocks (CR). The RIR had the heaviest eggs and LB hens had larger eggs than LW. Shells of eggs from LB and LW hens were heavier than those of eggs from other lines and those of LB eggs were greater than for LW eggs, but LW and LB eggs had similar % shell. Shell wt and % was lower for the Agassiz lines, suggesting not surprisingly that the breeding industry has paid significant attention to shell quality. The shell % of the Agassiz White Leghorn eggs was close to that of commercial lines and higher than for the BR, CR, and RIR lines, which could suggest that White Leghorns have inherently higher shell % than brown-egg layers. The number of cracked eggs from commercial lines was lower than that of other lines, and RIR had the most cracked eggs. Many observed correlations were because egg production decreases with age, while cracked eggs and egg and shell wt increase and shell % decreases. High producing lines had higher shell % leading to a positive association (0.28)

between production and % shell. The association between shell % and cracked eggs was surprisingly low (−0.19). The line appeared to be more important than the age for the correlation between eggshell and number of cracked eggs because those within the line over the 3 periods were lower than those within age for all lines. These data suggest that industrial breeders have been successful at reducing variation in cracked eggs that relate to eggshell wt, especially for white-egg layers. Breeders should look for other factors, such as eggshell structure, to further reduce cracked eggs.

Key Words: eggshell quality, layer lines, cracked eggs

338 The effect of marine and flaxseed oil inclusion in diets for pastured laying flocks on EPA, DHA, and consumer acceptability of eggs. L. K. Shires*, K. G. S. Lilly, and B. N. Swiger, *West Virginia University.*

Pastured hen egg producers must demand a premium for their eggs due to increased labor and cost of production. Consumers have justified spending more for these eggs because they perceive animal welfare, sustainability, and nutrition are enhanced compared with conventionally produced eggs. However, scientific data does not support these perceptions. This study implemented practical management strategies to increase eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) composition of eggs which may better justify egg premiums due to these fatty acids being associated with numerous health benefits. A randomized complete block design was utilized with 15 single-comb-white leghorn Hyline W-36 hens per experimental unit and 5 replications. Hens were reared in 5 different portable houses that were divided into 4 pens of equal size. Pens contained 2 doors for access to outdoor paddocks. Hens were allowed to forage during daylight hours and paddocks were rotated to assure fresh pasture access. Corn and soybean based basal diets were provided for ad libitum consumption and depending on treatment utilized a 1:1 replacement of soybean oil with either marine or flaxseed oil. Each house contained 4 different treatments 1) basal, 2) basal + 0.5% marine oil, 3) basal + 1% marine oil, and 4) basal + 1% flaxseed oil. The marine oil was analyzed to contain 18% EPA and 12% DHA and flaxseed oil primarily contained α-linolenic acid (>50%). Hens were on experiment from 20 to 24wks, and eggs were collected for nutrient analysis at the end of this period. Hen performance among treatments was not different. Pastured hens fed the basal diet had the lowest EPA and DHA levels, followed by basal + 0.5% marine oil and basal +1% flaxseed oil ($P = 0.0001$). Hens fed the basal diet + 1% marine oil produced eggs with the greatest concentration of EPA and DHA (213 mg/egg total, $P = 0.0001$). This level could provide nearly all of the American Heart Association's daily recommendation for EPA and DHA consumption (220mg/day). Aroma and flavor attributes determined by a taste panel were similar among eggs from all treatments.

Key Words: marine oil, EPA, DHA

Wealth of Knowledge II

339 Retrospective study of novel picornavirus associated with turkey viral hepatitis. H. L. Shivaprasad*, K. H. Honkavuori, T. Briese, and W. I. Lipkin, *CAHFS-Tulare, Tulare, CA.*

AAAP abstract†

340 Detection of lymphoid leukosis tumors in white leghorn chickens of line alv6 that is resistant to subgroups A and E avian leukosis virus and maintained under specific pathogen free conditions. A. Fadly*, J. K. Mays, and R. Kulkarni, *USDA-ARS Avian Disease and Oncology Laboratory, East Lansing, MI.*

AAAP abstract†

341 Current status of the National Poultry Improvement Plan. C. S. Roney*, *NPIP, Conyers, GA.*

AAAP abstract†

342 Significant poultry disease notifications in Arkansas, Missouri, and Oklahoma: A model voluntary system. J. Barton*, *The Poultry Federation Lab.*

AAAP abstract†

343 The Council for Agricultural Science and Technology: A vital poultry industry partner. N. Tablante*, *University of Maryland, College Park.*

AAAP abstract†

344 New insights into plasmid-associated phenotypes and genotypes of APEC strain chi7122 (O78:K80:H9). M. Mellata*, J. Maddux, T. Nam, and R. Curtiss III, *The Biodesign Institute, Arizona State University, Tempe.*

AAAP abstract†

345 Characterization of APEC isolates from broilers in Latin America. T. M. Barbosa*, E. Turpin, and L. K. Nolan, *Pfizer Poultry Health, Research Triangle Park, NC.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Laryngotracheitis and Newcastle

346 Field experiences of the hatchery subcutaneous HVT + ILT recombinant (INNOVAX) vaccine in table egg layers. H. A. Medina*, *Sparboa Farms Inc.*

AAAP abstract†

347 Genome analysis of infectious laryngotracheitis virus (ILTV) live-attenuated vaccines and virulent isolates. M. Garcia*, S. Spatz, S. Riblet, E. S. Mundt, and J. S. Guy, *Department of Population Health, College of Veterinary Medicine, University of Georgia, Athens.*

AAAP abstract†

348 Compatibility of vectored LT vaccines and Vectormune HVT NDV. A. Godoy*, M. Esaki, P. Flegg, J. K. Rosenberger, S. Rosenberger, K. Moore Dorsey, and Y. Gardin, *Ceva Biomune, Lenexa, KS.*

AAAP abstract†

349 Construction of recombinant Newcastle Disease Viruses, LaSota strain, expressing the G protein of avian metapneumovirus, subtype A or B, for use as bivalent vaccines. J. P. Roth*, H. Hu, C. Estevez, L. Zsak, and Q. Yu, *USDA-ARS, Southeast Poultry Research Laboratory, Athens, GA.*

AAAP abstract†

350 Generation and evaluation of a LaSota strain-based recombinant Newcastle disease virus (NDV) expressing the glycoprotein (G) of avian metapneumovirus subgroup C (aMPV-C) as a bivalent vaccine. Q. Yu*, H. Hu, J. P. Roth, C. N. Estevez, and L. Zsak, *USDA-ARS, Southeast Poultry Research Lab.*

AAAP abstract†

351 vvNDV in south MS? P. A. Stayer*, F. D. Wilson, and J. L. McReynolds, *Sanderson Farms.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Mycoplasma

352 Molecular characterization of mycoplasma gallisepticum isolated from chicken and turkey. A. Metwally*, S. I. Eissa, A. E-W. M. Hassan, Y. M. Hashem, and E. A. A. El-Aziz, *Animal Health Research Institute, Dokki, Giza, Egypt.*

AAAP abstract†

353 Pathogenicity of *Mycoplasma gallisepticum* strains using ELD50 in embryonated chicken eggs. M. Farrar*, R. Wooten, V. Laibinis, and N. Ferguson-Noel, *Department of Population Health, Poultry Diagnostic and Research Center, University of Georgia, Athens.*

AAAP abstract†

354 Evaluation of three DNA extraction methods for the detection of *Mycoplasma* spp. with an MG/MS multiplex real-time PCR method. B. Lungu* and N. Ferguson-Noel, *Poultry Diagnostic Research Center, University of Georgia, Athens.*

AAAP abstract†

355 Experiences in the use of a live MG Vaccine in northeast Georgia. L. Chappell*, *Georgia Poultry Laboratory Network.*

AAAP abstract†

356 Use of MG/MS serology and PCR to determine flock status. B. Glidewell*, *Georgia Poultry Laboratory Network.*

AAAP abstract†

357 Expanded sequencing of *Mycoplasma synoviae* vlhA gene as a complementary genotyping tool. M. M. El-Gazzar*, A. N. Wetzel, and Z. Raviv, *The Ohio State University, Columbus.*

AAAP abstract†

358 A Survey of recent *Mycoplasma synoviae* vlhA sequence types in the southeastern United States. V. Laibinis* and N. Ferguson-Noel, *Department of Population Health, Poultry Diagnostic and Research Center, University of Georgia, Athens.*

AAAP abstract†

359 Amplified fragment length polymorphism (AFLP) analysis of historic and recent *Mycoplasma iowae* isolates. Z. Raviv* and A. Wetzel, *The Ohio State University.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Avian Influenza I

360 Multiyear surveillance of avian influenza in wild waterfowl on the Texas Coast. B. Lupiani*, P. J. Ferro, O. Khan, C. M. Budke, M. J. Peterson, D. Willems, E. Roltsch, T. Merendino, and M. Nelson, *Department of Veterinary Pathobiology, College of Veterinary Medicine and Biomedical Sciences, Texas A&M University, College Station.*

AAAP abstract†

361 Surveillance of avian influenza virus in Grenada, West Indies. R. Nath Sharma*, D. S. Arathy, K. P. Tiwari, S. Kumthekar, and G. P. Sabarinath, *School of Veterinary Medicine, St. George's University, Grenada, West Indies.*

AAAP abstract†

362 Evaluation of primer and probe mismatches in sensitivity of select RRT-PCR tests for avian influenza. D. L. Suarez*, *Southeast Poultry Research Laboratory.*

AAAP abstract†

363 Evaluation of neuraminidase (NA) subtypes 1 and 2 ELISAs for detection of avian influenza vaccinated/infected poultry using an NA heterologous vaccination strategy. A. R. Reis*, A. Mundt, O. Bowen, D. L. Suarez, E. S. Mundt, and M. García, *Poultry Diagnostic and Research Center, Department of Population Health, College of Veterinary Medicine, The University of Georgia, Athens.*

AAAP abstract†

364 Clinical, pathological and virological investigations of H6 low pathogenic avian influenza virus field infection in turkeys. L. Corrand*, M. N. Lucas, M. Delverdier, G. Croville, and J. L. Guerin, *Ecole Nationale Veterinaire De Toulouse.*

AAAP abstract†

365 Pathogenicity of reassortant H5N1 highly pathogenic avian influenza viruses in domestic ducks. M. Pantin-Jackwood*, J. Wasilenko, and C. Cagle, *Southeast Poultry Research Laboratory, Agricultural Research Service, USDA, Athens, GA.*

AAAP abstract†

366 Expression and distribution of sialic acid receptors in tissues of wild birds. M. Franca*, D. E. Stallknecht, and E. W. Howerth, *University of Georgia, Department of Pathology, Athens.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

367 Histological description of Snail Kite (*Rostrhamus sociabilis*) testicles. S. K. Cunha[1], J. M. Silva[1], A. L. S. Valente[1], A. S. Varela Junior[2], S. M. L. C. Costa[1], M. A. A. Coimbra[1], C. D. Corcini[1], and D. C. Bongalhardo*[1], *[1]Federal University of Pelotas, RS, Brazil, [2]Federal University of Rio Grande, RS, Brazil.*

Birds of prey have an important role in maintaining the populations of small animals, helping to keep the ecological balance in the regions they inhabit. The Snail Kite (*Rostrhamus sociabilis*) is a bird from the Falconiforme order, Accipitridae family, which also comprises vultures, eagles and hawks. It is a diurnal bird found in the freshwater wetlands of Central and South America, Caribbean and southern United States. Although it is rated as Least Concern by Bird Life International, in Florida the species is locally endangered due to the water level control in the Everglades: the draining resulted in a decrease in the number of apple snails, the main element of its diet. The objective of this work was to study the testes of the Snail Kite, aiming to obtain knowledge about its reproductive cycle in southern Brazil. In October, one adult Snail Kite male was brought to the Wildlife Rehabilitation Center from the Federal University of Pelotas, presenting an exposed fracture in the distal portion of the humerus. The bird was euthanized one day after its arrival, and the testicles were collected for histology. The testes were placed in 10% buffered formalin; after fixation they were dehydrated in 7 crescent concentrations of alcohol (70, 80, 90, 96, 96, 100, and 100%), immersed 3 times in xylol at 100%, impregnated and included in Paraplast Xtra, and sliced (5 µm) in rotating microtone. To observe all the structures, different cuts from the same testis were stained with one of 4 colorations: Harris Hematoxylin and Eosin (HE), which stains cells nuclei and cytoplasm; Mallory trichrome, which stains connective tissue; Gomori trichrome, which stains muscle tissue, and Periodic Acid Schiff + HE, which stains carbohydrates present in basal lamina. When observed at optical microscope, the testes cuts showed a multi stratified epithelium containing sperm in different stages of development, as well as polygonal Sertoli cells, indicating intense seminiferous tubules activity. These results show that in October, the bird was in the reproductive season, with the testes fully functional and producing sperm with normal morphology.

Key Words: birds of prey, seminiferous tubules, histology, testicles, sperm

368 The role of serotonergic axis in reproductive failure associated to aging in broiler breeder roosters. N. Avital-Cohen* and I. Rozenboim, *Hebrew University of Jerusalem, Rehovot Israel.*

Decline in reproductive activities of aged roosters is a well known phenomena. Serotonin modulate hypothalamic function, gonads function and incubation behavior. Serotonin elevation in the brain is associated with decreased reproductive performances manifested in aged roosters. Seven serotonin receptors families are known with little information in avian species. The aims of this study were: 1. Characterization of serotonin receptors in aged broiler breeder roosters, 2. the role of testosterone and estrogen interaction with serotonergic axis in aged broiler breeder roosters. Exp. 1: 60 broiler breeder roosters at 64 wks of age were divided into 4 treated groups (n = 15): 1. LY272015-antagonist against 5-HT2B receptor (i.v. 0.3mg/kg once a week), 2. Metergoline- antagonist against 5-HT2C receptor (i.m. 3 mg/kg daily), 3. Ondansetron- antagonist against 5-HT3 receptor (i.m. 0.2 mg/kg daily) and 4. Untreated control. Exp. 2: 80 broiler breeders roosters at 66 wks of age were divided into 8 groups (n = 15) treated with: tamoxifen (TAM), testosterone (TES), TAM+TES, PCPA, TAM+PCPA, TES+ PCPA, TAM+TES+ PCPA and control. Semen qualities were weekly measured. Plasma steroid and prolactin level were measured every 2 wks. At the end of the experiments (66 wks in exp. 1 and 70 wks in exp. 2) roosters were euthanized and tissues were removed for mRNA genes expression of GnRH-I, VIP, LH-β, FSH-β, Prolactin, LH and Prolactin receptors. Treatment with 5-HT2B significantly improved semen quality. In addition, all antagonists groups increased gene expression of gonadal exis. Investigating the influence of TES, TAM and serotonin reviled that the combined treatment with TES, TAM and PCPA significantly increased semen quality, testis weight gonadal axis genes expression. The results suggest that reproductive failure associated with age is caused by an increase serotonergic level via its 5-HT2B receptor. In addition aging is associated with a decrease in gonads function manifested by decrease in testosterone and increase in estrogen levels.

Key Words: roosters, aging, fertility, serotonin, serotonin receptors

369 The use of reflectance spectroscopy for fertility detection in freshly laid egg and gender sorting in mid incubation period. I. Rozenboim*[1] and E. Ben Dor[2], *[1]Hebrew University of Jerusalem, Rehovot, Israel, [2]Tel Aviv University, Tel Aviv, Israel.*

The development of chicken embryos involves a complex sequence of physiological and biochemical changes. Their early detection is of significant commercial value, but is limited to non-invasive methods. The current method for detection of egg fertility is candling conducted by 10 d of incubation and is followed by gender sorting after hatch. Reflectance spectroscopy is being used for detection of biochemical characteristics in the food, cosmetics, pharmacological industries and others. Recent progress in reflectance spectroscopy permits optical screening of the egg to yield both embryo and shell spectral signatures. A preliminary analysis, presented here, shows favorable classification results based on statistical approach and neural-networks algorithms using a limited population. Following a successful feasibility test of visual classification of this population, a monitored experiment on 450 White Leghorn eggs from a young flock (24 wks of age) was conducted. The eggs were measured on d 0, 1, 2 and 10 by reflectance spectrometry (ASD Fieldspec) with a dual-beam finger probe. The data set underwent PCA discrimination using the Unscrambler platform and a neural-network classification model formulated for fertility and gender. Actual fertility was measured on the 10th day of incubation, and actual sorting of gender was conducted at hatch. Actual and predicted results comparison indicated that prediction capability is over 95% for fertility tested on d 0 and 90% for gender detection on d 10. We conclude that the reflectance spectroscopy method is adequate for detection of fertility in freshly laid eggs, and that of gender at mid incubation period.

Key Words: enbryo, fertility, gender, reflectance spectroscopy

370 Fasting reduces luteinizing hormone secretion and central galanin-like peptide expression but stimulates gonadotropin inhibitory hormone expression in the hypothalamus of the Pekin drake. E. Gerometta, S. Colton, E. Coombs, and G. S. Fraley*, *Hope College, Holland, MI.*

Pekin ducks are seasonal breeders that are also very sensitive to nutritional status. It is known that fasting reduces reproductive hormone

secretion, however the neurobiology underlying this effect is not clear. The purpose of this study was to first confirm that fasting reduces plasma luteinizing hormone (LH) levels in male ducks. Second we set out to determine if the reduced LH levels were associated with changes in the hypothalamic expression of 2 peptides known to regulate feeding and reproduction, galanin-like peptide (GALP) and gonadotropin inhibitory hormone (GnIH). Groups of adult male Pekin ducks (~60 weeks of age) were either fed or fasted for 17, 24 or 48 h (n = 6 per group). At the end of each time point, drakes were euthanized by cervical dislocation and blood collected for plasma determination of LH levels. Brains were removed and processed for immunocytochemical detection of fos-, GALP-, and/or GnIH-immunoreactivity (ir). Circulating LH levels were significantly ($P < 0.05$) reduced after 24 h of fast. A significant increase ($P < 0.01$) in fos-ir was found in the hypothalamic paraventricular nucleus (PVN) in fasted drakes compared with fed controls. Many of the fos-ir neurons within the PVN also colocalized GnIH-ir. There was virtually a complete loss of GALP-ir in the infundibular nucleus (INF) in fasted compared with fed drakes. These data suggest that GALP and GnIH neurons are important mediators between the feeding and reproductive systems in Pekin drakes.

Key Words: GALP, GnIH, seasonal breeder, hypothalamus, food intake

371 The maintenance of reproductive status in Pekin drakes requires both red and blue wavelengths of light: relationship to opsin-related proteins in the hypothalamus. G. S. Fraley*[1] and W. J. Kuenzel[2,3], *[1]Hope College, Holland, MI, [2]University of Arkansas, Fayetteville, [3]Center of Excellence for Poultry Science, Fayetteville, AR.*

In birds, neither bilateral enucleation nor pinealectomy appear to affect seasonal changes in hypothalamic-pituitary-gonadal activation. Thus in birds there is compelling evidence that photoresponsiveness is mediated in part by neurons that express photosensitive pigments. These neurons have been referred to as deep brain photoreceptors (DBPs). Some success in identifying putative DBPs has come from using anti-opsin antibodies. Two of these opsin-related proteins, opsin and melanopsin, have been identified in avian brains. Pekin ducks are seasonal breeders and as such, very sensitive to artificial and natural light. The purpose of these studies was to determine if specific wavelengths of light are necessary to maintain plasma luteinizing hormone (LH) secretion and to determine the hypothalamic circuitry underlying this effect. First, drakes were exposed to full spectrum, white light or red (~625 nm) or blue (~450 nm) light and blood samples were taken at intervals around lights-on. We found that neither red nor blue wavelengths of light could maintain circulating LH levels compared with that of drakes housed under full spectrum white light. Second, drakes housed under white lights and brains processed for immunocytochemstry using an opsin (RET-P1) or melanopsin antibody showed opsin-ir in the lateral septal area (LS) and infundibular nuclei (INF), both loci colocalized with vasoactive intestinal polypeptide. Melanopsin-ir was observed in the premammillary nucleus (PMM) and colocalized with tyrosine hydroxylase. Immunoreactive fibers for both opsin- and melanopsin were observed throughout the septum and anterior diencephalon and found to be in close contact with gonadotropin releasing hormone cell bodies. Third, a significant ($P < 0.01$) increase in fos-ir was observed in all 3 nuclei (LS, INF and PMM) in drakes exposed to white light compared with dark conditions. These data suggest that multiple opsin-related peptides within the basal forebrain and diencephalon may be necessary to maintain photoresponsiveness in Pekin drakes.

Key Words: testicular development, brain, photosensitivity, luteinizing hormone

372 Genetic selection for parthenogenesis in virgin quail hens impact embryonic mortality and hatchability following mating. H. M. Parker*, A. S. Kiess, J. B. Wells, M. L. Robertson, and C. D. McDaniel, *Mississippi State University, Mississippi State, MS.*

Unfertilized bird eggs are capable of developing embryos by parthenogenesis, which can be controlled by genetic selection. However, it is unknown if genetic selection for parthenogenesis affects embryonic development and hatchability of fertilized eggs. Additionally, most parthenogenic development resembles early embryonic mortality in fertilized eggs during the first 2–3 d of incubation. Therefore, it is possible that many eggs classified as containing early dead embryos may actually be unfertilized eggs that contain parthenogens. The objective of this study was to determine if genetic selection, for parthenogenesis in virgin hens, would impact embryonic development and hatchability after mating. Based upon their ability to produce unfertilized eggs that exhibited at least 10% parthenogenesis, 307 virgin Chinese Painted quail hens were utilized across 5 generations of selection. In the first generation (P), random males were selected for mating. However, for subsequent generations (F_1 to $_{F5}$), males whose sisters or mothers exhibited parthenogenesis were mated to hens so that fertility, embryonic mortality, and hatchability could be evaluated. Early embryonic mortality was divided into 2 groups: ≤ 7mm (small early dead embryos, possible parthenogens) and >7 mm (large early dead embryos). After the F_1 generation of selection, hatch of eggs set and hatch of fertile eggs decreased. The P generation had fewer possible parthenogens than did the F_5 generation, yet both generations were similar for large early embryonic mortalities, middle deads, and cracked eggs. The P generation had more late embryonic mortality and contaminated eggs than the F_5 generation. Fertility was not different across generation of selection, perhaps because many unfertilized eggs that exhibited parthenogenesis resembled early embryonic mortality and therefore were classified as early embryonic mortality. In conclusion, virgin quail hens that were selected for the parthenogenetic trait appear to have impaired hatchability and early embryonic development following mating.

Key Words: parthenogenesis, hatchability, embryonic mortality, quail, genetic selection

373 Induced deep pectoral myopathy and broiler plasma creatine kinase. R. J. Lien*, S. F. Bilgili, and J. B. Hess, *Auburn University, Auburn, AL.*

The objectives were to determine if broiler plasma creatine kinase (CK) levels change due to deep pectoral myopathy (DPM) induced by encouraged wing flapping (EWF), if basal CK is related to susceptibility, and if CK after early EWF is related to susceptibility. In trial 1, 40 broilers were subjected to EWF at 51 d. Plasma CK was determined 3 d before and 1, 2, 4, 8 and 13 d after EWF. At 64 d, DPM was assessed. In trial 2, 120 broilers had basal CK determined at 45 d, were subjected to EWF at 49 d, and were sampled to determine CK at 52 d. At 56 d, DPM was assessed. In trial 3, 120 broilers were subjected to early EWF at 22 d, which is before DPM can be induced. At 24 d, CK was determined. At 38 d, DPM was induced by EWF, and DPM was assessed at 42 d. Plasma CK was determined using a Roche auto analyzer. Data were analyzed by ANOVA with $P < 0.05$. In trial 1, CK 3 d before EWF was 13,500 IU/L. One d post EWF, CK was 401,150

IU/L in broilers that developed DPM and greater ($P = 0.0033$) than the 62,333 IU/L in those that did not. Plasma CK returned to basal levels 8 d post EWF in broilers that developed DPM, and 2 d post EWF in those that did not. In trial 2, CK before EWF was 43,302 IU/L and did not differ ($P = 0.6735$) between broilers that developed DPM, and those that did not. After EWF, CK was 185,966 IU/L and greater ($P < 0.0001$) in broilers that developed DPM than the 69,573 IU/L in those that did not. In trial 3, basal CK at 24 d in birds not subjected to EWF was 3,636 IU/L. In birds that developed DPM due to subsequent EWF at 38 d, CK at 24 d (2 d after early EWF) was 6,411 IU/L and similar ($P = 0.1607$) to the basal level. However, in birds that did not develop DPM due to subsequent EWF at 38 d, CK at 24 d (2 d after early EWF) was 9,506 IU/L and greater than the basal level ($P = 0.0061$) and that of birds that developed DPM due to subsequent EWF ($P = 0.0148$). Results indicate CK is increased more in broilers that develop DPM than in those that do not, that basal CK does not appear to be related to susceptibility, and that a reduced CK response to early EWF may indicate susceptibility.

Key Words: broiler, deep pectoral myopathy, creatine kinase

374 Effect of linseed oil on egg yolk cholesterol and performance of laying hens. G. M. K. Mehaisen*[1], A. Abbas[1], A. M. H. Ahmed[2], and A. Galal[2], *[1]Cairo University, Giza, Egypt, [2]Ain Shams University, Cairo, Egypt.*

This study aimed to investigate the effect of linseed oil as a natural source rich in omega-3 fatty acids on egg yolk cholesterol and performance of laying hens. A total of 180 commercial Hy-Line brown laying hens were randomly divided into 4 groups and were fed for 28 d on control diet and diets containing 2, 4 and 6% linseed oil. Egg production performance and feed consumption were recorded during 42 d of the study. Blood and egg samples were collected from laying hens at 14, 28 and 42 d of the experiment to measure the total protein, albumin, globulin, calcium and phosphorus in plasma as well as yolk cholesterol concentration in eggs. Results revealed that egg production performance was significantly improved by supplementation of linseed oil in the diets (egg number was 39.07 vs. 37.78 eggs/hen and egg mass was 2432.29 vs. 2358.13 g/hen for linseed groups vs. control group, respectively, $P < 0.05$). Feed consumption was significantly ($P < 0.05$) lower in linseed groups than in control group (110.78 vs. 121.05 g/hen/day), and consequently, the feed conversion ratio decreased (2.05 vs. 2.31). Plasma protein, albumin, globulin, calcium and phosphorus were not influenced by the linseed oil levels in the diet. Egg yolk cholesterol significantly decreased by linseed supplementation (11.57, 11.18 and 10.98 mg/g cholesterol in 2%, 4% and 6% linseed oil groups vs. 12.80 mg/g cholesterol in control group, $P < 0.05$). Therefore, the dietary supplementation of linseed oil in chicken diets as natural source of omega-3 fatty acids is healthier for egg consumers.

Key Words: laying hens, linseed oil, egg production, yolk cholesterol

375 The effect of breeder ages and egg sizes on yolk absorption and embryo development. A. Nangsuay*[1], Y. Ruangpanit[1,2], R. Meijerhof[3], and S. Attamangkune[1], *[1]Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom, Thailand, [2]Poultry Research and Development Center, Suwanvajokkasikit Animal R&D Institute, Nakhon Pathom, Thailand, [3]Poultry Performance Plus, Voorst, the Netherlands.*

An experiment was conducted to study the effect of breeder age and egg size on yolk absorption and embryo development. Four thousand eight hundred Ross 308 hatching eggs were subjected to 4 treatments in a 2 × 2 factorial randomized complete block design using 2 breeder ages (29 and 53 weeks of age or young and old) and 2 egg sizes (57–61 g and 66–70 g or small and large), with 8 replicates per treatment. The results indicate that yolk weight increased with flock age, whereas an increase in egg size resulted in higher albumen content. A significant interaction between breeder age and egg size at d 7 was observed, resulting in higher yolk free body (YFB) weight of embryos originating from large eggs of the old flock than from the young flock. This interaction disappeared at later stages of incubation. Until 14 d of incubation, eggs of the old flock yielded embryos with bigger YFB than those of the young flock. At hatch, chicks of both age groups had comparable wet YFB weight, chick weight, wet and dry residual yolk (RY) weight and chick length. Dry YFB weight was higher for chicks originating from the old flock than from the young flock. Embryos and chicks of the large egg group had bigger YFB from d 14 to hatching than those originating from the small egg group. At hatch, these chicks were also heavier, longer and had higher wet and dry YFB and RY weight. Yolk absorption at d 18 and at hatch was higher for embryos and chicks originating from the old flock compared with those of the young flock, both in absolute values and as percentage of initial yolk weight. Yolk absorption at 18 d of incubation both in absolute values and as percentage of initial yolk weight as well as percentage of initial yolk weight at hatch, of embryos and chicks of the small eggs was higher than that of the large eggs. In our experiment, egg size was the determining factor for embryo development expressed as YFB weight, chick weight and chick length at hatch. Yolk availability and yolk absorption did not influence chick YFB weight, chick weight and chick length, but tended to influence dry YFB weight.

Key Words: breeder age, egg size, yolk absorption, embryo development

376 Effects of in ovo injection of carbohydrates on somatic characteristics of broiler embryos and hatchlings. W. Zhai*[1], P. D. Gerard[2], and E. D. Peebles[1], *[1]Mississippi State University, Mississippi State, MS, [2]Clemson University, Clemson, SC.*

Increased carbohydrate injection volume has been shown to be positively related to broiler hatchling BW but negatively related to hatchability. Also, yolk absorption has been found to be reduced by the provision of certain external supplemental carbohydrates to embryos at high volumes. However, a low injection volume (0.4 mL) has recently been found to be non-detrimental to hatchability. In the current study, effects of the in ovo injection of 0.4 mL of various carbohydrate solutions into the amnion on d 18 of incubation on the somatic characteristics of Ross × Ross 708 broiler embryos and hatchlings were investigated. Embryonated eggs were injected with the following carbohydrates dissolved in commercial diluent using an automated multiple-egg injector: 1) 6.25% glucose, 18.75% dextrin (G+D); 2) 6.25% sucrose, 18.75% dextrin (S+D); 3) 6.25% maltose, 18.75% dextrin (M+D); and 4) 25% dextrin. A non-injected control, and commercial (0.1 mL diluent-injected) and experimental (0.4 mL diluent-injected) treatment controls were also included. In comparison to non-injected controls, chick BW relative to set egg weight (SEW) was increased by the injection of 0.4 mL of diluent, G+D, S+D, or M+D, but was not affected by dextrin. In addition, d 19 embryo BW relative to SEW increased in all carbohydrate injection groups as compared with the non-injected control, and embryo yolk free BW (YFBW) relative to SEW increased in the G+D and dextrin groups as compared with the

non-injected and commercial control groups. Yolk sac moisture in the groups that received carbohydrate, except for the M+D group on d 19, was higher than that of the non-injected control group. Nevertheless, hatchling yolk sac weight and YFBW were not affected by any injection treatment. In conclusion, the injection of 0.4 mL of various carbohydrate solutions may improve chick BW and yolk water content without detrimentally affecting yolk nutrient absorption and deposition into embryo body tissues.

Key Words: BW, carbohydrate, embryogenesis, in ovo injection, yolk sac

377 Aflatoxins and reproductive performance of two broiler breeder genotypes. A. Scher[1], A. P. Rosa*[1], J. M. Santurio[2], A. Londero[1], and L. S. Boemo[1], *[1]Poultry Laboratory, Universidade Federal de Santa Maria, RS, Brazil, [2]Lapemi, Universidade Federal de Santa Maria, RS, Brazil.*

The objective of this study was to determine the effect of aflatoxins (AFL) exposure on reproductive aspects of 2 broiler breeder genotypes. The experiment was carried out at The Federal University of Santa Maria – Brazil. 660 broiler breeder females and 60 males were submitted to intoxication with AFL (AFB1:86%, AFB2: 8.5%, AFG1:3.8%, AFG2: 1.7%) from the 24th to 64th week. To evaluate hatchability, hatchability of fertile eggs, fertility and embryo mortality were performed weekly incubations with all the hatching eggs produced in each week. The experimental design was in a CRD in factorial arrangement with 3 levels of AFL (0.0, 0.50 and 1.0 mg/kg diet) and 2 breeders' strains (A and B), totalizing 6 treatments with 5 replicate pens of 22 females and 2 males each. The intoxication with aflatoxins did not affect the hatchability and fertility. However, hatchability of fertile eggs was depreciated from 93.36% to 92.14% and total embryo mortality was increased from 5.16% to 6.20% when the breeders received diets containing 1.0 mg AFL/kg. AFL did not affect embryo mortality in the early and middle stages of incubation, but in the period of d 15 to 21d of incubation, eggs from breeders intoxicated with 1.0 mg AFL/kg in the diet showed higher embryo mortality rates. The strain A showed the highest hatchability rate (84.15%) when compared with strain B (77.77%), fertility (91.17 vs. 83.12%) and embryo mortality (5.82 vs. 5.31%). However hatchability of fertile eggs was increased in the strain B breeders (93.57 to 92.29%). In the fertility study was observed an interaction between the AFL levels and the evaluated strains ($P = 0.0620$). The fertility of the strain A was not affected by the AFL intoxication. In the strain B was observed a reduction in the fertility rate of eggs when the birds fed diets containing 0.5 or 1.0mg AFL/Kg. The studied levels of AFL can negatively affect important reproductive characteristics of broiler breeders.

Key Words: mycotoxins, hatchability, strains

Metabolism and Nutrition: Production, Dietary Manipulation and Manufacturing

378 Efeects of Canthaxanthin and 25-hydroxycolecalciferol on the productive performance of broiler performance from broiler breeders from 25 to 52 weeks of age. C. B. Santos[1], A. P. Rosa*[1], A. Scher[1], D. A. Alves[1], A. Bridi[1], and J. O. B. Sorbara[2], *[1]Universidade Federal de Santa Maria - Poultry Laboratory, Santa Maria, RS, Brazil, [2]DSM Nutritional Products, Sao Paulo, SP, Brazil.*

Chick embryo development is associated with an accumulation of polyunsaturated fatty acids in lipid tissues making them susceptible to lipid peroxidation. It has been accepted that canthaxanthin has high antioxidant capacity. Research findings have repeatedly indicated that feeding 25(OH)D3 (25-hydroxycholecalciferol), to poultry breeders, broilers and layers increased performance and health. Therefore, one experiment was conducted with the objective to evaluate a product called Rovimix MaxiChick (association of 6 ppm of canthaxanthin and 69 µg/kg feed of 25(OH)D3) to broiler breeders diets on their performance and hatchery parameters. It was used 264 females and 24 males COBB 500 broiler breeders with 25 to 52 weeks of age. The diets were based on corn and soybean meal. The treatments were: control diet and control diet with Rovimix MaxiChick. The parameters evaluated were body weight, laying rate, egg weight, specific gravity, percentage of albumen, yolk and shell, yolk color. Other parameters evaluated were the hatching rate, hatching of fertile eggs, fertility, embryo mortality, chick's weight and percentage of chicks of low quality. To evaluate the laying rate were performed 6 daily collections during the experimental period. Eggs collect a day of week were used for all others analysis. Non-hatched eggs were submitted to to embryo diagnostics. The addition of MaxiChick in diets of broiler breeders not affected the productive performance of birds and quality of eggs. Broiler breeders fed with MaxiChick had highest deposition of carotenoids in the yolk, also increase the hatchability ($P < 0.0075$) from 87.15 to 89.67%, hatchability of fertile eggs ($P < 0.0237$) from 91.63 to 92.60% and reduce the percentage of early embryo mortality (first 48 h of incubation) ($P < 0.0178$) from 1.42 to 1.04% during the total period evaluated. The number of contaminated eggs, average weight of chicks and the percentage of low chicks and fertility were not affected by the addition of products. In conclusion MaxiChick improve most of the reproductive parameter evaluated in this trial.

Key Words: carotenoid, carophyll, HyD, vitamin D

379 Mathematical models to optimize profit and define nutritional strategies for broiler chickens. D. E. Faria*[1], R. B. Araujo[2], C. G. Lima[1], W. F. Velloso Junior[1], K. M. R. Souza[1], and M. I. Sakamoto[3], *[1]Universidade de São Paulo (FZEA/USP), Pirassununga, SP, Brazil, [2]Novus do Brasil, Indaiatuba, SP, Brazil, [3]Universidade Anhanguera, Descalvado, SP, Brazil.*

This study was carried out to optimize economic outcome and define the best feed nutritional levels, based on AMEn, by using mathematical tools. 1080 d old males Cobb-500® were randomly distributed in 6 treatments with 6 replicates of 30 birds each. Diets were formulated to contain different nutritional density in each feed phase, based on metabolizable energy (AMEn), varying in steps of 100 kcal/kg from conventional treatment (T4 = nutritional levels near of Rostagno et al. (2005) requirements), reaching −300 kcal/kg (T1) and +200 kcal/kg (T6). Microsoft Excel was used to elaborate a program and, through Solver optimization tool, determine the best AMEn level in each feed phase to reach maximum gross margin, according to market prices and conditions: current prices for feed and broiler (Normal), feed cost 10% above (A), broiler price 10% below (B), and A+B. Feed intake (FI), feed conversion (FC) and feed price (FP) were calculated according to the average diet energy level. The equations were used to calculate revenues, cost and gross margin, as follow: Revenues = [initial broiler weight + (FI/FC)] x (broiler price); Costs = (FI x feed cost)/0.70; Gross margin = Revenues - Costs. According to Costs equation, feed consumption was considered as 70% of production cost. FI ($y = -1.6503x + 10927$, $R^2 = 0.76$) and FC ($y = -5.3467(10–4)x + 3.4775$, $R^2 = 0.94$) showed a linear trend at 49 d, while FP ($y = 3.8557(10^{-7})x^2 – 2.1532(10^{-3})x + 3.2979$; $R^2 = 0.99$) showed a quadratic trend. The nutritional levels that resulted in maximum gross margin in all market situations were below the recommendations (T4) and nearer T2. Profitability per broiler prediction ($y = -2.7712(10^{-6})x^2 + 1.6043(10^{-2})x – 23.0958$; $R^2 = 0.99$) showed a quadratic trend, what confirm the fact that the response of birds to diet nutritional density is a diminishing returns phenomenon and should be evaluated economically to estimate an economic optimum level rather than a biological maximum. So, computational modeling is presented as a tool to make decisions and to solve the complex problem of nutrient requirement estimation for poultry under different market conditions.

Key Words: avian, feeding programs, nutrition

380 Effect of maternal energy and protein on broiler carcass yield. T. G. V. Moraes*, A. Pishnamazi, E. T. Mba, R. A. Renema, and M. J. Zuidhof, *University of Alberta, Edmonton, AB, Canada.*

Protein and energy in broiler breeder nutrition can alter offspring carcass fat and protein. The current research was conducted to determine the effect of different ME and CP levels in broiler breeder diets during rearing and laying on broiler carcass yield. A 3 × 2 × 2 × 2 factorial arrangement of treatments was used. Ross 708 21-d-old broiler breeder pullets were fed 3 ME levels: high, standard, and low (2,950, HEr; 2,800, SEr; and 2,650, LEr, kcal/kg, respectively), combined with high (16%, HPr) or low (14%, LPr) CP levels. At 23 wk of age, 384 breeders were individually caged and fed laying diets from 25 wk with high (2,900 kcal/kg, HEl), or low ME (2,800 kcal/kg, LEl) combined with high or low CP (15.5%, HPl; or 14.5%, LPl, respectively). Hens were inseminated at 34 wk of age; 1,885 eggs were collected and pedigree hatched. A total of 1,400 eggs hatched and 881 chicks were placed sex separately according to their maternal laying phase diet and fed ad libitum. At 39 d, 300 broilers were processed and breast muscles (Pectoralis major and P. minor), legs and wings were weighed. ANOVA was performed using the MIXED procedure of SAS. Differences were reported when $P < 0.05$. The LEr x HPr interaction had higher P. major yield than SEr x LPr (16.3 vs. 15.7%) and both of these treatments had lower carcass yield than HEr x HPr (63.8 vs. 64.9%, respectively), whereas the other treatments did not differ. Males from the HPl treatment had higher carcass yield (64.2 vs. 63.4%, respectively) and heavier breast P. major yield (15.9 vs. 15.3%, respectively) compared to those from LPl treatment. Within LEl, LPl breeders produced females with higher P. major yield (16.8%) than HPl breeders (15.9%). In the LEl treatment, males from LPl breeders had reduced yields: 15% compared to 15.7% P. major in HPl; and 63% carcass compared to 64.5% in HPl. Male and female broiler yields

depended on the maternal diet. High protein in maternal laying phase diets increased P. major yield of male progeny.

Key Words: breeder, energy, protein, broiler, carcass

381 Effect of feeding low-density diets to Hy-Line W-36 laying hens on long-term production performance. S. A. dePersio*[1], K. A. Bland[1], K. W. Koelkebeck[1], C. M. Parsons[1], P. L. Utterback[1], C. W. Utterback[1], N. O'Sullivan[2], K. Bregendahl[2], and J. Arango[2], *[1]University of Illinois, Urbana, IL, [2]Hy-Line International, Dallas Center, IA.*

An experiment was conducted with 480 Hy-Line W-36 laying hens to determine whether feeding diets that varied in nutrient density would affect long-term egg production performance. At 18 wk of age, laying hens were weighed and randomly allocated to 6 replicate groups of 16 hens each (2 adjacent cages containing 8 hens per cage, 60.9 × 58.4 cm) in a randomized complete block design. Placement within house and initial bodyweight were used as blocking criteria. The hens were fed 5 treatment diets formulated to contain 85 (Trt 1), 90 (Trt 2), 95 (Trt 3), 100 (Trt 4), and 105 (Trt 5) % of the energy and nutrient recommendations stated in the 2009 Hy-Line W-36 management guide. Production performance was measured for 52 wk from 18 to 70 wk of age. Over the course of the trial, a significant linear response to increasing nutrient density was seen for average hen-day egg production (18–70 wks of age), with Trts 2 through 5 being 81.87, 81.28, 85.98, and 84.62%, respectively. From 18 to 70 wks of age, an increase in nutrient density showed a significant linear response in decreased feed efficiency [g egg/g feed], with Trts 2 through 5 being 0.47, 0.48, 0.49, and 0.50, respectively. From 18 to 70 wks of age, a significant linear response to increasing nutrient density was found for egg weight, with Trts 2 through 5 being 58.38, 59.15, 59.10, and 60.00, respectively. These results indicate that feeding Hy-Line W-36 hens diets formulated to contain lower nutrient density specifications (85% of control) than recommended may compromise production performance. Furthermore, increasing nutrient density in the diet of a laying hen will increase egg production, egg weight, and decrease feed efficiency. However, these benefits do not take effect in early production and seem to be most effective in later stages of the production cycle; perhaps â€˜primingâ€ the birds for better production.

Key Words: laying hens, low density diets, egg production

382 Evaluation of different levels of trypsin inhibitor and particle size of expeller-extracted SBM on broiler performance. W. J. Pacheco*, C. R. Stark, P. R. Ferket, and J. Brake, *North Carolina State University, Raleigh.*

Soybean meal is the major protein source in poultry and swine diets. Expeller soybean meal (ESBM) is what remains after the oil has been mechanically removed from whole soybeans. ESBM contains more fat, less protein than solvent-extracted SBM, but it contains higher trypsin inhibitor levels, which limits its inclusion in diets of young chicks. Tolerance to dietary trypsin inhibitor may be enhanced by increasing particle size of ESBM in the diet. This hypothesis was tested in a 16 d broiler growth performance trial evaluating 12 dietary treatments consisting of a factorial arrangement of 2 ESBM particle sizes (coarse 1,300 µm and fine 530 µm) and 6 ESBM trypsin inhibitor (TI) levels (6, 9, 12, 15, 18, 21 TIU/mg). The coarse and fine ESBM were produced by grinding the soy cake with different roll gap widths on a roller mill. A total of 672 male 1-d old broiler chicks were randomly assigned among 8 replicates per treatment and 7 birds per cage. The birds were fed a starter diet in crumble form. The pancreas, gizzard, and liver were excised and weighed at 16 d of age. The ESBM was analyzed for moisture, crude protein, crude fiber and crude fat, which were used to estimate the ME. The estimated ME content of ESBM was 3,2 kcal/g. BW and feed consumption were determined at 7, 14, and 16 d of age and feed conversion (FCR) was adjusted for weights of mortality. There was a quadratic effect on BW (659, 659, 673, 669, 652, and 645 g, $P < 0.01$) due to the level of TI; the highest BW was obtained when birds were fed 12 and 15 TIU/mg. Birds fed coarse ESBM were heavier at 16 d (666 versus 653 g, $P < 0.01$). There was no difference on FCR due to particle size and TI level at 16 d. The weight of the pancreas relative to BW increased linearly as the TI level increased ($P < 0.001$). The weight of the gizzard relative to BW was not affected by ESBM particle size. The results of this experiment indicated that birds performed better when fed coarse ESBM with 12 and 15 TIU/mg, which could indicate poor protein digestion at high TI levels and damage to amino acids due to overcooking of the ESBM at low TIU/levels.

Key Words: trypsin inhibitor, expeller, particle size, gizzard, pancreas

383 Evaluation of the CYP1A1 and CYP2H1 gene expression in liver tissue of broilers fed with different concentrations of dietary aflatoxin. R. Kakani*, J. Fowler, S. Kallur, A. Haq, M. J. Bailey, and C. A. Bailey, *Department of Poultry Science, Texas A&M University System, College Station.*

Cytochrome P450 (CYP, CYP450) genes are involved in the biotransformation of aflatoxin B1 (AFB1) into the highly toxic metabolite known as aflatoxin-8,9-epoxide (AFBO) in chicken hepatic tissue. The current study aims at evaluating the expression of 2 such CYP genes involved in biotransformation of AFB1 namely CYP1A1 and CYP2H1 in broiler birds receiving different concentrations of dietary aflatoxin. A total of 60 d old broiler birds (Ross x Cobb) were used to test lowest levels of aflatoxin at which the 2 CYP genes (CYP1A1 and CYP2H1) would get expressed. All birds were randomly allocated to 6 dietary treatments with 2 replications per treatment and fed broiler starter feed with no aflatoxin for the first 3 d. Basal broiler starter diet was prepared using aflatoxin contaminated yellow dent corn at a dietary aflatoxin concentration of 0, 300, 500, 1000, 2000 and 4000 ppb in the final feed and being fed for a period of 13 d. Birds were sacrificed on d 17 and liver samples were collected by flash-freezing them in liquid nitrogen for studying the expression of the genes CYP1A1 and CYP2H1 using Polymerase Chain Reaction (PCR) technique. RNA samples were extracted from 3 liver samples per treatment selected randomly. cDNA was prepared from the RNA (High Capacity cDNA Reverse Transcription Kit, AB system). Primers (reverse and forward) specific to each CYP gene were used for conducting PCR (PCR Super mix, Invitrogen) and the products were run on a 2% gel. Evidences in the literature reported that significant differences in the growth response were seen in birds when the dietary aflatoxin concentration was more than 1000 ppb. All our preliminary data indicates that CYP1A1 and CYP2H1 genes are transcribed in all the treatment groups indicating that the birds are sensitive to AFB1 at concentrations as low as 300 ppb of aflatoxin.

Key Words: aflatoxin, broilers, liver, gene expression

384 Evaluation of roller mill ground corn inclusion on broiler performance and digestive tract development. Y. Xu*, C. R. Stark, and J. Brake, *NC State University, Raleigh.*

Previous research has shown that the addition of coarse ground grain improved broiler performance and increased gizzard weight. A 14-d cage study was conducted to evaluate the effect of percentage coarse ground corn on broiler performance. A total of 672 d-old male broiler chicks were used in a factorially arranged randomized complete block design with 2 feed forms (mash and crumble) and 6 coarse corn levels (0, 10, 20, 30, 40, and 50%) with 8 replicate pens per treatment and 7 birds per pen. A portion of the corn and all soybean meal was ground with a hammermill (3.4 mm screen) while the coarse corn was ground with a roller mill. The average particle size of the final diets was 422, 431, 471, 509, 542, and 560 µm when 0, 10, 20, 30, 40, and 50% coarse corn was added to the diets, respectively. Feed consumption and BW were determined at 7 and 14 d of age and adjusted feed conversion ratio (AdjFCR) was calculated by including BW of all dead birds. The 14 d BW of the birds fed the crumbles as compared with mash was greater (661 versus 534 g). The addition of coarse corn to the mash diets decreased BW but did not change BW in the crumble diets, thus creating an interaction. Birds fed crumbles had improved AdjFCR compared with mash (1.29 versus 1.37). The addition of coarse particles in the mash diet resulted in poorer AdjFCR but showed no effect in the crumble diet. Fecal nitrogen (N) and gizzard weight relative to BW was calculated at 14 d. The birds fed mash feed had larger gizzards (2.3 versus 1.8%) and the addition of coarse corn resulted in a linear increase in gizzard weight. Fecal N was lower in the mash compared with the crumble diets (3.14 versus 3.23%). However, fecal N increased in the mash diet but tended to decrease in the crumble diets as the overall particle size of the diet increased. The results of the study confirmed that young broilers perform better when fed diets in crumble form and coarse particles increase gizzard weight.

Key Words: roller mill, particle size, broiler, pellets, gizzard

385 Interactive effects of feed form and dietary lysine on growth responses of commercial broiler chicks. L. Mejia*[1], C. D. McDaniel[1], J. S. Moritz[2], and A. Corzo[1], *[1]Mississippi State University, Mississippi State, MS, [2]West Virginia University, Morgantown.*

Dietary Lys requirement estimates have been estimated for various genotypes, sex, environmental conditions and growing phases. Previous studies have shown how older broilers can be affected by feed form, particularly as it relates to not allowing these birds to express their full growth potential. In this study, the interactive effects of dietary Lys concentration and feed form were evaluated in broiler male chicks. Broilers were given one of 3 possible feed forms (mash [M], mash exposed to conditioner steam [C], and pellet in the form of crumbles [P]), and one of 5 possible graded levels of true digestible Lys (0.85, 0.95, 1.05, 1.15, and 1.25%), from hatch until 18 d of age. The study comprised a 3 × 5 factorial arrangement of treatments where feed form and dietary Lys were the factors evaluated, with 15 treatment combinations being represented by 8 replicate floor pens (15 chicks/pen), for a total of 120 floor pens. Results showed that Lys and feed form interacted for BW gain and feed conversion, showing that M-fed birds were able to attain BW gain and feed conversion values similar to those in the C- and P-fed chicks but only when Lys was fed at the highest level ($P < 0.05$). Regression analysis revealed that BW gain and feed consumption of chicks fed the P diets responded much quicker to increasing dietary Lys levels than those fed the M and C diets, and chicks fed the P diets also achieved their optimum response with less dietary Lys. In addition to quickly reaching a maximum response for BW and feed consumption, chicks fed the P diets also obtained a higher projected BW gain accretion and feed consumption. In contrast, BW gain, feed consumption, and feed conversion were decreased in chicks fed mash diets. Blood plasma analysis of total protein and albumin further corroborate the response observed by the chicks fed M diets ($P < 0.05$), but uric acid and blood glucose were shown to be unaffected. Overall, data emphasizes the need to achieve optimum feed form quality as a way to avoid feeding excessive dietary Lys concentration, in turn allowing broiler chicks to express their full growth potential much easier.

Key Words: lysine, pellet quality, feed form

386 Choice feeding under heat stress conditions in broilers from 15 to 35 days of age. A. Helmbrecht*[1], T. G. Madsen[2], S. Srinongkote[3], and A. Lemme[1], *[1]Evonik Degussa, Health & Nutrition, Hanau, Germany, [2]Evonik Degussa, Health & Nutrition, Singapore, [3]Bangkok Animal Research Centre, Bangkok, Thailand.*

Breeder companies recommend nutrient compositions for each broiler strain and phase to optimize performance. However, due to the heat stress in hot and humid climates, it is often difficult to meet these recommendations. Additionally, there are questions whether broilers would prefer a higher or a lower concentration of amino acids (AA) in an isoenergetic diet as a means to mitigate the impact of heat stress. To test this, two isoenergetic diets were calculated to meet the requirements of birds from 14 to 35 days of age except for AA, which were formulated to meet 90% or 110% of Evonik's recommendations (2010). 360 male Arbor Acres Plus broiler chicks were randomly allocated to 2 treatments fed one of the experimental diets exclusively and in a 3rd treatment birds were given the choice between both diets, with 12 replicates and 10 birds/pen. The experiment was conducted in Thailand during the hot and humid months of April and May. A commercial starter diet adequate in all nutrients was fed from day of hatch to d 13. Birds were raised on floor pens equipped with 2 feeders and 2 nipple water drinkers each. Feed and water were provided ad libitum. Humidity during the trial was between 42.5 and 58.5%, ambient temperatures varied between 29.5°C and 30.5°C during day and 26.0°C and 30.5°C during night, representing a clear heat stress situation for the broiler chickens. Although diets were calculated iso-energetic with table values, an additional determination of apparent metabolizable energy corrected for nitrogen (AMEn) showed significant differences between both diets (3309 vs. 3122 kcal/kg; $P < 0.05$), which probably resulted from an adaption of metabolism to heat stress. Under the tested heat stress conditions broilers given a choice between a lower or a higher AA density significantly prefer the lower one (feed intake 1467 vs. 1243 g; $P < 0.05$). Body weight improved significantly with lower AA compared to higher AA density (1552 vs. 1489 g; $P < 0.05$). However, the diet with higher AA density allowed for a significantly higher breast meat deposition (348 vs. 339 g; $P < 0.05$).

Key Words: broiler, heat stress, amino acids, choice feeding

387 Performance of female broilers fed different feeding programs. D. E. Faria*[1], M. Pavesi[1], D. E. Faria Filho[2], C. G. Lima[1], W. F. Velloso Junior[1], V. S. Nakagi[1], and B. L. U. Schmidt[1], *[1]Universidade de São Paulo (FZEA/USP), Pirassununga, SP, Brazil, [2]Universidade Federal de Minas Gerais, Montes Claros, MG, Brazil.*

This study was conducted to evaluate the performance characteristics of female broilers fed different feeding programs at 35, 42, and 49 d of age. 1080 d old females Cobb-500® were randomly distributed in 6 treatments with 6 replicates of 30 birds each. Diets were formulated to contain different nutritional density in each feed phase, based on

metabolizable energy (AMEn), according to Rostagno et al. (2005) requirements (T1 – 85%, T2 – 90%, T3 – 95%, T4 – 100%, T5 – 105%, and T6 – 110% of recommendations). Performance characteristics evaluated were feed intake (FI), weight gain (WG), feed conversion (FC), viability (V) and productive efficiency index (PEI). Feed intake of the birds fed feeding program T6 had significantly lower values compared with other programs for all ages. At 35 d of age, feeding programs T4 and T5 showed higher values for WG, however, at 42 and 49 d of age, the feeding programs with higher values for WG were T4, T5, and T6. Regarding the characteristics FC and PEI, for 35 and 42 d of age, the programs T5 and T6 had significantly higher values. At 49 d of age, the feeding program T6 showed the highest values compared with other programs for both characteristics. Viability was not influenced by the feeding programs. In general, feeding programs containing highest densities showed higher values for performance characteristics.

Key Words: avian, nutrition, profitability

388 Resolving pellet quality issues and improving turkey poult performance with the manufacture of commercial turkey diet formulations. K. G. S. Lilly*, L. K. Shires, B. N. Swiger, A. M. Evans, K. J. Shipe, and J. S. Moritz, *West Virginia University, Morgantown.*

High throughput and high fat inclusion in commercial turkey diets decreases pellet quality. This necessitates feed manufacturers to address these factors to realize the potential of feeding high quality pellets. In previous research at West Virginia University, a lignosulfonate binder was added to a commercial turkey diet that was pelleted using 3% mixer-added fat (MAF) at our pilot feed mill. This manufacturing technique improved manufacturing variables and the digestibility of several amino acids when fed to cecectomized roosters. The objective of this study was to explore similar manufacturing effects in a commercial feed mill and to examine these effects on turkey poult performance. Four dietary treatments were arranged in a 2x2 factorial design having variations in amino acid density (AAD) (normal or high) and manufacturing technique (3% MAF and binder or 1% MAF and sand). Total fat additions were similar and adjusted via post-pellet. Crumbled diets were assigned to one of 16 pens arranged in a randomized complete block design that contained 105 10-d-old male poults. Diets were fed from 10 to 38d with poult weight and feed intake recorded weekly. On d 39, poults were weighed individually and on d 40, 25poults/pen were randomly selected for breast extraction. Descriptive data from the mill indicated that diets manufactured utilizing 3% MAF and binder inclusion created comparable feed quality to those using 1% MAF and sand. A significant AAD x Technique interaction was established on d 39, demonstrating the highest average poult weight for birds fed High AAD, manufactured using 3% MAF + Binder. Significant differences were also recorded for the main effect AAD, demonstrating that poults fed High AAD diets had higher d 40 average live poult weight (of 25 poults randomly chosen for extraction), pectoralis major weight, and total breast weight. Our previous research that found improved amino acid digestibility when using the same binder and 3% MAF may explain the performance differences observed in the current study for 1–39 d male turkey poults.

Key Words: pellet quality, turkey diets, mixer-added fat, pellet binders, poult performance

389 Effects of feed manufacture techniques that vary feed exposure to pellet die heat and pressure on pellet quality and subsequent broiler lysine utilization. K. J. Shipe*, A. M. Evans, K. G. S. Lilly, L. K. Shires, B. N. Swiger, and J. S. Moritz, *West Virginia University, Morgantown.*

The objective of this study was to identify feed manufacture techniques that alter lysine availability as indicated by feeding broilers in the finishing phase. Feed production rate, pellet die specification, and level of mixer-added fat (MAF) influence feed exposure to pellet die heat and pressure that may alter chemical structures of ingredients. Lysine has been indicated as a nutrient with potential to be structurally altered, especially in the presence of heat and reducing sugars, as in Maillard reactions, that decreases nutrient availability. A practical diet containing 7.5% bakery by-product meal and 0.13% lysine HCL was formulated to 90% lysine recommendations of Cobb-Vantress to best demonstrate lysine availability differences when manufactured and fed. This diet was utilized in a 2x2x2 factorial design that evaluated the effects of production rate (0.5 or 0.8 tonne/hr), die thickness (38.1 or 44.5 mm), and MAF level (0.5 or 3%) on feed manufacture, broiler performance, and processing yield. Two additional treatments: unprocessed mash and double pelleted (exposed twice to 0.5 tonne/hr production using a 44.5mm die after 0.5% MAF) were also manufactured and fed. All diets, excluding mash, were steam conditioned at 82oC and reground before feeding. Pellet mill electrical energy usage, pellet quality, and bulk density were increased with 0.5 tonne/hr production rate, 44.5 mm pellet die, and 0.5% MAF techniques ($P = 0.0001$) that created greater feed exposure to pellet die heat and pressure. Regardless of these effects, upon feeding, no differences in performance or processing yield were observed among treatments in the factorial structure ($P > 0.05$). Contrasts demonstrated that mash fed birds had decreased FCR compared with double pelleted fed birds, with birds fed diets from the factorial treatments being intermediate ($P < 0.05$). These data suggest that pelleting in general had deleterious effects on nutrient availability that could not be identified by varying feed exposure in the die. It was unclear whether or not lysine or other nutrients were affected.

Key Words: lysine, feed manufacture, pellet quality

390 Broiler breeder composition restriction. 1: Do attempts to shift body composition using dietary protein and energy affect early production traits? A. Pishnamazi*, E. T. Mba, T. G. V. Moraes, R. A. Renema, and M. J. Zuidhof, *University of Alberta, Edmonton, AB, Canada.*

The effectiveness of a composition restriction program to limit muscle deposition and support early egg production traits was assessed between photostimulation (23 wk) and 33 wk of age in 432, Ross 708 breeder hens. A 3 × 2 x 2 × 2 factorial arrangement of treatments was used. A total of 1,186 pullets were housed in floor pens and from 21 d were fed 3 ME levels: high, standard, and low (2,950, HEr; 2,800, SEr; and 2,650, LEr, kcal/kg, respectively), combined with high (16%, HPr) or low (14%, LPr) CP levels. At 23 wk, 432 pullets were caged and from 25 wk fed breeder diets with high (2,900 kcal/kg, HEl), or low ME (2,800 kcal/kg, LEl) with high or low CP (15.5%, HPl; or 14.5%, LPl, respectively). Feed allocation changed every week based on BW compared with breeder targets. Individual BW, sexual maturation, and egg production and weights were recorded. At 27, 30 and 33 wk of age, 144 hens dissected and breast muscle, liver, abdominal fatpad, ovary and oviduct were weighed. Analysis of variance was performed using the MIXED procedure of SAS ($P < 0.05$). The LEl birds matured earlier than HEl pullets (186 vs. 188 d). Initial egg wt. of LEr birds was heavier than HEr pullets (51.2 vs. 49.4g). Pullets fed HEr×HPr×LEl reached consistent 52 g egg wt. 9 d earlier than

those on LEr×LPr×HEl. Overall, feeding a HE rearing or breeder diet led to higher relative fatpad wt. (2.05 vs. 1.88% and 1.99 vs. 1.83%, respectively). Birds on LEl×HPl had more breast muscle than those on LEl×LPl (24.3 vs. 22.4% of BW). Overall, the LEl×LPl hens had heavier ovary wt., yellow follicle wt., and number of large yellow follicles than HEl×LPl birds (58.9 vs. 49.8 g; 51.2 vs. 42.3 g; and 6.1 vs. 5.2, respectively). Feed intake was lower for HEl pullets that LEl birds (131.3 vs. 136.2 g/d) due to birds equalizing energy intake (HEl = 380.7, LEl = 381.4 kal/d). Crude protein intake was higher in LEl than HEl birds (20.4 vs. 19.7 g/d). Feed changed carcass fatness and muscling, and ovary development did not do well with lower protein intake. Nutrient needs change with age and need to be considered over the life of the bird.

Key Words: broiler breeder, CP, ME, ovary, breast muscle

Clostridium

391 The effect of probiotic and prebiotic in comparison with antibiotic on controlling necrotic enteritis in *clostridium perfringens* challenged broilers. H. Hoseinyan Bilandi[1], S. Rahimi*[1], A. Jabari[2], P. Khaki[2], and A. Haghrusta[2], *[1]Tarbiat Modares University, Tehran, Tehran, Iran, [2]Razi Vaccine and Serum Research Institute, Karaj, Alborz, Iran.*

This work was conducted to study the effect of probiotic and prebiotic in comparison with antibiotic on colonization of *C. perfringens* on broilers intestine. In this experiment 225 male chicks (Cobb-500) randomly distributed to 5 dietary groups of 3 replicates with 15 chicks/pen as follows: negative control group; positive control group; probiotic (Primalac); prebiotic (Fermacto); antibiotic (Virginiamycin). On d 14, all the birds except negative control group, were inoculated by oral gavage of sporulated oocysts of *E. acervulina, E. tenella* and *E. maxima*. At 18, 19 and 20 d of age, challenged birds were also gavaged with *C. perfringens* (10^8 cfu/mL; 1mL/bird). On d-21 and 42, one bird per pen was killed and contents from the cecum were collected and transferred into sterile bottles containing 10 mL of PBS. The suspension was blended and 6-fold serial dilutions were performed. *C. perfringens* were enumerated on Tryptose Sulfite Cycloserine agar after anaerobic incubation at 37°C for 24 h. Results indicated that the challenge depressed broilers growth. Body weight from 4 to 6 weeks of age was significantly higher in negative control group and antibiotic supplemented diets ($P < 0.05$). Experimental diets did not have any significant effect on feed conversion ratio at any period. The results indicated significant ($P < 0.05$) reduction in colonization of *C. perfringens* in the intestine of chickens due to dietary supplementation of probiotic and prebiotic. According to the results of this experiment, one can say that supplementation of Primalac and Fermacto in broilers diets can reduce colonization of *C. perfringens* and necrotic enteritis in broilers intestine.

Key Words: probiotic, prebiotic, antibiotic, *C. perfringens*, broiler

392 Toll-like receptors and cytokines profile of chicken challenged with *Clostridium perfringens* and fed organic diets supplemented with MOS. A. Yitbarek*, J. Brady, H. Echeverry, S. Sharif, B. Guenter, J. D. House, and J. C. Rodriguez-Lecompte, *University of Manitoba.*

AAAP abstract†

393 Histopathology, immunohistochemistry and cytokine responses in gangrene dermatitis-affected chickens. H. Lillehoj*, K. W. Lee, G. Li, S. I. Jang, S. H. Lee, D. Ritter, D. A. Bautista, A. P. Neumann, and G. R. Siragusa, *Agricultural Research Service, USDA.*

AAAP abstract†

394 Characterization of *Clostridium septicum* isolates from cellulitis cases in turkeys. A. J. Thachil*, A. Ghosh, D. A. Halvorson, and K. V. Nagaraja, *University of Minnesota, College of Veterinary Medicine, Saint Paul.*

AAAP abstract†

395 Dexamethasone model for cellulitis in turkeys. K. V. Nagaraja*, A. J. Thachil, A. Sasikala-Appukuttan, C. Heeder, and D. A. Halvorson, *University of Minnesota, College of Veterinary Medicine, Saint Paul.*

AAAP abstract†

396 Effects of yeast extract and vitamin D on turkey mortality and cellulitis incidence in a transport stress model. G. R. Huff*, W. E. Huff, and N. C. Rath, *USDA, Agricultural Research Service, Poultry Science Center, University of Arkansas, Fayetteville.*

AAAP abstract†

397 Use of a repeatable model creating significant clostridium dermatitis mortality in turkeys to determine management and other risk factors that affect the severity of the disease. S. Davis*, *Colorado Quality Research Inc.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Avian Influenza II

398 Pretreatment of chickens with interferon alpha reduces morbidity and virus shedding following low pathogenic avian influenza infection. D. R. Kapczynski* and H. Jiang, *USDA-ARS-SEPRL, Athens, GA.*

AAAP abstract†

399 Virus-specific antibodies interfere with avian influenza infection in peripheral blood mononuclear leukocytes from young or aged chickens. O. T. Bowen*, D. R. Kapczynski, M. J. Pantin-Jackwood, C. Cagle, and D. L. Suarez, *USDA-ARS-SEPRL.*

AAAP abstract†

400 Aerosol vaccination of chickens with baculovirus expressed virus-like particles induced immune response in chickens. J. Earnest*, R. O. Donis, M. Papania, M. J. Hossain, J.-M. Song, S.-M. Kang, R. W. Compans, G. Smith, H. S. Sellers, and E. Mundt, *Department of Population Health, The University of Georgia, Athens.*

AAAP abstract†

401 Towards the development of a virosome-based vaccine against avian influenza virus. S. Sharif*, R. Kulkarni, P. Parvizi, L. Read, E. Nagy, S. Behboudi, and A. I. Mallick, *University of Guelph, Guelph, ON, Canada.*

AAAP abstract†

402 Determination of efficacious vaccine seed strains for use against Egyptian H5N1 highly pathogenic avian influenza viruses through antigenic cartography and in vivo challenge studies. D. Eggert*, E. Spackman, M. Kim, C. Rue, D. J. Smith, L. M. O. Farag, N. Ahmed, A. A. Mohamed, M. Aly, M. Hassan, R. Fouchier, D. L. Suarez, and D. E. Swayne, *Southeast Poultry Research Laboratory, Athens, GA.*

AAAP abstract†

403 Virus versus vaccine: Variants of highly pathogenic avian influenza virus H5N1 from Egypt. C. Grund*, E. M. Abdelwhab, A.-S. Arafa, M. Ziller, M. K. Hassan, M. M. Aly, H. M. Hafez, T. C. Harder, and M. Beer, *Friedrich Loeffler Institute.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

POSTER PRESENTATIONS

Avian Influenza Posters

404 The effects of interspecies adaptation to different poultry on a wild bird origin H5N1 low path avian influenza viral genome. B. S. Ladman*, J. Gelb Jr., R. Slemons, C. R. Pope, and E. Spackman, *Department of Animal and Food Sciences & Avian Biosciences Center, University of Delaware, Newark.*

AAAP abstract†

405 Evaluation of cytokine gene expression after avian influenza virus infection in avian cell lines and primary cell cultures. C. Cagle*, O. Bowen, J. Wasilenko, and M. Pantin-Jackwood, *Usda Southeast Poultry Research Laboratory.*

AAAP abstract†

406 Replication of swine-lineage influenza virus in juvenile and adult turkey hens. C. W. Lee*, A. Ali, H. Yassine, M. Khatri, and Y. M. Saif, *The Ohio State University.*

AAAP abstract†

407 Natural infection of H5N1 avian influenza in budgerigars and zebra finches. G. S. Moussa*, *Assiut University, Egypt.*

AAAP abstract†

408 Highly pathogenic avian influenza H5N1 natural infection in domestic and free living water fowls in Egypt. G. S. Moussa*, *Assiut University, Egypt.*

AAAP abstract†

409 Breaks of H5N1 avian influenza in previously vaccinated chicken flocks. S. A.-A. Mousa* and O. K. Amen, *Assiut Univ. Egypt.*

AAAP abstract†

410 Sequencing of H5N1 virus circulating in Egypt. S. A.-A. Mousa* and O. K. Amen, *Assiut University, Egypt.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

411 Characterization of *Ornithobacterium rhinotracheale* from commercial chicken and turkey flocks in Russia. A. V. Chernyshev*, A. V. Sprygin, O. I. Ruchnova, N. S. Mudrak, O. V. Pruntova, and V. V. Drygin, *Laboratory of Molecular Diagnosis of Poultry Diseases, Federal Centre for Animal Health, Vladimir, Russia.*

AAAP abstract†

412 Prevalence of *Salmonella*, *Campylobacter* and *E. coli* in wild game birds 2009–2010 season. C. M. Logue*, J. S. Sherwood, R. Bergquist, and C. Sletten, *North Dakota State University.*

AAAP abstract†

413 Evaluation and validation studies of real-time PCR assay for the detection of *Chlamydophila psittaci*. H. Lu*, S. Myers, R. Schneider, and L. Lin, *Penn State University.*

AAAP abstract†

414 Characterization and distribution of avian pathogenic *Escherichia coli* isolates from broilers in Peru. C. Carranza*, A. Neumann, C. Kromm, N. Falcon, and R. Leon, *Technical Department of Innova Andina S.a., Lima, Peru.*

AAAP abstract†

415 Serum survival in avian pathogenic *Escherichia coli*. L. K. Nolan* and G. Li, *Iowa State University, College of Veterinary Medicine.*

AAAP abstract†

416 Characterization of attaching and effacing *Escherichia coli* (AEEC) isolated from poultry. T. Denagamage*, J. Blair, and S. Kariyawasam, *Department of Veterinary and Biomedical Sciences, The Pennsylvania State University, University Park.*

AAAP abstract†

417 Efficacy of BMD versus probiotics in the feed for the control of necrotic enteritis by *Clostridium perfringens* in broiler chickens. S. H. Miller* and S. W. Davis, *Alpharma.*

AAAP abstract†

418 Experience of using inactivated *Salmonella* vaccines for chickens, Salenvac and Salenvac T, in Europe. J. Schrader*, C. A. Pugh, C. F. Crouch, and M. J. Francis, *Intervet Schering Plough Animal Health.*

AAAP abstract†

419 Rapid detection of *Campylobacter jejuni* using quantum dots and nanobeads based optical biosensor. H. Wang*, Y. Li, and M. F. Slavik, *University of Arkansas, Fayetteville.*

Campylobacter jejuni is estimated to cause 2.1 to 2.4 million cases of foodborne illness in the United States each year. Some of the previous cases have been linked to eating or handling undercooked or raw poultry products. A rapid, specific method is needed to detect *C. jejuni* in real time to ensure food safety. The objective of this research was to develop a sensitive biosensor method for rapid detection of *C. jejuni* by using both magnetic nanobeads to separate and concentrate the target bacteria and quantum dots (QDs) as fluorescent markers. In this research, both streptavidin conjugated QDs 605 (15–20 nm diameter) and magnetic nanobeads (150 nm diameter) were separately coated with the specific biotin conjugated anti-*C. jejuni* antibody. The conjugated magnetic nanobeads then were mixed with a sample containing *C. jejuni*. After immunomagnetic separation, the magnetic nanobeads-*C. jejuni* conjugates were mixed with the conjugated QDs. Unattached conjugated QDs were removed using immunomagnetic separation. A spectrometer was used to measure the fluorescence of the complexes of magnetic beads-*C. jejuni* -QDs. The results showed that this method could detect *C. jejuni* in pure culture and chicken wash solution at a concentration of 2–3 cells/0.1 mL sample (20–30 cfu/ml). A linear co-relationship with $r^2 = 0.97$ was found between the fluorescence intensity and the concentration of *C. jejuni* in a range of 10^1-10^5 cfu/ml. The total detection time was less than 2 h. Based on the result of this study, it should be very possible to develop a sensitive biosensor instrument for applications in the rapid detection of *C. jejuni*.

Key Words: *Campylobacter jejuni*, optical biosensor, quantum dots, nanobeads, immunoseparation

420 Differences in pathogen colonization and mortality of genetically selected Japanese quail lines subjected to heat stress and *Escherichia coli* challenge. W. E. Huff*[1], G. R. Huff[1], I. V. Wesley[2], N. B. Anthony[3], N. C. Rath[1], and D. G. Satterlee[4], *[1]USDA/ARS/PPPSRU, Fayetteville, AR, [2]USDA/ARS/NADC, Ames, IA, [3]University of Arkansas, Fayetteville, [4]Louisiana State University, Baton Rouge.*

Japanese quail selected for divergent corticosterone response to restraint stress were evaluated for their resistance to heat stress and aerosol challenge with avian pathogenic *Escherichia coli* (APEC) to determine the impact of stress response on APEC pathogenesis and colonization with food-borne pathogens. These quail lines are designated as the high stress line (HS), low stress line (LS), and the random-bred control line (CS). Heat stress (35°C, 8h/d) was initiated at 24d until the end of the study. Birds were challenged with an aerosol spray containing $2x10^9$ cfu of *E. coli* at 25d and 32d. At 38d the birds were necropsied and the intestinal tract was screened for both *Salmonella* and *Campylobacter*. Body weights of the CS birds were higher than both HS and LS at 17d, 25d, and 32d, but there were no line differences at 38d. At 32d there was no difference in mortality between males and females and the CS line had significantly higher mortality compared with the LS line with the HS line being intermediate. At

38d, females of the CS line that were both heat stressed and challenged had a mortality incidence of 25%, which was significantly higher than male birds of the same line and treatment (5.3%) suggesting a change in susceptibility to heat stress and *E. coli* challenge in females coming into lay. While Campylobacter was not recovered, we observed an increased incidence in *Salmonella enterica* serotype Agona isolation in the intestine of quail subjected to heat stress, suggesting that a resident population of *Salmonella* is present in these quail lines. There was a differential effect of heat stress on *Salmonella* isolation from male and female quail suggesting that the additional stress of coming into lay may have confounded the female isolation data. Further work using this model will lead to an understanding of the influence of sex and stress hormones on host immunity, APEC pathogenesis, and pathogen colonization. The failure to isolate *Campylobacter* from these birds suggests that they will be useful for *Campylobacter* challenge studies.

Key Words: heat stress, genetics, *Escherichia coli*, *Salmonella*, quail

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

421 Onion consumption and bone density in laying hens. H. W. Cheng* and R. L. Dennis, *Livestock Behavior Research Unit, USDA-ARS, West Lafayette, IN.*

Onion and its flavonoid component, quercetin, increase bone density in rabbits, rodents, and humans. The purpose of this study was to determine whether there is a similar effect of onion on laying hens. Thirty-two Hy-line W36 White Leghorn hens at 30 weeks of age were randomly divided into 2 groups, i.e., control and treatment (n = 16). The hens were kept at 2-hen cages, each cage providing 658 cm^2 per hen. The hens were fed regular layer diet or layer diet containing 5% onion powder (by wt) for ad libitum consumption for 4 weeks. The hens were evaluated for body weight (BW) at wk 1, 2, 3, and 4; egg production and eggshell weight at wk 2 and 4; and blood calcium and bone mineral contents at wk 4. Data were analyzed using an ANOVA and repeated measures analysis when required. There was no differences in BW between the controls and treated hens from wk 1 to 3 ($P > 0.05$) while it was reduced in the treated hens at wk 4 ($P < 0.05$). Compare with the controls, both egg production and eggshell weight of the treated hens were increased at wk 2 ($P < 0.05$) but eggshell weight was reduced at wk 4 ($P < 0.05$). Blood calcium concentrations were lower at wk 4 in the treated hens compared with those of controls ($P < 0.05$). The weight of bone ash of the femur, tibia, and ulna was not affected by the onion supplement ($P > 0.05$); but the levels of phosphorus in the femur and ulna ash was higher for the treated hens ($P < 0.05$). These results indicate that onion consumption affects bone contents and metabolisms in laying hens. It provides signs for further investigating the effects of onion on stimulating bone plasticity in laying hens, especially in aged hens.

Key Words: onion, bone density, calcium, phosphorus, laying hens

422 Evaluation of heterophil lymphocyte ratio and relative asymmetry as welfare parameters for broiler breeders. M. J. Da Costa*[1], E. O. Oviedo–Rondón[1], P. E. Eusebio–Balcazar[1], V. Moraes[2], N. A. Barbosa[2], and K. Claassen[1], *[1]North Carolina State University, Raleigh, [2]Universidade Estadual Paulista, Jaboticabal, SP, Brasil.*

This study was conducted to evaluate the adequacy of heterophil lymphocyte ratio (H/L) and relative asymmetry (RA) as welfare parameters for broiler breeders. Samples and data from one breeder experiment with 198 observations were used. Treatments included broiler breeders of 2 strains (A, B) housed in 16 pens and fed either corn (C) or wheat (W) based diets during rearing and production. At 21 wk, hens and roosters representing the BW distribution from each treatment were moved to a cage breeder house. Hens were placed at either 1 or 2 hens/cage to cause concurrently competition for feeder space and changes in stocking density which can be associated with commercial stress conditions. Hen shank length, thickness and circumference of both legs were measured at 22 and 39 wk of age in approximately 24 hens per treatment. The RA of each trait was calculated. At 51 wk, blood samples were collected and H/L was evaluated. Statistical analyses included the pairwise correlations among all variables and ANOVA according to a 2 × 2 × 2 factorial arrangement of treatments in a CRD design with strain, diet type, and hens per cage as main factors. Results indicated that there were no significant ($P > 0.05$) correlations among the RA traits of shanks taken at the 2 age periods. There were no significant ($P > 0.05$) correlations between H/L and any of the shank RA parameters. Breeder BW was affected by the 3 way interaction ($P \leq 0.05$), but the most important factor was hens/cage suggesting some effect on welfare. However, the H/L was not influenced ($P > 0.05$) by treatments. In the literature, H/L is accepted as indicator of chronic stress. In contrast, the RA of shank length and thickness were impacted ($P \leq 0.05$) by the interaction of diet by cage space. Diet by strain interaction had an effect ($P \leq 0.01$) on shank circumference. These treatments seem to affect symmetry of bone development but this effect was not correlated with H/L. The lack of correlations between H/L and RA leads to the conclusion that these parameters may not be interchangeable as measurements of stress and welfare in broiler breeders.

Key Words: welfare parameters, broiler breeder, H/L, relative asymmetry, stress

423 Effects of different housing environment on neural plasticity in the chicken. H. Taira*, M. M. Beck, S. C. Chapman, and P. A. Skewes, *Clemson University, Clemson, SC.*

Exposure to an enriched environment has been thought to have positive effects on welfare, and may be accompanied by changes in neural development. There is a continuing debate over the effect of housing systems on the well-being of laying hens. The debate includes the use of cages, modified cages, and aviaries. This study, therefore, was conducted to determine if different housing environments affect neural development as it relates to improving overall welfare of laying hens. Hy-Line W-36 Variety hens were kept in different housing systems from one day of age to 34 weeks of age; battery cage system (brooder, grower, and layer cages) and floor pens (enriched with perches, dust baths and nest boxes). At wk 36, half of the hens from each treatment were switched to the other treatment, and kept them until the age of 45 weeks. Brain samples (n = 5 per treatment) were collected at wk 1, 3, 5, 9, 13, 18, 22, 26, 30, 34, 38, 42, 45. The Golgi-Cox technique was used to examine total dendritic length of neurons in the hippocampus. Data were analyzed using PROC MIXED procedure of SAS. From wk 1 to 34, there were no significant differences between 2 housing systems, except at wk 5 (floor > cage; $P < 0.05$). The cage chicks were moved from battery brooders at 4 weeks of age to battery growers, which might have contributed to this difference. At wk 38, hens moved from their original environment to alternative showed a significant increase ($P < 0.05$) in total dendritic length compared with birds maintained in their original environment. This increase was also observed at wk 42 and 45 ($P < 0.05$). Although conventional cages are considered impoverished environments for laying hens, the results showed that different housing systems did not affect dendritic arborization. Changes to dendrites did occur, however, when the birds were moved from a known environment to a novel environment. Although enriched environments may benefit the welfare of laying hens in other ways, it appears that changes to the environment have a greater influence on modifications of brain structure than does the environment itself.

Key Words: laying hen, hippocampus, dendrite, housing environment, laying hen welfare

Case Report Posters

424 Occurrence of the cutaneous trematode collyriclum faba in an American robin (*Turdus migratorius*) located in the Midwestern United States. D. A. Wilson*[1], P. S. Wakeness[1], and J. N. Caudell[2], *[1]Purdue University, West Lafayette, IN, [2]USDA, APHIS Wildlife Services, Dubois, IN.*

AAAP abstract†

425 *Aspergillus fumigatus* in day-old broiler chicks: What does it mean? D. Magee*, S. A. Hubbard, and F. D. Wilson, *Poultry Research and Diagnostic Laboratory, College of Veterinary Medicine, Mississippi State University, Pearl.*

AAAP abstract†

426 *Macrorhabdus ornithogaster* (Megabacterium) infection in adult hobby chickens in the North Georgia Mountains, USA. E. L. Behnke* and O. J. Fletcher, *Georgia Poultry Laboratory Network.*

AAAP abstract†

427 A case of unilateral periorbital cellulitis and mandibular osteomyelitis in a turkey flock. J.-L. Guerin*, A. Cadec, O. Albaric, M.-N. Lucas, J.-Y. Douet, and L. Corrand, *Ecole Nationale Veterinaire De Toulouse, France.*

AAAP abstract†

428 Enteritis and elevated mortality in young guinea fowl. S. Tilley*, K. M. Robbins, J. M. Day, and H. J. Barnes, *Department of Population Health and Pathobiology, College of Veterinary Medicine, North Carolina State University, Raleigh.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

429 Global gene expression analysis to compare intestinal transcriptional responses against three major *Eimeria* species, *E. acervulina*, *E. maxima*, and *E. tenella*. H. Lillehoj*, D. K. Kim, and C. H. Kim, *Animal Parasitic Diseases Laboratory, Animal and Natural Resources Institute, USDA-ARS, Beltsville, MD.*

AAAP abstract†

430 Comparison of probiotic, prebiotic, vaccine and coccidiostat in prevention and control of coccidiosis in broilers. H. Fayazi[1], S. Rahimi*[1], and M. M. Kiaei[2], *[1]Department of Poultry Science, Faculty of Agriculture, Tarbiat Modares University, Tehran, Tehran, Iran, [2]Department of Animal & Poultry Health & Nutrition, Faculty of Veterinary Medicine, University of Tehran, Tehran, Tehran, Iran.*

The aim of this study was to compare the effects of coccidiostat, vaccine and probiotic on fecal oocyst shedding and performance of coccidia-infected broiler chickens. A total of 300 one d-old male chicks (Arbor Acres) were randomly assigned to 5 treatments with 3 replicates in a completely randomized design. Treatments 1 and 2 were designated as negative and positive control, and treatments 3, 4 and 5 received probiotic (Primalac), Salinomycin and vaccine (Livacox T) respectively. At d 28 of experiment, all groups (except negative control) were challenged orally with a suspension (100 µL) of sporulated oocystes of E.acervulina (2.4×10^5), E. maxima (6×10^4) and E. tenella (4×10^4). From d 35 to 39 of age, feces samples were taken from each replicate for determining the number of oocysts per gram feces (OPG). Performance parameters and lesion score were also determined during the experiment. The results indicated that OPG of the groups treated with coccidia vaccine, Salinomycin and probiotic were significantly lower than positive control ($P < 0.05$). There was no significant difference in number of OPG between vaccinated and anti-coccidia supplemented groups ($P < 0.05$). There was no significant difference on lesion scores in small intestine among the treatments ($P > 0.05$), but differences between Salinomycin and vaccinated groups with positive group were significant ($P < 0.05$). No significant difference on lesion scores were seen between probiotic and positive control group ($P < 0.05$). After challenge, the highest and lowest body weight gain belong to negative and positive control groups, respectively ($P < 0.05$). It was concluded that using Livacox T and coccidiostat have greater effect to control coccidiosis in broilers in compared with probiotic.

Key Words: coccidosis vaccine, probiotic, Salinomycin, oocyst, broiler

431 Anethol enhances in vitro parameters of immunity and augments in vivo protection against avian coccidiosis. S.-H. Lee*[1], H. Lillehoj[1], S. Jang[1], K.-W. Lee[1], M.-S. Park[1], D. Kim[1], and D. Bravo[2], *[1]Animal Parasitic Diseases Laboratory, Animal and Natural Resources Institute, Agricultural Research Service-USDA, Beltsville, MD, [2]Pancosma S.A., Geneva, Switzerland.*

This study examined the effects of anethol on in vitro parameters of immunity and evaluated its ability to provide in vivo protection against avian coccidiosis. In vitro stimulation of chicken spleen lymphocytes with anethol induced greater cell proliferation compared with the media control. Anethol significantly reduced the viability of *Eimeria acervulina* sporozoites compared with media controls. In in vivo experiments, one-day-old broiler chickens were fed with a standard diet either without anethol (uninfected control and infected control groups) or supplemented with anethol at 15 mg/kg of the diet from the time of hatch. Chickens in the infected control and anethol groups were orally challenged with 5,000 sporulated oocysts of *E. acervulina* at d 10 post-hatch, while control animals were uninfected. Anethol-fed chickens showed 12% increased body weight gain and 42% reduced oocysts shedding following challenge infection with live parasites of *E. acervulina* compared with birds fed a standard diet alone. Anethol-fed chickens produced higher levels of IgY serum antibodies against coccidia parasites compared with the control group. Finally, the percentage of spleen T lymphocytes expressing the γδ-T cell receptor (γδ-TCR) cell surface marker significantly increased in anethol-fed chickens compared with controls. This study provides the first evidence that anethol enhances immunity and protects chickens against experimental coccidiosis.

Key Words: anethol, chicken, coccidiosis, immunity, cytokines

432 Effects of *Bacillus subtilis*-based direct-fed microbials on growth performance, immune characteristics and resistance against experimental coccidiosis in broiler chickens. K. W. Lee*[1], H. S. Lillehoj[1], S. H. Lee[1], S. I. Jang[1], U. S. Babu[2], M. S. Park[1], D. K. Kim[1], A. P. Neumann[3], and G. R. Siragusa[3], *[1]Agricultural Research Service, Beltsville, MD, [2]US Food and Drug Administration, Laurel, MD, [3]Danisco, Waukesha, WI.*

The present experiment was conducted to study the effects of dietary *Bacillus*-based direct-fed microbials (DFMs) on cytokine expression patterns, intestinal intraepithelial lymphocyte (IEL) subpopulation, splenocyte proliferation, macrophage functions and resistance against experimental coccidiosis in broiler chickens. Birds were fed diets containing one of 8 *Bacillus subtilis* strains (designated Bs2084, LSSAO1, 3AP4, Bs18, 15AP4, 22CP1, Bs27, and Bs278) or one multiple-strain DFM product (AVICORR) for 21 d, and then the chickens were uninfected or orally infected with 5000 *Eimeria maxima* (EM) oocysts. DFMs did not significantly modify body weight gain, but altered intestinal morphometric measurements. At d 21 (before EM challenge), strong phagocytosis ability using BSA-coated fluorescent latex beads and GFP-labeled salmonella was seen in birds given Bs18, 15AP4, Bs27, or Bs278 compared with the no DFM control group. In addition, splenic lymphocyte proliferation, intestine IEL subpopulations, and cytokine mRNA levels in IELs were increased, decreased, or unchanged compared with controls depending on the DFM used. At d 27 (6 d post infection), EM-induced reduction of body weight gain and intestinal lesions were significantly decreased by adding 15AP4 or Bs27 into broiler diets compared with no DFM/EM inoculated control. All experimental diets increased concanavalin A-induced splenocyte mitogenesis in infected broilers compared with the no DFM/EM inoculated control. The present study provides the scientific evidence that *Bacillus*-based DFMs can modulate the host immunity and thus provide the protective immunity against enteric pathogens in broiler chickens.

Key Words: chicken, coccidiosis, direct-fed microbials, immune response, growth performance

433 Illeal and cecal fungal communities in broilers given probiotics, specific essential oil blends, and *Eimeria* infection. M. E. Hume*[1], C. A. Henandez[1], N. A. Barbosa[2,3], S. E. Dowd[4], N. K. Sako-

mura[2], and E. O. Oviedo-Rondon[3], *[1]USDA, ARS, FFSRU, College Station, TX, [2]Universidade Estadual Paulista, UNESP-Jaboticabal, Brazil, [3]North Carolina State University, Department of Poultry Science, Raleigh, [4]Medical Biofilm Research Institute, Research and Testing Laboratories, Lubbock, TX.*

Fungal communities occupying the poultry digestive tract have gained far less scrutiny than corresponding bacterial communities. Attention given poultry-associated fungi have focused almost entirely on feed-associated toxin-producers, yeast, and yeast products. The objectives of the current project were to identify and monitor broiler digestive fungal communities following *Eimeria* infection and treatment with probiotics and essential oil blends. Eight treatments included 4 controls: Uninfected Unmedicated, Unmedicated-Infected, the antibiotic BMD plus the ionophore monensin as positive control, and the ionophore as a negative control. Four treatments included: 2 probiotics, BC-30 and Calsporin; and 2 specific essential oil blends. All chickens except the Unmedicated Uninfected were exposed at 15 d of age to a standard oral *Eimeria* inoculum of sporulated oocysts. Ileal and cecal digesta were collected at pre-*Eimeria*-infection at 14 d of age and post-infection at 22 d of age. Extracted DNA was analyzed by pyrosequencing to examine the impact of feed additives and *Eimeria* infection on individual fungal constituents, while denaturing gradient gel electrophoresis (DGGE) was used to compare more gross changes in the communities. Pyrosequencing identified 3 phyla, 7 classes, 8 orders, 13 families, 17 genera, and 23 fungal species. Ileal and cecal DGGE patterns showed fungal communities were clustered mainly into pre- and post-infection patterns. Post-infection Unmedicated Uninfected patterns were clustered with pre-infection groups demonstrating a strong effect of *Eimeria* infection on digestive fungal populations. These combined techniques offered added versatility toward unraveling the effects of enteropathogen infection and performance enhancing feed additives on broiler digestive microflora.

Key Words: probiotic, essential oils, *Eimeria*, pyrosequencing, DGGE

434 Effects of novel nanoparticle adjuvant Montanide IMS 1313 N VG on mucosal vaccination of poultry against *Eimeria acervulina*. H. S. Lillehoj*[1], S. I. Jang[1], S. H. Lee[1], K. W. Lee[1], F. Bertrand[2], L. Dupuis[2], and S. Deville[2], *[1]Animal Parasitic Diseases Laboratory, Agricultural Research Service-U.S. Department of Agriculture, Beltsville, [2]Seppic, Puteaux, France.*

AAAP abstract†

435 Immunoenhancing effects of Montanide ISA oil-based adjuvants on recombinant coccidia antigen vaccination against *Eimeria acervulina* infection. S. I. Jang*[1], H. S. Lillehoj[1], S. H. Lee[1], K. W. Lee[1], M. S. Park[1], G. R. Bauchan[2], E. P. Lillehoj[3], F. Bertrand[4], L. Dupuis[4], and S. Deville[4], *[1]Animal and Natural Resources Institute, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD, [2]Plant Science Institute, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD, [3]University of Maryland School of Medicine, Baltimore, [4]Seppic Inc., Puteaux, France.*

The current study was conducted to investigate the immunoenhancing effects of Montanide adjuvants on protein subunit vaccination against avian coccidiosis. Broiler chickens were immunized subcutaneously with a purified *Eimeria acervulina* recombinant profilin protein, either alone or mixed with one of 4 adjuvants (ISA 70 VG, ISA 71 VG, ISA 201 VG or ISA 206 VG), and body weight gains, fecal oocyst shedding, and humoral and innate immune responses were evaluated following oral challenge infection with live *E. acervulina* oocysts. Immunization with profilin plus ISA 70 VG or ISA 71 VG increased body weight gains compared with vaccination with profilin alone. Profilin plus ISA 71 VG also reduced fecal oocyst shedding compared with vaccination in the absence of adjuvant. All adjuvants enhanced profilin serum antibody titers. Increased levels of gene transcripts encoding IL-2, IL-10, IL-17A, and IFN-γ, but decreased levels of IL-15 mRNAs, were seen in intestinal intraepithelial lymphocytes of chickens immunized with profilin plus adjuvants compared with immunization with profilin alone. Finally, increased infiltration of lymphocytes, especially CD8+ lymphocytes at the site of immunization was observed in birds given profilin plus ISA 71 VG compared with profilin alone. These results demonstrate that vaccination with the *E. acervulina* profilin subunit vaccine in combination with Montanide adjuvants enhances protective immunity against avian coccidiosis.

Key Words: coccidiosis, vaccine, adjuvant, chickens

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436 The effect of cage design on feed efficiency and egg weight of white leghorn hens: An epidemiological study. P. Y. Hester*[1], A. S. Kiess[2], J. A. Mench[3], R. C. Newberry[4], and J. P. Garner[1], *[1]Purdue University, W. Lafayette, IN, [2]Mississippi State University, Mississippi State, MS, [3]University of California at Davis, Davis, [4]Washington State University, Pullman.*

The influences of cage design features, including feeder design and space, cage depth, cage area, stocking density, and the placement of resources, on production parameters of White Leghorns have not been fully assessed under commercial conditions. Assessing all these variables in a traditional experimental study would be difficult. An epidemiological approach, using variability in cage design among producers, is a useful tool to assess the impact of a multitude of variables on hen productivity. The objective of the current study was to identify aspects of cage design that affect feed efficiency and egg weight. A universal cage measurement system and an industry survey were developed. Out of 179 houses visited, a total of 167 yielded data suitable for analysis. Feed efficiency and egg weight outcomes were assessed from placement to 60 wk of age. Using GLM, a statistical model was identified that best described the variance in feed efficiency and egg weight. The analysis explicitly controlled for the effects of all other variables to avoid confounding effects. Among producers, the model explained 56% and 67% of the variation in feed efficiency and egg weight, respectively. Feed efficiency was not affected by cage or feeder design. Variation in feed efficiency among producers was small. Feed efficiency improved as caloric content of the feed increased up to 196 kcal/hen per d after which feed efficiency decreased with increasing caloric content. Egg weight was greater in A-frame houses where manure was removed regularly instead of being left in the house; with increasing cage floor slope; in cages where drinkers were placed either toward the front or the back of the cage rather than the middle; with more space per hen; and with feed with higher caloric intake. Perhaps because of its strong negative correlation with egg production, egg weight increased with less feeder space allocation and with shorter cage heights. These results show that cage design did not affect feed efficiency, but egg weight was influenced by several factors.

Key Words: cage design, egg weight, feed efficiency, White Leghorn, epidemiology

437 The effect of cage design on egg production of white leghorn hens: An epidemiological study. A. S. Kiess*[1], P. Y. Hester[2], J. A. Mench[3], R. C. Newberry[4], and J. P. Garner[2], *[1]Mississippi State University, Mississippi State, MS, [2]Purdue University, Lafayette, IN, [3]University of California at Davis, Davis, [4]Washington State University, Pullman.*

The influence of critical aspects of cage design, such as cage height and shape, on hen productivity has not been fully assessed in the commercial systems commonly used in the US. Different aspects of cage design may interact in critical ways and assessing all of these variables in a traditional experiment would be impossible. Therefore, an epidemiological approach was used to examine the impact of a multitude of cage design variables on hen productivity, to identify features of cage design that optimize egg production. A survey was developed in consultation with industry. A total of 179 houses were visited, and egg production outcomes for each house were assessed from placement to 60 wk of age. Out of the 179 houses visited, 167 were used for the analysis. Using GLM, a statistical model was identified that best described, the variance in egg production of white egg laying strains. The analysis explicitly controlled for the effects of all other variables to avoid confounding effects. Among producers, the model explained 60% of the variation in hen-housed egg production. Eggs/hen housed increased with more feeder space allocation, with maximum egg production noted at 10.7 cm (4.2 in) of feeder space/hen ($P = 0.031$). Taller cages ($P = 0.029$), rear (vs front) drinker location ($P = 0.026$), and regular removal of manure from the house ($P = 0.005$) were associated with increased eggs/hen housed. These results indicate that cage design features such as feeder space, cage height, position of the drinkers, and waste management systems affect egg production under commercial conditions.

Key Words: cage design, egg production, white leghorn, epidemiology, well-being

438 Effect of daily and skipped organic acid oral regimens on final weight of Broiler chickens. G. Guzman*[1,2] and A. Garcia[1], *[1]Viator, Guadalajara, Jal. Mexico, [2]Universidad de Guadalajara, Zapopan, Jal., Mexico.*

Purpose: To analyze the effect of 2 organic acid oral regimens, daily and skipped, and 3 doses with 2 commercial formulations on broiler final weight. Experimental design: Multifactorial 2 × 3 experimental design, six experimental groups (A to F) with two replicates of 15,000 Ross male chicks each, were treated with two different organic acid oral formulations. Controlled factors were the oral regimen and the oral doses, while dependent variable measured was chick weight at 49 days old. The doses were 0.3 ml/L, 0.5 ml/L and 1 ml/L, and the regimens were daily for 49 days and skipped in each diet change for three days (starter, growth and finisher). Groups A, B and C were treated with a product of anonymous provider (product A), consisting of 33% formic, acetic, citric, picric and glutamic acid plus copper and zinc. Regimen and dose of group A was 0.5 ml/L of product A daily, group B 0.3 ml/L of product A daily and group C 1 ml/L of product A skipped. Groups D, E, and F were treated with Spacid, a product provided by Viator (product B), consisting of 40% acetic and citric acid. Regimen and dose of group D was 1 ml/L of product B skipped, group E 0.3 ml/L of product B daily and group F 0.5 ml/L of product B daily. Chick's weights were obtained at 49 days old and statistically compared among groups. Group D (1ml/lt skipped) was statistically different ($P < 0.05$) of the rest of the groups, while groups A, B, C and F were different to group E. Poultry weights at 49 days old in decreased order were for group D 3,064 Kg, group C 2,803 Kg, group F 2,725 kg, group A 2,631 Kg, group B 2,552 Kg and group E 2,549 Kg. Group C and D (skipped oral regimen) were different between them, therefore the effect of skipped regimen could be product dependent. Organic acid skipped oral regimens should be considered in contrast to daily regimens. Each organic acid commercial product should be evaluated previously to avoid ineffective regimens and doses, because of the effect of differences in product formulations.

Key Words: acid, broiler, growth, citric, acetic

439 Durability testing of incandescent, cold cathode, compact fluorescent and LED lamps under poultry conditions. E. Benson*, D. Hougentogler, J. McGurk, E. Herrman, and R. Alphin, *University of Delaware, Newark.*

As part of the Energy Independence and Security Act (2007), general purpose incandescent lamps in many common sizes are being phased out by 2012 – 2014. For the poultry industry, this will result in replacement of the primary lighting technology. Three practical alternatives include cold cathode (CCFL), compact fluorescent (CFL), and LED lamps. A durability test was conducted to evaluate the use of the lights in a poultry environment. A 16 chamber light apparatus was constructed and placed in a layer house to evaluate 4 lamps each for 4 lighting technologies (incandescent, CCFL, CFL, LED). Each light was cycled in a 15 min On and 45 min Off pattern 16 times per day. Illumination sensors with a vacuum based clearing system were used to record light output. Every 2 weeks, each bulb was removed, cleaned, an intensity pattern developed, and returned to the lighting apparatus. Incandescent lamps failed at 2176 h (136 d), 2500 h (150 d), 2624 h (164 d), and 3520 h (220 d). One CCFL lamp failed at 4640 h (290 d), well less than the typical 10,000 to 25,000 h expected. Two CFL lamps failed at 2400 h (150 d) and 3296 h (206 d), again, well before the 10,000 h lifespan expected. No LED lamps failed during testing. Incandescent lamps decreased in intensity an average 30% over the lifespan of the lamp. CCFL lamps decreased an average of 28% over the duration of the trial. CFL lamps decreased at an average of 49% with 2 lamps having over s 60% decrease in illumination during the trial. LED lamps decreased an average of 47%, with significant lamp to lamp decreases in intensity. Two of the 4 lamp technologies failed outside the expected range and all 4 technologies had material lumen depreciation during the test.

Key Words: lighting, LED, cold cathode, compact fluorescent, incandescent

440 The impact of peat moss amendments on the microbial load in used pine shavings poultry litter. D. L. Everett*[1], Y. Vizzier-Thaxton[2], C. D. McDaniel[1], and A. S. Kiess[1], *[1]Mississippi State University, Mississippi State, MS, [2]Unversity of Arkansas, Center for Animal Wellbeing, Fayetteville.*

In addition to pine shavings, alternative litter sources for poultry bedding include sand, pine straw, or even peat moss. Peat moss has a high absorptive capacity and is naturally acidic, possibly making it a potentially good poultry litter amendment. The objective of this study was to determine if microbial populations changed when different levels of peat moss were added to poultry litter. Experimental treatments included 0%, 13% and 20% peat moss, which were added to used pine shaving. A total of 216 broilers (42 d) were separated into 18 pens (6 pens/3 treatment). Control litter samples (100 g) were collected before the addition of peat moss and birds (0 d); then litter samples from each pen were collected weekly thereafter for 3 wk. From each litter sample, 10 g was diluted in 90 mL of Buttersfields Phosphate, and then serially diluted. For tryptic soy agar, MacConkey agar, and Sabouraud Dextrose agar, 100 µL were plated in duplicate to detect aerobic bacteria, total coliforms, and yeasts/molds, respectively. Plates were incubated aerobically for 24 h at 37°C and then counted. Data was analyzed using a randomized complete block design with a split plot over weeks. An interaction between week and peat moss treatment ($P = 0.028$) indicated that during Week 1 pine shavings alone contained fewer coliforms and yeast/molds (3.54 mean log cfu/g vs 4.7 mean log cfu/g for coliforms, respectively; 4.68 mean log cfu/g vs. 5.55 mean log cfu/g for yeasts/molds, respectively). However, by wk 2 peat moss treatments yielded less coliforms and yeast/molds than that of used pine shavings (3.75 mean log cfu/g vs 4.97 mean log cfu/g for coliforms, respectively; 4.08 mean log cfu/g vs. 4.81 mean log cfu/g for yeasts/molds, respectively). In conclusion, the data demonstrates that the addition of peat moss may be a useful amendment for reducing bacteria, yeasts, and molds in poultry litter. Overall, future studies should test the absorptive capacity of peat moss for trapping ammonia and changing the litter pH, which could demonstrate how peat moss is actually reducing bacteria and yeast/mold growth in poultry litter.

Key Words: litter, peat moss, pine shaving, microflora, litter amendment

441 Hematology and serum metabolites profile of egg-type chickens in different intensive housing systems in humid tropics. O. M. Alabi*[1], D. O. Adejumo[2,1], and A. O. Ladokun[3], *[1]Bowen University, Iwo, Osun state, Nigeria, [2]University of Ibadan, Ibadan, Oyo state, Nigeria, [3]University of Agriculture, Abeokuta, Ogun state, Nigeria.*

Chickens meant for commercial table egg production are usually confined inside battery cages or deep litter for maximum productivity, automation of devices, and ease of handling. However, housing egg-type chickens inside battery cages is receiving strong opposition from a welfare point of view and there has been a shift to alternative housing systems. Blood parameters of 2 strains of commercial egg-type chickens housed on 3 different intensive housing systems were investigated. 108 17-week-old Super Black and 108 17-week-old Super Brown hens were randomly allotted to to 3 intensive housing systems of Partitioned Battery Cage(conventional and control), Extended Battery Cage and Deep Litter System in a randomized complete block design with 36 hens per housing system each with 3 replicates. The experiment lasted 37 weeks. Hematological parameters measured were packed cell volume, hemoglobin concentration, red blood cells, and white blood cells. Serum metabolites measured were total protein, albumin, uric acid, cholesterol, glucose, bilirubin, and creatinine. All hematological parameters and serum metabolites investigated were not significantly ($P > 0.05$) affected by the housing system and strain. Adoption of housing systems other than battery cages will not negatively affect the blood parameters and health status of egg-type chickens in humid tropics.

Key Words: blood parameters, housing systems, layers, strain

442 Evaluation of feeding spray-dried bovine plasma protein on production performance of laying hens exposed to acute heat stress temperature. S. A. dePersio*[1], K. W. Koelkebeck[1], J.M. Campbell[2], K. Lima[1], P. C. Harrison[1], C. W. Utterback[1], P. L. Utterback[1], A. Green[1], and R. Gates[1], *[1]University of Illinois, Urbana, [2]APC Inc., Ankeny, IA.*

An experiment was conducted to evaluate feeding 2 levels of bovine spray-dried plasma protein on production performance of laying hens subjected to acute heat stress (HS). Two groups of 96 Hy-Line W-98 hens (38 wk of age) were housed in each of 2 environmentally-controlled chambers (529 cm2/hen, 4 hens per cage). All hens were fed a 16% CP layer mash with water provided. At 40 wk of age, all hens were then fed 3 treatment diets consisting of 1) a control diet (0% plasma); 2) the control diet supplemented with 0.75% plasma; and 3) the control diet supplemented with 1.50% plasma. Thus, 8 replicate cages per chamber were fed one of each diet (64 hens per diet) for 5 wk (40 to 44 wk of age). The HS chamber was maintained at 21°C (wk 1); 29°C (wk 2); and 35°C (wk 3 to 5), while the thermoneutral chamber (TN) was maintained at 21°C from wk 1 to 5. There was a significant decrease in egg production by wk 4 and 5 for hens exposed to 35°C. A significant environment by diet interaction occurred during wk 5, in

which production was not different between hens fed the 1.5% plasma in either chamber. Heat stress caused a reduction in egg weights for hens fed all diets during wk 3 to 5. Egg mass was reduced for hens exposed to HS during wk 4 and 5. There was a numerical trend for hens fed the 1.5% plasma diet in the HS chamber to produce more egg mass than those fed the 0.75% plasma or control diet. Hens exposed to the HS temperature consumed less feed than those in the TN chamber regardless of diet during wk 3 to 5. However, feed efficiency was greater for hens exposed to HS during wk 3 and 4 vs. those in the TN chamber. The overall results indicate that HS negatively effects short-term production, and supplementation of a control diet with 1.5% bovine plasma protein may positively affect performance during short-term HS exposure.

Key Words: laying hens, spray-dried bovine plasma, heat stress

443 Variations in preenrichment pH of poultry feed and feed ingredients after incubation periods up to 48 hours. N. A. Cox*[1], R. J. Buhr[1], J. A. Cason[1], K. E. Richardson[2], L. J. Richardson[3], L. L. Rigsby[1], and P. J. Fedorka-Cray[1], *[1]USDA/ARS Russell Research Center, Athens, GA, [2]Anitox Corp., Atlanta, GA, [3]The Coca-Cola Company, Atlanta, GA.*

Human salmonellosis outbreaks have been linked to contaminated animal feed. The literature indicates that Salmonella sustains acid injury at about pH 4.0, so we determined the pH of various preenrichment media during incubation of feed and feed ingredient samples. Five poultry finished feeds were individually added to 45 mL of 4 different preenrichment broths: buffered peptone water (BPW), lactose broth (LB), minimal salts medium (M-9) and universal preenrichment (UP) and incubated at 37oC for 18, 24, and 48 h. In addition to the finished feeds, ground feed ingredients were tested following the protocol for finished feeds. After each incubation period the pH was determined using a calibrated (at pH 4 and 7) pH meter and the entire experiment was replicated 3 times with very little variation among reps. With finished feeds, longer incubation time did not alter pH greatly, although a slightly lower pH was observed at 48h compared to 18h and 24h. With the broiler, broiler breeder and layer feeds, the pH ranged from 3.9 - 4.7 with all the media except UP. For UP the range was 4.7 - 5.3. Overall the lowest pH values were with LB and BPW broths with the lowest pH values of 3.9 with LB for broiler breeder feed. The pH's were slightly higher for turkey grower and turkey breeder feeds ranging from 4.4 - 5.5. With feed ingredients, a similar pattern was observed with LB and BPW producing the lowest pH's with ground corn (3.7 - 4.7), wheat middlings (3.8 - 4.2), DDG (3.8 - 4.1), sorghum (3.9 - 4.5) and soybean meals (4.4 - 4.6); moderate to slight drop in pH with fish meal, beef or pork meat and bone meal, poultry byproduct and canola meals. Overall, UP and M-9 broths were more resistant to a drop in pH than LB and BPW broths. Low pH can impair ability of the organism to metabolize certain biochemicals that are critical in the identification process for this organism. If this injury and lack of biochemical utilization is occurring during the analysis of feed, Salmonella may be present within the sample and go undetected.

Key Words: acid, feed, feed ingredients, preenrichment media, pH

444 National Air Quality Site Assessment Tool for poultry and livestock producers. C. W. Ritz*[1], D. M. Karcher[2], C. R. Angel[3], T. J. Applegate[4], and B. D. Fairchild[1], *[1]University of Georgia, Athens, [2]Michigan State University, East Lansing, [3]University of Maryland, College Park, [4]Purdue University, West Lafayette, IN.*

The National Air Quality Site Assessment Tool (NAQSAT) was developed to assist poultry and livestock producers in determining the areas of their operations where opportunities exist to make changes resulting in reduced air emissions. NAQSAT is appropriate for all livestock species and has been designed in cooperation with more than 20 university professionals and 15 partnering agencies to be applicable across the diversity of enterprises. The tool provides a free, voluntary, non-threatening, on-line, user friendly format. When used in concert with consultants, NRCS personnel and published emission mitigation resources, livestock and poultry producers will identify air emissions challenges and make appropriate decisions for mitigation strategies to best improve air quality from all aspects of their production systems. The on-line tool addresses 8 constituents of concern that relate to air emissions: animals and housing, feed and water, collection and transfer of manure, manure storage, land application, mortality, on-farm records and public perception. Use of the tool estimates the degree to which current management has incorporated practices to manage air emission given the current understanding of how production practices impact emissions and the opportunity for additional changes to mitigate air emissions. The tool provides the opportunity to run scenarios with proposed changes to determine the impact a new practice would have on emissions. The NAQSAT assessment tool evaluates management practices and control technologies that are in place or under consideration relative to the potential for managing emissions from the given facility and associated infrastructure. The tool is unique in that multiple gaseous emissions, including odor, particulates, hydrogen sulfide, ammonia, methane, and VOCs will be considered during a single assessment. The tool does not provide emissions data or regulatory guidance; rather it is designed to provide producers with opportunities to make on-farm changes to reduce air emissions. The tool is now archived at: http://naqsat.tamu.edu/

Key Words: air quality, assessment, poultry, ammonia

445 Effect of environmental and drinking water sanitation on respiratory post-vaccine mortality of broiler chickens. G. Guzman*[1,2] and A. Garcia[1], *[1]Viator, Guadalajara, Jal., Mexico, [2]Universidad de Guadalajara, Zapopan, Jal., Mexico.*

Purpose: To analyze the effect of environmental sanitation of air and drinking water during 14 d post-vaccine chick mortality vaccinated with attenuated Newcastle disease and Infectious Bronchitis virus. Unifactorial experimental design conformed of four experimental groups, one treated with benzalkonium chloride, other with citric extract and two untreated. All groups had two replicates of 18,000 Ross chicks each. The variable dependent was the post-vaccine chick mortality during 14 days (10 days old to 24 days old). The trial started on middle March (spring season). Group A was treated with commercial product Biodda provided by Viator with 400 ppm of benzalkonium chloride sprayed in the air twice daily and 25 ppm in the drinking water for 14 days post-vaccine. Group B was treated with 1,000 ppm of commercial citric extract sprayed in the air twice daily and 40 ppm in the drinking water for 14 days post-vaccine. Group C and group D were untreated control groups. All groups were vaccinated with commercial attenuated Newcastle disease virus and Infectious Bronchitis disease virus at nine days old, and medicated three days post-vaccine with thiamphenicol and bromhexine. The post-vaccine mortality was measured 14 days, from 10 days old to 24 days old. To analyze the post-vaccine mortality by respiratory causes, all death birds were evaluated by necropsy, seeking serosal tracheitis with fibrillar mucus accumulation in the trachea bifurcation. Group A (benzalkonium chloride) had effect on post-vaccine mortality ($P < 0.05$) while Group B (citric extract) had

not. Post-vaccine mortality results in increasing order were for group A 1.2% (± 0.2%), group D 4.5% (± 0.8%), group C 7.7% (± 0.4%) and group B 8.3% (± 0.6%). Environmental sanitation for the reduction of post-vaccine mortality during broiler production may be considered in contrast with or without the use of antibiotics in the preventive medicine program.

Key Words: respiratory, environmental, quaternary ammonium compound, sanitizing, citric extract

446 The role of an early paratyphoid *Salmonella* infection in a necrotic enteritis challenge model in broilers. S. Shivaramaiah*[1], J. R. Barta[2], M. J. Morgan[1], R. E. Wolfenden[1], B. M. Hargis[1], and G. Téllez[1], *[1]University of Arkansas, Fayetteville, [2]University of Guelph, Guelph, ON, Canada.*

Necrotic enteritis (NE) caused by *Clostridium perfringens* (CP) is an economically important disease in poultry. An *Eimeria* infection is considered as an absolute pre-requisite to cause NE. Preliminary data from our studies have indicated that a *Salmonella typhimurium* (ST) infection early in age followed by an *Eimeria maxima* (EM) and CP challenge accentuates clinical signs of NE. In these experiments, we investigated whether an early *Salmonella enteritidis* (SE) infection would cause the same effect as that of an early ST infection. Day-old broiler chicks (n = 25/trt) were randomly allocated to treatment groups and 1×10^7 cfu of either SE or ST was administered at hatch. EM and CP challenge was performed at d 18 and 22–23 respectively. Body weight was recorded before EM challenge and at termination to determine weight gain. In addition, total mortality and lesion scores were evaluated. Data were analyzed using GLM procedure of SAS. Mortality and lesion scores were higher while weight gain was lower ($P < 0.05$) in chicks challenged with ST as compared with those challenged with SE or controls. These preliminary studies indicate distinct differences in the ability of different paratyphoid *Salmonella* to accentuate NE. Further studies will evaluate possible reasons associated with these observations.

Key Words: *Salmonella*, *Eimeria*, necrotic enteritis, paratyphoid, *Clostridium*

447 Evaluation of a lignite-coal water additive designed to reduce ammonia emissions on broiler performance, carcass attributes, selected welfare measures and ammonia emissions. C. Bench[1], B. Chmilar[1], M. Oryschak[2], and D. Korver*[1], *[1]University of Alberta, Edmonton, AB, Canada, [2]Alberta Agriculture and Rural Development, Edmonton, AB, Canada.*

A 35-d trial was conducted to determine the effect of a commercially-available lignite-coal water additive on ammonia gas emissions from broilers reared on softwood shavings. At 1 d of age, Ross 308 broiler chicks (n = 2000) were divided equally among 8 test rooms controlled for humidity, ventilation and temperature. Each test room received either untreated water (CON) or water containing the lignite-coal additive (LIGN) through nipple drinkers for the 35-d trial in a randomized complete block design with 4 replicate rooms per treatment. Water consumption, ADFI, ADG, and G:F ratios were determined for each growth phase. Ammonia emission rate at 5 sites within each test room was determined using a static chamber system on d 27 and 34. Litter samples corresponding to each ammonia measurement site in each pen on d 27 and 34 were collected and analyzed for chemical composition. Birds were scored for respiratory distress on d 27 and 34. On d 35, 36 broilers were randomly selected from each test room and slaughtered to determine carcass attributes. Feet from slaughtered birds were scored for foot pad lesions. No differences in ammonia emissions or litter composition were detected between CON and LIGN treatments, though significant differences were observed between sampling sites and sampling days. Overall water consumption, ADG, ADFI, G:F were not different between CON and LIGN groups. No significant differences due to treatment were observed for carcass weight, yield of carcass components, mortality, cull rates, respiratory distress scores or foot pad lesion scores. In conclusion, the LIGN additive did not reduce ammonia emission rates for broilers raised on litter to 35 d, but also did not appear to adversely impact broiler performance, carcass attributes or selected measures of bird welfare.

Key Words: ammonia, broilers, carcass, water supplement, footpad lesions

448 Evaluation of a fermented rice/soy product on broiler performance, litter characteristics, ammonia and odorant volatilization when applied to used broiler litter. M. P. Williams*[1], C. Coufal[1], E. Caraway[2], R. Carpenter[3], I. Smith[3], and J. T. Lee[1], *[1]Poultry Science Department, AgriLife Research, Texas A&M Systems, College Station, [2]Olfactory Laboratory, West Texas A&M University, Canyon, [3]BiOWiSH Technologies, Chicago, IL.*

A study was conducted to evaluate the use of a fermented rice/soy product (BiOWiSH-Aqua) applied to used broiler litter and the observed effect on broiler performance, ammonia and odorant volatilization, caked litter weight, litter moisture, and litter pH. The study consisted of 2 experimental treatments (control vs. treated) with each treatment consisting of 6 replicate pens containing 135 d old broilers per pen at a placement density of 0.8 sq. ft./bird for a 46 d grow out. The fermented rice/soy product was activated for a 12 h period before litter application and was applied to the litter 48 h before chick placement. The activation process consisted of dilution of 2 kg of product into 60 gallons of water with aeration. The activated solution was applied at a rate of 22.7 mLs/sq. ft. Used litter (6 previous flocks) was acquired and placed in all pens at a depth of 12 cm at the initiation of the study. Body weights and feed consumptions were determined on d 1, 14, and 46 of age and daily mortality was recorded. Litter samples were collected before litter treatment, at chick placement, and on a weekly basis throughout the experiment. Litter odor volatiles were sampled using a dynamic flux chamber placed directly on the litter between the feed and water lines on d 14 and 28. No differences were observed in body weight, feed conversion ratio, feed consumption, litter moisture and pH, cake weight, or ammonia and odorant volatilization.; however, a significant decrease ($P < 0.05$) in mortality was observed throughout the trial in broilers reared on litter treated with the fermented rice/soy product as compared with the control pens. The data indicate that application of BiOWiSH-Aqua may increase broiler flock livability.

Key Words: litter, broiler, ammonia, performance, odor

449 Tomato pomace as an ingredient in diets of laying hens. A. J. King* and J. K. Griffin, *University of California, Davis.*

In California, where over 90% of the processed tomatoes in the U.S. are produced, there is an abundance of the inexpensive agricultural by-product, tomato pomace (TP), containing cores, culls, trimmings, seeds, peels, liquor and unprocessed green tomatoes picked by harvest machinery. Although used to a limited extent in diets of animals and livestock, many tons of TP are added to landfills yearly. While high in fiber, TP contains α-tocopherol, β-carotene, lutein and lyco-

pene. Though fiber content limits the quantity of TP that can be fed to layers, it is important to determine how much can be substituted for more costly commercial diets during a limited amount of time without detrimental effects as previously observed. Invert sugar (IS), another agricultural by-product, is produced in many parts of the world from refining of commercial white sugar. It has been suggested that IS could be added to diets of layers to enhance palatability when TP is also an ingredient. Two experiments were conducted to evaluate the use of TP and IS in layer diets. In Experiment 1, hens received course meal diets containing 100% Layena (a commercial feed source, L), 90% L + 10% TP (L90TP) or 80% L + 10% TP + 10% IS (L80TPIS) for two weeks. In Experiment 2, diets from Experiment 1 were fed as pellets for the same period. Weight gain, feed consumption, egg (520) production, egg shell thickness and egg yolk color were measured. Results of Experiment 1 showed no effect of diet on any measurements except for egg color, scored as orange for all hens receiving TP as compared to yellow for hens fed L alone. Visual observations revealed a slight increase in diarrhea for hens fed TP and a preference for IS particles for hens fed L80TPIS. In Experiment 2, diarrhea was observed for hens fed TP and egg yolk color scores were similar to those from Experiment 1. No selective feeding was observed. Overall, results suggested that up to 20% of commercial layer hen diets could be substituted with abundant and inexpensive TP and IS without detrimental effects on the selected measurements and to change the color of egg yolk. It seems that, where abundant, these two ingredients could be used to offset the cost of feed substantially.

Key Words: tomato pomace, invert sugar, laying hens, weight gain, yolk color

450 Effects of mycotoxin contaminated diets on early performance in replacement layer pullets. S. Iselt*[1], J. Lee[1], M. Farnell[1], M. Williams[1], M. Ross[1], K. Stringfellow[1], S. Anderson[1], U. Hofstetter[2], R. Beltran[2], G. Schatzmayr[2], and D. Caldwell[1], *[1]Poultry Science Department, Texas A&M University, College Station, [2]Biomin GmbH, Herzogenburg, Austria.*

Compared with broilers, fewer studies in recent years have focused upon the negative impact of mycotoxin consumption in replacement layer stock. The objective of the current trial was to evaluate layer pullet body weight when fed diets contaminated with deoxyvinalenol (DON) and aflatoxin B1 (AFLA) with or without the inclusion of a mycotoxin deactivating compound (Mycofix Select) during rearing in floor pens. On day of hatch, Lohmann LSL-LITE female chicks were obtained from a local commercial hatchery and transported to our research facility for randomization and placement. Toxin levels in diets were separated into low (1.0 ppm DON + 1.0 ppm AFLA) or high (2.0 ppm DON + 2.0 ppm AFLA) experimental groups. Chicks in low or high toxin administration groups began receiving contaminated diets at placement. Body weights between 2 and 5 weeks of age were reduced ($P < 0.05$) in high, but not low ($P > 0.05$) toxin groups. At 5 weeks of age a subset (n = 8) of pullets from each group was subjected to necropsy to determine relative liver, kidney, bursa, spleen, and thymus weights. Relative liver weights were increased ($P < 0.05$) in high, but not low ($P > 0.05$) toxin groups. Regarding mycotoxin deactivating compound inclusion, an interaction was detected with 3 and 4 week body weights as improved body weight ($P < 0.05$) was observed in the non-toxin administered group. Additional measurements to be obtained from this trial include parameters of histopathology and immune status. These data suggest that early replacement layer pullet body weight and relative liver weight were negatively impacted by high level (2.0 ppm DON + 2.0 ppm AFLA), but not low level (1.0 ppm DON + 1.0 ppm AFLA) experimental mycotoxin challenge.

Key Words: mycotoxins, layers, deoxyvinalenol, aflatoxin, performance

451 Initial life cycle assessment for conventional broiler production on the farm: Carbon footprint. E. J. Van Loo*[1,3], E. G. Killeen[2], S. C. Ricke[1], and G. J. Thoma[2], *[1]Department of Food Science and Center for Food Safety, University of Arkansas, Fayetteville, [2]Ralph E. Martin Department of Chemical Engineering, University of Arkansas, Fayetteville, [3]New Organic Solutions, Fayetteville, AR.*

In recent years, the popularity of sustainable food production has grown tremendously. Sustainability has become a mainstream value to current shareholders and is a key factor in product branding. Green consumerism is an influential driver of innovation and product change in the food sector. Manufacturers, retailers and importers are seeing an increasing number of requests for verifiable data on their product's environmental performance. The US has an enormous poultry production sector: 35.5 billion lbs in 2009, valued at $21.8 billion. Sustainability of the US poultry industry is vital to maintain a secure food supply and to preserve hundreds of rural economies in many states. To identify the environmental impact of poultry production, we conducted a high level life cycle assessment (LCA) of the conventional poultry production supply chain including feed/grain production and feed processing and live bird production. The first goal of this LCA was to evaluate the carbon footprint (CF) of poultry production. The CF refers to the cumulative greenhouse gas (GHG) emissions, expressed as CO2 equivalents emitted to the atmosphere resulting from these activities. Our model was based on LC Inventory data from literature and assumptions made for a few unknown parameters. The production of one live weight chicken (6 lbs) at farm gate is responsible for 2.39 kg CO2 eq distributed among feed (71%), energy (20%) and manure management methane emissions (9%). With this model established, more data can be collected from farms and processors to improve our estimates. With an improved model, we can identify points where innovation can lead to a reduction in the consumption of fossil fuel, and where potential for reduction of GHG emissions exists. In conclusion, our initial estimates indicate that LCA is an effective tool to evaluate the sustainability of the poultry production and holds the promise of identifying inefficiencies in the system which can be addressed to foster the long-term health of the industry.

Key Words: LCA, carbon footprint, broiler production, sustainability

452 Microbiological effects of *Bacillus*-based DFM supplementation in broilers raised on used litter from commercial farms with different disease histories. A. P. Neumann*[1], J. A. Benson[1], K. W. Lee[2], G. D. Ritter[3], D. A. Bautista[4], H. S. Lillehoj[2], and G. R. Siragusa[1], *[1]Danisco USA Inc., Waukesha, WI, [2]Animal Parasitic Diseases Laboratory, Animal and Natural Resources Institute, Agricultural Research Service, USDA, Beltsville, MD, [3]Mountaire Farms Inc., Millsboro, DE, [4]Lasher Poultry Diagnostic Laboratory, University of Delaware, Georgetown.*

In recent years *Bacillus* probiotics have increasingly been applied as feed additive direct-fed microbials (DFMs) for livestock due to their ability to form heat stable endospores. These products have generally recognized as safe (GRAS) status. Supplementation with *Bacillus spp.* in poultry has identified several benefits that include disease prophylaxis and enhanced performance. The purpose of this study was to

examine gastrointestinal (GI) levels of aerobic spore-forming bacteria, litter spore levels of *Clostridium perfringens* (Cp), and GI microbial ecology in broiler chickens fed a *Bacillus* based DFM and raised on used litter from farms with and without a history of clostridial gangrenous disease (GD). Four dietary treatments were included; 1)basal corn-soy diet, 2) basal diet plus DFM, 3) basal diet plus salinomycin, and 4) basal diet plus DFM and salinomycin. Three different types of litter were utilized; 1) used GD positive, 2) used GD negative, and 3) unused fresh pine shavings. Intestines were sampled from broiler chickens representative of the 4 dietary and 3 litter treatments at d 14, 28, and 45 post-hatch. Aerobic spore-forming bacteria and Cp levels were determined by agar plate counts and GI microbial community profiles generated by bacterial tag-encoded FLX amplicon pyrosequencing. Examination of pre-trial and post trial litter identified a numeric reduction in Cp spore levels in both DFM and ionophore treatments, alone or combined, regardless of disease association. No significant differences in the levels of GI aerobic spore-formers were observed during the study. Microbial community analysis of small intestinal mucosa revealed higher proportions of *Lactobacillus* sequences at d 14 in broilers receiving the *Bacillus* DFM compared with treatments receiving the basal diet alone or supplemented with ionophore only. *Clostridiaceae*, consisting primarily of segmented filamentous bacteria, dominated GI mucosal populations in younger broilers but were largely replaced with *Lactobacillus spp.* as the birds aged.

Key Words: *Bacillus*, direct-fed microbials, GI microbiota, *Clostridium*, *Lactobacillus*

453 Testicular development of breeder males reared on accelerated growth schedules. W. Berry*, S. Oates, L. Stevenson, and J. Hess, *Auburn University Poultry Science, Auburn, AL.*

The objective of this study was to determine how rearing on a relatively accelerated growth schedule affects broiler breeder testicular development. In this study, male breeder chicks reared using a conventional feeding/growth schedule (CON) were compared with males reared on a growth schedule accelerated by 4 (ACCEL4) or 6 weeks (ACCEL6). The ACCEL males were grown on a linear growth line designed to reach the recommended (CON) 22-week body weight at 18 or 16 weeks of age. Male broiler breeder chicks in all treatments were started on a standard starter diet and full fed for 2 weeks. ACCEL4 male chicks were started 4 weeks after CON and ACCEL6 started 6 weeks after CON. Both treatments were then fed 15% protein grower diet for the remainder of the rearing period. The birds received 8 h light/day during rearing. The birds were transferred to breeder housing at 22 weeks of age (CON), 18 weeks of age (ACCEL 6), or 16 weeks of age (ACCEL 6). Light was increased to 12 h/day to stimulate sexual maturation. Birds in all treatments were then fed to maintain the same body weight until termination of the experiment. Body and testes weights were recorded throughout the experiment. Testes samples were formalin fixed, sectioned, and stained for morphology. Testes areas and cell numbers were obtained from photomicrographs using Image J software. Body weights did not differ at photostimulation. Body weight uniformity was the same for the 3 treatments at photostimulation. However, ACCEL birds tended to be less uniform. Testes weight at initial sexual maturity was higher for ACCEL4 vs. CON or ACCEL6 (7.87 ± 0.67 vs. 7.16 ± 0.62 vs 7.15 ± 0.65). Sertoli cell numbers/testes area and interstitial cell numbers/testes area were not different between the treatments.

Key Words: breeder, male, testes, reproduction, growth

454 Expressed sequence tag profiling of the guinea fowl pancreatic functions. C. Darris*, A. Tinnon, and S. Nahashon, *Department of Agricultural Sciences, Tennessee State University, Nashville.* The demand for guinea fowl (GF) as alternative poultry in the US has continued to increase. However, their production potential lags that of other commercial poultry. There have been sustained efforts to improve production performance of the GF, however, there is paucity of genetic resource information to facilitate such efforts. The aim of this study was to construct a complementary DNA (cDNA) library and to generate expressed sequence tags (ESTs) from the pancreas of the Pearl Gray GF. mRNA was isolated from the pancreas of adult GF. Following reverse transcription, cDNAs were cloned into the pBluescript plasmid vector using the Stratagene pBluescript II XR cDNA Library Construction kit. Transformation efficiency was $8x10^4$ cfu/ug with an average insert length of 175 base pairs. Approximately 500 clones were selectively screened via blue-white selection, restriction digestion and PCR. Positive clones were cycle-sequenced by PCR and analyzed with the ABI PRISM 3100-Avant Genetic Analyzer. Three hundred individual ESTs with sizes ranging from 50 to 700 bp were analyzed. Percent homology of the GF ESTs against other avian species ranged from 80 to 100. Functional profile of 50 randomly selected putative ESTs uncovered sequences of proteins associated with metabolism, cell structure, enzymatic activity, cell cycle, and immunity. These include aromatase, an enzyme that aids in the production of estrogens, and Toll-like receptor 7, an immune gene that plays a vital role in the recognition of pathogens and the activation of innate immune system. These and other genes derived from the GF cDNA library provide an invaluable resource in comparative mapping of avian species and the understanding of the molecular processes associated with avian performance in growth, production and reproduction.

Key Words: guinea fowl, cDNA Library, genome, pancreas

455 South Carolina Ag-Watch Program—An awareness and response program for food & agriculture producers, processors and responders. J. Helm*, C. A. Krugler, and C. F. Harden, *Clemson University Livestock-Poultry Health Division, Columbia, SC.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

456 Growing the undergraduate poultry science program at North Carolina State University: Undergraduate recruitment strategies & program development. J. B. Hoffman*, *North Carolina State University, Raleigh.*

Maintaining a substantial undergraduate population in a highly specialized major such as poultry science can be quite challenging when competing with larger, well-known majors like biology or animal science. However, with creative recruiting strategies and the development of recruitment conduits from high school programs to undergraduate Poultry Science departments, undergraduate growth can increase at an exponential rate. For example, the undergraduate poultry science population at North Carolina State University (NCSU) has increased by 82% since August 2008 from 56 students to 102 students in March 2011. Growth has occurred in both the science and technology concentrations offered with a 63% increase in enrollment in the science concentration and a 200% increase in enrollment in the technology concentration. A plethora of recruitment strategies are responsible for the significant growth in the NCSU undergraduate poultry science population. Recruitment strategies have primarily focused on developing the "ASPIRE"- Acquiring SAT Preparation in Rural Education program, a summer SAT preparatory program offered to high school juniors and seniors interested in pursuing Poultry Science degrees at NCSU. Additionally, veterinary school application workshops for pre-veterinary students and recruitment seminars for double-majors have been implemented to attract undergraduate students interested in gaining a wider background in comparative anatomy and physiology to the NCSU Department of Poultry Science. Recruitment activities have also focused on interactions with high school students participating in the NCSU Poultry Science Summer Institute program, a week-long intensive summer camp aimed to expose high school students to opportunities in the poultry industry. These recruitment strategies represent a wide range of activities that may be implemented to maintain an active, substantial, and growing undergraduate student population at a large land-grant institution.

Key Words: recruitment, undergraduate students, enrollment trends

457 A field study to evaluate the efficiency of four types of incinerators on broiler breeder farms. A. J. Pescatore*[1], J. Jacob[1], and M. Miller[2], *[1]University of Kentucky, Lexington, [2]Kentucky Poultry Federation, Winchester.*

Four incinerators of similar capacity were obtained from 4 manufacturers, (Choretime Shenandoah, National Incinerator, Southern Breeze and Earth smart). The incinerators were placed at 4 broiler breeder farms within a complex. All incinerators were set up to operate on propane gas. The weight and number of dead animals and culled eggs incinerated and fuel usage was recorded daily at each farm over a 6-week period. Wide variations in efficiency were observed for the 4 incinerators. The least efficient incinerator was able to operate at only 5.4 kg birds and eggs per gallon of propane. The most efficient incinerator operated at 26.2 kg/gallon of propane. The other 2 incinerators operated at 9.1 and 12.25 kg/gallon of propane. While incinerator design is important, other factors also influence the overall efficiency of the incinerator. Factors influencing the efficiency of the incinerators were duration of run time, ratio of birds to egg material, and total poundage per burn. Producers can improve the efficiency of their incinerators by incinerating full loads and following manufacturers recommendations. Incinerators have a role in dead animal disposal however there is wide variation in both original cost and operational cost. Both factors need to be considered to determine the ultimate cost of dead animal disposal.

Key Words: incinerators, energy efficiency, dead animal disposal

458 Pastured poultry in Georgia: Growers' and consumers' perspective. E. J. Van Loo[1,4], W. Alali*[2], S. Welander[3], P. G. Crandall[1], and S. C. Ricke[1], *[1]Department of Food Science and Center for Food Safety, University of Arkansas, Fayetteville, [2]Center of Food Safety, University of Georgia, Griffin, [3]Georgia Organics, Atlanta, GA, [4]New Organic Solutions, Fayetteville, AR.*

Federal laws exempt farms processing <20,000 birds from USDA inspection but state laws may be stricter. In 2003, Georgia removed the exemption of their state rules, making it difficult for local poultry farms to process. With the US having a strongly vertically integrated poultry industry, there are few options for off-farm processing for small-scale farms and Georgia growers must travel to other states to process. The purpose of this survey was to 1) evaluate processing options for pastured poultry farmers in Georgia and 2) determine the consumers' interest in pastured poultry. A total of 82 Georgia farms participated (37,642 bird/year). Most of these farms (81%) are processing on-farm but grow only 43% of the birds. They are mostly small farms (60% is producing < 500 birds/year). Some farms (18%) process off-farm in South Carolina and Kentucky where there are processors that serve small-scale farmers and provide USDA inspection. These farms are larger and process each more than 1,000 birds/year, responsible for raising 57% of the total amount of birds. Evaluation of the preferences for processing options shows that the off-farm drop-off scores the best, followed by on-farm processing, off-farm rental, and contract growers. Overall, off-farm processing was the most popular and would increase the number of pastured birds raised in Georgia. However, it may be difficult to find a location of one single facility to be convenient for all interested growers. The second part was a consumer study (n = 508) targeted to consumers with an interest in sustainable and local foods from Georgia. Approximately 96.6% of the respondents expressed an interest in supporting efforts to make sustainably raised poultry processed in Georgia available. Even for a high premium of $5/lb, respondents would shift 50% of their current chicken purchases toward this local product. The most important chicken product attribute was sustainably raised followed by Georgia grown, pastured raised and certified organic. Knowledge about the potential supply and demand for local pastured poultry can quantify the need for infrastructure to support processing for farms interested in raising chickens.

Key Words: pastured poultry, surveys, consumers, processing, local

459 Opportunities for veterans in agriculture: Development of an integrated educational and training program for new and beginning farmers and ranchers. J. R. Moyle*[1], A. M. Donoghue[1], I. Reyes-Herrera[2], H. L. Goodwin[2], J. M. Burke[3], D. M. Burner[3], R. L. Raper[3], A. C. Fanatico[4], O. J. Gekara[5], G. Kuepper[6], A. Wells[6], T. Spencer[7], M. Hale[7], and D. J. Donoghue[2], *[1]Poultry Production and Product Safety Research Unit, USDA-ARS, Fayetteville, AR, [2]Dept. Poultry Science, University of Arkansas, Fayetteville, [3]Dale Bumpers Small Farms Research Center, USDA-ARS, Booneville, AR, [4]The Goodnight Family Sustainable Development Program, Appalachian State University, Boone, NC, [5]Dept. Agriculture, University of Arkan-*

sas at Pine Bluff, Pine Bluff, [6]The Kerr Center for Sustainable Agriculture, Poteau, OK, [7]National Center for Appropriate Technology, NCAT, Fayetteville, AR.

According to the Office of the Actuary, Office of Policy and Planning of the Department of Veterans Affairs, there are about 2 million young military veterans in this country, with the largest concentration of veterans living in the South of the country. Many of these young veterans earn less and have a harder time finding work than do civilians in the same age group. At the same time, America's farms require young people interested in agriculture. Studies have shown that a large percentage of enlisted young adults come from rural America, and at the end of their military service they would likely try to return to their place of origin and reincorporate to traditional local activities. In the last few years various organizations have initiated efforts to support the transition of returning veterans into farming life by offering internship opportunities for them However, there are few educational programs specifically tailored to the particular needs and abilities of returning veterans. We are developing a unique learning and production program that would provide returning veterans with customized learning and training opportunities to initiate and succeed in their farming operations. Our objectives are to: 1) develop a comprehensive educational program that provides returning veterans interested in agriculture with relevant knowledge and tools to operate sustainable farms, focused primarily on integrated poultry, livestock and agroforestry systems; 2) develop various delivery strategies for our programs including an eLearning system and farmer friendly publications; 3) offer unique experiential learning opportunities such as workshops and internships for beginning farmers at production farms; and 4) create and offer custom mentoring strategies to provide an effective support system for farmers. This dynamic program is generating specific training and learning opportunities and networking systems for veterans new to farm production. This program is funded by the USDA-NIFA-BFRDP 2010–03143.

Key Words: educational and training program, new and beginning farmers and ranchers, returning military veterans

460 Using quantitative PCR to investigate three candidate genes related to pulmonary hypertension in the chicken. A. A. K. Al-Rubaye*, N. B. Anthony, G. F. Erf, R. F. Wideman, and D. D. Rhoads, *University of Arkansas, Fayetteville.*

Idiopathic pulmonary arterial hypertension syndrome (IPAH) is a disease of humans and chickens that results from chronic high pulmonary arterial pressure. IPAH in broiler chickens results in right-sided congestive heart failure leading to ascites that, if not aggressively treated, will result in death. We have been mapping chicken genes affecting resistance or susceptibility to IPAH. Previously, we identified 2 regions on Gga9 and one on Gga27 that show significant linkage disequilibrium to IPAH in our susceptible line. Within these regions we identified 3 candidate genes that are known to be related to susceptibility to pulmonary hypertension in humans. Those genes are angiontensinogen converting enzyme (ACE), 5-hydroxytryptamine (serotonin) receptor 2B(HTR2B), and a type 1 angiotensin II receptor (AGTR1). We are examining the expression of these 3 genes in chicken IPAH using reverse transcriptase quantitative PCR. Initial analyses suggest differences in the expression levels for 2 of the candidate genes in whole blood RNAs. Ribosomal Protein 14 (RPS14), β2-microglobulin (β2M), TATA Binding Protein (TBP), and RNA polymerase 2B (RP2B) were used as reference genes for qPCR. RPS14 and RP2B were found to give the most consistent qPCR delta-Ct values relative to TBP and β2M . We are expanding the analyses to include increased numbers of samples and a wider range of tissues specifically lung, kidney, liver, and heart. This work was supported by grants from the Arkansas Biosciences Institute and NIH/NHLBI Grant 1R15HL092517 01.

461 Microarray analysis in early and late passage of chicken embryo fibroblast cells. B.-W. Kong*, J. Y. Lee, W. G. Bottje, and K. Lassiter, *University of Arkansas, Fayetteville.*

Normal tissue derived primary cultured cells have limited life span due to replicative senescence showing distinct phenotypes such as irreversible cell cycle arrest and resistance to apoptosis. Study of senescence-associated genetic alterations in chicken cells will provide valuable knowledge of cellular growth characteristics, when compared with both normal and rapidly growing cell lines. Microarray analysis in early- and late passage (passage 4 and 18, respectively) of primary chicken embryo fibroblast (CEF) cells was performed with 4X44K chicken oligo microarray. A total of 2149 differentially expressed genes were identified with a 2 fold level cutoff that included 289 upregulated and 1860 downregulated genes in late passage senescent CEF cells. Network, functional and canonical pathway analyses were generated using Ingenuity Pathways Analysis (IPA, Ingenuity Pathway Analysis, www.ingenuity.com). Of the 2149 differentially expressed genes in senescent CEF cells, 489 were classified into several functional groups including tissue development, cancer, organ development, embryonic development, and genetic disorder. Also, 10 possible gene networks were generated to identify intermolecular connections and the first and the second closely networking genes are associated with functions of tissue development, skeletal and muscular system, cell death, behavior, and nervous system development. Specifically, VEGF (vascular endothelial growth factor) induced transcription factors, such as KIF15 and ZEB1, were downregulated, but stress responsive genes, such as OSGIN1 (oxidative stress induced growth inhibitor 1), were upregulated, suggesting that major growth promoting pathways may not be active in senescent CEF cells. Interestingly, 39 genes, including BRCA1 (breast cancer 1), MELK (maternal embryonic leucine zipper kinase), and GSTO1 (glutathione S transferase omega 1), in senescent CEF cells were regulated opposite to what has been observed in the rapidly growing CEF cell line, DF-1. The results provide insight into epigenetic regulations in growth potential for avian cells.

Key Words: chicken embryo fibroblast, senescence, microarray, differential expression

462 The protective efficacy of rMd5ΔMeq against challenge with a very virulent plus strain of MDV in relatively resistant lines of chickens. S. Chang*[1,2], J. R. Dunn[1], L. F. Lee[1], M. Heidari[1], J. Z. Song[3], C. W. Ernst[2], and H. M. Zhang[1], *[1]Avian Disease and Oncology Laboratory, USDA-ARS, East Lansing, MI, [2]Michigan State University, East Lansing, [3]University of Maryland, College Park.*

Marek's disease (MD) is a T-cell lymphoma of domestic chickens induced by MD virus (MDV), a naturally oncogenic and highly contagious cell-associated α-herpesvirus. A recombinant MDV lacking both copies of *Meq* oncogene, rMd5ΔMeq, was tested as a candidate vaccine against MD in a series of 19 recombinant congenic strains (RCS) of chickens. Early reports suggest that rMd5ΔMeq provides protection equally well or better than commonly used MD vaccines in susceptible experimental and commercial lines of chickens challenged with very virulent plus (vv+) strains of MDV. In this study, protection was assessed using maternal antibody positive chickens from 19 relatively resistant RCS in trial 1 and maternal negative chickens from 14 of the 19 RCS in trial 2. In both trials, chickens from each RCS were divided into 3 treatment groups. The first 2 groups were vaccinated either with rMd5ΔMeq or CVI988/Rispens on the day of hatch followed by challenge with a vv+ strain of MDV, 648A, on the fifth day post hatch. The third group was not vaccinated but challenged with the same virus. The protection indices among the RCS ranged from 43 to 100% and 42–95% for rMd5ΔMeq, 6–83% and 40–70% for CVI988/Rispens for trials 1 and 2, respectively. Our findings from this study provide experimental evidence that rMd5ΔMeq protects significantly better than the CVI988/Rispens ($P < 0.01$) in relatively resistant lines of chickens against vv+ MDV. Together with earlier reports, rMd5ΔMeq appeared to be a better vaccine, compared with the most commonly used commercial vaccine, CVI988/Rispens, for control of MD in lines of chickens regardless of their genetic background or maternal antibody status.

Key Words: Marek's disease, host genetic resistance, vaccine efficacy

463 Variations in the proteome and metabolic profiles of broiler chickens during adipose tissue accretion. G. Kelley*, S. Nahashon, X. Wang, F. Chen, and A. Stewart-Bohannon, *Tennessee State University, Nashville.*

Fat accretion in poultry directly influences the efficiency of feed utilization and consumer acceptability of poultry and poultry products. Losses estimated at about US$250–300 million are incurred by consumers and processors annually in pollution control, extraction and disposal of excess carcass fat. Understanding underlying mechanisms of excessive fat deposition in poultry will aid in improving carcass quality and minimize production cost. We hypothesized that chicken adipocity is highly influenced by factors beyond the genome. Therefore, the aim of this study was to employ a proteomics approach to identify proteins that may be associated with fat accretion in broiler chickens. Metabolic profiles of the experimental birds were also evaluated. One hundred and 20 1-d-old broiler chickens were fed standard

broiler diet for 8 weeks. The diets comprised 3,200 Kcal ME/kg diet and 23% crude protein (CP) and 3,275 Kcal ME/kg diet and 20% CP. At 8 WOA, experimental birds were bled, sacrificed and adipose tissue from the abdominal and visceral areas was collected, weighed and frozen in liquid nitrogen before storage at −80 oC until used. Adipose proteome from the birds with the highest and lowest abdominal fat percentage (8 birds each) was assayed using 2-dimensional differential gel electrophoresis (2D-DIGE) followed by in-gel digestion and Matrix Assisted Laser Desorption/ionization Time-of-Flight (MALDI-TOF) mass spectrometry. A total of 132 spots were found to be differentially expressed between the extreme birds ($P < 0.05$). Several of the proteins are unique and some are involved in metabolic pathways that are associated with fat accretion. These include vimentin, which was confirmed by Western blot, apolipoprotein and annexin. Metabolic profiling revealed that male obese birds contained higher amounts of potassium than lean males. Glucose levels were higher in all males as opposed to all females. Alkaline phosphatase levels were higher in the lean individuals as opposed to the obese birds. SGOT levels were high in female obese and male lean animals.

Key Words: proteome, differentially expressed proteins, metabolic profile

464 *Brucella abortus* antigen challenge of chicken lines divergently selected for high and low antibody response. C. D. Smith*[1], C. M. Ashwell[1], S. J. Nolin[1], Z. S. Lowman[1], and R. L. Taylor[2], *[1]North Carolina State University, Raleigh, [2]University of New Hampshire, Durham.*

Divergent selection of a White Leghorn population for 5d anti-sheep red blood cell antibody production has resulted in high (HAS) and low (LAS) lines that differ by more than 5-fold. Genetic selection was based upon hemagglutination assay (HA) of antibody titer. Prior work has focused on the differential response of the 2 resulting lines to various pathogens with very little work characterizing the actual immune responses mounted by these animals at the gene expression level and the specific genetic factors beyond the MHC driving these differential responses. We have generated pure line offspring that were reared to 6 weeks of age and then challenged with SRBC to confirm high or low antibody production by HA. After 8 weeks of age, these animals were challenged with *Brucella abortus* antigen injected intravenously. Blood samples were taken at 0, 12, 24, and 48 h and 2 animals of each sex were sacrificed at each time point for spleen collection. Differential expression of IL-2 and Interferon gamma were measured by real-time PCR. Interferon gamma production was measured by ELISA assay. Results show that at early time points, the low antibody selected line has a significantly higher IFN-gamma production suggesting an alternative response to *Brucella abortus* antigen. The further characterization of the HAS and LAS lines at the molecular level will provide a clearer insight into the specific gene networks that are responsible for the differential responses to antigens and pathogens between the lines.

Key Words: antibody, *Brucella abortus*, MHC, interferon-gamma, antigen

465 Kinetics of anti-cryptosporidia antibody response, oocyst shedding and bursa/body weight ratios in SPF white leghorn chickens infected with *Cryptosporidium baileyi* oocysts at different ages. H. Abbassi* and M. Naciri, *Department of Animal Science, University of Minnesota, St. Paul.*

AAAP abstract†

466 An essential role of avian interleukin (IL)-22 as immune mediator during inflammatory response. R. Dalloul*, S. Kim, L. L. Faris, R. H. Fetterer, K. B. Miska, and M. C. Jenkins, *Avian Immunobiology Laboratory, Animal & Poultry Sciences, Virginia Tech, Blacksburg.*

AAAP abstract†

467 US Veterinary Immune Reagents Network: Progress with poultry immune reagents development. Y. H. Hong[1,2], H. S. Lillehoj[2], S. H. Lee*[2], C. Baldwin[3], D. Tompkins[3], J. LaBresh[4], Y. Sullivan[4], and B. Wagner[5], *[1]Chung-Ang University, Anseong, Republic of Korea, [2]Animal and Natural Resources Institute, Agricultural Research Services, United States Department of Agriculture, Beltsville, MD, [3]University of Massachusetts, Amherst, [4]Kingfisher Biotech Inc., St. Paul, MN, [5]Cornell University, Ithaca, NY.*

A major obstacle to advances in veterinary immunology and disease research is the lack of sufficient immunological reagents specific for veterinary animal species. In 2006, US Veterinary Immune Reagent Network (VIRN) Consortium (www.vetimm.org) was developed to develop immune reagents against major veterinary and aquatic animal species. The initial priority list for poultry immune reagent development was focused on developing immune reagents against chicken cytokines and chemokines. This poster will report our progress with the poultry immune reagent development efforts of the US VIRN from August 2006 to July 2011. During this period, 26 cytokine and chemokine genes have been cloned and recombinant cytokines became commercially available through the Kingfisher Biotechnology laboratory (www.kingfisherbiotech.com). In addition, transformed cell lines with a transient expression of cell surface molecules of CD25, CD80, CD83 and CD86 have been developed and these cells were used to immunize mice for mouse mAb production. Because there are very few established chicken cell lines which can be used in in vitro cytokine/chemokine bioassays for poultry, validation of biological activity of recombinant chicken cytokines was carried out using primary lymphocytes and macrophages. Several stable mouse hybridomas secreting monoclonal antibodies (mAbs) against major chicken cytokines have been developed for immunoassay development. These immune reagents will serve as valuable tools for basic and applied research in poultry immunology (This project was supported, in part, by the AFRI grant of NIFA, US Veterinary Immune Related Reagent Network Grant #2010–65121–20649 and by the National Research Foundation of Korea grant funded by the Korea government (MEST) (No. 2010–009360)).

Key Words: poultry, immune reagents, cytokines, chemokines

468 The effects of medicinal plants on carcass characteristics, serum lipids and immune system in broilers. A. Golpour, S. Rahimi*, M. Hatamzade, M. Mazaheri, M. Mirzade, M. Saeedi, and S. Yakhkeshi, *Tarbiat Modares University, Tehran, Tehran, Iran.*

The aim of this study was to compare the effects of 4 herbal products on carcass characteristics, serum lipids and immune system of broiler chickens. A total of 150 one-day-old female broiler chicks were randomly assigned to 5 treatments with 3 replicates. Treatments include: control, control diet supplemented with 0.03% Sangrovit, 0.15% Digestrom, 1% Bioherbal and the group with 250 mL Mentofin per 1000 L in drinking water. Feed and water were provided ad libitum throughout the experiment. Serum Chol, TG, LDL, HDL and antibody titer response to Newcastle disease vaccine and SRBC were measured. Among the medicinal plants which used in this experiment, the lowest Chol and LDL was observed for Digestrom and Bioherbal, respectively. But it did not show significant difference with other treatments except Sangrovit ($P < 0.05$). The highest HDL was observed in Bioherbal treatment which had no significant difference with other treatments ($P > 0.05$). The carcass weight in Sangrovit, Mentofin, Digestrom and Bioherbal groups were significantly different compared with control group ($P < 0.05$). The relative breast weight in Mentofin group was significantly higher than control group ($P < 0.05$), while the other groups did not have significant difference with control treatment. The highest antibody titer on d 28 was related to Digestrom group ($P < 0.05$). Also the relative weight of bursa of Fabricius and spleen did not show any significant difference among the treatments ($P > 0.05$). According to results of this study it can be concluded that use of these medicinal plants can improve broiler immune response and reduce serum Chol and LDL.

Key Words: medicinal plants, serum lipids, carcass characteristics, immune system, broiler

469 Global changes of transcriptional expression in broiler chickens with gangrenous dermatitis. D. K. Kim*[1], H. Lillehoj[1], K. W. Lee[1], A. Neumann[2], G. Siragusa[2], and G. Ritter[3], *[1]Animal Parasitic Diseases Laboratory, Animal and Natural Resources Institute, USDA-ARS, Beltsville, MD, [2]Danisco-Agtech Products Inc., Waukesha, WI, [3]Mountaire Farms, Millsboro, DE.*

Gangrenous dermatitis (GD) is a disease of poultry associated with the infection of *Clostridium septicum* (CS) and *C. perfringens* (CP) type A causing significant poultry morbidity and mortality and economic losses in poultry industry. The present study was conducted to understand molecular and cellular changes associated with GD using global gene expression microarray analysis in GD-affected and clinically healthy chickens from a recent disease outbreak. Comparisons between GD-affected and clinically healthy cohorts were performed using the Agilent 44K Chicken Gene Expression Microarray chips. To identify biological functions of the differentially expressed genes, further analysis was performed with Ingenuity Pathway Analysis (IPA). A total of 952 genes (468 upregulated and 484 downregulated) were differentially expressed between GD-affected and clinically healthy control birds. Using IPA, the most relevant biological functions of differentially expressed genes were classified into the categories of 'Disease and disorders' and 'Molecular and cellular functions'. The most significant functions of each category were the inflammatory response and the cellular growth and proliferation responses, respectively. In the Canonical Pathway analysis on the genes altered by GD infection, the pathway of NRF2-mediated oxidative stress response was identified as the most significant pathway. In conclusion, genes related to inflam-

matory responses and the oxidative stress responses were differently expressed in GD-affected birds indicating the role of these genes in host-pathogen interaction in GD-mediated immunopathology. These results provide new information concerning the genome-wide gene expression patterns of the host response against GD infection.

Key Words: gangrenous dermatitis, microarray, chicken

470 The effect of vitamin C and betaine on broiler chicks immune system in heat stress condition. A. Zarei*[1], S. Taghilo[1], H. Lotfollahian[2], H. Neurozian[1], and F. Vakili[1], *[1]Islamic Azad University, Karaj Branch, Karaj-Alborz, Iran, [2]IRANIAN Animal Science Research Institute, Karaj-Alborz, Iran.*

The experiment was conducted to evaluate the effects of vitamin C and betaine on performance of broiler chicks at 1 to 42 days of age under heat stress condition. For this purpose, 3 basal diets were formulated according to the Ross 308 (2007) recommendation. Vitamin C and betaine were then added to basal diets to prepare 4 dietary treatments: 1-Basal diet; 2- Basal diet + 0.05% vitamin C; 3- Basal diet + 0.15% betaine; and 4- Basal diet + 0.05% vitamin C + 0.15% betaine. The diets were fed ad libitum to 4 replicate groups of 10 mixed sex Ross broiler chicks from 1 to 42 days of age. The birds were exposed daily to heat stress for 7 h. On day 28, 2 broilers from each experimental group were selected randomly and injected i.v. with SRBC (sheep red blood cells). On d 35, blood sample were collect from SRBC-injected broilers to determine anti-SRBC antibody titers. Additionally, for each experimental group blood was collected from another two randomly selected broilers on d 35 for complete blood count (CBC) analysis. The results of this experiment indicated significant effects of dietary treatments on the mean percentages of hematocrit, heterophils and monocytes, as well as, the concentration of total white blood cells (WBC). The mean percentage of lymphocytes and the mean concentration of red blood cell (RBC) were not affected by treatment. The average anti-SRBC titer between treatments was not significantly different. Based on the results obtained, dietary vitamin C and betaine supplementations altered the proportions and number of blood cells under heat stress conditions.

Table 1. Compare means of treatments

	1	2	3	4
N	16^{a}	19^{b}	20^{b}	18^{ab}
M	2^{a}	5^{b}	3^{ab}	3^{ab}
L	68	69	75	74
WBC	25125^{a}	23712.5^{b}	28400^{ab}	28300^{ab}
RBC	2	2	2	2
SRBC	8	10	9	9

Key Words: vitamin C, betaine, heat stress, broiler chicks, immune system

471 A time-course study of transcriptional responses in laying hen reproductive-tract tissues in response to *Salmonella* Enteritidis infection. U. S. Babu and K. V. Balan*, *Food & Drug Administration, Laurel, MD.*

Salmonella Enteritidis (SE) outbreaks attributed to egg products and egg contamination represent a serious human health concern. An understanding of the host-response to SE colonization within the reproductive tract is important as intraovarian and oviduct colonization results in transmission of SE to forming eggs. The aim of the present study was to determine the effect of orally dosed SE phage-type 4 (109 cells) in mediating transcriptional responses for an array of inflammatory cytokines, chemokines and cell regulators within the ovary and utero-vaginal junction (UVJ) of laying hens. The tissues were excised at 3 d, 7 d and 14 d post infection, bacterial colonization enumerated and the changes in transcriptional responses were analyzed by using quantitative reverse transcriptase-polymerase chain reaction. In particular, within the ovary there is an upregulation of Lipopolysaccharide-induced TNF-α factor (LITAF) and the chemokine CxCliI at 3 d followed by upregulation of proinflammatory cytokines IL-1β and IL-6 at 2 weeks post infection. In contrast, the UVJ showed upregulation of the proinflammatory cytokine IL-12B and Signal transducer and activator of transcription 1 (STAT1) at 3 d followed by a decline in expression. In addition, dexamethasone-induced RAS gene (RASD1), a member of the Ras superfamily that plays a role in preventing aberrant cell growth, was upregulated over time in both the ovary and UVJ. In light of the complex interplay among cytokines, chemokines and cell regulators, additional studies are needed to characterize genes modulating host responses and further elucidate the physiological significance of these signaling molecules.

Key Words: *Salmonella* Enteritidis, laying hen, qRT-PCR, reproductive tissue

472 Immune response of laying hens fed diets containing cottonseed meal treated with sodium bentonite. M. Azghadi, H. Kermanshahi, A. Golian*, A. Tahmasbi, and A. Gilani, *Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi, Iran,*

The objective of this study was to evaluate the effect of cottonseed meal (CSM) treated with sodium bentonite (SB) on humoral immune response of laying hens. Nine mash diets in a CRD experiment with a 3 × 3 factorial arrangement with 4 replicates of 8 birds each were fed to 288 Hy-Line W-36 hens from 51 to 63 weeks of age. Nine isocaloric and isonitrogenous diets were comprised 3 levels of SB (0, 1 and 2%) and 3 levels of CSM (0, 10 and 20%). Sheep red blood cells (SRBC) were used as antigen to quantify the antibody response. Two birds per replicate were injected with SRBC (one ml of 3% suspension in phosphate-buffered saline in breast muscle of each hen) at 60 week of age. After 7 and 14 d of SRBC inoculation, blood samples were obtained from the brachial vein of each hen, and total anti-SRBC, IgG and IgM titers were determined. There was not a significant effect of SB, CSM or their interaction on total antibody response against SRBC inoculation, but IgG was significantly increased in birds fed diet contained 20% CSM at 7 d (7.62 vs. 8.45) and 2% SB at 14 d (2.79 vs. 3.66) after injection of SRBC. The interaction effect of SB and CSM on IgG was significantly different among dietary treatments and birds fed diet with 2% SB and 20% CSM had the higher titer as compared with control group (5.0 vs. 2.5) at 14 d after injection of SRBC. Diet containing 2% SB and 20% CSM significantly decreased hen-day egg production (73 vs. 79%) and daily egg mass (47 vs. 52 g) as compared with control group. High stimulation of humoral immunity and reduction of performance in birds fed diet with 20% CSM and 2% SB indicated that there was a negative correlation between performance criteria, especially egg production and immune response.

Key Words: humoral immunity, layer, cottonseed meal, sodium bentonite

473 Effect of yeast culture supplementation on carcass characteristics and humoral immune response of broiler chicks. M. M.

Fathi[1], I. Al-Homidan[1], A. Al-Khalaf[1], and S. Al-Mansour*[1,2], *[1]College of Agriculture & Veterinary Medicine, Qassim University, Buraidah, Al-Qassim, Saudi Arabia, [2]Al-Watania Poultry.*

An experimental study was conducted to evaluate the effect of supplemental yeast culture (Diamond V XP Yeast Culture; YC) in broiler diets on carcass characteristics and humoral immune response. One-day-old Ross 308 broiler chicks (n = 240) were randomly assigned to 1 of 4 dietary treatments based on corn and soybean meal containing 0, 1, 1.25 (recommended level) and 1.5 g/kg of YC in the diet over 42 d totaling 60 birds per treatment. All birds were kept under the same managerial, environmental and hygienic conditions except for different dietary levels of yeast. Chicks were vaccinated against Newcastle disease virus on d 7 and 18 and antibody titer was determined on d 7, 14 and 21using hemagglutination inhibition test. At 3 weeks of age, 12 chicks per treatment were injected with sheep red blood cells (SRBC). Antibody titers against SRBC were determine on d 28, 35 and 42. At the end of the experiment (d 42), 15 broilers per dietary treatment were sacrificed to evaluate carcass characteristics. Total carcass, breast muscles, drumstick and thigh yields were determined in relative figure to live body weight. The current results revealed that the chicks fed supplemented diets had significantly ($P < 0.05$) heavier body weight at market age compared with control one. Yeast inclusion significantly increased (P 0.05) carcass, breast meat, drumstick and thigh percentages. There was no significant difference among dietary groups for antibody titer against Newcastle disease. However, the chicks fed a diet supplemented with YC exhibited better antibody titers against SRBC. In conclusion, dietary inclusion of yeast significantly improved carcass yields and humoral immunity of broilers.

Key Words: yeast, broiler, immunity, carcass

474 Distinct lines of chickens express different splenic cytokine mRNA profiles in response to *Salmonella enteritidis* challenge. D. J. Coble*, S. B. Redmond, B. Hale, and S. J. Lamont, *Iowa State University, Ames.*

Chicken meat and eggs contaminated with *Salmonella* result in economic losses in the poultry industry and potential human infection. One strategy to reduce bacterial colonization and enhance food safety is to improve the immune system of chickens. The purpose of the current study is to provide insight into the immune responses of hens from 3 genetically distinct chicken lines (broiler, Leghorn, and Fayoumi) at homeostasis and after *S. enteritidis* infection. Understanding the immune responses used by different lines in response to *S. enteritidis* may assist in genetically selecting more pathogen resistant birds. Splenic messenger Ribonucleic Acid (mRNA) levels of immune-related genes (IL-6, IL-8, IL-10, IL-18, MIP1β, IFN-γ, TGFβ1, and RANTES) in 6 *S. enteritidis*-challenged and 6 mock-challenged hens were analyzed by quantitative Polymerase Chain Reaction (qPCR) in each line. Line, challenge, and their interaction were considered fixed effects. Line had a significant effect on RANTES and IFN-γ mRNA expression. Broilers expressed significantly more RANTES mRNA than Fayoumis; and significantly more IFN-γ mRNA than Leghorns. There were significant interactions of genetic line and *Salmonella* challenge on IL-6 and IL-18 mRNA expression. Bacterial challenge was significant for IL-6 mRNA expression within the Fayoumi line. Challenged Fayoumis expressed significantly less IL-6 mRNA than non-challenged Fayoumis. Although there was a significant interaction of genetic line and challenge for IL-18, Tukey′s test analysis only showed differences at a suggestive level ($P < 0.1$). Differences in mRNA expression of selected cytokines in the tested lines support the concept of distinct genetic lines utilizing different immune responses at homeostasis and in response to *S. enteritidis* infection. This highlights opportunities for using diverse lines or selecting for different immune mechanisms to maintain good health in poultry. Partial funding from USDA-NRI grant number 2007–35604–17866.

Key Words: *Salmonella*, splenic, cytokine, infection, homeostasis

475 A study on the effects of aloe vera gel on phagocytic ability of macrophages and blood parameters in broilers. B. Darabi Ghane*[1], A. Zarei[1], A. Zare Shahneh[2], and A. Mahdavi[3], *[1]Islamic Azad University-Karaj Branch, Karaj, Iran, [2]University of Tehran, Karaj, Iran, [3]University of Semnan, Semnan, Iran.*

Polysaccharides contained in herbs are among the most important factors in immunomodulatory functions. Acemannan, a polysaccharide formed by mannose units, is found in Aloe vera gel. Given the high tendency of mannose receptors in macrophages to form connections to mannose-containing carbohydrates, such link can improve phagocytic ability and activate immune system. The present study aims to examine the effects of different levels of Aloe vera gel on phagocytic abilities of macrophages as well as on blood parameters in broilers using 240 male chickens from Ross 308 distributed on a completely randomized design to 4 groups, 4 replicates each consisting of 15 chickens. The groups included a control group (basal diet), and 3 groups fed with basal diets mixed with different levels of Aloe vera gel (1.5, 2, and 2.5 percent). To study phagocytic abilities of macrophages on the d 38, carbon clearance assay method was applied to 2 birds randomly selected from each replicate. On the d 10, 24, and 42, 2 birds were randomly selected from each replicate and measure total white blood cells (WBCs), red blood cells (RBCs), hemoglobin, and hematocrit. The findings of the study revealed higher levels of phagocytic abilities in the Aloe vera gel groups compared with the control group ($P < 0.05$) and although no significant difference was observed between the groups treated by Aloe vera gel regarding phagocytic abilities, however, the 2.5% Aloe vera gel group had the highest level of phagocytic abilities. On the 10th day, the largest total WBCs was observed in the 2% Aloe vera gel while on the d 24 and 42, the largest total WBCs was that of the 2.5% Aloe vera gel group showing significant difference from the control group. No significant difference was observed between the groups regarding the level of RBCs, hemoglobin, and hematocrit on the d 10, 24, and 42. We can conclude that Aloe vera gel, which contains polysaccharides formed by mannose units (i.e., Acemannan), can improve phagocytic abilities of macrophages and increase total WBCs.

Key Words: Aloe vera, Acemannan, macrophage, blood parameter, broiler

476 Impact of non-antibiotic alternatives on performance, gut inflammation and integrity in broiler chickens. H. Lu*, O. Adeola, and K. M. Ajuwon, *Purdue University, West Lafayette, IN.*

The study was conducted to determine the effect of 6 treatments on growth performance and inflammatory gene expression in broilers chickens: organic acid (Orego-Stim), yeast extract (Alphamune), direct fed microbial (Avicorr), crude yeast extract, salinomycin (positive control, PC) and a non-treated group (negative control, NC). 672 d-old broilers were allocated to the 6 treatments. Each treatment had a total of 8 replicates at 14 birds per replicate. Birds were orally vaccinated with eimeria species using the coccivac B vaccine at 2 weeks (d 14) and at 5 weeks (d 35). On d 21 and 42, one bird per replicate was killed

for expression analyses of mucin (MUC2), interleukin 1 (IL-1Î²) and 10 (IL10) and tumor necrosis factor (TNF-Î ±) by RT-PCR in mucosal samples from the duodenum, jejunum, ileum and ceca tonsils. There was no significant difference in average daily gain (ADG) between treatments on d 21. However, on d 42 the ADG of birds treated with salinomycin was significantly higher than the Avicorr and Orego-stim treated groups ($P < 0.05$). Additionally, feed efficiency was improved by salinomycin compared with NC and Orego-stim treatments ($P < 0.05$). Gene expression levels were not different among treatments on d 21. However on d 42, expression level of TNF-Î ± was lower in the Orego-stim treatment group than NC ($P = 0.0112$). In addition, birds treated with crude yeast had a significantly higher level of IL-10 ($P = 0.0229$). Overall, these results confirm the expected improved animal performance with antibiotic (salinomycin) treatment and further show reduced inflammation with organic acid (Orego-stim) treatment in broiler chickens.

Key Words: broiler chicken, antibiotic alternatives, inflammation, immune challenge

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Infectious Bronchitis Posters

477 Pathogenicity of Colombian infectious bronchitis virus isolates. A. Rodriguez-Avila*, G. Quiñones-Chois, N. Bermudez, and M. Garcia, *Laboratorio De Biología Molecular Bioara S.a. Bogotá, Colombia.*

AAAP abstract†

478 Host-driven selection of infectious bronchitis virus. J. Phillips*, S. Thor, D. A. Hilt, and M. W. Jackwood, *Poultry Diagnostic And Research Center, University of Georgia, Athens.*

AAAP abstract†

479 Phylogenetic analysis and identification of infectious bronchitis virus (IBV) strains worldwide. M. Jackwood* and D. A. Hilt, *University of Georgia.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Infectious Bursal Disease Posters

480 Molecular diversity in the hypervariable region of VP2 from infectious bursal disease viruses. D. J. Jackwood* and S. E. Sommer-Wagner, *Food Animal Health Research Program, The Ohio State University/OARDC, Wooster.*

AAAP abstract†

481 Reassortant infectious bursal disease viruses from California with a vvIBDV genome segment A and a serotype 1 non-vvIBDV segment B. S. Stoute*, D. J. Jackwood, S. E. Sommer-Wagner, B. M. Crossley, P. R. Woolcock, and B. R. Charlton, *Food Animal Health Research Program, Ohio Agricultural Research and Development Center, The Ohio State University, Wooster.*

AAAP abstract†

482 Correlation between phylogenetic topology and antigenic properties determined by virus neutralization of field infectious bursal disease viruses detected in U.S. during 2009 and 2010. A. Banda*, T. Tabor, and R. Mackey, *Poultry Research and Diagnostic Laboratory, College of Veterinary Medicine, Mississippi State University, Pearl.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Laryngotracheitis Posters

483 Glycoprotein J and glycoprotein I specific ELISA for the detection of ILT. A. Mundt* and M. García, *Poultry Diagnostic and Research Center, Department of Population Health, University of Georgia.*

AAAP abstract†

484 Exploration of the early mechanisms involved in the immune protection against the infectious laryngotracheitis virus infection. A. Vagnozzi*, M. García, S. Riblet, G. Zavala, R. Ecco, and C. Afonso, *Poultry Diagnostic and Research Center, Department of Population Health, College of Veterinary Medicine, University of Georgia, Athens.*

AAAP abstract†

485 Whole genome sequencing of infectious laryngotracheitis. C. Boettger* and C. L. Keeler Jr., *University of Delaware.*

AAAP abstract†

486 Onset of immunity in chickens following vaccination with a recombinant herpesvirus of turkeys vaccine expressing infectious larynogotracheitis antigens. L. S. Melson* and D. L. Laris, *Intervet Schering Plough Animal Health, Millsboro, DE.*

Infectious laryngotracheitis (ILT) is an acute viral infection in chickens associated with acute respiratory disease; decrease in egg production and in some cases, high mortality. While chicken embryo origin (CEO) live attenuated infectious laryngotracheitis virus (ILTV) vaccines are efficacious in controlling ILT, these vaccines are sometimes associated with spread of vaccine virus to non-vaccinates, latently infected carriers, and the ability to revert to high levels of virulence following in vivo passage. Since infections can spread quickly through flocks, it is important that ILT vaccines provide rapid early onset of immunity. Intervet Inc. licensed a herpesvirus of turkeys (HVT) recombinant vaccine (INNOVAX-ILT) expressing glycoproteins D (gD) and I (gI) of ILTV that provides protection against both Marek′s disease and ILT. In 3 separate trials, INNOVAX-ILT was administered by the in ovo route to 18-d-old embryonated eggs or by the subcutaneous route to one-day-old chicks and challenged at 2 weeks of age with a virulent ILT challenge virus by the intratracheal route. Chickens were observed daily through 10 d post-challenge for clinical signs of ILT. At 2 weeks of age, protection was observed in 75% (Trial 1) and 91% (Trial 2) of the chickens vaccinated by the in ovo route and 94% (Trial 3) of the chickens vaccinated by the SC route while 92% - 100% of the non-vaccinated, challenged chickens developed clinical signs of ILT.

Key Words: chicken, ILT, recombinant vaccine, onset of immunity

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

487 Relative effectiveness and toxicity of methionine sources in diets for White Pekin ducks. M. Xie*[1,2], S. S. Hou[1,2], and W. Huang[1,2], *[1]Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, [2]State Key Laboratory of Animal Nutrition, Beijing, China.*

All procedures of our experiments were approved by the animal care and welfare committee of the Institute of Animal Science of Chinese Academy of Agricultural Sciences. Two dose-response experiments were conducted to assess the bioefficacy and toxicity of DL-methionine hydroxy analog free acid (MHA-FA) relative to DL-methionine (DLM) in White Pekin ducks. In experiment 1, the methionine-deficient basal diets were supplemented with 5 levels of DLM (0.3, 0.6, 1.0, 1.5, and 2.1 g/kg) or 5 equimolar levels of MHA-FA (0.34, 0.68, 1.13, 1.70, and 2.39 g/kg), respectively. A total of 704 7-d-old male White Pekin ducklings were assigned to 11 experimental treatments, each containing 8 replicate pens with 8 birds per pen. These birds were reared in raised wire-floor pens from 7 to 42 d of age. In experiment 2, the methionine-adequate control diets were supplemented with 30g/kg DLM or equimolar 33.9 g/kg MHA-FA, respectively. A total of 126 7-d-old male White Pekin ducklings were divided to 3 experimental treatments, each containing 6 replicate pens with 7 birds per pen. These birds were reared in raised wire-floor pens from 7 to 14 d of age. At the end of both experiments, the weight gain, feed intake, and feed conversion efficiency of ducklings from each treatment were measured. In our study, supplementation of DLM or MHA-FA to the methionine-deficient basal diets could all improve weight gain of Pekin ducks significantly ($P < 0.05$). However, according to the slope-ratio assay on equimolar basis, the bioavailabilities of MHA-FA relative to DLM for weight gain were 67%. On the other hand, excess DLM and MHA-FA caused significant decrease in weight gain and feed intake of ducklings ($P < 0.05$) but MHA-FA was less growth-depressing and lethal than equimolar DLM ($P < 0.05$).

Key Words: methionine, methionine hydroxy analogue, duck

488 Inevitable endogenous amino acid and CP losses in the terminal ileum of Pekin ducks as affected by cellulose supplementation. O. Akinde*[1], H. Kluth[1], and M. Rodehutscord[2], *[1]University of Halle-Wittenberg, Halle (Saale), Germany, [2]University of Hohenheim, Stuttgart, Germany.*

The objective was to study the effects of crude fiber (CF) on the inevitable losses of individual amino acids (AA) and CP measured in the terminal ileum of Pekin ducks. The study involved a 2 × 3-factorial arrangement of treatments with 2 CF levels (30 or 80 g/kg) and 3 CP levels (20, 60 or 100 g/kg). Differences in CP and CF concentrations were achieved by inclusion of corn starch at the expense of an AA-balanced protein mix and α-cellulose. The AA pattern was the same in all diets and TiO2 was used as the indigestible marker. One hundred and 92 85-d old mixed-sex Pekin ducks (3.63 kg average body weight) were housed in floor pens in groups of 8. Four pens were randomly assigned to each of the 6 treatments. After 5 d of feeding the experimental diets, ducks were asphyxiated by CO2 exposure. Digesta from a defined section of the terminal ileum was flushed out with distilled water, pooled per pen, immediately frozen and subsequently freeze-dried. Prececal flow of AA was determined for each pen based on quantitative AA intake and calculated prececal AA digestibility. Inevitable endogenous loss was estimated as the intercept of the linear regression calculated for prececal AA flow in dependence on AA or CP intake. Analysis of variance showed no significant CP × CF interaction for prececal flow of AA and CP. Prececal flow of individual AA and CP was not significantly affected by CF, but significantly ($P < 0.05$) affected by CP concentration. As judged based on confidence intervals, estimated intercepts of linear regressions between intake and prececal flow were not significantly affected by CF level for CP and any AA studied. Consequently, pooled intercepts were calculated taking both CF levels together. Estimates for inevitable losses at the terminal ileum were (±SE of estimate; in mg/kg BW per d): LYS 52 ± 5, MET 17 ± 2, CYS 34 ± 5, THR 56 ± 6, TRP 12 ± 1, VAL 55 ± 6, ARG 48 ± 5, LEU 73 ± 8, ILE 40 ± 4, ALA 52 ± 5, ASP 84 ± 9, GLY 55 ± 6, GLU 117 ± 12, PHE 44 ± 5, PRO 65 ± 8, SER 57 ± 7 and CP 1138 ± 99. It was concluded that inevitable losses of AA and CP are not affected by dietary CF concentration in heavy Pekin ducks.

Key Words: inevitable loss, amino acids, fiber, Pekin duck, ileum

489 Estimation of ileal endogenous amino acid flow in broiler chickens fed various nitrogen-free diets. C. Kong* and O. Adeola, *Purdue University, West Lafayette, IN.*

A total of 480 3-week-old broiler chickens were used in a 4-d trial to estimate ileal endogenous flow (IEF) of amino acid (AA) from feeding nitrogen-free diets (NFD) with different ratio of cornstarch to dextrose. Cornstarch (849, 566, 283 or 0 g/kg) and dextrose (0, 283, 566 or 849 g/kg) were used in Diet numbers 1, 2, 3 or 4, respectively. All diets contained calculated dietary electrolyte balance of 115 mEq/kg, and solka floc, soybean oil, monocalcium phosphate, MgO, and limestone at 50, 35, 22, 0.9, and 17 g/kg, respectively. Vitamin-mineral premix was supplemented according to NRC (1994) recommendations and chromic oxide was incorporated into diets (5 g/kg) as an indigestible marker. The birds received a standard starter diet from d 1 to 22 post-hatch. On d 22 post-hatch, all the birds were weighed and allocated to 4 treatments in a randomized complete block design. The 4 diets were fed to 12 replicate cages with 10 birds per replicate cage. On d 26 post-hatch, birds were asphyxiated with CO_2, ileal digesta from the distal section of ileum was collected. Ileal endogenous N flow was highest ($P < 0.01$) in Diet 4 (3,169 mg/kg DMI) but there were no significant differences among other diets. The IEF for all the indispensable amino acids were different ($P < 0.01$) among diets with the exception of Thr, which was not ($P = 0.07$). The respective IEF of AA (mg/kg of DMI) in birds fed Diets 1, 2, 3 or 4 were 630, 664, 646, or 1,235 for Lys, 173, 172, 177, or 361 for Met, and 68, 74, 70, or 166 for Trp. For the dispensable AA and total AA, IEF of most AA except for Cys and Pro was highest ($P < 0.01$) in Diet number 4. Ileal endogenous flow of Pro was not different among diets. Diet 4 has the lowest ($P < 0.01$) IEF of Cys, whereas there was no difference among other diets. In conclusion, the data from the current study show that the ratio of corn starch to dextrose in a nitrogen-free diet may have affect estimates of ileal endogenous flows of N and AA.

Key Words: amino acid, broiler chicken, ileal endogenous flow, N, nitrogen-free diet

490 Optimization of broiler performance fed diets varying in digestible protein and amino acids using response surface model. H. Ahmadi* and A. Golian, *Ferdowsi University of Mashhad, Mashhad, Iran.*

Response surface methodology (RSM) and 5-level-4-factor central composite design (CCD) were used to evaluate the response of broilers (BWG and FCR) to dietary digestible protein (dP), lysine (dLys), methionine+cysteine (dTSAA), and threonine (dThr). Eighty 4 cages of 5 birds each were assigned to feed diets contained 5 levels of dP (16, 17, 18, 19 and 20%), dLys (0.92, 0.98, 1.04, 1.10 and 1.16%), dTSAA (0.73 0.78, 0.83, 0.88 and 0.93%), and dThr (0.58, 0.63, 0.68, 0.73 and 0.78%) from 25 to 31 d of age. Diets were prepared using corn, soybean meal (45.2% CP), and corn gluten meal (48.6% CP). Protein and amino acid analyses were performed for these ingredients. All diets were formulated to have 3100 kcal/kg. The experimental results of CCD were fitted with the second-order polynomial equation. A ridge analysis was utilized to compute the optimum response for maximizing BWG and minimizing FCR. The fitted second-order polynomial equations for BWG and FCR are produced as follow: BWG (g/bird/d)= 570.1 −46.7 dP +1.6 dP^2 +48.2 dLys −121.4 $dLys^2$ −96.7 dTSAA −160.9 $dTSAA^2$ −321.5 dThr −289.4 $dThr^2$ −8.2 dP*dLys −5.2 dP*dTSAA +4.3 dP*dThr +191.0 dLys*dTSAA +309.6 dLys*dThr +416.7 dTSAA*dThr; R^2= 0.57; Root MS error= 3.10. FCR= −4.26 +0.80 dP-0.04 dP^2 −0.27 dLys +1.53 $dLys^2$ +8.37 dTSAA −1.93 $dTSAA^2$ −9.88 dThr +6.22 $dThr^2$ +0.01 dP*dLys +0.18 dP*dTSAA +0.52 dP*dThr −2.92 dLys*dTSAA −0.84 dLys*dThr −8.84 dTSAA*dThr; R^2= 0.66; Root MS error= 0.075. The ridge max analysis on BWG and ridge min analysis on FCR models revealed that the maximum BWG may be obtained with dP 19.9, dLys 1.05, dTSAA 0.85, and dThr 0.70% and minimum FCR may be obtained with dP 20.0, dLys 1.04, dTSAA 0.84, and dThr 0.67%. At the optimum point, the predicted BWG and FCR were 70.6 g/bird/d and 1.54, respectively. The combination of CCD and RSM techniques consider simultaneously all investigating factors and their possible interactions. Thus, it appears that the platform may be used to describe relationship between dietary concentration of nutrients and broiler performance to achieve optimal target.

Key Words: response surface model, digestible protein and amino acid, broiler chicken

491 Performance of broiler chicks fed pre-starter diets formulated with increasing digestible lysine levels and obtained from eggs of different breeder ages. E. S. Oliveira*[1,2], J. S. Santos[1,2], E. M. Oliveira[1,2], S. L. Aguilar[1,2], and J. H. Stringhini[1,2], *[1]Universidade Federal de Goiás, Goiânia, Goiás, Brazil, [2]Cnpq.*

This study was performed to determine the performance of broiler chicks from different breeder ages fed increasing levels of digestible lysine. An experiment was performed with 320 Cobb day-old chicks obtained from breeders with 37 and 52 weeks of age. The birds were previously weighed and placed in heated batteries. The randomized block design was a 2 × 4 factorial arrangement (ages and digestible lysine levels in pre-starter diets) in a total of 8 treatments and 5 replications of 5 birds each. The performance of chicks was evaluated from 1 to 7 d and from 1 to 21 d of age. Experimental basal diets were formulated with corn and soybean meal and lysine HCl was used to obtain 1.1%, 1.2%, 1.3% and 1.4% of digestible lysine. Experimental diets were fed from 1 to 7 d of age and after that birds were fed with commercial starter diet. The performance variables analyzed were weight gain, feed intake and feed-to-gain ratio. Birds and diets were weighed at 1, 7, 14 and 21 d of age, and mortality was measured in the end of each period. Chicks hatched from different breeder ages did not present any response to the lysine levels used. Breeder age did not affect performance in pre-starter ration. All digestible lysine levels can be used but the authors recommend 1.3% digestible levels to attend Brazilian nutrition tables.

Key Words: digestible lysine, eggs, poultry, broiler breeder

492 Effects of glutamine added to glutamic acid and phytogenics additive on intestinal mucous morphology of broilers challenged with *Eimeria acervulina*. V. C. Pelícia*, J. R. Sartori, A. C. Stradiotti, P. C. Araujo, M. K. Maruno, T. C. Putarov, W. T. Silva, L. A. Madeira, and A. C. Pezzato, *São Paulo State University, Botucatu, SP, Brazil.*

This study evaluated the influence of glutamine added to glutamic acid and phytogenics additive supplementation on small intestine mucous morphology of broilers, experimentally infected with *Eimeria acervulina*. A total of 450 Cobb male chicks were distributed in a completely randomized design with 6 treatments with 3 replications on time. The treatments were: control diet (CD); CD + vaccine against coccidiosis; CD+ antibiotics growth promoter (AGP); CD+ glutamine and glutamic acid (Gln/Glu); CD+ phytogenics additive (FAs) and DC+ Gln/Glu+ FAs. Birds from CD + vaccine treatment were orally vaccinated at the third day old against coccidiosis. At the 16 d old, all birds were individually inoculated by oral via with 500.000 *Eimeria acervulina* oocists. At 21th days old, 2 broilers from each repetition were sacrificed for intestinal sample collection. Birds from Gln/Glu and Gln/Glu +FAs showed greater duodenum villi height compared with birds from CD treatment and these 2 treatments did not differ from the other treatments which also did not differ among them ($P < 0.05$). The ileum villi were greater in Gln/Glu and Gln/Glu +FAs treatments compared with CD and AGP and did not differ from treatment FAs ($P < 0.05$). There was no difference for jejunum villi height and crypt depth. Duodenum crypts were greater for Gln/Glu treatment compared with control and vaccine and it did not differ from FAs, Gln/Glu+FAs and AGP ($P < 0.05$). Ileum crypts were greater in Gln/Glu+FAs-fed broilers compared with control, vaccine and AGP and it did not differ from Gln/Glu and FAs-fed broilers ($P < 0.05$). In general, the better results were observed in broiler chickens fed supplemented diets with Gln/Glu combined or not with FAs. These additives can be an alternative to antibiotics growth promoter and can minimize the negative effects on the structure of intestinal mucous of broilers challenged with coccidiosis.

Key Words: coccidiosis, additives, poultry

493 Dietary lysine levels for broiler breeder hens. C. F. S. Oliveira[2], N. K. sakomura[1], F. G. P. Costa*[2], E. P. Silva[1], and L. Hauschild[1], *[1]Universidade Estadual Paulista - Faculdade de Ciencias Agrarias e Veterinarias, Jaboticabal, SP, Brazil, [2]Universidade Federal da Paraiba, Areia, Paraiba, Brazil.*

The aim of this paper was to determine the digestible lysine nutritional requirements for broiler breeder hens. Three hundred and 20 birds were distributed into 40 pens using a completely randomized design with 8 treatments (0.220, 0.293, 0.367, 0.440, 0.513, 0.660, and 0.733% of lysine), with 5 replicates of 8 birds. The diets were formulated based on dilution technique. A diet based on corn and soybean meal was formulated to contain 0.733% of lys, and another protein free diet with the same levels of ME, minerals and vitamins. The dietary lys levels were obtained by diluting the first diet with protein free diet. The eighth treatment was to check if the response of birds it would be in function of lys level. Data was analyzed by quadratic regres-

sion, broken-line and first intercept X value of the broken-line (on the plateau) and the quadratic curve. The estimated digestible lys levels based on egg mass (g of egg/bird/day), feed conversion ratio (kg feed/kg of egg and kg feed/dozen of egg) were 706, 569, 566 mg/bird/day using the broken line model, and by quadratic model were 1086, 893 e 908 mg/bird/day, respectively. The estimated digestible lys levels for the first intersection of the broken line and quadratic models were 826, 688, and 695 mg/bird/day, respectively. The best model to estimate lysine requirement was the first intersection of the broken line with the quadratic model.

Key Words: requirements, lysine, broiler breeder hens, dose response, dilution technique

494 Crude protein requirement for egg production of free-range laying hens. M. M. A. Brainer[1,2], C. B. V. Rabello*[1], C. C. Lopes[1], W. R. L. Medeiros[1], and R. A. Lima[1], *[1]Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil, [2]IFET Goiano, Campus Ceres/GO, Ceres, Goias, Brasil.*

The objective of the current study was to determine the crude protein requirement for egg production of free-range laying hens raised in semi-intensive system. The experimental design was a complete randomized design with 4 pens of 30 birds, 120 birds of 33 weeks of age. The experiment lasted 9 weeks and the birds had access to paddocks areas from 7h to 17h daily. The diet provided ad libitum was formulated in accordance with the recommendations of the strain (Embrapa 051); the composition was: 2,800 kcal/kg metabolizable energy, 15.5% crude protein, 3.7% calcium and 0.42% available phosphorus. A sample of 6 eggs from each group was collected weekly, weighed and mixed in a blender for 3 min, frozen, lyophilized and analyzed for dry matter and nitrogen. The nitrogen requirements for egg production (Ne) was determined considering the average of the eggs composition divided by the nitrogen efficiency utilization, which when multiplied by 6.25 determined the crude protein requirement for egg production (CPe). The efficiency of the utilization of nitrogen for egg production (ke) was determined considerng the nitrogen retained in the egg (NRe) divided by N intake (NI) minus the nitrogen designed for maintenance (Nm) and weight gain (Ng), then: ko = NRO/[NI-(Nm + Ng)]. The data of Nm and Ng were obtained by the authors in the previous tests. According to the values of mass and protein of eggs produced weekly during the experimental period, was observed that the protein content of eggs did not vary with the age of birds, with an average of 11.20% crude protein. The nitrogen efficiency utilization for egg production was 39%, a value lower than those found in the literature for commercial poultry. The crude protein (CPe) for egg production was calculated by dividing the amount of egg protein (11.20%) by the protein efficiency utilization of production (39%), resulting in 0.289g of CP/g egg produced.

Key Words: egg production, factorial method, layers, protein requirements

495 Threonine biomass as a source of amino acids for poultry. P. Utterback*[1], E. Jimenez[1], S. Block[2], J. Less[2], and C. Parsons[1], *[1]University of Illinois, Urbana, [2]ADM, Decatur, IL.*

During the production of threonine, biomass occurs as a coproduct. Two trials were conducted to determine its value as an amino acid source for poultry. A precision-fed cecectomized rooster assay was conducted to determine digestibility of amino acids in drum-dried threonine biomass (TBM). The TBM contains 79% crude protein, 3.91% Thr, 0.71% Cys, 2.07% Met, 4.83% Val, and 5.13% Lys. Standardized amino acid digestibility of amino acids in the roosters was very high, averaging 96–98%. The lysine digestibility coefficient was found to be 95.8%. Threonine, Met, and Val digestibility coefficients were 97.9%, 98.6%, and 97.2%, respectively. A 14-d growth assay was conducted using 8-d old crossbred chicks to evaluate TBM as a source of amino acids, particularly valine, in chick diets. Treatments 1–4 evaluated TBM as a source of valine only. These treatments consisted of a semi-purified, valine-deficient diet as treatment 1 (T1) with 1, 2.5, and 5% TBM added to T1 for treatments 2–4, respectively. Treatments 5–7 evaluated TBM as a general source of amino acids. Treatment 5 (T5) had a 20% reduction of the NRC recommended values for Met, Lys, Thr, Trp, Ile, and Val. The T5 diet was supplemented with 1 and 2.5% TBM for treatments 6 and 7. There was a large and linear increase in weight gain and feed efficiency from adding 1, 2.5, and 5% TBM to the valine-deficient diet, T1. There was a significant improvement in feed efficiency when 2.5% TBM was added to T5, the diet containing reduced levels of several essential amino acids. This study shows that TBM is a good source of highly digestible valine and other amino acids for poultry.

Key Words: threonine biomass, amino acids, valine, chicks

496 Broiler responses to essential crystalline amino acid supplementation of a low crude protein starter diet with different glycine + serine:lysine ratio. I. C. O. Rojas[1], A. E. Murakami*[1], R. V. Nunes[2], F. J. Urgnani[1], and C. Eyng[1], *[1]Universidade Estadual de Maringá, Maringá, Paraná, Brazil, [2]Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.*

A study was carried out to evaluate responses of broiler chicks to essential crystalline amino acid supplementation of a low crude protein starter diet (1 to 21 d old) with different Gly + Ser:Lys ratio. A total of 1,050 one-day-old Cobb male broilers were distributed in a completely randomized experimental design into 6 treatments with 5 replicates of 35 birds each. Dietary treatments consisted: T1 (control) – corn-soybean meal based diet supplemented with DL-Met, L-Lys HCl, and L-Thr, formulated without crude protein (CP) restriction to meet or exceed ideal amino acids recommendations (Gly + Ser:Lys ratio of 150%); T2 – reduced-CP diet until the next limiting AA requirements were met containing supplemental L-Val (Gly + Ser:Lys ratio of 140%); T3 – T2 plus Gly (Gly + Ser:Lys ratio of 150%); T4 – T2 plus L-Ile and L- Arg (Gly + Ser:Lys ratio of 130%); T5 and T6 – T4 plus Gly (Gly + Ser:Lys ratio of 140 and 150%, respectively). Data were submitted to ANOVA and means were compared using Tukey′s multiple-range test at 5% probability. At d 7 and 21, low CP diet supplemented with Val, Ile, and Arg but not with Gly (T4) resulted in chicks with worse feed conversion ($P \leq 0.05$) than the control diet. Treatments with Gly + Ser:Lys ratio of 140 and 150% to low CP diets resulted in similar feed conversion ($P \geq 0.05$) to that of chicks fed the control diet. Feed intake, BW gain, abdominal fat, carcass, and parts yields were unaffected by dietary treatments ($P \geq 0.05$). The findings of this study suggest that nutritionists can reduce CP of the diets maintaining the Gly + Ser:Lys ratio not lower than 140% with no changes in chicken performance.

Key Words: amino acid, broiler, glycine, low-protein diet

497 The effect of a low crude protein starter diet with different glycine + serine:lysine ratio on serum parameters and litter characteristics in broilers. I. C. O. Rojas[1], A. E. Murakami[1], R. V. Nunes[2], K. M. O. Boso[1], and C. R. do Amaral Duarte*[1], *[1]Universidade Estad-*

ual de Maringá, Maringá, Paraná, Brazil, [2]Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.

An experiment was conducted to determine the effect of a low crude protein starter diet (1 to 21 d old) with different Gly + Ser:Lys ratio on serum parameters and litter characteristics in broilers. A total of 1,050 one-day-old Cobb male broilers were distributed in a completely randomized experimental design into 6 treatments with 5 replicates of 35 birds each. Dietary treatments consisted: T1 (control) – corn-soybean meal based diet supplemented with DL-Met, L-Lys HCl, and L-Thr, formulated without crude protein (CP) restriction to meet or exceed ideal amino acids (AA) recommendations (Gly + Ser:Lys ratio of 150%); T2 – reduced-CP diet until the next limiting AA requirements were met containing supplemental L-Val (Gly + Ser:Lys ratio of 140%); T3 – T2 plus Gly (Gly + Ser:Lys ratio of 150%); T4 – T2 plus L-Ile and L- Arg (Gly + Ser:Lys ratio of 130%); T5 and T6 – T4 plus Gly (Gly + Ser:Lys ratio of 140 and 150%, respectively). At d 21, treatments T4, T5 and T6 caused in lower N contents and NH3 emission in litter ($P \leq 0.05$) than the control diet. Broilers fed with low CP diets containing Gly + Ser:Lys ratio of 140 and 150% presented lower serum uric acid (SUA) ($P \leq 0.05$). Low CP diet supplemented with Val, Ile, and Arg but not with Gly (T4) resulted in lower serum total protein and albumin ($P \leq 0.05$) than T3 and control diet. According to the results, broilers fed low crude protein diet with Gly + Ser:Lys ratio not lower than 140% improve N utilization in terms of SUA, N contents and NH3 emission in litter. These advantages can improve the air quality into the poultry houses.

Key Words: amino acid, broiler, low-protein diet, poultry litter

498 Digestible lysine requirement of broilers based on practical diet. M. Shivazad*, F. Alami, M. Zaghari, and H. Moravej, *University of Tehran, College of Agriculture and Natural Resources, Animal Science Department, Karaj, Tehran, Iran.*

This study was conducted to estimate the requirement of digestible lysine for broiler from 35 - 49 d of age. 240 chicks were used in a completely randomized design, consisted of 2 sexes and 6 digestible lysine levels. Experimental diets were formulated to be isoenergetic, isonitrogenous. Fitted broken lines on different responses indicated break points at 0.93, 0.93 for body weight, 0.98, and 0.92 for FCR for male and female, respectively. The results showed that digestible lysine requirement of male broilers for maximum breast yield percentage, plasma free lysine and antibody titer against Newcastle disease virus was exceeded the range of lysine levels tested. The result showed that the dietary lysine had a significant increasing effect on the plasma free lysine, albumin, total protein, immunoglobulin, antibody titer against SRBC and Newcastle disease virus and H/L. In conclusion, lysine requirements of broilers for performance were lower than breast yield percentage and immune responses. Broken-line analysis showed that the concentrations of plasma free lysine were useful physiological indicator for determining digestible lysine requirement of male and female broilers. The results from this experiment suggested that the estimated requirements based on exponential response curves were higher than estimated requirements by using broken-line model.

Key Words: digestible lysine, blood, immune response

499 Effects of different dietary level of arginine, lysine and their ratios on performance and meat yield of broilers. F. Sun*, H. Yan, and H. Cai, *Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China.*

This study was designed to evaluate the effects different dietary levels of lysine, arginine and arginine:lysine ratios on performance and carcass yield of broiler chickens. AA broilers (n = 672) were divided into 6 treatments, each treatment contained 8 replicates with 14 birds each. At each phases (0–21day and 22 to 42 d) Lys was set up at low and high levels according to NRC Recommendation (1994) (low) and AA recommendation (high). In each level of Lysine, arginine was added according to argine:lysine at 1:1, 1.2:1, and 1.4:1, respectively. At 0–21 d and 22–42 d, broilers had largest ($P < 0.05$) body weight and lowest ($P < 0.05$) feed efficiency in the treatment with high lysine level and high arginine and lysine ratio, while BWG was lower and feed efficiency was higher in the treatment with low lysine level and high arginine and lysine ratio. The results also showed that different lysine and arginine level and arginine and lysine ratios had different effect on carcass yield. At0–21day high lysine level and high arginine:lysine ratio in broiler's diet increased ($P < 0.05$) carcass weight, thigh yield and breast yield. While at 22–42day, high lysine and high arg:lys ratio affected only breast yield, but not thigh. Effects of different dietary level of Arginine, Lysine and their

Key Words: lysine, arginine, broiler

500 Methionine plus cystine requirements for pullets from 13 to 18 weeks of age. F. G. Perazzo Costa*[1], M. Ramalho Lima[1], Y. Mercier[2], P. Geraert[2], M. Ceccantini[2], S. G. Pinheiro[1], R. B. Souza[1], A. S. Cardoso[1], and C. S. Santos[1], *[1]Federal University of Paraiba, Areia, Paraiba, Brazil, [2]Adisseo France S.A.S, France, [3]Adisseo Brazil, Sao Paulo.*

It is well established that layer egg production is reflecting pullet initial rearing phases. A better knowledge of the accurate nutrient and TSAA need for these birds is essential for a sustainable development of egg production. Thus, the aim of this study was to evaluate the Met + Cys dietary requirement of layers from 13 to 18 weeks of age, based on growth performance. This study compared 2 nutritional recommendations currently used NRC (1994) and Rostagno et al. (2005). The study was conducted at Federal University of Paraiba, Brazil. A total of 480 birds were allocated in completely randomized design with 6 treatments and 10 replicates of 8 birds each. The experimental diets were formulated for supplying the recommendations proposed by NRC (1994) and Brazilian Tables for poultry and swine (Rostagno et al. 2005). The treatments were: T1: corresponding to NRC (1994); T2 to T6 corresponding to Brazilian table nutrients recommendation with a range of 80% to 120% of the TSAA recommendations suggested by Rostagno et al. (2005), with T2: 80%; T3: 90%; T4: 100%; T5: 110% and T6: 120%. Our results show that NRC (1994) TSAA recommendations gave the lowest final body weight and weight gain; moreover, these birds had also the highest feed intake compared with other treatments, leading to highest numerical FCR. For diets formulated using the recommendations suggested by Rostagno et al. (2005), while there was no effect of treatments on feed intake, there was a significant ($P < 0.01$) linear increase for final body weight and weight gain, and consequently a significant linear ($P < 0.01$) decrease in feed conversion ratio. These results show that neither NRC (1994) nor Brazilian Table (Rostagno et al. 2005) recommendations allow reaching maximum performance and that TSAA requirement for replacement light pullets from 13 to 18 weeks of age is underestimate. Finally, the best results on growth and feed conversion ratio were observed when the supply of nutrients was based on Brazilian Tables nutrients recommendation with digestible Met + Cys corresponded to 120% of recommended level.

Key Words: dietary requirement, methionine, pullet, performance, TSSA

501 An approach to determine endogenous lysine in the gastrointestinal tract of broiler chickens. S. Cerrate*, C. Salas, R. Ekmay, J. England, and C. Coon, *University of Arkansas, Fayetteville.*

An isotope dilution technique was developed to measure the jejunum or ileal endogenous lysine recovery in broiler chickens. Chicks were fed a diet high in non starch polysaccharides from 7 to 24 d of age. Previous fasting of 12 h, D4-lysine label were orally administrated to the chicks every day from 16 to 23 d of age at 2% of lysine intake (30 - 25 mg/kg BW/d). Two hours after the oral administration plasma, jejunum or ileal samples were taken every day. Real lysine digestibility was proposed as the ileal lysine digestibility plus endogenous lysine in jejunum or ileal. The isotopic steady state of D4-enrichment was reached at d 5 for both plasma and jejunum. The D4 enrichments of ileal samples were significantly similar among days of oral administration. Significant inverse allometric power-law relationships between D4-enrichements and lysine amount of jejunum and ileal show that when the amount of lysine is low the endogenous lysine is high and this effect was more marked in ileal samples. The endogenous lysine recovery (ENR) was higher in the jejunum than in the ileal (0.52 vs 0.19 g/kg dry matter, $P = 0.034$). The ileal lysine digestibility was 80.7% and the real lysine digestibility was greater in the jejunum than did in ileal (84.5 vs 82.1%). We concluded that the 5 d of oral administration and the jejunum are the best time and place to determine ENR in broiler chickens.

Key Words: D4-isotope dilution technique, endogenous lysine, oral label administration

502 Effect of wheat inclusion and xylanase supplementation of the diet on intestinal enzyme activity, nutrient retention and performance in laying hen from 25 to 47 wks of age. S. Mirzaei[1], M. Zaghari[1], S. Aminzadeh[2], M. Shivazad[1], M. P. Serrano[3], and G. G. Mateos*[3], *[1]Department of Animal Science, University of Tehran, Karaj, Iran, [2]Department of Animal and Marine Biotechnology, National Institute of Genetic Engineering and Biotechnology, Tehran, Iran, [3]Department of Animal Science, Universidad Politécnica de Madrid, 28040 Madrid, Spain.*

A trial was conducted to examine the effects of increasing levels of wheat in the diet and xylanase (ES) supplementation on nitrogen and ether extract retention, pH of the GIT, productive performance from 25 to 47 wks of age, and enzyme activity at the small intestine level. The basal diets (from 25 to 33 wks and from 33 to 47 wks) consisted of soybean meal and corn, and the wheat was introduced in the experimental diets at expenses of corn, primarily. The experiment was completely randomized with 8 treatments arranged factorially with 4 levels of wheat (0, 23, 46, and 69% that resulted in a dietary xylan content of 1.8, 2.0, 2.2, and 2.4%, respectively) and 2 levels of xylanase [none or added at the dose recommended by the supplier) Lesaffre, Marquette-lez-lille, France)]. Each treatment was replicated 5 times (6 hens). The inclusion of wheat in the diet did not influence average daily feed intake, egg production, or BW gain of the hens but decreased ($P \leq 0.05$) egg weight and egg mass. The reduction in egg weight with increased level of wheat in the first feeding period could be due to the low linoleic acid content (LIN) of some of the wheat diets (1.3, 1.1, 1.0, and 0.8%, respectively) as well as the antinutritional effects of xylans. The ES improved egg production, egg mass, and FCR ($P \leq 0.05$). Diet did not affect the pH of any of the segments of the GIT. Wheat inclusion or ES of the diet did not affect nitrogen or fat retention at 47 wk. The inclusion of wheat in the diet increased aminopeptidase activity ($P \leq 0.01$) in the duodenum but not amylase or lipase activity. Enzyme supplementation did not influence enzyme activity. It is concluded that wheat with a high NSP content, supplemented with xylanase, could be used in diets for laying hens at levels of up to 69% without hindering productive performance. However, the level of linoleic acid has to be taken into account if egg weight is important when wheat is included in the diet in substitution of corn.

Key Words: intestinal enzyme activity, laying hen performance, egg weight, xylanase

503 Effect of wheat cultivars and enzyme supplementation on broiler chicks performance from 1 to 42 day of age. N. Saeidi, A. Karimi*, G. Sadeghi, and A. Vaziri, *Animal Science Department, Faculty of Agr., University of Kurdistan, Sanandaj, Kurdistan, Iran.*

It has been well established that some wheat cultivar contained higher level of soluble non-starch polysaccharides which may adversely influence broiler chicks' performance, especially when wheat inclusion level in the diet exceed birds' tolerance level. An experiment was carried out using 3 common wheat varieties popular in Kurdistan region, Iran (known as Sardari, Zarrin and Azar) with or without enzyme preparation (0.30 g / kg of diet, Grindzyme GP 15000) on performance of broiler chicks during 1 to 42 d of age. A total of 416, one day old Ross 308 broiler chicks were randomly assigned to 8 dietary treatments, each replicated 4 times (in floor pen) in a completely randomized design (CRD) with 4 × 2 factorial arrangements. Wheat inclusion level in wheat-SBM based diets during starter and grower period was set at 62.05 and 66.47%, respectively. Corn-SBM based diet (with or without enzyme supplementation) set as control treatments. Chick's body weight, feed intake and feed conversion ratio, after mortality adjustments, were determined in weekly intervals. At ages of 20 and 40d, 4 birds per treatment were sampled for measurement of relative weight of gastrointestinal organs and carcasses characteristics. Results showed that birds fed corn-SBM basal diet had significantly ($P < 0.05$) higher feed intake during 1–21d, body weight at 21d, and daily gain during 1–21d compared with birds fed with wheat-SBM based diets; however, the difference among corn and wheat based treatments disappeared during 21–42d. The results also indicated that wheat cultivar did have significant ($P < 0.05$) impacts on birds' feed intake, feed conversion ratio and relative weight of different gastrointestinal organs. Results showed that addition of enzyme to the diet did not have significant ($P > 0.05$) influence on birds body weight; however, enzyme supplementation significantly ($P < 0.05$) improved feed conversion ratio and increased ileum relative weight (%). In conclusion, the results showed the wheat variety has significant effects on birds' performance and addition of enzyme to the diet has a potential to improve feed utilization.

Key Words: broiler, corn, enzyme, performance, wheat

504 True ileal amino acid digestibility of ingredients in broilers in the presence or absence of a mono component protease. M. Iwaniuk*[1], C. R. Angel[1], S. L. Vieira[2], and N. E. Ward[3], *[1]University of Maryland, College Park, [2]Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, [3]DSM Nutritional Products, Parsippany, NJ.*

A study was conducted to evaluate the true amino acid (TAA) digestibility of individual ingredients for broilers. Straight run Ross 708 broilers were raised to 17 d in floor pens and assigned to battery pens in a completely randomized design of 12 treatments (Trt), 8 replicates of 7 birds per pen. A nitrogen free diet (NFD) was formulated with 0.3% TiO_2 as a marker. The corn-starch, sucrose and SolkaFlock in the NFD diet were replaced in part by the ingredients being tested such that all the protein in the diet came from the tested ingredient. Ingredients were added to achieve 20% protein for the high protein ingredients or to a maximum of 96% of the diet for the low protein ingredients. Ingredient percentages tested in the final diets were: 42% soybean meal (SBM), 40% meat and bone meal (MBM), 75% corn distiller dried grains (DDGS), 96% corn and 96% bakery by-product meal (BPM). Each Trt was supplemented or not with 200 ppm of a mono component serine protease (RONOZYME ProActTM CT, DSM Nutritional Products, containing 75,000 protease units/g of enzyme product). Birds were fed the diets for 4 d. At 22 d birds were euthanized and the distal half of the ileal content collected, pooled by pen and freeze-dried. Statistics were done with a 2 way ANOVA (5 ingredients with or without protease) and contrasts between diets with students T-Test. There was a main effect ($P < 0.05$) of protease on digestibility of Thr, Met, Cys, Lys, Arg, Ser, Val, Asp. Ile, and His. There were no protease by ingredient interactions except for Cys. Addition of the protease improved ($P < 0.05$) the digestibility of Thr, Cys, Met, Lys and Ser in SBM; Thr, Cys, Met, Ser and His in corn; Cys, Met, Arg, Ser, Val and His in DDGS; Cys, Met, Lys, Ser and His in MBM; and Met, Arg, and Ser in BPM. For SBM the TAA digestibility was improved ($P < 0.05$) from 75.2 to 83.2% for Thr, 74.9 to 81.2% for Cys, 83.1 to 86.3% for Met, 83.8 to 87.1% for Lys, and 80.6 to 85.4% for Ser with the prote-

ase. The protease was effective in improving the true AA digestibility of selected AA and the degree of the impact varied between AA and ingredients.

Key Words: amino acid digestibility, broiler, protease

505 Effects of a mono component protease on true ileal amino acid digestibility of selected ingredients for turkey poults. C. R. Angel*[1], S. L. Vieira[2], M. Iwaniuk[1], and N. E. Ward[3], *[1]University of Maryland, College Park, [2]Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, [3]DSM Nutritional Products, Parsippany, NJ.*

A study was conducted to evaluate the true amino acid (TAA) digestibility of individual ingredients for turkeys in the presence or absence of a protease. Female Nicholas turkey poults were raised to 17 d of age on a common starter diet in floor pens. At 17 d of age, birds were assigned to battery pens in a completely randomized design of 12 treatments (Trt), 8 replicate pens, 6 birds per pen. A nitrogen free diet (NFD) was formulated with 0.3% TiO_2 as a marker. The corn starch, sucrose and SolkaFlock in the NFD diet were replaced in part by the test ingredients which were added to achieve 20% diet crude protein or to a maximum diet inclusion of 96% for the low protein ingredients. Ingredient inclusion in diets was 42% soybean meal (SBM), 40% meat and bone meal (MBM), 75% corn distiller dried grains (DDGS) and 96% bakery by-product meal (BPM). Each Trt was supplemented or not with 200 ppm of a mono component serine protease (RONOZYME ProActTM CT, 75,000 protein units/g of enzyme, DSM Nutritional Products). Birds were fed the diets for 4 d, euthanized and distal ileal content collected and pooled by pen. Data were analyzed with a 2 way ANOVA (5 feed ingredients supplemented or not with protease) and contrasts done with a Student's t-test. There were no interactions between feed ingredient and protease. Addition of the protease improved ($P < 0.05$) TAA digestibility of Thr (87.7 to 91.5%), Met (89.7 to 92.3%) and Cys (82.2 to 86.3%) in SBM and Thr (80.6 to 84.5%), Met (86.9 to 89.8%), Ser (84.4 to 87.2%), Cys (59.6 to 64.0%), Arg (86.7 to 90.0%) and Phe (86.6 to 90.0%) in MBM. The addition of the protease improved the TAA digestibility of Thr, Met, Lys, Arg, and Val in DDGS; Thr, Met, Cys, and Phe in corn; while for BPM Thr, Met, Lys and Phe were improved. The protease effectively improved the TAA digestibility of selected AA and the degree of the impact varied between AA and ingredients.

Key Words: true amino acid digestibility, turkey, amino acid, ingredient

506 Performance of broilers fed diets containing multienzyme complex and lipid sources during starter phase. G. V. Polycarpo*[1], A. C. Pezzato[1], V. C. Cruz[2], J. R. Sartori[1], V. B. Fascina[1], F. B. Carvalho[1], I. M. G. P. Souza[1], W. T. Silva[1], N. C. Alexandre[1], L. P. Centenaro[1], and F. Vercese[1], *[1]São Paulo State University, UNESP–Botucatu Campus, Botucatu, São Paulo, Brazil, [2]São Paulo State University, UNESP–Dracena Campus, Dracena, São Paulo, Brazil.*

This work was carried out at Botucatu Campus, Brazil, with the aim of evaluating the performance of broilers fed diets containing multienzyme complex (MeC) and different lipid sources from 1 to 21–d old. A total of 840 1–d–old male Cobb chicks were housed, allotted in a completely randomized design featuring a 2x2+2 factorial arrangement, 2 lipid sources (soybean oil and poultry fat) with 2 inclusion levels (2% and 4%) in feeds supplemented with MeC; and 2 control treatments without added lipids — a positive control using MeC–supplemented feed, and a negative control without added MeC. There were 4 replications with 35 broilers per experimental unit (density = 14 birds/m^2). Mean initial chick weight was 44.55g. The different feeds featured similar energy and amino acid levels within each breeding phase, and were formulated based on corn and soybean meal. Water and feed were supplied ad libitum. There was no interaction ($P > 0.05$) between lipid source and inclusion level for the following studied variables: body weight (BW), average gain (AG), average feed intake (AFI) and feed:gain ratio (F:G). Lipid sources did not influence ($P > 0.05$) broiler performance. Birds fed diets containing lipids in feed showed greater ($P < 0.01$) BW, AG and AFI than those fed lipid–free diets. Chickens fed with MeC in rations without inclusion of lipid led to higher ($P < 0.01$) BW (921 g vs. 884 g), AG (876 g vs. 839 g) and AFI (1250 g vs. 1190 g) than those fed without MeC. The inclusion of 4% lipid in feed provided higher BW (1019 g vs. 980 g), AG (974 g vs. 935 g), and AFI (1358 g vs. 1307 g) compared with 2% inclusion, and better F:G in relation to lipid–free diets. Inclusion of 4% of lipid in feed increases BW, AG and AFI of birds, regardless the lipid source. The addition of MeC in rations without lipid increases BW, AG and AFI of broiler chickens.

Key Words: additive, enzyme, fat sources, poultry fat, soybean oil

507 Effect of phytase supplementation on the sodium needs of broilers. S. D. Goodgame*, F. J. Mussini, C. D. Bradley, C. Lu, N. Comert, and P. W. Waldroup, *University of Arkansas, Fayetteville.*

It has been reported that phytase influences sodium metabolism. However, it has not been demonstrated that this influences the total dietary requirement for Na. A study was conducted to evaluate the possible effects of phytase supplementation on sodium needs. A nutritionally complete corn-soybean meal diet with 0.45% nonphytate P (NPP) and 0.90% Ca was subjected to modification in amounts of limestone, dicalcium phosphate, sodium chloride, and sand. Levels of Ca and NPP were adjusted for phytase supplementation based on assumed release of these minerals (0.10% NPP and 0.10% Ca for 1 X; 0.15% NPP and 0.20% Ca for 2 X; 0.20% NPP and 0.20% Ca for 4X) where X = 500 FTU/kg of Quantum phytase. Within each phytase group a low-Na and high-Na diet was prepared. The low-Na diet had no supplementation (0.10% Na) while the high-Na diet was supplemented with NaCl to provide 0.28% Na. The low and high Na diets were then blended to give a range of Na levels in increments of 0.03%. Each diet was then fed to 6 pens of 5 male chicks (Cobb 500) from one to 18 d of age. Measurements included BW, FCR, fecal moisture, tibia diameter, and bone break force (BBF). Regression analysis was used to estimate Na needs for each measurement. The phytase level had no significant effect on BW, FCR, fecal moisture, mortality, tibia diameter, or BBF, indicating that the reductions in dietary NPP and Ca were overcome by the phytase supplementation. In contrast, dietary sodium level had significant effects on BW, FCR, fecal moisture, tibia diameter, and BBF. The only significant interaction between dietary Na and phytase was for BBF; at the 4X level of phytase the BBF was reduced at the lowest Na levels compared with other Na levels; however the Na estimate for BBF was identical for diets with 0 or 4X phytase. Based on one-slope regression analysis the Na requirements over all phytase levels for BW, FCR, and BBF were 0.21, 0.15, and 0.15%, respectively.

Key Words: phytase, sodium, broilers

508 Effects of a mono component protease on true ileal amino acid digestibility of selected ingredients for commercial laying hens. C. R. Angel*[1], S. Purdum[2], S. L. Vieira[3], M. Iwaniuk[1], and N. E. Ward[4], *[1]University of Maryland, College Park, [2]University of*

Nebraska, Lincoln, [3]Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, [4]DSM Nutritional Products, Parsippany, NJ.

A study was conducted to evaluate the true amino acid (TAA) digestibility of individual ingredients for laying hens. Hyline W36 white leghorn hens 56 wks of age were assigned to cages in a completely randomized design of 10 treatments (Trt) with 6 replicates of 4 birds per cage. A nitrogen free diet (NFD) was formulated with 0.3% TiO_2 as a marker. The corn-starch, sucrose and SolkaFlock in the NFD diet were replaced in part by the ingredients being tested such that all the protein in the diet came from the tested ingredient. Ingredients were added to achieve 20% protein for the high protein ingredients or to a maximum of 96% of the diet for the low protein ingredients. Ingredient percentages tested in the final diets were: 42% soybean meal (SBM), 40% meat and bone meal (MBM), 75% corn distiller dried grains (DDGS), and 96% bakery by-product meal (BPM). Each Trt was supplemented or not with 200 ppm of a mono component serine protease (RONOZYME ProActTM CT, 75,000 protease units/g of enzyme product). Birds were fed the diets for 4 d and euthanized by cervical dislocation and the distal half of ileal content collected, pooled by pen and freeze-dried. Data was analyzed using a 2 way ANOVA (4 feed ingredients supplemented or not with protease) and contrasts between diets were done using students T-Test. There was a main effect of protease on the TAA digestibility of Thr, Met, Cys, Lys, Arg, Ser and Val and there were protease by ingredient interactions for Cys, Lys, Ser and Val primarily associated with the more pronounced impact of protease when added to meat MBM vs in SBM and DDGS. Addition of the mono component protease to SBM improved ($P < 0.05$) TAA digestibility of Thr (84.1 to 90.09%) and Met (89.1 to 94.4%). For MBM, the addition of the protease improved the TAA digestibility of Thr (64.1 to 75.1%), Cys (47.1 to 59.6%), Met (79.1 to 83.8), Lys (70.2 to 81.4%), Ser (64.1 to 74.9%) and Val (71.8 to 81.0%). The addition of the protease improved the TAA digestibility of Thr, Lys, Arg, Ser, and Val for DDGS while only Thr, Met, and Lys for BPM.

Key Words: true amino acid digestibility, laying hens, protease, ingredient

509 Keratinase treatment improves feather meal processing conditions and quality. S. Kaczowka*, B. Spencer, B. Talbot, J. D. Garlich, and J. J. Wang, *BioResource International Inc., Morrisville, NC.*

Commercial feather meal (FM) production currently utilizes a combination of temperature and pressure to disrupt the highly cross-linked structure of keratin to improve digestibility and increase the bioavailability of the component amino acids. However, the high temperatures and pressures required for processing often result in reduced amino acid quality and also increases energy costs. Valkerase (VK), a thermostable keratinase derived from the fermentation of *Bacillus licheniformis* PWD-1, was examined for its utility to improve current production processes. Enzymatic production of FM was accomplished by incubating raw feathers with VK at 50–60°C for 60 min before hydrolysis with steam at 120° or 140°C for 20 min. Control samples were subjected to identical conditions in the absence of VK treatment. Two feeding trials were then conducted to compare the quality of the FM in vivo. In each feeding trial a total of 384 Ross 308 X Ross 708 FS male broiler chicks (age 1–21 d) were fed diets formulated to contain 20% crude protein (CP) and 3180 Kcal of ME/kg in a corn-soy based test diet. A total of 6 diets were utilized in this study with the positive and negative control diets containing 20% and 15% CP, respectively. In the 4 FM diets (FM120, FM120VK, FM140 and FM140VK), 5% FM CP replaced 5% CP from soybean meal. In exp. 1, pretreatment with VK (FM120VK) produced significantly better BWG than FM120 and not different than FM140 or FM140VK. In exp. 2, FM120VK was significantly better than FM120 and also not significantly different than the positive control. Cysteine content of the FM120VK was much higher than in FM140 and FM140VK (6.89% vs 5.52% and 5.32% of CP) indicating the better quality of FM processed at the lower temperature. Conclusion: Pretreatment with Valkerase significantly improves the nutritive value of FM hydrolyzed at 120°C and yields a product of higher quality than FM hydrolyzed at 140°C.

Key Words: feather meal, keratinase, protease, broilers

510 Effects of supplementing Allzyme SSF and Allzyme PT in wheat based diet on the performance of chicks. T. Ao*, J. L. Pierce, M. Paul, A. J. Pescatore, A. H. Cantor, K. A. Dawson, and M. J. Ford, *Alltech-University of Kentucky Nutrition Research Alliance, Lexington.*

Allzyme SSF and Allzyme PT are naturally fermented enzyme products with activity of carbohydrase and phytase in Allzyme SSF and pentosase in Allzyme PT. A study was conducted to investigate the effect of supplementing Allzyme SSF alone or with Allzyme PT in wheat based diet on growth performance of broiler chicks. A 2 × 3 factorial dietary treatment structure was used with 2 nutrient levels (normal or low) and 3 ways of enzyme inclusion (no enzyme, + Allzyme SSF or + Allzyme SSF and Allzyme PT). A total of 384 1-d old chicks was randomly assigned to 6 dietary treatments with 8 replicate groups of 6 chicks and was raised in pullet cages in an environmentally controlled room for 21d. Chicks had free access to feed and water. The feed intake of chicks given Allzyme SSF alone or with Allzyme PT was higher ($P < 0.01$) than those given no enzyme control diet with normal nutrient level. The feed to gain ratio of chicks during d1–14 was decreased ($P < 0.01$) by supplementing Allzyme SSF and Allzyme PT in the basal diets. The reduction of dietary nutrient level decreased ($P < 0.01$) weight gain and increased ($P < 0.01$) feed to gain ratio of chicks during 1–14d and 1–21d. Dietary supplementation of Allzyme SSF alone or with Allzyme PT increased feed intake of chicks during 1–14d. Compared with control with no enzyme supplementation, supplementing Allzyme SSF increased ($P < 0.01$) weight gain of chicks and supplementing Allzyme SSF plus Allzyme PT further increased ($P < 0.01$) weight gain of chicks. The dietary supplementation of Allzyme SSF plus Allzyme PT decreased ($P < 0.01$) feed to gain ratio compared with control. Data from this trial indicate that supplementation of Allzyme SSF alone or with Allzyme PT in wheat based diet can improve growth performance of broiler chicks.

Key Words: broiler, performance, wheat, enzyme

511 Effects of dietary inclusion of β-D-mannanase and a cocktail NSPase separately and in combination in low energy diets on broiler performance and white meat yield. J. Klein*[1], M. Williams[1], B. Brown[2], S. Rao[3], and J. T. Lee[1], *[1]Poultry Science Department, AgriLife Research, Texas A&M System, College Station, [2]Enzyvia LLC, Sheridan, IN, [3]Foster Farms, Livingston, CA.*

An experiment was conducted to investigate if an additive effect on growth performance and processing yield can be achieved with the inclusion of a β-D-mannanase (Hemicell-L) and a cocktail NSPase (developmental formula of Enspira). The experimental design included a total of 5 dietary treatments including a positive control (PC), negative control (NC) with a reduction of 130 ME/kg through-

out the experiment compared with the PC, NC supplemented with β-mannanase, NC supplemented with NSPase, and NC supplemented with β-mannanase and NSPase. Each treatment included 8 replicate pens with 28 straight-run broilers placed per treatment group (1120 total chicks placed). Dietary program consisted of a starter (0.68 kg/bird), grower (1.45 kg/bird), finisher (1.45 kg/bird), and withdrawal (remainder of grow out). Broilers were weighed and feed consumption determined on d 14, 28, 42, and 47. Following an 8 h feed withdrawal, 5 male and 5 females per replicate pen were processed, air chilled, and deboned for white meat yield determination. Body weight was reduced ($P < 0.05$) in the NC diet as compared with the PC diet on d 14 and 28. Increases ($P < 0.05$) in body weight were observed with the inclusion of the NSPase and the NSPase + β-mannanase on d 14 and with all enzyme inclusion treatments on d 28. Feed conversion (FCR) was increased ($P < 0.05$) through 28 d of age in the NC as compared with the PC. An additive effect was observed with regard to reduced FCR through 28 d of age with the combination of β-mannanase and NSPase. The NC diet yielded the lowest processing yields and all enzyme inclusion treatments increased multiple processing parameters to a level similar to the PC including WOG weight, breast weight, tender weight, and carcass yield. These data confirm that enzyme supplementation in low energy diets improve growth performance and indicate that additive effects may be observed when using multiple enzymes.

Key Words: enzyme, energy, broiler, performance, processing

512 Effect of an enzyme blend supplementation on performance of broiler chickens fed wheat based diets. L. Romero[1], P. Medel*[2], J. Sánchez[2], and M. I. Gracia[2], *[1]Danisco Animal Nutrition, Marlborough, Wiltshire, United Kingdom, [2]Imasde Agroalimentaria, S.L., Madrid, Spain.*

A total of 924 male Ross 308 one-day-old broilers were used to study the efficacy of an enzyme feed additive (Axtra XAP, Danisco Animal Nutrition) containing xylanase, protease and amylase. A randomized complete design was applied using 4 experimental treatments: T1 designated as control (no added enzyme), and T2, T3 and T4, the control diet with 50, 75 and 100 g enzyme/t of feed, respectively. The experimental design was applied to 12 pens (6 pens in T4) of 22 broilers per treatment in both the starter (0–21 d) and the grower (21–42 d) phases. The experimental diets, based on wheat and soybean meal, were presented as mash, did not contain any coccidiostat or growth promoter and were fed ad libitum to the chicks. Body weight, mortality, weight gain, feed intake, feed to gain ratio, and the European Production Efficiency Factor (EPEF) were analyzed as a randomized complete design by GLM procedure of SAS. Enzyme supplementation improved feed to gain ratio from 0 to 42 d (1.85^b, 1.79^a, 1.78^a and 1.77^a g feed/g gain, for T1, T2, T3 and T4, respectively) compared with Control birds. No significant differences in growth rate, feed intake or EPEF were observed among treatments. Chickens fed the highest dose of the enzyme (T4: 100 g/t feed) ate less feed (108.9 *vs* 103.7 g/d; $P = 0.007$), had reduced feed conversion ratio (1.84 *vs* 1.77 g feed/g gain; 0.0158) and tended to have higher EPEF values (287 *vs* 313; $P = 0.06$) compared with Control birds. In conclusion, supplementation with this enzyme feed additive, containing xylanase, protease and amylase, improved the efficiency of feed utilization of broiler chickens.

Key Words: enzyme blend, performance, wheat based diets, broilers

513 The influence of supplemental fat and enzyme inclusion on passage rate and metabolizable energy in broiler diets. J. D. Hamburg* and A. B. Batal, *University of Georgia, Athens.*

Fat inclusion has been shown to decrease gut transit time, which increases the energy availability of the diet; this is known as the extra metabolic effect of fat. Enzymes, specifically xylanases and β-glucanases are available commercially to reduce gut viscosity by breaking down non-starch polysaccharides, which improves availability and absorption of nutrients. Thus, the objective of this study was to determine the effects of fat and enzyme inclusion on passage rate, apparent metabolizable energy, and true metabolizable energy. A 4 × 3 factorial study was conducted in which a standard corn, soybean meal, distillers dried grains plus solubles based diet was fed to 30 d old broilers and excreta was collected for AME determination and passage rate was measured using a TiO_2 indigestible marker. True metabolizable energy was determined by crop intubating single comb white leghorn roosters using the traditional precision fed rooster assay. The experimental diets contained one of 4 levels of supplemental fat: 0, 1, 2, and 3% and one of 3 levels of enzyme: no enzyme, a xylanase at 0.2lbs/ton, and a β-glucanase at 0.2lbs/ton. Diets were formulated to meet the birds digestible amino acid requirements; however the ME of the diets varied with fat inclusion. The calculated ME of the control diet (0% fat and no enzyme) was 2,900 kcal/kg and the ME increased 84 kcal/kg for every 1% inclusion of fat. After an overnight fast 72 birds housed in collection cages were given ad libitum to one of the 12 treatment diets (6 replications per diet) for 3 h. After 3 h time each bird was fed a #3 gelatin capsule filled with 0.3 g of TiO_2. Excreta was then collected from each of the 72 pens at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 24 h post TiO_2 capsule ingestion. TiO_2 recovery was performed using UV spectrophotometer measuring the absorbance at 410 nm. Significant recovery of the marker appeared in the third hour after the TiO [2 gelatin capsule ingestion. Diets with higher levels of supplemental fat had slower passage rates. Increased fat level also increased the AME and TME_N of the diets.

Key Words: broiler, fat, passage rate, AME, TME_N

514 Gene expression study reveals the association of dietary supplementation of Actigen and the regulation of pathogen-influenced signaling pathways in broiler chickens. R. Xiao*[1,2], R. F. Power[1,2], D. Mallonee[1,2], L. Spangler[1], K. Routt[1], K. M. Brennan[1,2], J. L. Pierce[1,2], and K. A. Dawson[1,2], *[1]Alltech, Nicholasville, KY, [2]Alltech-University of Kentucky Nutrition Research Alliance, Lexington.*

Actigen, a commercial product derived from yeast cell wall mannan oligosaccharides, is added to poultry diets to promote intestinal health. Previous research suggested that the beneficial effects of Actigen are related to enhanced mucosal immunity. This study investigated the effects of dietary supplementation of Actigen on the gene expression profile of broilers, and gained insights on the mechanisms related to immunomodulatory activities. One-day old chicks were either fed a corn-soya based diet (Control) or a diet supplemented with 400g Actigen/ton for 42d. Jejunum samples were collected and used for gene expression analysis using an Affymetrix microarray system. Results indicated that 928 genes in the jejunum were significantly changed ($P < 0.05$, FC > 1.2) by Actigen. Gene ontology analysis indicated that a broad range of biological functions were associated with altered genes. More interestingly, pathway analysis suggests a strong connection between Actigen and upregulation of signaling pathways that are directly involved in cellular immune response, inflammatory response and antimicrobial response such as toll-like receptor signaling, interferon signaling and retinoic acid inducible protein-1(RIG1) receptor mediated innate immunity. Significant upregulation of such genes as toll-like receptor 3 (TLR3), myxovirus resistance 1 (MX1), interferon regulatory factor 7 (IRF7), suppressor of cytokine signaling 1 (SOCS1) and downregulation of ADP-ribosyltransferase (CHAT2) further indicate that Actigen has modulatory effects on the intestinal immune system.

Key Words: Actigen, mannan-oligosaccharides, immunomodulation, gene expression, broiler chicks

515 Effect of medicinal plants on protein and lipid oxidation of broilers meat. A. Niknam, S. Rahimi*, S. Askari, M. Hoseinzade, and M. A. Karimi Torshizi, *Department of Poultry Science, Faculty of Agriculture, Tarbiat Modares University, Tehran, Tehran, Iran.*

Lipid and protein oxidation are major causes of deterioration in the quality of meat products. By increasing consumption of prepackaged raw meat, control of oxidation has become very important. Currently, Î ± -tocopheryl acetate is used as antioxidant to control oxidation in meat and its products. Other antioxidant agents such as medicinal plants also can be used to approach to this purpose. The aim of this study was to compare the effectiveness of antioxidants in prevention of lipid and protein oxidation of broiler meat. A total of 200 one-day-old male broiler chicks (Arbor Acres) randomly assigned to 4 treatments with 5 replicates in a completely randomized design. Treatments were as follows: basal diet as control; or supplemented with vitamin E (100IU/kg diet); garlic (*Allium sativum*) (15g/kg feed); or peppermint (*Mentha piperita*) (15g/kg feed). In d 42 of experiment, 15 birds per treatment were sacrificed by cervical dislocation and tissue samples were taken from the breast and thigh muscles. The samples were stored at −18°C for 7 d. Lipid and protein oxidation were determined by the TBARS and carbonyl contents of samples. The results showed that vitamin E significantly decreased both lipid and protein oxidation reactions in breast muscle rather than other treatments ($P < 0.05$). But, lower MDA level was observed for garlic treatment in compare with peppermint treatment ($P > 0.05$). Neither garlic nor peppermint could decrease lipid and protein oxidation in thigh muscle like vitamin E ($P < 0.05$). However, a significant difference was found between garlic and control treatments ($P < 0.05$). Protein carbonyl content showed a similar trend to that observed for MDA values in all groups in both breast and thigh muscles. Results of this experiment demonstrated antioxidant properties of garlic as a natural antioxidant and its protective role against lipid and protein oxidation.

Key Words: lipid oxidation, protein oxidation, vitamin E, medicinal plants, broilers

516 Reducing cholesterol levels in broiler serum and meat using *Ocimum basilicum*. S. Askari, S. Rahimi*, A. Niknam, M. Hoseinzade, M. A. Karimi Torshizi, and F. Asadi, *Department of Poultry Science, Faculty of Agriculture, Tarbiat Modares University, Tehran, Tehran, Iran.*

Nowadays, public concern about negative effects of cholesterol on human health has been forced producers to use the various ways to reduce cholesterol level in poultry products. One of the solutions is application of antioxidant materials such as medicinal plants in poultry diets. This study was designed to evaluate the effectiveness of *Ocimum basilicum* in decreasing cholesterol levels in broilers serum and tissues. A total of 200 one-day-old male broiler chicks (Arbor Acres) randomly allotted to 4 dietary treatments with 5 replicates in a completely randomized design. The chicks were fed a basal diet (as control), or supplemented with vitamin E (110 IU/kg) or basil in 2 levels (15 and 30 g/kg). Basil plant was harvested, dried and ground. Blood samples were taken in d 42 of experiment from 3 birds per replicate. After sacrificing birds by cervical dislocation, tissue samples were collected from breast muscle. Serum cholesterol (Chol), TG, HDL and LDL levels were measured by photometric method and meat Chol content was determined by enzymatic method. The highest concentrations of serum Chol, TG and LDL were observed for control diet (118.81, 52.83 and 76.05 mg/dL respectively) and the lowest levels were found for vitamin E treatment (97.24, 36.65 and 45.92 mg/dL respectively) ($P < 0.05$). No significant difference was observed for serum HDL content among groups ($P > 0.05$). The results of determination of Chol level in meat showed that the highest and lowest levels were related to control and vitamin E treatments, respectively (121.06 vs. 93.02 mg/dL) ($P < 0.05$). The obtained data for 1.5 and 3% basil treatments for all evaluated factors were not significantly different, but had significant differences with control and vitamin E groups ($P < 0.05$). Results of this experiment showed that basil can be used as an effective medicinal plant in decreasing levels of Chol in broilers serum and breast meat.

Key Words: cholesterol, serum, meat, *Ocimum basilicum*, broiler

517 Effects of turmeric rhizome powder and black pepper on blood constituents and performance of male broiler chickens. A. Akbarian, A. Golian*, H. Kermanshahi, A. Gilani, and S. Moradi, *Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi Province, Iran,*

The objective of this study was to evaluate the effect of turmeric rhizome powder (TRP) and black pepper (BP) on blood constituents and performance of male broiler chickens. A total of 288 d-old male chicks

of Ross 308 were used in a CRD experiment with a 2 × 3 factorial arrangement of 2 levels of TRP (0 and 0.05%) and 3 levels of BP (0, 0.05 and 0.1%) that were added to the starter and grower basal diets. Each diet was randomly fed to 4 replicates of 12 chicks each. Feed and water were provided ad- libitum throughout the experiment. Body weight gain (BWG), Feed intake (FI), and feed conversion ratio (FCR) were determined for each group of birds. Blood samples were collected from wing vein and were analyzed by an autoanalyzer at 21 d of age. The results showed that BWG, FI, and FCR of male broilers during different weeks were not influenced by TRP. Turmeric rhizome powder in the diets significantly($P < 0.05$) decreased ALT (12 to 9 IU/L), but did not have an effect on AST and LDH activities and LDL, HDL, cholesterol and triglycerides concentrations of serum. Chloride and total electrolyte balance of serum were significantly decreased by TRP ($P < 0.05$), but sodium and potassium concentrations were not influenced by TRP. Black pepper at the level of 0.1% significantly reduced FCR in the first week, but this pronounce effect was not observed in the later weeks. Also, BP did not have a significant effect on BWG and FI. Serum metabolites of LDL, HDL, cholesterol, electrolytes and AST, ALT and LDH activities were not influenced by BP. Serum triglycerides were significantly ($P < 0.05$) reduced in birds fed diet contained 0.1% BP as compared with control diet (63.3 vs 87 mg/dl). There was not a significant interaction between TRP and BP on blood metabolites and performance of male broiler chickens.

Key Words: turmeric rhizome, black pepper, blood constituents, broiler chickens, performance

518 Evaluation of mistletoe (*Viscum album*) and water plantain (*Alisma canaliculatum*) on the growth performance, internal organ development, fatty acid composition and lipid oxidation of broiler. M. E. Hossain*[1], K. S. Kim[1], G. M. Kim[1], S. S. Sun[2], J. D. Firman[3], and C. J. Yang[1], *[1]Department of Animal Science and Technology, Sunchon National University, Suncheon, Korea, [2]Department of Animal Science, Chonnam National University, Gwanju, Korea, [3]Department of Animal Sciences, University of Missouri, Columbia.*

Mistletoe (*Viscum album*) and water plantain (*Alisma canaliculatum*) have been used as a food or drug in traditional medicine and recently in animal production. The present study was conducted to examine the potential use of water plantain and mistletoe as alternative feed additives for broiler. One hundred 40 Ross broiler chicks had been assigned to 4 dietary groups in 5 replications with 7 birds per replication for a period of 5 weeks following completely randomized design. The dietary groups were control (basal diet), antibiotic (basal diet + 0.005% oxytetracycline), mistletoe (basal diet + 0.5% mistletoe powder) and water plantain (basal diet + 0.5% water plantain powder). The results indicated that feed conversion ratio of the water plantain group was higher compare with the antibiotic group in the finishing period, but when considering the total period no differences were observed among the additive groups. Moisture content of both breast and thigh meat was higher, but crude fat and crude protein contents were lower in the water plantain group when compare with the other groups. The average thiobarbituric acid values of breast and thigh meat were not changed, but the water plantain group showed more susceptibility to oxidation at d 7 in breast meat. Among the fatty acids composition, linoleic acid was decreased and α-linolenic acid was increased, which resulted lower n6/n3 ratio of breast meat in the water plantain group whereas; supplemented groups showed higher PUFA content in thigh meat. Proventriculus and gizzard weight were increased in the water plantain group compare with the antibiotic and mistletoe group, but the other organs weight were not different among the treatment groups. Statistical difference was not found in the serum IgG concentration, but a numerical increased trend was observed in the supplemented groups. It is suggested from the study that low level of mistletoe and water plantain could be the natural feed additives for broiler.

Key Words: mistletoe, water plantain, performance, broiler

519 Effect of a mixture of cinnamaldehyde, carvacrol and capsicum oleoresin and of a combination of enzymes on performance of broilers fed standard and low dietary energy levels. C. Oguey* and D. M. Bravo, *Pancosma, Geneva, Switzerland.*

XTract 6930 (XT, Xtract 6930, Pancosma) is a blend of cinnamaldehyde, carvacrol and capsicum oleoresin. The increasing effect on ME of XT and non starch polysaccharide enzymes (EZ) has been demonstrated in previous studies. The objective of this trial was to evaluate the effect of XT and EZ alone or combined on performance of broilers fed standard or low energy levels. One day old male chicks were randomly allocated to one of the 6 following treatments (7 birds*10 cages/treatment): CT: corn and soybean meal control diet, with a standard energy level (d1 to 14: 2950 kcal/kg ME, d15 to 28: 3050 kcal/kg ME, d29 to 42: 3100 kcal/kg ME); XT: CT + 100 ppm XT; EZ: CT + 100 ppm EZ; XT-50: CT + 100 ppm XT – 50 kcal/kg ME; EZ-50: CT + 500 ppm EZ – 50 kcal/kg ME; and EZ_XT-100: CT + 500 ppm EZ + 100 ppm XT – 100 kcal/kg ME. AMEn from d15 to 17 and FI, BWG and FCR per feeding period were measured and analyzed using the GLM procedure of SAS. Results showed that AMEn for EZ and XT were similar to CT ($P > 0.36$). Compared with CT, AMEn of EZ-50 and XT-50 tended to be reduced respectively by 25.1 kcal/kg ($P = 0.25$) and 41.3 kcal/kg ($P = 0.08$) and it was lower by 96.3 kcal/kg ($P < 0.01$) for EZ_XT-100. From d14 to 28, FCR of XT-50 and EZ-50 were similar to CT (respectively 1.57, 1.62 and 1.59 g/g, $P > 0.16$) and EZ_XT-100 increased FCR compared with CT (+3.1%, $P = 0.03$). This suggests that performance in XT-50 and EZ-50 groups is maintained compared with CT despite a reduced AMEn. However the association of EZ and XT combined to a 100 kcal/kg AMEn reduction is not sufficient to maintain FCR. For the whole trial duration, compared with CT, EZ and XT reduced ($P < 0.05$) FCR respectively by 1.7% and 2.7%, while CT, EZ-50, XT-50 and EZ_XT-100 had similar FCR (respectively 1.91, 1.90, 1.89 and 1.92 g/g, $P > 0.13$). This trial shows that XT-50 kcal/kg ME and EZ-50 kcal/kg ME, alone or combined can be applied to the diet of broilers without affecting the global performance of the birds.

Key Words: broiler, capsicum oleoresin, cinnamaldehyde, carvacrol, carbohydrase

520 Effect of a blend of carvacrol, cinnamaldehyde and capsicum oleoresin and of an antibiotic on growth performance, metabolizable energy and ileal digestibility. D. M. Bravo*[1], L. T. Albino[2], and H. S. Rostagno[2], *[1]Pancosma, Geneva, Switzerland, [2]Federal University of Viçosa, Viçosa, Brazil.*

Our objective was to evaluate the effect of a mixture of carvacrol, cinnamaldehyde and capsicum oleoresin (XT, XTract 6930, Pancosma) on the performances (trial 1), ME and CP digestibility (trial 2) of broilers fed corn-sorghum-soybean meal diets with or without an antibiotic. In both trials, chicks were fed starter (S) until d21, grower (G) and finisher (F) until d40 and d45. The trials were complete randomized designs with 5 treatments (T). T1 was not supplemented. T2 contained 7 ppm avilamycine (AV) in S and 5 ppm in G/F. T3 contained 75 ppm

XT in S, G/F. T4 contained 150 ppm XT in S, G/F. T5 contained 3.5 ppm AV + 75 ppm XT in S and 2.5 ppm AV + 75 ppm XT in G/F. Nine rep. of 20 birds/T (trial 1) and 9 rep. of 10 birds/T (trial 2) were used. Birds and feed were weighted at d1, 21, 40, 45 (trial 1) and at d1, 7, 21 (trial 2). At d17–21, total excreta were collected to determine AMEn. At d22, chicks were killed and samples of terminal ileum were obtained for CP digestibility (CPD). The data were subjected to one-way ANOVA. Means were compared using the Duncan multiple range test. From d1 to 21, supplementation improved BWG (P = 0.160, +2.0% T3, +2.2% T4, +2.8% T2, +3.5% T5) but not G:F (P = 0.330). From d22 to 45, BWG was not altered (P = 0.380) but G:F was increased (P = 0.09, +1.3% T3, +1.9% T2, +2.7% T4). From d1 to 45, BWG was not affected (P = 0.150) and G:F was improved (P = 0.04) with highest effects for T4 (+2.3%) and T5 (+2.2%); no effect of T2 and T3. Highest CPD was observed with T5 (+5.5%), T4 (3.5%), T2 (+3.0%) and T3 (+2.8%), all being higher than T1 ($P < 0.05$). AMEn was not affected by T2, increased by T3 (+53 kcal, $P > 0.05$), T4 (+74 kcal, $P < 0.05$) and T5 (+114 kcal, $P < 0.01$). The results indicated that 150 ppm of XT improved G:F, CPD and AMEn. When compared with AV, XT showed similar performance, CPD and AMEn. Finally, when XT and AV were combined, G:F, CPD and AMEn were improved.

Key Words: capsicum olreosin, carvacrol, cinnamaldehyde, broiler, ME

521 The effects of medicinal plants, nettle (*Urticaceae dioica*) chicory (*Chicorium intybus*) with enzyme on performance, and constituents in broilers. A. Safamehr*[1,2], F. Fallah[1], and A. Nobakht[1], *[1]Department of Animal Science, Islamic Azad University, Maragheh branch, Maragheh, East Azarbyjan, Iran, [2]Department of Plant & Animal Science, Nova Scotia Agriculture College, Truro, Nova Scotia, Canada.*

This experiment was conducted to evaluate the effects of dietary inclusion of 2 herb medicinal, dried nettle (*Urticaceae dioica*) and chicory (*Chicorium intybus*) with enzyme (Kemin) on performance, and biochemical and immunity parameters of broilers. This experiment was conducted in a completely randomized design with 250 male broiler chickens (Ross-308) in 5 treatments from 1 to 42 d. Birds were fed on 5 diets (a non supplemented corn-soybean meal diet (negative control); 2) the basal diet + E (%0.05, positive Control), 0.5% nettle +E (NE), o.5% chicory + E (CE), and N+C plus E (NCE). Each diet was fed to 5 replicate pens of 10 male birds. Birds were given feed and water ad libitum. Dietary treatment had no effect on the feed intake, glucose, triglyceride, albumin and total protein. Dietary C or N herb with enzyme supplementation had the positive effect on body weight gain and feed conversion ratio ($P < 0.05$). Carcass and breast yield increased by inclusion of herbal ($P < 0.05$). The CE and NCE resulted in a significantly lower cholesterol concentration compared with other dietary treatments ($P < 0.05$). Feeding the diets containing N or C or blend of them with enzyme significantly decreased the heterophile and proportion of heterophile to lymphocyte, whereas there was significant increase in lymphocyte percentage in experimental groups containing C or N ($P < 0.05$) compared with control diet. Thus, dried nettle and chicory may be used as a growth promoter for broiler chickens.

Key Words: nettle, chicory, enzyme, broiler

522 The effects of different levels of canola oil, lupin seed and garlic powder on performance, egg quality in laying hens. A. Safamehr*[1,3], S. Farajollahzade[1], M. H. Shahir[2], and S. Chodaee[1], *[1]Department of Animal Science, Islamic Azad University, Maragheh branch, Maragheh, East Azarbyjan, Iran, [2]Deparment of Animal Science, Zanjan University, Zanjan, Iran, [3]Department of Plant & Animal Science, Nova Scotia Agriculture College, Nova Scotia, Canada.*

One experiment was conducted to evaluate the effects of different levels of canola oil, Lupin seed and garlic powder on performance, egg quality of laying hens. A total of 288 Hy-Line W-36 Laying hens were fed diets with 2 levels of canola oil (1.5 and 3%), lupin seed (10 and 20%) and garlic powder (0.2 and 0.4) in a 2 × 2 × 2 factorial arrangement from 37 to 49 wk of age. All diets were formulated to be isoenergetic and isonitrogenous. The results showed that inclusion different levels of canola oil, Lupin seed, and garlic powder to the diets had significant effect on performance (egg weight, egg production, egg mass, feed conversion ratio). Egg production and egg mass significantly decreased by high level of Lupin seed ($P < 0.05$). The highest egg weight (60.13 g) was observed in treatment containing 3% canola oil, 20% Lupin seed plus 0.4% garlic powder. The average egg production in treatment containing 3% canola oil plus 10% of Lupin seed and 0.4% of garlic powder was significantly higher than that of the control group($P < 0.05$). There were no significant effects of different levels of canola oil, garlic powder and lupin seed and their interaction on egg quality (egg gravity, shell weight, Haugh unit, shell thickness) and yolk cholesterol. In conclusion, using of appropriate levels canola oil (1.5 percent), Lupin seed (20 percent) and garlic powder (0.4 percent) in laying hens diets can be improved performance and egg quality.

Key Words: garlic powder, lupin seed, canola oil, egg quality, layer hens

523 Impact of Oasis supplement and lysozyme on incidence of early mortality, digestive system development and growth performance of turkey poults having delayed access to feed and water. A. Gillcrist*, D. Anderson, and J. MacIsaac, *Nova Scotia Agricultural College, Truro, Nova Scotia, Canada.*

Delayed intake of feed and water by turkey poults during long transport time to the growing facility may result in high early mortality rates and impact subsequent growth performance. This study evaluated the effect of providing supplements during the transport of poults, and during the early growing period. Eight hundred and 20 5 female poults were used in a 3 × 4 factorial analysis (transportation supplement x post placement supplement) with supplement provided during transport (no supplement (No), Oasis (O) and Oasis + lysozyme (OL)) and dietary supplement post-placement (no supplement (Ns), commercial antibiotic (A), lysozyme (L), commercial antibiotic + lysozyme(AL)) as the main effects. The (L) treatments were fed from 1 d through to 28 d of age whereas (A) was fed through to 70 d of age. Oasis during transport did not affect ($P > 0.05$) growth performance. Birds receiving (No) during transport and (L) post placement showed lower body weights at 70 d ($P < 0.05$) with a body weight of 4942g. All other treatment combinations showed body weights ranging from 5116 to 5526g. Feed consumption, feed conversion, and mortalities were not affected by dietary supplement ($P > 0.05$). Intestinal weights (duodenum (D), jejunum (J), ileum (I), proventriculus, gizzard) and lengths (D, I, and J) were not affected by dietary supplement ($P > 0.05$). Jejunum strength measured using a TA.TXplus texture analyzer at 28d showed significantly higher tensile strength (0.592kg force required to break) for birds that received (O) during transport and (Ns) upon placement ($P <$ 0.05). Jejunum strength at 70d showed no differences among supplements ($P > 0.05$). Providing birds with dietary supplements during long transport did not improve mortality rates or subsequent growth

and development of the birds through to market weight. Providing lysozyme to birds gave equal growth and intestinal development as birds that were receiving no supplement or an antibiotic supplement.

Key Words: turkey, mortality, oasis, growth, lysozyme

524 Effects of essential oils on performance of broilers fed diets with different nutrient concentrations. L. Borsatti[1], R. V. Nunes*[1], T. Steiner[2], J. L. Schneiders[1], T. R. Hofferber[1], and R. Frank[1], *[1]State University West of Paraná, Marechal Cândido Rondon, Paraná, Brasil, [2]Biomin Holding GmbH, Industriestrasse, Herzogenburg, Austria.*

1152 d-old broiler chicks were used to investigate the influence of nutrient density and supplementation with essential oils or antibiotic growth promoters (AGP) on growth performance. Birds were assigned to 6 treatments with 8 replications per treatment: (1) Standard diet (SD), SD + Essential oils (oregano, anise, citrus) (Biomin P.E.P. 125 poultry, 125 g/t), (3) SD + AGP (Enramycin, 10 g/t and salinomycin, 125 g/t), (4) Reduced diet (RD), (5) RD + Essential oils, (6) RD + AGP. Birds were fed starter (1–10 d), grower 1 (11–21 d), grower 2 (22–35 d) and finisher (36–42 d) diets. Diets in treatments 1–3 were formulated to meet the requirements of the birds for metabolizable energy protein and digestible amino acids, whereas diets in treatments 4–6 were formulated to provide 5% less energy and amino acids. From 1 to 42 d the birds fed diets with reduced nutrient and energy density had reduced ($P < 0.05$) live weight and weight gain compared with the other treatments. Furthermore, birds fed diets with reduced nutrient and energy density showed an increase ($P < 0.05$) in feed consumption, resulting in an increase ($P < 0.05$) in feed conversion ratio. In conclusion, dietary supplementation with essential oils improved growth performance of birds from 1 to 21 d, hence may compensate for a reduction in dietary levels of amino acids and metabolizable energy.

Key Words: performance, fructooligosaccharides, broilers, essential oils

525 Live performance and intestinal morphology of broiler chickens fed diets supplemented with BMD, Actigen or neither product in two pen trials on built-up litter. S. R. Collett*[1], G. F. Mathis[2], B. Lumpkins[2], D. M. Hooge[3], K. M. Brennan[4], and J. L. Pierce[4], *[1]Poultry Diagnostic and Research Center, Athens, GA, [2]Southern Poultry Research Inc., Athens, GA, [3]Hooge Consulting Service Inc., Eagle Mountain, UT, [4]Alltech Inc., Nicholasville, KY.*

Actigen is a yeast cell wall derivative used as to enhance broiler intestinal health and performance. In 2 separate pen trials, broilers were raised on 10.2 cm (4 in.) of used litter top dressed with pine shavings at a stocking density of 0.0864 m^2 (0.93 ft^2) per chick in a randomized block design (LSD ≤ 0.05). In Trial 1, 36 pens containing 50 male Cobb chicks each were assigned to 3 treatments: 1) negative control; 2) Actigen at 800 g/tonne 0–7 d, 400 g/tonne 7–21 d, and 200 g/tonne 21–42 d; and 3) BMD at 50 g/ton 0–21 d and 25 g/ton 21–42 d (BMD). In Trial 2, 39 pens containing 50 straight-run Cobb broiler chicks each were allocated to the same 3 treatments as in Trial 1. Coccidiosis was controlled by vaccination (Coccivac-B) administered by spray at hatch in Trial 1 and by adding salinomycin to the feed at 50 g/ton (0–21 d) and 60 g/ton (21–35 d) in Trial 2. In Trial 1, 42-d BW were 2.382^b, 2.503^a, and 2.530^a kg ($P = 0.014$); feed conversion ratios (FCR) were 1.911^a, 1.820^b, and 1.815^b ($P = 0.018$); and mortality was 4.83, 4.50, and 4.17% ($P = 0.650$) for the negative control, Actigen, and BMD treatments respectively. In Trial 2, 42-d BW were 2.081^b, 2.134^a, and 2.124^a kg ($P = 0.033$); FCR were 1.814^a, 1.767^b, and 1.782^b ($P < 0.001$); and mortality was 3.69, 4.77, and 3.85% ($P = 0.559$) for the negative control, Actigen, and BMD treatments respectively. Intestinal villus height, villus height:crypt depth ratio, and goblet cell count were increased ($P < 0.010$), and litter scores were improved ($P < 0.001$), when birds were fed Actigen or BMD versus the negative control. There was a statistically significant improvement in broiler performance when birds reared on built-up litter were fed diets supplemented with Actigen or BMD.

Key Words: Actigen, bacitracin, broiler, mannan oligosaccharide, yeast cell wall

526 Ethanolic extract of propolis: Intestinal morphology and digestive organs weight of broiler chickens. C. Eyng*, C. R. A. Duarte, A. E. Murakami, and T. C. Santos, *Universidade Estadual de Maringa, Maringa, Parana, Brazil.*

The prohibition of the use of antibiotic growth promoters has intensified the search for natural substances that can replace it. An alternative approach is the use of propolis and its sub products in fed diet. Thus, this study was conducted to evaluate the effects of ethanolic extract of propolis (EEP) inclusion on digestive organs weight and intestinal morphology in broiler chickens. The birds were randomized in a complete design, with 5 levels of EEP inclusion (0; 0.1; 0.2; 0.3; 0.4 and 0.5%), 5 replications and 34 birds per experimental unit. At 21st d of age, 5 broilers of each treatment were killed, the digestive organs were weighted and their relative weight were evaluated. In addition, duodenum, jejunum, and ileum segments were collected for morphology analysis. The segments were processed and stained with hematoxylin and eosin, and the villus weight, crypt depth and villus/crypt ratio were evaluated using a light microscopy. It was found that all parameters were similar between the treatments with inclusion of EEP and the control group ($P > 0.05$, Dunnett's test). However, when the data were submitted to linear and quadratic regression analysis it was observed a quadratic response to the crypt depth to levels ($P < 0.05$). Shorter ($P < 0.05$) crypt depth was observed in the duodenum and jejunum at 0.29 and 0.32% of EEP, respectively. A higher ($P < 0.05$) villus:crypt ratio was observed in the duodenum with the inclusion of 0.30% EEP. The relative weight of small intestine, liver and pancreas were not affected by the treatments, whereas the cecae relative weight increased linearly ($P < 0.05$) according to the levels. The results of this study suggest that ethanolic extract of propolis affects the intestinal morphology and digestive organs weight, and the best responses are obtained from 0.29 to 0.32% of ethanolic extract of propolis inclusion.

Key Words: gastrointestinal tract, growth promoter, propolis, intestinal villi

527 Ethanolic extract of propolis affects the maltase activity in broiler chickens. C. R. do Amaral Duarte*, C. Eyng, A. E. Murakami, and A. F. Q. M. Garcia, *Universidade Estadual de Maringá, Maringá, Paraná, Brazil.*

The numerous biological and therapeutic functions of propolis are well-known for human medicine. Recently, its beneficial actions have been studied in animal nutrition, as growth promoter, however its effects in the nutrient digestion are not known. Thus, this study has investigated the effects of ethanolic extract of propolis supplementation on the performance and intestinal and pancreatic enzymes

activities in broiler chickens. For this, 1-d-old chicks were randomly assigned to 5 levels of inclusion of ethanolic extract of propolis: 0; 0.1; 0.2; 0.3; 0.4 and 0.5%, with 5 replications and 34 birds per experimental unit. Each treatment was supplemented from 1 to 21 d old, after that, all groups were fed with a basal diet. The activities of maltase and sucrase in the intestinal segments (duodenum, jejunum, ileum) and the lipase, amylase, trypsin and chymotrypsin activity in the pancreas were evaluated at 7, 21 and 42 d old. The data were analyzed by Anova followed by Dunnett's test and also by linear and quadratic regression analysis. It was found a linear decrease in the body weight gain from 1 to 42 d old, with a lower gain with the increase of levels. A similar response was obtained to maltase activity in the duodenum at 7 d old ($P \leq 0.05$), in the jejunum at 21 d old ($P \leq 0.05$), in the ileum at 42 d old ($P \leq 0.05$). However, when the data were compared with the control group, the 0.5% supplemented group presented a higher sucrase activity in the jejunum at 21 d old ($P \leq 0.05$, Dunnett's test). The feed conversion ratio and pancreatic enzymes activities in all ages were not affected by the levels of ethanolic extract of propolis supplementation ($P \geq 0.05$). The results of this study suggest that ethanolic extract of propolis supplementation affects the digestive process, decreasing the carbohydrate digestion by the disaccharidases in the small intestine. Moreover, this response causes the reduction in the chicken growth, endangering the performance.

Key Words: disaccharidase, enzymes activity, pancreatic enzymes, propolis

528 Effect of dietary inclusion of Actigen on ileal villi morphology of turkey poults. I. B. Barasch*, P. R. Ferket, J. L. Grimes, C. R. Stark, and R. D. Malheiros, *North Carolina State University, Raleigh.*

Dietary supplementation of *Saccharomyces cerevisiae* mannan oligosaccharide (MOS) is commonly used to manage the enteric microbial ecosystem of animals, including turkeys. MOS is thought to inhibit the colonization of pathogens and stimulate innate immunity and mucosal barrier function. Actigen (Alltech, Inc.), a concentrated mannose-rich oligosaccharide fraction derived from the cell wall of a specific strain of *Saccharomyces cerevisiae*, was evaluated for its effect on ileal villi morphology as an indicator of enteric health. 864 Hybrid Converter turkey tom poults were randomly distributed among 48 floor pens and naturally challenged by placing them on used litter from a previous flock. Poults were fed one of 2 dietary treatments: a control diet (CON) or a diet containing 400 ppm Actigen (ACT). Both corn-soy-based diets were formulated to meet standard industry nutrient specifications and were supplemented with 66 ppm monensin. Feed and water were provided *ad libitum* to all birds throughout the study. Eight birds per treatment were sampled on 6, 10, and 14 d and ileal sections dissected for histomorphometric analysis and scanning electron microscopy (SEM) evaluation. At 10d, ACT increased villus surface area by 18% over CON (306 vs 257 μ^2, $P < 0.005$). At 14d, ACT reduced apical width 15%, (78 vs 92 μ, $P < 0.02$), base width by 15%, (173 vs 200 μ, $P < 0.02$), and crypt depth by 20% (183 vs 229 μ, $P < 0.005$), without effect on muscularis thickness or surface area. From SEM, segmented filamentous microorganisms were observed to be present on CON villi at 14 d but not on ACT villi. Moreover, there appeared to be more mucosal mucus secretion among ACT than CON. The results suggest ACT enhances ileal mucosa health of turkey poults.

Key Words: turkey, Actigen, yeast, villi, monensin

529 The effects of eucalyptus, rosemary and mint essential oils on cecal microflora and performance: A comparison to antibiotic effects in broilers. M. Koopaie[1], K. Ghazvinian[2], A. Mahdavi[2], B. Darabi Ghane*[3], M. A. Jafari[1], and F. Alemi[4], *[1]Islamic Azad University-Ghaemshahr Branch, Ghaemshahr, Iran, [2]Semnan University, Semnan, Iran, [3]Islamic Azad University-Karaj Branch, Karaj, Iran, [4]Iranian Research Organization for Science and Technology, Tehran, Iran.*

The present study was carried out to determine the effects of eucalyptus, rosemary and mint essential oils on cecal microflora and performance. We also compared these results to the effects of antibiotic. The Cobb broilers studied here were distributed in 5 groups: the control group (basal diet), 3 groups fed with basal diet plus 0.02% essential oils (eucalyptus, rosemary and mint) and finally a group treated with basal diet mixed with 0.05% zinc bacitracin. On the d 49, the smallest *E. coli* count was that of the antibiotic group ($P < 0.05$) and among the essential oil groups, the mint group had the lowest *E. coli* count. The largest lactobacillus count was observed in the essential oil groups among which the rosemary group had the largest lactobacillus count. In the starter period (0–21 d), no significant difference in feed intake was observed among the groups; however, in the finisher period (36–49 d), the antibiotic group showed the highest feed intake ($P < 0.05$). In the starter period (0–21 d), the groups had no significant difference in body weight gain. But during the grower period (22–35 d) and the finisher period (36–49 d) the largest body weight gain was found in the antibiotic group and the rosemary group, respectively, although no significant difference was observed between the essential oil groups and the antibiotic group. Feed conversion ratio in the groups treated with essential oils was significantly reduced compared with this ratio in the control group; the rosemary group had the lowest feed conversion ratio; and during the grower (22–35 d) and the finisher periods (36–49 d) this group showed no significant difference from the antibiotic group regarding feed conversion ratio. It can be concluded that essential oils studied here were effective in enhancing performance by improving the cecal microflora compared with the control group, and among these groups, the group treated with rosemary essential oil achieved a better performance in comparison to the antibiotic group as a result of improved microflora.

Key Words: essential oil, microflora, performance, antibiotic

530 Sugar cane yeast in the diet of laying hens and effects on intestinal morphology. J. C. R. Silva, C. B. V. Rabello*, C. C. Lopes, V. A. S. Júnior, D. A. T. Silva, and E. M. F. Arruda, *Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil.*

The purpose was to evaluate the effect of diets containing different levels of spray dry sugar cane yeast on the morphometric development of the intestinal mucosa of laying hens in the laying phase. 200 birds were used, 47 weeks of age, strain Lohman, distributed in a completely randomized design consisting of 5 treatments and 5 replicates of 8 birds each. The treatments consisted of increasing levels of 0, 2, 4, 6 and 8% inclusion of spray dry sugar cane yeast. The experiment lasted 84 d, 3 cycles of 28 d. At the end of the experiment, 1 bird with an average weight of the parcel was sacrificed by cervical dislocation for collection of approximately 2 cm from the mean portion of each segment of small intestine (duodenum, jejunum and ileum). Subsequently 2 slides were prepared for each segment of each animal to

evaluate the parameters of villus height, crypt depth and villus:crypt ratio. The data obtained for all variables were tested for their homogeneity, with the aid of the Barlet′s Test; when necessary, the data suffered log-transformation of (x). Finally, all data were submitted to the regression analysis. The heights of the villi of the duodenum showed no significant differences (1,317.5 μm), however, there was a quadratic effect on crypt depth in this same segment, with lower crypt depth in the 5.46% level of inclusion of yeast. The villus:crypt ratio in the duodenum behaved in a linear way (Y = 0.716084 + 0.021508X). The reduction in crypt depth may indicate a reduction in cell synthesis due to less wearing of the villi of the duodenum. In the jejunum and ileum adding yeast to the diets did not provide significant effect on the parameters. The averages were: 866.6 and 557.0 μm for villous height, 171.5 and 118.3 μm for crypt depth and, 5.35 and 5.00 μm for segments of the jejunum and ileum, respectively. It′s possible to verify that the spray dry sugar cane yeast may be included in the diet of hens in laying stage to the level of 5.46% to reduce the energy requirement for cell synthesis without compromising the integrity of the villi in all segments of the small intestine.

Key Words: laying hens, sugar cane yeast, intestinal morphology

531 Hematology, organ development and performance of broiler finishers fed rations supplemented with *Telfaria occidentalis* leaf meal (TOLM) (Ugu leaves). A. H. Ekeocha*, *University of Ibadan, Ibadan, Oyo, Nigeria.*

One hundred and 50 d old Arbor Acre broiler chicks were randomly allocated to 5 experimental rations of 30 birds each. The first ration was standard (basal) finisher ration and served as control. The other rations contained 2.5%, 5.0%, 7.5% and 10.0% TOLM respectively as graded replacement (w/w) for wheat bran. The study investigated the performance, organ development and hematological responses of the birds to the diets. *Telfaria occidentalis* leaf meal supplementation improved performance characteristics over basal diets and significantly ($P < 0.05$) enhanced feed intake, growth rate, hematological parameters (erythrocyte count and Hemoglobin concentration) while organ weights were largely unaffected except for an increase in liver and heart weights of *Telfaria occidentalis* leaf meal fed broilers. The *Telfaria occidentalis* leaf meal at 7.5% level of inclusion was found to conveniently replace wheat bran without any deleterious effect on the growth response and organ weights of broilers at the finisher phase.

Key Words: hematology, organ development, broiler finishers, *Telfaria occidentalis* leaf meal

532 Response of broiler starters fed rations supplemented with *Vernonia amygdalina* leaf meal (VALM) (Bitter leaf). A. H. Ekeocha*, *University of Ibadan, Ibadan, Oyo, Nigeria.*

One hundred and 50 d old Abor acre broiler chicks were randomly allotted to 5 experimental rations of 30 birds per treatment such that each treatment had 3 replicates of 10 birds. The first ration was the standard (basal) starter ration and served as control. The other rations contained 2.5%, 5.0%, 7.5% and 10.0% TOLM respectively as graded replacement (w/w) for wheat bran. The study investigated the performance of the birds to the diets. *Vernonia amygdalina* leaf meal supplementation did not improve performance characteristics over basal diets but significantly ($P < 0.05$) decreased feed intake, feed conversion ratio and growth rate. The average final body weight decreased as the levels of VALM increased in the diets with highest value of 784.21g on the control diet and while those on the 10% VALM diet having the least value of 561.83g. There were no significant ($P > 0.05$) difference in the average daily weight gain between broilers fed the control 0% (VALM) and 2.5% (VALM) diets which were significantly($P < 0.05$) higher than the observed values recorded in other diets. The highest value of average daily feed intake was recorded for broilers fed 0% VALM diet. The feed conversion ratio significantly ($P < 0.05$) increased as the levels of VALM inclusion increased in the diets. The blood glucose level significantly ($P < 0.05$) reduced as the levels of VALM inclusion increased in the diets. Values obtained for serum chemistry (serum albumin, globulin, total serum protein and serum uric acid) were not significantly ($P > 0.05$) different. The Vernonia amygdalina leaf meal at 2.5% level of inclusion was found to conveniently replace wheat bran without any deleterious effect on the growth response of broilers at the starter phase.

Key Words: broiler starters, *Vernonia amygdalina* leaf meal

533 Dose responses to a dietary experimental MOS product versus a leading commercial MOS product in a 42-day broiler chicken pen trial with relatively high stocking density and recycled litter. T. T. Lohrmann*[1] and M. D. Sims[2], [1]*Quality Technology International (QTI), Elgin, IL,* [2]*Virginia Diversified Research Corp., Harrisonburg.*

A 42-d pen trial was conducted with 1,500 straight-run Cobb 508 broiler chicks using 5 dietary treatments: 1) negative control (NC); 2) 0.1% commercial mannan oligosaccharide (MOS) product (comMOS); 3) 0.025% new, experimental MOS product (expMOS); 4) 0.05% expMOS; 5) 0.1% exp MOS. The comMOS produt analyzed 29.3% mannan and 65.0% glucan and the experimental MOS had 53.5% mannan and 46.3% glucan (% of total carbohydrate weight). There were 10 replicate pens of 30 chicks each per treatment (50 pens total). Each pen measured 1.22 × 1.52 m, which provided a stocking density a stocking density of 0.062m^2 or 0.67 ft^2 per bird. Chicks were placed on 7.6 cm of clean litter initially, and at 7 d of age 0.91 kg of recycled litter was added to each pen. Salinomycin 60 g/ton was added to all starter and grower feeds (0–35 d). At 21 d, BW was significantly ($P = 0.009$) increased by 0.1% expMOS vs NC, and each expMOS or comMOS treatment significatly ($P < 0.001$) improved feed conversion ratio (FCR) compared with NC. At 35 d, BW was significantly ($P < 0.001$) greater for 0.05 or 0.1% expMOS or 0.1% MOS-fed birds than for NC birds,and mortality-adjusted FCR was significantly ($P < 0.001$) improved by each expMOS or comMOS treatment vs NC. Mortality % from 0 to 21, 0–35 or 0–42 d was unaffected by treatment. Fecal microbial profiles (enterobacteria, lactobacilli and total anaerobes) at 27–28 d were unaffected by treatment. In conclusion, 0.025% expMOS gave 42-d BW equivalent to that of 0.1% comMOS while 0.05% and 0.1% expMOS increased 42-d BW vs other treatments. Each MOS treatment improved 0–42 d mortality-adjusted FCR (expMOS most effective) vs NC.

Key Words: MOS, mannan oligosaccharide, broiler, FCR, calorie conversion

534 Feeding value of *Capsicum frutescens* on laying performance and egg quality. H. Paguia*, R. Paguia, and D. Magpantay, *Bataan Peninsula State University, Abucay, Bataan, Philippines.*

The study was conducted to evaluate the effect of diets supplemented with *C. frutescens* on chicken laying performance and egg quality. Specifically, it aimed to determine the biological performance, production efficiency and egg quality. Three hundred 20 heads of 54–70 weeks old Lomann layers were used in 4 (4) months feeding trial. They were randomly distributed in 4 dietary treatments following the single

factor experiment. Each treatment is replicated 8 times with 16 heads for each replicate. Experimental diets were formulated to contain 17.7 percent crude protein and ME level of 2650 kcal/kg following the nutrient recommendation by (Philsan, 2003).The experimental additive was incorporated in the ration following the inclusion rates of 0.5, 1.0, 1.5 and 2.0 percent. Layers were fed with treated and pre-weighed diets 4 d a week. Feed left was measured on weekly basis to determine the actual feed intake of layers. Application of effective microorganisms (EM) on manure was done to regulate ammonia build-up and rapid flies multiplication. Results showed that feed consumption and feed efficiency of layers were significantly ($P < 0.05$) affected by addition of *C. frutescens* on the ration. However, hens egg production and monthly laying percentage from 54 to 70 weeks of age were comparable to those of control group ($P > 0.05$). Moreover, feed cost per kilogram of egg produced and income over feed cost were significantly affected ($P < 0.05$) by treated diets. Egg quality on the other hand were determined based on egg weight, yolk color intensity and shell thickness did not affect ($P > 0.05$) by treated diets. Among the parameters used in egg sensory evaluation, the general acceptability was found to be significant while comparable results were obtained from egg flavor, off-flavor and texture. Meanwhile, mortality rate was not significant indicating that *C. frutescens* can improve overall health conditions of layers.

Key Words: *C. frutescens*, performance enhancer, egg quality, health performance, herbal

535 Comparison of herbal extracts, antibiotic, probiotic and organic acid on serum lipids, immune response, GIT microbial population, intestinal morphology and broilers performance. S. Rahimi[1], S. Yakhkeshi*[1], K. Gharib Naseri[1], and A. Rahimi[2], *[1]Tarbiat Modares University, Tehran, Tehran, Iran, [2]Islamic Azad University, Tehran, Tehran, Iran.*

A study was conducted to investigate the effects of herbal extracts, probiotic, organic acid and antibiotic on serum lipids, immune response, intestinal morphology, GIT microbial population and performance of broilers. A total of 300 d-old male broilers (Cobb 500) were randomly divided into 4 treatments, 3 replicates with 15 birds in each. Treatments included: control, herbal extracts (Sangrovit), probiotic (Primalac), organic acid (Termin-8) and antibiotic (Virginiamycin). The greatest WG were achieved by Virginiamycin ($P < 0.05$) during the experiment. The highest and lowest FCR were obtained by control and Virginiamycin at 29–42 and 1–42 d of age, respectively ($P < 0.05$). Highest and lowest antibody titers against SRBC were observed in Primalac and Virginiamycin treatments, respectively ($P < 0.05$). The serum Chol, TG, LDL and HDL levels were affected by treatments ($P < 0.05$). Lowest mentioned parameters were obtained by Primalac and Sangrovit ($P < 0.05$). The lowest and highest coliform counts in ileum at 21 d of age were achieved in Virginiamycin and control, respectively ($P < 0.05$). Moreover, the highest and lowest lactic acid bacteria in crop, ileum and cecum at 21 d of age were respectively observed in Primalac and Virginiamycin, ($P < 0.05$). The lowest coliforms counts in ileum and cecum were attained by Virginiamycin at 42 d of age ($P < 0.05$). The highest and lowest villous height in duodenum and jejunum were attained by Primalac and control at 21 and 42 d of age, respectively ($P < 0.05$). Also greatest villi height: crypt depth in duodenum and jejunum were obtained by Primalac ($P < 0.05$). The results of current study have shown that administration of Primalac, Termin-8 and Sangrovit can improve broilers performance.

Key Words: Virginiamycin, Primalac, Termin-8, Sangrovit, broiler

536 Effects of yarrow (*Achillea millefolium*), antibiotic and probiotic on GIT microbial population, immune response, serum lipids and broilers performance. S. Yakhkeshi[1], S. Rahimi*[1], H. R. Hemati Matin[1], and A. Rahimi[2], *[1]Tarbiat Modares University, Tehran, Tehran, Iran, [2]Islamic Azad University, Tehran, Tehran, Iran.* The study was conducted to investigate the effects of medicinal plant of yarrow (*Achillea millefolium*), probiotic (Primalac) and Virginiamycin on GIT characteristics and microbial population, serum lipids, immune response, and performance of broilers. A total of 250 one-day-old male broilers (Ross 308) were randomly allocated to 5 treatments, 5 replicates with 10 birds in each in CRD. Treatments were control, Virginiamycin (15 ppm), Primalac (0.1%), and 2 levels of yarrow powder (1.5 and 3%). Highest and lowest FCR were observed in control and Virginiamycin at d 42 ($P < 0.05$). Moreover, highest and lowest BWG were obtained by Virginiamycin and control, respectively ($P < 0.05$). Carcass yields were not different between treatments ($P > 0.05$). Relative weights of breast and thigh were similar between all treatments ($P > 0.05$). Relative weights of bursa Fabricius, spleen and primary immune response (total titer, IgY and IgM) against SRBC were not affected by treatments ($P > 0.05$). The serum Chol, TG, LDL and HDL levels were differently affected by treatments ($P < 0.05$). Lowest mentioned parameters were obtained by 3% of yarrow ($P < 0.05$). Highest and lowest antibody titers against SRBC were observed in yarrow (3%) and antibiotic treatments, respectively ($P < 0.05$). Highest *lactic acid* bacteria were attained by Primalac in crop, ileum and cecum ($P < 0.05$). Inclusion of Virginiamycin and yarrow (3%) caused a significant decrease in coliforms and total aerobic bacteria counts in crop, ileum and cecum ($P < 0.05$). The results of current study have shown that administration of yarrow (3%) can reduce the levels of serum lipids and GIT pathogenic bacteria, also improve broilers immune response. It is proposed that yarrow can be used as an antibiotic alternative in poultry diets.

Key Words: yarrow, Virginiamycin, Primalac, immune response, broiler performance

537 Performance assessment of three prebiotic feed supplements in pasture flock broilers. I. Hanning*, A. Clement, S. Milillo, S. Park, S. Pendleton, E. Scott, and S. Ricke, *University of Arkansas, Fayetteville.*

Pasture flock raised chicken is becoming an increasingly popular product. For these producers, prebiotics are a popular option because they are generally recognized as safe (GRAS) and can be mixed into the feed and thus do not require adjustments to production protocols. However, if prebiotic treatments reduce production performance, they would not be useful to producers. Thus, the objective of this study was to measure performance of pasture raised broilers fed one of 3 prebiotic treatments. For these trials, 2 breeds of birds were utilized, naked neck slow growers and Cornish and White Rock cross fast growers. The experimental design was replicated for each breed. A total of 340 birds were split into 4 groups, each group fed one feed additive 1) galactoligosaccharides (2Kg / ton); 2) fructooligosaccharides (1Kg / ton); 3) plum fibers (1Kg / ton); or 4) no additives. Every 2 weeks over the 8 week rearing period, 10 birds from each group were collected for small intestine samples. Histological preparations were made from the small intestine tissue and 4 measurements of villi height and crypt depth from each cross section were taken. Throughout the study mortality was monitored, mass measurements were taken at 2 week intervals and feed consumption measured daily. The group receiving feed

supplemented with plum fibers had the lowest final weight, poorest adjusted feed conversion and highest mortality. The group receiving the feed supplemented with GOS had the highest final weight, optimum adjusted feed conversion and lowest mortality. However, among all the groups none of these differences were statistically significant. Similarly, there were apparent differences in crypt depth and villi height but none of the differences were statistically significant. Finally, there were no differences in measurements by breed. The results of this study indicate that there were some apparent differences in performance measurements dependent on the prebiotic given, but the differences were not statistically significant. Therefore, the 3 prebiotics utilized in this study could be used without risk of decreasing production performance.

Key Words: prebiotic, feed, broiler, pasture flock, supplement

538 Effect of Maxigen (yeast product) supplementation on broiler growth performance. Y. Fasina* and Y. Olowo, *Auburn University, Auburn, Alabama.*

Yeast products contain nucleotides that are essential for cellular functions and growth. Supplementing yeast products into broiler diets may enhance growth performance and overall flock uniformity. Accordingly, a 42-d experiment was conducted to evaluate the efficacy of Maxigen (a novel yeast product obtained from Canadian Biosystems, Canada) in enhancing broiler growth performance and flock uniformity. Four hundred and 80 d-old chicks were obtained from a commercial hatchery, weighed, and randomly assigned to 2 dietary treatments. Treatment 1 (CX, control) consisted of chicks fed corn-soybean meal (SBM) diet that was not supplemented with Maxigen. Treatment 2 (MG) consisted of chicks fed corn-SBM basal into which Maxigen was added at 0.075% level. Each treatment consisted of 12 replicate pens, with each pen housing 20 chicks. On d 21 and 42 of experiment, growth performance (body weight and feed conversion) and flock uniformity were assessed. Results showed that on d 21, there was no difference ($P > 0.05$) between the body weights, feed conversion efficiency, and flock uniformity of CX and MG chicks. However, by d 42, the feed conversion efficiency of MG chicks (1.67) became superior ($P < 0.05$) to that of CX chicks (1.71). In addition, flock uniformity of MG chicks (66.4%) was better than the uniformity of CX flock (56.8%; ($P = 0.0527$). It was concluded that Maxigen supplemented at 0.075% level of the diet enhanced growth performance and flock uniformity of broiler chickens.

Key Words: Maxigen, yeast extract, flock uniformity, broiler chicks

539 Impact of dietary supplementation of EconomasE on egg selenium, production performance and egg quality of white egg laying hens. A. N. Meredith*, A. H. Cantor, A. J. Pescatore, M. J. Ford, J. L. Pierce, T. Ao, K. A. Dawson, L. M. Macalintal, and W. D. King, *Alltech-University of Kentucky Nutrition Research Alliance, Lexington.*

EconomasE (Alltech, Inc.) is a proprietary blend of ingredients that has been shown to improve the antioxidant status of poultry. A study was conducted to compare the effects of including EconomasE, vitamin E, and selenium (Se) in the diet of laying hens on production performance, egg quality and egg Se concentrations. Dietary treatments consisted of feeding 1) corn-soybean meal control diets (starter, grower and layer) without supplemental Se or vitamin E 2) control + 0.3 mg/kg Se as Na_2SeO_3, 3) control + 0.3 mg/kg Se as Na_2SeO_3 + 30 IU/kg of vitamin E, and 4) control + 0.2 g/kg EconomasE. Six replicate groups of 16 Hy-Line W-36 pullets were randomly assigned to each dietary treatment. Day-old birds were initially housed in pullet cages. At 17 wk they were moved to layer cages and the number of birds was reduced to 12 per replicate. The dietary treatments continued throughout the production period. Egg samples (6 per replicate) were taken every 4 weeks to evaluate egg quality. No significant differences were found among production performance and egg quality parameters. Overall average values for some of these parameters during Weeks 18 through 45 were: hen-day egg production = 83%, feed per hen per day = 96 g, feed/dozen eggs = 1.61 kg, egg weight = 57 g, per cent shell = 9.3, and shell breaking strength = 3.6 kg force. The concentration of Se in the egg contents (fresh basis) was significantly ($P < 0.05$) increased by the 3 supplemental treatments, compared with the control treatment (0.14 μg/g). Egg Se concentration for hens fed EconomasE was 0.32 μg/g, which was significantly higher than the respective values for the hens fed Na_2SeO_3 alone (0.22 μg/g) or with vitamin E (0.23 μg/g). The results indicate that adding EconomasE to laying hen diets increases egg Se levels, compared with supplements of Na_2SeO_3 alone or with vitamin E.

Key Words: EconomasE, selenium, vitamin E, egg quality, laying hen

540 Influence of EconomasE supplementation on egg selenium, production performance and egg quality parameters of brown egg laying hens. A. N. Meredith*, A. H. Cantor, A. J. Pescatore, M. J. Ford, J. L. Pierce, T. Ao, K. A. Dawson, L. M. Macalintal, and W. D. King, *Alltech-University of Kentucky Nutrition Research Alliance, Lexington.*

EconomasE (Alltech, Inc.) is a proprietary blend of ingredients that has been shown to increase the antioxidant status of poultry. The effect of supplementing diets with EconomasE or selenium (Se) alone or with vitamin E on production performance, egg quality and egg selenium concentration was studied using brown eggshell laying hens. Dietary treatments consisted of feeding 1) corn-soybean meal control diets (starter, grower and layer) without supplemental Se or vitamin E 2) control + 0.3 mg/kg Se as Na_2SeO_3, 3) control + 0.3 mg/kg Se as Na_2SeO_3 + 30 IU/kg of vitamin E, and 4) control + 0.2 g/kg EconomasE. Six replicate groups of 16 Hy-Line W-36 pullets were randomly assigned to each treatment. Day-old birds were housed in pullet cages. At 17 wk they were moved to layer cages and the number of birds was reduced to 12 per replicate. The dietary treatments continued throughout the production period. Egg samples (6 per replicate) were taken every 4 weeks to evaluate egg quality. No significant differences found among production performance and egg quality variables. Overall average values for some of these parameters during Weeks 17 through 44 were: hen-day egg production = 85%, feed/hen/day = 108 g, feed/dozen eggs = 1.66 kg, egg weight = 61 g, per cent shell = 8.7, and shell breaking strength = 3.4 kg force. The concentration of Se in the egg contents (fresh basis) was significantly ($P < 0.05$) increased by the 3 supplemental treatments, compared with the control treatment (0.14 μg/g). Egg Se concentration for hens fed EconomasE was 0.33 μg/g, which was significantly higher than the respective values for the hens fed Na_2SeO_3 alone (0.24 μg/g) or with vitamin E (0.24 μg/g). The results indicate that increased levels of Se in eggs can be obtained with EconomasE supplementation of layer diets, compared with supplements of Na_2SeO_3 alone or with vitamin E.

Key Words: EconomasE, selenium, vitamin E, egg quality, laying hen

541 Impact of non-antibiotic alternatives on performance, gut inflammation and integrity in broiler chickens. H. Lu*, O. Adeola, and K. M. Ajuwon, *Purdue University, West Lafayette, IN.*

The study was conducted to determine the growth performance and inflammatory gene expression of 6 treatments on broilers chickens: organic acid (Orego-Stim), yeast extract (Alphamune), direct fed microbial (Avicorr), crude yeast extract, salinomycin (positive control, PC) and a non-treated group (negative control, NC). 672 d-old broilers were allocated to the 6 treatments. Each treatment had a total of 8 replicates at 14 birds per replicate. Birds were orally vaccinated with eimeria species using the coccivac B vaccine at 2 weeks (d 14) and at 5 weeks (d 35). On d 21 and 42, one bird per replicate was killed for expression analyses of mucin (MUC2), interleukin 1 (IL-1β) and 10 (IL10) and tumor necrosis factor (TNF-α) by RT-PCR in mucosal samples from the duodenum, jejunum, ileum and ceca tonsils. There was no significant difference in average daily gain (ADG) between treatments on d 21. However, on d 42 the ADG of birds treated with salinomycin was significantly higher than the Avicorr and Orego-stim treated groups ($P < 0.05$). Additionally, feed efficiency was improved by salinomycin compared with NC and Orego-stim treatments ($P < 0.05$). Gene expression levels were not different among treatments on d 21. However on d 42, expression level of TNF-α was lower in the Orego-stim treatment group than NC ($P = 0.0112$). In addition, birds treated with crude yeast had a significantly higher level of IL-10 ($P = 0.0229$). Overall, these results confirm the expected improved animal performance with antibiotic (salinomycin) treatment and further show reduced inflammation with organic acid (Orego-stim) treatment in broiler chickens.

Key Words: broiler chicken, challenge, inflammation, antibiotic alternatives

542 Growth response of broilers to lysine levels and hydrolyzed porcine digestive mucosa (Palbio) inclusion in diet from 1 to 21 d of age. M. Frikha[1], S. Mirzaie[1], H. Irandoust[1], M. Mohiti-Asli[1], C. Chetrit[2], and G. G. Mateos*[1], *[1]Departamento de Producción Animal, Universidad Politécnica de Madrid, Madrid, Spain, [2]I+D Nutrition and Health Care, Bioibérica S.A., Palafolls, Barcelona, Spain.*

Palbio (PAL, Palbio 50 RD, Bioibérica, Spain) is a protein concentrate based on hydrolyzed porcine digestive mucosa dried under a fluid bed system over a soybean carrier, currently used in piglet feeds. The digestibility of PAL is very high and the product may be an excellent source of protein for young chicks. An experiment was conducted with 1,280 straight-run one-d-old Ross 308 chicks to evaluate the growth response of broilers to dietary inclusion of PAL. The experiment was conducted as a completely randomized design with 8 treatments arranged as a 2 × 4 factorial with 2 levels of PAL (0 vs. 2.5%) and 4 levels of lysine (1.1, 1.2, 1.3, and 1.4%). All diets contained 3,020 kcal ME/kg and the ratio of indispensible amino acids to Lys was maintained constant. From 21 to 32 d of age all the birds received a common commercial finisher diet without any PAL inclusion. Each treatment was replicated 5 times and the experimental unit was a pen with 32 chicks from 1 to 21 d of age and with 15 chicks from 21 to 32 d of age. Body weight gain (BWG), average daily feed intake (ADFI), and feed conversion ratio (FCR) were recorded weekly. From 1 to 21 d of age, PAL inclusion reduced ADFI ($P \leq 0.05$) and improved FCR ($P \leq 0.01$) and BWG ($P = 0.10$). An increase in dietary LYS level improved BWG ($P \leq 0.001$) and FCR ($P \leq 0.05$). From 1 to 7 d of age, the beneficial effects of PAL inclusion were more evident in the diets with the lower LYS content. From 21 to 32 d of age, when all birds were fed a common diet, no differences between treatments were observed for any of the variables except for ADFI that was higher ($P \leq 0.01$) for the treatment that consumed PAL previously. We conclude that the inclusion of 2.5% PAL in the diet results in improved performance of the birds. Broilers require at least 1.3% dietary LYS to maximize growth performance from 1 to 21 d of age.

Key Words: broilers, lysine, hydrolyzed porcine mucosa

543 Effects of heat treating rapeseed meal on amino acid digestibility in broilers. J. Boguhn[1], A. Helmbrecht[2], and M. Rodehutscord*[1], *[1]University of Hohenheim, Institute of Animal Nutrition, Stuttgart, Germany, [2]Evonik Degussa GmbH, Animal Nutrition Services, Health & Nutrition, Hanau, Germany.*

The objective was to study effects of extreme feed conditioning on prececal amino acid (AA) digestibility of rapeseed meal (RSM) in broilers. The RSM contained 34% CP and was obtained from a commercial cracking plant. It remained either untreated or was exposed to moist heat (135°C) for 20 or 60 min in an autoclave. A basal diet mainly based on corn, corn starch, soybean meal and wheat gluten was used. The untreated and treated RSM was included at 10 or 20% into the basal diet at the expense of corn starch, resulting in a total of 7 dietary treatments. TiO_2 (0.5%) was used as the indigestible marker. Diets were fed in pelleted form to 3-wk old Ross 308 broilers. Each diet was allocated to 7 pens of 12 birds each and offered for ad libitum intake for 7 d. Birds were asphyxiated by CO_2 exposure. The content of a defined section of the terminal ileum was flushed out, pooled on pen basis, and freeze-dried. Chemical analyses were run using established methods. AA digestibility of RSM was calculated by linear regression analysis. Hence correction for basal endogenous AA was not necessary. Heat treatment reduced the analyzed Lys concentration of RSM from 2.1 (Con) to 1.6 (20 min) and 1.4% (60 min). Average AA digestibility was 73% in the untreated RSM, 57% in the RSM treated for 20 min, and 44% in the RSM treated for 60 min. Heat treatment for 20 min significantly reduced ($P < 0.05$) the digestibility of 7 out of the 17 AA studied. Heat treatment for 60 min significantly ($P < 0.05$) reduced the digestibility of all AA. Most affected among the essential AA were Thr (68, 48 and 39%) and Lys (75, 56 and 45%; for Con, 20 and 60 min, respectively). It was concluded that moist heat applied in feed conditioning will reduce AA digestibility greatly. Details of the technological process contribute to the variation in AA digestibility within same raw material found in the literature.

Key Words: amino acids, digestibility, broilers, heat treatment, rapeseed meal

544 Feeding plant extract to chickens reared under different hygienic conditions: effects on metabolizable energy, nutrient digestibility and endogenous losses. V. Pirgozliev*[1] and D. Bravo[2], *[1]SAC, Ayr, Scotland, UK, [2]Pancosma S.A., Geneva, Switzerland.*

Plant extracts are often added to poultry diets to improve nutrient availability, growth performance and flock uniformity. Although it has been hypothesized that dietary plant extracts work better when fed to birds reared under "less hygienic" conditions, there is a lack of consistent data to support this hypothesis. Two experiments were conducted to investigate whether the response of broilers to supplementation of plant extract, a mixture of carvacrol, cinnamaldehyde and capsaicin (XT, Pancosma S.A.) depend on the rearing condition using dietary apparent metabolizable energy corrected for nitrogen retention (AMEn), coefficients of dry matter (DMD), nitrogen (ND) and fat digestibility (FD), and endogenous secretions (measured as sialic acid (SA)) as response criteria. In Expt. One birds were reared in cages (high hygiene) whereas birds were reared in floor pens (low hygiene) with used litter in Expt. 2. In both experiments, a corn-soybean meal control diet adequate in protein (215 g/kg diet) but slightly lower in AME (2890 kcal/kg) than breeders' recommendation and slightly high in non-starch polysaccharides, achieved by inclusion of ~10% barley and rye were fed to the birds with or without XT (100 g XT/tonne). The birds were allocated to dietary treatments in a randomized complete block design, each diet was fed to 12 cages or 10 floor pens. In Expt. 1, feeding XT decreased ($P < 0.05$) ND, and tended ($P < 0.10$) to decrease DMD ($P = 0.072$) and SA secretions although dietary AME and FD did not differ ($P > 0.05$) between treatment. However, feeding XT to the birds reared on used litter improved FD ($P < 0.05$), and tended ($P < 0.10$) to improve AMEn whereas dietary DMD, ND and endogenous secretions remained unchanged ($P > 0.05$). The current data support the hypothesis from previous research that dietary plant extracts are more efficient when fed to birds reared in less hygienic conditions.

Key Words: plant extract, hygienic conditions, ME, digestibility, chicks, endogenous secretions

545 Prediction model of digestible amino acid in sorghum. M. Sedghi[1], M. R. Ebadi[2], A. Golian*[1], and H. Ahmadi[1], *[1]Ferdowsi University of Mashhad, Iran, [2]Isfahan Research Center of Agriculture and Natural Resources, Isfahan, Iran,*

The accurate knowledge of true digestible amino acid (TDAA) contents of feedstuff is necessary to formulate the more accurate poultry diets for a profitable production. Several experimental approaches have been used to determine available amino acids which are highly expensive and time consuming. Prediction of nutritive value of a feed ingredient from its chemical composition via regression method has been attempted for many years. Artificial neural network (ANN) model is the powerful method which may describe the relationship between digestible amino acid contents and chemical composition. Therefore we developed multiple linear regressions (MLR) and ANN models for predicting the TDAA contents of sorghum grain based on chemical composition. The precision fed assay trials using cecectomized roosters were performed to determine the TDAA contents in 48 sorghum samples from 12 sorghum varieties differing in chemical compositions. The input variables for both MLR and ANN models were CP, ash, crude fiber (CF), ether extract (EE), and total phenols whereas the output variable was the each individual TDAA for every sample. The results of this study revealed that it is possible to satisfactorily estimate the TDAA of sorghum grain through its chemical composition. The chemical compositions of sorghum grain seems to highly influence the TDAA contents when considering components such as CP, CF, EE, ash and total phenols. It is also possible to estimate the TDAA contents through multiple regression equations with reasonable accuracy depending on compositions but, a more satisfactory prediction may be achieved via ANN for all amino acids. The R2 values corresponding to testing and training of the ANN model showed a higher accuracy of prediction than equation established by MLR method. In addition, the current data confirmed that the chemical composition, often considered in total amino acid prediction, could be also a useful predictor of true digestible values of selected amino acids for poultry.

Key Words: prediction model, sorghum, true digestible amino acid

546 Relationship between chemical composition and total amino acid contents in pearl millet hybrid. P. Soleimani, M. Sedghi, and A. Golian*, *Ferdowsi University of Mashhad, Iran.*

Pearl millet is tolerance to harsh growing conditions such as drought. It is at least equivalent to maize and generally superior to sorghum in protein content and metabolizable energy levels. Thus it can be important for poultry feeding. Amino acid (AA) determination is expensive and time consuming. Therefore nutritionists have prompted a search for alternatives to estimate AA levels. Traditionally, 2 methods of predicting AA levels have been developed using multiple linear regression (MLR) with an input of either CP or proximate analysis. Artificial neural networks (ANN) may be more effective to predict AA concentration in feedstuff. Therefore a study was conducted to predict the AAs level in pearl millet with either MLR or ANN. Fifty 2 data lines contained chemical compositions and AAs which collected from literature were used to find the relationship between chemical analysis and AA contents. For both MLR and ANN models chemical composition (dry matter, ash, crude fiber, crude protein, ether extract) was used as inputs and each individual AA was the output in each model. The results of this study showed that it is possible to predict AAs with a simple analytical determination of proximate analysis. Furthermore ANN models could more effectively identify the relationship between AAs and proximate analysis than linear regression model.

Key Words: amino acid, neural network model, pearl millet

547 Application of mathematical models for true metabolizable energy determination in sorghum grain for poultry. M. Sedghi[1], M. R. Ebadi[2], A. Golian*[1], and P. Soleimani[1], *[1]Ferdowsi University of Mashhad, Iran, [2]Research Center of Agriculture and Natural Resources, Isfahan, Iran,*

Sorghum grain is an important ingredient in poultry diets. Nitrogen-corrected true metabolizable energy (TMEn) content of sorghum grain is a measure of its quality. As for the other feed ingredients, the biological procedure used to determine the TMEn value of sorghum grain is costly and time-consuming. Therefore, it is necessary to find an alternative method to accurately estimate the TMEn content of sorghum grain. Artificial neural networks are the powerful method which widely used in agriculture and poultry nutrition. Therefore In this study, an artificial neural network (ANN) and a multiple linear regression (MLR) models were used to predict the TMEn of sorghum grain based on its acid detergent fiber (ADF) and total phenols content. The accuracy of the models was calculated by R2, MS error and bias. The predictive ability of an ANN was compared with a MLR model using the same training data sets. The results of this study showed that it is possible to estimate sorghum grain TMEn with a simple analytical determination of ADF and phenolic content. The R2 values corresponding to testing and training of the ANN model showed a higher accuracy of prediction than that established by regression method (R2 = 0.84 vs 0.56 for training and R2 = 0.83 vs 0.47 for testing data sets respectively). In conclusion, the ANN model may be used to accurately estimate the TMEn value of sorghum grain from its corresponding chemical composition (ADF and total phenols content).

Key Words: metabolizable energy, neural network model, sorghum

548 Feeding the meal or full fat seeds of *Camelina sativa* or flax to laying hens: Effects on egg production, egg quality and fatty acids. G. Cherian*, A. E. Aziza, and N. Quezada, *Oregon State University, Corvallis.*

Two experiments were conducted to investigate the effect of feeding the meal or full fat seeds of *Camelina sativa* or flax to layer birds on egg production, egg quality and egg fatty acid content. Seventy-five 26-week-old (n = 75) laying birds were kept in cages and were fed a corn-soybean meal diet (Control) or Control diet with Camelina meal (CAM-Meal) or Flax meal (Flax-Meal) added at 10%. The diets were fed for a period of 4 mo. Birds were taken off the experimental diets for 6 weeks and were fed a corn-soybean meal diet (Control) or Control diet with Camelina seed (CAM-Seed) or Flax seed (Flax-Seed) added at 10% for another 4 mo period. Hen-day egg production was highest for the Camelina and Flax meal and seed in both experiments ($P < 0.05$). A reduction in egg and albumen weight was observed for CAM-Meal and CAM-Seed when compared with Control and Flax-Meal or Flax-Seed eggs in both experiments ($P < 0.05$). Shell thickness was lowest for Flax-Meal and Flax-Seed eggs ($P < 0.05$). There was no difference in yolk weight or yolk:albumen ratio upon inclusion of CAM-Meal, CAM-Seed or Flax-Meal or Flax-Seed ($P > 0.05$). Total n-3 fatty acids constituted 1.27% in Control eggs compared with 4.40 and 1.74% in CAM-Meal and Flax-Meal eggs, respectively ($P < 0.05$). A 2-fold increase in docosahexaenoic acid was observed in CAM-Meal when compared with Control eggs and the total n-6:n-3 fatty acid ratio was 13.01, 4.45 and 9.37 for Control, CAM-Seed and Flax-Seed eggs, respectively ($P < 0.05$). Arachidonic acid, and total saturated and monounsaturated fatty acids were lowest for CAM-Meal

($P < 0.05$). Total n-3 fatty acids constituted 1.19% in Control eggs compared with 3.12 and 3.09% in CAM-Seed and Flax-Seed eggs, respectively ($P < 0.05$). The total n-6:n-3 fatty acid ratio was 5.99, 2.45 and 2.80 for Control, CAM-Seed and Flax-Seed, respectively ($P < 0.05$). Camelina meal or seed could be incorporated into layer rations as a source of energy, protein and n-3 fatty acids and Camelina meal would be more efficient in incorporating n-3 fatty acids into eggs than whole seed.

Key Words: eggs, camelina, flax, n-3 fatty acids

549 Metabolizable energy values of corn distillers grains and corn distillers grains with solubles for 6-week-old broiler chickens. O. Adeola and H. Zhai*, *Purdue University, W. Lafayette, IN.*

The objective of this study was to determine the ileal digestible energy (IDE), ME, and ME_n contents of corn distillers grains (DDG) and corn distillers grains with solubles (DDGS) for 6-week-old broiler chickens using multiple linear regression method. The birds were fed a standard broiler starter diet from d 1 to 21 post-hatch and a standard broiler grower diet from d 22 to d 35 post hatch. The analytical composition of DDG and DDGS used in this study were 4,879 and 4,762 kcal of gross energy/kg, 315 and 287 g of CP/kg, and 921 and 901 g DM/kg, respectively. The DDG and DDGS were incorporated into a reference diet at 3 levels (0, 300, or 600 g/kg) by replacing the energy-yielding ingredients. These 5 diets were fed to 240 male Ross 308 from d 35 to 42 post hatch with 6 birds per cage and 8 replicate cages per diet in a randomized complete block design. The inclusion of DDG or DDGS to the reference diets linearly ($P < 0.001$) decreased ileal digestibility of DM and energy, total tract digestibility of DM, N, and energy, and IDE, ME and ME_n in assay diets. By regressing the DDG and DDGS -associated IDE intakes in kilocalories against kilograms of intakes of DM in DDG and DDGS, the IDE regression equation was established as $Y = -12 + 2{,}125 * DDG + 2{,}589 * DDGS$, $r^2 = 0.96$, which indicates IDE values of 2,125 kcal/kg for DDG and 2,589 kcal/kg for DDGS. Similary, the ME regression equation was $Y = -17 + 1{,}988 * DDG + 2{,}460 * DDGS$, $r^2 = 0.97$, which implies ME values of 1,988 kcal/kg for DDG and 2,460 kcal/kg for DDGS. For ME_n, the regression equation was $Y = -14 + 1{,}891 * DDG + 2{,}360 * DDGS$, $r^2 = 0.97$, which alludes to ME_n values of 1,891 kcal/kg for DDG and 2,360 kcal/kg for DDGS. Based on these results, we calculated the advantages in IDE, ME, and ME_n of DDGS over DDG used in this study to be 22%, 24%, and 25%.

Key Words: broiler chicken, corn distillers grains, corn distillers grains with solubles, ileal digestible energy, metabolizable energy

550 Effects of the inclusion of oat hulls or sugar beet pulp in the diet on gizzard characteristics, apparent ileal digestibility of nutrients, and microbial count in the ceca in 36-day-old broilers reared on floor. E. Jimenez–Moreno*, C. Romero, J. D. Berrocoso, M. Frikha, and G. G. Mateos, *University Polytechnic of Madrid, Madrid, Spain.*

The effects of the inclusion of oat hulls (OH) and sugar beet pulp (SBP) in the diet on gizzard characteristics, apparent ileal nutrient digestibility (AID), and *Clostridium perfringens*, *Enterobacteriaceae*, and *Lactobacillus* proliferation in the ceca were studied in 36 d–old broilers. There were a control diet with a low CF content (1.61%) and 2 additional diets that resulted from the dilution of this feed with 5% of either OH or SBP. Each treatment was replicated 7 times (10 chicks each) and birds were kept on pens with straw as bedding. Only one of the chicks of each of the replicates was used for microbiology counts. Broilers fed additional fiber had heavier gizzards ($P \leq 0.001$) with higher digesta contents ($P \leq 0.001$) and lower pH ($P \leq 0.01$) than those fed the control diet. More digesta was retained in the gizzard with SBP than with OH inclusion, a finding that was presumably related with the higher water holding and swelling capacity of the SBP. Neutral detergent fiber, acid detergent fiber, and acid detergent lignin content of gizzard digesta were increased ($P \leq 0.001$) with OH but not with SBP inclusion. The AID of starch was higher ($P = 0.05$) with OH than with SBP inclusion, with that of the control diet being intermediate. However, the AID of CP was not affected by diet. The inclusion of OH but not of SBP, reduced cecal counts of *Cl. perfringens* ($P \leq 0.05$), *Enterobacteriaceae* ($P \leq 0.01$), and *Lactobacillus* ($P = 0.08$). The data suggest that the inclusion of OH, a lignified insoluble fiber source, improves gizzard function and AID of starch and reduced cecal pathogen microbial count in 36 d–old broilers. Under practical conditions, feeding OH may be used to improve nutrient digestibility and control microbial growth in the gastrointestinal tract of broilers.

Key Words: fiber sources, gizzard characteristics, ileal nutrient digestibility, cecal microbial count, broiler

551 Effect of snack food byproduct on the feeding behavior and production parameters of laying hens. R. C. Van Wyhe*, S. E. Fraley, C. Szybisty, D. M. Karcher, and E. L. Karcher, *Michigan State University.*

The increased interest in becoming 'green' for consumers and companies is driving groups to develop innovative ways to become more efficient and reduce their waste. Foods past their expiration dates are large sources of waste and are causing food-manufacturing companies to develop waste disposal strategies. Integrating by-products of these companies into animal diets, specifically that of laying hens, could be significantly more cost effective for both the human food manufacturers and the agricultural producers. The study's objective is to evaluate laying hen diets containing snack food by-product, consisting mostly of expired potato chips, and the impact on hen performance and feeding behavior. One hundred and 92 white Leghorn laying hens (45 wks old) were selected from the MSU Poultry Farm. Hens were housed in conventional cages (3 birds/cage) and received one of 4 diets for 4 wks: 1) industry standard corn-soybean meal control 2) control with 3% by-product 3) control with 6% by-product and 4) control with 9% by-product. Diets were formulated to be isocaloric, isonitrogenous, and balanced for sodium. Feed intake was measured for 3 consecutive days each wk. During the first wk, feed intake was significantly higher in birds fed the 6% and 9% diets compared with those fed control ($P < 0.05$). Birds feed the 9% had a higher feed intake than control again during the fourth wk ($P < 0.01$). Egg production, egg weight, and specific gravity were measured weekly. Hen body wt was measured on day one and every 2 weeks thereafter. Egg production, egg wt, specific gravity, and body weight were not significantly affected by the addition of snack food by-products to the diet. In conclusion, the addition of expired snack food by-product into poultry diets does not significantly effect laying hen egg production and has the potential to be used as an alternative feed stuff in the future.

Key Words: snack, egg, laying, hen

552 Different levels of biodiesel glycerin in the diets of broiler chickens. K. C. Zavarize*[1], J. F. M. Menten[1], R. Pereira[1], L. L. Freitas[1], C. L. S. Silva[1], Y. K. Carvalho[2], and S. R. A. Rosa[3], *[1]University of São Paulo, Piracicaba, Sao Paulo, Brazil, [2]Federal University of*

Acre, Rio Branco, Acre, Brazil, [3]Montes Belos College, São Luis de Montes Belos, Góias, Brazil.

Glycerin obtained from biodiesel production using soybean oil as its feedstock has been shown to be a highly available energy source for animals. It can potentially be used as a substitute for other energy sources such as corn. The objective of this study was to determine the effects of diets containing different levels of glycerin on chicken performance and litter moisture. In this trial 1,620 d old male chicks (Cobb 500) were assigned to 6 experimental diets with 6 replicates of 45 birds each in a completely randomized design. Treatments consisted of a control diet without glycerin and diets formulated with increasing levels of biodiesel glycerin (2.5, 5.0, 7.5, 10.0 and 12.5%). The glycerin was analyzed to contain 80.7% glycerol, 12.6% moisture, 2.3% sodium and 80 ppm methanol; its metabolizable energy content had been previously determined to be 3,145 kcal/kg. The diets were isonutritive and were based on corn, soybean meal and corn oil and were supplemented with nutrients to meet the nutritional requirements of chickens. The chickens were raised in floor pens with rice hulls as litter material. Live weight (LW), feed conversion (FC) and feed intake (FI) were determined at weekly intervals until 40 d of age. Birds were checked twice daily for mortality with the weight of dead birds used to adjust FC. Litter moisture was determined at 21, 28, 35 and 40 d of the growth period. At 7 d, LW (176 vs. 171 g) and FI (143 vs. 138 g) were increased with 12.5% glycerin compared with control ($P < 0.05$). At 21 d, LW increased with 7.5% glycerin (927 vs. 900 g, $P < 0.05$) without affecting FI. At 40 d, LW (avg. 2.58 kg) and FI (avg. 4.33 kg) were not affected by glycerin levels, but the highest inclusion level was detrimental to FC (1.737 vs. 1.702, $P < 0.05$). At 40 d, the 10.0 and 12.5% glycerin treatments resulted in increased litter moisture (52% and 57%, respectively) compared with control (42%, $P < 0.05$). The results of this study demonstrated that glycerin may be incorporated to a level of 10.0% in the diet of broilers without any detrimental effect on performance, but there is an increase in litter moisture.

Key Words: alternative feeds, biodiesel glycerin, litter quality, chicken growth

553 Determination of metabolizable energy contents of barley and wheat for broiler chickens using regression method. O. A. Bolarinwa* and O. Adeola, *Purdue University, West Lafayette, IN.*

Broiler chickens were used in an experiment to determine the metabolizable energy (ME) contents of barley and wheat using the regression method. The respective gross energy, crude fiber, and crude fat contents of the barley or wheat samples used were 4,567 or 4,407 kcal/kg, 23.8 or 55.4, and 16.6 or 15.7 g/kg DM. A standard corn-soybean meal diet with GE and ME of 4,645 and 3,482 kcal/g DM, respectively, and 4 test diets (TD) were used for the study. In the standard diet, corn, soybean meal, corn starch and soy oil were used as the sources of energy. In the test diets, barley and wheat were added at the rate of 100 or 200 g/kg diet to partly replace corn, soybean meal, corn starch and soy oil such that the ratio of all energy-yielding feedstuffs to one another was the same in all the assay diets. Each of the 5 dietary treatments had 8 replicates with 8 birds per replicate. Birds received starter diet from d 1 to d 15 post-hatch. Birds with average body weight of 328 g at d 15 post-hatch were assigned to 5 diets in a randomized complete block design. The assay diet was fed for 7 d and excreta was collected twice daily on d 20 and 21. Average weight gain and feed efficiency were between 321 to 350 g and 678 to 729 g/kg, respectively for the 7-d period. The ME content of the barley or wheat sample was determined from the slope of the regression of barley or wheat contribution to apparent ME intake against amount of barley or wheat intake. Metabolizable energy values for barley and wheat samples derived from the regression analyses were 3,665 and 3,746 kcal/kg DM, respectively. The result suggests that barley and wheat have high metabolizable energy and can be used to partly replace corn and SBM in diets fed to broiler chickens.

Key Words: broiler chickens, barley, wheat, metabolizable energy, regression

554 Use of the corn germ meal in diets of laying hens. C. S. Albuquerque[1], C. B. V. Rabello*[1], D. A. T. Silva[1], M. B. Lima[2], T. S. Lima[1], D. P. V. Silva[1], C. C. Lopes[1], and E. P. Silva[3], *[1]Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil, [2]Esalq, USP, Piracicaba, São Paulo, Brasil, [3]Unesp, Campus de Jaboticabal, Jaboticabal, São Paulo, Brasil.*

The purpose of this study was to evaluate the effect of increasing levels of corn germ meal (CGM) on diets of laying hens on productive performance and egg quality. 200 laying hens, Dekalb White lineage, were used at 29 weeks of age. The fowls were distributed in a completely randomized design with 5 treatments and 5 replicates of 8 fowls each. The treatments were consisted of a reference diet based corn, soybean meal and oil soybean and 4 diets with the following levels of inclusion of CGM: 2.0, 4.0, 6.0 and 8.0%. The CGM used in this research had the following chemical and energetic composition: 10.09% of crude protein, 0.03% of calcium, 0.08% of available Phosphorus, 0.02% of sodium, 0.62% of potassium, 0.46% of lysine, 0.19 of methionine, 0.34% of methionine and cystine, 0.33% of threonine, 0.09% of tryptophan and 5,670 kcal/kg transformed energy. The results were submitted to ANOVA and means were subjected to the Dunnett test at 5% probability for the reference treatment compared with the other and a regression analysis was used to verify the effect of inclusion of CGM on the performance and egg quality parameters. The inclusion levels of GIM did not affect the feed intake (g/b/d), egg production (%) and egg mass (g/b/d). However, the egg weight and feed conversion were affected. The inclusion of up to 6% did not affect the performance parameters of laying hens when compared with the reference treatment. Regarding the regression analysis there was a linear effect for both variables (weight and feed conversion). The parameters studied regarding the eggs (shell percentage, albumen and yolk, albumen height, specific gravity and yolk color) weren't affected by increasing levels of CGM. The inclusion of CGM in diets of laying hens in 2% did not influence the production performance and egg quality and that higher levels can increase the weight of eggs, with levels up to 6% can be maintained and feed conversion in some cases may be recommended depending on their price of CGM.

Key Words: egg production, egg quality, feed conversion, feed intake

555 Energetic and nutritional values of sugar cane yeasts for broilers post-hatch. E. N. R. Barbosa[1], C. B. V. Rabello*[1], W. R. L. Medeiros[1], R. V. S. Júnior[1], L. R. Custódio[1], K. L. A. Carvalho[1], A. M. A. T. Samay[1], C. C. Lopes[1], and E. P. Silva[2], *[1]Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil, [2]Unesp, Campus Jaboticabal, Jaboticabal, São Paulo, Brasil.*

The objective of this work was to determine the chemical composition and energetic of sugar cane yeasts (*Saccharomyces cerevisiae*) from different ethanol distilleries for broilers. The digestibility assay was conducted using 180 broilers, male Cobb 500, in the period from 11

to 18 d of age using the method of total excreta collection. The broilers were distributed to metabolism cages, in a completely randomized design with 5 treatments, 6 replications and 6 birds for experimental units. The treatments consisted of a reference diet (RD) based on corn and soybean meal and 4 test diets with replacement of 30% of RD by different yeasts (A, B, C and D). Chemical composition of yeasts were determined: dry matter(DM,%), crude protein (CP,%), ether extract (EE,%), ash (%), neutral detergent fiber (NDF,%) and gross energy (GE, kcal/kg). The metabolism assay was used for determining the apparent metabolizable energy (AME, kcal/kg), apparent corrected for nitrogen balance (AMEn, kcal/kg), apparent metabolizable coefficients of dry matter (AMCDM,%), and gross energy (ACMGE,%) of yeasts. The data were subjected to ANOVA and means compared by Tukey test at 5% probability. The composition in DM, CP, EE, ash, NDF and GE of the yeasts were, respectively: 90.71, 17.11, 0.37, 7.54, 6.86 and 4,214 for yeast A; 88.84, 18.05, 0.44, 8.05, 7.65 and 4,268 for yeast B; 89.99, 14.94, 0.49, 9.1, 3.02 and 4,011 for the yeast C; and 90.47, 21.12, 0.30, 9.0, 12.13 and 4,095 for yeast D. The values were: 1,229c, 1,802a, 1.285c and 1,571b AME; 1.070d, 1,670a, 1,197c and 1,527b AMEn; 19.38a, 19.88a, 20.35a and 20.11a AMCDM; 25.41c; 39.13a, 29.84 and 37.30a AMCGE, for yeast A, B C and D, respectively. The higher values AME and AMEn value were shown for yeast B; the CMAGE values of the yeast B and D were similar and higher than the others, and the values of CMADM were not significantly different between yeasts. The variability in the chemical and energetic composition has influence in the digestibility values of the yeasts.

Key Words: chemical composition, digestibility, metabolizable energy, *Saccharomyces cerevisiae*

556 Development of intestinal mucosa of broiler chicks post-hatch fed sugar cane yeast (*Saccharomyces cerevisiae*). C. C. Lopes, C. B. V. Rabello*, V. A. S. Júnior, E. M. F. Arruda, J. C. R. Silva, and M. C. M. M. Ludke, *Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil.*

The objective was to evaluate the effect of increasing levels of sugar cane yeast in the diets of broiler chickens post-hatch, from one to 8 d of age, on the morphological development of the intestinal mucosa. The experiment utilized 450 one day old chicks, male Cobb 500, housed in a brick shed divided into boxes of 1.95m2. A completely randomized design was used consisting of 5 treatments and 6 replicates of 15 birds per experimental unit. The sugar cane yeast was included in diets at levels of 0, 1.25, 2.5, 3.75 and 5.0%. At the end of experiment, 2 birds from each replicate were randomly selected and sacrificed by cervical dislocation for collection of approximately 2-cm of fragments of the duodenum, jejunum, and ileum. Subsequently 2 slides were prepared for each segment of each animal to evaluate the parameters of villus height, crypt depth and villus:crypt ratio. The data obtained for all variables were tested for their homogeneity, with the aid of the Barlett′s Test and transformed by log-transformation of (x). Finally, all data were submitted to the regression analysis. The villus height values (1163,5 µm), crypt depth (243,6 µm) and villus:crypt ratio (4,9) did not show significant differences between all treatments in duodenum mucosa. The villus height and crypt depth in jejunum showed quadratic effect as the maximum height and depth in the levels of 2.09 and 2.06%, respectively, without exerting influence on the villus:crypt ratio in this segment. In Ileal mucosal, the levels of yeast did not influenced the villus height, however, crypt depth was reduced from the level of 2.56%, and also provide an increase in villus: crypt. The results of this research suggest that the inclusion of yeast in the diets of broiler chickens post-hatch promote increases in villus height and crypt depth in jejunum and increased villus:crypt ration in the ileum, important features that favor absorption of nutrients from the diet, recommending the use of 2% inclusion of sugar cane yeast.

Key Words: broiler chicken, intestinal morphology, sugar cane yeast

557 Metabolizable energy of castor bean meal through broiler metabolism trial. J. C. N. Santana[1], M. C. M. M. Ludke*[1], J. V. Ludke[2], A. S. Silva[1], C. B. V. Rabello[1], and G. R. Bertani[3], *[1]Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil, [2]Embrapa Suínos e Aves, Concórdia, Santa Catarina, Brasil, [3]Universidade Federal de Pernambuco, Recife, Pernambuco, Brasil.*

Castor bean meal (CB) submitted to different processing methods resulted in 5 different CB types and were evaluated for metabolizable energy values using 210 broilers in a standard metabolism trial with 7 treatments (n = 5/treatment with 6 broilers per replicate). The trial lasted 10 d. The 5 CB types were: CBA obtained by mechanical oil extracting process and the other CB were generated from the same industrial process and additionally submitted to an ethanol bath followed by an alcohol recuperation either with 80°C during 20 min (CBB) and 6 min (CBD and CBE) or with 110°C during 15 min (CBF). Additionally CBD and CBE were neutralized with NaOH at 5% and submitted either for solar drying during 2 d (CBD) or submitted to pelletization (CBE). Metabolism trial were established using 20% substitution of a reference diet (a standard corn soybean meal diet). The 5 CB types (CBA, CBB, CBD, CBE and CBF), soybean meal and the reference diet were evaluated. Apparent metabolizable energy (AME, Kcal/kg as is) and AME corrected to nitrogen retention (AMEn, Kcal/kg as is) mean ± standard deviation values were, respectively, for soybean meal (2,555 ± 78 and 2,408 ± 82), CBB (2,787 ± 169 and 2,781 ± 181), CBD (2,603 ± 32 and 2,709 ± 42), CBE (2,759 ± 80 and 2,709 ± 79) and CBF (2,849 ± 64 and 2,739 ± 71). CBA were toxic (lethal to 26.6% of broilers, no weight gain of survivors) and gave negative EMA and EMAn values. All other CB had higher EMAn values than soybean meal ($P \leq 0.05$) and were not different ($P \geq 0.05$) between each other. The nutritional characteristics of CB (respectively CBA, CBB, CBD, CBF and CBF) were: for crude protein (Nx6.25, % as is) 32.7; 28.2; 29.9; 31.0 and 29.8; for ether extract (% as is) 11.9; 10.9; 8.4; 9.2 and 9.1; for crude fiber (% as is) 24.2; 26.9; 29.7; 28.4 and 27.7; for acid detergent fiber (% as is) 30.4; 33.5; 31.0; 31.0 and 36.3; for Gross Energy (Kcal/kg as is) 4,884; 4,757; 4,680; 4,734 and 4,700. Considering the simplicity of industrial processing and metabolism trial results of CBF may need to undertake more research.

Key Words: alternative feedstuff, industrial by-product, alternative protein source, poultry nutrition

558 Effects of dietary content of corn distillers dried grains with solubles (DDGS) on chemical composition and nutrients of eggs. H. Sun[1], E. J. Lee*[1], M. Persia[1], H. S. Ragheb[2], and D. U. Ahn[1], *[1]Department of Animal Science, Iowa State University, Ames, [2]Indiana State Chemist Laboratories, Biochemistry Department, Purdue University, West Lafayette, IN.*

The objective of this study was to determine the effects of DDGS as a feed ingredient on egg yolk chemical composition and important nutrients of yolk. Four levels of corn DDGS (0, 17%, 35%, and 50%) were used in a corn and soybean meal-based diet. A total of 256 60-week-old single-comb White Leghorn laying hens were randomly selected, 2 birds were placed in a cage, and 3 consecutive cages were assigned as a pen. Each pen was randomly assigned to one of the 4 diets and fed

for 24 weeks. Two values of amino acid digestibility were used to form 2 diet formulas of which all meet or exceed the National Research Council nutrient recommendations for laying hens. Each diet formula was fed for 12 weeks. The chemical composition and nutrient contents of egg yolk were measured bi-weekly. Protein, lipids, moisture, fatty acid composition, cholesterol, lutein, and choline content of yolk were measured. The results showed that egg from hens fed diets containing higher DDGS levels had higher fat but lower protein content. Total polyunsaturated fatty acids, and linoleic acid and arachidonic acid content increased linearly as DDGS level in the diet increased. Choline and cholesterol content in yolk were not influenced by the DDGS content in the diet. Lutein content in egg yolk increased linearly as DDGS level in the diet increased. The results indicated that feeding high levels of DDGS increased the content of lutein, linoleic acid and arachidonic acid, but did not affect cholesterol and choline content in egg yolk.

Key Words: corn distillers dried grains with solubles, laying hen, nutrient content, fatty acid composition, lutein

559 Effect of Mexican sunflower leaf meal (MSLM) based diets on carcass characteristics of turkey (*Meleagris gallopavo*). A. H. Ekeocha*, *University of Ibadan, Ibadan, Oyo, Nigeria.*

A study was conducted for 16 weeks to investigate the effect of feeding Mexican Sunflower Leaf Meal (MSLM) based diets on carcass characteristics of male turkey. One hundred and 50 male poults were randomly assigned to 5 treatments A, B,C,D and E of 30 birds per treatment such that each treatment had 3 replicates of 10 poults. Treatments A served as control while birds in treatments B, C, D and E received Mexican sunflower leaf meal (MSLM) based diets at 3.5, 7.0, 10.5 and 14.0% respectively as graded replacement (w/w) for maize, soymeal and groundnut cake (GNC). Feeds and water were provided ad-libitum and the routine vaccination/medication followed the standard procedures. The results shows a significant ($P < 0.05$) decrease in all the parameters measured for carcass characteristics (shank, gizzard, head, thigh, crop, drumstick, wings, breast, back, neck, abdominal fat, spleen, heart, lung, liver, intestine and proventriculus) where cut parts of birds on the control diet were significantly ($P < 0.05$) higher than the MSLM inclusion diets. The carcass quality were also significantly decrease ($P < 0.05$) except for the breast weights where birds on treatments B (3.5% MSLM) obtained the highest breast weight as a percentage of dressed weight (21.91%). The result of this study shows that inclusion of MSLM at 3.5, 7.0, 10.5 and 14.0% has almost no effect on both the carcass characteristics and carcass quality of the turkey under study.

Key Words: Mexican sunflower, carcass characteristics, turkey

560 Carcass traits of Nigerian local hens fed varying dietary levels of palm kernel cake with added vegetable oil. K. D. Afolabi*, A. O. Akinsoyinu, A. H. Ekeocha, and O. I. Adeyosoye, *University of Ibadan, Ibadan, Oyo, Nigeria.*

In a completely randomized designed one hundred eighty 28-week old Nigerian local hens were randomly allotted to 6 experimental diets that contained 0, 10, 20, 30, 40, and 50% dietary palm kernel cake (PKC) for 12 weeks. The diets also contained varying levels (0.5, 1.48, 3.35, 5.22, 7.11 and 8.89% respectively) of palm oil. Each diet was replicated 10 times and the hens were housed one per cage cubicle. Feed (20%crude protein and 2700 kcalME/kg) and water were offered ad libitum. After 12 week in lay, 2hens per replicate (120 hens) were tagged and starved overnight with access to water. These were individually weighed, slaughtered, stunned, de-feathered, dissected, eviscerated, cut into parts and weighed. Data obtained were analyzed ($P = 0.05$) using SAS (1999). Carcass weights (460 – 510g) were similar ($P > 0.05$) across board. Dressing out percentage increased significantly from 48.93% for hens fed 10% PKC-based diet to 50.41 and 50.89% for those on 30 and 40% PKC-based diets. Hens raised on 10 – 50% PKC-based diets with up to 7.11% added palm oil had higher ($P < 0.05$) abdominal and gizzard fat (2.69 – 2.90) than those on control diet (0% PKC). The gizzard weight and %gizzard increased significantly with increasing level of PKC in local hens' diet while higher values (16.62 – 22.45g and 1.77 – 2.30% respectively) were obtained for hens fed 10 – 50% PKC-based diets. Dietary PKC with palm oil increased the abdominal and gizzard fat and gizzard weight of Nigerian local hen. Feeding up to 40% dietary palm kernel cake had no adverse effect on carcass weight and carcass qualities of Nigerian local hen.

Key Words: Nigerian local hens, palm kernel cake, carcass traits, vegetable oil

561 Metabolizable energy of different soy products. T. Loeffler* and A. B. Batal, *University of Georgia, Athens.*

To determine the metabolizable energy (ME) of 8 soy products, a precision-fed rooster TME assay and a chick AME assay were conducted. The soybean (SB) products can be grouped into 3 categories: cold pressed soybean meal (SBM), defatted SB, and full-fat SB. Of the cold pressed varieties (unheated), there was an ultra-low trypsin SBM, a low-trypsin SBM, and both a heated and unheated commodity SBM. The defatted SBM was a heated commodity blend. In full-fat SB varieties, there was a high protein ultra-low oligosaccharide, a high-protein and a commodity SB. The TME and AME values were compared between each category: cold-pressed, defatted and full-fat SB, as well as between the 2 assays. Semi-purified diets containing dextrose as the main energy source were formulated to meet the bird's nutrient requirements, with each diet containing a different SB product. The TME rooster assay was a traditional precision-fed rooster assay in which 5 birds per diet were fasted for 24 h, crop intubated with 35 g of the test diet containing 46.58% cold-pressed or defatted SBM, or 75% full-fat SB, and excreta was then collected for 48 h. For the chick assay, 480 one-day-old chicks were fed a standard corn-SBM starter diet until 17 d of age, and on d 18, the chicks were allowed ad libitum access to the SB-dextrose diets. There were 6 pens of 10 chicks per replication assigned to the 8 SB-dextrose diets. Excreta was collected on d 22, dried, ground and analyzed for gross energy and crude protein to determine metabolizable energy. The SBM samples that were genetically modified to have lower trypsin levels and higher protein had higher ME values than the commodity cold pressed SBM samples. However, the genetic reduction in the oligosaccharide content of the SB increased the TME and AME due to removal of anti-nutritional factors. Superior feed efficiency was attributed to the higher ME value of the full-fat soy products. Genetic modification of SB can have positive effects on the metabolizable energy value for both roosters and chicks.

Key Words: soybean meal, TME, AME, roosters

562 Effects of heating and drying on xanthophyll levels of distillers grains. C. M. Rude*, F. Karim, M. A. Barrios, J. S. Smith, and R. S. Beyer, *Kansas State University, Manhattan.*

Dried distillers grains (DDG) are an important component of poultry diets, but at times suffer from a fluctuation in protein quality based

on drying conditions. Less is understood about how xanthophylls are affected by the drying of distiller's grains. Two experiments were conducted to investigate effects of heating and drying on lutein and carotenoids due to interest in developing nutraceutical egg products. In Experiment 1, 500 g of DDG was autoclaved from 0 to 60 min, in 5 min intervals. Samples were collected, and lutein and β-carotene were extracted and analyzed using an HPLC. Experiment 2 was designed to simulate the drying conditions that are similar to industrial drying of DDGS. Wet distillers grains (WDG) (32.38% moisture) were obtained from a local ethanol plant. A Fisher Scientific Isotemp oven was set to 175°C, a temperature between reported DDG dryer entry and discharge temperatures. Five g samples of WDG were placed inside and removed at 5, 10 and 20 min. Three replications were conducted and duplicates were used. Sample weights were recorded after drying, and were analyzed for lutein and β-carotene using same method as experiment 1. Experiment 1 regression analysis showed a strong negative linear effect of time on lutein (R2 = 0.8453), and a reduced linear effect on β-carotene (R2 = 0.5255). In experiment 2 a significant effect ($P < 0.001$) was observed on loss of mass, water and other volatiles, of WDG and a negative linear effect ($P < 0.001$) was observed. Drying time had an effect on lutein ($P < 0.05$) and β-carotene ($P < 0.01$) concentrations, but unlike autoclaving a positive linear effect was observed for lutein ($P < 0.05$) and β-carotene ($P < 0.01$). When lutein and β-carotene levels were adjusted for loss of mass, there were no effects ($P > 0.10$) observed. Autoclaving DDG reduced lutein levels, while the dryer, set to a higher temperature, had no effect. Only autoclaved DDG were observed to brown, indicative of Maillard reactions and over-processing. Results indicate over-processing DDG reduces lutein and xanthophyll content, and decreases xanthophyll levels of feed ingredients in poultry rations.

Key Words: distillers, drying, xanthophyll

563 Production performance and egg quality of hens fed diets containing up to thirty percent distillers dried grains with solubles (DDGS) and an enzyme supplement. A. D. Quant*, A. J. Pescatore, J. L. Pierce, T. Ao, P. Rossi, A. H. Cantor, M. J. Ford, and W. D. King, *Alltech/ University of Kentucky Nutrition Research Alliance, Lexington.*

The inclusion of distillers dried grains with solubles (DDGS) in poultry diets has become more prevalent as a cost-cutting strategy in response to the high demand of corn for fuel ethanol production. Previous work in our lab has indicated that inclusion of up to 23% DDGS in layer diets has negative effects on egg quality which can be corrected by the addition of an exogenous enzyme. An experiment was conducted to evaluate the effect of feeding up to 30% DDGS with an enzyme supplement (Allzyme SSF, Alltech, Nicholasville, KY). This experiment utilized 288 Hyline W36 hens that were randomly allotted to 5 dietary treatments (12 hens per rep). Dietary treatments were fed through 29 weeks of production and include a 1) positive control (corn-soybean meal), 2) 15% DDGS, 3) 15% DDGS + 150 g/ton Allzyme SSF, 4) 30% DDGS, 5) 30% DDGS + 150 g/ton Allzyme SSF. In comparison to the positive control diet, diets containing DDGS had reduced levels of ME (2877 vs. 2794.04 Kcal/kg), Ca (4.22 vs. 4.10%), and available P (0.29% vs. 0.17% for the 15% DDGS diet, and 0.23% for the 30% DDGS diet). Six eggs from each pen were randomly selected every 4 weeks for determination of egg quality. The addition of 30% DDGS and Allzyme SSF to the diet resulted in an increase in Haugh unit values. Shell breaking strength at 6 weeks of production was significantly lowered in the 2 diets containing 30% DDGS. There was no effect of dietary treatment on egg weight, egg shell weight, yolk weight, albumen weight, average daily feed intake, average body weight, hen day production and feed conversion through 29 weeks of production. The current study suggests that DDGS can be included up to 30% in layer diets with limited detrimental effects on hen performance or egg quality. Shell quality in the early stages of production warrants further study.

Key Words: DDGS, egg quality, enzyme, layers

564 Effect of pearl millet in broiler diets fed until 21 days of age: Carcass characteristics and organ weights. T. R. Torres[1], M. C. M. M. Ludke*[1], J. V. Ludke[2], E. J. O. Souza[3], M. R. Lima[1], J. E. Serafim[1], and G. M. Silva[1], *[1]Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil, [2]Embrapa Suínos e Aves, Concórdia, Santa Catarina, Brasil, [3]UAST - Universidade Federal Rural de Pernambuco, Serra Talhada, Pernambuco, Brasil.*

A trial was established to evaluate the effect of diet type (DT) presented in 2 physical forms (PF) fed to broilers. Six treatments were established with 3 diets (CSM: corn soybean meal diet, WMG: diet with 20% whole millet grain or GMG: diet with 20% ground millet grain) either in mash (MSH) or pellet (PEL) form. The trial lasted 21 d with 300 Ross male broilers being used (n = 5/treatment, 10 birds/replicate). Diet Apparent Metabolizable Energy (AME, Kcal/kg) and crude protein (CP) from 1 to 7 were 3,000 and 22.1%, respectively. From d 8 to 21 the AME value was changed to 3,050 with 21.1% CP. At 21 d of age one bird per replicate, representing plot average weight, was slaughtered. Live weight was not different ($P \geq 0.05$) between DT with average values of 959 g for CSM; 938 g for WMG and 938 g for GMG. Diet PF had only a slight effect ($P = 0.057$) on weight with 931 g for MHS and 959 g for PEL diets. Carcass weight was affected ($P \leq 0.05$) by PF with values of 710 g for MSH and 730 g for PEL. Carcass yield and carcass parts (leg + thigh, chest, wings and drumstick) were not affected ($P \geq 0.05$) by treatments. Liver, pancreas, lung, spleen and intestines weight expressed as percentage of live weight were not affected ($P \geq 0.05$). Heart and gizzard percentages were affected ($P \leq 0.05$) only by PF with MSH and PEL diets having gizzard percentages of 2.87% x 2.62%, respectively. Heart percentage values were 0.80% for MSH diets and 0.67% for PEL diets. Total abdominal fat weight and percentage were only affected by DT ($P = 0.025$ and $P = 0.018$, respectively) with values of 18.4 g and 1.83% for WMG, 18.6 g and 1.88% for GMG, 13.9 g and 1.39% for CSM diet. Use of MSH diets resulted in higher gizzard and heart percentages. The use of millet at 20% level in the diets resulted in higher abdominal fat. Physical form of diet had effect of internal organs while the use of millet in diets had effect on broiler fat deposition.

Key Words: alternative feedstuffs, diet physical form, whole and ground millet

565 Evaluating the effect of feeding up to 30 percent distillers dried grains with solubles (DDGS) and an enzyme supplement on the performance and egg quality of brown egg layers through 30 weeks of production. A. D. Quant, A. J. Pescatore, J. L. Pierce, T. Ao, P. Rossi*, A. H. Cantor, M. J. Ford, and W. D. King, *Alltech/ University of Kentucky Nutrition Research Alliance, Lexington.*

As the supply of distillers dried grains with solubles continues to grow there is increased interest in using higher levels of DDGS in poultry diets. Previous studies have indicated that inclusion of up to 23% DDGS in layer diets has negative effects on egg quality which can be corrected by the addition of an exogenous enzyme. Therefore an

experiment was conducted to evaluate the effect of feeding up to 30% DDGS with an enzyme supplement (Allzyme SSF, Alltech, Nicholasville, KY) to brown laying hens on performance and egg quality parameters. This experiment utilized 288 Hyline Brown hens that were randomly allotted to 5 dietary treatments.. Dietary treatments were fed through 30 weeks of production and include 1) positive control (corn-soybean meal), 2) 15% DDGS, 3) 15% DDGS + 150 g/ton Allzyme SSF, 4) 30% DDGS, 5) 30% DDGS + 150 g/ton Allzyme SSF. In comparison to the positive control diet, diets containing DDGS had reduced levels of ME (2877 vs. 2794.04 Kcal/kg), Ca (4.22 vs. 4.10%), and available P (0.29% vs. 0.17% for the 15% DDGS diet, and 0.23% for the 30% DDGS diet). Six eggs per rep were randomly selected every 4 weeks for egg quality. Dietary inclusion of DDGS resulted in a decrease in egg shell weight when compared with the positive control. There was no difference in egg shell weight between the control and the 15% DDGS with Allzyme SSF. Haugh unit values were increased by the addition of DDGS to the diets. The DDGS diets resulted in decreased shell breaking strength overall, however the addition of Allzyme SSF to the 15% DDGS diet resulted in better shell breaking strength compared with the others treatments.. Body weight was reduced as a result of DDGS inclusion, but was corrected by inclusion of Allzyme SSF. Dietary treatment had no effect on egg weight, yolk weight, albumen weight, average daily feed intake, hen-day production and feed conversion. The addition of Allzyme SSF to diets containing high levels of DDGS may help alleviate the detrimental effects on shell quality and body weight..

Key Words: DDGS, brown egg layers, egg quality, shell quality

566 Cost analysis of poultry feed formulated with insect larvae. R. Holser and D. Samuel*, *Russell Research Center, Athens, GA.*

Sustainable agricultural practices reflect the current interest in managing resources both effectively and economically with minimum environmental impact. Modern commercial poultry production follows an integrated approach which offers an effective strategy to minimize operating costs. However, the cost of inputs such as poultry feed is not easily controlled and subject to market fluctuations. For example, the demand for biofuels that occurred over the past few years in response to petroleum generated significant increases in the cost of feed components derived from corn and soybean crops. Such price increases drive the search for inexpensive feed components. Fly larvae were previously investigated as an alternative protein source with a proximate analysis of 55 wt% protein (db) and 14 wt% lipids (db). The composition of the larval protein and lipid fractions display favorable amino acid and fatty acid profiles, respectively. The larvae also contain numerous trace elements and vitamins. An economic analysis was performed to examine the benefit of formulating a poultry feed ration with fly larvae. The results indicated that when larvae were used as an alternative ingredient the cost could be reduced by 17% per kg feed. This assumed that larvae were available on-site and obtained as a by-product from a novel litter treatment system at no cost. The additional benefits provided by the litter treatment system were not factored into the analysis. This example demonstrates the potential economic advantage of using insect larvae to replace commodity feed ingredients and supports the sustainable agricultural initiative.

Key Words: economics, feed, larvae, protein, sustainable

567 Effect of canola on the growth performance and carcass composition of heavy hen turkeys. J. L. MacIsaac[1] and D. M. Anderson*[2], [1]*Atlantic Poultry Research Institute, Truro, Nova Scotia, Canada,* [2]*Nova Scotia Agricultural College, Truro, Canada.*

There is increased consumer demand for choice in poultry meat based on what the birds are fed. Choice may include all plant-based ingredients in the diet. To determine the effect of black and yellow seeded canola products on the growth performance and carcass composition of heavy hen turkeys, a one-way ANOVA in a completely randomized design with protein/energy sources (soybean meal/poultry by-product meal/poultry fat (Control), commercial black-seeded canola meal/canola oil (BCM), yellow-seeded canola meal/canola oil (YCM), full-fat black-seeded canola/canola oil (BCS), full-fat yellow-seeded canola/canola oil (YCS)) as the main effect was conducted. Isocaloric and isonitrogenous diets were fed for phases 0–14d, 15–28d, 29–56d and 57–70d. Feed consumption and weight gains were not affected ($P \geq 0.05$) by canola treatment for the entire trial. At 56 d of age, turkeys fed YCM (3163 g bird^{-1}) and YCS (3127 g bird^{-1}) were heavier ($P \leq 0.05$) than those fed the other treatments (3060, 2920, 3098 g bird^{-1}). At 70 d age, turkeys fed YCM (5651 g bird^{-1}) were heavier ($P \leq 0.05$) than those fed BCM (5350 g bird^{-1}) and the Control (5430 g bird^{-1}). Weights for turkeys fed BCS (5548 g bird^{-1}) and YCS (5549 g bird^{-1}) were heavier ($P \leq 0.05$) than those fed BCM. Feeding canola, either as full-fat seeds or meal supplemented with canola oil increased ($P \leq 0.05$) the α-linolenic (LNA) and total omega-3 contents of the skin tissue, breast tissue (skinless) and wings (skin on and bone in). The eicosapentaenoic acid (EPA) (0.04, 0.08, 0.07, 0.09, 0.08 mg g^{-1}; Control, BCM, BCS, YCM, YCS, respectively) and docosahexaenoic (DHA) (0.07, 0.14, 0.12, 0.15, 0.13 mg g^{-1}; Control, BCM, BCS, YCM, YCS, respectively) contents of the wings from all of the canola treatment birds were higher ($P \leq 0.05$) than the Control. Wings from the YCM birds had a higher ($P \leq 0.05$) EPA content than the BCM, BCS, and YCS birds. The DHA in the wings from the YCM birds was higher ($P \leq 0.05$) than the BCS birds. Feeding canola-based diets significantly increased the total omega-3 content, EPA, DHA and LNA content of the turkey skin and breast tissues.

Key Words: canola, turkeys, omega 3, eicosapentaenoic acid, docosahexaenoic acid

568 Effect of storage on lipid composition of egg from hens fed with shrimp meal (*Penaeus* spp.) and red crab meal (*Pleuroncodes planipes*). M. E. Carranco[1], C. Calvo[1], E. Avila[2], L. Sanginés[1], E. Morales[3], R. Ramírez[4], B. Fuente[2], S. Carrillo*[1], and F. Pérez-Gil[1], [1]*Depto.Nutrición Animal, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, México,* [2]*Facultad de Medicina Veterinaria y Zootecnia, UNAM, México,* [3]*Universidad Autonóma Metropolitana-Xochimilco, México,* [4]*Facultad de Química, UNAM, México.*

The aim of this study was to include shrimp meal (SM) and red crab meal (RCM) in laying hen diets and to know their effect on lipid composition and oxidation of egg storage at 0, 15 and 30 d /4° and 20°C. 135 laying hens were distributed into 3 treatments: control, 20% SM and 4% RCM. At the end of the 4th week, 100 eggs per treatment were taken to quantify total lipids, fatty acid profile, cholesterol, fat soluble vitamins, astaxanthin, peroxide and TBAR'S in eggs stored at different times (0, 15, 30 d) and temperatures (4° and 20°C). Data were analyzed using a 3 × 3 × 2 factorial design and a multiple range test of Duncan for comparison of the means ($P < 0.05$). The treatment with SM showed highest total lipids, n-6, n-3, and cholesterol content in eggs. In the treatment with RCM, the eggs showed highest astaxanthin content ($P < 0.05$). In regard to storage times and temperatures, the content of total lipids, LA, EPA, DHA and astaxanthin in eggs were

lowest at 30 d/20°C, in all treatments. On the other hand, AA, ALA, cholesterol, and fat soluble vitamins were no affected at 30 d/4° and 20°C. Oxidation was not detected in any treatments at 15 and 30d/4° and 20°C. Under the conditions of this study, it is conclude that SM is a good source of n-3 and RCM of astaxanthin, and that these lipid components are not affected by storage at 15d/4° and 20°C.

Key Words: crustacean meals, eggs, lipid fraction, storage, laying hens

569 Growth response and economic benefits of male turkey on Mexican sunflower leaf meal (MSLM) based diets. A. H. Ekeocha*[1] and A. A. Mako[2], *[1]University of Ibadan, Ibadan, Oyo, Nigeria, [2]Tai Solarin University of Education, Ijagun Ijebu-Ode, Ogun, Nigeria.*

This study determined the growth and economic benefits of 150 male poult turkeys on Mexican sunflower leaf meal (MSLM) based diets from day old. The poults were randomly allotted to 5 experimental rations A, B, C, D and E of 30 birds per treatment such that each treatment had 3 replicates of 10 poults. Treatment A served as the control and treatments B, C, D and E received Mexican sunflower leaf meal (MSLM) at 3.5, 7.0, 10.5 and 14.0% levels replacing maize and soymeal respectively. Feed and water were provided ad-libitum and routine medications and vaccinations administered. Performance characteristics measured were feed intake, weight gain and net profit. The results of the experiment showed that there were significant differences ($P < 0.05$) in the live weight and feed intake. However, birds on treatment A performed best by attaining a live weight of 9670.46g in 16 (16) weeks with feed intake of 16,093.16g per bird. The same birds yielded the highest net profit of N880.04k or $5.87 per bird on dressed weight unlike a deficit of N5.28k or $0.04 per bird on birds in treatment E (14% MSLM) and N 1399.81k or $9.33 profit per bird on live weight and a profit of N308.30k or $2.06 per bird in treatment E (14% MSLM). The study indicated that MSLM based diets enhanced performance of male turkey and could serve as alternative replacement for maize and soymeal at 3.5 to 10.5% level with good returns on investment.

Key Words: growth response, economic benefits, male turkey

570 Increasing feeding meals influences the reproductive performance of broiler breeder females during laying period. S. Moradi[1], M. Zaghari[1], M. Shivazad*[1], R. Osfori[2], and M. Mardi[2], *[1]University of Tehran, Karaj, Iran, [2]Agriculture Biotechnology Research Institute of Iran (ABRII), Karaj, Iran.*

Broiler breeder hens are commonly fed restricted during the laying period to prevent or reduce health and reproductive disorders associated with obesity. Feed restriction performed as once-a-day feeding regimens during laying period, this feed is completely consumed in about 4 h, and as a result they will fast for a long time of each day which has a negative impact on their welfare. The aim of this research was to evaluate the effects of increasing feeding meals to 2 or 3 times per day on performance and welfare of female broiler breeder hens from 24 to 38 wk of ages. Seventy-two Cobb 500 breeder pullets were assigned to 3 feeding regimens with 4 replicates per each treatment. Feeding treatments included a control group was once-a-day feeding schedule, which all birds were received their total restricted feed at 0615 h; twice-a-day feeding schedule, which 50% of restricted feed was fed at 0615 h and the other 50% at 1230 h; and thrice-a-day feeding, in which daily restricted feed allowance was divided to 3 equal parts and were fed at 0615 h, 1230 h and 1815 h. Total daily feed intake was the same in all treatments. Egg production and egg weight were measured on daily basis. Blood samples were collected and birds were killed at peak of production (wk 32) and the end of trial (wk 38). During the early phase of production cycle, feeding schedules significantly affect egg production rate and egg weight. Broiler breeder hens fed 2 and 3 meals per day produced more eggs than once-a-day fed birds from wk 26 to 38 ($P < 0.01$). Increasing feeding meals significantly elevated mean egg weight throughout the experimental period ($P < 0.01$), but did not influence yolk weight at 26, 31 and 38 wk of age. The plasma level of NEFA and corticosterone did not differ consistently among experimental treatments. We concluded that feeding twice and thrice-a-day did not significantly improve broiler breeder welfare as indicators of hunger and stress have not changed. Elevated feeding frequency to 2 or 3 times per day can improve the productivity of broiler breeder hens during the early lay cycle.

Key Words: broiler breeder, feeding meals, performance

571 Prediction models of productive parameters and energy utilization due energy levels for young laying hens. P. A. P. Ribeiro*[1], J. B. Matos Junior[2], L. J. C. Lara[2], and N. C. Baiao[2], *[1]Universidade de Sao Paulo, Pirassununga, Sao Paulo, Brazil, [2]Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.*

The recommendations of energy levels for laying hens vary greatly between the strain manuals and also between strains manuals and tables of research institutions. The use of inadequate levels of energy can lead to productivity losses and low efficiency of energy use. To establish mathematical models for yield response of young laying hens to different levels of AMEn and evaluate the influence of energy levels on energy use by these birds, an experiment was conducted with 1200 Dekalb White hens, 23 to 40 weeks of age, housed in conventional cages. These birds were divided into 5 groups according to the level of dietary AMEn: A - 2700 kcal/kg, B - 2775 kcal/kg, C - 2850 kcal/kg, D - 2925 kcal/kg, and E - 3000 kcal/kg, with 6 replicates per group. The experimental design was randomized and data were submitted to polynomial regression. There was a linear decrease effect in egg production with increased levels of AMEn, being found the equation $y = -0.0183376x + 141.805$ ($R^2 = 0.85$). No significant effects of AMEn levels on egg weight, live weight of poultry and livability were found. The egg mass was influenced by levels of AMEn: $y = -0.012928x + 90.124850$ ($R^2 = 0.88$). The regression equation that best explains the effect on the levels of AMEn on feed intake is: $y = -0.033564x + 188.35559$ ($R^2 = 0.96$), there is no effect of AMEn levels on consumption of AMEn. The feed conversion was influenced by the levels of AMEn: $y = -0.000208x + 2.333480$ ($R^2 = 0.90$). The feed conversion per egg dozen was also influenced by levels of AMEn being the equation $y = -0.000196x + 1.801573$ ($R^2 = 0.87$) indicating a linear improvement in feed conversion per egg dozen with the increase of the levels of AMEn . With increasing levels of AMEn there is worsening in the efficiency of energy conversion: y = 0.001141x 1.703423 ($R^2 = 0.96$). There is a linear decrease in egg production and feed intake by young hens with the increase of AMEn levels from 2700 to 3000 kcal/kg, while the other productive parameters remain unaffected regardless of the level used. Therefore the level of 2700 kcal/kg diet can be recommended for young hens.

Key Words: energy, laying hens, models, requirements, eggs

572 Effects of feeding strategy, fiber source of the diet, and crude protein content on productive performance of broiler breeder hens. M. Mohiti-Asli[1], M. Shivazad[1], M. Zaghari[1], M. Rezaian[2], S. Aminzadeh[3], and G. G. Mateos*[4], *[1]Department of Animal Science, University of Tehran, Karaj, Iran, [2]Department of Veterinary Science, University of Tehran, Tehran, Iran, [3]National Institute of Genetic Engineering and Biotechnology, Tehran, Iran, [4]Departamento de Producción Animal, Universidad Politécnica de Madrid, Madrid, Spain.*

A 12-wk experiment was conducted to investigate the effect of feeding program, dietary fiber, and CP content of the diet on productive performance of Ross broiler breeder hens (41 wk of age). There were 12 treatments arranged factorially with 2 levels of CP (14.5 vs. 17.4%), 3 fiber sources (0 vs. 3% inulin vs. 3% cellulose), and 2 levels of feed intake (160 vs. 208 g/d) that corresponded to restricted (R) or ad libitum (AL) feeding systems. The experimental diets contained 2,800 kcal ME with either 0.65 (14.5% CP) or 0.78% Lys (17.4% CP). Treatments were replicated 4 or 5 times (a floor pen with 6 hens and one male). Egg weight, ADFI, and total number of eggs and second grade eggs were recorded daily. Shell thickness, proportion of egg components, and Haugh units were recorded in 2 eggs per replicate every 4 wks and BW of the hens every 2 wk. Percentage of hatched chicks, BW of newborn chicks, and the cause of infertility and the stage of embryonic mortality were determined by replicate in all the unhatched eggs. No interaction among main effects was detected for any trait. Dietary CP level did not affect any of the productive traits. At the end of the trial, BW of hens was higher for AL than for R hens (4,775 vs. 4,272; $P \leq 0.001$) and was reduced with fiber inclusion ($P \leq 0.01$), with effects being more noticeable with cellulose than with inulin. Feed intake decreased with fiber inclusion in the AL hens ($P \leq 0.05$). Egg production, egg mass ($P \leq 0.001$), and egg fertility ($P \leq 0.05$) decreased, but egg weight ($P \leq 0.001$), egg yolk, and BW of chicks at hatch ($P \leq 0.01$) increased with AL feeding. No difference in hatchability and hatch percentage of fertile eggs was detected among treatments. Egg production increased ($P \leq 0.05$) but egg weight was reduced ($P \leq 0.05$) with fiber inclusion in the diet, with the effects being more noticeable for cellulose than for inulin. The results suggest that the inclusion of 3% inulin or cellulose in the diet reduced ADFI and BW in AL hens, and improved productive performance in both AL and R broiler breeder hens.

Key Words: broiler breeder hens, crude protein, dietary fiber, performance

573 Fatty acids and cholesterol oxidized products in turkey breast meat with different ultimate pH. P. K. Hong*, I. V. Spevackova, and M. Betti, *University of Alberta, Edmonton, Canada.*

Pale, soft and exudative (PSE)-like meat is one of the main concerns in the poultry industry. It is characterized as pale and low ultimate pH meat with less water holding capacity (WHC). Conventional practices in sorting out PSE-meat rely on color and pH measurement as they are correlated with WHC. However, information on the fatty acids and cholesterol oxidized products (COP) in turkey meat are scarce. In this study, fatty acid profile and COP in turkey breast meat with different ultimate pH were investigated. Turkey breasts (16 pieces) from a local poultry processing plant at 24 h postmortem were screened and divided into 2 groups (Low pH (LpH): $L^* > 51$, pH <5.7; and, Normal pH (NpH): $46 < L^* < 51$, $5.9 <$ pH <6.0). All samples were minced and stored at −18°C until use. Total lipids in breast meats were extracted by the Folch method and were analyzed for total fatty acid content and COP content by gas chromatography detection. The data obtained were analyzed using independent *t*-test. Probabilities lower than 5% were considered significant. Total amount of extracted fatty acid in NpH and LpH were similar. However, fatty acid profile showed that LpH meat had lower levels of eicosanoic acid (20:0) ($P < 0.005$), arachidonic acid (20:4n-6) ($P = 0.05$), and long chain n-3 polyunsaturated fatty acids ($P < 0.05$), particularly in eicosapentaenoic acid (20:5n-3) ($P < 0.05$) and docosahexaenoic acid (22:6n-3) ($P < 0.05$) compared with NpH meat. A total of 5 COP were detected in both types of the turkey breast meat: 7a-hydroxycholesterol, 7b-hydroxycholesterol, cholesterol-5a,6a-epoxide, cholesterol-5b,6b-epoxide and 7-ketocholesterol. Low ultimate pH reduced the formation of each of the COP in turkey breast meat as they were found significantly lower than that of NpH. This could be explained by the lower unsaturation index ($P = 0.073$) and peroxidation index ($P < 0.05$) found in LpH meat than NpH meat. Despite the low pH, PSE-like turkey meat seems to be more stable to lipid oxidation than normal turkey breast meat at 24 h postmortem.

Key Words: turkey, pale, soft and exudative (PSE), cholesterol oxidized product, lipid oxidation, fatty acid

574 Expression of nutrient transporters and digestive enzymes in the yolk sac membrane and embryonic intestine. J. S. Speier*[1], L. Yadgary[2], Z. Uni[2], and E. Wong[1], *[1]Virginia Tech, Blacksburg, [2]University of Jerusalem, Rehovot, Israel.*

Chick embryos derive nutrients from the yolk during incubation and transition to intestinal absorption of nutrients posthatch. The uptake of nutrients is mediated by a variety of membrane bound transporter proteins. The objective of this project was to determine the expression profiles of nutrient transporters and digestive enzymes during incubation in the yolk sac membrane (YSM) and embryonic intestine of egg-laying (Leghorn) and meat-producing (Cobb) chickens derived from young (22–30 wk) and old (45–50 wk) breeder flocks. Transporters examined included the peptide transporter PepT1, the glutamate/aspartate transporter EAAT3, and the sodium-dependent glucose transporter SGLT1. Digestive enzymes included aminopeptidase N (APN) and sucrase-isomaltase (SI). Expression of these genes was measured in YSM at embryonic (e) d 11, 13, 15, 17, 19, 20, and day of hatch (DOH) and intestine at e15, e17, e19, e20, and DOH. Gene expression was assessed by real-time PCR using the absolute quantification method. PepT1 and APN gene expression in the YSM increased until e15 and then decreased until DOH, while expression in the intestine increased from e15 to DOH. Expression of SGLT1 and EAAT3 showed increased gene expression over time in both the intestine and YSM. Expression of the digestive enzyme SI showed little to no gene expression in the YSM, while the intestine exhibited consistently high levels of gene expression. There was no difference between Leghorn and Cobb and age of breeder flock. These results demonstrate that these nutrient transporters and digestive enzymes show tissue- and development-specific patterns of expression and that the YSM expresses many of the digestive enzymes and nutrient transporters typically associated with the intestine.

Key Words: yolk sac membrane, intestine, PepT1, nutrient transporters, digestive enzymes

575 Maternal n-3 polyunsaturated fatty acid alters cardiac phospholipids and gene expression in post-hatch chicks. G. Cherian* and C. J. Bullock, *Oregon State University, Corvallis.*

Maternal feeding of n-3 fatty acids has been reported to have beneficial effects on polyunsaturated fatty acid (PUFA) metabolism and eicosanoid generation in chicks. The current study investigated the impact of maternal dietary n-3 PUFA on the cardiac PUFA content and gene expression in progeny chicks. Fertilized eggs enriched (High n-3) or lacking (Low n-3) in n-3 PUFA were incubated. Cardiac ventricle phospholipid content (HPLC) and fatty acids (gas chromatography), fatty acid molecular species (electrospray-ionization mass spectrometry) and gene expression (microarray) were determined. Cardiac phospholipid was predominantly phosphatidylcholine (PC), sphingomyelin, phosphatidylethanolamine and phosphatidylinositol. A significant increase in the content of PC in High n-3 chicks when compared with Low n-3 chicks was observed up to d 14 of growth ($P < 0.05$). The retention of arachidonic acid (20:4n-6) was higher up to d 14 of growth in the phospholipids of Low n-3 chicks when compared with High n-3 chicks ($P < 0.05$). Major phospholipid species of cardiac PC were 34:2, 34:1, 36:2 and 38:4. A significant increase in 38:4 (18:0/20:4) in Low n-3 compared with High n-3 chicks was obtained ($P < 0.05$). High n-3 chicks demonstrated an altered expression for over 5,590 genes (2-fold), 842 genes (4-fold) and 94 genes (8-fold) ($P < 0.05$). Functional analysis using gene ontology categorized the genes exhibiting different expression patterns between Low n-3 and High n-3 chicks into several gene ontology terms including metabolic (23 up, 25 down), developmental (19 genes > 2-fold), immunity and defense (3 up, 2 down, 10 genes > 2-fold) and signaling processes (29 genes > 2-fold). Phospholipids containing PUFA are involved in cellular signaling mechanisms such as cardiac rhythm and neurotransmission. Therefore, these results demonstrating differential gene expression and changes in tissue phospholipid composition associated with maternal diet perturbation could provide insights into the role of early exposure to n-3 PUFA through the egg in modulating metabolic processes of progeny chickens.

Key Words: n-3 fatty acids, phospholipids, gene expression, microarray

576 Prediction models of productive parameters and energy utilization due energy levels for old laying hens. P. A. P. Ribeiro*[1], N. C. Baiao[2], L. J. C. Lara[2], and J. B. Matos Junior[2], *[1]Universidade de Sao Paulo, Pirassununga, Sao Paulo, Brasil, [2]Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brasil.*

Egg production and feed intake by hens depend on several factors, such as strain, body weight, temperature, composition and concentration of nutrients and energy level of the feed. The energy level of the diets is inversely proportional to feed consumption. To establish mathematical models for yield response of old laying hens to different levels of AMEn and evaluate the influence of energy levels on energy use by these birds, an experiment was conducted with 1200 Lohmann LSL hens, from 64 to 80 weeks of age, housed in conventional cages. These birds were divided into 5 groups according to the level of dietary AMEn: - 2700 kcal / kg, B - 2775 kcal / kg, C - 2850 kcal / kg, D - 2925 kcal / kg, and E - 3000 kcal / kg, with 6 replicates per group. The experimental design was randomized and submitted to polynomial regression. AMEn levels did not influence the production, egg weight, egg mass, viability, and the body weight of old hens. Feed consumption of old hens was influenced by the level of the diet AMEn regression yielded the following equation: $y = -0.022883x + 167.409617$ ($R^2 = 0.95$). There is a linear effect in the consumption of AMEn according to the increasing level of dietary AMEn $y = 0.037155x + 185.097317$ ($R^2 = 0.88$). AMEn levels influenced the feed conversion in kg of feed per kg of egg of old laying hens $y = -0.000374x + 2.936107$ ($R^2 = 0.94$) and feed conversion in kg of feed per dozen of eggs $y = -0.000295x + 2.323883$ ($R^2 = 0.95$). The levels of AMEn influenced energy efficiency, with a positive linear effect of worsening in results with increasing levels of AMEn $y = 0.000798x + 3.05315$ ($R^2 = 0.87$). Levels between 2700 and 3000 AMEn kcal/kg diet did not influence the production and egg weight of laying hens older. The level of 2700 kcal/kg diet may be used for these birds. There is a decrease in food consumption and consequently in nutrient intake with increased energy levels and therefore levels of nutrition for older hens may be overestimated.

Key Words: egg production, energy, old hens

577 Digestion of fat and fatty acids along the digestive tract of chickens. P. Tancharoenrat, F. Zaefarian, G. Ravindran, and V. Ravindran*, *Massey University, Palmerston North, New Zealand.*

The present experiment was designed to investigate the digestion of fat and fatty acids along the intestinal tract of broiler chickens fed diets supplemented with either soybean oil or tallow. Broilers (2 weeks of age) were fed corn-soy based diets containing 5% soybean oil or tallow for 7 d and, digesta were collected from duodenum, upper jejunum, upper ileum and lower ileum. Apparent digestibility coefficients were calculated using titanium marker ratios in the diet and digesta. Digestibility of fat was determined to be highly negative in the duodenum, indicating marked net secretion of fat into this segment. Fat was rapidly digested and absorbed in the jejunum, with digestibility coefficients of 0.60 to 0.65 being determined at the end of jejunum. The digestion and/or absorption of fat continued in the ileum. The digestibility coefficients of fat in soybean oil and tallow diets at lower ileum were 0.82 and 0.74, respectively. The main fatty acids secreted into the duodenum were palmitic (16:0) and stearic (18:0) acids, as indicated by their highly negative digestibility coefficients. There was some net secretion of oleic acid (18:1), but no secretion of linoleic acid (18:2). Linoleic acid was absorbed throughout the intestinal tract, while the digestion and absorption of palmitic, stearic and oleic acids start only in the jejunum. Measurements at lower ileal level showed that the unsaturated fatty acids (linoleic and oleic acids) were well digested (0.90 to 0.94), irrespective of the source of fat. In contrast, it was found that the digestibility of saturated fatty acids (palmitic and stearic acids) was influenced by the fat source. Digestibility coefficients of palmitic and stearic acids at lower ileum were markedly higher in the diet containing soybean oil (077 to 0.85) compared with that containing tallow (0.58 to 0.68). This finding can be attributed to the natural emulsifying action of high concentrations of unsaturated fatty acids present in the soybean oil diet and, may highlight the potential usefulness of supplemental emulsifiers to improve fat digestion in diets containing tallow.

Key Words: fat, fatty acids, digestibility, broilers

578 Apparent digestibility and metabolizable energy content of lipid sources in poultry. M. Frikha[1], J. Alcaniz[2], J. J. Mallo[2], M. P. Serrano[1], and G. G. Mateos*[1], *[1]Departamento de Producción Animal, Universidad Politécnica de Madrid, 28040 Madrid, Spain, [2]I+D Norel Animal Nutrition, S.A, 28007 Madrid, Spain.*

A trial was conducted to determine the apparent digestibility (ATTD) and AME content of different lipid sources in 21d-old broilers. There were a control diet based on corn and soybean meal without any supplemental fat and 6 additional diets forming a 3x2 factorial with 3 sources of fat (soy oil, SBO; reconstituted monoglyceride oil, RMG; and reconstituted triglyceride oil, RTG) included in the diet (3 or 6%) at expenses (wt:wt) of the basal diet. The RMG and RTG were obtained from Norel S.A. and resulted from a proprietary process that consists on a sterification reaction from glycerol and oleins from the soy and sunflower oil industry. The linoleic acid content was 56, 45, and 42% and the GE was 9.47, 9.08, and 9.21 Mcal/kg for the SBO, RMG, and RTG, respectively. Each of the 7 diets was replicated 6 times (cage with 10 chicks). Broilers were fed a common commercial diet from 1 to 6 d of age and then their respective experimental diets from 6 to 21 d of age. Excreta was collected the last 2 d on trial and the ATTD of fat was determined using 2% celite as acid insoluble ash. The AME was calculated by multiplying the GE by the ATTD of the experimental fats. Data were analyzed as a completely randomized design. Ether extract digestibility was lower for the basal diet (77.6%) and highest for the diets that included 6% fat (ranging from 90.7 for RTG to 89.9 for RMG; $P \leq 0.001$) than for the diets that included 3% of fat. The AME content of the fats tested were higher ($P \leq 0.05$) for the SBO than for the RMG with that of RTG being intermediate. The main reason was probably the lower GE content of these 2 reconstituted oils. It is concluded that the reconstituted oils are as well digested as the SBO but that the AME is lower. Thus, both products can used in substitution of SBO in diets for broilers.

Key Words: broilers, lipid sources, fat digestibility, metabolizable energy

579 Nitrogen-corrected apparent metabolizable energy of poultry oil for broiler chickens. E. J. Kim*[1] and W. A. Dozier III[2], *[1]ARS-USDA Poultry Research Unit, Mississippi State, MS, [2]Department of Poultry Science, Auburn University, Auburn, AL.*

This research determined the nitrogen-corrected apparent metabolizable energy (AME_n) of poultry oil for broilers at 2, 5, and 8 weeks of age. Two energy balance trials utilizing straight-run Ross × Ross broilers were conducted. Two experimental diets were formulated; one was a low energy corn-soybean meal basal diet (2,826 kcal/kg) and a second comprised of 94% basal diet with 6% poultry oil. Identical diets were fed to each age group to make comparisons across ages. Birds were raised in floor pens until d 10, 31, and 52 and then randomly allocated into 8 battery cages per treatment with group size differing with age. After an adaptation period, birds were fed diets and excreta were quantitatively collected over a 3 d period. Gross energy of the feed and the excreta were analyzed and AME_n was then subsequently calculated by subtracting the AME of the basal diet from the AME of the experimental diet with added poultry oil. To increase replicates, 2 trials were conducted and the effect of trial was analyzed as a statistical factor. The effect of trial × treatment was significant ($P < 0.0001$), therefore, trials were analyzed separately. In Trial 1, AME_n of the basal diet at 2, 5, and 8 wk of age was determined at 3,174, 2,978, and 3,038 kcal/kg DM, respectively. Apparent ME_n for the poultry oil with broilers at 2, 5, and 8 wk of age was 10,730, 10,949 and 10,261 kcal/kg DM, respectively. No differences were observed for age ($P = 0.981$) or interaction between treatment and age ($P = 0.561$). In Trial 2, AME_n of the basal diet at 2, 5, and 8 wk of age was determined at 3,010, 2,969, and 2,862 kcal/kg DM. Apparent ME_n for poultry oil with broilers at 2, 5, and 8 wk of age was 10,183, 9,242, and 12,516 kcal/kg DM, respectively. Age effects ($P < 0.0001$) and interactions between age and poultry oil addition ($P = 0.01$) were apparent. Apparent ME_n of poultry oil may be higher than previously reported and be affected by age; however, these results were inconsistent between trials.

Key Words: metabolizable energy, poultry oil, broilers

580 Characterization of the intestinal microbiota of chickens with deprived growth. C. Eyng*[1,2], AA Pedroso[2], and MD Lee[2], *[1]Universidade Estadual de Maringa, Maringa, Parana, Brazil, [2]The University of Georgia, Athens.*

Chickens that are correctly managed, from the same poultry house and receiving the same diet should exhibit similar performance. However, this is not observed in the commercial houses. It has been proposed that the acquisition of nutrients is influenced by the intestinal microbiota. Here we hypothesize that the intestinal microbiota is different between chickens exhibiting good and poor performance. Cecal samples were collected from 15 d old chickens with average live weight of 454 and 183 g, respectively. The cecal bacterial community was characterized using fluorescent in situ hybridization (FISH) and fluorescent activated cell sorting (FACS). We detected no differences in the proportion of bacteria belonging to the *Clostridial cluster* I and II (probe Chis150),

Roseburia spp. and *Eubacterium* subgroup cluster XIVa (Rrec584), *Lactobacillus* spp. (Lacb72) between individuals displaying normal and deprived growth. Significant reduction ($P < 0.001$) in the amount of *Gammaproteobacteria* (Prot1027), *Enterobacteriaceae* (Enteric) and species related to *Bacteroidaceae*, *Prevotellaceae* and *Porphyromondaceae* group (Bacto303) were observed in chickens exhibiting good performance. Results obtained in our study agree with past findings, where subjects of high weight presented an increase in the proportion of species relate do *Bacteroidetes*. Cecal samples collected in this study were negative to *Salmonella* when tested by qPCR, however the reduction of enterobacterias, members of the *Gammaproteobacteria* group, could be related to the presence of another pathogen in cecal samples. These results demonstrate that animals with variable live weight have different intestinal microbiota.

Key Words: bacteria, flow cytometry, FACS, FISH

581 Effects of essential oils on carcass yield of broilers fed diets with different nutrient concentrations. L. Borsatti[1], R. V. Nunes*[1], T. Steiner[2], C. Polese[1], R. Shone[1], and J. R. Henz[1], *[1]state university west of Paraná, Marechal Cândido Rondon, Paraná, Brasil, [2]Biomin Holding GmbH, Industriestrasse, Herzogenburg, Austria.*

1152 d-old broiler chicks were used to investigate the influence of nutrient density and supplementation with essential oils or Antibiotic Growth Promoters (AGP) on growth performance. Birds were assigned to 6 treatments with 8 replications per treatment: (1) Standard diet (SD), SD + Essential oils (oregano, anise, citrus) (Biomin P.E.P. 125 poultry, 125 g/t), (3) SD + AGP (Enramycin, 10 g/t and salinomycin, 125 g/t), (4) Reduced diet (RD), (5) RD + Essential oils, (6) RD + AGP. Birds were fed starter (1–10 d), grower 1 (11–21 d), grower 2 (22–35 d) and finisher (36–42 d) diets. Diets in treatments 1–3 were formulated to meet the requirements of the birds for metabolizable energy protein and digestible amino acids, whereas diets in treatments 4–6 were formulated to provide 5% less energy and amino acids. At the age of 42 d, 2 birds per treatment were sacrificed and carcass yield, cuts (breast, wing, drumstick and thigh), liver and abdominal fat were determined. There was a significant difference ($P < 0.05$) for the variables of income drumstick and abdominal fat in birds fed diets with reduced levels of energy and amino acids. It is concluded that a reduction in metabolizable energy and amino acids causes increased deposition of fat in the carcass.

Key Words: essential oils, broiler, carcass yield

582 Interrelationships among diet, bone growth and black bone discoloration in broiler chickens. S. Singla, D. R. Korver*, and M. Betti, *University of Alberta, Edmonton, Alberta, Canada.*

Rapid growth rate of broiler chickens has resulted in more muscle growth but increased bone porosity. This allows pigment leakage during freezing and may cause darkening of the bone and adjoining meat after cooking which may cause consumer rejection. Dietary vitamin D is important in bone formation, and reduced growth rate is associated with less porous bones. Male Ross 308 broilers (n = 320) were reared to 40 d of age and fed either a standard, nutritionally-complete diet with only vitamin D_3 as the supplemental vitamin D source (2,760 IU; Control), a diet with equivalent vitamin D activity (69 µg/kg feed) as 25-hydroxyvitamin D_3 (25-OHD_3) only or a reduced nutrient density diet (Reduced; Control diet diluted with 25% wheat bran). Heme iron, non-heme iron, myoglobin and total pigment were measured in fresh raw, fresh cooked, frozen raw and frozen cooked bone-in broiler thighs (n = 4 per diet). Cooking (180C oven temperature, 80C core meat temperature), freezing (−20C for 4 wk), diet and their interactions were studied. Data were analyzed using ANOVA; differences were considered significant at $P < 0.05$. The freezing*diet ($P < 0.01$) interaction for heme iron and cooking*freezing*diet ($P < 0.01$) for non-heme iron showed that their concentrations were lowest in fresh uncooked samples from birds fed with 25-OHD_3 diet as compared with Control and Diluted diet. Lower bone porosity might lead to less pigment leakage in 25-OHD_3 birds. However after freezing or cooking, significant differences were not seen. The cooking*freezing*diet interactions for total pigment ($P < 0.01$) and myoglobin ($P < 0.01$) indicated a decrease in concentration after freezing or cooking the meat in all diets This is due to pigment protein breakdown during the treatments. Freezing favored myoglobin oxidation indicated by decreased oxymyoglobin and increased metmyoglobin ($P < 0.01$) with no diet effect. The study revealed that dietary 25-OHD_3 may increase bone quality but diet did not significantly affect bone discoloration under the applied conditions.

Key Words: broiler, growth rate, vitamin D, 25-hydroxyvitamin D, black bone discoloration

583 Poultry offal meal traceability in meat broiler chicken using the technique of carbon (13C/12C) and nitrogen (15N/14N) stable isotopes. V. C. da Cruz*[1], C. Ducatti[2], J. R. Sartori[2], and A. C. Pezzato[2], *[1]São Paulo State University, Dracena Campus, São Paulo State University, Dracena, São Paulo, Brazil, [2]São Paulo State University, Botucatu Campus, São Paulo State University, Botucatu, São Paulo, Brazil.*

Animal co-products have been used in animal feeding for many years without much concerning. However, the use of fish, meat, blood, and offal meals, and milk co-products has been widely questioned, and were even banned in some countries. This was partially due to public perception after BSE (bovine spongiform encephalopathy-mad cow disease) cases and problems of animal product contamination with Salmonella and *Escherichia coli*. With the development of the technique of stable isotopes for traceability purposes and certification of broilers′ diet patterns, it has been necessary to know the behavior of the isotopic signature of different tissues in birds, just in case of a potential replacement of a diet containing animal ingredients for a strictly vegetable one and vice versa. Thus, this work carried out at the São Paulo State University, Botucatu Campus, Brazil, aimed to evaluate the meat of the breast, thigh, drumstick and wings to trace the presence of poultry offal meal (OM) in rations of broilers using the analysis of stable isotopes of carbon (13C/12C) and nitrogen (15N/14N) by mass spectrometry. Seven-hundred and twenty 1-d-old chicks were distributed into 6 groups, with 4 replications of 30 birds each: G1- vegetal diet (VD) from 1 to 42 d; G2- diet with 8% of OM from 1 to 42 d; G3- VD from 1 to 21 d and 8% OM diet from 22 to 42 d; G4- VD from 1 to 35 d and 8% OM diet from 36 to 42 d; G5- 8% OM diet from 1 to 21 d and VD from 22 to 42 d; G6- 8% OM diet from 1 to 35 d and VD from 36 to 42 d. At 42 d of age, 4 birds per treatment were randomly sampled for breast, thigh, drumstick and wing collection for future determination of respective isotopic ratios (13C/12C and 15N/14N). Through analysis of C and N, it is possible to trace the use of OM in broiler feeding when this ingredient is part of the feeding throughout the breeding phase or when it replaces a strictly VD even up to 35 d. When an OM diet is replaced by VD, the animal origin ingredient has to be part of the feeding for 21 d or longer to detect it by this method.

Key Words: animal origin ingredient, carbon-13, certification, nitrogen-15, poultry

584 Study of the mechanisms of lipid mobilization towards egg formation in broiler breeder hens using stable isotopes. C. Salas, R. D. Ekmay*, J. England, S. Cerrate, and C. N. Coon, *University of Arkansas.*

The contribution of dietary, tissue or newly synthesized fatty acids (FA) in the formation of the egg yolk during different periods of egg production was determined. In a first study, 20 broiler breeder pullets (BB) were fed daily 136 g of a breeder diet plus 25 mg meal of U-^{13}C-linoleic acid (LA) on the day of first oviposition. Two birds were sacrificed each day for the next 10 d and all large yellow follicles were collected from the ovary. In a second study a group of BB was also fed 136 g of breeder diet daily plus a daily 15 mg dose of U-^{13}C- glucose (G) 10 d before sexual maturity and until the end of the experimental period. Additionally, a 50 mg meal of U- 13C- LA was orally administered 10 d before their first egg (estimated time). On the day of their first egg, each bird received a 25 mg meal of D31-LA. All eggs were collected for the next 10 d. The incorporation of U-^{13}C-LA in the follicles and yolks, D31-LA and labeled palmitic acid (PA) from U-^{13}C-G metabolism in the egg was determined using a GC-MS. The second study was repeated at peak of production and 45 weeks of age. The results of Experiment 1 show that after dosing the birds at first egg, the smaller follicles received a higher relative dose of the labeled LA ($P < 0.0001$). The results for Experiment 2 indicate that the recovery of the labeled isotopes is altered as the bird age increases. At first egg, the deposition of labeled PA is higher when compared with its deposition at peak of production and 45 weeks of age. The deposition of the 2 LA labels has the opposite behavior of the labeled PA. At first egg, the recovery of both labels is low and continues to increase as the birds get older. These results suggest the mechanisms of incorporation of dietary and tissue fat become more utilized as the birds age and that U-^{13}C-G is being utilized for fatty acid synthesis in a higher level at the beginning of the production period. In summary, the present study indicates that the mechanisms of lipid mobilization toward the formation of egg yolk are altered as the broiler breeders increase in age.

Key Words: broiler breeders, lipid mobilization, stable isotopes

585 Energy utilization modeling for broiler breeder hens. C. Salas, R. D. Ekmay*, J. England, S. Cerrate, and C. N. Coon, *University of Arkansas.*

Broiler breeder hens have been subjected to genetic selection that has caused important changes in performance and rates of fat and lean deposition in the body. The main objective of the present study was to develop a model for metabolizable energy (ME) requirements for broiler breeder hens. Two experiments were conducted to develop and evaluate the proposed model. The first experiment evaluated the metabolizable energy requirements of hens with different body weights and compositions fed 6 different levels of caloric intake (330, 360, 390, 420, 450 and 480 kcal/d). MEm was 100.67 kcal/kg$^{0.75}$(28°C) and was calculated with a previously developed formula; MEm = BW$^{0.75}$(111.02 - 0.49T + 0.049(T-22.07)^2 (Reyes, unpublished). The partial efficiencies for fat (κf), protein (κp) and egg production (κe) were 0.96, 0.44 and 0.83, respectively. The obtained requirements for fat and protein deposition are 9.69 and 12.27 kcal/g, respectively. Based on the partial efficiencies for fat and protein deposition, the developed single equation is as follows: MEI = 29.83 + BW$^{0.75}$ (111.02 - 0.49T + 0.049(T-22.07)2) + 1.04 ERf + 2.26 ERp + 1.21 ERe. Where MEI is metabolizable energy intake (kcal/d), BW is body weight in kilograms, T is temperature in °C, ERf is energy retained as fat, ERp is energy retained as protein and ERe is energy retained as egg mass output. Data of BW, body composition and egg production of Experiment 2 were fitted into the proposed model and the model proposed by Rabello et al. (2006). The estimated ME requirements obtained from the model herein were closer to the observed ME intake compared with other models.

Key Words: broiler breeders, energy requirements, modeling

586 Improving egg quality and reducing egg cholesterol level by supplementing layer diets with sugar syrup. A. S. Hussein*[1], J. Al-Ghurair[2], P. G. John[2], and H. M. Habiba[1], *[1]Faculty of Food and Agriculture, United Arab Emirates University, Al-Ain, United Arab Emirates [2]Al-Khaleej Sugar CO (L.L.C.), Dubai, United Arab Emirates.*

The effect of supplementing laying hen rations with graded levels of sugar syrup (0, 5 and 10%) on table egg quality, egg cholesterol level, production performance and blood biochemical parameters was investigated using 300 Lohmann LSL-White layers. Five replicate groups of 20 laying hens, 30 weeks of age, were used per replicate and randomly assigned to each of the dietary treatments. Treatments consisted of feeding a corn-soy basal diet alone or with graded levels of sugar syrup in increments of 5 and 10%. All diets were isonitrogenous and isocaloric. The data showed that hen-day egg production, feed intake, body weight gain and egg weight of laying hens in all treatments were similar during the 5-mo trial period. Adding sugar syrup to layer rations improved Haugh unit scores, but had no significant effect on blood plasma glucose, total protein, creatinine, and liver enzymes. In this present study, the cholesterol levels of eggs laid by hens fed diets supplemented with sugar syrup were significantly reduced compared with hens fed the control diet.

Key Words: egg quality, egg cholesterol, layers, diets, sugar syrup

587 Evaluation of crumble and pellet quality on broiler performance and gizzard weight. B. Hu*[1,2], C.R. Stark[1], and J. Brake[1], *[1]North Carolina State University, Raleigh, [2]China Agricultural University, Beijing, China.*

Previous research has shown that high quality crumbles and pellets improved broiler performance and gizzard development. A 14-d cage followed by a 35-d floor pen study investigated the effects of percentage fines in crumbles and pellets on broiler performance. A total of 960 d-old broiler chicks initiated a completely randomized factorial design of 2 sexes and 6 feed forms (mash, 0, 25, 50, 75, and 100% fines) with 8 replicates per treatment and 10 birds per cage to 14 d. Birds were fed corn-soy starter diets in either mash or crumble form to 14 d of age. Nine birds per cage were moved to floor pens at 15 d of age and fed a diet of 100 or 50% pellets in grower and finisher diets. Feed consumption and BW were determined at 7, 14, 28, 35, 42, and 49 d of age and adjusted feed conversion (AdjFCR) was calculated by using the BW of dead birds. Gizzard and BW were obtained from one bird per pen at 14 and 49 d of age. The actual amount of fines in the crumbled 0, 25, 50, 75, and 100% starter diets was 9, 39, 53, 75, and 93%, respectively. The amount of fines in the pelleted grower and finisher 50 and 100% diets was 46 and 97% and 51 and 81%, respectively. The 14 d BW of the birds fed the crumbles was higher than

those fed mash (488 versus 422 g). Greater fines in the crumbled diets linearly decreased BW (503, 497, 490, 482, and 466 g, respectively). The BW differences at 14 d in the cages disappeared by 28 d in the pens. The 49 d male BW was greater than of the females (3897 versus 3129 g) with a better AdjFCR (2.05 versus 2.25) from 15 to 49 d. Birds fed 100% pellets were heavier (3602 g) than 50% pellets (3424 g) with improved AdjFCR (2.11 versus 2.19) from 15 to 49 d. The relative gizzard weight of birds fed 50% pellets was greater for birds fed 100% pellets (0.43 versus 0.35 g/100 g BW). The results indicated that differences in BW due to the amount of fines in the starter feed did not carry over to 49 d while greater amounts of fines in the grower and finisher feeds produced lower BW and poorer AdjFCR.

Key Words: crumbles, pellet, feed form, broiler, gizzard

588 Effect of a fumonisin-degrading enzyme in broiler diets contaminated with aflatoxins and/or fumonisins. U. Hofstetter*[1], C. A. Mallmann[2], and R. Rauber[2], *[1]Biomin Holding GmbH, Herzogenburg, Austria, [2]Instituto Samitec, Instituto de Soluções Analíticas Microbiológicas e Tecnológicas Ltda., Santa Maria, Brazil.*

The objective was to evaluate the efficacy of a fumonisin-degrading enzyme (FUMzyme) in diminishing the toxic effects of aflatoxins and/or fumonisins added to broiler diets. For 21 d, 600 d old COBB male broilers were kept in battery cages. Animals were fed and given water ad libitum. They were randomly divided into 8 treatments with 6 or 12 replicates and 10 birds per replicate, according to the experimental design shown in Table 1. Body weight and feed intake per replicate (weekly); feed conversion rate (FCR) and sphinganine:sphingosine ratio (Sa:So) measured by HPLC-MS/MS after blood collection to 12 birds randomly selected per treatment at the end of the trial were evaluated. Data were submitted to variance analyses (ANOVA). Differences between averages were compared by Bonferroni test ($P \leq 0.05$). Analyses were done by Statgraphics Centurion XV, version 15.1. The negative effect of both mycotoxins was observed with the feed intake of the contaminated animals (722g, 1034g, 652g) inferior to that of the control group (1078g). The addition of FUMzyme improved significantly ($P \leq 0.05$) both feed intake (733g, 1043g, 699g) and final body weight of the birds (539g, 739g, 486g), when in comparison with the animals given the mycotoxins (481g, 693g, 431g). The accumulation of sphingosine and sphinganine in the serum is a useful biomarker for the exposure to fumonisins. These free esphingoid bases are toxic to most cells by affecting cell proliferation and inducing apoptosis or necrotic cell death and are associated with hepato- and nephrotoxic effects. As expected, animals consuming diets contaminated with FUM and Afla+FUM showed an increase in the Sa:So (4.08 and 1.92) when in comparison with the control group (0.20). The addition of the fumonisin detoxifying enzyme significantly ($P \leq 0.05$) decreased these values (2.57 and 0.19). Supplementation of FUMzyme in the contaminated diets improved body weight of animals challenged with Afla (+12%), body weight (+7%), FCR (−6%) and Sa:So (−37%) of animals challenged with FUM and body weight (+13%), feed intake (+7%) and Sa:So (−90%) of animals challenged with concomitant contamination of Afla+FUM.

Table 1. Experimental design

Treatment	No. of birds	Afla (ppm)	FUM (ppm)	Feed additive (%)
1	60	-	-	-
2	60	-	-	0.5
3	60	2.8	-	-
4	60	2.8	-	0.5
5	120	-	100	-
6	120	-	100	0.5
7	60	2.8	100	-
8	60	2.8	100	0.5

Key Words: fumonisins, aflatoxins, broiler

589 Low dosage efficacy of a commercial purified phylosilicate to reduce the toxicity of T-2 toxin in broilers. M. Forat[1], V. Brito[1], and D. Zaviezo*[2], *[1]Instituto Internacional Investigacion Animal, Queretaro, Mexico, [2]Special Nutrients, Miami, FL.*

Performance and health are both affected when poultry consume feed contaminated with T-2 toxin (T-2). The dietary use of 0.1% of a commercial purified phylosilicate (Myco-Ad A-Z) has been demonstrated to effectively prevent the toxic effect of T-2 in broilers. An experiment was conducted to confirm previous results and evaluate the efficiency of a lower dose of Myco-Ad A-Z in reducing the deleterious effects of T-2 in broilers. Ninety 10-d-old Ross 308 male broiler chicks individually caged were randomly distributed into 5 dietary treatments with 18 replications of one chick each. Birds were fed a corn-soybean meal based mash diet containing or exceeding NRC recommended nutrients levels. The feed was experimentally contaminated with synthetic T-2 from Sigma Chemical Company, USA. Treatments were: (1) control diet; (2) control + 1.0 kg/mt Myco-Ad A-Z; (3) control + 1.25 ppm T-2; (4) control + 1.25 ppm T-2 + 0.5 kg/mt Myco-Ad A-Z and (5) control + 1.25 ppm T-2 + 1.0 kg/mt Myco-Ad A-Z. Results at 39 d of age indicated that broilers fed 1.25 ppm T-2 contaminated diet presented significant ($P \leq 0.05$) lower body weight gain, poorer feed conversion, and greater incidence/severity of macroscopic oral lesions than chickens fed the control diet. The highest mortality occurred in broilers fed the T-2 contaminated diet. The addition of either 0.5 or 1.0 kg/mt of Myco-Ad A-Z to the contaminated diet resulted in broilers with statistically significant ($P \leq 0.05$) heavier body weight gain (1972 and 1946 v 1746 g); more efficient feed conversion (1.75 and 1.76 v 1.94) and reduced oral lesions incidence/severity than those fed 1.25 ppm T-2. The addition of 1.0 kg/mt of Myco-Ad A-Z to the diet did not show any statistical ($P \leq 0.05$) difference in overall performance compared with the control diet, demonstrating its lack of interference with nutrients absorption. These results indicated that Myco-Ad A-Z at the low dosage of 0.5 kg/mt was effective in preventing the toxic effects of T-2 in broilers.

Key Words: Myco-Ad A-Z, T-2 toxin, broilers

590 The laying performance and egg quality traits of Nigerian local hen fed diets with varying energy levels. K. D. Afolabi*, A.

H. Ekeocha, A. B. Omojola, and O. A. Abu, *University of Ibadan, Ibadan, Oyo, Nigeria.*

One hundred and 20 local hens at point of lay (28 weeks) were randomly allotted to 4 isonitrogenous (20% crude protein) experimental diets with varying levels of dietary energy (2600, 2700, 2800 and 2900 kcal ME /kg) for 12weeks in battery cages. Each treatment comprised of 3 replicates of 10 birds each. The laying performance and egg quality traits of Nigerian local hen fed diets with varying energy levels were hereby assessed. Daily feed intake for hens fed diets containing 2800 and 2900 kcal ME /kg (71.35 and 69.82 g/bird respectively) were similar but significantly ($P < 0.05$) higher than what obtained for hens fed diet containing 2600 (61.29g) and 2700 kcal ME/kg (58.24g). The Feed Conversion Ratio (FCR) for hens on diets 1, 3 and 4 were similar but higher than the least value obtained for those on diet 2 (2700 kcal ME/kg). Cost of feed increased as the ME level increased. The highest cost of feed/kg of egg produced and cost of feed/kg produced were obtained for birds fed diet 3 (N160.09 and N5.70 respectively) and the least cost (N104.87 and N3.91) were obtained for those on diet 2 (2700 kcal ME/kg and 20%). The Nigerian local hens on experimental diets were similar for hen day production, egg weight, Egg Circumference, egg shape index, % shell weight and shell thickness. The egg albumen height obtained for hens fed diets 3 and 4 were similar but significantly ($P < 0.05$) higher than 3.37 and 3.00mm obtained for those on diet 1and 2, while the egg albumen weight for birds on diets 1 and 2 were similar and significantly higher ($P < 0.05$) than those of eggs from birds fed diet 3 (46.78%) and 4 (44.40%). Eggs laid by birds on diets 2 and 3 had the highest Haugh unit while those on diets 4 and 2 had the highest %yolk weight and yolk index respectively. Feeding Nigerian local hens with 2700kcal metabolizable energy and 20% crude protein elicited optimal performance and egg quality.

Key Words: Nigerian local hens, performance, egg quality, metabolizable energy

591 Dietary dihydropyridine can improve laying rate, feed efficiency, and regulate lipid metabolism of broiler breeder hens. Z. Y. Niu, F. Z. Liu*, H. Y. Wang, J. Zhang, W. C. Li, and L. Li, *College of Animal Science and Technology, Northwest A&F University, Yangling, Shaanxi, China.*

The experiment was conducted to investigate the effects of dihydropyridine supplementation on laying performance and lipid metabolism of broiler breeder hens. A total of 720 40 5-week-old broiler breeder hens were randomly divided into 4 groups, each of which included 6 replicates of 30 birds. The each group was fed a corn-soybean meal diet supplemented with 0, 100, 200, 300 mg/kg dihydropyridine respectively for 10 weeks. Daily egg weight and daily feed intake were not affected by dihydropyridine supplementation, but laying rate and feed efficiency were significantly increased ($P < 0.05$). Percentage of abdominal fat and percentage of liver fat were significantly decreased ($P < 0.05$) by dietary dihydropyridine. A level of 100 mg/kg dihydropyridine had no effect on hormone-sensitive triglyceride lipase (HSL) activity in liver or abdominal fat, but higher levels of dietary dihydropyridine(200mg/kg or 300mg/kg) increased HSL activity in liver or abdominal fat ($P < 0.05$). The content of cAMP and superoxide dismutase activity were significantly increased by dihydropridine, but malondialdehyde content was decreased ($P < 0.05$). Apolipoprotein B was increased by levels of 100 and 200 mg/kg dihydropyridine ($P < 0.05$), but 300mg/kg dihydropyridine had no effect on apolipoprotein B compared with control group. Triiodothyronine was significantly increased by dietary dihydropyridine ($P < 0.05$). It is concluded that supplementing dihydropyridine in the diet has a beneficial effect on laying performance and regulate the fat metabolism of broiler breeder hens, and that 200mg/kg dihydropyridine supplementation is the optimum dose for broiler breeder hens.

Key Words: dihydropyridine, laying performance, lipid metabolism, abdominal fat, broiler breeders

592 Effects of dietary energy and protein on growth performance and carcass quality of broilers during finishing phase. F. Z. Liu*, J. S. Shi, Z. Y. Niu, and Y. P. Gao, *College of Animal Science and Technology, Northwest A &F University, Yangling, Shaanxi, China.*

The present study was undertaken to investigate the influence of varying levels of dietary energy and protein on broiler performance and carcass quality from 22 to 42 d of age. A total of 720 22-d-old Avian broiler chicks were randomly divided into 12 groups, each group had 6 replicates, and each replicate contained 10 birds. These birds were randomly assigned to 12 dietary treatments in a 3 × 4 factorial arrangement with 3 metabolizable energy (ME) levels (12.55 12.97, 13.38 MJ/kg) and 4 crude protein (CP) levels (18.5, 19.0, 19.5, and 20.0%), respectively, from 22 to 42 d of age. The results showed that: (1) Both ME and CP significantly affected on daily gain, feed efficiency and body weight of 42d of age ($P < 0.05$). ME levels significantly affected on Feed intake ($P < 0.05$), while CP not affected ($P > 0.05$). However, there were no significant interaction in BW, average daily gain, feed intake between dietary ME and CP; (2) Dietary ME significantly affected on semi-eviscerated percentage, dressing percentage, leg meat percentage and abdominal fat ($P < 0.05$). Higher level of dietary ME (13.38 MJ/kg) significantly increased abdominal fat percentage when compared with lower ME (12.55 MJ/kg and 12.97 MJ/kg). Breast meat percentage was increased by dietary CP ($P < 0.05$); (3) L* of both leg meat and breast meat was not affected by dietary ME and CP($P > 0.05$), b* of both breast meat and leg meat was increased with increasing dietary ME ($P < 0.05$). Both a* and b* were not affected by dietary CP; (4) pH of breast meat was increased by dietary ME, while not affected by dietary CP. WHC of breast meat was decreased by dietary ME, but the effect was not significantly ($P > 0.05$). WHC of leg meat was increased by dietary ME ($P < 0.05$). The results of present research indicated that the optimal dietary ME requirement of broilers from 22 to 42d of age is 12.97MJ/kg, and the CP requirement is 19.0% to 20.0%.

Key Words: broiler, energy, protein, growth performance, meat quality

593 The effect of acidifiers on broilers GIT microbial population, intestinal morphology, ileal digestibility and performance. S. Yakhkeshi, S. Rahimi*, and K. Gharib Naseri, *Tarbiat Modares University, Tehran, Tehran, Iran.*

The study was conducted to investigate the effects of some commercial acidifiers on intestine microbial population and morphology, ileal nutrient digestibility and broilers performance. A total of 240 d old male broilers (Cobb 500) were randomly allocated to 4 treatments, 4 replicates with 15 birds in each by CRD. Treatments were including control; Selko-pH; Termin-8 and NeoGermicin. The lowest feed intake was attained by Selko-pH ($P < 0.05$) at 1–42 period. Moreover, the highest weight gain were achieved by NeoGermicin ($P < 0.05$) at 22–42 and 1- 42 d of age. The highest and lowest feed conversion ratio

were obtained by control and NeoGermicin at 22–42 and 1–42 d of age, respectively ($P < 0.05$). In all treatments except control group villi height and villi height: crypt depth ratio were significantly increased at 21 and 42 d of age ($P < 0.05$). No significant differences were observed between treatments in the villous width, crypt depth and villous surface area at 21 and 42 d of age ($P > 0.05$). Control and NeoGermicin induced the lowest and greatest Dry matter, Gross energy, AME and AMEn digestibility, respectively ($P < 0.05$). Organic matter and Crude protein digestibility were not significantly different ($P > 0.05$). Higher Ether extract digestibility was seen by NeoGermicin ($P < 0.05$). Crop pH significantly decreased by all treatments rather than control at 21 and 42 d of age ($P < 0.05$). Duodenum, jejunum and ileum pH significantly diminished by all treatments rather than control at 21 and 42 d of age ($P < 0.05$). Moreover, a significant decrease in cecum pH was obtained by all treatments except control at 21 d of age ($P < 0.05$). The results of current study have shown that organic acids improved the gut microflora and villous characteristics by pH reduction. The digestibility of nutrients and energy utilization were superior by acidifiers, but Selko-pH plays the minor role in broilers performance.

Key Words: acidifiers, microflora, villi, digestibility, broilers

594 Use of Nonlinear programming to determine the economically optimal energy density in laying hens diet. M. Shivazad*[1], M. Afrouziyeh[2], M. Chamani[3], and S. Amirdahri[4], *[1]University of Tehran, College of Agriculture and Natural Resources, Animal Science Department, Karaj, Tehran, Iran, [2]Tabriz Branch, Islamic Azad University, Tabriz, Iran, [3]Department of Animal Science, Science and Research Branch, Islamic Azad University, Tehran, Iran, [4]Department of Animal Science, University of Tabriz, Tabriz, Iran.*

This study was designed to show the advantage of nonlinear programming in diet formulation. A nonlinear programming Excel Workbook was developed that used the Excel solver to optimize energy density and bird performance. In this study 6 dietary treatments (include 2.515, 2.615, 2.715, 2.815, 2.915 and 3.015Mcal of metabolizable energy per kilogram) were fed to Hy-line W-36 laying hens (n = 192) in phase 1(from 24 to 32 week of age). Data were fitted to quadratic equations to express egg mass, feed consumption, and the objective function return over feed cost in terms of energy density. Nutrient:energy ratio constraints were transformed into equivalent linear constraints. To demonstrate the capabilities of the model, the prices for egg, corn and soybean meal were increased and decreased by 25% and the program solved for the maximum profit and optimized feed mix. Formulations were identical in all other respects. By increasing egg price, the model changed the optimal diet formulation and energy density in such a way as to improve performance and feed consumption and accepted a higher energy concentration. To make nutritional and economical decisions for a given feed formulation problem, the sensitivity analysis was performed. The sensitivity analysis for linear programming showed that if the protein level of the diet were to change from 16.046 to 15.046%, the cost of the diet would decrease by $0.0293 from $0.4089 to $0.3799/kg. The sensitivity analysis for nonlinear programming showed that if the protein level of the diet were to change from 14.96 to 13.96%, the cost of the diet would decrease by $0.0272/kg from $0.3547 to $0.3275/kg. Results indicated that there are considerable savings to be made for egg producers from the use of the nonlinear programming model described here as opposed to a linear one with fixed minimums for energy and other nutrients. These savings result from the nonlinear programming models' ability to determine the most profitable energy density that should be fed as energy and protein prices change.

Key Words: energy, feed formulation, laying hen, nonlinear programming

595 Influence of soy oil source and supplementation of the diet with vitamin E and vitamin C on performance and egg quality of Single Comb White Leghorn laying hens from forty four to fifty six weeks of age. H. Irandoust[1], A. H. Samie[1], H. R. Rahmani[1], J. Pourreza[1], M. Kadivar[2], M. A. Edriss[1], P. García-Rebollar[3], and G. G. Mateos*[3], *[1]Department of Animal Sciences, Isfahan University of Technology, Isfahan, Iran, [2]Department of Food Science and Technology, Isfahan University of Technology, Isfahan, Iran, [3]Departamento de Producción Animal, Universidad Politécnica de Madrid, Spain.*

Two experiments (Exp.) were conducted to determine the AME content of refined soybean oil (SO), recycled soybean oil (RSO), and acidulated soybean oil soapstocks (ASO) and the effects of inclusion of vitamin E and vitamin C in diets containing 3.5% of these soy oils on performance and egg quality of Hy-line hens from 44 to 56 wks of age. In Exp. 1 the AME of the 3 experimental oils were determined in adult cocks using 6 individual replicates per treatment. The apparent total tract digestibility (ATTD) of SO, RSO, and ASO were measured by 1) difference between AME values of the basal diet without any oil added and that of the diet based on 95% basal diet and 5% of the experimental oil, and 2) directly multiplying the ATTD of the ether extract fraction of the diet by the GE of the oil. The determined ATTD were 95.2, 94.5, and 85.9% for SO, RSO, and ASO, respectively. The AME of the oils were 9,138, 8,955, and 7,961 kcal/kg measured by the substitution method, and 8,916, 8,880, and 7,849 kcal/kg calculated directly from the ATTD coefficient of the ether extract, respectively. In Exp. 2 there were 12 treatments arranged factorially with 3 oil sources (SO, RSO, and ASO), 2 levels of vitamin E (0 vs. 250 mg/kg), and 2 levels of vitamin C (0 vs. 250 mg/kg). Each diet was replicated 5 times and the experimental unit was formed by 5 hens caged together. The trial was conducted under moderate temperature conditions (21 ± 3°C and 50% humidity) and lasted for 12 wks (44 to 56 wks of age). For the entire experimental period, diet did not affect laying hen performance or egg quality traits. It is concluded that recycled oil and acidulated soybean oil soapstocks are good alternatives to refined soybean oil in diets for laying hens. Under the conditions of this research, the supplementation of the diet with extra amounts of vitamin E and C to improve egg production or egg quality is not justified.

Key Words: apparent metabolizable energy, laying hen performance, soy oil sources, vitamin C, vitamin E

596 Differential effects of sodium selenite and Sel-Plex selenium yeast on the hepatic gene expression profile of laying hens. R. Xiao*[1,2], R. F. Power[1,2], D. Mallonee[1,2], K. Routt[1], L. Spangler[1], T. Ao[1,2], J. L. Pierce[1,2], and K. A. Dawson[1,2], *[1]Alltech, Nicholasville, KY, [2]Alltech-University of Kentucky Nutrition Research Alliance, Lexington.*

The advantage of organic selenium over inorganic selenium in animal diets has been well documented. To gain further insights into biological functions at the molecular level, this study investigated the effects of dietary sodium selenite (SS) or organic yeast selenium Sel-Plex (SP, Alltech Inc.) on the hepatic gene expression profiles of laying hens. Hens were assigned at age of 6 wks to one of 3 treatments: basal semi-purified diet (control), basal diet + 0.3 ppm SP or basal diet + 0.3 ppm SS. At 49 wks, liver samples were collected and used for gene expression analysis. Results indicated that 1039 transcripts were differentially regulated by SP (508 down, 531 up, $P < 0.01$, FC > 1.2), while 514 transcripts were altered by SS (207 down, 307 up, respectively). There were 135 transcripts commonly changed by SP and SS. Further pathway analysis revealed the significant upregulation of genes involved in energy metabolism and other mitochondrial functions including oxidative phosphorylation and ubiquinone biosynthesis pathways by SP, while similar effects were not observed in SS-fed chickens. Genes involved in signaling pathways that are important in response to cellular stress and injury such as P53 signaling (e.g., CCNK, GADD45B) and production of nitric oxide and reactive oxygen species were also suppressed by SP. On the other hand, increased expression of multiple genes that have been linked with development of certain liver diseases, such as aryl hydrocarbon receptor (AHR), nuclear factor kappa (NFKB1) and microsomal glutathione S-transferase 2 (MGST2) by SS may suggest an increased risk of hepatic system diseases when high levels of inorganic selenium are added to the diets of hens. This study indicates that differences in liver gene expression profiles, especially on genes involved in energy production and cellular stress, may partially explain the reported biological differences related to SP and SS.

Key Words: selenium, gene expression, liver, hen, microarray

597 Effect of chelated trace minerals, zinc, manganese, copper and iron on layer performance and egg shell quality. S. S. Padhye[1], A. S. Ranade[1], D. N. Desai*[1], P. E. Avari[1], M. Manangi[2], M. Vazquez-Anon[2], and D. Joardar[2], *[1]Bombay Veterinary College, Mumbai, Maharashtra, India, [2]Novus International Inc., St. Charles, MO.*

Two trials were conducted to study the effect of chelated organic trace minerals such as Mintrex Zn [$Zn(HMTBa)_2$], Mintrex Mn [$Mn(HMTBa)_2$] and Mintrex Cu [$Cu(HMTBa)_2$] and Glytrex Fe on layer performance and egg shell quality for 16 weeks. The first trial was conducted on 360 layers of BV 300 strain of 23 weeks of age. The birds were randomly divided into 3 equal groups, A, B and C of 120 birds, having 24 replicates, each. The second trial was conducted on 9886 layers of BV-300 strain of 24 weeks of age under field conditions. The birds were randomly divided into 3 groups having 4 replicates of about 825 birds. In both the trials, group A received control diet containing Zn, Mn, Cu and Fe in inorganic form at the levels of 60, 60, 9 and 60 ppm, respectively, as per Indian standards. Groups B and C received treatment diets containing Zn, Mn, Cu and Fe in chelated form at 50% and 25% of the levels used in control group, respectively. The levels of Se and I were kept same in all the groups. For both the trials, production performance, egg quality, economics, ND titers and tissue mineral levels were studied. Results from both the trials showed no differences ($P \geq 0.05$) among treatments for the measured variables such as egg production, feed consumption, FCR, mortality, egg quality, tissue mineral levels and NCD titers. However, % broken eggs was significantly ($P \leq 0.05$) reduced for groups B and C compared with control. The % broken eggs for groups A, B and C were 0.150, 0.039, 0.062 for Trial-1 and 0.113, 0.069 and 0.076 for Trial-2, respectively. In summary, results from the current trials indicate a significant reduction in % broken eggs with no change in production performance and egg shell quality when chelated trace minerals were used in layers at significantly reduced levels compared with higher levels of inorganic trace minerals that are currently being used in Indian poultry industry.

Key Words: layer nutrition, chelated trace minerals

598 Influence of graded levels dietary sodium on the development of foot pad dermatitis in broiler chickens. ö Cengiz[1], J.

B. Hess[2], and S. F. Bilgili*[2], [1]*Adnan Menderes University, Aydın, Turkey,* [2]*Auburn University, Auburn, AL.*

An experiment was conducted to investigate the effects of graded levels of dietary sodium (0.15, 0.20, 0.25 and 0.30% Na) on live performance and development of footpad dermatitis (FPD) in broiler chickens reared to 49 d of age. On the day of hatch, 1280 mixed sex chicks were randomly allotted to 4 treatments with 8 replicate pens of 40 broilers per pen. A 3-stage feeding program, consisting of a starter, grower, and finisher feeds, as well as water were provided ad libitum and lighting was continuous throughout the study. Litter samples were collected, pooled by pen and analyzed for moisture at 0 and 49 d of age. FPD incidence and severity were assessed by examining all birds on Days 28 and 49. Data were statistically analyzed for linear (L), quadratic (Q) and cubic (C) treatment effects by the GLM procedure of SAS. Dietary supplementation of broiler diets with graded levels of Na improved ($P < 0.05$) feed conversion ratio on Day 14 (L and Q), BW on Days 28 and 49 (L), decreased mortality on Day 49 (L), increased total water consumption (L) and water to feed ratio (C). Litter moisture level also increased ($P < 0.001$) linearly from 24% (0.15% Na) to 32% (0.30% Na) on Day 49. Moreover, the incidence and severity of FPD on Days 28 and 49 increases linearly with Na levels in the diet. On Day 49, FPD severity was worst on treatments receiving the 2 highest levels of Na. These results confirm the earlier reports that high dietary Na can increase litter moisture and hence be a direct trigger of FPD development in broiler chickens.

Key Words: broiler, sodium, footpad dermatitis, performance

599 Performance and egg iron contents of Cobb 500 female broiler breeders fed diets having meat meal or iron-amino acid. F. Bess*[1], S. L. Vieira[1], E. Allix[1], P. C. Nascimento[2], and A. Favero[1], [1]*Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil,* [2]*Universidade Federal de Santa Maria, Santa Maria, RS, Brazil.*

The objective of this study was to compare diets with or without animal by-product and different Fe supplementation in broiler breeder diets. Sixty Cobb 500 females, 22 wks of age, were placed individually in cages and fed a typical breeder diet (15.6% CP, 2,840 kcal ME/kg, 3.2% Ca, 0.45% Av P) without Fe supplementation for 84 d. Starting on d 85, birds were randomly allocated to 6 dietary treatments in a factorial of 2 diets (Vegetable and Animal) and 3 Fe sources (None, Inorganic and Chelated). Diets had similar nutrient profile with the exception of Fe. Vegetable diet was formulated with corn, wheat bran and soybean meal, whereas the Animal diet had the inclusion of 2.5% meat and bone meal. The None diet was not supplemented with Fe, whereas 60 ppm of Fe was supplemented in the Inorganic (Fe (II) sulfate) or in the Chelated (Fe-amino acid: 6% Fe, with varying percentages of AA). Diets were provided for 3 periods of 4 wks and eggs were collected daily. In the last 2 d of each week, eggs were weighed, and yolk and albumen were separated. Egg composites were frozen for further analysis of Fe content using atomic absorption spectrometry. Resulting data were analyzed using a 2-way ANOVA with repeated measures. Yolk Fe contents increased with time in all treatments, except for the Vegetable diet without Fe supplementation ($P < 0.05$). Average Fe concentration in yolk was the highest for the Animal diet supplemented with Fe-AA, lowest for the Vegetable diet not supplemented with Fe, and without differences between the other 4 treatments. Egg production was reduced for birds fed both diets without Fe supplementation when compared with those with any type of Fe supplementation ($P < 0.05$). No differences were found for egg weight, specific gravity, or for the weight of egg yolk, albumen or shell ($P > 0.05$). In conclusion, Fe concentration was increased when 60 ppm of Fe from ferric sulfate or Fe-AA sources were added to breeder diets traditionally formulated without meat and bone meal, but Fe was further increased in Animal diets when Fe-AA was used.

Key Words: broiler breeder, chelated mineral, egg contents, iron

600 Effect of dietary zinc proteinate on growth performance, and skin and meat quality of male and female broiler chicks. H. M. Salim[1,2], H. R. Lee[1], C. Jo[1], S. K. Lee[1], and B. D. Lee*[1], [1]*Department of Animal Science and Biotechnology, Chungnam National University, Daejeon, South Korea,* [2]*Department of Livestock Services, Dhaka, Bangladesh.*

Two experiments were conducted to evaluate the effect of dietary zinc proteinate (ZP) on growth performance, and skin and meat quality of broiler chicks. In both experiments, 120 each of 1-d-old male and female broiler chicks were allotted to 2 dietary levels of ZP (2 × 2 factorial) with 6 replicates per treatment, and 20 birds per replicate. The ZP levels were 0 and 25 ppm in Exp. 1, and 0 and 40 ppm in Exp. 2. In Exp. 1, ZP did not affect the growth performance of male and female broiler chicks, but the males showed significantly higher ($P < 0.05$) growth performance than females. ZP did not affect the thickness of both back and thigh skin of male and female broilers; however, male had thicker skin than females. Dietary ZP did not affect the collagen contents in skin and meat samples. Males had higher skin collagen contents than females, but no sex difference was found in meat collagen contents. ZP did not affect the shear force values of skin and meat samples. Males had higher shear force values of back skin than females, but not in the meat samples. In Exp. 2, ZP did not affect the growth performance of males and females, but males showed better growth performance than did females. ZP increased the total thickness of skin samples in both sexes, and males had thicker skin than females as in Exp. 1. Dietary ZP increased ($P < 0.05$) the collagen content of skin samples, but not in meat samples. Like in Experiment 1, males had higher skin collagen contents than females, but no sex difference was found in meat collagen contents. ZP did not affect the shear force values of skin and meat samples; however, male broilers had higher shear force values of back skin than females. It is concluded that dietary ZP could increase the collagen content and skin thickness which, in turn, would improve the skin and meat quality of broiler chicks. Females had lower collagen content and thinner skin than males, indicating a higher ZP requirement for females than its counterpart.

Key Words: zinc proteinate, skin quality, growth, male broilers, female broilers

601 Identification of copper and manganese glycinate complexes in enriched feeds and study of their bioavailable forms using capillary electrophoresis coupled with inductively coupled plasma mass spectrometry (CE-ICP-MS). C. Ionescu*[1], V. Vacchina[2], R. Lobinski[3], and D. M. Bravo[1], [1]*Pancosma, Geneva, Switzerland,* [2]*UT2A, Pau, France,* [3]*CNRS, Pau, France.*

Poultry feeds contain copper and manganese supplements. Some organic trace minerals have shown better absorbability than inorganic sources and raised the concern for trace mineral dose reduction in diets. However, feed efficacy with lower copper and manganese doses could be different from one organic trace mineral source to another increasing the feed producer concerns for organic trace minerals sources iden-

tification in their feeds. Our first aim was then to develop an analytical method allowing identification of glycinate complexes (BT Cu and BT Mn, Pancosma) in feeds. In a second step, we mimicked gastrointestinal conditions to know under which species BT products could reach animal enterocytes. For the first aim, a feed sample spiked with BT Cu and BT Mn at 15 mg/kg (as metal) was analyzed after aqueous extraction. The extracts obtained were then analyzed by CE-ICP-MS. The concentrations measured, namely 14 ± 3 mg/kg (as metal) for both species were in agreement with the theoretical concentrations, showing the efficiency of the coupling for such analysis. For the second step, the BT Cu and BT Mn-spiked feed sample was subjected to gastric and gastro-intestinal simulations. The measurement of the total Cu and Mn content showed that both elements were under a bioavailable form (79 - 94% was extracted). The extracts obtained were then analyzed by CE-ICP-MS and the electropherograms showed that both BT Cu and BT Mn were present after gastro-intestinal simulations. However, quantitative glycinates data were difficult to obtain due to the presence of other species. These results show the possibility to identify BT Cu and BT Mn molecules in both feeds and after gastro-intestinal simulations.

Key Words: glycinate complex, feed, traceability, chelates

602 Feeding organic trace minerals source instead of inorganic sources at high trace mineral doses improves broiler carcass quality. C. Ionescu*[1], S. Elmaliach[2], R. Planck[2], and D. Bravo[1], *[1]Pancosma, Geneva, Switzerland, [2]Bar-Magen, KfarBenei-Zion, Israel.*

Organic trace mineral (OTM) efficiency have been heavily studied compared with inorganic sources. However, sources differences were mainly visible when animals were subject to deficiencies. The objective of this study was to check if a combination of OTM (Zn, Cu, Mn and Fe) could beneficially replace inorganic sources and modify carcass quality of male broilers even in adequate to high trace mineral concentrations. A total of 384 male broilers Ross 308 were held in pens (14.2 birds/m^2) for 47 d. All the diets contained Flavomycin at 10g/t as a growth promoter and Salinomycin as a coccidiostat at 60 g/t. Diets trace minerals contents were set as following: 100 ppm zinc, 100 ppm manganese, 40 ppm Iron and 15 ppm Copper and exceeded NRC recommendations for all trace minerals except for Iron. Inorganic sources (IN) included zinc sulfate, manganese oxide, ferrous carbonate and copper sulfate and organic sources included zinc-, manganese-, iron- and copper-glycine complexes as (BT, B-Traxim 2C, Pancosma). BW gain, feed intake, feed conversion ratio and mortality were measured or calculated from d 1 to 42. On d 47, 10 broilers from each treatment with the same BW were selected for subsequent carcass quality measures such as dressing percentage, drumsticks, breast and abdominal fat percentages. As expected, no modifications in the overall performance of broilers has been seen between organic and inorganic sources, confirming the point that sources impact on performance could only be seen in trial designs with trace elements deficiency. However some carcass quality parameters were different between the IN and BT sources. Dressing percentage of BT broilers was improved when compared with IN broilers (76% vs. 69% respectively, $P < 0.001$). Drumstricks percentage was also increased in BT broilers (31.8% vs. 28.2%). No modification of breast or abdominal fat were observed between the 2 treatments. These results indicate that an OTM source (BT) with a better bioavailability can influence carcass quality parameters in presence of adequate trace mineral diet concentrations.

Key Words: organic trace minerals, glycinate complexes, carcass quality, broiler

603 Inclusion of organic selenium on performance and egg quality of Japanese quails at 56 to 76 d old. V. C. da Cruz*[1], L. C. Carvalho[1], R. V. Ferreira[1], D. D. Millen[1], G. do Valle Polycarpo[2], D. O. dos Santos Gomes[1], L. H. Zanetti[1], R. F. de Oliveira[1], A. L. C. Brichi[1], and R. G. A. Cardoso[1], *[1]São Paulo State University, Dracena Campus, São Paulo State University, Dracena, São Paulo, Brazil, [2]São Paulo State University, Botucatu Campus, São Paulo State University, Botucatu, São Paulo, Brazil.*

This study was carried out at São Paulo State University, Dracena Campus, Brazil, to evaluate the performance and egg quality of Japanese quails supplemented with organic zinc and chromium associated with different inclusions of selenium also in organic form. The experimental design was completely randomized and birds were allocated to the following treatments: T1 = basal diet - without chelated minerals, T2 = 0.25 ppm Se + 60 ppm Zn + 0.5 ppm Cr, T3 = 0.50 ppm Se + 60 ppm Zn + 0.5 ppm Cr, T4 = 0.75 ppm Se + 60 ppm Zn + 0.5 ppm Cr, T5 = 1.00 ppm Se + 60 ppm Zn + 0.5 ppm Cr; with 8 replications of 5 birds per treatment. In the period from 56-d to 76-d old was observed by regression analysis that there was no significant difference ($P > 0.05$) in performance: dozen eggs produced, average egg weight, feed intake, feed conversion by egg mass (kg feed/kg eggs) and feed conversion by egg dozen (kg feed/dozen eggs), daily egg production and feed intake per bird. The yolk height decreased linearly ($P < 0.05$) and albumen index had a quadratic effect ($P < 0.05$), with better results observed for both in the eggs of birds submitted to the consumption of inorganic minerals. No significant effects ($P > 0.05$) of treatments were observed for Haugh unit, specific egg weight, albumen height, yolk index, shell weight and shell thickness, agreeing with previous research that assessed organic minerals in the diet of laying hens and also found no advantages in its use. Despite presenting higher bioavailability and easier absorption by the animal, supplementation with chelated minerals in this study did not influence the internal and external quality of eggs and did not improve quails performance. The lack of response of supplementing chelated minerals may be explained not only by different doses of selenium, but also by the use of different sources.

Key Words: chelated mineral, mineral supplement, trace element, selenium methionine, *Coturnix coturnix japonica*

604 Effect of dietary vitamin E on tocopherol content and fatty acid profile of liver. J. Viguera[1], O. Caso[2], A. Ayllón[2], M. D'Arrigo[3], A. Villares[3], and P. Medel*[1], *[1]Imasde Agroalimentaria, S.L., Pozuelo de Alarcón, Madrid, Spain, [2]Canard, S.A., Abejar, Soria, Spain, [3]INIA, Soria, Spain.*

Ducks overfed with a carbohydrate-rich diet for less than 2 weeks develop a fatty liver (foie gras), which has a high susceptibility to lipid oxidation, which could be reduced with vitamin E supplementation. A trial was conducted to investigate the effects of dietary vitamin E supplementation on tocoferol content of liver. Three-hundred seventy-five male Mulard ducks were assigned to one of 3 dietary groups. Control group received the control diet with corn grain and corn meal. In addition to the control diet, 2 experimental diets included 200 mg vitamin E/kg (T2), and 400 mg vitamin E/kg (T3). Animals were fed with a common diet from birth to the overfeeding period. At 12 weeks of age, all ducks were housed in individual cages and were overfed at the maximum of their ingestion potential for 14 d with its respective diet. At the end of this period, animals were slaughtered under commercial conditions and all livers were weighed. Then, 17 livers of each treatment were collected to analyze α and γ tocopherol content

and fatty acid profile. All data were analyzed by ANOVA with diet as main effect. No significant differences were found between treatments for carcass weight. However, vitamin E supplementation reduced liver weight (573.2 *vs* 605.4 g; $P < 0.05$) and tended to decrease liver yield (17.22 *vs* 18.14%; $P = 0.08$) compared with control ducks. Animals with vitamin E supplementation showed greater α-tocopherol content of the liver than control ducks (5.65 *vs* 0.50 mg/g; $P < 0.01$), but no significant differences between treatments were found for γ-tocopherol content. Vitamin E supplementation did not affect fatty acid profile of the liver. In conclusion, dietary vitamin E supplementation in ducks increases the α-tocopherol level in the liver, which seems to be a valuable method for increasing the antioxidant capacity of the liver.

Key Words: duck, vitamin E, tocopherol, liver

605 Effect on omega 3 fatty acids egg content and productive parameters when laying hens diets are supplemented with sardine oil and vitamin E. S. Carrillo*[1,2], E. Avila[1], C. Vasquez[1], B. Fuente[1], C. Calvo[2], M. E. Carranco[2], and F. Perez-Gil[2], *[1]FMVZ, Universidad Nacional Autonoma de Mexico, Mexico, D.F., Mexico, [2]Depto. Nutricion Animal, Insituto Nacional de Cienicas Medicas y Nutricion Salvador Zubiran, Mexico.*

Several authors had observed that when laying hens diets are supplemented with fish oil (FO) levels up to 1.5%, the omega 3 fatty acid egg content increase, but the egg weight and egg production decrease. As seem, adding more vitamin E at the rations, this problem can be avoided, and the loss of EPA and DHA due to oxidation, too. The aim of this study was to know the effect on omega 3 fatty acids egg content and productive parameters, when laying hens diets are supplemented with sardine oil (SO) and α-tocopherol (ATA). 240 laying hens were distributed into 4 treatments with 5 replicates of 12 birds each one. The treatments were: T1-basal diet (BD), T2-BD+2.5%SO, T3-BD+2.5%SO+100ATA and T4-BD+2.5%FO+200ATA. The study was carried out during 4 weeks. At end 50 egg per treatment (10 per replicate) were taken to fatty acids analysis, by gas chromatography. The results showed any effect on egg FA content and productive parameters when 100 mg/kg ATA were added to laying hens diets, but when 200 mg/kg ATA were added, the egg FA content was reduced, mainly the omega 3 FA ($P < 0.05$). It is concluded that adding high levels of ATA (200 mg/kg) in the laying hens supplemented with sardine oil can decrease the egg fatty acid content.

Key Words: Fatty acids, sardine oil, vitamin E, eggs, laying hens

606 The effect of selenomethionine vs. sodium selenite supplementation on vitelline membrane strength, glutathione peroxidase activity in the liver and magnum of laying hens, and egg se content when using a corn starch based diet. A. A. Aljamal*[1], C. A. Fassbinder-Orth[2], K. J. Hanford[1], and S. E. Purdum[1], *[1]University of Nebraska-Lincoln, Lincoln, [2]Creighton University, Omaha, NE.*

The objective of this study was to investigate the effects of dietary selenium (Se) source and level on production parameters of laying hens fed a semi-purified diet. A total of 90 White Bovan hens were fed the experimental diets for 6 weeks. Hens were assigned to 30 cages with 6 replicate cages/treatment. Cages were blocked by side, north and south, each side with a total of 15 cages. Hens were fed a semi-purified corn starch-soybean meal diet supplemented with: (0, 0.2 ppm selenomethionine, 0.2 ppm sodium selenite (SS), 0.4 ppm selenomethionine, or 0.4 ppm SS) for a total of 5 dietary treatments in a factorial treatment design. Three eggs per treatment were collected 3 times throughout the study for yolk and albumen Se content. At the end of the study, 2 hens/ cage were euthanized to measure GSH-Px activity of the liver and magnum tissues. Feed intake and egg production increased as dietary Se supplementation increased in the diet but this was significant only with feed intake ($P < 0.05$). Hens supplemented with selenomethionine consumed more feed compared with the inorganic source of Se ($P < 0.05$). Yolk Se content was significantly higher in all treatments supplemented with Se than the control diet ($P = 0.0497$). There was a significant interaction effect of Se source and level on albumen Se content ($P = 0.0358$); albumen Se content increased when selenomethionine levels in the diet increased, whereas when sodium selenite levels increased in the diet, there was no significant increase in egg albumen Se content. Dietary treatments had no significant effects on egg quality parameters or GSH-Px activity in the liver and magnum of hens. Our research hypothesis was that the semi purified basal diet used should have low Se content to show significant effects on egg quality and production parameters, but the results showed the basal diet had higher amounts of Se (417.5 ppb) than regular diets that met minimum requirements of the laying hen of 0.06 ppm (NRC, 1994).

Key Words: vitelline membrane strength, glutathione peroxidase, egg Se content

607 Performance of Pearl Grey guinea fowl fed diets varying in calcium and available phosphorus concentrations. S. N. Nahashon*, L. Glover, and G. Kelley, *Department of Agricultural Sciences, Tennessee State University, Nashville*

The demand for guinea fowl (GF) as alternative poultry has been steadily increasing worldwide. However, their production performance lags that of other commercial avian species partly because there is insufficient knowledge of their nutrient requirements. Dietary calcium (Ca) and phosphorus requirement for optimum growth performance of the Pearl Grey GF replacement pullets was evaluated. In a 4 × 3 factorial arrangement of dietary treatments, 540 Pearl Grey GF (1-d-old) were assigned to brooding cages and fed diets containing 0.6, 0.8, 1.0 and 1.2% calcium each in combination with 0.32, 0.4, or 0.48% available phosphorus (AP). The starter diets were isocaloric 3,000 kcal/kg ME and isonitrogenous (24% CP) and were fed from 8 weeks of age (WOA). The grower diets comprised of 3,100 kcal/kg ME and 18% CP and were fed from 9-15 WOA. The diets were replicated four times and both feed and water were provided at free choice. The birds were reared on a 23 and 8 hour lighting regimen at 0-8 WOA and 9-15 WOA, respectively. Experimental birds were observed for feed consumption (FC), BW gain and feed conversion ratio (FCR). Birds fed diets containing 0.6% Ca and 0.4-0.8% AP exhibited higher ($P < 0.05$) FC than other treatments. Average FCR was lower in birds fed diets containing 0.8% Ca and 0.32-0.48% P than other dietary treatments. In most part, BW gains were not different among dietary treatments except for birds fed the 0.6% Ca and 0.32% AP whose BW gain was higher than other treatments. Therefore, the Pearl Grey guinea fowl seems to utilize more efficiently diets containing 0.8% Ca and 0.32-0.48% AP.

Key Words: Pearl Grey guinea fowl, calcium, phosphorus

608 The regulation of intestinal folic acid absorption in the laying hen supplemented with increased levels of dietary folic acid. G. B. Tactacan*, J. C. Rodriguez-Lecompte, K. O, and J. D. House, *University of Manitoba, Winnipeg, Manitoba, Canada.*

Different aspects of folic acid (FA) absorption in the intestine of the laying hen have been previously characterized. However, much less is

known about the regulation of this process. A study was conducted to evaluate the effect of increased dietary folic acid (FA) supplementation on the regulation of intestinal FA absorption and the gene expression of the intestinal folate transporters, the proton coupled folate transporters (PCFT) and the reduced folate carrier (RFC). Twenty-four Shaver White hens at 34 wk of age were randomly assigned to receive 1 of 3 dietary treatments (n = 8): 1) basal diet with no supplemental folate, 2) basal diet + 10 mg/kg of FA, and 3) basal diet + 100 mg/kg of FA. A CRD with 3 dietary treatments was used. Data were subjected to PROC GLM and *t*-test procedure of SAS. Results showed that relative to the control-fed birds, egg and plasma folate concentrations increased ($P < 0.001$), while plasma homocysteine decreased ($P < 0.011$) in birds fed with 10 and 100 mg/kg of FA. With respect to FA absorption, the uptake of FA (nmol•100 g tissue-1•min-1) in the duodenum was downregulated ($P < 0.002$) (basal = 25.1 ± 1.7; 10 mg FA = 19.7 ± 1.8; 100 mg FA = 18.5 ± 2.1), but the mRNA levels of the duodenal PCFT and RFC genes were not affected by the supplementation of 10 and 100 mg/kg of FA. In the jejunum, the uptake of FA and the mRNA levels of PCFT and RFC genes were not influenced by increased FA supplementation. Overall, these data demonstrated that increased dietary levels of FA resulted in a downregulation of FA absorption in the duodenum, but not in the jejunum of the laying hen. This was not associated with decreased expression of the duodenal PCFT and RFC genes. Therefore, a post-transcriptional or translational regulation of the intestinal folate transporters may be involved in the downregulation of duodenal FA absorption during increased supplementation of dietary FA.

Key Words: folic acid, folate transporter, gene expression, egg, laying hen

Mycoplasma Posters

609 Virulence evolution of mycoplasmal conjunctivitis in house finches. D. Ley*, D. M. Hawley, E. E. Osnas, A. P. Dobson, K. V. Dhondt, J. L. Grodio, K. A. Schat, W. M. Hochachka, and A. A. Dhond, *Dept. of Population Health and Pathobiology, College of Veterinary Medicine, North Carolina State University, Raleigh.*

AAAP abstract†

610 Phylogenetic analysis of *Mycoplasma synoviae* isolated from the chickens with history of clinical signs. E.-O. Jeon*, K. Jung, and I. Mo, *Chungbuk National University, Republic of Korea.*

AAAP abstract†

611 Sequencing of South African *Mycoplasma gallisepticum* isolates reveals novel genotypes. N. K. Armour*, V. Laibinis, and N. Ferguson-Noel, *Department of Population Health, Poultry Diagnostic and Research Center, The University of Georgia, Athens, GA.*

AAAP abstract†

612 Revised amplified fragment length polymorphism (AFLP) protocol for avian mycoplasmas. A. Wetzel* and Z. Raviv, *The Ohio State University.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Newcastle Disease Virus Posters

613 Further assessment of the VG/GA Newcastle disease virus strain (AVINEW) for in ovo vaccination in commercial broilers. F. A. Perozo*, R. Marcano, L. Gómez, R. Fernandez, and F. Rojo, *University of Zulia, Maracaibo, Venezuela.*

AAAP abstract†

614 Effect of Newcastle disease virus (La Sota strain) infection on chicken respiratory macrophage. H. Jang* and I.-P. Mo, *Chungbuk National University, Republic of Korea.*

AAAP abstract†

615 Characterization of avian paramyxoviruses isolated from migratory waterfowl in chickens, turkeys and ducks. Jack Gelb*, B. S. Ladman, G. V. Oldfield, C. R. Pope, L. A. Preskeni, and S. K. Sama, *Avian Bioscience Center, University of Delaware, Newark.*

AAAP abstract†

616 Avian paramyxovirus serotype 1 strains of low virulence with unusual fusion protein cleavage sites isolated from poultry species. P. Miller*, M. L. Killian, J. C. Pederson, and C. L. Afonso, *Southeast Poultry Research Laboratory, USDA/ARS, Athens, GA.*

AAAP abstract†

617 Analysis of transcriptional cytokine responses of chickens infected with different Newcastle disease virus isolates using paraffin embedded samples. R. Ecco*, C. Brown, L. Susta, C. Cagle, I. Cornax, M. Pantin-Jackwood, P. J. Miller, and C. L. Afonso, *Universidade Federal De Minas Gerais-Ufmg, Veterinary School.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

618 Comparison of microscopic methods for bursa histopathology evaluation. F. Wilson*, A. Banda, and I. Alvarado, *MVRDL & PRDL, Pearl, MS.*

AAAP abstract†

619 Testicular and epididymal lesions in broiler breeders. H. J. Barnes*, S. A. Montgomery, S. E. Tilley, and J. Brake, *North Carolina State University, Department of Population Health & Pathobiology, Raleigh.*

AAAP abstract†

620 An efficient method of blood collection from poultry presented for necropsy. J. L. Cline* and B. M. Parker, *Alabama Department of Agriculture And Industries, J. B. Taylor Diagnostic Laboratory, Elba, AL.*

AAAP abstract†

621 Bacteria and viruses present in light and heavy turkey poults. A. J. Calvert*[1], S. L. Noll[1], S. M. Goyal[1], Y. Chander[1], C. M. Logue[2], J. S. Sherwood[2], T. J. Johnson[1], K. V. Nagaraja[1], and A. F. Ziegler[1], *[1]University of Minnesota, St Paul, [2]North Dakota State University, Fargo.*

Light turkey syndrome was identified by Minnesota producers as flocks with low body weight (BW) at slaughter. Examination of producer records indicated weights were less than standard near the end of brooding. Poor growth may be partially attributable to intestinal damage. The objective of this study was to determine if a difference in prevalence of certain bacteria and viruses existed between poults 10–15% below (light) or above (heavy) average flock BW. Six commercial (CF) and 2 research (RF) flocks were sampled. Intestinal contents were collected at 1, 2 and 3 wks of age; contents from 5 poults were pooled; and 2 to 4 pools per weight group were collected and analyzed for the presence of several viruses and bacteria via PCR/RT-PCR and culture respectively. Average BW at 1 wk was similar to breeder potential performance. However at 3 wks, weights were 20% lower in RF, 40% lower in 5 CF and 10% lower in 1 CF. Three factor ANOVA (Proc Glimmix, SAS) was used to examine the difference for positive pools within weight group, age and flock. No differences were found between weight groups for reovirus, rotavirus, astrovirus, *Campylobacter*, *Salmonella* and *E. coli*. Reovirus was found in 2 and rotavirus in 5 flocks. Astrovirus was found in all flocks but presence decreased with age ($P < 0.004$). *E. coli*, *Salmonella* and *Campylobacter* were found in 99, 68, and 25% of pooled samples, respectively. Flock differences were observed for *Salmonella* ($P < 0.03$) and astrovirus ($P < 0.006$). Though no differences were attributed to weight group (light vs. heavy), the presence of microorganisms with the potential to cause avian diseases, such as astrovirus and rotavirus and their association with enteritis, warrants further research on their interaction with other aspects of the poult environment. Furthermore the severe growth depression in CF compared with RF justifies future investigation into the possible microbial component of this syndrome.

Key Words: astrovirus, *Salmonella*, *Campylobacter*, growth depression

622 Comparison of incidence of poultry diseases in commercial and noncommercial poultry in North Alabama. S. P. Christenberry*, F. J. Hoerr, S. B. Lockaby, J. D. Bright, and L. Waldrep, *State of Alabama Department of Agriculture and Industries.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

623 Elimination of sensitive chicks to ascite syndrome by adding salt to drinking water. S. Askari*[1] and M. A. K. Torshizi[1], *[1]Tarbiat Modares University, Tehran, Iran, [2]Tarbiat Modares University, Tehran, Iran.*

Pulmonary hypertension syndrome (ascite) is a metabolic malformation cause important economic losses to broilers industry. Main mechanism of ascite outbreak is hypertension of pulmonary blood which occurs after incompetency of heart right ventricle. Promotion of damages leads to right ventricle enlargement. High levels of salt can lead to early ascite syndrome in broiler chickens. High levels of dietary Sodium (Na) can induct pulmonary hypertension. In this study 204 d-old male chicks (Arian hybrid) were allocated to 4 treatments with 3 replicates. Salt were supplemented to drinking water as follows: 0% (control), 0.2%, 0.4% and 0.6%. Treatments applying were started at d 7 and last until mortality reached to 3%. Factors evaluated were average body weight and mortality (weekly), and feed conversion ratio (FCR) and hematocrite percent (in end of experiment). No differences were observed between groups for average body weight in any weeks. There were differences among treatments in FCR, highest and lowest FCR were found for 0.6% and control treatments. Weekly mortality showed that highest mortality outbreak for 0.6% treatment was occurred in wk 4 (7 birds). Peak of mortality for 0.2% and 0.4% treatments belongs to 6th week that were 6 and 5 birds, respectively. Highest mortality of control group was occurred in wk 7 (8 birds). No differences were found for hemaocrit percent between treatments. According to these results, it can be recognize that this study could shift mortality peak from 7th week to earlier weeks. Because of damages due to high levels of salt supplementation, FCR were increased but were not significantly. Hematocrit percent were not changed which means that salt had no negative effects on circulatory system. In previous studies harmful effects of salt on heart and blood were demonstrated, while in this study because of limited use of salt, no negative effects were observed.

Key Words: broiler, ascite, sodium

624 Packed cell volume and blood sugar level as indicators of approaching sexual maturity in Japanese quail. V. Vatsalya and K. L. Arora*, *Fort Valley State University, Fort Valley, GA.*

The Japanese quail (*Coturnix japonica*) is an ideal animal model for a variety of biomedical studies; therefore, its continuous characterization is highly desirable. The objective of this study was to explore onset of sexual maturity because it is an important parameter being used for the assessment of treatment effect in physiology, endocrinology, reproduction, toxicology and nutrition. The eggs of uniform size, shape and weight were collected from 65 d old breeding colony of Japanese quail during 3:00 to 5:00 p.m. After holding eggs at room temperature for about 3 h, the eggs were incubated at 98–99°F and 65–68% RH. After hatching, the chicks were transferred to a brooder under a continuous light for 16 d and then shifted to 14L: 10D lighting system. Starting at d 8, 6 males were randomly selected every 4 d; weighed, and blood was collected from the brachial vein in EDTA coated hematocrit tubes with a lancet. The blood was processed for packed cell volume (PCV) by centrifuging hematocrit tubes for 5 min. Blood sugar level (BGL) was determined with a glucometer (Elite XL) at the time of blood collection. Following d36, the PCV level began to rise gradually above the preceding levels of 38.2 ± 1.4% to 40.6 ± 1.9% on d40, to 45.6 ± 0.8% at d40, to 47.9 ± 3.5 on d44, and then to 51.8 ± 3.1% during d48 to 52 ($P < 0.05$). At this time period, the birds were expressing sexual activity in terms of crowing and matting behavior with females; and laying of fertile eggs by the matted females. Concurrently, with the increase of PCV, BGL decreased from the preceding levels of 252.2 ± 5.2 mg/dl to 215 ± 4.8 mg/dl on d40; to184.6 ± 8.4 mg/dl on d44 (at $P < 0.05$); and then to 182.2 ± 4.9 mg/dl during d48 to 52. In conclusion, PCV and blood sugar level could be used to assess approaching sexual maturity in addition to plumage color and growth of cloacal gland.

Key Words: Japanese quail, packed cell volume, sexual maturity, blood sugar

625 Effect of differing temperature-humidity index values on physiological blood parameters in broilers. H. A. Olanrewaju*, J. L. Purswell, S. D. Collier, and S. L. Branton, *USDA-ARS Poultry Research Unit, Mississippi State, MS.*

Two experiments were conducted to investigate the effects of different temperature-humidity index values on physiological blood parameters in broilers under environmentally controlled conditions. Combinations of temperature and humidity (THI) values are typical of that used in commercial facilities. The experiment consisted of 3 levels (Low = 15.6, Moderate = 21.1, High = 26.7°C) of temperatures and 3 levels (50, 65, 80%) of relative humidity from d 41 to d 62 of age. In each study, 450 (25 males/25 females) Ross × Ross 708 chicks were randomly distributed into 9 chambers at 1 d of age. Feed and water were provided *ad libitum*. Venous blood samples were collected on d 41 (base line) and d 62. High temperature-humidity index significantly ($P \leq 0.001$) reduced BW, partial pressure of CO_2 (pCO_2), HCO_3^-, Hct, Hb, Ca^{2+}, K^+, and Na^+ while significantly ($P \leq 0.002$) elevated pH level, Cl^-, glucose, osmolality, and anion gap concentrations. Partial pressure of O_2 (pO_2) was slightly decreased due to high temperature-humidity index. Acid-base regulation during high temperature-humidity index had not deteriorated despite lower pCO_2 that consequently increased blood pH, due to a compensatory mechanism for mild alkalosis by decrease in HCO_3^- concentration. Plasma corticosterone was not affected by high temperature-humidity index. Our results suggest that broilers experience significant physiological changes during continuous exposure to high temperature-humidity without inducing stress in broilers.

Key Words: broiler, stress, temperature, relative humidity, acid-base

626 Role of dopamine in maternal behavior of the native Thai chicken. D. Chokchaloemwong[1], O. Chaiyachet[1], N. Prakobsaeng[1], N. Sartsoongnoen[2], S. Kosonsiriluk[3], M. E. El Halawani[3], and Y. Chaiseha*[1], *[1]Suranaree University of Technology, Nakhon Ratchasima, Thailand, [2]Nakhon Ratchasima Rajabhat University, Nakhon Ratchasima, Thailand, [3]University of Minnesota, St. Paul.*

It is well established that dopaminergic (DAergic) neurotransmission is involved in the regulation of the avian reproductive cycle. Prior studies from our laboratory show that the DAergic system is a key regulator of prolactin (PRL) secretion and incubation behavior in the native Thai chicken. Circulating PRL levels significantly decline after termination of egg incubation and hatching of the chicks. And, this is associated with a decline in the number of DA neurons in both the nucleus intramedialis (nI) and nucleus mammillaris lateralis (ML). The objective of the present study was to investigate the interrelationship between

the DAergic system and maternal behavior (caring for the chicks after hatch) in the native Thai chicken. Incubating hens were used in the present study. Hens were divided into 2 groups. One group was allowed to care for their hatched chicks, and the chicks were removed from hens in the other group, immediately after hatch. Changes in the number of TH-immunoreactive (TH-ir) neurons, a marker for DAergic activity were determined in the nI and ML. The results revealed that the numbers of TH-ir neurons in the nI were greater ($P < 0.05$) in hens that cared for their chicks on d 4 (39.2 ± 3.4 vs 24.7 ± 1.1), 7 (42.9 ± 1.5 vs 22.8 ± 1.5), 10 (39.8 ± 1.8 vs 27.8 ± 2.4), and 14 (35.5 ± 1.9 vs 24.4 ± 3.2) after hatch. No significant differences ($P > 0.05$) were observed in the number of TH-ir neurons in the ML between hens that cared for chicks and those without chicks. The findings in the present study provide for the first time evidence, suggesting a role for the nI DA neurons in parental care of hatched chicks in the native Thai chicken. Supported by The Royal Golden Jubilee Ph.D. Program; #PHD/0097/2549(YC/DC).

Key Words: bird, dopamine, immunohistochemistry, native Thai chicken

627 Comparison of Actigen and bacitracin methylene disalicylate (BMD) supplementation gene expression profiles in the jejunum of 6-week old broilers. K. M. Brennan*[1], G. F. Mathis[2], R. Xiao[1], B. S. Lumpkins[2], and J. L. Pierce[1], *[1]Center for Animal Nutrigenomics & Applied Animal Nutrition, Alltech Inc., Nicholasville, KY, [2]Southern Poultry Research Inc., Athens, GA.*

Previous studies in our lab have indicated that the addition of Actigen, a yeast-derived feed supplement, to the diet positively affects gut health including increasing goblet cell size and intestinal mucin secretion in the small intestine. Based on these data, the objective of this study was to compare the effects of supplementing Actigen and bacitracin methylene disalicylate (BMD) in the diet on mRNA levels in the jejunum of 6-week old chickens. Dietary treatments included 1) corn-soy control diet; 2) Diet 1 plus Actigen; 3) Diet 1 plus BMD. Chicks (n = 7) from each dietary treatments were randomly selected and euthanized at d42. Jejunum samples were collected for RNA isolation. Gene expression analysis was done using the Affymetrix chicken genome array. After filtering the microarray data, analysis revealed that supplementation with Actigen resulted in 928 genes that were significantly changed ($P \leq 0.05$, FC $\geq$1.2; 456 downregulated, 472 upregulated). BMD supplementation resulted in 857 genes that significantly changed (408 downregulated, 449 upregulated). Surprisingly, 316 genes were commonly significantly changed by Actigen and BMD (146 downregulated, 170 upregulated). Ingenuity Pathway Analysis revealed that the Actigen and BMD commonly altered biological functions including antimicrobial response, inflammatory response, and infection mechanism, cell-to-cell signaling and interaction, and cellular development. Genes involved in nucleotide and protein metabolism were commonly affected by Actigen and BMD including: ubiquitin specific peptidase 18 (3.65 and 3.48-fold, respectively), uridine phosphorylase 1 (7.15 and 3.57-fold, respectively) and vanin 1 (−1.91 and −1.72-fold, respectively). These data indicate that Actigen and BMD have similar effects on gene expression patterns in the jejunum of broiler chicks.

Key Words: microarray, jejunum, broiler, gene expression

628 Organ development of embryos and chicks from eggs of different broiler breeder ages and egg weights. J. S. Santos[1,2], J. H. Stringhini*[1,2], E. S. Oliveira[1,2], M. M. Jardim[1,2], and R. M. A. D. Castro[1], *[1]Universidade Federal de Goias, Goiania, Goias, Brazil, [2]CNPq, Brasilia, Distrito Federal, Brazil.*

Two experiments were carried out with 1440 fertilized Cobb breeder eggs, 720 from 39 to 54 weeks of age and other 720 from 52 to 57g and 56–72g in the same breeder age. Eggs were incubated in the Poultry Experimental Unit of the Federal University of Goias, Brazil. In the incubation assay, 720 eggs from 2 breeder ages (39 and 54 weeks) and 720 eggs from 2 egg weights - 52–57g and 56–72g obtained from 45 weeks old breeders were distributed in 6 incubator machines equipped with automatic control of temperature and temperature maintained constant at 37.8°C and 60 to 65% moisture until 18 d of incubation and at 37,5Â°C and 65 to 70% moisture from 19 to hatch. Fertile eggs were selected at 19 d and just the viable eggs were maintained. The biometrical indices were determined in embryos at 19 d of incubation anda t hatch, at 4, tem and 14 d of age. The viscera weighed were intestines, pancreas and liver with gall bladder and vitellin sac. Values were expressed as absolute and relative weight. Data was analyzed and compared by Student's test. Lighter eggs indicated lighter embryos and relative eggshell weight. Intestine length was higher for embryos form lighter eggs. Heavier eggs resulted in heavier chicks. Heavier eggs resulted in higher intestine length and increased liver weights in newborn chicks. Chicks from older breeders had higher bursa relative weights. Heavier eggs produced heavier chicks, and it contributes to organ development of chicks.

Key Words: chicks, broiler breeder age, egg weights, embryos, gastrointestinal organs

629 Effect of genistein on the bone quality of laying hens. L. M. Stevenson*, S. S. Oates, J. B. Hess, and W. D. Berry, *Auburn University, Auburn, AL.*

Phytoestrogens, such as genistein, are known to be biologically active in several animals, including humans and poultry. Research has suggested that genistein may help alleviate the symptoms of osteoporosis in human females through estrogenic action. White leghorn laying hens are prone to developing "cage layer fatigue" a form of osteoporosis. It is unknown whether genistein might improve bone density in aging laying hens or actually contribute to the problem through negative interaction with the hen hormonal system. The objective of this study was to characterize and quantify the effects of the soy phytoestrogen, genistein, on bone strength in aging laying hens. Sixty, 2 year-old white leghorn laying hens that were never molted were randomly selected and divided into 4 treatments. Each treatment consisted of 15 hens. The treatments were: Sham Control (sesame seed oil carrier), Low Genistein (10 mg genistein/kg body weight), Medium Genistein (15 mg genistein/kg body weight), and High Genistein (20 mg genistein/kg body weight). All treatments were dissolved in dimethyl sulfoxide (DMSO) and mixed with sesame seed oil as a carrier. Doses were given by injection in the subcutaneous tissue in the back of the neck every other day for 8 weeks. Birds were weighed before placement and at termination. There was a significant difference ($P < 0.05$) in the final body weights of the High Genistein and Medium Genistein treatments. There were no significant differences in the change in body weights for any of the treatments. Femurs were collected and analyzed to determine differences in wet, dry, and ashed bone weight. Femurs and vertebrae were also analyzed to determine bone breaking strength. The High Genistein treatment had significantly heavier ($P < 0.05$) wet, dry, and ashed femur weights than the Sham Control and Medium Genistein treatments. The High Genistein treatment required significantly more force ($P < 0.05$) to break the femurs than the Medium

Genistein treatment. These results suggest that genistein exerts beneficial effects on the bone in a dose-related manner.

Key Words: genistein, bone, phytoestrogen, cage layer fatigue, osteoporosis

630 Mineralization of the developing embryo and post-hatched chick. N. P. Johnston* and C. L. Buckley, *Brigham Young University, Provo, UT.*

Initially the yolk and subsequently the shell are the sources of calcium for the mineralization of the embryo skeleton and following hatching the yolk sac again supplies calcium while the GI tract becomes functional. The objective of this trial was to study the degree of skeletal mineralization from each of these sources and the body centers of mineralization. 48 SCWL incubated eggs were divided into 6 groups of 8 and on d-11, d-18, and d-21 (hatching) of incubation embryos or hatched chicks and their shells were ashed for mineral and Ca content. Hatched chicks at d-3, d-7 and d-10 post-hatching were also analyzed for mineral and Ca. Embryos and chicks were also scanned for bone mineral density (BMD). There was an increase ($P < 0.05$) in embryo mineralization at d-18 (120g), and at hatching (156g) as the shell became the exclusive source of Ca. There was a concurrent decrease ($P < 0.05$) in shell-Ca at d-18 and d-21. Mineralization of the skeleton proceeded rapidly after hatching with large increases ($P < 0.05$) in skeletal mineral d-3 (240g), d-5 (305g), d-7 (374g) and d-10 (634g). Using BMD (g/cm2) readings it was noted that at d-18 the head was the most densely mineralized region of the embryo (0.052 g/cm2) but shifted to the torso at hatching and then proceeded rapidly ($P < 0.05$) in first the legs and then the wings. The hatched chick had 135mg of Ca with 8% or 11g (d-11 embryo) from the yolk and remainder (124mg) or 92% from the shell.

Key Words: embryo, mineralization, bone mineral denstiy, post-hatched chick

631 Characterization of the Chilean tinamou (*Nothoprocta perdicaria*) major egg white proteins. O. Varon*, C. H. Scaman, D. C. Bennett, and K. M. Cheng, *The University of British Columbia, Vancouver, BC, Canada.*

The aim of this study was to identify the major proteins of the Chilean tinamou (*Nothoprocta perdicaria*) egg white and to compare them to the chicken (*Gallus gallus*). As a ratite species, the tinamou egg white was expected to have a protein composition that differed qualitatively and quantitatively from that of the chicken. In particular, the tinamou egg white has a distinctive pink hue that may be due to high levels of iron-saturated ovotransferrin. Since chicken ovotransferrin and ovotransferrin peptides are reported to have antimicrobial properties, we wanted to determine whether the tinamou egg white could serve as an abundant source of ovotransferrin, as a first step toward commercial utilization of the tinamou egg. Chicken and tinamou egg whites were separated using Fast Protein Liquid Chromatography (FPLC), equipped with an anion-exchange column. The FPLC profile suggested that chicken and tinamou egg whites have a different protein composition by type and quantity. Major protein fractions were collected and aliquots were deglycosylated using peptide:N-glycosidase F (PGNase F). Fractions with and without PGNase F treatment were subjected to a second separation using SDS-PAGE. PGNase F treatment caused a molecular weight decrease of 5 and 7 KDa in the tinamou ovotransferrin and ovoalbumin bands, respectively, confirming that these proteins are N-linked glycoproteins. Additionally, the SDS-PAGE profile confirmed the FPLC results, as the ovotransferrin band was 30% higher in the tinamou compared with the chicken. Other notable characteristics for the tinamou egg white were the presence of high molecular weight proteins (120–230 kDa) and the absence of a band associated with lysozyme. The ovotransferrin associated band from SDS-PAGE was subjected to peptide mass fingerprinting using the MASCOT database. The results confirmed the identity of the ovotransferrin. The next phase of the research will compare tinamou and chicken ovotransferrin for antimicrobial activity against human pathogens. It is expected that sequence similarities between the 2 proteins will result in similar antimicrobial characteristics.

Key Words: tinamou, egg white, proteins, ovotransferrin, characterization

632 The effect of selenium supplementation on oxidative damage and mRNA levels of antioxidant genes in the testes of Single Comb White Leghorn roosters. M. L. Spry, K. M. Brennan*, K. E. Routt, A. J. Pescatore, and J. L. Pierce, *Alltech-University of Kentucky Nutrition Research Alliance, Lexington.*

Reactive oxygen species (ROS) are produced in the cell through normal metabolic processes. Uncontrolled ROS can lead to cell damage and disease states. In this study using testes of Single Comb White Leghorn roosters, mRNA levels of key genes involved in redox control were evaluated as were cellular markers that are commonly used to denote oxidative damage. The genes and markers were analyzed to determine if they were affected by inorganic (sodium selenite; SS) or organic yeast derived selenium (Sel-Plex®, Alltech Inc.; SP) supplementation. Roosters were randomly assigned at 17 weeks of age to one of 3 treatments: basal grower diet (control; C), basal grower diet + 0.3ppm SP, or basal grower diet + 0.3ppm SS. At 40 weeks, 7 birds from each treatment were selected, the testes were removed, flash frozen in liquid nitrogen and stored at −80°C until analysis. RNA was extracted from the tissues, reversed transcribed to cDNA and mRNA levels were measured using real-time PCR. Genes of interest included superoxide dismutase 1 (SOD1) and superoxide dismutase 2 (SOD2), which are both involved in binding and converting superoxide radicals, as well as thioredoxin reductase (TXRD1) which reduces thioredoxins and protects against oxidative stress and thioredoxin (TXN) which acts as an antioxidant. The mRNA levels of SOD1 and SOD2 in SP testes increased ($P \leq 0.05$) compared with C and SS. The mRNA levels of TXRD1 in SP testes tended to increase ($P \leq 0.10$) compared with C and SS. The mRNA levels of TXN in SP testes increased ($P \leq 0.05$) compared with C and SS. To measure oxidative damage, protein carbonyls (PC), a marker for protein oxidation, and 8-hydroxy-2-deoxy Guanosine (8OHdG), a marker for nucleic acid oxidation, were measured. Protein carbonyl levels did not differ among treatments. The 8OHdG levels were decreased ($P \leq 0.05$) in SP and SS testes compared with C, but SP and SS did not differ from each other. These data indicate that SP supplementation increases mRNA levels of key genes needed for maintenance of oxidative damage in the cell and decreases the amount of oxidative injury to DNA.

Key Words: selenium, gene expression, antioxidant, testes

633 Potential candidate genes for fat deposition revealed by transcriptome and proteome analysis. X. Wang*[1], F.-C. Chen[1], A. Stewart[1], G. Kelley[1], H. Zhou[2], H. H. Cheng[3], and S. Nahashon[1], *[1]Tennessee State University, Nashville, [2]Texas A&M University, Col-*

lege Station, [3]USDA ARS Avian Disease and Oncology Laboratory, East Lansing, MI.

In the historical juncture of obesity pandemic in developed countries, excessive adipose tissue has become an unwanted trait. In broiler chickens, adipose tissue may account for as much as 15% of carcass weight. To discern the genetic determinants of adipose tissue development, we analyzed the transcriptome and proteome with microarray and 2D differential gel electrophoresis (2D DIGE) followed by mass spectrometry, respectively. One hundred 20 1-d-old broiler chickens were randomly assigned to floor pens covered in pine shavings. The chicks were fed a standard broiler diet comprised of 3,200 Kcal ME/kg and 23% crude protein (CP) for 0 to 3 weeks of age (WOA), and subsequently a diet comprised of 3,275 Kcal ME/kg and 20% CP for 4 to 8 WOA. Feed and water were provided ad libitum and body weights were measured weekly. At 8 weeks of age, the birds were sacrificed and adipose tissue from the abdominal and visceral areas were collected, weighed, snap frozen in liquid nitrogen, and then stored at −80°C until use. Total RNA was extracted from abdominal fat pad of 10 chickens (5 males and 5 females) each from the highest (fat chickens) and lowest visceral (lean chickens) fat percentage. Transcript levels were measured with 44 K Agilent microarrays, then analyzed with eBayes-moderated *t*-test implemented in WebArray. Results showed that some regulatory genes including IGFBP2, FGFR3 and GREM1 were expressed higher in fat chickens ($P < 0.01$). A comparison of abdominal adipose protein levels revealed that 132 protein spots were differentially expressed between lean and fat chickens (n = 8, $P < 0.05$). Mass spectrometry analysis indicated that the differentially expressed proteins include vimentin, apolipoprotein, aspartate aminotransferase and annexin A2. It appears that genes with mRNA level differences were not the ones with protein level differences. This discrepancy highlights the complexity in the mechanism of quantitative trait regulation. Nevertheless, differentially expressed genes identified here are potential candidates regulating fat deposition in chickens.

Key Words: adiposity, transcriptome, proteome, quantitative trait, adipokine

634 Assessment of bioenergetics in intestinal tissue from neonatal broiler chicks. A. Piekarski*, K. Lassiter, K. Byrne, B. M. Hargis, and W. G. Bottje, *Dept. of Poultry Science, Center of Excellence for Poultry Science, University of Arkansas, Fayetteville.*

The primary objective of this study was to develop methods for assaying intestinal bioenergetics (aerobic respiration and glycolysis) by flux analysis of oxygen consumption rate (OCR) and extracellular acidification rate (ECAR) that reflect mitochondrial and glycolytic activities, respectively. Using sequential additions of oligomycin (inhibitor of ATP synthase, FCCP (uncoupler of oxidative phosphorylation), and Antimycin-A (electron transport chain inhibitor), oxygen consumption linked to ATP synthesis and proton leak, maximal oxygen consumption and oxygen reserve capacity of cells, as well as oxygen consumption linked to activities of oxidases and mitochondrial reactive oxygen species production can be determined. The XF24 Flux analyzer (Seahorse Biosciences, Billerica MA) used in these studies creates a 7 μL chamber in each well of a specially designed 24 well microtiter plate. In our approach, mid-jejunal tissue rings (approximately 1–2 mm wide) were obtained from neonatal broiler chicks (<48 h post hatch) using a scalpel for sectioning under a dissection microscope. The intestinal rings were placed in each well in growth media (DMEM with 10% fetal bovine serum and1% penicillin-streptavidin) and covered with a screened islet to hold the tissue in place. The intestinal rings were washed with Seahorse analyzer media and incubated for 1 h in a non-CO2 incubator while the analyzer probes were calibrated. Once probes were calibrated, the cells were placed into the machine for a runtime of up to 5 h with OCR and ECAR measurements obtained at 5 to 10 min intervals. During this time energy substrates and/or chemicals can be introduced through the ports in the Seahorse Flux Pak cartridges to assess intestinal bioenergetics. The long-term goal of these studies are to identify effects that a wide range of factors (e.g., dietary components, microbial populations) have on intestinal bioenergetics that in turn play important roles in productivity and health in commercial poultry.

Key Words: intestines, bioenergetics, broiler

635 Performance and immune response of broiler chickens fed with crude propolis. C. Eyng*, A. E. Murakami, C. R. A. Duarte, and T. C. Santos, *Universidade Estadual de Maringa, Maringa, Parana, Brazil.*

With the possibility of antimicrobial resistance from antibiotics, considered a risk to human health, research has been conducted to search new additives with the same growth promoter capacity of antibiotics. Among the studies, the propolis and its sub products are a viable alternative. Therefore, an experiment was conducted to evaluate the effects of different levels of inclusion of crude propolis on performance (weight gain, feed intake and feed conversion) and immune response in broiler chickens. The immune response was evaluated by determination of cutaneous basophil hypersensitivity (CBH) response to phytohemagglutinin (PHA) and weight ratio of bursa of Fabricius, spleen and thymus in relation to body weight. The birds were randomized in a complete design, with 5 different levels of inclusion of crude propolis (0, 100, 200, 300, 400 and 500 ppm), 5 replications and 34 birds per experimental unit. It was found that the averages of the treatments with inclusion of crude propolis did not presented a significant difference ($P > 0.05$) about performance and immune response when compared with the control group (0 ppm of crude propolis) by the Dunnett′s test. However, when the data were submitted to linear and quadratic regression analysis it was observed that the thymus weight responded to levels quadratically ($P < 0.05$) on seventh day old. Lower thymus weight was observed at 339.72 ppm of inclusion. Besides that, after 6 h of the PHA injection it was observed that the inflammatory reaction responded to levels linearly ($P < 0.05$), with a higher intensity reaction with the increased of levels. Based in these results, it is possible to conclude that the levels used were not sufficient to cause changes in performance and immune responses, compared with the group that was not supplemented. However, diets added crude propolis showed a positive influence on cutaneous basophil hypersensitivity corresponding a cellular immune response.

Key Words: cellular immune response, chicken, cutaneous basophil hypersensitivy, growth promoter

636 Effect of light wavelength on growth and sexual maturation of Smoky Joe Leghorn. G. Y. Bedecarrats*, K. Marinac, B. Scace, J. Fleming, and N. Joseph, *University of Guelph, Guelph, Ontario, Canada.*

The sale of incandescent light bulbs will be banned in Canada in 2012 and alternative sources need to be adopted by the industry. However, each type of light possesses specific spectrum that may not be optimum for reproduction efficiency. In this study, we adapted a RGB (red, green, blue) light emitting diode (LED) system for battery cages, and tested the effect of wavelength on growth and sexual maturation in blind and sighted Smoky Joe pullets. An experimental room was par-

titioned into 3 independent sections each equipped with LED lights providing either pure green (G) red (R) or white (W). For all groups, intensity was adjusted to 10 lx at hens' level. At 14 wks of age, 20 pullets were randomly allocated to each section (G: 11 blind, 9 sighted; R: 11 blind, 9 sighted; W: 12 blind, 8 sighted). During the 1st week, incandescent lighting was provided (10 lx, 8h photoperiod) for pullets to adapt to their environment. At 15 wks of age, LED lights (G, R and W) were turned on (8h photoperiod) and at 20 wks, pullets were photostimulated by an abrupt change to a 14h photoperiod. Feed and water were provided ad libitum throughout the study. Body weight progressively increased with no difference observed between light treatments or between blind and sighted birds. Similarly, no difference in tibia length was observed. Age at first egg was significantly advanced ($P < 0.001$) for pullets from the R (165.9 ± 1.3 d) and W (166.8 ± 1.7 d) groups compared with G birds (188.4 ± 2.2 d). However, no difference was observed between blind and sighted hens. Similarly, combs from R and W birds were significantly taller than for G birds. Egg production peaked first for the R group (25 wks), followed by the W group (26 wks) while it was not yet reached for the G group. At 27 wks of age, total egg production was greatest for the R group (662 eggs; 33.1 ± 1.5 eggs/hen) followed by W group (586 eggs; 30.8 ± 1.2 eggs/hen) and significantly ($P < 0.001$) lower for G group (242; 12.7 ± 1.8 eggs/hen). In conclusion, although light wavelength did not influence growth of pullets in cages, red light is required for advancing sexual maturation and this effect does not require a functional retina.

Key Words: light, wavelength, reproduction, cages, layers

637 Efficacy of the antimicrobial compound enrofloxacin for reducing the incidence of lameness in broilers grown on wire flooring. K. N. Mitchell*[1], J. Blankenship[1], I. Pevzner[2], and R. F. Wideman[1], *[1]University of Arkansas, Fayetteville, [2]Cobb-Vantress Inc., Siloam Springs, AR.*

Growing broilers on wire flooring provides an excellent experimental model for triggering lameness attributable to osteochondrosis and osteomyelitis of the proximal femur and tibia. Enrofloxacin is a broad-spectrum fluoroquinolone antimicrobial that is used to treat diseases of bacterial or mycoplasmal origin. Enrofloxacin exerts toxic effects on articular-epiphyseal cartilage when administered at excessively high levels to rapidly growing animals. In a pilot study we demonstrated that administering 150 mg enrofloxacin/kg BW/d for 5 d failed to trigger clinical lameness in broilers. Accordingly in the present study enrofloxacin was administered in the drinking water at approximately 15 mg/kg BW/d to evaluate its efficacy as a therapeutic treatment for lameness. Broiler chicks were placed at 1 d of age on 5′ x 10' flat wire floor panels within 8 environmental chambers. They were provided ad libitum corn and soybean meal-based starter and finisher diets formulated to meet NRC standards for all ingredients. Each pen contained 59 clinically healthy chicks on d 14. The birds in all pens were walked and observed for lameness every 2 d starting on d 15 and continuing through d 62. After the onset of clinical lameness on d 35, enrofloxacin was added to the drinking water (60 mg/L) in the even numbered chambers (Enrofloxacin group). Broilers in the odd numbered chambers continued to receive tap water (Control group). Birds unable or unwilling to walk were diagnosed as 'clinically lame', euthanized with CO2 gas, and necropsied to assess leg lesions. The most prevalent diagnoses for lame birds were osteochondrosis and osteomyelitis of the proximal femur and tibia. The Control group developed more than twice the incidence of clinical lameness when compared with the Enrofloxacin group on d 42 ($P = 0.005$; z-test of proportions; chambers pooled), and this difference persisted until enrofloxacin administration ceased on d 54. The results this study demonstrate that enrofloxacin is an effective therapeutic treatment for reducing the incidence of clinical lameness in broilers grown on wire flooring.

Key Words: broilers, leg quality, enrofloxacin

638 Efficacy of biomin probiotic for reducing the incidence of lameness in broilers grown on wire flooring. J. M. Stark*[1], G. Lorenzoni[2], I. Pevzner[3], J. Blankenship[1], and R. F. Wideman[1], *[1]University of Arkansas, Fayetteville, [2]Biomin GmbH, Herzogenburg, Austria, [3]Cobb-Vantress Inc., Siloam Springs, AR.*

Growing broilers on wire flooring provides an excellent experimental model for reproducibly triggering significant levels of lameness attributable to osteochondrosis and osteomyelitis of the proximal femur and tibia. In the present study we evaluated the efficacy of the Biomin PoultryStar probiotic as a prophylactic feed additive for preventing the onset of lameness. Male broiler chicks were placed at 1 d of age on 5′ × 10' flat wire floor panels within 10 environmental chambers. Throughout the experiment they were provided ad libitum a corn and soybean meal-based starter diet formulated to meet minimum NRC standards for all ingredients (Control group), or the same diet mixed with the Biomin probiotic at 500g PoultryStar/ton of feed (Probiotic group). Each pen contained 50 clinically healthy chicks on d 14. The birds in all pens were walked and observed for lameness every 2 d starting on d 15 and continuing through d 56. Birds unable or unwilling to walk were diagnosed as 'clinically lame', humanely euthanized with CO2 gas, and necropsied to assess the presence of leg lesions. The most prevalent diagnoses for lame birds were osteochondrosis and osteomyelitis of the proximal femur and tibia, with minor incidences of spondylolisthesis (4.1%) and tibial dyschondroplasia (0.5%). The difference in lameness between the groups was significant ($P = 0.001$; z-test of proportions; chambers pooled), with incidences of 32.4% in the Control group and 18.0% in the Probiotic group. Broilers that did not develop lameness by d 56 did not differ in BW when compared by group (Control: 3.35kg vs. Probiotic: 3.28kg; $P = 0.108$). The results of this study demonstrate that the Biomin probiotic reduces the incidence of lameness in broilers grown on wire flooring. Theoretically the probiotic reduces the onset of lameness by interfering with bacterial translocation into sub-clinically damaged voids or clefts in or adjacent to the proximal femoral and tibial epiphyseal plates.

Key Words: broilers, leg quality, probiotic

639 Finding background material for duckling mineral DXA scans. B. C. Browne* and N. P. Johnston, *Brigham Young University, Provo, UT.*

The GE Lunar dual scan DXA is used extensively for scanning humans but when used alternatively for animal scans it is important to find an appropriate background material to place on the scanner pad that will minimally distort the scan results of bone mineral content (BMC) and maintain a sanitary environment. It was hypothesized that that Nalgene polyethylene soaker paper (NPS paper) would best serve this purpose as compared with rice, plexiglass, styrofoam, solid poster board, and core poster board. All were compared with the ashed-duckling as a control. To test the hypothesis 16 euthanized, day-old Rouen ducklings were scanned 3 times on the GE Lunar scanner on each of the background materials to determine the duckling's BMC. Following the scans the ducklings were dried for 48-h at 1050C and then ashed in a muffle furnace at 6500C for 48-h to determine mineral or ash content of the duckling. As determined by ash, the actual mineral content of

the ducklings was 0.819 g as compared with DXA scan values of 3.146 g plexiglass, 1.331 g rice, 0.7401 g core-poster board, 0.702 g solid-poster board, 0.546 g styrofoam, and 0.481 g NPS paper. The value for rice background appeared to be distorted by reading of 1.011 g BMC independent of the bird. Contrary to our hypothesis, only the core-poster board/duckling scans were statistically similar ($P < 0.05$) to the ashed-duckling mineral weight; hence, core poster board appears to be a suitable background material for accurate duckling BMC scans.

Key Words: ducks, DXA, bone mineral content, scan

640 Effects of egg remover on bone development at hatch, and male broiler live performance and leg health at market age under commercial conditions. E. O. Oviedo-Rondon*, M. J. G. Costa, M. R. Dalmagro, C. Evans, C. Miller, and M. J. Wineland, *Department of Poultry Science, North Carolina State University, Raleigh.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

641 Effects of medicinal plants, probiotic and organic acids on *Campylobacter* excretion, immune response and serum lipids in broilers. K. Gharib Naseri[1], S. Rahimi*[1], and P. Khaki[2], [1]*Tarbiat Modares University, Tehran, Tehran, Iran,* [2]*Razi Vaccine and Serum Research Institute, Karaj, Alborz, Iran.*

The effect of medicinal plant (Sangrovit), probiotic (PrimaLac), and organic acid (Selko-pH) as feed additives, on fecal excretion of *Campylobacter* (cfu/g) on broilers were evaluated. Other measurements such as performance, immune response and serum lipids were determined. A total of 300 broilers (Cobb 500) were fed unsupplemented diet (negative and positive controls), feed containing probiotic (1g/kg) or medicinal plant (5g/kg) and/or drinking water containing organic acid (1mL/L). All birds except negative control were orally challenged with (10^9 cfu/mL) *C. jejuni* at d 21. Fecal samples were collected at d 35 and 42 for *Campylobacter* count. BW, FI and FCR were determined weekly. The immune response to SRBCs was determined twice during the experiment. Serum lipids were estimated on d 49. Fecal samples in negative control and organic acid groups had the lowest count of *Campylobacter* ($P < 0.05$). Moreover, probiotic and Sangrovit groups showed a significant reduction of this bacteria compared with control positive group ($P < 0.05$). FI of organic acid group was significantly lower than control negative ($P < 0.05$). Other groups did not have significant differences with these 2 treatments. Highest and lowest weight gain was achieved in control negative and positive groups, respectively ($P < 0.05$). Lowest and highest FCR observed in control negative and control positive groups, respectively ($P < 0.05$). On d 49 probiotic, Sangrovit and negative control group had a significant higher immune response compared with control positive and organic acid groups ($P < 0.05$). The Chol, TG, HDL and LDL levels were not affected by treatments ($P > 0.05$). This study indicates that the use of probiotic and Sangrovit could be potential treatment for decreasing *Campylobacter* excretion and improve broilers performance.

Key Words: *C. jejuni*, probiotic, organic acids, Sangrovit

642 The effect of probiotic, prebiotic and organic acids on *Campylobacter jejuni* count in cecum and intestinal morphology of broilers. K. Gharib Naseri[1], S. Rahimi*[1], and A. Rahimi[2], [1]*Tarbiat Modares University, Tehran, Tehran, Iran,* [2]*Islamic Azad University, Tehran, Tehran, Iran.*

The effect of probiotic (PrimaLac), prebiotic (Fermacto) organic acid (Selko-pH) as broiler feed additives, on cecal colonization of *C. jejuni* (cfu per gram) of broilers were studied. Other measurements such as performance and intestinal morphology were examined. A total of 300 broiler chicks (Cobb 500) were fed unsupplemented diet (negative and positive controls), probiotic (1g/kg), prebiotic (1g/kg) and/or drinking water containing organic acid (1cc/L). All chickens except negative control were orally challenged with (10^9 cfu/mL) *C. jejuni* at d 21. Cecal samples (d 28 and 49) were collected for *Campylobacter* count. Body weight (BW), feed intake (FI) and feed conversion ratio (FCR) were determined weekly through the experiment. Intestinal samples for morphology examination were taken at d 49. On d 49 in all supplemented treatments reduction of *C. jejuni* colonization in cecal was observed. Probiotic and organic acid groups had shown a significant reduction in this bacteria compared with control positive group ($P < 0.05$). No significant difference was observed between feed intake in probiotic and prebiotic groups. Feed intake of organic acid group was significantly lower than control negative group ($P < 0.05$). Weight gain and FCR of control negative group was significantly higher than control positive group ($P < 0.05$). Intestinal morphology showed an improvement ($P < 0.05$) on duodenum and jejunum villi height and villi height/ crypt depth ratio in probiotic and control negative treatment. It is concluded that using probiotic and prebiotic as feed additives could be potential alternative and improve broilers performance. These feed additives along with acidified water could reduce *Campylobacter* infection in poultry.

Key Words: *Campylobacter jejuni*, probiotic, organic acids, prebiotic

643 Effects of electron-beam irradiation on diet characteristics, intestinal microbial population and morphology, ileal digestibility and performance of broilers. S. Yakhkeshi[1], S. Rahimi*[1], and P. Shawrang[2], [1]*Tarbiat Modares University, Tehran, Tehran, Iran,* [2]*Agricultural, Medical and Industrial Research School, Nuclear Science and Technology Research Institute, Atomic Energy Organization, Karaj, Alborz, Iran.*

This study was conducted to investigate the effects of electron-beam irradiation on chemical composition and microbial load of diets, broilers intestinal morphology and microflora population, ileal digestibility and performance. A total of 300 d-old male broilers (Cobb 500) were randomly divided into 4 treatments, 5 replicates with 15 birds in each. Treatments were: control, 3, 5, and 7 kGy doses electron-beam irradiation. Doses of 5 and 7 kGy completely eliminated microbial load in diets ($P < 0.05$). The best BWG and FCR at (d 28–42 and 1–42) were observed in chicks fed diet irradiated at doses of 5 and 7 kGy ($P < 0.05$). The lowest and highest coliforms counts in ileum at d 21 were achieved in chicks fed diet irradiated at dose of 7 kGy and control groups, respectively ($P < 0.05$). Moreover, the highest lactic acid bacteria in ileum and cecum were observed in chicks fed diet irradiated at dose 7 kGy ($P < 0.05$). Additionally the lowest coliforms bacteria counts and total aerobic bacteria in ileum and cecum were attained by 7 kGy dose at d 42 ($P < 0.05$). The highest villous height (VH) in duodenum and jejunum were attaind by 7 kGy dose at d 42 ($P < 0.05$). Also greatest villi height: crypt depth (CD) ratio in jejunum were obtained by 5 and 7 kGy doses at d 21 and 42 ($P < 0.05$). Treatment 7 kGy dose caused a significant increase in VH:CD ratio in jejunum at d 42 ($P < 0.05$). The greatest DM, OM, EE, GE, AME and AMEn digestibility were attained by 7 kGy dose ($P < 0.05$) and no significant differences were observed in CP digestibility ($P > 0.05$). The results of current study showed that electron-beam irradiation of diets reduced microbial load without any changes in chemical composition. Weight gain, FCR and digestibility of nutrients were improved by irradiation.

Key Words: broiler, digestibility, electron-beam irradiation, microflora

644 Microbial identification and analysis of antimicrobial resistance in samples of avian cellulitis from slaughterhouses located in the Federal District, Brazil. M. M. Santos*, A. C. M. Alcântara, A. P. Santana, and P. H. C. Silva, *University of Brasília, Federal District, Brazil.*

The avian cellulitis is an inflammatory process in subcutaneous tissue observed on abdomen and thighs. This problem is commonly detected in these animals in the moment of the slaughter and is considered one of the major causes of condemnation of carcasses in Brazil. The aim of

this work was to identify the agents presents in avian cellulitis lesions, perform the antibiogram and detect the genes of resistance to tetracycline (tetA, tetB, tetC). We collected 20 samples of avian cellulitis lesions from slaughterhouses located in the Federal District area, Brazil. We carried out the microbial isolation according to Koneman et al. (2001; Diagnóstico Microbiológico).The antimicrobial testing were realized by method of discodifusion for 16 antimicrobial drugs (ampicillin, cefazolin, gentamicin, Spiramycin, Doxycycline, Cephalexin, sulfonamide, cephalothin, penicillin, enrofloxacin, tetracycline, neomycin, norfloxacin, erythromycin, amoxicillin and chloramphenicol) and the detection of resistance genes was performed by PCR according to Van et al. (2008; Int. J. Food Microbiol., 124:217–223). We detected 21 strains (72.41%) of *Escherichia coli* in all collected samples. It is important to note that in some samples more than one bacterial colony was found. All 21 *E. coli* strains analyzed (100%) were resistant to penicillin and spiramycin. 90.91% to sulfonamide, 81.82% to erythromycin, 68.18% to amoxicillin, 59.09% to ampicillin and cephalexin, 54.55% to cefhalothin. Only one colony (4.55%) was resistant to tetracycline and none were resistant to chloramphenicol. The gene Tet A was detected in the only one sample resistant to tetracycline. Our results showed that *E. coli* was the main agent detected in avian cellulitis lesions and suggest a possible problem of public health due the high resistance observed.

Key Words: resistance, *Escherichia coli*, avian cellulitis

645 Effect of simultaneous use of high pressure processing and transglutaminase enzyme on spent hen protein isolate (SPI). D. A. Omana* and M. Betti, *University of Alberta, Edmonton, Alberta, Canada.*

Every year millions of egg production hens become spent at the end of their laying cycle. Meat from spent hens is generally tough, less tender and poor in functional properties, because of its increased collagen content and cross linkages. Due to these problems associated with spent hen meat, it has become inevitable to find new ways for its utilization. Isolating proteins from spent hen meat is one of the approaches and improving the properties of isolated protein will help in utilizing this meat for preparation of gel type of products. In this study, protein isolation was carried out using pH shift technology. The isolated proteins were subjected to high pressure processing (400/600 MPa) at a temperature of 40°C with/without transglutaminase (TGase) enzyme (0.3%). Samples without TGase enzyme served as control. Color and textural properties of high pressure processed SPI were studied. Increase in pressure level caused significant ($P < 0.05$) increase in L* value, however addition of TGase enzyme did not affect lightness values. a* and b* values were unaffected by high pressure application or TGase addition. Improvement in water holding capacity of the sample was evident with enzyme treated sample as revealed by significant ($P < 0.05$) decrease in expressible moisture content. Textural profile analysis showed significant ($P < 0.05$) increase in hardness, chewiness, cohesiveness and resilience values for TGase treated samples; however increase in pressure did not affect these parameters. This study demonstrates that simultaneous use of transglutaminase enzyme and high pressure processing is of much importance in improving the functionality of SPI, especially in improving water holding capacity and gel texture.

Key Words: spent hen protein isolate, high pressure processing, transglutaminase enzyme, water holding capacity, texture

646 Application of high pressure processing to improve the functional properties of pale, soft, and exudative (PSE)-like turkey meat. J. T. Y. Chan, D. A. Omana*, and M. Betti, *University of Alberta, Edmonton, Alberta, Canada.*

Turkey with pale, soft, exudative (PSE)-like condition is a major concern in the poultry industry as it affects meat quality attributes involved in the production of further processed products. PSE-like meat has pale color and reduced functionality. The objective of this study was to determine the functional and rheological properties of proteins in turkey breast meat with low and normal ultimate pH at 24 h postmortem (pH_{24}) that have been subjected to high pressure processing (HPP) and determine the optimal conditions to improve the functionality of PSE-like meat. Turkey breasts from Hybrid Toms were collected from a processing plant at 24 h postmortem. A total number of 35 breasts (26 pale and 9 normal) were selected based on lightness (L*) values. Further selection of 8 breasts from each class was made based on pH_{24}. Samples were within values: pale ($L^* > 52$, $pH \leq 5.7$) and normal ($46 < L^* < 52$, $pH \geq 6.0$) and referred to as low and normal pH meat, respectively. Preparation of batters for HPP was made by comminuting turkey meat (89.5%) with water (10%) and NaCl (0.5%). Batters were subjected to 0, 50, 100, 150 AND 200 MPa pressure at 4°C for 5 min. Data obtained were analyzed using ANOVA and means were separated using Tukey′s HSD. The functional properties of low and normal pH meat control (unpressurized) samples were not different, except lower water holding capacity (WHC) in low pH meat. Pressures at 50 and 100 MPa caused increase in WHC of low pH meat, which may be due to significantly higher protein surface hydrophobicity ($P < 0.05$) and reactive sulfhydryl groups ($P < 0.0001$). The formation of a better gel network was evident at 50 and 100 MPa as revealed by rheology. HPP application caused increase ($P < 0.05$) in total protein solubility. Improvements in functionality of PSE-like turkey meat were achieved by HPP while allowing reduced amounts of salt addition and elimination of phosphates.

Key Words: PSE, turkey, ultimate pH, high pressure processing, functional and rheological properties

647 Effect of testosterone injection on occurrence of lipid and protein oxidation in frozen stored broilers meat. S. Askari*, M. A. K. Torshizi, and F. B. Kasmani, *Tarbiat Modares University, Tehran, Iran,*

Oxidation is a natural phenomenon coordinated with the cell metabolism. Sensitive polyunsaturated fatty acids (PUFA) or peroxidants, or a low intake of nutrients are involved in the antioxidant defense system. Generally it is accepted that oxidation of vitamins, carbohydrates, lipids, and proteins are one of the mechanisms that damage food stuffs quality, especially meat. Role of administered testosterone on antioxidants balance of cockerels is main object of present study. Total of 60 1-d-old male broiler chicks were randomly allotted into 2 treatments with 3 replicates including: control (received no testosterone) and testosterone treated (injected intramuscularly with 25 mg of testosterone enanthate at 14 d of age) groups. At end of experiment on d 42, 10 randomly selected birds from each experimental group were sacrificed. Breast and thigh skin-less meat of each carcass were further apportioned into 2 sub-samples. The first set of samples analyzed for MDA and carbonyl occurrence freshly. The second set of meat samples were freeze stored for 30 d at −18°C, before measurement of MDA and carbonyl contents. In fresh thigh samples of testosterone treated birds the MDA content was significantly higher in comparison to control ($P < 0.05$), while the MDA content of breast and carbonyl concen-

tration of both thigh and breast were not influenced by testosterone injection. The testosterone injected birds produced thigh and breast meats which were more susceptible to oxidation in lipid and protein moiety in frozen samples during 30 d storage, else in protein oxidation which did not influenced by testosterone administration. It could be concluded that injection of testosterone hormone will increase the susceptibility of broiler's meat to lipid and protein oxidation.

Key Words: testosterone, meat storage, lipid oxidation, protein oxidation

648 Effect of extruded full fat soybean (EFFSB) on performance and blood constituents of broiler chickens. S. A. Mirghelenj*, A. Golian, and H. Kermanshahi, *Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi, Iran,*

An experiment was conducted to assess the effects of different levels of extruded full fat soybean (EFFSB) on blood constituents, digestive organ weights, ileal digesta viscosity and performance of broiler chickens. Full-fat soybeans (FFSB), were extruded at high temperature-short time (155°C, 15 s) with high pressure and shear forces at a feed plant and used at the levels of 0, 75, 150 and 225 g/kg in isocaloric and isonitrogenous starter, grower and finisher diets. One hundred and 90 2 d-old Ross 308 male broiler chicks were allocated to 4 dietary treatments with 4 replicates of 12 birds each. Performance criteria were recorded weekly. Blood samples of one bird from each replicate were taken via wing vein and percentage of oxygen saturation (SO2%) measured with gasometric system on d 18. One bird from each replicate was slaughtered, digestive organs weighed and ileal digesta was collected to determine the viscosity on d 21. All data was analyzed using GLM procedure of SAS (9.1). The blood gasometry results showed that percentage of oxygen saturation in blood (SO2%) of control birds was significantly ($P < 0.05$) higher than those fed diet contained high level of EFFSB (69.83% vs. 64.43), showing that high level of EFFSB in diet, can affect blood oxygen saturation in chicks. With increasing the level of EFFSB in diet up to 225 g/kg, total body weight gain (BWG) reduced significantly ($P < 0.05$) but feed conversion ratio (FCR) and production number (PN) were similar in birds fed different diets. The pancreas to live bird weight increased significantly ($P < 0.05$) in birds fed diet contained high level of EFFSB as compared with control ones (0.420 vs. 0.502%), but gizzard, proventriculus, small intestine, ceca, liver and abdominal fat to live bird weight were similar in all birds ($P > 0.05$). High levels of EFFSB in diet, did not affect ileal digesta viscosity in chicks ($P > 0.05$). It is concluded that addition of EFFSB up to 225 g/kg diet did not have negative effects on broiler performance and ileal digeta viscosity but influenced blood SO2% and pancreas weight.

Key Words: extruded full fat soybean, ileal digesta viscosity, broiler performance

649 Effect of full fat soybean extruded at different temperatures on performance and blood constituents of broiler chickens. A. Golian*, S. A. Mirghelenj, H. Kermanshahi, and S. Zhaleh, *Ferdowsi University of Mashhad, Mashhad, Khorasan, Iran,*

A study was conducted to evaluate the effect of full fat soybean (FFSB) extruded at different temperatures on blood constituents, digestive organ weights, ileal digesta viscosity and performance of broiler chickens. Full fat soybeans were extruded (EFFSB) at 145°C, 155°C and 165°C for 15 s with high pressure and shear forces at a feed plant and used at the level of 150 g/kg in isocaloric and isonitrogenous starter, grower and finisher diets. One corn-soy diet was used as a control treatment with similar protein and energy. One hundred and 90 2 d-old Ross 308 male, broiler chickens were allocated to 4 dietary treatments with 4 replicates of 12 birds each. Performance criteria were recorded weekly. Blood sample of one bird from each replicate was taken via wing vein and percentage of oxygen saturation (SO2%) measured with gasometric system on d 18. One bird from each replicate was slaughtered, digesta collected from ileum and digestive organs weighed on d 21. All data was analyzed using GLM procedure of SAS (9.1). The blood gasometry results showed that percentage of oxygen saturation (SO2%) and oxygen pressure (PO2, mmHg) in blood were similar in all chicks ($P > 0.05$) showing that extrusion temperatures did not affect oxygen saturation of chicks blood. There were not significant differences ($P > 0.05$) in body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR) and production number (PN) of birds fed FFSB extruded at different temperatures. All digestive organs such as gizzard, proventriculus, small intestine, ceca, liver, pancreas and abdominal fat to live bird weight ($P > 0.05$) and ileal digesta viscosity were similar in all birds ($P > 0.05$). It is concluded that extrusion of FFSB (150 g/kg diet) at 145°C, 155°C and 165°C did not affect performance, blood constituents, digestive organ weights and ileal digesta viscosity of broiler chicks compared with birds fed corn-soybean meal diet.

Key Words: extrusion temperature, full fat soybean, broiler performance

650 Improving the functionality of mechanically separated turkey meat protein isolates by enzymatic cross-linking using transglutaminase. Y. Hrynets*, D. A. Omana, and M. Betti, *University of Alberta, Edmonton, Alberta, Canada.*

Mechanically separated turkey meat (MSTM) protein isolate is a high-protein ingredient obtained by pH-shifting extraction of MSTM. However, during the extraction process proteins undergo partial denaturation which in turn affects their functionality. A possible solution to increase the functional properties of isolated muscle protein (IMP) is by using enzymatic treatments. In this regard, transglutaminase (TGase), an enzyme which catalyzes protein cross-linking via acyl-transfer reactions, may be used with the potential ability to improve the quality of products prepared from IMP. An experiment was conducted to determine the combined effect of TGase and salt (NaCl) on improving the water-holding capacity, texture and color of MSTM protein isolates. The effect of 3 levels of TGase (0.1; 0.3 and 0.5%), combined with 2 levels of salt (1.0 and 2.5%) at 2 incubation times (60 and 90 min) was examined. The entire experiment was replicated at least 4 times. Data were analyzed as 3 × 2 x 2 factorial ANOVA. Means were separated by using HSD Tukey′s adjustment. The study revealed that the combination of 0.5% of TGase with 2.5% of salt resulted in the lowest ($P < 0.0001$) level of cooking loss (4.79%). Higher salt level in combination with higher amount of TGase and longer incubation time resulted in a significant ($P < 0.0001$) increase of water-holding capacity and improvement of textural characteristics, including hardness and springiness. Significant ($P = 0.0371$) increase in lightness (L*) was also obtained from the samples prepared with higher level of TGase, salt and longer incubation time. The results of the study indicated that functionality of MSTM protein isolates might be greatly improved with the addition of salt and TGase enzyme.

Key Words: mechanically separated turkey meat (MSTM) protein isolate, transglutaminase (TGase), texture, cooking loss, water-holding capacity

651 Antibacterial activity of plant extracts on major foodborne bacterial pathogens. N. Murali*, G. S. Kumar, and M. F. Slavik, *Poultry Science Department, University of Arkansas, Fayetteville.*

Bacterial foodborne diseases are caused by consumption of foods contaminated with the bacteria and/or their toxins. In this study, we evaluated the antibacterial properties of different plant extracts including turmeric, lemon and different kinds of teas against 4 major bacterial foodborne agents including *Campylobacter jejuni*, *Escherichia coli* O157:H7, *Salmonella enteritidis* and *Staphylococcus aureus*. The extracts were prepared in phosphate buffered saline and were added to the bacterial cultures and incubated. Viable cell counts were made at regular intervals and the viability percentages were calculated. Out of the 12 extracts, the lemon extract was found to be most antibacterial and killed all the bacteria within 12 h of incubation. Among the bacterial pathogens, *E. coli* O157:H7 was most susceptible to the lemon extract and *C. jejuni* was the least susceptible. Turmeric was found to kill all the bacteria within 36 h of incubation and had maximum activity against *S. aureus*. Ten different teas were evaluated and green and white tea extracts were found to be the most effective antibacterial compounds and killed all the bacteria within 36hours of incubation. Other tea varieties including Rose of Suzhou, Sweet Fruit Garden and Silver Needle had various degrees of bactericidal effects. These results demonstrate the potential for using plant extracts, especially lemon extracts, as successful antibacterial agents. These extracts could be used as food additives to certain foods to reduce or eliminate foodborne pathogens.

Key Words: foodborne bacteria, tea, turmeric, lemon, plant extract

652 pH shifting processing of spent hens mince: Protein extraction optimization. H. Wang*, J. Wu, and M. Betti, *University of Alberta, Edmonton, Alberta, Canada.*

Spent hens are referred to the hens that are at the end of their productive lives. Approximately over 144 million spent hens must be removed annually for the production and it becomes the major waste for the egg industry in US. The poultry industries face the challenge of finding an effective and economic method to deposit this protein-rich low value material. One of the alternative methods is the extraction of functional proteins from these raw materials using pH-shift technology. The experiment was conducted to study the extracting conditions of pH-shifting method to optimize the protein recovery from spent hens mince. Spent hen carcasses were manually deboned, homogenized and treated with 4 levels of pH for extraction (2.0, 2.5, 11.5, and 12.0). After homogenization, myofibrillar proteins were separated from the fat and other impurities using a refrigerated centrifuge at 3 levels of centrifugation speed (7520xg, 15300xg and 25900xg) and then precipitated at the isoelectric points (pH 5.2). The entire experiment was replicated 3 times resulting in 36 extractions (4 × 3 x3). The total protein content in the extraction was determined by the LECO TruSpec (N and C) analyzer. The data was analyzed using HSD Tukey ′s adjustment. The highest protein yield (72–75%) was obtained with pH 2.5 at 15300xg and 25900xg centrifugation speed and the lowest at pH 11.5 (60–62%) at all 3 centrifugation speeds ($P < 0.05$). The higher protein yield ($P < 0.05$) obtained in the acidic conditions compare with the alkaline extractions could be explained by the more exposure of hydrophobic amino acid on the protein surface as indicated by the proteins solubility profile obtained in this study. As a consequence, this would promote protein aggregation during precipitation at the isoelectric point. The protein content was average about 90% (dry based). No statistical differences ($P \geq 0.05$) were observed for protein content among the 4 treatments.

Key Words: pH-shifting, spent hens, myofibrillar proteins, hydrophobic groups, optimizing extracted conditions

653 Consumer preference for omega-3 fatty acid enriched chicken frankfurters. S. Srinivasan[1], B. Rathgeber*[2], K. Thompson[2], and N. Pitts[1], *[1]Nova Scotia Agricultural College, Truro, Nova Scotia, Canada, [2]Agriculture and Agri-Food Canada, Kentville, Nova Scotia, Canada.*

The preparation of omega-3 enriched meat products is an emerging practice to meet consumer demands. The partial replacement of animal fats with omega-3 oils would produce healthier meat products provided flavor and textural properties were unchanged. The present study evaluated the effect of microencapsulated fish oil (MFO) and flaxseed oil (FSO) on consumer acceptability of chicken frankfurters. Frankfurters were prepared using skin-on chicken thigh meat, mechanically separated chicken meat, and chicken fat as the main ingredients. Six test treatments were prepared by partially replacing chicken fat with FSO or MFO at 1.2%, 2.4% and 3.6% of the batter. The control treatment contained chicken fat and no oil. Prepared frankfurters were cooked to an internal temperature of 74°C, vacuum packaged and stored overnight at 4°C. During sensory testing, 18 trained panelists were offered warm 2.5 cm long pieces of frankfurter in a balanced and randomized order. A commercial chicken frankfurter was included in the test. Panelists were asked to record their perception of fishy flavor, hardness and juiciness on a 15 cm long line. Potable water and salt less crackers was provided as palate cleansing agents. The test was performed in duplicate over 2 d by the same panelists. Commercial and MFO frankfurters were found to be significantly ($P < 0.05$) harder and less juicy than other treatments. For MFO frankfurters, hardness increased and juiciness decreased as the level of fish oil in the formulation increased. Panelists did not detect a fishy flavor in MFO frankfurters compared with treatments with no fish oil added. Overall, taste panelists rated the commercial and high MFO frankfurters as less acceptable than the chicken fat control but not different from the other treatments. Results of this study indicate that the inclusion of omega-3 fatty acids from MSO or FSO in chicken frankfurters does influence sensory perception. Production of omega-3 enriched frankfurters may be an excellent means to deliver healthy long-chain fatty acids to individuals who prefer not to consume marine-based foods.

Key Words: chicken frankfurter, fatty acid, fish oil, flax oil, consumer

654 Black bone discoloration in bone-in broiler chicken thighs. S. Singla, D. R. Korver*, and M. Betti, *University of Alberta, Edmonton, Alberta, Canada.*

Black bone discoloration is associated with broiler chicken bone-in thighs and drums which may result in consumer rejection and financial loss to the industry. Hemoglobin leaks from inside the marrow cavity onto the bone surface and adjoining areas. The dark discoloration is caused by hemoglobin oxidation and breakdown after freezing or cooking. Myoglobin, a major muscle protein is oxidized to metmyoglobin after exposure to air resulting in also muscle discoloration especially after freezing or cooking. Oxidation state of iron in hemoglobin and myoglobin defines meat color. Research related to black bone discoloration in broilers is limited and hence our objective was to study the effect of freezing and cooking on discoloration. Bone-in thighs (n = 40) were obtained from 20 whole-carcass broiler chickens bought from a supermarket. Effects of cooking (180C oven temperature, 80C core meat temperature), freezing (−20C for 4 weeks) and their interactions

were studied. Color, heme iron, non-heme iron, myoglobin and total pigment were estimated in fresh raw, fresh cooked, frozen raw and frozen cooked thighs. Data were analyzed using 2-way ANOVA using the mixed procedure of SAS. Cooking*freezing interactions were significant only for heme ($P < 0.01$) and non-heme iron ($P < 0.01$) among all the above parameters. In general, heme iron increased ($P < 0.01$) after freezing possibly due to pigment release from bone. Non-heme iron increased after freezing ($P < 0.01$) and cooking ($P < 0.01$) due to heme to non-heme conversion after protein denaturation. Total pigment ($P < 0.01$) and myoglobin ($P < 0.01$) decreased after cooking due to pigment breakdown and coagulation while freezing had no effect ($P > 0.05$). Meat was lighter in color as lightness (L*) increased ($P < 0.01$) and redness (a*) decreased ($P < 0.01$) after cooking while freezing had no effect ($P > 0.05$). The study revealed that even though there was release of pigments, the current conditions used for cooking and freezing did not lead to discoloration to a detectable level and hence had no influence in black bone discoloration.

Key Words: hemoglobin, myoglobin, broilers, freezing, cooking

655 Relationship between ground flaxseed-based omega-3 PUFA enrichment of broiler breast meat and meat quality attributes. S. Nain*, R. A. Renema, B. L. Schneider, M. Betti, and and M. J. Zuidhof, *University of Alberta, Edmonton, AB, Canada.*

Inclusion of flaxseed in the poultry ration is an effective method of enriching broiler meat with omega-3 polyunsaturated fatty acid (ω-3 PUFA). An experiment was designed to correlate the effect of the duration of feeding ground flaxseed-based ω-3 PUFA enrichment with breast meat quality and fatty acid profile. A total of 400, 1-d-old, Ross x Ross 308 mixed-sex broilers were divided among 16 pens and fed an enriched diet containing 10% ground flaxseed for 8 time durations (0, 4, 8, 12, 16, 20, 24, or 35 d) before processing at 35 d. During processing, sex was verified, and in the 64 birds allocated to this study, breast meat quality traits, including pH, texture, color, driploss and cooking loss were assessed. Each breast was shrink-wrapped and stored at −20 C pending fatty acid composition analysis. The data were analyzed with SAS ($P < 0.05$). Breast meat fatty acids were not affected by sex of broilers. Total ω-3 PUFA after 35 d on enriched feed was 353 mg/100g, which was up to 3 times the level found in Control birds ($P < 0.0001$). Long chain ω-3 PUFA (LC ω-3 PUFA) also increased, with docosapentaenoic acid most predominant (45% of LC ω-3 PUFA). The ω-6:ω-3 PUFA ratio in the breast at 35 d decreased in birds on the enriched (1.6) compared with the non-enriched diet (8.5). Broken stick analysis indicated 18 d of feeding 10% flaxseed is required to enrich ω-3 PUFA to the target enrichment labeling level of 300 mg/100 g of meat. However, 1 in 4 birds were unable to reach this target even with 35 d on enriched diets. Bird-to-bird variability in ω-3 PUFA enrichment (measured by CV analysis) was reduced by 50% in the enriched period (20 to 35 d) compared with non-enriched period (0 to 16 d). The LNA and total ω-3 PUFA content in breast were associated with negative meat quality traits such as decreased ultimate pH ($r = −0.38$; $P = 0.001$) and increased lightness ($r = 0.40$; $P = 0.001$) and driploss ($r = 0.35$; $P = 0.006$) and, in the female, increased cooking loss ($r = 0.53$; $P = 0.001$). Strategies to enrich ω-3 PUFA in broiler breast meat should include study of impact of enrichment source on meat quality.

Key Words: broiler, omega-3 PUFA, breast meat, meat quality

656 Models to predict specialty egg purchasers' behavior. M. Bejaei*, K. Wiseman, and K. M. Cheng, *University of British Columbia, Vancouver, BC, Canada.*

Market share of specialty eggs (e.g., free-range, free-run and organic eggs) has increased more than 2 fold since 2002 in Canada (10.3% in 2002). Their market share is higher in British Columbia (BC) than across Canada. The objective of our research was to develop models to predict purchasers' behavior with regards to white regular, brown regular, free-range, free-run, organic and nutrient enhanced eggs. Moreover, we used the models to investigate the market potentials for regular eggs (brown and white) and cage-free eggs (free-run, free-range and organic) in separate categories. An online survey was the primary research tool used to gather data for developing and testing the models. Potential subjects were randomly selected from email addresses of adult BC residents. A total of 702 completed questionnaires were submitted online (68% response rate). Potential purchase model for each type of egg was investigated using logistic regression analysis. The outcome variable for each model was a dichotomous variable of whether consumers bought a type of egg. Predictor variables were selected (considering multicollinearity) from questions answered by survey respondents. Models resulted from our research can account for 42 to 59% of the variance in the purchase of white regular eggs, 33 to 45% of the variance in the purchase of free-range eggs and 45 to 60% of variance in the purchase of cage-free eggs (Cox & Snell, and Nagelkerke R Squares, respectively). Regular egg purchasers were more concerned about price than care and feeding of hens, used flyers to make purchase decision, preferred white shell color, had lower educational level, and bought their eggs from major chain grocery stores or local grocery stores. Cage-free egg purchasers were more concerned about care and feeding of hens than price, did not use store flyers to make the purchase decision, preferred brown shell color, were younger, and bought their eggs directly from farm, organic/local grocery stores, or major chain grocery stores. These models could be used to investigate the influence of a change in each predictor variable on the probability of purchase of a special type of egg.

Key Words: specialty eggs, logistic regression, consumer characteristics, purchase models

657 Enzymatic susceptibility of phosvitin for improved hydrolysis. H. Samaraweera*, E. J. Lee, and D. U. Ahn, *Iowa State University, Ames.*

Egg yolk phosvitin is the most phosphorylated protein found in the nature. Due to phosphorylated serine moieties it shows high metal chelating, antioxidant and emulsifying properties. Phosvitin is considered as a nutritionally negative protein because it forms insoluble complexes in the presence of bivalent cations and is resistant to enzymatic digestion. If fragmented, however, the peptides containing phosphates (phosphopeptides) can greatly enhance the mineral bioavailability, and thus can be exploited as mineral carrying bioactive phosphopeptides. The aim of this study was to find out an effective protease enzyme/enzyme combinations for phosvitin and to increase the protease susceptibility of phosvitin. Phosvitin was digested with trypsin, pepsin, α-chymotrypsin, enzyme protein Multifect P3000, alkalase (Bacterial alkaline protease: Protex 6L) and thermolysin (from *Bacillus thermoproteolyticus Rokko*) and the combinations of trypsin and pepsin, enzyme protein Multifect P3000 and α-chymotrypsin and alkalase and α-chymotrypsin. Enzymatic hydrolysates were subjected to SDS-PAGE and HPLC analysis. Also, phosvitin was treated with 0.5% and 1% SDS with/without temperature treatment of 100°C for 15 min. Then samples were subjected to circular dichroism to evaluate the secondary structural changes of the protein. Thermolysin hydrolysates of the treated phosvitin were evaluated by SDS-PAGE. Among the 6 enzymes tested, enzyme protein Multifect P3000 and alkalase

showed higher protease activity on phosvitin than other 4 enzymes tested. Thermolysin activity was better than the rest of 3 enzymes. Use of enzyme combinations did not show any further digestion of the resulted phosphopeptides from the first enzymes used. SDS with and without temperature treatments caused significant changes of sheet and coil structures of phosvitin. However, none of these treatments improved the enzymatic susceptibility of phosvitin. Even though SDS with and without temperature treatments resulted some structural differences in phosvitin, SDS did not improve the enzymatic digestion of phosvitin.

Key Words: phosvitin, phosphorylated protein, enzymatic digestion, circular dichroism, phosphopeptides

658 Effects of dietary content of corn distillers dried grains with solubles (DDGS) on the egg production and internal quality of eggs. H. Sun, E. J. Lee*, M. Persia, and D. U. Ahn, *Department of Animal Science, Iowa State University, Ames*

The effects of DDGS as a feed ingredient on egg production, egg internal quality, and egg composition, and analyze optimal levels of DDGS for laying hens were determined. Four levels of corn DDGS (0, 17%, 35%, and 50%) was used in a corn and soybean meal-based diet. A total of 256 60-week-old single-comb White Leghorn laying hens were randomly selected, 2 birds were placed in a cage, and 3 consecutive cages were assigned as a pen. Each pen was randomly assigned to one of the 4 diets and fed for 24 weeks. Two values of amino acid digestibility were used to form 2 diet formulas of which all meet or exceed the National Research Council nutrient recommendations for laying hens. Each diet formula was fed for 12 weeks. Egg production and feed consumption were recorded, and egg component, egg quality and its changes during storage and shell strength were measured. With formula 1, egg production, egg weight, egg mass, feed intake, and feed efficiency were the best with 0% DDGS treatment and the worst with 50% DDGS treatment with no differences between 17 and 35% DDGS treatments. With formula 2, the differences among the 4 DDGS treatments were smaller than those with formula 1. No differences in egg production, egg weight, and feed intake among DDGS treatments were observed with formula 2 during the last 5 weeks of study. DDGS in diet improved yolk color, Haugh unit, and shell strength. Shell percentage also increased as DDGS levels in the diet increased, but no difference in yolk and albumen percentage was observed. The results indicated that DDGS can be included in layer diets as high as 50% without affecting egg production and egg quality. However, amino acid digestibility of DDGS must be carefully estimated to meet production need.

Key Words: corn distillers dried grains with solubles, laying hen, egg production, Haugh unit, yolk color

659 Influence of dietary vitamin E supplementation on shelf life of ground broiler chicken meat during frozen storage. B. Saenmahayak*, M. Singh, J. B. Hess, and S. F. Bilgili, *Auburn University, Auburn, AL.*

This study was conducted to determine the microbial spoilage and oxidative stability of ground raw and cooked breast and thigh meat from broiler chickens fed graded levels of vitamin E during frozen storage. A total of 480 female broilers were assigned to 4 dietary vitamin E treatments (IU/kg of feed): 30 (basal level), 60, 120 and 240. Each of the 4 dietary treatments was fed in a 3 stage feeding program to 12 replicate pens of 10 birds and reared to 49 d of age. Upon processing, one-half of the replicate pens from each dietary treatment were used for raw and the other half for cooked meat treatments. Boneless-skinless breast and thigh meat (5 birds per pen) was ground, pooled by pen, formed into patties, vacuum packaged (oxygen impermeable) either raw or cooked (internal temperature of 80°C), and held under −18°C. Samples were analyzed for microbial spoilage (aerobic plate counts; APC, lactic acid bacteria; LAB, and yeast and molds; YAM) and lipid oxidation (TBARS) following 6, 12, 24, 48 d of frozen storage. Microbial numbers increased with storage time in both raw breast and thigh meat, with APC counts remained lower (3 $\log_{10}$ cfu/g) after 48 d of storage. Cooking reduced microbial counts and slowed the rate of microbial growth in breast and thigh meat during frozen storage. Vitamin E supplementation affected microbial counts only for raw breast (APC on 12 d; 0.84 cfu/g) and raw thigh (LAB on 12 d; 0.63 cfu/g), with levels of 240 IU/kg significantly impeding microbial growth as compared with basal levels. Lipid oxidation increased during frozen storage on both raw and cooked ground meat (breast < thigh). Dietary vitamin E supplementation at levels more than 120 IU/kg significantly reduced the rate of lipid oxidation in cooked ground breast and thigh meat as compared with the basal level (4.18 and 4.94 mg MDA/kg of meat). In this study, oxidative changes that occur during frozen storage of ground cooked broiler meat appeared to correlate and were positively influenced by dietary vitamin E supplementation.

Key Words: vitamin E, shelf-life, lipid oxidation

660 Influence of growth rate on the occurrence of white striping in broiler breast fillets. V. A. Kuttappan*, V. B. Brewer, P. W. Waldroup, and C. M. Owens, *University of Arkansas, Fayetteville.*

The occurrence of white striping on breast fillets is mainly associated with heavier broiler birds. It has been found that the condition can result in significant reduction of the consumer acceptance of the breast fillets. The objective of the study was to estimate the occurrence of normal (NORM), moderate (MOD) and severe (SEV) degrees of white striping with respect to the growth rate of broilers. Low and high nutrient diets, based on Rostagno et al. (2005) recommendations, were used to obtain slow or rapid growth patterns in the birds. Straight-run day old chicks (n = 280) were randomly assigned to either low or high nutrient diet treatments. There were 5 replicates for each treatment, with 28 birds each. Birds were processed at an age of 54 d. Live weight, deboned fillet weight and the occurrence of the 3 degrees of white striping were recorded. The birds grown on a high nutrient diet showed a significantly ($P < 0.05$) lower feed conversion ratio when compared with the low nutrient diet (2.08 vs 2.28, respectively) birds. Also, the high nutrient diet birds had a significantly ($P < 0.05$) higher live weight and fillet weight when compared with the birds on the low nutrient diet. Interestingly, the low nutrient diet birds showed a higher percentage of NORM and lower percentage of SEV white striping fillets when compared with the high nutrient diet birds. There was a significant ($P < 0.05$) increase in fillet weight and fillet yield (percent of live weight) as the degree of white striping increased from NORM to SEV. These data suggest that an increased growth rate can result in increased occurrence of white striping in broiler breast fillets.

Key Words: White striping, low and high nutrient diets, growth rate, broiler breast fillets, increased occurrence

661 Impact of further processing on dielectric properties of broiler poultry meat. D. Samuel* and S. Trabelsi, *Russell Research Center, Athens, GA.*

Currently in the US more than 90% of the turkeys and more than 70% of the broilers are processed beyond the normal ready-to-cook stage. Up to 50% of raw poultry meat is marinated with mixtures of water, salts, and phosphates. Physical properties of foods provide essential data to the food industry and can be used in the design, installation, operation and control of processes, plant and equipment used in food processing. Dielectric properties of foods are the electrical properties which strongly influence the temperature distribution of food during radio frequency and microwave heating. The objective of this research was to examine the effect of 2 commonly practiced further processing techniques (grinding and marination) on the dielectric properties of broiler poultry meat. All poultry meat was obtained from a local commercial processing plant. Dielectric properties of all samples were obtained utilizing an Agilent 85070A open-ended coaxial-line probe connected to an N5230C PNA L-Network Analyzer. Measurements were collected at 501 frequencies on a logarithmic scale from 500 MHz to 50 GHz. To evaluate effect of grinding on dielectric properties, measurements were conducted on ground and whole muscle. *t*-tests showed that ground muscle (a common ingredient in further processed meats) exhibited lower dielectric properties than the whole muscle ($P < 0.001$). To examine the effect of marination on dielectric properties, groups of breast filets were sorted into classes of pale, normal and dark before adding marination pickup percentages of 0, 5, 10, and 15. Data was analyzed using Sigma Plot. Overall, dielectric properties increased as the pickup percentage increased. Differences between samples were more pronounced at lower frequencies for the loss factor. Differences in dielectric constant between samples were less significant. The dielectric properties of poultry meat were significantly affected by the 2 processes.

Key Words: broilers, further processing, marination, dielectric properties, frequency

662 *Salmonella* spp., *Escherichia coli* and *Campylobacter* spp. in chickens: Updates on antimicrobial resistance trends, patterns and recovery rates in Canada. A. Agunos*, B. Avery, C. Carson, A. Deckert, L. Dutil, S. Gow, D. Légrr, J. Parmley, M. Tessier, R. Reid-Smith, and R. Irwin, *Laboratory for Foodborne Zoonoses, Public Health Agency of Canada.*

AAAP abstract†

663 The effects of Cordyceps fermented products on the production performance and the protection against infection of *Salmonella* Enteritidis in laying hens. T. T. Chen*[1], C. Chu[2], B. C. Weng[2], and K. L. Chen[3], *[1]Graduate Institute of Agriculture, National Chiayi University, Chiayi City, Taiwan, [2]Microbiology and Immunology, National Chiayi University, Chiayi City, Taiwan, [3]Animal Science, National Chiayi University, Chiayi City, Taiwan.*

The purpose of this study is to investigate the effects of different fermented Cordyceps products on the production performance, immune response and the protection against infection of *Salmonella* Enteritidis in laying hens. One hundred 39-week-old selected Hy-Line W36 hens () were randomly allocated into 5 dietary groups with 5 replicates for a 20 weeks feeding experiment. Diets were supplemented with 0% or 0.3% submerged *Acremonium implicatum* fermented products (AIFP), and wheat, oat and barley based solid *Cordyceps militaris* fermented products (CMW, CMO and CMB). The functions of peripheral blood mononuclear cell and polymorphonuclear granulocyte (PMN) were analyzed at the 10th week. To evaluate the protection of these different feedings, each hen was then intraperitoneally challenged with 1×10^5 SE equal to half LD_{50}. In the first 10 weeks feeding period (before challenge), the highest egg mass was observed in CMB with a difference than the control group ($P < 0.05$), whereas CMW and AIFP were falling in the middle. After LPS treatment, PMN isolated from the hens of CMO group showed the highest oxidative burst ($P < 0.05$). After challenge with SE, in contrast to highest mortality in the control group (40.0%), the lowest mortality was found in CMO group (16.7%), followed by CMB, AIFP, and CMW (21.1–26.3%). There was no any significant difference in SE contaminations in egg contents and shell membranes ($P > 0.05$). However, better recovery in production performance was obtained in the supplemental groups. In contrast to egg mass and feed intake/egg mass in control group, CMB group showed 18.5% and 17.2% increase in both performances. In conclusion, diet supplementary with 0.3% barley based *Cordyceps militaris* fermented products showed the best egg mass before challenge, and the lower mortality and the better performance recovery after challenge with half LD_{50} of SE.

Key Words: barley, *Cordyceps militaris*, fermented products, laying hens, *Salmonella* Enteritidis

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Runting Stunting Syndrome Posters

664 Evaluation of lymphoid tissues from broilers with runting and stunting syndrome. H. Sellers*, S. Williams, E. Linnemann, and E. Mundt, *University of Georgia, Athens.*

AAAP abstract†

665 Isolation, purification and full genome sequence of a chicken astrovirus isolated from broiler chickens with runting and stunting syndrome. S. Cheng*, G. Zavala, and T. Barbosa, *Department of Population Health, University of Georgia, Athens.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

Virus - Miscellaneous Posters

666 Development of an enteric virus panel test for detection of turkey enteric viruses. S. Kariyawasam*, D. Trampel, and T. N. Denagamage, *Pennsylvania State University, Department of Veterinary and Biomedical Sciences, University Park.*

AAAP abstract†

667 Protection against turkey coronaviral enteritis by DNA vaccination. T. L. Lin*, M. Ababneh, M. Hsieh, and C. C.Wu, *Department Of Comparative Pathobiology, Purdue University, West Lafayette, IN.*

AAAP abstract†

668 Sequential pathogenesis of chicken proventricular necrosis virus (R11/3 Virus) in transmissible viral proventriculitis-affected chickens. J. S. Guy*, M. West, and O. Fletcher, *North Carolina State University, Raleigh, NC.*

AAAP abstract†

669 A preliminary survey of hemoagglutinating virus in red-winged tinamous from Buenos Aires Province, Argentina. C. Buscaglia*, *Comisión De Investigaciones Científicas De La Buenos Aires, Argentina. Fundacion Ecologica Pinamar, Argentina.*

AAAP abstract†

670 Propagation and characterization of turkey reoviruses isolated in Germany, 2004–2008. M. Day*, S. Kenklies, and R. Günther, *USDA/ARS, Athens, GA.*

AAAP abstract†

671 Identification and molecular characterization of avian reovirus in commercial broilers using RT-PCR and sequencing. L. Li*, E. M. Handley, M. R. Luther, A. Wise, A. Fulmer, and F. J. Hoerr, *Auburn University, Auburn, AL.*

AAAP abstract†

672 Comparison of fluorescent antibody and RT-PCR testing for the detection of avian reovirus in clinical diagnosis. L. Li*, E. M. Handley, M. R. Luther, A. Wise, A. Fulmer, and F. J. Hoerr, *Auburn University, Auburn, AL.*

AAAP abstract†

673 Clinical, pathological and virological investigations of multicentric lymphomas reported from pheasants flocks. L. Corrand*, X. Chatenet, P. Albaric, M. L. Lucas, S. Tricoire, and J. L. Guerin, *Ecole Nationale Veterinaire De Toulouse.*

AAAP abstract†

674 Emergence of an acute chicken fibrosarcoma induced by avian leukosis virus in China. Z. Cui*, S. Sun, X. Wang, and C. Li, *Shandong Agricultural University, College of Veterinary Medicine, Taian, China.*

AAAP abstract†

†This abstract from the American Association of Avian Pathologists (AAAP) is available in the AVMA Convention Notes at www.avmaconvention.org and at www.aaap.info/2011meeting.

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