

early as 19 h of incubation. This condition, RL-2, has a resemblance to a previously described early embryonic failure in turkey embryos, Ring lethal (J Hered 76:474,1985). This new disorder is not influenced by the length of pre-incubation storage, incubation temperature and duration. The mode of genetic transmission determined by select matings indicated the disorder was the expression of an autosomal and recessive gene. The gene locus and allele symbol, RL-2 is proposed for this embryonic developmental mutation.

Key Words: Coturnix quail, Embryo, Lethal mutation, Autosome, Recessive

98 Comparison of myosin heavy chain isoform transitions in poultry lines selected for breast yield, an unimproved line and White Leghorns. J. M. Reddish*, M. Wick, J. C. Sawdy, and M. S. Lilburn, *The Ohio State University/OARDC*.

The temporal expression of the developmental fast myosin heavy chain (MHC) isoforms in commercial broiler lines selected for breast yield (A and B) and an unimproved line (C), were compared with a White Leghorn line in a semi-quantitative immunoassay. The hypothesis was that accelerated growth is accompanied by changes in the temporal expression of the developmental chicken fast MHC isoforms. Randomly selected male chicks from all lines were sampled at hatch, 7 d, 14 d, and 21 d post-hatch. Myosin was extracted from the *Pectoralis major* muscle from 3 birds per line per day. Myosin purity and total protein concentration were determined by SDS-PAGE and BCA protein analyses. Microtiter plate wells were incubated with 500 ng of total protein and the relative concentration of MHC isoforms evaluated by semi-quantitative ELISA employing three monoclonal antibodies specific for chicken fast embryonic (EB165), neonatal (2E9) and adult (AB8) MHC. The temporal expression of the embryonic MHC was similar in lines A, B, and Leghorn, with expression being maximal at hatch and declining through 14 d and increasing again by 21 d. In contrast, expression of the embryonic MHC isoform in line C was similar, except no increase in the isoform was observed at 21 d. The temporal expression of the neonatal MHC isoform in the Leghorn and line C was similar with expression beginning at 7 d and decreasing through 21 d. In contrast, the expression of the neonatal MHC in lines A and B began at hatch and then decreased through 21 d. Expression of the adult MHC isoform in the Leghorn began at 14 d and increased through 21 d, as expected. However, lines A, B and C exhibited expression of the adult MHC isoform at 7 d and increased through 21 d. These results support the hypothesis that the accelerated muscle growth is accompanied by changes in the temporal expression of the developmental MHC isoforms. The association of MHC isoform transitions during embryonic development with rapid growth is being further investigated.

Key Words: Myosin, Muscle, Broiler, ELISA

99 Markers associated with Marek's Disease survival in commercial layers. J. P. McElroy*¹, H. H. Cheng², J. Fulton³, M. Soller⁴, E. Lipkin⁴, J. C. M. Dekkers¹, and S. J. Lamont¹, ¹Iowa State University, ²USDA-ARS-ADOL, ³Hy-Line International, ⁴Hebrew University of Jerusalem.

The objective of this study was to locate genomic regions affecting resistance to Marek's disease (MD), a major disease affecting the poultry industry, for use in marker-assisted selection or candidate gene analyses. The experimental population was a backcross (BC) of two partially inbred commercial lines that were fixed for different serologically typed B blood group alleles and that differed in mortality, tumor development, and other disease-related parameters when MD virus challenged. Pair mating of susceptible-line males to resistant-line females produced 5 full-sib F1 families. BC chicks were produced by mating 7 F1 males per family each to 15 susceptible-line females, vaccinated with HVT/SB1 MD vaccine at 0 d, and subcutaneously inoculated with MD virus 648A at 6 d. Of survivors past 33 d (n = 692), 134 individuals with tumor(s) and short survival times (33 to 48 d) and 133 individuals with long survival (76 to 140 d = test end) were selectively genotyped for 56 out of 117 microsatellites that were chosen based on selective DNA pooling analysis. Markers associated with MD were identified within each B genotype by regressing survival on line allele inheritance probabilities, which were calculated based on marker genotypes and BC dam line allele frequencies (BC dams were unknown and not genotyped). A total of 17 marker by B genotype effects, on chromosomes 1, 2, 5, 8, and Z, were significant at the 10% comparison-wise level, of which 9 were significant at 5%. Two markers were significant for both B genotypes. Significant QTL were confirmed on chromosomes 2, 5 and Z by least-squares interval mapping at the 5% chromosome-wise level. B genotype was not significant; however, several markers had significant interactions with B genotype. Within-grandsire family analysis revealed differential marker effects among families. The results suggest that non-B blood group QTL for MD survival segregate between and within the parental lines.

Key Words: Marek's disease, QTL, Chicken

100 Integrating the chicken classical linkage group II and the new consensus molecular map. D.M. Karcher* and J.J. Bitgood, *University of Wisconsin - Madison*.

The chicken classical linkage group II includes dominant white (I), crest (CR), and frizzled feathers (F). The current consensus linkage map for E22C19W28 includes I and MCW 0317, a microsatellite. The objective of this study was to determine the order of CR, I, F, and MCW 0317. Heterozygous males carrying all three phenotypic traits were backcrossed to Light Brown Leghorns recessive for all three traits. The males were polymorphic for the marker while the females were not. The progeny were raised to six weeks of age where blood was collected and traits recorded. After PCR and gel electrophoresis of the progeny DNA, segregation of the microsatellite was recorded. The results of the study indicated the order was MCW 0317 (12.5 ± 3.3) CR (14.2 ± 3.3) I (14.7 ± 3.3) F; map distances agreed with both the published classical and molecular maps.

Key Words: Linkage map, Chicken, Linkage Group II

Nutrition - Feed Ingredient and Broiler Nutrition

101 Protein quality of poultry byproduct meal from whole fowl co-extruded with corn or wheat. O. C. Aimiuwu* and M. S. Lilburn, *The Ohio State University, Columbus, Ohio*.

The disposition of mortality and fowl are two critical issues facing the commercial egg industry. In a series of experiments, a test protein source resulting from the co-extrusion of whole fowl with either corn (CHM) or wheat (WHM) was compared with soybean meal or meat and bone meal. In a preliminary experiment, semi-purified diets were formulated to contain 12%, 15% or 18% CP with the only source of protein being either CHM or WHM. Each diet was fed to 4 replicate pens of turkey poults for a 7 d experimental period. There were positive, incremental increases in BW with each level of protein so these diets were utilized for subsequent experiments. In Experiment 2, a nitrogen-free dietary treatment was included in the study. In the 12% and 15% CP treatments, there was considerable variation between protein sources in intake, gain, protein efficiency ratio (PER), and net protein ratio (NPR). The values for all variables were consistent, however, between the CHM and WHM diets for

poults fed the 18% CP diet. In Experiment 3, diets containing commercial meat and bone meal (MBM) and soybean meal (SBM) were included in the comparisons. The four sources of protein were again incorporated into diets containing 12%, 15%, or 18% CP. Over all levels of dietary CP, PER and NPR values for SBM, CHM, and WHM were similar and all were significantly higher (P < 0.05) than for diets containing MBM. This was supported by amino acid digestibility comparisons among the three animal protein sources. The methionine and lysine digestibility values for MBM were 63% and 58%, respectively, compared with values greater than 80% for the two extruded hen meals. In summary, the CHM and WHM protein sources compare favorably with soybean meal as a source of protein for turkey poults and was significantly better than a commercial source of meat and bone meal.

Key Words: Turkey poults, CHM, WHM, SBM, MBM

102 The bioavailability of lysine in distiller's dried grains plus solubles. B. S. Lumpkins*, A. B. Batal, and N. M. Dale, *University of Georgia.*

Distiller's dried grains plus solubles (DDGS) is a by-product from ethanol production. 'New generation' DDGS is almost entirely from corn fermentation and apparently undergoes a gentler drying process than the DDGS available in the past. The drying of DDGS raises questions about the availability of lysine. Thus, two experiments were conducted to evaluate the lysine availability in 'new generation' DDGS. In experiment 1, chicks were placed on a standard starter feed from 0 to 7 d of age. After an overnight fast, 6 replications of 6 chicks were fed each of five experimental diets from 8-19 d of age. The experimental treatments were: 1) Corn gluten meal-cornstarch basal diet with 0.40% available lysine, 2) Basal + 0.10% Lys from L-Lys HCL (0.50% available Lys), 3) Basal + 0.20% Lys from L-Lys HCL (0.60% available Lys), 4) Basal + 10% DDGS, and 5) Basal + 20% DDGS. The basal diet was adequate in all nutrients except for Lys, and DDGS was added at the expense of cornstarch. In a second experiment, true digestibility of lysine in DDGS was determined with total excreta collection of cecectomized roosters. In experiment 1, both slope-ratio and standard curve methodology were used to estimate lysine availability. A linear response ($P < 0.05$) was observed for weight gain and feed efficiency from the addition of L-Lys HCL to the basal diet. Multiple regression analysis produced the model: gain (g) = 14.4 + 0.15 lysine intake (mg) + 0.10 DDGS intake (g) ($R^2 = 0.98$). The ratio of slopes indicated a bioavailable lysine concentration of 0.66% in DDGS. The linear regression analysis produced the model: gain (g) = 14.3 + 0.15 lysine intake (mg) ($r^2 = 0.93$) and resulted in an average lysine bioavailability estimate of 0.79%. These values, expressed as a percent of the 0.83% total lysine in DDGS, yields availability estimates of 80.4 and 95.1% for multiple regression and linear analysis, respectively. True digestibility of lysine determined with cecectomized roosters (74.2%) was lower than the lysine availability determined with the chick assays.

Key Words: Lysine, Bioavailability, Distiller's dried grains plus solubles, Chicks, Cecectomized roosters

103 Potential of secondary protein nutrients as feed ingredient in broiler chick diets. Y. Sungwaraporn*¹, P. R. Ferket¹, and T. F. Middleton², ¹*North Carolina State University, Raleigh, NC 27695-7608*, ²*AgPro Vision, LLC Kenansville, NC 28349*.

Secondary protein nutrients (SPN), a product of processed dissolved air flotation (DAF) sludge from wastewater of poultry processing plant, has potential value as a source of protein and fat in animal diets. In the first experiment, 140 1 d old male broiler chicks were subjected to 2 experimental diets including, control (corn-soy) and control with 20% SPN for 2 wk. Feces were collected for 3 consecutive days starting at 10 d and the nutrient digestibility of SPN was determined using 1.5% insoluble ash (CeliteTM) as ingestible marker. Apparent metabolizable energy (AMEn), apparent nitrogen retention (ANR), and apparent fat digestibility (AFD) of dietary SPN (mean±SD) were determined to be 1727.97±320.63 kcal/kg, 28.24±14.06%, and 19.50±8.26%, respectively. In the second experiment, 360 1-d-old male broiler chicks were subjected to 5 corn-soy diets with different levels of SPN including, negative control (NC, 85% of NRC req.), positive control (PC, 100% NRC req.), 7.5% SPN, 15% SPN, and 20% SPN for 3 wk. All diets were formulated to meet NRC (1994) requirements for digestible nutrients, and using the nutrient digestibility values for SPN determined from exp 1. AMEn, ANR, AFD, body weight gain (BW) and feed intake (FI) all decreased as the level of dietary SPN increased in broiler diets ($P < 0.01$). BW and FI of the NC and the 7.5% SPN groups were similar but they were lower than that of PC ($P < 0.01$). Similar results were observed on feed conversion ratio (FCR). FCR of the 15% SPN group was higher than that of PC ($P < 0.01$), but not different from the others. Including 20% SPN in the diet resulted in higher incidence of rickets in broilers at 2 wk of age, thereby causing a significantly higher mortality rate ($P < 0.01$) during 3 wk of age. The reduction in bird performances indicated adverse effects of including high level of dietary SPN because of poor nutrient availability and palatability of diets.

Key Words: Dissolved air floatation sludge, Secondary protein nutrients, AMEn, ANR, AFD

104 Palm kernel cake (PKC) as a substitute for maize and soybean meal (SBM) in pullet starter and grower diets. O. C. Aimiwu*¹ and J. M. Olomu², ¹*Ohio State University, Columbus, Ohio*, ²*University of Benin, Benin City, Nigeria*.

Cereal grains comprise approximately 65-70% of the cost of poultry feed in Nigeria and are often scarce. SBM which is the main protein source is usually twice the cost of cereal grains. Studies were conducted to test the effectiveness of PKC as a replacement for maize and SBM in pullet starter and grower diets. In Experiment 1, 340 Neira pullets were used in a randomized complete block design for an experimental period of 8 weeks. Each treatment had two replicates of 26 birds. Percent maize replacement in the chick starter diets was 0 (Control), 25, 50, 75 and 100%. To make the diets isonitrogenous, SBM inclusion was gradually reduced to 0%. The study also utilized two diets in which PKC was at 100%, and another with no SBM. Weight gain, feed consumption and daily water consumption per bird increased with increasing level of PKC ($P < 0.05$) while feed efficiency decreased and feed cost per kg weight gain decreased. The performance of birds fed 100% PKC with no supplemental SBM was significantly poorer ($P < 0.05$) when compared with diets containing SBM. In Experiment 2, 300 eight-week-old pullets were used with 25 birds per each of two replicates per treatment. The experimental period was from 8 wks through 25% hen-day production. Percentage maize replacement in grower diets was similar to that described for Experiment 1. Increasing levels of PKC had no effect ($P < 0.05$) on weight gain through initial production but it did increase feed intake and daily water consumption. Feed efficiency was decreased while feed cost was reduced ($P < 0.05$) with increasing levels of PKC. Birds on 25% and 50% PKC started laying and attained 25% egg production before hens fed the Control diet. Birds fed diets with no SBM produced the smallest eggs. Diets with 50% PKC but no SBM resulted in higher liver, heart and gizzard weights. It can be concluded that PKC can replace 75% of the maize and partially replace SBM in chick starter diets and can completely replace maize in grower diets. The complete removal of SBM in PKC based diets is not recommended.

Key Words: PKC, SBM, Maize, Starter diet, Grower diet

105 Comparative feeding values between dehulled and non-dehulled soybean meals assessed by broiler feeding trials and various in vitro methods. H. S. Lee*¹, J. H. Choi², I. S. Shin¹, K. Y. Whang², and K. M. Chee², ¹*American Soybean Association, Korea*, ²*Korea University*.

Feeding values of dehulled and nondehulled soybean meals (SBM) of various origins were determined by a digestibility study, an in vivo protein quality assay and a feeding trial. SBMs used were dehulled meal from U.S. or non-dehulled meals from Brazil and India. To compare amino acid digestibility, broilers were surgically operated to set up cecal ligation and urethral tubing. The overall mean true digestibility value of the dehulled SBM was higher with 94.7% than 91.0% for Brazilian- and 91.5% for Indian-SBMs ($P < 0.05$). When fed semi-purified, isocaloric and isonitrogenous diets with the SBMs as the only source of protein for 14 d, birds of the dehulled SBM group grew faster with better FCR and showed better protein efficiency ratio and net protein retention values than those of the other two groups ($P < 0.05$). Broilers fed commercial type diets containing U.S. dehulled SBM for 21 and 14 d for starter and grower, respectively, performed significantly better in BW gain and FCR compared to those of the other SBM groups ($P < 0.05$). Birds fed the SBMs from Brazil and India showed fairly similar results between the two groups in both trials. In vitro measurements of the U.S. dehulled SBM were 22.2% protein dispersibility index; 80.6% KOH protein solubility; 95.0% pepsin digestibility; 0.10 urease activity and 2.65% available Lys. These values of the dehulled meal tended to be slightly higher than those of the other SBMs. This observation provides a significant implication in terms of comparative feeding values of the SBMs of which origins are different. Since levels of ME and chemical composition of the test diets were equal including limiting amino acids such as Met+Cys and Lys, the differences in broiler performances could mainly be resulted from differences in biological availability of proteins and energy utilization of the SBMs.

Key Words: Comparative feeding value, Dehulled soybean meal, Non-dehulled soybean meal, Amino acid digestibility, Broiler

106 Effect of feed form on lysine needs of broilers from 16 to 30 days of age. M. W. Greenwood*¹, K. R. Cramer¹, P. M. Clark², and R. S. Beyer¹, ¹*Animal Science and Industry-Kansas State University*, ²*Grain Science and Industry-Kansas State University*.

Past research indicates that increasing diet density by producing pellets of good quality can contribute to the productive energy value of a diet. Increasing the energy available for protein synthesis may require higher dietary levels of lysine and other essential amino acids (AA) to maximize growth performance and efficiency. An experiment was conducted to determine the effects of feed form on digestible lysine necessary for maximum body weight gain (BWG) and feed efficiency (FE) of broilers from 16-30 d. Male broiler chicks (Cobb 500) were provided a nutritionally adequate diet (NRC, 1994) from 0-16d. Subsequently, a corn, soybean meal, and corn gluten meal-based diet (1435 kcal ME/lb. and 21% CP) was formulated on a digestible AA basis to obtain a lysine deficient diet. Digestible essential AAs were estimated from a composite of reported data. A 2x5 factorial treatment arrangement was achieved by feeding diets in two forms (mash and steam-conditioned pellets) with five levels of dietary digestible lysine (0.75, 0.85, 0.95, 1.05, and 1.15%). Six pens of 25 chicks were fed each dietary treatment. Mean body weight and feed consumption were obtained at 16 and 30 d. Significant interactions were noted for AWG ($P \leq 0.0009$) and FE ($P \leq 0.0001$). Performance of birds fed pelleted diets with digestible lysine levels above 0.95% was generally superior to that of birds fed the mash diets regardless of lysine level. Average feed intake and kcal ME consumed/bird were both significantly ($P \leq 0.0001$) greater for the pellet fed birds. Digestible lysine needs (95% of the asymptote of the quadratic model) were measured for BWG and FE. Digestible lysine needs of the mash fed birds from 16 to 30 d for BWG and FE were 0.87% and 0.90%, respectively. Digestible lysine needs for the pellet fed birds for BWG and FE were 1.00% and 0.99%, respectively. These data suggest that feed form is a factor affecting the estimated lysine needs of broilers in dose-response studies.

Key Words: Broilers, Feed form, Lysine

107 Effects of particle size and physical form of ration on performance of broiler chickens. C.A.A. Lpez* and N. C. Baiao, ¹*Escola de Veterinria da UFMG*, ²*Escola de Veterinria da UFMG*.

An experiment was carried out in order to evaluate the effects of dietary particle size and physical form of ration on performance of broiler chickens. Nine hundred day-old Ross broiler male chicks were used during the 47 days of trial, following a completely randomized design of six treatments in a 3 x 2 factorial arrangement: three physical forms of rations (mash, pellet and expanded-pellet) x two methods of grinding (intermediary and coarse). Intermediary and coarse grinding were performed using screen size of 3.18 and 4.76 mm, respectively. Processing of diet by intermediary grinding caused an increase in body weight broilers fed expanded-pellet diet grew faster than broilers fed pellet diet, but these birds performed better as compared with birds fed with unprocessed diet ($P < 0.05$). The body weights were: 3.354; 3.255 and 3.040 kg, as intensity processing was reduced, respectively. In the coarse grinding, body weights was higher with processed rations as compared with mash diet ($P < 0.05$). Broiler chickens body weight fed expanded-pellet, pellet and mash rations were in the following order: 3.329; 3.276 and 3.064 kg, respectively. Broiler fed pellet and expanded-pellet diets had higher feed intake than those fed mash diet ($P < 0.05$), but among there was no differences. A dietary particle size did not affect the feed intake. Feed consumptions were in the following order: 5.484; 5.509; 5.870; 5.879; 5.948 and 5.913 kg for intermediary and coarse grinding mash rations, intermediary and coarse grinding pellet rations, and intermediary and coarse grinding expanded-pellet rations, respectively. Feed conversion and viability were the same among the coarse grinding rations, but were higher and lower, respectively, in the intermediary grinding and mash rations as compared to intermediary grinding and expanded-pellet rations ($P < 0.05$). It is concluded grinding size of diet has no effect on broiler performance. Heat-treatment of diet improves broiler performance.

Key Words: broiler, particle size, pellet

108 Effect of grain particle size and feed texture on broiler performance and carcass quality. A. S. Parsons*, J. S. Moritz, K. P. Blemings, and B. M. Steinfelt, *West Virginia University*.

Past research suggests that adding moisture to corn-soybean based diets can improve pellet quality, and in turn broiler performance. Corn particle size has also been suggested to affect broiler performance. However, a specific understanding of these feed form effects has not been determined. The objective of the current study was to determine the effects of particle size and feed texture on broiler performance and carcass quality. Treatments consisted of five similarly formulated mash diets, which varied in corn particle size (781, 950, 1042, 1109, 2242 microns) and two pelleted diets of varying texture - soft (manufactured with added moisture) and hard (manufactured with a commercial pellet binder). Soft pellets had a higher durability (90%) as well as fines percentage (44%) compared to hard pellets (86 and 40% respectively). Each of these diets was fed to thirteen replicate floor-pens of 21 straight-run 308x344 Ross broilers during the growing period. Linear regression showed an increasing trend in feed intake ($P = 0.0016$) and gizzard weight ($P = 0.0001$) as particle size of mash diets increased; however, feed efficiency ($P = 0.0058$) and percent breast yield ($P = 0.0250$) decreased. Broilers fed pelleted diets showed an increased live weight gain ($P = 0.0001$), increased breast yield ($P = 0.0229$), decreased gizzard weight ($P = 0.0001$) and increased mortality ($P = 0.0073$) compared to those fed mash diets. Broilers fed hard pellets had greater weight gain ($P = 0.0001$) but otherwise similar performance as broilers fed soft pellets. Broilers fed soft pellets had an increased percent breast yield ($P = 0.0127$) compared to those fed mash diets, although, broilers fed hard pellets did not ($P = 0.3244$). These results demonstrate that feeding broilers pelleted diets can improve performance compared to feeding mash diets, and feeding pellets of soft texture may increase breast yield. Furthermore, feeding broilers corn particles of smaller size may improve performance and carcass characteristics compared to diets that incorporate larger sized corn particles.

Key Words: Broiler performance, Feed texture, Particle size, Pellet quality

109 Caloric value of pelleting and the consequential creation of nutritional dead zones. L. J. McKinney*¹ and R. G. Teeter¹, ¹*Department of Animal Science, Oklahoma State University*.

Two trials were conducted with male broilers to quantify the caloric value attributable to pelleting and pellet quality (PQ), defined as the pellets:pellet fines ratio at the feeder. In Trial 1, chicks were reared in floor pens to 56 days of age on diets that varied in caloric density (CD). Four diet CD ranging from 2,650 to 3,250 kcal ME_n/kg were fed. Starter diets were fed as mash, while grower and finisher diets were pelleted. Pen BW, feed intake, and feed conversion ratio (FCR) were measured on 21, 42, and 56 days. On days 42 and 56, birds from each pen were sacrificed and carcass traits were measured. Increasing diet CD significantly enhanced BW, energy consumption, and FCR. Feed intake remained similar across the upper three CD treatments to 42 days. By day 56, feed consumption tended to decline as CD increased. Increasing diet CD beyond 3,066 kcal ME_n/kg diet failed to result in greater lean tissue accretion, while fat deposition increased disproportionately. Trial 1 results enabled creation of models relating BW, diet CD, and FCR. In Trial 2, 38-d old broilers were used to evaluate PQ effects on growth, feed intake, FCR, and behavior. Weight gain and FCR were significantly enhanced by pelleting and were positively correlated with PQ. Feed intake was not affected by PQ. Application of the Trial 1 model enabled prediction of diet CD for each Trial 2 treatment, and consequently dietary CD effect attributable to PQ. The model was validated for Trial 2, as it closely estimated the CD for diets of similar PQ used in Trial 1. Results suggest pelleting contributes 187 kcal ME_n/kg diet at 100% PQ. Pelleting value was dependent upon PQ as the caloric value diminished curvilinearly with PQ. Birds were observed eating less and resting more as PQ increased, suggesting that caloric value of pelleting is mediated by influencing activity energy expenditure. As fat addition prior to pelleting results in reduced PQ, additional energy from fat may be offset. Such interactions may result in formulation dead zones, whereby calories added as fat are negated due to reduced PQ.

Key Words: Pelleting, Energy, Behavior

110 Response of broilers fed graded levels of balanced dietary protein at three different levels of metabolizable energy to 21 days of age. P. W. Plumstead*, B. A. Lenfestey, H. Romero-Sanchez, and J. Brake, *North Carolina State University, Raleigh, NC USA.*

It was hypothesized that young broilers can respond to high dietary crude protein (CP) and amino acid (AA) levels provided that formulations retained a consistent balance of all other nutrients across a range of CP and metabolizable energy (ME). A series of twelve corn-soy based diets were formulated to contain four levels of total lysine (1.20%, 1.29%, 1.38%, and 1.47%) at each of three dietary levels of ME (3.0 kcal/g, 3.1 kcal/g, and 3.2 kcal/g). The percentage of dietary ME contributed from soy oil was kept constant, dietary CP was set such that lysine was 5.5% of CP (21.8%, 23.5%, 25.2%, and 26.9% CP) and remaining AA levels adjusted to a consistent profile. An inert filler was used to maintain specified nutrient ratios across all CP and ME levels. Two trials were conducted using Cobb 500 broilers. Exp. 1 utilized an environmentally modified

broiler facility with 72 floor pens and 16 mixed sex birds per pen. Exp. 2 utilized 72 floor pens with 10 mixed sex birds per pen. Experimental diets were pelleted and crumbled and fed to 21 d of age. BW and mortality by sex and total feed intake per pen were recorded weekly and the feed conversion ratio (FCR) calculated. There were no CP by ME interactions at 21 d for mortality, BW or FCR in either experiment. In Exp. 1 BW did not differ between the 21.8% and 23.5% CP diets but was increased stepwise at 25.2% CP and 26.9% CP. In Exp. 2 BW was increased stepwise from 21.9% CP to 23.5% CP to 25.2% CP with no further increase at 26.9% CP. In both experiments BW was increased by the 3.1 and 3.2 kcal/g ME levels relative to the 3.0 level. FCR to 21 d improved in a stepwise manner with incremental CP and ME to the 25.2% and 3.1 kcal/g levels in both experiments. It can be concluded that 21 d broiler BW and FCR can respond positively to incremental dietary lysine and ME of up to at least 1.38% lysine and 3.1 kcal/g ME provided that a balance of all other nutrients is maintained.

Key Words: Broilers, Crude protein, Lysine, Metabolizable energy

Nutrition - Feed Additives

111 Xanthophyll supplementation (lutein and canthaxanthin) may affect the broiler immune system and body composition within 9 days after test feed introduction. A. Mireles Jr.*, S. Kim, R. Thompson, E. Vasquez, and B. Amundsen, *Foster Poultry Farms.*

To examine the effect of high xanthophyll feeds on body composition and the immune response, two experiments were involved in this study. The first study was conducted in pens. Control (CONTROL) birds were given corn-soy control feed (1.6 mg lutein, 0.7 mg zeaxanthin, 0 mg/kg canthaxanthin) and test birds received High xanthophyll feed (HIGHX) (4.6 mg lutein, 0.9 mg Zeaxanthin, and 1.1 mg canthaxanthin) from day 33 - 45. There were 24 cockerels/treatment. Nine days after test feed introduction, chicks were injected with 1 gm E. coli lipopolysaccharide (LPS)/kg BW. At 42 days, body temperature was similar ($P = 0.393$) between groups prior to injection (41.66 vs. 41.78 C for CONTROL and HIGHX respectively). Two hours later, HIGHX chicks had lower ($P = 0.030$) body temperature (42.66 vs. 42.26 C). Day 42 to 45 mortality tended to be lower for HIGHX birds (8.33 vs. 0.00%). 45 Days tibia strength and elasticity of LPS CONTROL birds was lower ($P = 0.0327$) than non-injected CONTROL birds (37.52 vs. 41.74 kg and 4.26 vs. 4.64 mm). HIGHX birds had similar tibia strength and elasticity as non-LPS CONTROL chicks (40.77 vs. 41.74 kg and 4.54 vs. 4.64 mm). The second study was done in battery cages and consisted of 17 cockerels per treatment fed corn-soy based diets for 29 days. In addition to the control (CONTROL, 1.1 mg lutein, 0 mg canthaxanthin/kg), 2 levels of lutein (HIGHL, 5.2 mg, and HIGHESTL, 8 mg lutein), and 2 levels of canthaxanthin (HIGHC, 1.2 and HIGHESTC, 2.3 mg/kg) were included. CONTROL chicks had lower ($P < 0.05$) body weight than the other groups (0.94, 1.05, 1.08, 1.06, 1.10) at 28 days. One day after an E. coli LPS injection, breast yield for CONTROL birds was lower ($P = 0.0001$) than for the other groups (11.96, 13.54, 13.62, 13.83, 13.77%), tibia strength for CONTROL and HIGHL birds was lower ($P = 0.0001$) (18.77, 19.91, 22.11, 21.42, and 22.61 kg), and tibia elasticity was higher ($P = 0.0035$) for HIGHESTL and HIGHESTC birds (3.31, 3.41, 3.59, 3.50, 3.63 mm). Significant ($P = 0.0106$) diet x LPS interactions were found in tibia calcium results. CONTROL chicks had lower calcium when injected LPS (17.22 vs. 16.57%) whereas HIGHESTL birds had higher tibia calcium after LPS (16.48 vs. 18.26%).

Key Words: Xanthophylls, Lutein, Canthaxanthin, Acute phase response, Nutritional immunomodulation

112 Effects of β -mannanase (Hemicell[®]) on broiler performance without growth promoting antibiotics. H.-Y. Hsiao, F. L. Jin*, D. M. Anderson, M. E. Jackson, and R. L. James, *ChemGen Corporation, Gaithersburg, MD/USA.*

The long-term trend facing feed and live production industries is the restricted use of growth promoting antibiotics (GPA). The negative consequence of removing GPA in feed will be most felt on the growth and health of very young animals. From European experience and reports from US long-term trials, the incidence of necrotic enteritis is expected to rise and growth performance deteriorates about 1-2%. But flock uniformity can decrease very significantly, as much as 15-20%. Five controlled

trials designed to test effect of β -mannanase on broiler performance fed GPA free diets. The first two trials were done in the research farm without artificially infecting birds. The last three trials, birds were purposely challenged with *Eimeria acervulina*, *Eimeria maxima* and *Clostridium perfringens* as a model of necrotic enteritis to test β -mannanase's potential benefit in GPA and/or Salinomycin free situation. Body weight uniformity, weight gain, and feed efficiency were measured including the weighing of individual birds. Supplementation with β -mannanase produced a benefit virtually equivalent to the growth benefit to using GPA under the test conditions, but clearly the mechanisms are different. The summary of the five trials indicated that β -mannanase and GPA improved body weight uniformity by 18.5% and 14.9%, respectively, and it was by largely reducing the numbers of lightweight birds. The average GPA improvement on weight gain and feed conversion were 9.26% and 5.69%, respectively. The average β -mannanase improvement on weight gain and feed conversion were 7.98% and 4.16%, respectively. These studies indicated that β -mannanase may be used as an alternative to GPA in situation where removal of GPA from poultry feed is mandated or preferred.

Key Words: β -Mannanase, Hemicell[®], Growth promoting antibiotics, Broiler, Body weight uniformity

113 Effect of β -mannanase (HemicellTM) compared to antibiotics on broiler chicken performance and flock uniformity to 42 days. M. E. Jackson*¹, H. Y. Hsiao¹, R. L. James¹, D. A. Anderson¹, F. L. Jin¹, and G. F. Mathis², ¹*ChemGen Corp., Gaithersburg, MD,* ²*Southern Poultry Research, Athens, GA.*

β -mannan is a polysaccharide found in soybean meal and other plant proteins. Low concentrations of β -mannan have been shown to reduce carbohydrate metabolism and IGF production in monogastrics. In many experiments with broilers, the enzyme β -mannanase has been shown to improve growth and feed conversion. Several recent broiler studies have demonstrated a large effect of β -mannanase in the presence of disease stress. A 42-day pen trial was designed to compare the effect of a commercial antibiotic program (50 g/ton BMD and 45 g/ton 3-Nitro to 35 days, Antibiotics) with that of addition of a commercial preparation of β -mannanase at 100 MU/ton (Enzyme). Diets were corn-soybean meal based with commercial nutrient levels containing 60 g/ton of Salinomycin. Criteria to judge performance and health status were weight gain, feed conversion, and flock uniformity determined by weighing individual birds. The experiment was conducted in floor pens with 45 male Cobb X Cobb birds per cage, 5 diets, and 8 replications. Dietary treatments were 1. No Antibiotics or Enzyme, 2. Antibiotics, 3. Enzyme, 4. Enzyme to 17 days only, and 5. Antibiotics + Enzyme. To 17 days, improvements in gain were observed for Antibiotics, Enzyme, and Antibiotics+Enzyme, and improvements in feed conversion were observed for Enzyme, and Antibiotics+Enzyme, ($P < 0.05$). To 42 days, improvements in gain were observed for Enzyme, and Antibiotics+Enzyme, and improvements in feed conversion were observed for Antibiotics, and Antibiotics+Enzyme ($P < 0.05$). Body weight uniformity as determined by %CV reduced from 9.77 to 8.20 ($P < 0.05$) with Enzyme. Enzyme application to 17 days yielded intermediary results. The experiment clearly