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## POSTER PRESENTATIONS

\*AuthorPresenting Paper

**M1 Dietary conjugated linoleic acid enhanced spleen PPAR- $\gamma$  mRNA expression in chicks.** H. J. Zhang, Y. M. Guo\*, Y. Yang, and J. M. Yuan, *China Agricultural University, Beijing, China.*

This experiment was aimed at investigating the anti-inflammatory effects of conjugated linoleic acid (CLA) in broilers challenged repeatedly with lipopolysaccharide (LPS). Day-old broiler chicks were allotted into 3 (0, 5.0 or 10.0 g CLA/kg diet) treatments. Six chicks from each treatment were injected with LPS (0.25 mg/kg body weight) at 16, 18 and 20 day of age. Cyclooxygenase (COX) and inducible nitric oxide synthase (iNOS) activities, and prostaglandin E2 (PGE2) and nitric oxide (NO) production as well as peroxisome proliferator-activated receptor-gamma (PPAR- $\gamma$ ) mRNA expression in spleens were examined at 21 d of age.

Results showed that chicks fed 10.0 g/kg CLA diet had significantly lower COX activities and PGE2 production than the controls. Dietary 10.0 g/kg CLA did not significantly diminished LPS-induced enhancement of COX-2 activities, but remarkably inhibited the subsequent elevation of PGE2 production. Regulation of COX-1 activities contributed to the difference of PGE2 production. CLA did not remarkably attenuate the elevation of iNOS activities and NO production due to LPS challenge. Chicks fed CLA had significantly lower iNOS activities and NO production than the controls. Dietary CLA significantly activated PPAR- $\gamma$  mRNA expression. Compared to control group, chicks fed CLA had significant elevation of PPAR- $\gamma$  mRNA expression after LPS administration.

These results suggested that dietary CLA had immunomodulatory effects in spleen by restricting basal PGE2 and NO at lower levels and enhancing PPAR- $\gamma$  mRNA expression. During inflammatory response, dietary CLA did not alleviate the elevation of COX-2 and iNOS activities but significantly enhanced PPAR- $\gamma$  mRNA expression.

**Key Words:** conjugated linoleic acid, broiler chicks, cyclooxygenase

**M2 Effects of dietary cellulose on excreta moisture and egg production in laying hens.** A. Arti\* and T. K. Smith, *University of Guelph, Guelph, ON, Canada.*

It has been hypothesized that the problem of sticky droppings in laying hen flocks may be influenced by dietary levels of non-starch polysaccharides (NSP). A study was conducted, therefore, to determine the effects of feeding different levels of NSP in the form of cellulose, on excreta moisture content and egg production in laying hens. Two hundred and forty,

35-week-old commercial strain (Shaver) laying hens were fed corn-soybean meal diets including: (1) 0% cellulose (2) 1% cellulose (3) 1.5% cellulose (4) 2 % cellulose (5) 2.5% cellulose (6) 3% cellulose. Egg production was monitored daily. Excreta was collected for 24h after 21 days of feeding. Excreta moisture loss was measured over 98h following collection. A randomized complete block design was employed with Tukey's multiple range tests to separate means. Egg production was not significantly affected by diet. The feeding of 2% cellulose, however, resulted in the highest numerical value for excreta moisture. Excreta moisture tended to be higher for layers fed diets containing 2% and 2.5% cellulose. Average rate of excreta moisture tended to be greatest in birds fed diets containing 1% and 1.5% cellulose. Although the effects of dietary cellulose were not statistically significant with respect to excreta moisture content and rate of excreta moisture loss ( $P > 0.05$ ) the results indicate that the use of an appropriate level of NSP in laying hen diets will reduce the problem of sticky droppings.

**Key Words:** non starch polysacchrides, laying hens, excreta moisture

**M3 Effect of probiotic on broiler performance and blood factors.** M. R. Abdollahi\* and F. Zaefarian, *Tehran University, Karaj, Tehran, Iran.*

The microbial populations in the gastrointestinal tracts of poultry play a key role in normal digestive processes and in maintaining animal health. Disease- and stress-induced changes in the physicochemical environment in the gastrointestinal tract, or simple changes in feed management practices can significantly influence the microbial populations and their effects on animal performance and health. In the last five decades, increased knowledge of the factors that influence the activities of microorganisms in the alimentary tract has helped to define the critical role of these symbiotic organisms. Probiotics, competitive exclusion and direct-fed microbial feed supplements can be used as a strategic tool for managing these microbial populations. The aim of this trial was study of effect of different levels of bacterial probiotic on broilers performance and some of blood factors.

This experiment was conducted in a randomized complete block design (RCBD) and included 600 Ross broiler chicks (male and female) which were divided into four groups with five replicates. This experiment was conducted in two periods starter 0-21, and grower 22-42, days. All of the diets were isocaloric and isonitrogenous. In this experiment, the birds received 0, 800, 1000, 1200 gr probiotic per ton diets in the starter period, and 0, 320, 400, 480 gr probiotic per ton diets in the

grower period, which were termed T1, T2, T3 and T4, respectively. The used probiotic was a powder in which the active ingredient is an equal mixture of spray-dried spore-forming bacteria, *Bacillus licheniformis* and *B. subtilis*, at a minimum concentration of  $3.2 \times 10^9$  viable spores/g. Our measurements were, weight gain, feed intake, feed efficiency, mortality, carcass quality, serum cholesterol, blood hemoglobin and number of white blood cells. Weight gain at starter period was significantly affected by dietary treatments ( $P < 0.05$ ), but weight gain at grower period was not affected by using probiotic supplement ( $P > 0.05$ ). At the end of trial, the T4 had maximum weight gain, and T1 had minimum weight gain. The feed intake and mortality were not affected by experimental diets ( $P > 0.05$ ). Analysis of variance showed no significant difference between treatments for feed efficiency ( $P > 0.05$ ), but there was significant difference between mean of treatments that were derived from Duncan's multiple range test ( $P < 0.05$ ). There were no significant difference between groups in dressing, breast meat and thigh percent, at the end of 6th week ( $P > 0.05$ ). The first treatment had the highest abdominal fat (3.04 %) and fourth treatment had the lowest abdominal fat (2.43 %), but among them, there was no significant difference ( $P > 0.05$ ). Analysis of variance showed no significant difference between treatments for serum cholesterol content ( $P > 0.05$ ), but significant difference between mean of treatments were derived from Duncan's multiple range test ( $P < 0.05$ ). The blood hemoglobin content was not affected by experimental diets ( $P > 0.05$ ). The number of white blood cells were significantly affected by dietary treatments ( $P < 0.05$ ), the T4 had maximum number of white blood cells, and T1 had minimum number of white blood cells.

**Key Words:** broilers, probiotic, blood factors

**M4 Dietary tocopherols attenuate hepatic triacylglycerol cContent and cyclooxygenase-2 expression in the cardiac tissue of mtat-Type chickens challenged with lipopolysaccharide.** G. Cherian\*, Z. Ma, and M. P. Goeger, *Oregon State University, Corvallis.*

Eicosanoids are lipid mediators of inflammation derived from n-6 and n-3 fatty acids. Our previous research demonstrated that the dietary n-6:n-3 fatty acid ratio affects the synthesis of proinflammatory eicosanoids in poultry. Cyclooxygenase (COX) is a key enzyme in eicosanoid synthesis. Two isoforms (COX-1, COX-2) have been identified. COX-1 is constitutive and COX-2 is induced upon cell activation and its expression is associated with inflammation. The current study investigates the effect of feeding n-6 fatty acids and tocopherols on lipopolysaccharide (LPS)-induced alterations in hepatic lipid metabolism and COX-2 expression in the cardiac tissue of meat-type chickens. A total of forty-eight one day-old broiler chicks (n=12/treatment) were randomly assigned to a corn soy bean meal based diet containing 31, 62, 124 and 248 IU/Kg tocopherols. The n-6:n-3 fatty acid ratio of the diet was 13:1. LPS injection led to an increase in hepatic total fat and triacylglycerol in birds fed 31 IU/Kg tocopherols when compared to birds fed 62 or 248 IU/Kg tocopherols ( $P < 0.05$ ). The COX-2 protein level was lower ( $P < 0.05$ ) in cardiac tissue of birds fed 248 IU/Kg tocopherols when compared to 31 and 62 IU/Kg tocopherols. No effect of tocopherols or LPS on liver weight was observed ( $P > 0.05$ ). During inflammation, lipid substrates for the activated immune system are provided by triacylglycerol-rich lipoproteins. Therefore, dietary strategies directed at attenuating hepatic lipid and triacylglycerol content and COX-2 expression may prove beneficial in reducing inflammatory diseases and in increasing production performances in meat-type chickens.

**Key Words:** tocopherols, eicosanoids, cyclooxygenase-2

**M5 The effect of graded concentrations of a novel thermotolerant xylanase on the performance of laying hens fed wheat/soybean meal-based diets.** A. J. Cowieson\*<sup>1</sup>, A. Knox<sup>2</sup>, and J. McNab<sup>2</sup>, <sup>1</sup>*Danisco Animal Nutrition, Marlborough, Wiltshire, United Kingdom,* <sup>2</sup>*Roslin Nutrition, Roslin, Midlothian, United Kingdom.*

The use of endo- $\beta$ -1-4-arabinoxylanases to improve the nutritional value of wheat-based diets for broilers is well accepted by the poultry industry and the mode of action is considered to be well elucidated. However, the use of xylanases to improve the nutritional value of diets for laying hens is not as comprehensively accepted by the industry. This may be due to the fact that laying hens have a more mature gastrointestinal tract than broilers and so are less adversely affected by the presence of high concentrations of soluble polysaccharides in the diet. In order to assess the effect of a new xylanase on laying hen performance a 42 week production study was conducted using a total of 384 Lohmann brown laying hens. The hens were split at 20 weeks of age into 3 treatment groups of 32 replicate cages with 4 birds in each cage. The control group received a wheat/soy-based diet (2730kcal/kg AME; 150g/kg crude protein) and the remaining two experimental groups received the same diet supplemented with either 625 or 2500 U/kg of a new thermotolerant xylanase from *Trichoderma reesei*. Feed consumption, changes in body weight, egg mass, egg numbers, mortality and egg quality were assessed from week 20 to week 62. Treatment effects were established using ANOVA and means separated using Tukeys LSD ( $P < 0.05$ ). Ingestion of the diets containing xylanase reduced (1.4%;  $P < 0.05$ ) feed intake and improved (4.1%;  $P < 0.05$ ) egg production compared with the control resulting in a significant improvement in FCR (2.32 vs. 2.21). In general, 2,500 U/kg of exogenous xylanase proved more effective than 625 U/kg but the lower inclusion concentration still elicited a significant improvement (2.1%) in egg production compared with the control. The xylanase used in this trial is inherently thermostable and although this is a trait that may be considered inconsequential in layer nutrition, the changes in enzyme conformation, the strength of ionic bonds and the degree of glycosylation in inherently thermotolerant enzymes can detrimentally alter bioefficacy. This is an accepted compromise for broiler production due to the benefits arising from improved recovery following conditioning, but it is important, in diets that are not pelleted, to demonstrate a high degree of efficacy. These data demonstrate that this new *Trichoderma* xylanase is effective in improving nutrient retention and egg production in Lohmann brown laying hens over a full 42-week production cycle and so is an effective nutritional tool to improve the profitability of egg production.

**Key Words:** enzyme, laying hen, wheat

**M6 Ideal protein based turkey diets result in substantial cost savings.** J. D. Firman\*, *University of Missouri, Columbia.*

An experiment was conducted to determine if diets formulated to digestible amino acid specifications based on the Missouri Ideal Protein Ratio would perform similarly to an industry standard diet. Four treatments consisted of a control diet based on industry specifications (A), the second (B) was the exact requirements (digestible amino acids) with no safety factor, the third treatment (C) was B + 5% additional amino acids (recommended diet with safety factor included) and the final treatment was B + 10% additional amino acids. Thirty-two pens of 25 tom poult were fed for 18 weeks in a curtain-sided two stage building. Body weight, feed:gain and mortality were recorded with diet changes occurring at 3 week intervals and processing yield data at the

conclusion of the trial. All data were analyzed with ANOVA followed by LSD for mean separation. Performance of the ideal protein diet was slightly reduced at 3 wks of age. The addition of 5 or 10% amino acids brought growth back to even with the industry diet at that time. No differences in performance were noted through 15 weeks. At 18 weeks, the ideal protein fed group was significantly lighter in weight (4.8%) than the industry diet while the diets with 5 or 10% AA additions did not differ from the control. Small differences in feed efficiency occurred through different phases of the trial, but there were no differences at the conclusion of the trial. These data would indicate that the exact requirements were slightly low, but the addition of a safety factor overcame this. Cost savings when comparing the ideal + 5% with the industry standard diet were dramatic. Cost savings per ton of feed ranged from \$10.64 to \$17.03 depending on phase. These data would indicate that ideal protein based turkey diets can be successfully fed with significant cost savings possible.

**Key Words:** turkey, amino acids, ideal protein

**M7 The effect of grain type and choice-feeding on the performance of organically-reared broiler chickens.** A. L. Rack\*, R. E. Loar, N. P. Buchanan, R. W. Wood, and J. S. Moritz, *West Virginia University, Morgantown.*

Feed constitutes the majority of investment in organic poultry production. Past research has demonstrated that broilers have the ability to self-regulate nutrient intake based on individual metabolic requirement and changes in environmental conditions. Incorporating a choice-feeding management system and utilizing grains produced on-farm may improve broiler performance and reduce production cost for small-scale organic broiler producers. The objective of this study was to evaluate performance and production cost of choice-feeding management using one of two different grains. Three hundred one-day-old Cobb 500 broilers were reared from 0-to-3-weeks in floor pens and fed a certified organic diet that met all NRC recommendations. On day 21, broilers were transferred to houses located on the West Virginia University certified organic farm. Broilers had access to pasture 12 hours daily and were exposed to natural fluctuation in environmental conditions. Experimental grower diets were certified organic and consisted of two feeding strategies (choice or no choice) arranged in a factorial structure with two grains (corn or oats). Diets were formulated to contain 30% grain and 70% of a complementary grain-specific premix. Broilers with no choice feeding option exhibited improved live weight gain (LWG), gain:feed (G:F), and carcass weight (CW) compared to broilers with a choice feeding option ( $P = 0.0054$ ,  $0.0001$ , and  $0.0020$ , respectively). Broilers fed oats exhibited improved G:F ( $P = 0.0309$ ) and smaller fat pad weights ( $P = 0.0052$ ) compared to broilers fed corn. Grain type did not affect LWG ( $P = 0.7605$ ). When utilizing a choice-feeding system, broilers fed oats consumed a grain to premix ratio more similar to formulated values (oats- 21.3 to 78.7 vs. corn- 58.1 to 41.9). However, the cost of the oat premix was approximately twice that of the corn premix. These results demonstrate that utilizing oats, a grain that may be produced on-farm, can improve broiler performance. However, choice-feeding may not be a viable economic option for small-scale poultry producers.

**Key Words:** organic, choice-feeding, oats

**M8 Laying hen diets formulated with meat and bone meal and different amino acid digestibility coefficients.** E. M. Casartelli\*, O. M. Junqueira, R. S. Filardi, A. C. Laurentiz, and V. Assuena, *Universidade Estadual Paulista/FCAV, Jaboticabal, SP, Brazil.*

The objective of this study was to evaluate the performance and egg quality of laying hens fed diets formulated with a high quality meat and bone meal (MBM) and different amino acid (AA) digestibility coefficients. Formulation on a digestible AA basis allows for the formulation of diets with better precision and use of alternative ingredients more efficiently. During 4 periods of 28 days, 150 Isabrown hens 28 weeks of age were distributed in a completely random experiment with 5 treatments and 5 replicates of 6 birds each. The experimental treatments were: T1 and T2 diets were formulated with corn and soybean meal (CSB) with T1 formulated on total AA (TA) and T2 formulated on digestible AA (DA); T3, T4 and T5 diets were formulated with 6% MBM with TA (T3), diets formulated with DA coefficients determined in a previous experiment (T4), and diets formulated with DA recommended by Brazilian Standards (T5). DA was determined in a previous experiment using Acid Insoluble Ash as the indigestible marker. The parameters observed were feed intake (FI), egg production (EP), egg weight (EW), feed conversion (FC), Haugh units (HU), shell thickness (ST) and specific gravity (SG). Statistical evaluation of experimental data was done by GLM process from SAS<sup>®</sup>. Means were compared with 5% probability through orthogonal contrasts: C1 – T1 vs T2; C2 – comparison of the treatments T3, T4 and T5 and C3 – T1 and T2 vs T3, T4 and T5. Under the conditions of this experiment, the use of digestible as opposed to total AA values did not affect EP, EW, HU or SG. TA formulation promoted higher and lower values for FI and ST ( $P < 0.05$ ), respectively in the C1 contrast. In the C2 contrast the lowest value for FC ( $P < 0.05$ ) was obtained for T4. The diets formulated with MBM diets decreased FI ( $P < 0.05$ ) in comparison with CSB diets (C3). While the use of digestible AA values in general is to be recommended, when feed ingredients of high digestibility are employed, improvements in performance maybe difficult to observe.

**Key Words:** laying hens, amino acids, meat and bone meal

**M9 Evaluation of guar meal TME<sub>n</sub> using feed-trained roosters.** O. Gutierrez\*, A. Haq, J. C. Wood, and C. A. Bailey, *Texas A&M University, College Station.*

A preliminary study was conducted to determine the nitrogen-corrected true metabolizable energy (TME<sub>n</sub>) of guar meal. Varying slightly from Farrell's method, 12 Single Comb White Leghorn roosters were trained to voluntarily consume a daily feed allocation of guar meal in less than two hours. Over a two month period, roosters were adapted to consuming high levels of guar meal by blending increasing proportions with ground corn, eventually reaching a maximum level of 40% inclusion. A total of eight roosters were placed in non-adjacent cages equipped with individual feeders, drinkers, feed spillage trays, and fecal collection trays. Following a 48 hour period during which no feed was administered, a 24 hour fecal collection was taken in order to determine endogenous energy losses. Test diets, consisting of ground corn mixed with guar meal (0, 10, 20, 30, and 40%) were administered on consecutive days, beginning with the 0% guar diet and increasing to the 40% guar diet. For each diet, birds were administered approximately 40 g of feed and allowed a two hour voluntary feed consumption period, after which remaining feed was weighed in order to determine individual feed consumption. Water was available *ad libitum*. Fecal

samples were frozen for later lyophilization and calorimetry. A Parr adiabatic calorimeter was used to determine gross energy of feed and feces, and a Vario elemental C/N analyzer was used to determine nitrogen content in feed and feces. When extrapolated to 100%, guar meal  $TME_n$  was calculated at 1987 kcal/kg DM. Although the trend line ( $y = -10.772x + 3064$ ;  $r^2 = 0.686$ ) demonstrated an overall decrease in  $TME_n$  as guar levels increased, individual observations for guar meal between 10 and 30% actually increased to a maximum of 2393 kcal/kg DM at 30% inclusion. This observation may be explained by gut adaptation that possibly occurred during the training period when roosters were fed high levels of guar, followed by an abrupt change in feed composition when the energy trials began in earnest.

**Key Words:**  $TME_n$ , guar meal, SCWL rooster

**M10 Impact of dietary protein levels on growth and body composition of broiler chickens.** A. D. Mitchell\* and R. W. Rosebrough, *Growth Biology Laboratory, USDA-Agricultural Research Service, Beltsville, Maryland.*

Studies were conducted to determine the effects of variable levels of dietary protein on the growth and composition of broiler chickens. Ross 708 broiler chickens (8 birds per treatment) were fed eleven combinations of dietary protein levels. In one experiment, birds were fed diets containing 24% protein from 0 to 14 days of age, 18 or 21% from 14 to 26 days of age and 12 or 18% protein until 35 days of age. In a second experiment, birds were fed diets containing 12, 24 or 30% protein from 0 to 35 days of age; in addition, at day 26 birds fed the 12% protein diet were switched to 30% protein, birds fed 30% protein were switched to 12% protein, and birds fed 24% protein were switched to either 12 or 30% protein. Birds were killed at day 35 and dual X-ray absorptiometry (DXA) was used to approximate body composition. Lower levels of protein during early growth periods resulted in lower BWT at day 35. Body weights for the diet groups ranged from 747 g (12% protein diet) to 1865 g (24% protein diet,  $P < 0.05$ ). The same pattern was observed between diet and total body lean mass, thus, lean mass was highly correlated with body weight ( $r = 0.98$ ). Percentage of body fat was not correlated with body weight ( $P = 0.20$ ), but was influenced by the level of protein in the diet. The percentage of body fat ranged from 8.4% (30% protein diet) to 19.5% (24-21-12% protein diet,  $P < 0.05$ ). Total body bone mineral content (BMC) and density (BMD) were highly correlated with body weight ( $r = 0.91$  and  $0.79$ ). The results of this study demonstrate that as the level of protein in the diet is altered, lean mass and bone mineral deposition are closely associated body weight gain while fat deposition is more dependant on the pattern in which the level of protein in the diet is altered.

**Key Words:** broilers, body composition, DXA

**M11 Fate of Cry3Bb1 protein in laying hens fed diets containing MON 863.** S. E. Scheideler<sup>1</sup>, P. Weber\*<sup>1</sup>, K. Sok<sup>1</sup>, R. E. Hileman<sup>2</sup>, and G. F. Hartnell<sup>2</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Monsanto Company, St. Louis, Missouri.

Two trials were conducted to assess the fate of the Cry3Bb1 protein from YieldGard<sup>®</sup> Rootworm corn (MON 863) when fed to laying hens. Two diets, one formulated with MON 863 and one with conventional corn, were fed to laying hens for 8 wk during the first trial. Diets were formulated to be equal in all nutrient requirements for laying

hens. Each corn treatment was fed to birds in 12 replicate cages with 4 hens/cage. Daily feed intake (FI) and egg production (EP) were measured during the trial and body weight (BW) at the beginning and 2-wk intervals. At the end of week 4 and 8, egg and fecal samples were collected from each pen and tested for the presence of Cry3Bb1 protein using a double antibody sandwich format lateral flow strip test. Corn and diet samples were also tested for the protein. At the end of the trial, 12 hens/diet were euthanized and hepatic and pectoralis tissue samples tested for the Cry3Bb1 protein. The corn source had no significant effects on FI, EP, or BW in this experiment. Feces from hens fed diets containing MON 863 were all positive for the Cry3Bb1 protein or proteolytic fragments of the Cry3Bb1 protein. Feces from hens fed diets containing conventional corn were all negative for the Cry3Bb1 protein. These findings were expected since proteins from corn and soybean meal are not totally digested in the chicken. Cry 3Bb1 protein could not be detected in eggs due to the presence of an interfering protein in all test and control eggs. Hepatic and pectoralis tissue samples were all negative for the presence of Cry3Bb1 protein in both corn treatments. A second trial was conducted to further study the presence of Cry3Bb1 protein in the digesta of hens fed a diet containing MON 863. The same test and control diets used in the first trial were used and fed to 12 hens each. Six hens/treatment were sampled after 7 and 28 days. Digesta samples were collected from the crop, small and large intestine, and ceca. Feces and blood samples were also collected. Cry 3Bb1 protein could not be detected in blood due to the presence of an interfering protein in all test and control blood samples. The results from the second trial confirmed that detectable levels of Cry3Bb1 protein and/or partially digested fragments were found in all sections of the chicken's digestive tract. We calculated that 98 to  $\geq 99\%$  of the dietary Cry3Bb1 protein was digested based on the level of Cry3Bb1 and/or fragments that were detected in the feces and on estimates of corn protein digestion. This degree of digestion is greater than the reported literature values (84-90%) for dietary protein. Thus, Cry3Bb1 protein is highly digestible in laying hens with only small amounts being detected in the feces. Overall, MON 863, when fed to laying hens, had no significant effects on FI, EP, or BW. Cry 3Bb1 protein was extensively digested similar to that of other dietary protein and was not detected in hepatic or muscle tissue.

**Key Words:** Cry3Bb1 protein, rootworm corn, laying hens

**M12 Coconut meal in laying hen diets: Nutrient digestibility, performance and egg quality.** M. F. F. Fuentes\*, R. C. Lima, E. R. Freitas, F. S. Sucupira, R. F. Moreira, and N.M. Braz, *Universidade Federal do Ceara, Fortaleza, Ceara, Brasil.*

This experiment was conducted to evaluate the effect of inclusion of coconut meal (CM) in diets on nutrients digestibility, bird performance, and egg characteristics of laying hens. A total of 150 laying hens at 76 weeks of age were weighed and distributed in a completely randomized design with five treatments and five replicates of six birds in each experimental unit. Treatments consisted of one diet without CM and four diets containing 5, 10, 15, and 20% CM. Values for ether extract, crude fiber and gross energy increased with the inclusion of CM in diets. Related to digestibility it was observed a quadratic effect of CM inclusion levels on metabolizable coefficients for dry matter (MCDM), nitrogen (MCN), and gross energy (MCGE). Quadratic effects were also verified for the values of apparent metabolizable energy (AME) and nitrogen corrected apparent metabolizable energy (AMEn). The maximum inclusion level found for energy utilization by birds was 15%. Values of AME and AMEn were higher in diets containing 10,

15, and 20% CM than in that without CM. Egg production, egg weight (g) and egg mass (g) were not affected by the inclusion levels of CM. However feed intake (g/bird/day) decreased and feed conversion (g feed/g egg) improved as CM level increased in diets. According to the estimated point of maximum utilization of energy, CM can be used in laying hens diets in levels up to 15%.

**Key Words:** alternative feed, egg characteristics, metabolizable coefficients

**M13 Tibia quality of broilers fed diets with phytase and reduced nonphytate phosphorus levels.** M. C. Oliveira<sup>1</sup>, R. A. Gravena<sup>2</sup>, R. H. Marques<sup>2</sup>, A. B. Traldi<sup>2</sup>, and V. M. B. Moraes<sup>\*2</sup>, <sup>1</sup>Universidade de Rio Verde, Rio Verde, GO, Brazil, <sup>2</sup>Universidade Estadual Paulista, Jaboticabal, SP, Brazil.

An experiment was carried out to evaluate the morphometry, breaking strength and mineral content of tibia from broilers fed diets containing reduced nonphytate phosphorus (NPP) levels and phytase. The broilers were distributed in a factorial arrangement (2 x 3) with two phytase levels (0 and 25 U/kg) and three NPP levels (100, 85 and 70% of bird requirement), totaling six treatments with five replicates in a completely randomized design. The phytase inclusion improved ( $P < 0.05$ ) the bone weight and the reduction of NPP in the diet to 70% of the bird's requirement decreased ( $P < 0.02$ ) bone strength compared with birds of the treatments with 100 and 85% of the NPP requirements. There was no effect ( $P > 0.05$ ) of phytase, NPP or interaction on length, diameter and mineral content. It was concluded that it is possible to use diets with 85% of NPP requirements, supplemented with 25 U/kg phytase, with no negative effect on tibia quality.

**Key Words:** bone strength, bone mineralization, enzymes

**M14 The effect of a novel phytase to improve phosphorus utilization of wheat-based diets.** H. Shah<sup>\*1</sup>, M. M. Harris<sup>1</sup>, C. Fodor<sup>1</sup>, N. Wall<sup>1</sup>, A. Smykot<sup>1</sup>, J. Remus<sup>2</sup>, and D. R. Korver<sup>1</sup>, <sup>1</sup>University of Alberta, Edmonton, AB, Canada, <sup>2</sup>Danisco Animal Nutrition, St. Louis, Missouri.

A 2x2x2 factorial arrangement of treatments was used to investigate the effect of a novel phytase in wheat-based diets. Basal diets containing either normal (Normal; wheat-soy diet) or high (High; wheat-soy-canola meal diet; 0.05 % higher) phytate were formulated. Within each phytate level, negative control (NC) diets were formulated to provide 28 to 38% lower P and Ca values than the positive control (PC) diet within each diet phase. The decrease was based on the expected effect of phytase on P and Ca availability. Within each phytate/nutrient density diet, half of the basal diet was supplemented with phytase (Phyzyme XP; 500 U/Kg feed); the other half was not supplemented. A xylanase (Avizyme 1302) was added to all diets. Each of the 8 diets was fed to 8 replicate pens (75 chicks/pen) of Ross 308 broiler chicks. The diets were fed as a starter (0–10d), grower (11–28d) and finisher (29–37d). Body weight (BW), gain, and feed intake and feed conversion efficiency (FCE; gain g/g feed) were measured. At 37 d of age, bone mineral density (BMD) was determined using quantitative computed tomography on the femur of 1 bird per pen. The Normal phytate diets increased feed intake ( $P < 0.05$ ) and FCE ( $P < 0.001$ ) during the grower phase relative to the High diets but had no effect on BW and gain. High dietary phytate reduced ( $P = 0.04$ ) BMD at 38 d of

age. The PC birds had increased BW ( $P < 0.05$ ), gain ( $P < 0.05$ ) and feed intake ( $P < 0.05$ ) relative to the NC birds. Phytase increased ( $P < 0.001$ ) body wt, gain ( $P < 0.001$ ), feed intake ( $P < 0.001$ ) and FCE ( $P \leq 0.001$ ) throughout the study, and BMD at 38 d of age ( $P < 0.02$ ). There were phytate×nutrient density and phytate×phytase interactions ( $P < 0.05$  and 0.01, respectively) for FCE over the entire experiment. The NC treatment decreased FCE in the High-, but not the Normal phytate diet relative to the PC treatment ( $P < 0.05$ ). Phytase supplementation in the High phytate diet increased FCE, but not in the Normal phytate diet ( $P < 0.01$ ). Phytase increased BMD in the NC groups but not in the PC groups. Phyzyme XP improved performance and BMD of broilers fed wheat-based diets.

**Key Words:** phytase, broiler, bone mineral density

**M15 An examination of the role of dietary protein in regulating metabolism during the broiler finisher period.** R. W. Rosebrough<sup>\*</sup>, A. D. Mitchell, B. A. Russell, S. M. Poch, and M. P. Richards, USDA, Agricultural Research Service, Growth Biology Laboratory, Beltsville, Maryland.

Growth trials were conducted with the Ross 708 broiler chicken to corroborate the relationships between changes in the growth curve (7 to 35 days) and in vitro metabolic parameters. These in vitro parameters also included estimates of the expression of certain genes regulating proteins implicated in the regulation of lipogenesis. Birds were fed diets containing 24% protein from 0 to 14 days of age, 21% from 14 to 26 days of age and 18% protein until 35 days of age (Exp 1). Birds were fed diets containing 24% protein from 0 to 14 days of age, 18 or 21% from 14 to 26 days of age and 12 or 18% protein until 35 days of age (Exp 2). Birds were fed diets containing 12, 24 or 30% protein from 0 to 26 days of age. The 12% group was switched to 30% protein and the 30% group to 12% protein. The 24% group was switched to either 12 or 30% protein (Exp 3). Birds were selected and killed at ages corresponding to protein changes. Dual X-ray absorptiometry (DXA) was used to approximate body composition of birds at day 36. The switch from the starter protein level of 24% crude protein to the only slightly lower protein grower diet (21% crude protein) increased both in vitro lipogenesis and malic enzyme activity. A similar observation was noted when the birds were switched to the 18% crude protein finisher diet. These same switches also elicited initial increases in malic enzyme, fatty acids synthase and acetyl CoA carboxylase gene expression that were not sustained following adaptation to the dietary change. Data also show that DXA can be used to estimate body composition of this type of bird.

**Key Words:** metabolism, gene expression, finisher

**M16 The effect of different levels of fat and L-carnitine on performance and serum composition of male broiler chicks.** M. Rezaei<sup>\*1</sup>, A. Attar<sup>1</sup>, A. Ghodrattnama<sup>2</sup>, and H. Kermanshahi<sup>3</sup>, <sup>1</sup>Mazandaran University, Sari, Mazandaran, Iran, <sup>2</sup>Center of Khorasan Agricultural Researches, Mashhad, Khorasan, Iran, <sup>3</sup>Ferdowsi University, Mashhad, Khorasan, Iran.

An experiment was carried out to investigate the effect of 3 levels of fat (1, 3, 5%), and 2 levels of L-carnitine (0, 250 mg/kg) on 360 male Ross broiler chicks in a factorial arrangement (2×3). A completely randomized design with 6 treatments replicated 4 times with 15 chicks per replicate was used. Diets were fed to chicks from 1 to 42 days

of ages. During the experiment, feed intake, body weight gain, and feed conversion ratio were measured weekly. Mortality was measured throughout the experiment. At 42 days of age, blood samples were collected from 4 birds in each treatment. Data of the experiment were analyzed by GLM procedure of SAS. Increasing fat in the diets significantly improved performance of chicks during the grower (1 to 21 days) and whole period (1 to 42 days) of the experiment ( $P < 0.05$ ). Adding L-carnitine to diets significantly decreased the level of triglyceride (TG), cholesterol, very low density lipoprotein (VLDL) of chick blood serum ( $P < 0.05$ ). The level of serum TG, VLDL, and glucose were also affected by fat level ( $P < 0.05$ ). Interaction between fat and L-carnitine on serum TG, and glucose was significant ( $P < 0.05$ ). Results of the present study indicated the positive effect of fat on performance and significant effect of L-carnitine on decreasing of serum TG, cholesterol, and VLDL of male broiler chicks.

**Key Words:** fat, L-carnitine, broiler

**M17 The effects of phytase supplemented diets on TME, and sialic acid excretion in female turkeys.** V. Pirgozliev\*<sup>1</sup>, T. Acamovic<sup>1</sup>, and M. R. Bedford<sup>2</sup>, <sup>1</sup>ASRC, Scottish Agricultural College, Edinburgh, Scotland, <sup>2</sup>Syngenta Animal Nutrition Inc., Marlborough, Wiltshire, England, United Kingdom.

A precision feeding experiment was conducted to compare the effect of feeding three dietary activities of phytase (Quantum: Syngenta Animal Nutrition Inc.) on endogenous secretions, measured as sialic acid (SA), from the gastrointestinal tract (GIT), and true metabolizable energy (TME) of the diets when fed to young turkeys. Forty BUT 6 female turkeys, weighing approximately 2.5 kg were used in this experiment. Five treatments (control diet based on a maize/soy diet, control + 250 IU phytase, control + 500 IU phytase, control + 2500 IU phytase, and glucose for endogenous loss estimation) were used in this study and each treatment was replicated eight times in a randomised block design. The concentration of excreted SA decreased ( $P < 0.05$ ) when the amount of phytase in the feed increased. The amount of SA excreted also tended to decrease ( $P = 0.066$ ) when comparison was made between the negative control and 250 FTU supplemented vs 500 and 2500FTU diets. TME tended ( $P > 0.05$ ) to increase two treatments (250 and 500 IU phytase) in comparison with the control diet. A negative linear relationship ( $P = 0.001$ ) between dietary TME and sialic acid excreted for 48h was determined. An increase in the turnover and production of the GIT is biologically very expensive for the birds and involves losses of endogenous amino acids. It can be concluded that a decrease of secretion from the gastrointestinal tract is one of the mechanisms involved in the mode of action of dietary phytases.

**Key Words:** phytase, turkeys, endogenous losses

**M18 Effect of pelleting temperature and phytase type on phytase survivability and broiler performance.** R. Angel\*<sup>1</sup>, N. Ward<sup>2</sup>, and A. D. Mitchell<sup>3</sup>, <sup>1</sup>University of Maryland, College Park, <sup>2</sup>DSM Nutrition Products, Inc., Parsippany, New Jersey, <sup>3</sup>USDA, BARC, Beltsville, Maryland.

A two part study was conducted to determine survivability of phytases when subjected to pelleting and their subsequent. A basal corn-soy diet was used. To achieve all Ca, P, and phytase concentrations, monocalcium phosphate, calcium carbonate, phytase, and Celite® (marker and filler) were used. Diets were: 0.24, 0.32, and 0.40%

non-phytate P (nPP), no added phytase diets and 8 diets with added phytase at different concentrations to the 0.24% nPP diet. Ronozyme (P) CT® (R) and Quantum Phytase TM 2500 D (Q) were tested. Q was added at 250, 500, and 1000 U/kg and R at 500 U/kg. Enzymes were added based on analyzed activity and added either pre-or post pelleting (PreP, PostP) resulting in 8 diets. Pelleting was done at 70, 80, or 90 C. Only diets pelleted at 90 C were fed. Ross 308 broilers were allocated, at hatch (H), to battery pens, 7 pens (7 b/pen) per diet. BW, FC and feed/gain were determined at 8 and 18d of age. At 18 d, 3 b/pen were frozen and bone mineral content and density determined using dual energy X-ray absorptiometry. Toes and right tibia were removed and dry-defatted ash determined. Excreta were collected, to determine apparent P retention, excreta P solubility. Enzyme survivability during pelleting was 61.8, 25.4, and 7.1% for Q and 77.2, 67.1, and 57.7% for R at 70, 80, or 90 C, respectively. The greatest BW ( $P < 0.01$ ) was in broilers fed the 0.40% nPP diet (731.4 g), followed by those fed the PreP Q1000 diet (685.9 g). Broilers fed the PostP Q1000 and R500 diets had similar weight at 18 d (688.1 and 684.1 g). Tibia ash was greatest ( $P < 0.01$ ) in broilers fed the 0.40% nPP diet and the PreP Q1000 diet (51.12 and 50.04%), followed by those fed the PreP Q500 and R500 diets (49.86 and 48.82%). Broilers fed the PostP R500 and Q1000 diets had similar tibia ash (47.91 and 47.53%). P retention was similar ( $P > 0.05$ , 57.5 and 54.7%) for birds on the pelleted R 500 and Q500 diets and was lower ( $P < 0.01$ ) for birds fed the 0.40% nPP diet (47.9%). The R enzyme survived pelleting better than the Q enzyme. Apparent efficacy of the enzymes after pelleting was similar, while the Q enzyme had better efficacy than the R enzyme if fed in PreP diets.

**Key Words:** phytase, pelleting, broiler

**M19 The effects of vitamin D supplementation to peak-producing hens fed diets containing different fat source and level on laying performance, metabolic profile, and egg quality.** L. Turgut<sup>1</sup>, A. Hayirli\*<sup>2</sup>, S. Çelebi<sup>1</sup>, M. A. Yörük<sup>2</sup>, M. Gül<sup>2</sup>, M. Karaoglu<sup>1</sup>, and M. Macit<sup>1</sup>, <sup>1</sup>Atatürk University, Erzurum, Turkey, <sup>2</sup>Atatürk University, Erzurum, Turkey.

This experiment was designed to examine the effects of supplemental vitamin D on laying performance, metabolic profile and egg quality of hens fed diets containing different fat source and level. Lohman strains (n=480) were assigned to one of 10 diets: diets containing 0, 2.5 and 5.0% sunflower oil (SO) or tallow (T), and these diets with 3-fold vitamin D. Each diet was tested in 12 replicate cages of 4 hens, from wk 30 to 44. Both fats decreased feed intake (FI) as compared to basal diet. Increasing SO and T levels linearly decreased and quadratically increased FI, respectively. Diets did not affect egg production (EP) and egg weight. Vitamin D supplementation increased and decreased EP when diets contained SO and T, respectively. Feed conversion ratio (FCR) for hens fed SO was lower than for hens fed T. However, increasing T level improved FCR, whereas increasing SO level worsened FCR. Serum vitamin D concentration was higher for hens fed SO than for hens fed T. Vitamin D supplementation increased serum vitamin D concentration. Increasing fat level linearly increased TG and VLDL concentrations. Increasing SO level linearly decreased cholesterol concentration. Vitamin D supplementation did not alter lipid metabolites. Diets did not affect serum Ca, and P concentrations. As compared with control diet, SO decreased dry tibia and ash weight more than T. Vitamin D supplementation tended to increase dry tibia weight and decreased tibia ash weight. Most of egg quality parameters were not responsive to the diets. Eggshell strength quadratically

increased with increasing T level. Yolk color for hens fed SO was lower than for hens fed T. Increasing SO level quadratically decreased yolk C18:2 concentration. Vitamin D addition increased and decreased yolk C18:2 concentration when diets contained SO and T, respectively. In conclusion, increasing fat level improved laying performance without adverse effects on metabolic profile and egg quality. Vitamin D supplementation had minor alteration effects on parameters in response to fat feeding.

**Key Words:** sunflower oil, tallow, vitamin D

**M20 Developmental regulation of monosaccharide transporter mRNA in the small intestine of broiler chicks.** E. R. Gilbert\*<sup>1</sup>, H. Li<sup>1</sup>, D. Emmerson<sup>2</sup>, K. E. Webb, Jr.<sup>1</sup>, and E. A. Wong<sup>1</sup>, <sup>1</sup>Virginia Tech, Blacksburg, <sup>2</sup>Aviagen, Huntsville, Alabama.

The objective of this research was to investigate mRNA abundance of sugar transporters in the small intestine of two genetic lines of broilers, selected on corn-soybean (Line A) or wheat based (Line B) diets. The genes examined included SGLT1, SGLT5, GLUT5, and GLUT2. Intestine was collected from four males from each line at the following time points: embryo day 18 (e18) and 20 (e20), day of hatch (doh), and d 1, d 3, d 7 and d 14 after hatch. After hatch, birds were given ad libitum access to a low-protein, corn-soy based diet, as this has been shown to accentuate differences in body weight between the two lines. At e18 total intestine was collected, and thereafter, intestine was divided into duodenum, jejunum, and ileum. Total RNA was isolated and mRNA abundance was assayed using real time PCR and the absolute quantification method. Data were analyzed using the PROC MIXED procedure of SAS. The model included the main effects of bird line, intestinal segment and age, and appropriate interactions. Segment differences were evaluated by the Tukey test. For SGLT1, GLUT5 and GLUT2, mRNA levels were greatest in the jejunum ( $P = 0.0001$ ). For SGLT5, mRNA was greatest in the ileum and lowest in the duodenum ( $P = 0.0001$ ). Quantities of SGLT1 mRNA were approximately sixfold greater than SGLT5, suggesting an important role for SGLT1 in apical membrane glucose transport. For GLUT5, GLUT2, and SGLT1 there was an interaction of age x segment ( $P = 0.008$ ), with mRNA increasing most dramatically with age in the jejunum. For GLUT2 there tended to be an age x line interaction ( $P = 0.0549$ ), with line B mRNA increasing more dramatically after d3. In conclusion, sugar transporter mRNA was expressed the greatest in the mid-region of the small intestine, except for SGLT5, which was greatest in the distal region. Quantities of SGLT5 mRNA were higher in Line A.

**Key Words:** glucose transporter, real time PCR, broiler

**M21 Morphometry of intestinal mucosa in 21 day-old broiler chickens fed mannan-oligosaccharides and a blend of enzymes.** M. C. Oliveira\*<sup>1</sup>, R. A. Gravena<sup>2</sup>, R. H. Marques<sup>2</sup>, L. C. Cancherini<sup>2</sup>, E. A. Rodrigues<sup>2</sup>, and V. M. B. Moraes<sup>2</sup>, <sup>1</sup>University of Rio Verde, Rio Verde, GO, Brazil, <sup>2</sup>State University of Sao Paulo, Jaboticabal, SP, Brazil.

This experiment evaluated the morphometry (height and perimeter of villi and crypt depth) of intestinal mucosa in broiler chickens fed mannan-oligosaccharides (MOS) and a blend of enzymes (BE) at 21 days of age. Seven hundred fifty day-old Cobb chicks were randomly assigned to a  $2 \times 2 + 1$  factorial design - two levels of MOS (0 and

0.1%), two levels of BE (0 and 0.05%) plus a positive control diet for a total of five treatments with five replicates each. Positive control contained colistin sulphate (125 ppm) and virginiamycin (10 ppm) as growth promoters, and salinomycin (51 ppm) as anticoccidial. BE was comprised of cellulase, protease and amylase. After 12 h of fasting, five birds per treatment were euthanized, and a 3-cm sample of each small intestine segment were collected. Height and perimeter of villi, and crypt depth were evaluated by light microscopy. A MOS x BE interaction were observed for perimeter ( $P < 0.002$ ) and height ( $P < 0.002$ ) of duodenal villi, which were larger compared with those of negative-control chickens. Addition of MOS to the diet increased ( $P < 0.05$ ) the perimeter of the jejunal villi. Perimeter ( $P < 0.04$ ) and height ( $P < 0.05$ ) of ileal villi from chickens fed non-additive diets were both smaller. The high proliferation of bacteria in intestine of broilers fed diets without antibiotic, MOS and/or BE probably damaged the intestinal mucosa. The stimulatory effects of MOS were attributed to the reduction of pathogens in the gut together with the production of short chain fatty acids after fermentation of digest in the distal intestine. The inclusion of enzyme to the diet quantitatively lowered the available substrate to the bacteria growth, usually high in the lower segment of the small intestine. Compared with chickens fed an antibiotic-treated diet, duodenal villi from birds of MOS group had larger perimeter ( $P < 0.02$ ), larger height ( $P < 0.005$ ), and deeper crypt ( $P < 0.02$ ). In conclusion, it was observed that the use of MOS and/or BE improved the integrity of intestinal mucosa in broilers from 1 to 21 days of age.

**Key Words:** additives, intestinal morphology, prebiotic

**M22 Effect of supplementing a probiotic feed additive on performance and digestibility of broilers.** J. Sánchez\*<sup>1</sup>, A. Quiles<sup>2</sup>, A. E. Espinel<sup>3</sup>, D. Díaz<sup>3</sup>, and M. I. Gracia<sup>1</sup>, <sup>1</sup>Imasde Agropecuaria S.L., Madrid, Spain, <sup>2</sup>Universidad de Murcia, Spain, <sup>3</sup>Norel S.A., Madrid, Spain.

A total of 960 Ross 308 d-old broilers were used to study the efficacy of a probiotic feed additive (Ecobiol®) containing  $1 \times 10^9$  CFU/g of *Bacillus coagulans* CECT 5940. A randomized complete design was applied using four experimental treatments: T1 designated as control (no added probiotic), and T2, T3 and T4, the control diet with 100, 500 and 1,000 mg/kg of probiotic, supplying  $1 \times 10^8$ ,  $5 \times 10^8$  and  $1 \times 10^9$  CFU/kg feed, respectively. The experimental design was applied to 10 pens of 24 broilers (half males and half females) per treatment in both the starter (0-21 d) and the grower (21-42 d) phases. The experimental diets, based on barley, wheat and soya, were presented as mash, did not contain any coccidiostat or growth promoter and were fed ad libitum to the chicks. At the end of the trial, four birds per replicate were sacrificed, the ileum content collected and freeze-dried. Apparent ileal digestibility (AID) of crude protein, ether extract, starch and crude fiber were calculated using acid insoluble ash as indigestible marker. Body weight, mortality, weight gain, feed intake, feed to gain ratio, the European Production Efficiency Factor (EPEF), and AID coefficients were analyzed as a randomized complete design by GLM procedure of SAS. Probiotic supplementation at 1,000 mg/kg improved feed to gain ratio (1.98 vs 1.89 g feed/g gain from 22-42 d;  $P = 0.06$ , and 1.91 vs 1.84 for 0-42d;  $P \leq 0.05$ ) and EPEF at 42 d (273 vs 299;  $P \leq 0.05$ ) compared to control diet. In addition, broilers supplemented with the probiotic at 1,000 mg/kg showed higher AID of crude protein (+8.1%;  $P \leq 0.001$ ), ether extract (+7.3%;  $P \leq 0.05$ ), starch (+3.8%;  $P \leq 0.05$ ), and crude fiber ( $P \leq 0.05$ ) than control birds. No differences were detected in performance when the probiotic was supplemented at

lower doses. It is concluded that *B. coagulans* probiotic feed additive at 1,000 mg/kg improves performance and AID of broilers fed wheat-barley/soya diets.

**Key Words:** probiotic, ileal digestibility, broilers

**M23 Screening of selected probiotic isolates for phytase activity and effects on poultry when fed low phosphorus diets.**

A. Torres Rodriguez<sup>1</sup>, G. Gaona\*<sup>2</sup>, A. Wolfenden<sup>2</sup>, G. Tellez<sup>2</sup>, and B. Hargis<sup>2</sup>, <sup>1</sup>*Cobb-Vantress, Siloam Springs, Arkansas*, <sup>2</sup>*University of Arkansas, Fayetteville*.

Selected probiotic strains of lactic acid bacteria were screened for phytase activity with an agar plate staining technique. The staining technique is based on the color reaction between free phosphate and ammonium molybdate (Yanke *et al.*, 1998). Agar plates containing phytate substrate (1% w/v) were used to grow 11 strains of lactic acid bacteria (LAB) selected for their ability to exclude *Salmonella enteritidis* from the gastrointestinal tract of poultry with improvements in performance. The presence of the enzyme phytase was confirmed in 9 of the 11 selected LAB strains. Experiments were conducted with turkey poults fed low phosphorus diets alone or supplemented with LAB. Preliminary trials using ten day-old poults reared with regular turkey starter feed prior to feeding phosphorus-deficient diets for periods of at least two weeks indicate that poults receiving a low phosphorus diet supplemented with LAB and lactose may grow at similar or higher rates than the P-deficient and unsupplemented counterparts. No apparent statistical significances were detected in tibia bone ash and tibia diameter, although the latter tended to be greater in the probiotic-supplemented group.

**Key Words:** probiotic, phytase

**M24 High glucose levels in ovo causes damage to embryos.**

A. A. Pedroso\*, L. S. Chaves, V. T. Barbosa, I. B. Maciel, and C. E. Barbosa, *University of Goias, Goiania, Goias, Brazil*.

High glucose levels were tested as in ovo feeding to chick embryos. An experiment was carried out using 600 fertilized eggs. The eggs were identified, weighed, and allocated into five incubators regulated at 65% RH and 37.5°C. At the 15th incubation day, eggshells were drilled in air chamber region and the solution was manually injected with a sterile syringe. Each egg was injected with either 0, 100, 200 or 300 mg of glucose dissolved in 300 ml of saline solution (0.9%). The glucose was deposited in the amniotic liquid. Entire eggs represented the control group. The experiment consisted by five treatments with 120 eggs used in each treatment. Each egg represented an experimental unit. After inoculation, the eggs were packed individually in tulle and relocated into the incubators until hatch. The treatments 100, 200 or 300 mg of glucose cause damage to embryos. High mortalities were observed in later embryonic phase (from 15 to 20 days of incubator). Possibility, glucose altered the egg osmotic balance, and damaged the embryonic cells. Glucose levels did not improve hatchability, relation of chick:egg, and chick weight.

**Key Words:** in ovo feeding, chicks, carbohydrate

**M25 Effects of broiler fed amylase, protease, and xylanase on intestinal enzyme activities.** X. Sun\*, C. Troche, A. Parsons, A. McElroy, E. Wong, A. Stevens, and C. Novak, *Virginia Tech, Blacksburg*.

A study was conducted to investigate the effects of dietary enzymes on growth performance, intestinal enzyme activities. Ninety broiler chicks were assigned to one of two dietary treatments (with or without Avizyme 1502) from d 0 to 21. Sixteen chicks were weighed from each treatment at d 7, 14, and 21. Half (n = 8) were used to collect digesta from the jejunum and ileum to determine amylase and protease activities. Remaining chicks were used to obtain duodenum, jejunum, and ileum tissues to evaluate maltase, sucrase, and aminopeptidase N activity. There were no significant differences between dietary treatments in body weight. Jejunal amylase activity in enzyme supplemented chicks at d 7 and 21 was higher (P < 0.05) compared to control chicks (d7, 93.40 vs. 160.86 U/g wet digesta; d 21, 92.78 vs. 162.45 U/g wet digesta). There was no significant difference in ileal amylase and protease activity at any age. Duodenum maltase activity on d 21 was higher (P < 0.05) compared to d 14 and 7 (9.85 vs. 5.55 and 2.50 U/mg protein, respectively) with activity on d 14 being higher than (P < 0.05) d 7. Duodenum aminopeptidase N on d 21 was higher (P < 0.05) compared to d 7 (0.58 vs. 0.41 U/mg protein). Jejunal maltase activity on d 21 was greater (P < 0.05) compared to d 14 and 7 (3.61 vs. 1.44 and 1.39 U/mg protein, respectively). Ileum maltase activity on d 14 was higher (P < 0.05) compared to d 21 (0.95 vs. 0.50 U/mg protein). There were no differences observed in maltase activity between control and enzyme supplemented chicks in duodenum (5.45 vs. 6.45 U/mg protein), jejunum (2.25 vs. 2.04 U/mg protein), and ileum (0.59 vs. 0.86 U/mg protein). Also noted was a trend of decreasing maltase activity from duodenum to ileum. Jejunal sucrase activity on d 7 was higher (P < 0.05) compared to d 14 and 21 (0.022 vs. 0.014 and 0.014 U/mg protein). Ileal sucrase activity on d14 was greater (P < 0.05) compared to d 21 (0.037 vs. 0.020 U/mg protein). This study indicates supplementing chicks with Avizyme 1502 will increase digesta amylase activity but not protease, disaccharidase or aminopeptidase N.

**Key Words:** broiler, amylase, disaccharidase

**M26 Maternal dietary conjugated linoleic acid had no adverse effects on progeny development.** V. A. Leone\* and M. E. Cook, *University of Wisconsin, Madison*.

We have previously shown that decreased hatchability of eggs from hens fed conjugated linoleic acid (CLA) could be prevented by the addition of monounsaturated (MUFA) or polyunsaturated (PUFA) fats. While linoleic acid (LA) addition to the diet prevented CLA-induced embryonic mortality, the feeding of both CLA and LA (both inhibitors of stearoyl CoA desaturase, SCD-1) dramatically reduced egg yolk MUFA. Studies involving SCD-1 knock-out mice have demonstrated altered lipogenesis; however, no study has reported the effects of maternal CLA (with particular reference to the hatchability in the presence of rescue oil) on post-hatch growth and development. Hence a study was conducted to investigate the effects of rescue oil type with or without CLA, on post-hatch development. Hens (48) were randomly assigned to 4 diets in a 2x2 factorial: 3.5% Safflower Oil (SO, 80% 18:2), 3.5% Olive Oil (OO, 80% 18:1), 3% SO+0.5% CLA (SO+CLA, CLA-60, 30% c9, t11 and 30% t10, c12 isomers), and 3% OO+0.5% CLA (OO+CLA). After two weeks on diet, hens were inseminated. Eggs were collected, held at 15 degrees C for one week, and incubated.

Egg production, fertility, and hatchability were recorded. Newly hatched chicks were separated by treatment and 50 chicks were assigned to 5 pens per treatment (10 chicks per pen). Individual chick weights and feed intake were monitored for 21 days. Maternal dietary CLA plus oil high in LA or OA had no adverse effects on egg production, fertility, or hatchability. Three experiments were performed to measure chick growth, feed consumption, and 21-day feed conversion. Data were pooled and analyzed for main effects of CLA and oil type, as well as CLA x oil interactions. Although not significant, a 6% improvement in 21-day feed conversion was seen in chicks hatched from hens fed OO+CLA in comparison to other treatment groups. CLA in the presence of rescue oil had no adverse effects on chick growth or 21-day feed conversion. Therefore, it appears that changes in fatty acids in the yolk associated with maternal CLA and rescue oils had no adverse effects on post-hatch chick development.

**Key Words:** maternal conjugated linoleic acid, progeny, development

**M27 Investigating possible interactions between phytase and xylanase in wheat-based diets for broilers.** T. A. Woyengo<sup>\*1</sup>, W. Guenter<sup>1</sup>, J. S. Sands<sup>2</sup>, and C. M. Nyachoti<sup>1</sup>, <sup>1</sup>University of Manitoba, Winnipeg, MB, Canada, <sup>2</sup>Danisco Animal Nutrition, St. Louis, Missouri.

An experiment was conducted to determine the effect of combining phytase and xylanase on nutrient utilisation and broiler performance. Three hundred and twenty male Ross-by-Ross broiler chicks were divided into 80 groups of 4 birds balanced for body weight (BW) and fed 10 wheat-based diets (8 groups/diet) from 1 to 23 d of age. The 10 diets were a control and a nutrient reduced (Ca and P) diet supplemented with phytase at 3 levels, 0, 250 and 500 FTU/kg and xylanase at 3 levels, 0, 1250 and 2500 XU/kg in a 3x3 factorial arrangement to give 9 treatment combinations. Chromic oxide (0.3%) was added to the diets as an indigestible marker to determine nutrient digestibility and retention at 3 weeks of age. There were no significant interactions ( $P > 0.05$ ) between phytase and xylanase on any of the parameters measured. ADFI and ADG were not affected by enzyme supplementation but FCE was improved only by phytase supplementation at 250 FTU/kg. Birds fed non-enzyme supplemented nutrient reduced diet had lower ( $P < 0.05$ ) ADFI (37.2 vs 45.3 g) and ADG (28.9 vs 34.6 g) than the positive control. Phytase, but not xylanase, increased ( $P < 0.05$ ) ileal digestibility and retention of P from 35.1 to 41.3 % and 47.3 to 51.4 %, respectively. However, there was no effect ( $P > 0.05$ ) of increasing the level of phytase from 250 to 500 FTU/kg on ileal digestibility (41.3 vs 42.3 %) and retention of P (51.4 vs 51.0 %). Both phytase and xylanase did not influence ( $P > 0.05$ ) ileal Ca digestibility and energy retention, but the 250 and 1250 levels increased ( $P < 0.05$ ) Ca retention by 8.6 and 13.8 % respectively. However, there was no further effect ( $P > 0.05$ ) at higher levels of phytase (56.8 vs 55.0 %) and xylanase (57.6 vs 55.8 %) on Ca retention.

**Key Words:** wheat, phytase/xylanase, nutrient digestibility

**M28 Effect of folic acid supplemented diets with and without enzyme on folate deposition in the egg yolk.** T. M. Dickson\*, W. Guenter, and J. D. House, University of Manitoba, Winnipeg, MB, Canada.

Previous research has shown that egg folate deposition is a saturable process. One potential regulatory mechanism exists at the level of intestinal folate absorption. Feed constituents can influence nutrient absorption: Diets high in non-starch polysaccharides (NSPs) are poorly digested, leading to increased intestinal viscosity and, potentially, reduced folate absorption. The objectives of the current trial were 1) to determine the effect of the addition of dietary enzymes to a wheat/rye-based diet on egg folate content, and 2) to determine the effect of rye- and wheat-based rations supplemented with crystalline folic acid on the egg folate content. To address these objectives, 120 Hy-Line CV20 laying hens ( $n = 12$  per diet) received a 40% (of grain) rye and wheat ration containing 0, 0.5, 1.0, 2.0, or 4 mg of crystalline folic acid/kg of feed plus or minus xylanase enzyme (2000 units/kg of diet) for five 7-day periods. Response criteria included measures of in vivo viscosity and measures of egg folate content. Data was analyzed as a completely randomized design, which revealed that the enzyme had significant ( $P < 0.0001$ ) main effects on in vivo viscosity. Folate data was analyzed as a repeated measures design using the mixed procedure which revealed that the addition of enzyme to the diet had no significant ( $P > 0.05$ ) effect on egg folate levels. Egg folate content significantly ( $P < 0.0001$ ) increased 2.2-fold; from 1.30 micrograms of folate/gram of yolk with an unsupplemented diet without enzyme to 2.96 micrograms of folate/gram of yolk when supplemented with 4 mg folic acid/ kg of diet and no enzyme. Average egg folate levels over the 5 periods were 1.3, 1.7, 2.1, 2.5, and 2.6 micrograms/gram of yolk for respective rations containing 0, 0.5, 1.0, 2.0, and 4 mg of crystalline folic acid/kg of diet without enzyme. While folate levels in the egg increased as the amount of supplemental dietary crystalline folic acid increased, the intestinal viscosity did not affect folate deposition.

**Key Words:** egg, folate, intestinal viscosity

**M29 EU promoted development of a multi-component feed additive for the safe use in poultry production.** V. Klose<sup>\*1</sup>, R. Plail<sup>1</sup>, M. Mohnl<sup>1</sup>, S. Nitsch<sup>2</sup>, and G. Schatzmayr<sup>2</sup>, <sup>1</sup>University of Natural Resources and Applied Life Sciences, Tulln, Austria, <sup>2</sup>Biomin GmbH, Herzogenburg, Austria.

Assessment of the main criteria for evaluation of probiotics in terms of identity, efficacy and safety is an essential part in the development of a zootechnical feed additive for use in European broiler production. An EU-promoted project (C-EX QLK-CT-2002-71662) was initiated to develop a well-defined multi-component product combining various effective strains. A large pool of gut bacteria was isolated out of the intestine of healthy broilers and classified by combining morphological, physiological and genotypic methods along the route of a polyphasic approach in order to obtain optimal strains for a competitive exclusion product. 121 strains were selected as representatives based on differences in whole cell protein patterns and screened for antagonistic properties by using a co-cultivation assay. A reduced number of 20 strains exhibited the ability to inhibit several common poultry pathogens (*Salmonella enteritidis*, *S. choleraesuis*, *E. coli* serotypes, *C. jejuni* and *C. perfringens*). Five effective strains (*Pediococcus acidilactici*, *Enterococcus faecium*, *Bifidobacterium animalis* ssp. *animalis*, *Lactobacillus reuteri*, *L. salivarius* ssp. *salivarius*) were

chosen for the combined use in the final product (Biomim<sup>®</sup> PoultryStar) and further evaluated with regard to the European safety requirements. The probiotic candidates were sensitive to the majority of clinically effective antibiotics. Single resistances were proven to be intrinsic (e.g. *vanA*) and not transferable. Positive effects of Biomim<sup>®</sup> PoultryStar have been shown *in vivo* with a feeding trial which revealed a statistically significant ( $P < 0.05$ ) increase in average body weight as well as in weight gain (~7.6%).

**Table 1. Results of the feeding trial with mixed sex Ross 308 broilers obtained at day 35**

group	control	Biomim <sup>®</sup> PoultryStar
no. of broilers	240	240
live weight (g)	1875 <sup>a</sup>	2017 <sup>b</sup>
daily weight gain (g)	52 <sup>a</sup>	56 <sup>b</sup>
feed conversion rate	1.66	1.61
mortality (%)	1.25	0.42
European Production Efficiency Factor	318	356

<sup>a, b</sup> significant difference ( $P < 0.05$ )

**Key Words:** competitive exclusion, European registration, safety assessment

**M30 The effect of Tasker Blue on shelf-life of fresh broiler chicken carcasses.** S. M. Russell\*, *The University of Georgia, Athens.*

A study was conducted to evaluate the effect of Tasker Blue (sulfuric acid, ammonium sulfate, and copper sulfate) on the shelf-life of fresh broiler chicken. To mimic application of the product in the scald, chillers, and as a post-chill dip, the following were prepared: two 55 gallon drums were filled with scald water (S), 2 with water from chiller 1 (CH1), 2 with water from chiller 2 (CH2), 2 with water from chiller 3 (CH3), and 2 with tap water (DIP) after 5 h of run-time in a commercial poultry processing facility. One of each of these pairs of drums was used as a control and one was dosed with Tasker Blue to a pH of 2.0 and copper content of 2.0 ppm, except the chiller water drums were dosed to a pH of 3.2 and a copper content of 2.0 ppm. Eighteen carcasses each were exposed to the control or treated S for 2 min, CH1 for 17 min, CH2 for 15 min, CH3 for 45 min, and DIP for 10 s, allowed to drip for 1 min, individually placed into sterile bags, and packed on ice in a cooler. The carcasses were transported to the laboratory and held at 4°C for 6 days. At Day 6, 8, 10, 12, 14, and 16, three carcasses each from the control and treated groups were evaluated by a three-member panel for odor score where 1=no off odor, 2=questionable with regard to acceptability, and 3=unacceptable. Additionally, psychrotrophic counts (PPC) were conducted. Odor scores were 1, 2, 3, 3, 3, and 3 for controls and 1, 1, 1, 2, 2, and 3 for treated samples on Day 6, 8, 10, 12, 14, and 16, respectively. Log<sub>10</sub> PPC were 7.3, 7.6, 11, 11, 11, and 11 for controls and 5.2, 5.1, 6.8, 7.7, 8.1, and 11 for treated samples on Day 6, 8, 10, 12, 14, and 16, respectively. Odor scores were significantly ( $P \leq 0.05$ ) reduced for treated carcasses at Day 8 through 14 of storage. PPC were significantly ( $P \leq 0.05$ ) lower on treated carcasses at Day 6 through 14 of storage. Tasker Blue dramatically suppressed the growth of spoilage bacteria with a 99.99% reduction at Day 10 and a 99.9% reduction at Day 12 of storage. Tasker Blue prevented any spoilage defect from occurring

on carcasses until Day 12 (4 days later than controls) and prevented complete spoilage from occurring until Day 16 (6 days later than controls). These data clearly indicate that Tasker Blue had a significant impact on spoilage of broiler chicken carcasses.

**Key Words:** shelf-life, Tasker Blue, chicken

**M31 Virtual field trip web site for poultry processing education.** J. M. Regenstein\*, *Cornell University, Ithaca, New York.*

The objective of this USDA Higher Education Challenge Grant is to establish a large library of video assets for the food processing industry, including poultry. These assets will be short videos from 5 to 30 sec showing unit operations and general overviews of food processing facilities. The assets are being supplied by the food industry, mainly suppliers. It is being reviewed and edited to obtain the most pedagogically useful items. The web site has search capabilities and contributor information. Users can "store" clips for later review or class sharing. The temporary site is open to the professional community. Additional assets are being processed. In addition, model active learning materials featured on the site will suggest ways that instructors can use the site to optimize learning by engaging the student. An instructional designer is working with us to optimize how these models can be used to optimize learning and enhance teaching. A set of active learning materials for poultry are based on input obtained from a group of American poultry faculty. Three active learning models have been developed. The first model is a PowerPoint based detailed flow chart of a poultry processing plant with metalinks to the video assets. The other two models involve metalinks embedded within the chapter text and outline on poultry processing written by Dr. Dan Fletcher at the University of Georgia in Athens. These active learning models and assets are at the temporary site [www.seeker.doit.wisc.edu/foodsci](http://www.seeker.doit.wisc.edu/foodsci). We are looking for feedback from the poultry community to improve these materials before completing the permanent web site.

**Key Words:** video clips, active Learning, poultry processing

**M32 Influence of deboning time on meat quality of broilers processed at two market weights.** B. Saenmahayak\*, S. F. Bilgili, J. B. Hess, J. Townsend, and M. Nagaraj, *Auburn University, Auburn, Alabama.*

Influence of post-mortem (PM) deboning time on breast meat yield and quality of broilers was assessed at two market weights. A total of 1600 male broilers were raised in 32 floor pens to 56 d of age. At 42 and 56 d of age, 10 birds were randomly selected from each pen, processed and chilled in static slush ice. At each age, one-half of the birds (5 birds/pen) were deboned immediately after static chilling (2 h postmortem; PM) and the remaining after overnight aging in a cooler at 4 C (24 h PM). Whole carcass, abdominal fat, parts (wings, leg quarters) and deboned breast (fillet and tender) yields were determined. Deboned breast fillets were individually bagged and stored at 4 C for drip loss (12 h and 48 h), cook loss, and water holding capacity (WHC) measurements. Breast fillet color ( $L^*$ ,  $a^*$  and  $b^*$ ) was determined at 56 d age.

At 42 d of age, no significant treatment effects were detected ( $P > 0.05$ ) for whole carcass and parts yields. However, breast fillet and total breast (fillet + tender) yields were significantly higher in the 2 h PM (25.7 and 30.8%) than in 24 h PM (25.2 and 30.3%) treatments, respectively. Conversely, at 56 d of age, birds deboned 2 h PM had

significantly higher parts yields than those deboned at 24 h. Deboned breast yields (fillet, tender and fillet + tender) were significantly different between the PM treatments (2 h PM; 26.2, 5.1 and 31.3%, 24 h PM; 25.2, 4.9 and 30.1%). As expected, drip loss (12 h), and WHC were higher for 2 h than 24 h PM treatments, both at 42 and 56 d of age. Cook loss differed between the PM treatments at 42 d, but not at 56 d of age. Breast fillets deboned 2 h PM were significantly darker ( $L^* = 54.8$ ) as compared to those deboned at 24 h ( $L^* = 56.5$ ). The yield advantage (0.5-1.2%) in breast meat from early deboning (2 h PM) observed at 42 and 56 d of age may be lost upon refrigerated storage and cooking.

**Key Words:** broilers, meat quality, market weight

**M33 Effects of proteolysis on textural properties and water-holding capacity of heat-induced turkey breast meat gels.** X. Li\*, Z. Pietrasik, and P. J. Shand, *University of Saskatchewan, Saskatoon, SK, Canada.*

Protein denaturation and degradation early postmortem are major defects of pale, soft, and exudative (PSE) turkey meat, however the relationship between degradation and gelation is unclear. The purpose of this research was to investigate the effect of an exogenous proteinase on textural properties and water-holding capacity (WHC) of heat-induced gels prepared from normal and PSE turkey breast meat.

Breast meat from normal and PSE turkeys was used to make low-fat high moisture meat gels. To create different extent of proteolysis in the meat,  $\alpha$ -chymotrypsin (EC3.4.21.1) was added to the meat batters at 0, 2.5, 5 and 10 ppm levels. Then meat batters were stuffed into 50 mL tubes, held at 37°C for 30 min and cooked to 80°C in a water bath.

SDS-PAGE of meat gels showed no visible changes in banding patterns with 2.5 ppm  $\alpha$ -chymotrypsin, but protein hydrolysis became apparent at higher levels. At the highest proteinase level, band density of the myosin heavy chain (MHC) decreased up to 43% and 38% for normal and PSE samples, respectively. Actin and other proteins were also hydrolyzed to a lesser extent. Texture profile analysis and torsional analysis of the cooked meat gels showed an incremental deterioration in texture with increasing enzyme level. For instance, hardness decreased by 10%, 22%, and 75%, and shear stress decreased by 15%, 26%, and 72% for normal meat gels, respectively. Smaller decreases in texture were observed for gels made from PSE meat, which may have been related to its inferior initial quality. No significant difference in cook loss was observed either between normal and PSE groups or among treatments. Expressible moisture (EM) of PSE gels was higher ( $p < 0.05$ ) than that of normal gels and increased with enzyme level. Pearson correlation coefficients indicated gel textural properties and EM were highly correlated to the degree of proteolysis, especially to that of MHC ( $p < 0.001$ ). Even a low extent of proteolysis had a dramatic effect on textural properties of turkey breast meat gels.

**Key Words:** proteolysis, textural properties, WHC

**M34 An assessment of antioxidant and oxidant status in diverse poultry species.** X. Guan\*, K. B. Gyenai, F. A. McNabb, and E. J. Smith, *Virginia Tech, Blacksburg.*

Oxidative stress, a result of an imbalance between oxidants and antioxidants, causes macromolecular damage which results in diseases

and other abnormalities. Though it has been implicated in many diseases in mammals, it has been little studied in economically important poultry species. Here, our objective was to compare the oxidant (thiobarbiturate acid reacting substance, TBARS, as biomarker) and antioxidant (plasma uric acid, PUA and glutathione, GSH as biomarkers) status of three poultry species including turkey (*Meleagris gallopavo*), Japanese quail (*Coturnix japonica*), and guinea fowl (*Numida meleagris*). At 2 months-of-age, oxidant levels in the three species were significantly different, with the quail having the highest at 0.72mg/L, and the turkey having the lowest at 0.31mg/L. At this age, the antioxidant levels were also significantly different with guinea fowl showing the highest value of 10.4 mg/dL and 750.6 $\mu$ M for PUA and GSH respectively. At 6 months of age, lipid peroxidation as reflected in the TBARS values, about 5mg/L, was not significantly different among the three species. Differences in the antioxidant levels, however, varied with biomarker. Guinea fowl had the highest PUA level of 7.6mg/dL and quail the lowest of 5.1mg/dL. Guinea fowl also had the highest GSH level of about 660.6 $\mu$ M though the differences between the turkey and quail were not significant. Though not consistent, the data suggests that the quail has the highest oxidant status while the guinea fowl the lowest antioxidant level. They appear to suggest that on the average oxidative stress is highest in the quail and may not be very different in the turkey and guinea fowl.

**Key Words:** antioxidant, oxidant, poultry

**M35 Effects of feeding grains naturally contaminated with fusarium mycotoxins on brain regional neurochemistry of laying hens, turkey poult, and broiler breeder hens.** M. Yegani\*<sup>1</sup>, S. R. Chowdhury<sup>1</sup>, N. Oinas<sup>2</sup>, E. J. MacDonald<sup>2</sup>, and T. K. Smith<sup>1</sup>, <sup>1</sup>*University of Guelph, Guelph, ON, Canada,* <sup>2</sup>*University of Kuopio, Kuopio, Finland.*

Three experiments were conducted in order to compare the effects of feeding blends of grains naturally contaminated with Fusarium mycotoxins on brain regional neurochemistry of laying hens, turkey poult, and broiler breeder hens. In experiment 1, thirty-six 45-wk-old laying hens were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2% polymeric glucomannan mycotoxin adsorbent (GMA) for 4 wk. Concentrations of brain neurotransmitters and metabolites were analyzed in pons, hypothalamus and cortex by high performance liquid chromatography with electrochemical detection. Neurotransmitters and the metabolites measured included dopamine (DA), 3, 4-dihydroxyphenylacetic acid (DOPAC), homovanillic acid (HVA), serotonin (5-HT), hydroxyindolacetic acid (5-HIAA), epinephrine (EPI), and norepinephrine (NE). The feeding of contaminated grains significantly increased concentrations of serotonin (5-HT) and decreased the ratio of 5-HIAA: 5-HT in the pons region in the brain stem. Dietary supplementation with GMA prevented these effects. There was no effect of diet on concentrations of other neurotransmitters or metabolites in the pons, hypothalamus or cortex. In experiment 2, thirty-six 1-d-old turkey poult were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2% GMA for 4 wk. Hypothalamic, pons, and cortex neurotransmitter concentrations were not affected by diet. In experiment 3, forty-two 26-wk-old broiler breeder hens were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2% GMA for 15 wk. There was no effect of diet on neurotransmitter concentrations in the pons, hypothalamus, or cortex. It was concluded that different effects of diet on brain neurotransmitter concentrations might explain

the intra-species differences in the severity of *Fusarium* mycotoxin-induced reductions in feed intake.

**Key Words:** fusarium mycotoxin, brain regional neurochemistry, broiler breeder hen

**M36 Effects of feeding grains naturally contaminated with fusarium mycotoxins on performance and metabolism of broiler breeders and efficacy of a polymeric glucomannan mycotoxins adsorbent.** M. Yegani<sup>\*1</sup>, T. K. Smith<sup>1</sup>, S. Leeson<sup>1</sup>, and H. J. Boermans<sup>2</sup>, <sup>1</sup>*University of Guelph, Guelph, ON, Canada*, <sup>2</sup>*University of Guelph, Guelph, ON, Canada*.

A study was conducted in order to investigate the effects of feeding grains naturally contaminated with *Fusarium* mycotoxins on performance and metabolism of broiler breeders. Forty two 26-wk-old broiler breeder hens and nine roosters were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2 % polymeric glucomannan mycotoxin adsorbent (GMA) for 12 wk. The major contaminant was deoxynivalenol (12.6 mg/kg feed) with lesser amounts of zearalenone and 15-acetyl deoxynivalenol. Feed consumption and body weights were not affected by diet. The feeding of contaminated grains did not significantly affect egg production. Decreased eggshell thickness was seen, however, at the end of week 4 and dietary supplementation with GMA prevented this effect. There was no effect of diet on other egg parameters measured. There was a significant increase in early (1-7 d) embryonic mortality in eggs from birds fed contaminated grains at week 4 but mid (8-14 d) and late (15-21 d) embryonic mortalities were not affected by diet. There were no differences in newly hatched chick weights or viability. The ratio of chick weight to egg weight was not affected by the feeding of contaminated grains. Weight gains of chicks fed a standard broiler starter diet at 7, 14 and 21 days of age were not significantly affected by previous dietary treatments for the dam. There were also no differences in weekly or cumulative feed efficiency of the progeny. There was no effect of diet on the relative weights of liver, spleen, kidney, and testes. Blood biochemistry and hematological parameters were not affected by the feeding of contaminated grains. It was found that rooster semen volume and sperm concentration, viability and motility were not affected by the feeding of contaminated diets. The feeding of contaminated grains decreased antibody titers against infectious bronchitis virus at the end of week 12 and this was prevented by dietary supplementation with GMA. There was no effect of the diet on serum antibody titers against Newcastle disease virus. It was concluded that the feeding of diets containing *Fusarium* mycotoxins to broiler breeders impair reproductive performance and immune status and much of these effects can be prevented by the feeding of GMA.

**Key Words:** fusarium mycotoxin, broiler breeder, eggshell thickness

**M37 Bone mineralization in four commercial strains of meat-type chickens.** P. Talaty<sup>1</sup>, M. N. Katanbaf<sup>2</sup>, and P. Y. Hester<sup>\*1</sup>, <sup>1</sup>*Purdue University, West Lafayette, IN*, <sup>2</sup>*Cobb-Vantress, Inc., Monticello, Kentucky*.

The objective of this study was to determine life cycle changes, including variability, in bone mineral density (BMD) of the tibia and humerus of four different strains of male and female commercial meat-type chickens from 4 to 8 wk of age. Broilers were raised using

standard management practices and consumed commercial diets and water ad libitum. Bone mineralization was determined in birds by scanning the humerus and tibia using dual energy X-ray absorptiometry (DEXA). Birds to be scanned (3 chickens per pen with 3 replicate pens/strain) were selected randomly at 4 wk of age and repeated measurements done on the same birds at 4, 6, and 8 wk of age. Totals of 104 to 108 scans were performed on each strain of commercial broiler. The BMD was analyzed using an analysis of covariance with body weight as the covariant. Strain and sex of the bird were main plots with bone and age of the bird as subplots. The mixed model of SAS was employed. The BMD did not differ among the four strains of commercial broilers (0.212, 0.218, 0.209, and 0.207 for Cobb 500, Cobb 500T, Ross 308, and Cobb 700, respectively, SEM = 0.003, P=0.11). Interactions with strain of chicken were non-significant indicating that all strains of chickens responded similarly with respect to age (4, 6, and 8 wk of age), sex, and type of bone (humerus vs tibia). The BMD of broiler males decreased at 8 wk of age when compared to 4 and 6 wk of age, while the BMD of females showed little change from 4 to 8 wk of age resulting in a significant sex x age interaction (P < 0.02). The decrease in BMD observed in males at 8 wk of age was most likely due in part to the inability of some males to reach the feeders due to lameness. Only healthy birds without defects were selected at 4 wk of age for DEXA scanning; however, a few males developed leg abnormalities by 8 wk of age. Coefficients of variation for BMD ranged from 15 to 16% indicating a potential use of DEXA for selection to improve skeletal integrity.

**Key Words:** bone mineralization, dual-energy X-ray absorptiometry, broilers

**M38 Properly reporting religious slaughter in the scientific literature.** J. M. Regenstein<sup>\*</sup>, *Cornell University, Ithaca, New York*.

With the current interest and emphasis on animal welfare, including poultry, within the agricultural and processing communities, the issue of religious slaughter and its evaluation, mainly kosher (Jewish) and halal (Muslim), continues to be studied by the scientific community. In the literature many different methods of religious slaughter are used. The pre-slaughter equipment that is used with ritual slaughter are very different from one situation to another, including animals being presented for slaughter right-side up, hanging (shackling), or upside down. These animals may be in various states of calm or stress at that time. The persons doing the slaughter may have very different skill sets and sometimes even use different techniques. They may be the actual person doing the religious slaughter, while others are researchers attempting to mimic religious slaughter. The details for evaluating the above issues and the additional information that would be needed to critically evaluate the impact of these factors on religious slaughter are not being reported. Many of these papers do prove that the particular system used at one time in one place may be inhumane and requires change. But, this information is often unfairly generalized to question all religious slaughter. The lack of sufficient detail about critical methods makes it difficult to determine the inherent humaneness of religious slaughter. These data do serve to show that the system is not being optimized and that improvements are needed. Thus, this project is designed to work with the religious community and the research community and those actually involved in slaughter to accomplish two goals: To improve the animal welfare of religious slaughter consistent with religious requirements and to look critically at the impact of religious slaughter when done using best available methodology. A set

of standardized reporting requirements are being developed. The input of the scientific community is desired.

**Key Words:** kosher slaughter, halal slaughter, scientific reporting

**M39 Turkey beak trim and feed form. 1. Effect on turkey performance.** S. L. Noll\*<sup>1</sup> and H. Xin<sup>2</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>Iowa State University, Ames.

Commercial turkeys undergo beak trimming at the hatchery prior to placement on the farm. The practice has come under scrutiny as an animal welfare issue. The research was conducted to assess methods of beak trimming and feed form on early tom poult performance and subsequent performance to market. Large White male turkey poults (1600 total, Hybrid strain) were obtained. At the hatchery, poults were beak trimmed via methods of electric arc (E), hot blade (HB) or infrared (I). A non-trimmed control (C) was also obtained from the same lot of poults. Turkeys within each beak trim treatment were fed a commercially prepared diet. Diets were fed either in mash (M) or as crumbles/pellets (CP). Crumbles were fed to 6 wks of age with pellets fed to 18 wks of age. For each treatment combination there were 8 replicate pens. A completely randomized block design was used for assignment of treatments and a factorial model used in the analyses of variance. The level of statistical significance is set to 0.05 unless stated otherwise. Live weight at 18 wks of age was improved by the feeding of CP by 5.3% and cumulative feed efficiency by 9.5%. Beak trimming did not affect body weight. Feed efficiency was improved in beak trimmed birds as compared to the non-trimmed controls when fed mash feed only. Higher mortality to 6 wks of age was observed with the birds that had beaks trimmed by hot blade as compared to the non-trimmed control ( $P < 0.06$ ). The greatest effect of beak trim treatment was the incidence of damage related to pecking and the amount of birds that were removed from the experiment due to pecking injuries. Removals averaged 19, 7, 11, and 21% for the untrimmed controls, and poults trimmed by E, I, and HB methods, respectively. Turkeys beak trimmed by HB exhibited more regrowth of the beak. The results indicate that beak trimming did not negatively affect production performance with the exception of the hot blade treatment. Beak trimming substantially reduced the incidence of pecking damage and culling when regrowth did not occur. Commercial market tom turkeys responded favorably to the feeding of pellets with increased body weight most likely as a result of increased early intake.

**Key Words:** turkey, beak trim, feed form

**M40 Turkey beak trim and feed form. 2. Effect on turkey behavior.** H. Kassube\*<sup>1</sup>, E. Hoerl Leone<sup>2</sup>, I. Estevez<sup>2</sup>, H. Xin<sup>3</sup>, and S. Noll<sup>1</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>University of Maryland, College Park, <sup>3</sup>Iowa State University, Ames.

Commercial market turkeys undergo beak trimming at the hatchery prior to farm placement in order to decrease aggressive activities, such as feather pecking and cannibalism, which lead to mortality. Limited research has been done to determine the effect this procedure has on turkey poults. The objectives of this study are to assess the method of beak trimming and feed form on turkey behavior. The hypothesis is that feed form and beak-trimming will modify feeding and aggression behavior. Male Large White commercial turkey poults were obtained from a hatchery following beak trimming by hot blade, electric arc, and infrared methods, along with a set of birds that were not beak-trimmed.

The poults were randomly assigned to 16 replicate floor pens per beak treatment with eight pens each fed mash or crumbled pelleted feed to 18 wks of age. Behavior observations were conducted using Observer software package (Noldus) and a time budget was created for each focal bird. Three birds per pen were observed, for a total of 24 replicate focal birds per feed/beak-trim treatment combination. Statistical analyses were conducted with SAS (V.9). Feed form was found to modify the time budget. Results indicate that poults fed the mash feed spent a larger percentage of their time feeding than those fed pellets (9.3 vs. 2.9%), along with less time resting and standing. Beak trim treatment did not affect the time budget nor were there any interactions of beak trim treatment with feed form. No significant interaction between feed form and beak trim method was detected. However, there was a significant interaction between feed form and period for the percentage time spent standing and preening while sitting. There was also an interaction between beak-trim method and age period on the amount of time spent drinking and foraging. Finally, a three-way interaction of beak trim, feed form and observation period was observed for the time spent preening while standing. In conclusion, feed form was found to alter the time budget of the turkeys primarily by changing the amount of time spent eating.

**Key Words:** turkey, behavior, beak trim

**M41 The influence of exercise on the bone mineral density of laying chickens consuming a marginally deficient calcium diet.** N. P. Johnston\*<sup>1</sup>, G. Aduviri<sup>2</sup>, R. T. Davidson<sup>1</sup>, S. Fullmer<sup>1</sup>, and B. Curfew<sup>1</sup>, <sup>1</sup>Brigham Young University, Provo, Utah, <sup>2</sup>University of San Andres, La Paz, Bolivia.

Research suggests that exercise in addition to diet has a positive influence on bone mineral density. It was hypothesized that as space and the opportunity for activity increased laying chickens would deposit progressively denser bones during the period of lay. To test the hypothesis individual laying hens were housed in either a standard research cage (38 x 51 x 47 cm, floor space, 1,938 cm<sup>2</sup>, area 91,571 cm<sup>3</sup>), modified turkey cage (61 x 81 x 72 cm, floor space 4,494 cm<sup>2</sup>, area 358,223 cm<sup>3</sup>), or floor pen (122 x 122 x 76 cm, floor space 14,884 cm<sup>2</sup>, area 1,071,864 cm<sup>3</sup>). In the turkey cage the birds had to mount a perch to eat and drink while in the floor pen a nest box and a perch were available. Twenty 18 wk old SCWL were equally divided into four treatment groups. In treatment 1 and 2 they occupied research cages and in 3 and 4 turkey cages and floor pens respectively. Treatment 1 received a complete diet with 3.5% Ca and served as the control while the remaining three treatments received a similar diet but with 3.0% Ca. The later was done to place a degree of stress on the cortical-trabecular bone system of treatment birds. Feed and water were provided ad libitum, ambient room temperature was 18°C with a light dark cycle of 14L:10D. The humerus, tibial, and tarsometatarsus bones were scanned for density using a GE Lunar DEXA at 20 wks, 35 wks, and 42 wks of age. All treatment bone densities were similar at the outset. At 35 wks humerus bones were denser ( $P < 0.05$ ) for turkey caged (0.201 g/cm<sup>2</sup>) and floor pen (0.205 cm<sup>2</sup>) birds than treatment 2 research cage (0.184 cm<sup>2</sup>) at 42 wks of age humerus bones were denser ( $P < 0.05$ ) for the floor pens (0.228 cm<sup>2</sup>) than both research cage groups (0.209, 0.205 cm<sup>2</sup>) and tibial bone density was greater for floor and turkey (0.362, 0.370 cm<sup>2</sup>) than treatment 2 research (0.335 cm<sup>2</sup>). In conclusion, as hypothesized, birds provided greater space and opportunity for exercise produced denser bones

**Key Words:** bone, density, space

**M42 Differences in light intensity by cage location and tier level affect egg production and quality.** A. Yildiz, A. Hayirli\*, E. Laçin, and M. Macit, *Ataturk University, Erzurum, Turkey.*

This experiment was conducted to determine the effects of cage location and tier level with respect to light intensity on egg production and egg quality of hens housed in semi-confined facility. ISA Brown hens (n=225), 75 wks of age, were placed into 3-tier cage as top (T), middle (M), and bottom (B) tiers located in cages either illuminated artificially (EI), by window (FW), or between corridors (C) for 2 mo. The light intensity was measured monthly for each cage from a 5 cm-distance from feeders every 6 hrs. Egg production was recorded daily and egg quality was assessed biweekly. The light intensity was the greatest for cages at FW (151.9, 119.8, and 89.8 lux for tiers T, M, and B, respectively), followed by EI (52.6, 54.5, and 51.0 lux for tiers T, M, and B, respectively), and C (44.5, 23.4, and 4.7 lux for tiers T, M, and B, respectively). Hens at location EI had greater egg production than hens at FW and C. Egg production for hens at tier T was also greater than for hens at tiers M and B. Egg production for hens at EI and C decreased quadratically whereas that for hens at FW decreased linearly from tiers T to B. Cage location but not tier level affected egg weight. Hens at EI and FW produced heavier eggs than hens at C. Shape index, yolk color, and yolk index were independent from cage location and tier level. Hens at EI and FW produced eggs with thinner and weaker shell than hens at C. Moreover, eggshell strength increased linearly from tier T to B. Both albumen index and Haugh unit were the greatest for hens at FW, followed by EI and C. Their responses to cage location varied with tier levels. In conclusion, variation in light intensity in multi-tier cage system in semi-confined laying hen houses may be contributing factors for depressed laying performance and egg quality.

**Key Words:** light intensity, cage location, tier level

**M43 Efficacy of sodium bisulfate as a litter amendment to reduce paw burns in broiler chickens.** M. Nagaraj\*, J. B. Hess, and S. F. Bilgili, *Auburn University, Auburn, Alabama.*

Broiler house environment, especially volatile ammonia content has a significant effect on paw burns in chickens. The objective of the present research was to evaluate the efficacy of sodium bisulfate (SB) [PLT; Jones-Hamilton Co.] in reducing paw burns in broilers. 960 straight-run day old chicks were randomly assigned to 16 environmental chambers with four different levels of SB (4 chambers per treatment). The treatments comprised of Trt 1 (control; no litter amendment), Trt 2 with SB applied at 1x rate at the day of placement of chicks, Trt 3 with SB applied at 2x rate at the day of placement of chicks and Trt 4 with SB applied at 1x rate at the day of placement of chicks and at 1x rate on day 21. Birds were raised for a period of 49 days on a four stage feeding program of high protein and all vegetable diets, which have been shown to induce high incidence of paw burns. At 35 d the litter was moistened artificially to see the effect of SB on ammonia volatilization. Body weight, feed conversion and mortality were determined on 42 & 49 d. Ammonia concentration (ppm) in the chambers was measured prior to placement of chicks and on a weekly basis throughout the experiment. Paws were scored on 42 & 49 d of age and the severity was recorded as none (no ulcerating lesion), mild (lesions of <1.5 cm), and severe (lesions of >1.5cm). No differences in live performance of the birds was observed throughout the study (P>0.05). Sex had significant effect on incidence of paw burns (P<0.05), with females showing higher incidence of paw burns than males.

However, males had higher proportion of severe burns compared to females. SB had a significant effect on ammonia volatilization in the chambers (P<0.05). Ammonia concentration was significantly reduced in all treatments, except the control (Trt 1). SB had no significant effect on ammonia levels after 35 d upon addition of moisture to the litter. Although not significant (P>0.05), using SB as a litter amendment appeared to reduce the incidence and severity of paw burns. Use of litter amendments to convert volatile ammonia to an inert form may help in a program designed to reduce paw burns in broilers.

**Key Words:** broiler, paw burns, litter amendment

**M44 Improving drag swab detection of *Salmonella* in broiler litter.** R. J. Buhr\*, L. J. Richardson, J. A. Cason, and N. A. Cox, *USDA-ARS Russell Research Center, Athens, Georgia.*

For the past 25 years drag swabs have been used to sample litter in broiler growout houses to predict *Salmonella* status of the flocks. A drag swab consists of a cotton gauze swab attached to a cord, moistened with double strength skim milk, and dragged across the surface of the litter as the sampler walks through the house. Recent reports have indicated that litter sampling with a shoe cover or sock (worn over disposable plastic boots) has detected *Salmonella*-positive litter with better sensitivity. In the present study, *Salmonella*-positive litter was sampled by intermittently stepped on drag swabs (ISODS) as well as the traditional drag swab and sock methods described above, to test whether increased contact of the sampling surface with the litter increases detection of *Salmonella*. Chicks in each of 12 pens had been challenged with *Salmonella* on the day of placement. At 6 wk of age, ceca were *Salmonella*-positive from 87/120 (73%) of the broilers sampled (10 per pen). Litter was sampled at 7, 8, and 9 wk of age. At 7 and 8 wk the pens were occupied with broilers and at 9 wk the pens had been vacant for 1 wk. At 7 wk, 11/12 drag swabs, 11/12 ISODS, and 12/12 socks were *Salmonella*-positive. With high levels of *Salmonella* present in the litter, all sampling methods were equally able to detect *Salmonella* from the litter. At 8 wk, 4/12 drag swabs, 8/12 ISODS, and 7/12 socks were *Salmonella*-positive and at 9 wk, 1/12 drag swabs, 6/12 ISODS, and 5/12 socks were *Salmonella*-positive. When sampling at 8 and 9 wk the ISODS and the sock sampling methods recovered more than twice as many *Salmonella*-positive samples when compared to traditional drag swab sampling. Intermittently stepping on drag swabs while sampling litter in broiler houses may increase detection of *Salmonella* in broiler flocks at no additional cost.

**Key Words:** *Salmonella* detection, litter sampling, drag swabs

**M45 Influence of housing system, grain type and particle size on *Salmonella* colonization and shedding in broilers fed triticale- and corn-soybean meal diets.** F. Santos\*, A. Santos, Jr, P. Ferket, and B. Sheldon, *North Carolina State University, Raleigh.*

The present study focused on determining the effect of feeding whole grains and housing design on cecal *Salmonella* colonization, growth performance and carcass yield of broilers fed triticale/ or corn/SBM-based diets. Broilers reared either in a cage-based house (Broilermatic System®) or a conventional house (litter floor) from 0-42 d were assigned to 1 of 4 dietary treatments (trt): 1) ground corn-SBM (C, 560µ), 2) coarse ground corn-SBM (CC, >1700µ), 3) ground triticale-SBM (T, 560µ), and 4) whole triticale-SBM (WT). A 4-strain

cocktail of *Salmonella enterica* was orally-gavaged into each chick at placement. Cecal populations were estimated on 7, 14, 21, 28, 35, and 42d. Growth performance was measured on 14, 28 and 42d. Broilers responded differently to the dietary treatments according to housing system. At 42 d, birds reared on litter had better body weights when fed ground grain (2.87, 2.86, 2.73, 2.69 kg; trt 3, 1, 4, 2, respectively;  $P=0.004$ , no statistical difference between T and C); however, broilers reared in the Broilermatic cages were heavier when fed T (2.75, 2.67, 2.65, 2.61 kg; trt 3, 4, 2, 1, respectively;  $P=0.01$ ), no statistical difference between WT, CC and C trt. Compared to Broilermatic, raising broilers on litter improved the 1-42d FCR (1.71 vs. 1.81 g/g,  $P<0.0001$ ). Independent of housing system, relative eviscerated carcass weights of birds fed T were equivalent to the C fed birds and heavier than CC and WT fed broilers (0.764, 0.760, 0.752, 0.752 g/g, respectively;  $P=0.01$ ). Feeding whole/coarse ground grains decreased cecal *Salmonella* populations in broilers (3.8, 3.9, 4.4, 4.4 log MPN/g; trt 2, 4, 1, 3, respectively;  $P=0.05$ ). Housing type also influenced cecal *Salmonella* populations. At 42d, birds reared on litter had lower populations than broilers reared in cages (3.8 vs. 4.4 log MPN/g,  $P=0.002$ ). In conclusion, triticale appeared to be a good alternative feed ingredient to corn resulting in improved body weights and reduced *Salmonella* colonization. Moreover, raising broilers on litter greatly reduced cecal *Salmonella* populations.

**Key Words:** *salmonella*, broilermatic, triticale

**M46 Cytogenetic telomere array profile analysis comparing different chicken genotypes.** T. H. O'Hare\* and M. E. Delany, *University of California, Davis.*

The degree to which telomere arrays, including both terminal and interstitial categories, vary for size, number, and position among different genotypes is unknown. This could be an important source of genetic variation determinative of genome stability, impacting growth, development, disease, and cellular aging. In the chicken genome, in addition to the standard-sized telomere arrays which exhibit shortening with the absence of telomerase, a category of extremely long telomeres (100s to 1,000s of Kb in length) known as mega-telomeres have been described. The objective of this study was to investigate the uniformity of telomere array profiles among different chicken genomes to better understand telomere length regulation and its impact on chicken biology. Here we report on initial studies focusing on two cell lines of high utility for applied and basic poultry biology research (DT40 and DF-1); results from the cell lines were compared to the inbred line UCD 003. Telomere array profile comparisons were achieved by fluorescence in situ hybridization (FISH) using a telomeric-DNA probe applied to mitotic chromosomes; the resulting images were analyzed for number and distribution of arrays on macro and microchromosomes as well as the sex chromosomes. Interestingly, the telomerase-negative cell line, DF-1 exhibits a greater amount of telomeric DNA and a higher number of mega-telomere signals than DT40 which is telomerase positive. DF-1 appears to have a similar number of mega-telomeres as compared to UCD 003 (4-5 loci) but initial analysis indicates that the chromosomal location of the mega-telomeres differs and that in fact the number and location may vary within the cell line. DT40 exhibited a lower number of mega telomere signals (3-4 loci) as compared to both UCD 003 and DF-1. The telomeric DNA signals in DT40 were of reduced intensity suggesting an overall altered telomere profile. Mechanisms for such differences will be discussed, including the contribution of karyotype anomalies in both cell lines.

**Key Words:** telomere, DT40, DF-1

**M47 Understanding eggshell matrix protein genes for improvements in shell quality.** M. Hincke\*<sup>1</sup>, H. Esmail<sup>1</sup>, G. Ansah<sup>2</sup>, and A. Kulenkamp<sup>2</sup>, <sup>1</sup>*University of Ottawa, Ottawa, On, Canada*, <sup>2</sup>*Shaver Poultry Breeding Farms Ltd., Cambridge, On, Canada.*

The objective of this research project was to characterize genes of eggshell-specific matrix proteins that are involved in the formation and properties of the eggshell, and investigate whether polymorphisms were correlated with eggshell phenotypes such as shell strength or thickness. We studied a uterine-specific matrix protein (ovocleidin-116, OC-116) and a mineralization-specific protein (Osteopontin, OPN). Eggshell matrix proteins influence shell biomechanics and strength due to their influence on calcium carbonate crystallization patterns. Shell was collected from 100 randomly selected pedigree white leghorn layers at 72 weeks of age. Birds producing eggshell of poor, average and superior strength were identified. Blood was collected from birds in each group for sequencing of these genes and identification of SNP's. Correlation analysis of polymorphisms with shell quality parameters was performed: specific gravity, breaking strength, deformation under load, thickness, egg weight, egg length and egg width. Sequencing of the Ovocleidin-116 and Osteopontin genes identified 2 alleles in each case, OC-116 - A, B and OPN - 0, 1, which were found to be highly linked. Breaking strength was not significantly different for eggs from the homozygotes (AA or BB) or the heterozygote group (AB); however, shell thickness and specific gravity were higher for BB than for AA groups, while AB was intermediate. These differences were significant for shell thickness. Egg indices (weight, length and width) were all higher for BB than for AA and AB. Overall, the relationship between AA00, BB11, and AB01 was the same as for AA, BB and AB. Breaking strength was the same for all groups, but BB11 birds have larger, thicker, and heavier eggs with highest specific gravity and lowest deformation. We have identified gene polymorphisms that are associated with differences in egg and eggshell properties. Therefore, selection based on OC-116 gene will be a novel tool to identify hens with superior production traits. (We acknowledge collaborative input from the EU EggDefence consortium, and financial support for these studies by NSERC and PIC).

**Key Words:** eggshell matrix, Ovocleidin-116, osteopontin

**M48 Pedigree and microsatellite marker analyses are comparable methods for estimating inbreeding in an inbred strain of Japanese Quail.** S. H. Kim\*<sup>1</sup>, K. M. Cheng<sup>1</sup>, C. Ritland<sup>1</sup>, K. Ritland<sup>1</sup>, and F. G. Silversides<sup>2</sup>, <sup>1</sup>*University of British Columbia, Vancouver, BC, Canada*, <sup>2</sup>*Agriculture and Agri-food Canada, Agassiz, BC, Canada.*

Accurately estimating the level of inbreeding in a population is essential because inbreeding reduces fitness, fertility, viability, hatchability, and other production traits in populations. Inbreeding has been estimated by analyses of pedigrees and genetic markers. The objective of this study was to evaluate the accuracy of the two methods in an inbred strain of Japanese quail. The inbred strain was derived from a randombred (QO) strain and maintained for 17 generations by pedigreed matings of brothers to groups of sisters. Data from analysis of 14 microsatellite markers, GUJ0001, GUJ0024, GUJ0030, GUJ0034, GUJ0040, GUJ0044, GUJ0057, GUJ0059, GUJ0060, GUJ0065, GUJ0068, GUJ0070, GUJ0071, and GUJ0085, were obtained. Pedigree data were used to calculate the inbreeding coefficient ( $F_{IT}$ ), which is the level of inbreeding based on a reference ancestor. From the microsatellite locus data, the population differentiation ( $F_{ST}$ ) of the two strains caused

by inbreeding was calculated as  $F_{ST} = 1 - (H_{E(INB)}/H_{E(RAND)})$ , where  $H_{E(INB)}$  and  $H_{E(RAND)}$  are the expected heterozygosity of the inbred and randombred strains, respectively. The  $F_{IT}$  was then calculated as  $F_{IT} = F_{IS} + (1 - F_{IS}) * F_{ST}$ , where  $F_{IS}$  is the level of inbreeding within the inbred strain. The heterozygosity observed by analysis of the microsatellite markers of the randombred and inbred strains was 0.414 and 0.193, respectively, and the number of alleles was 3.24 and 1.87, respectively, demonstrating that genetic diversity was reduced in the inbred strain. The  $F_{IT}$  of the inbred strain from the pedigree and microsatellite marker analyses was 0.687 ( $\pm 0.069$ ) and 0.567, respectively. These results suggest that pedigree and microsatellite analyses are comparable methods for estimating inbreeding in an inbred strain of Japanese quail. Further studies will be required to investigate reasons for the slight difference.

**Key Words:** inbreeding, microsatellite, FIS-FIT-FST

**M49 Microarray analysis of gene expression patterns in the anterior pituitary of chickens genetically selected for high and low body weight.** L. E. Ellestad<sup>\*1</sup>, M. S. Byerly<sup>1</sup>, J. Simon<sup>2</sup>, L. A. Cogburn<sup>3</sup>, E. Le Bihan-Duval<sup>2</sup>, and T.E. Porter<sup>1</sup>, <sup>1</sup>University of Maryland, College Park, <sup>2</sup>INRA, Nouzilly, France, <sup>3</sup>University of Delaware, Newark.

Understanding genetic mechanisms that govern growth in chickens has important implications for poultry production. Many processes that control growth and metabolism are regulated by hormones produced by the anterior pituitary gland. The objective of the current study was to use cDNA microarrays to assess global gene expression patterns in the anterior pituitary gland during the first 7 weeks of post-hatch growth in two lines of chickens genetically selected for high growth (HG) and low growth (LG). Total RNA was isolated from pituitaries of each line at 1, 3, 5, and 7 weeks of age, and mRNA was amplified by reverse transcription with an oligo-dT primer containing the T7 RNA polymerase promoter followed by in vitro transcription using T7 RNA polymerase. Amplified RNA was then analyzed with cDNA microarrays containing 14,053 genes. Expression levels of 1,631 mRNAs were significantly different by line or for the line-by-age interaction ( $P \leq 0.05$ ;  $n=4$ ). Of these, 263 genes were substantially different, where the highest expression level in one line was at least 160% greater than the lowest expression level in the other line. Four of the six hormones produced by the anterior pituitary gland were included in this set of differentially expressed genes. Thyroid-stimulating hormone  $\beta$ -subunit (TSH $\beta$ ), luteinizing hormone  $\beta$ -subunit (LH $\beta$ ), and follicle-stimulating hormone  $\beta$ -subunit mRNA levels were higher in the HG line; growth hormone (GH) mRNA was elevated in the LG line. Real-time PCR was used to confirm differences in expression of TSH $\beta$ , LH $\beta$ , and GH, as well six other genes. The identification of a large number of differentially expressed genes in the anterior pituitary of chicken lines with differing growth characteristics indicates that this gland plays a major role in regulating metabolic differences between the HG and LG lines that contribute to the divergent phenotypes.

**Key Words:** growth, RNA, cDNA

**M50 Developmental expression of preproghrelin, GHS-R, and GPR-39 in the small intestine of chickens divergently selected for high or low juvenile body weight.** C. R. Miller<sup>\*</sup>, P. B. Siegel, K. E. Webb, Jr., and E. A. Wong, Virginia Tech, Blacksburg.

The objective of this study was to evaluate the developmental expression of RNA for preproghrelin, the ghrelin receptor GHS-R, and the obestatin receptor GPR-39 in the intestine of chicken lines that had undergone long term selection for high or low 8-week body weight. High and low line chicks (HH and LL) and their reciprocal crosses (LH and HL) were used in this experiment. Chicks were reared in batteries with ad libitum access to feed and water. Chicks were weighed and killed on embryonic day 20 (e20), day of hatch (DOH), and days 3, 7, and 14 post hatch (D3, D7, and D14, respectively). Duodenum, jejunum, ileum and liver were collected. DNA extracted from liver was used to sex birds by PCR. RNA was extracted from the intestinal segments of four males from each line and time point except e20 HL ( $n=3$ ). cDNA was made using reverse transcription and was used in real-time PCR for relative quantification of RNA. There was no change over time in preproghrelin and GHS-R RNA expression in the selected and crossbred lines. GPR-39 RNA expression increased with time in all lines ( $P < .01$ ). In a subpopulation of LL birds, LL birds with greater preproghrelin RNA expression at D3 and D7 also had greater GHS-R expression at these time points. In summary, preproghrelin, GHS-R and GPR-39 are expressed in the small intestine of these populations of chickens, with GPR-39 developmentally regulated. In a subpopulation of the LL line, preproghrelin and GHS-R may be co-regulated.

**Key Words:** preproghrelin, GHS-R, GPR-39

**M51 Identification of differentially expressed genes in pituitary glands of day 24 turkey embryos following stimulation with VIP.** M-K. Ho<sup>1</sup>, B. Leclerc<sup>1</sup>, D. Zadworny<sup>\*1</sup>, N. Kansaku<sup>2</sup>, and U. Kuhnlein<sup>1</sup>, <sup>1</sup>McGill University, Montreal, QC, Canada, <sup>2</sup>Azabu University, Fuchinobe, Sagamihara, Japan.

Around the time of hatch, circulating levels of prolactin (PRL) increase in turkey embryos as lactotrope cells differentiate. Although the increased levels of PRL are likely to modulate many physiological processes associated with final maturation and the adaptation of the poult to ex ovo life via the circulation, PRL may also act in an autocrine and/or paracrine fashion to affect adenohypophyseal function. In order to investigate the transcription of genes that may be induced/suppressed by PRL in the adenohypophysis (AP), libraries from VIP stimulated or control AP were constructed using suppressive subtractive hybridization (SSH). Stimulation with VIP (10<sup>-7</sup> M) of AP isolated from day 24 turkey embryos for 4 h resulted in a 2.8 and 5.7 fold increase in AP and media content, respectively, of PRL and a significant increase in the glycosylated isoform (from 13 % to 44 % of total PRL). The changes in PRL were consistent with endogenous levels of PRL observed just prior to hatch. Total RNA from VIP stimulated and control AP was used to construct both forward (control cDNA as driver) and reverse (VIP stimulated cDNA as driver) SSH libraries. Random clones ( $n=96$ ) from each library were sequenced and compared to data banks. A total of 66 and 79 non-redundant putative genes were identified in the forward and reverse libraries, respectively, of which about 50 % had unknown function. Real time PCR was used to confirm the differential expression of a selected number ( $n=21$ ) of these genes in VIP treated and control AP. Since the majority of these genes were expressed

at levels consistent with the direction of subtraction, these data suggest that these libraries may be useful to study the direct and indirect effects of increasing levels of PRL on AP function at about the time of hatch.

**Key Words:** prolactin, turkey embryo, suppressive subtractive hybridization

**M52 Antimicrobial activity of the anseriform outer eggshell.**

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The avian eggshell cuticle is an organic layer which regulates gas exchange and inhibits microbial contamination of the interior contents by preventing the entry of contaminated water into the eggshell pores. In this study, we investigated the antimicrobial activity of eggshell cuticle proteins from four Anseriform species. Eggs of four anseriform species were analysed: wood duck (*Aix sponsa*), hooded merganser (*Lophodytes cucullatus*), Canada goose (*Branta canadensis*) and mute swan (*Cygnus olor*). Cuticle was removed from washed eggs by treatment with either 8M urea/50mM Tris-HCl pH 7.5 for 1 hour or 1N HCl for 5 minutes. Extracts were concentrated by dialysis and lyophilization. Protein samples were analysed by SDS-PAGE, western blotting and by an antimicrobial assay. Distinct differences were observed between the protein profiles for avian eggshell cuticle and egg white. SDS-PAGE analysis revealed that prominent bands at 32kDa and 14kDa were present in extracts from all species. Western blotting revealed that the 32kDa band reacted to antibodies raised against *Gallus gallus* ovocalyxin-32 and confirmed the identity of the 14kDa band as c-type lysozyme. However, ovalbumin and ovotransferrin were absent from outer eggshell extracts of all species. Mute swan urea extract (50ug/ml) was found to inhibit the growth of *B.subtilis*, *S.aureus* and *E.coli*D31. Canada goose urea extract was found to inhibit the growth of *P.aeruginosa* while HCl extract inhibited the growth of *B.subtilis*. Hooded merganser urea extract completely inhibited the growth of *B.subtilis* and *S.aureus* while showing lower inhibition of *P. aeruginosa* and *E.coli*D31. The results indicate that the outer eggshell proteins present in the avian cuticle possess antimicrobial properties, and that hooded merganser urea extract possesses the greatest antimicrobial activity which did not correspond to lysozyme or ovotransferrin. Surprisingly, Canada goose cuticle was found to contain c-type lysozyme immunoreactivity while the egg white from this species is known to contain g-type lysozyme. On the other hand, both cuticle extracts and egg white from wood duck contain only c-type lysozyme. (Supported by NSERC and PIC).

**Key Words:** eggshell, antimicrobial, cuticle

**M53 Ovocalyxin-36 is a novel chicken eggshell protein related to lipopolysaccharide-binding proteins (LBP) bactericidal permeability-increasing proteins (BPI), and Plunc family proteins.**

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The avian eggshell is a composite biomaterial composed of non-calcifying eggshell membranes and the overlying calcified shell matrix. The shell is deposited in a uterine fluid where the concentration of different protein species varies at different stages of its formation. The role of avian eggshell proteins during shell formation remains poorly understood, and we have sought to identify and characterize

the individual components in order to gain insight into their function during elaboration of the eggshell. In this study, we have used direct sequencing, immunochemistry, expression screening and EST database mining to clone and characterize a 1995 full-length cDNA sequence corresponding to a novel chicken eggshell protein that we have named Ovocalyxin-36 (OCX-36). Ovocalyxin-36 mRNA and protein were only detected in the regions of the oviduct where eggshell formation takes place; OCX-36 message was strongly upregulated during eggshell calcification. OCX-36 localized to the eggshell membranes was most abundant near the calcified shell and could be detected in decalcified eggshell matrix. Database searching indicates that there is no mammalian version of OCX-36; however, it possesses homology with proteins associated with the innate immune response: lipopolysaccharide-binding proteins (LBP), bactericidal permeability-increasing proteins (BPI) and Plunc family proteins. Moreover, the genomic organization of these proteins and OCX-36 appear to be highly conserved. These observations suggest that OCX-36 is a novel and specific chicken eggshell protein related to the superfamily of LBP/BPI and Plunc proteins. OCX-36 may therefore participate in natural defense mechanisms that keep the egg free of pathogens. We acknowledge support from the European Commission (EggDefence, QLRT-2001-01606) (JG, YN), NSERC and PIC (MDM, MH).

**Key Words:** ovocalyxin-36, eggshell, antibacterial

**M54 Diversity and relationship among APEC within the GI tract and APEC of diseased turkey poults.**

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Avian pathogenic *Escherichia coli* (APEC) are normal inhabitants in the gastrointestinal (GI) microflora of turkeys and can cause colibacillosis in young turkey poults. There is a lack of understanding of the relationship between APEC in the GI tract and strains known to cause colibacillosis in poults. Previous research has identified virulence genes associated with colibacillosis: *iss*, *iucC*, *tsh* and *evaC*. The aim of this research was to study the relatedness among APEC within the GI tract and APEC pathotypes isolated from tissues and organs of diseased turkey poults. Three turkey poults from 15 houses of an integrated turkey operation in Missouri were collected in April, 2005. Gastrointestinal scrapings were plated on CHROMagar for the enumeration of *E. coli*. Up to five *E. coli* colonies from each poult were collected and a total of 115 were isolated for PCR analysis. An additional 22 *E. coli* from turkeys that had died at the same operation were received from the Missouri Diagnostic Laboratory in April, 2005. These 22 diagnostic isolates came from the following: eight from tissue, seven from heart, three from lung, two from liver, one from thigh and one from spleen. Of the 115 GI *E. coli*, 67.8% (78/115) had two or more of the four virulence genes and were considered pathogenic. Of the 22 diagnostic *E. coli*, 100% had two or more genes present, 13 of which had all four genes present. Random Amplified Polymorphic DNA (RAPD) PCR was used to determine the diversity of these 100 APEC isolates and indicated that the 100 isolates belonged to 11 clusters at a similarity coefficient of 50%. Eight clusters only contained *E. coli* from the GI tract and two clusters had only diagnostic isolates. The largest cluster contained 54 *E. coli* isolates; 38 from the GI tract and 16 from the diagnostic lab. These results suggest that some APEC in the GI tract are closely related to APEC pathotypes causing colibacillosis. Understanding of the relationship among APEC isolates in the GI of poults is a prerequisite to develop more efficacious treatments for this disease.

**Key Words:** APEC, turkey

**M55 Characterization of Extraintestinal Invasive *Escherichia coli* (ExIEC) strains isolated from a Mexican Poultry Integration.** C. Rosario\*<sup>1</sup> and C. Eslava<sup>2</sup>, <sup>1</sup>*Universidad Nacional Autonoma de Mexico, Mexico*, <sup>2</sup>*Universidad Nacional Autonoma de Mexico, Mexico*.

Seventy-six *Escherichia coli ipaH+* were characterized. Biochemical identification shows positive reactions for lactose fermentation (100%), lysine decarboxylase (98.7%) and motility (67.1%) properties that do not correspond with those described to the EIEC group. Regarding the serotyping, the most common O antigens were O2 (n= 20), OR (n= 11) and non-determined O? (n= 10). The O2:NM serotype was the most common. Sixty-six percent (n = 50) of the *ipaH+* *E. coli* produced colicins, of them, 26 (34%) produced Col V and other colicins, 13 (17%) produced colicins other than Col V, and 11 (14.5%) produced Col V only. Trimethoprim/Sulfa (72%), ampicillin (64.5%), enrofloxacin (55.3%), and ciprofloxacin (47.4%) were the major antimicrobial resistance frequencies observed. Twenty-five different multiresistance

patterns were observed, where sixty-six strains (86.8%) were included. An invasiveness assay showed that the predominant alterations were changes in shape and staining, and in most of the specimens, a partial monolayer detachment was also seen. Fifteen strains invaded more than 30% of the monolayer cells, causing the formation of intercellular bridges or filipoidal-like protrusions. Ribotyping showed four main clusters, the last one being the most homogeneous, basically formed by O2 strains. Using PCR with the IS630 primers only eight isolates were positives. In the embryo lethality assay 095785 strain, a representative isolate of the fourth cluster, produced mortality in 86.6% of embryos and, consequently, was classified as a virulent strain. Additionally, it presented the highest growth ( $8.25 \pm 0.39$ ), almost twice that of the negative control ( $6.89 \pm 0.92$ ). The results suggest the existence of specific clone complexes derived from EIEC strains adapted to the avian host. To our knowledge, this is the first study that demonstrates the presence of extraintestinal invasive *E. coli* (ExIEC) strains.

**Key Words:** *escherichia coli*, virulence factors, invasiveness