

## Nutrition

**273 Influence of crumbled pre-starter feed on growth performance and round heart disease when fed to turkey poults.** K.D. Roberson\*, Michigan State University, East Lansing, MI.

A 2 X 2 factorial experiment was conducted to determine the effects of mash versus crumbled feed with or without a post-hatch nutritional supplement on growth and mortality of tom poults. A total of 900 B.U.T.A. Big 6 male poults were placed into 16 lamp-heated pens within about 4 h after leaving the hatchery. The poults had been hatched during the previous 24 h. A nutritionally common diet was fed to all birds. Half received the diet in mash form and half were fed crumbles. Half of the birds within each feed type were given a post-hatch supplement (Gro-Gel, Dawe's Laboratories, Arlington Heights, IL) top-dressed on the feed resulting in 4 pens per treatment. Heat lamps were removed at 7 d. Body weight was increased by feeding crumbles at 7 d (164 vs. 183 g,  $p < 0.001$ ), 14 d (362 vs. 412 g,  $p < 0.001$ ), and 21 d (663 vs. 733 g,  $p = 0.007$ ). Feed conversion was calculated at 14 and 21 d of age. Net feed:gain was decreased by feeding crumbles at 14 d (1.15 vs. 1.06,  $p = 0.011$ ), but was not different at 21 d (1.37 vs. 1.36,  $p = 0.668$ ). However, when adjusted for mortality, feed:gain was decreased at 21 d by feeding crumbles (1.36 vs. 1.30,  $p = 0.009$ ). Mortality was increased when crumbles were fed at 7 d (1 vs. 8%,  $p = 0.002$ ), 14 d (2 vs. 9%,  $p = 0.006$ ), and 21 d (2 vs. 13%,  $p = 0.001$ ). Approximately 90% of mortality in crumble-fed poults were due to round heart disease. There were no effects of the post-hatch supplement on growth or mortality. All birds were fed the same crumbled starter diet from 21 to 42 d of age. Birds fed crumbles throughout the experiment were heavier at 42 d (2493 vs. 2557 g,  $p = 0.031$ ). Crumble feeding improved growth during the brooder period. However, growth was so fast the first three weeks that round heart disease caused enough mortality to eliminate any improvement in feed conversion observed in the pre-starter period.

**Key Words:** Crumbled, Mash, Post-hatch supplement

**274 Comparison of broiler performance when fed diets containing insect-protected YieldGard® Plus (MON 810 x MON 863), non-transgenic control, or commercial corn.** M.L. Taylor\*<sup>1</sup>, B. George<sup>2</sup>, Y. Hyun<sup>1</sup>, S.G. Riordan<sup>1</sup>, M.A. Nemeth<sup>1</sup>, K. Karunanandaa<sup>1</sup>, and G.F. Hartnell<sup>1</sup>, <sup>1</sup>Monsanto Company, LLC, <sup>2</sup>Colorado Quality Research, Inc.

Growth performance and carcass measurements were evaluated in a 42-day study in which broiler chickens (Ross x Ross 508) were fed diets containing insect-protected YieldGard® Plus (MON810 x MON 863) corn, near isogenic control corn, or commercially available varieties of corn. YieldGard® Plus corn, developed by conventional breeding of MON 810 corn with MON 863 corn, produces the Cry1Ab protein from *Bacillus thuringiensis* subsp. *kurstaki* strain HD-1 that confers insect protection from the European corn borer (*Ostrinia nubilalis*) and a variant of the wild-type Cry3Bb1 protein, which protects against feeding damage caused by corn rootworm larvae (CRW; *Diabrotica* sp.). Broilers were fed approximately 55% w/w corn grain in their diet for the first 20 days and approximately 60% w/w corn grain in their diet from day 21 to day 42. The only sources of dietary protein and amino acids were corn and soybean meal and supplemental methionine and lysine. Feed and water were offered *ad libitum*. Broilers were assigned to eight treatment groups, each consisting of five male and five female pens and 10 birds/pen, using a randomized complete block design. The standard randomized block (ANOVA) statistical model was used to analyze the data. Another analysis compared the fit of the YieldGard® Plus corn diet data with the population of responses from all other diets. Performance parameters (weight gain, feed intake, feed efficiency, and adjusted feed efficiency) and carcass measurements (chill weight, fat pad on a percent live weight basis, and breast meat, thighs, drums, and wings, all on a percent chill weight basis) were not different ( $P > 0.05$ ) across treatments. No differences were observed in percentages of moisture, protein, and fat in thigh meat or breast meat across treatments. No significant gender by diet treatment interactions ( $P > 0.05$ ) were observed for any parameter. In conclusion, the diet containing grain of insect-protected YieldGard® Plus was nutritionally equivalent to diets containing the near isogenic control and commercial corn grain when fed to broilers in this 42 day study.

**Key Words:** Corn, Broilers, Biotechnology

**275 Evaluation of broiler performance when fed Roundup Ready® wheat Event MON 71800, control, and commercial wheat varieties.** C. A. Kan\*<sup>1</sup> and G. F. Hartnell<sup>2</sup>, <sup>1</sup>ID-TNO Animal Nutrition, <sup>2</sup>Monsanto Company, LLC.

The nutritional value of diets containing about 40% Roundup Ready® (glyphosate tolerant) wheat event MON 71800, its genetically similar non-transgenic control (MON 71900), and eight reference commercial wheat varieties (Express, Cavalier, Hank, 926, McNeal, Earnst, Fortuna and Westbred 936) was evaluated in broilers. The in-life phase of the study lasted for 40 days and each treatment group consisted of ten replicate pens (5 with males and 5 with females) with each pen initially containing 12 birds and later excess birds randomly removed to provide 9 broilers per pen at 13 days. Day-old sexed commercial Ross 308 broilers were used. Bodyweight and feed intake were measured per pen at 40 days. At 41 days, 4 broilers per pen were slaughtered. The carcasses were dissected and cut-up yields of the valuable parts determined. Dry matter, protein and fat content of breast meat were determined on the excised material. The data were analysed by an ANOVA procedure. All birds in the study performed exceptionally well, with body weights and feed conversion averaging 2450 g and 1.52, respectively, at day 40. There were no significant treatment x sex interactions except for evisceration yield in which there were large differences in yield between sexes of birds fed two of the commercial wheat varieties. All performance (final weight, feed conversion), carcass yield (weight, carcass, evisceration, breast meat, thigh, drum sticks, wings, remaining yields) and breast meat composition (dry matter, protein and fat) measurements were not different ( $P > 0.05$ ) among broilers fed Roundup Ready wheat and control when compared to the population of commercial wheat varieties except for a lower carcass yield at day 41 for those fed the nontransgenic control material. Based on these results, Roundup Ready wheat (event MON 71800) grain is nutritionally equivalent to non-genetically modified wheat varieties when fed to broilers.

**Key Words:** Roundup Ready wheat grain, Nutritive value, Broiler, Carcass yield

**276 Different criteria of feed formulation based on digestible amino acids for broilers.** O. M. Junqueira\*<sup>1</sup>, L. F. Araujo<sup>2</sup>, C. S. S. Araujo<sup>1</sup>, S. M. Baraldi Artoni<sup>1</sup>, and D. E. Faria<sup>2</sup>, <sup>1</sup>Universidade Estadual Paulista FCAVJ/UNESP - Brazil, <sup>2</sup>Faculdade de Zootecnia e Engenharia de Alimentos FZEA/USP - Brazil.

It was evaluated the performance and carcass yields of broilers fed diets formulated with different levels of digestible methionine, methionine + cystine, lysine and threonine, according ROSTAGNO (2000), BAKER & HAN (1994) and DEGUSSA (1997) from 22 to 42 days of age. Six hundred one day old male broilers Cobb were randomized in 12 pens each one with 50 birds. It was not found significant differences in body weight gain and feed intake between treatments. However, feed conversion showed better results in the treatments based on BAKER & HAN (1994) and DEGUSSA (1997). No differences were observed for carcass yields, legs, wings, back and abdominal fat. The broilers fed diet based on BAKER & HAN (1994) showed lower breast yield and feed formulated based in DEGUSSA (1997) resulted in better carcass yield. Financial Support: FAPESP. Proc. 98/06355-3.

**Key Words:** Broilers, Digestible amino acids, Feed formulations criteria

**277 Effect of dietary crude protein levels on the pectoralis breast muscle protein turnover in broiler chickens to 21 days of age.** M. Urdaneta\*<sup>1,2</sup> and S. Leeson<sup>2</sup>, <sup>1</sup>University of Guelph, Canada, <sup>2</sup>University of Zulia, Venezuela.

The effect of varied diet protein (CP) on breast muscle protein turnover in 21 d-old broiler chickens was assessed. The protein turnover in breast muscle was evaluated in chicks fed *ad libitum* from 7 to 21 d of age with iso-energetic diets containing dietary CP of 170, 210, 250 and 290 g CP/kg diets and lysine levels at 1.22 % of the diet. Protein fractional synthesis rates (FSR, % per day) were estimated in vivo using the flooding dose technique [D5 (ring)]-phenylalanine. Estimates of fractional breakdown rates (FBR, % per day) were calculated as the difference between FSR and the gain of breast tissue protein. Dietary CP affected ( $P < 0.05$ ) growth performance, and breast muscle FSR and FBR. Higher CP diets had increased FSR and FBR when comparing to the lower CP diets. No differences ( $P < 0.05$ ) were found in FSR and FBR when 250

and 290 g CP/kg diet were used. Absolute synthesis rate (ASR, mg # d) and Absolute growth rate (AGR, mg # d) were influenced ( $P < 0.05$ ) by the range of diet protein used. Increased dietary crude protein diets had improved ( $P < 0.05$ ) ASR and AGR. Results suggest that variable dietary crude protein levels containing constant levels of lysine not only influence productive parameters in chicks, but also have an effect on the metabolism of muscle protein.

**Key Words:** Broilers, Protein turnover, Crude protein

**278 Evaluation of dietary crude protein levels on the lysine requirements in broiler chickens to 21 days of age.** M. Urdaneta<sup>1,2</sup> and S. Leeson<sup>1</sup>, <sup>1</sup>University of Guelph, Canada, <sup>2</sup>University of Zulia, Venezuela.

Evaluation of growth and carcass nitrogen and fat deposition response to dietary lysine requirements were assessed in chicks to 21 d of age fed dietary crude protein (CP) at 170, 210, 250 and 290 g CP/kg diet. Comparisons of the response variables were evaluated using linear regression, quadratic regression, and linear-plateau (broken line) models. In all cases, the quadratic regression and linear-plateau models obtained better fit for response variables compared to the linear regression model. Weight gain, feed conversion (F:G), and carcass nitrogen and fat deposition were improved as dietary lysine was increased at all dietary CP levels although, a plateau was reached. Lysine requirements in chicks for weight gain to 21 d of age was significantly different ( $P < 0.05$ ) when 17% to 21% CP diets were used although, no differences ( $P > 0.05$ ) were found when 25% and 29% CP were fed. Feed conversion improved as lysine was increased although, again there was observed a plateau. Carcass nitrogen deposition increased as dietary CP and lysine levels were increased however, a maximum requirement for nitrogen deposition was achieved implying that excess lysine had no effect in increasing nitrogen deposition. Results suggest that dietary lysine requirements increase as CP increases (17 vs 21% CP) although, similar lysine requirement was found when high 25 or 29 % CP diet were used.

**Key Words:** Broilers, Lysine requirements, Crude protein

**279 Evaluation of qualitative and quantitative methodologies for measuring feather quality and re-growth post-molt and effects of dietary cystine on feather growth.** L. F. LaBrash\*<sup>1</sup> and S. Scheideler<sup>1</sup>, <sup>1</sup>University of Nebraska-Lincoln.

Post-molt feather quality and re-growth are important factors to the consumer's perception and reality of laying hen well-being. Little methodology exists for measurement of feather growth in response to diet or treatment. This study evaluated qualitative means of assessing feather status and established a quantitative means of measuring feather regeneration during and after molt. Two hundred forty 65-wk old ISA White laying hens were assigned to 60 cages (4 hens/cage) in a 2 × 4 augmented factorial (fasted or non-fasted molt with 250, 275, 300, or 325 mg Cys/hen/d). Hens were feather scored using a five-point feather score (FS) scale (Webster and Hurnik, 1990. Poul. Sci. 69:2118-21) on alternate days, from initiation of molt until 20 wk post-molt. Two weeks post-molt, one bird/cage was selected for daily measurement of new primary feather growth on each wing until feathers were 155 cm from the skin surface. During primary feather measurement, hens rested on their abdomen with wing raised. Primary feathers were measured with calipers on the ventral side, beginning with the axial feather and continuing to the distal tip of the wing. The same birds were inspected for broken feathers beginning 8 wks post-molt. Feather scoring identified a Cys by molt interaction with a quadratic response ( $P \leq 0.05$ ) to Cys for fasted molt and a cubic response ( $P \leq 0.05$ ) for non-fasted molt. Overall, relative to the fasted molt, the non-fasted molt had superior FS ( $P \leq 0.05$ ) at 275 and 325 mg Cys/hen/d. Fasted molt hens had best FS at 250 mg Cys/hen/d. Feather 16 showed a molt effect ( $P \leq 0.05$ ) with fasted hens having longer feathers than non-fasted. Feather 17 showed a quadratic response to Cys ( $P \leq 0.05$ ), with no feather growth at 300 mg Cys/hen/d. Feather 5 showed a Cys by molt interaction with quadratic effect ( $P \leq 0.05$ ). Feather 5 was longer for fasted hens at 300 mg Cys/hen/d and non-fasted hens at 325 mg Cys/hen/d. No difference ( $P \geq 0.05$ ) was detected in feather breakage.

**Key Words:** Feather measurement, Molt, Cystine

**280 Effect of the dietary fat unsaturation level on body fattening in female broiler chickens.** C. Villaverde, M. D. Baucells, L. Cortinas, J. Galobart\*, and A. C. Barroeta, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

An experiment was designed to determine the effect of the dietary fat unsaturation level on growth, abdominal fat weight, body composition and gross energy content of broiler chickens. Four dietary levels of polyunsaturation (15, 34, 45 and 61 g polyunsaturated fatty acids (PUFA)/kg of diet) were achieved by mixing different proportions of tallow, linseed and fish oil added (9%) to a basal diet. These diets were fed to 192 female broiler chickens from 8 to 44 days of age. Body weight and food consumption were measured to determine average daily gain (ADG), average daily intake (ADI) and food conversion rate (FCR). At the end of the trial half of the animals were killed in a slaughterhouse and the abdominal fat depot of each animal was weighed. The other half of the animals were killed with sodium pentobarbitate, frozen, minced, freeze-dried and ground to determine the body composition and gross energy content of the whole animal. There were no differences in the ADG but a decrease in the ADI was observed as the dietary PUFA increased (111, 108, 105 and 104 g/animal/day for the 15, 34, 45 and 61 g PUFA/kg diets respectively,  $P < 0.05$ ). This resulted in an improvement of 8% of FCR in the animals fed the most unsaturated diet ( $P < 0.05$ ). There were no differences in the final body weight of the chickens (mean=2318 g; RSD=108.2) but the abdominal fat weight decreased as the dietary PUFA increased, being the differences statistically significant between the two extreme treatments (1.17 vs. 0.76 g/100 g of live weight for the 15 and the 61 g PUFA/kg diet,  $P < 0.05$ ). Water, crude protein and ashes content were not affected, but there was a decrease in the whole animal total fatty acids content as the dietary PUFA increased from 37.5 (15 g PUFA/kg diet) to 31.8 g/kg DM (61 g PUFA/kg diets),  $P < 0.05$ . Furthermore, the gross energy content was also reduced in these animals (6574, 6316, 6220 and 5855 Kcal/Kg DM for the 15, 34, 45 and 61 g PUFA/kg diets respectively,  $P < 0.05$ ). These results suggest a reduction of the body fattening in the animals fed unsaturated diets, in spite of the better digestibility of unsaturated fats.

**Key Words:** PUFA, Body fat, Poultry

**281 Dietary mineral retention of growing and finishing turkeys fed wheat-based diets supplemented with enzymes.** A. A. Santos, Jr.\*, P. R. Ferket, J. L. Grimes, and F. B. O. Santos, *North Carolina State University, Raleigh, NC/USA.*

The amount of minerals excreted into the environment by an animal can be estimated by the difference between the dietary minerals consumed and the amount retained or utilized for growth and metabolism. Estimation of dietary mineral utilization, which depends upon age and dietary factors, is most important during the growing-finishing phases because this is the period when the amount of mineral emission is greatest. This study determined the effect of dietary pentosanase supplementation on dietary mineral retention (MR) of turkeys fed wheat-based diets from 9 to 17 wk of age. Nicholas toms were fed wheat-based diets containing one of the 3 enzyme treatments: unsupplemented control (C), >5,500 EXU Natugrain Blend<sup>®</sup>/g feed (NB), and >5,500 EXU Lyxasan<sup>®</sup>/g feed (LX100) (BASF AG, Ludwigshafen, Germany). NB contains a blend of enzymes from *Trichoderma longibrachiatum* fermentation, while LX100 contains mostly endoxylanase from a genetically modified strain of *Aspergillus niger*. Each treatment group was assigned to 2 slatted-floor pens containing 12 birds each. Retention of minerals per kg of body weight gain (BWG) generally decreased as the birds aged. In decreasing order retention (ppm of mineral/kg BWG) of Ca, P, S, Zn, Mn, and Cu were in ranges of 2958-8830, 2240-4471, 1100-2400, 51-117, 13-87, and 7-11, respectively. MR/BWG decreased ( $P < 0.05$ ) when diets were changed from 65% to 75% of wheat. The MR among enzyme treatments did not differ significantly. In comparison to C, enzyme supplementation improved phosphorus (3164 vs. 2794 ppm/kg,  $P < 0.05$ ), but there were no enzyme effects on the retention of Ca, Mn, or S. In contrast, dietary enzyme supplementation decreased Cu retention relative to control (16 vs. 6 ppm/kg,  $P < 0.05$ ). In conclusion, MR/BWG decreased as the birds aged and as dietary wheat inclusion level increased. Dietary endoxylanase supplementation of wheat-based diets may improve mineral utilization of turkeys, depending on the mineral in question.

**Key Words:** Turkeys, Wheat, Enzymes, Mineral retention

**282 Evaluation of dietary *Aspergillus* meal prebiotic (Fermacto<sup>TM</sup>) on poul performance, intestinal strength, tibial diameter and tibial strength: Hatch to 30 days-of-age.** G. Tellez<sup>\*1</sup>, G. M. Nava<sup>1</sup>, J. L. Vicente<sup>1</sup>, D. J. Donoghue<sup>1</sup>, A. M. Donoghue<sup>2</sup>, W. E. Huff<sup>2</sup>, J. M. Balog<sup>2</sup>, S. Higgins<sup>1</sup>, L. Sutton<sup>3</sup>, and B. M. Hargis<sup>1</sup>, <sup>1</sup>Department of Poultry Science, University of Arkansas, Fayetteville, Arkansas, 72701, <sup>2</sup>USDA-ARS-PPSRU University of Arkansas, Fayetteville, Arkansas, 72701, <sup>3</sup>PetAg Inc, Hampshire, IL 60140 USA.

In a preliminary study, we demonstrated that administration of eleven strains of lactic acid bacteria in the drinking water during the first three days of life combined with 0.2 % dietary *Aspergillus* meal (AM) prebiotic (Fermacto<sup>TM</sup>) for 30 days, increased growth, gut maturation, digestibility of nutrients and resistance to *Salmonella enteritidis* infection of turkey poults. Presently, we evaluated the effect of adding 0.2% dietary AM alone, on body weight (BW [g]), feed conversion (FC), total mortality (TM), gut strength (GS [Kg]), tibial diameter (TD[cm]) and tibial strength (TS [Kg]) in turkey poults days 0-30. Corn-soybean (C/S) based diets were isocaloric and isonitrogenous and met NRC recommended levels of critical nutrients for turkey poults. Two diets (control C/S diet or Control C/S plus 0.2 % AM) with four replicates of 25 poults each (n=100) were evaluated. On days 10, 20 and 30, BW was determined for all poults. At 30 days, FC and TM were recorded and eight poults (2 poults per replicate) from each group were killed to determine GS, TD and TS. Administration of AM increased (P<0.05) BW at day 10 (6.41%), 20 (5.58 %) and 30 (4.45 %) as compared to controls. Dietary AM also significantly improved FC (1.500.01) as compared to controls (1.970.01). No difference in TM between treatments was observed (AM: 8%; Control: 10%). Administration of AM increased significantly GS (AM: 0.340.05; Control: 0.22.012), TD (AM: 4.830.03; Control: 4.410.013) and TS (AM: 19.970.23; Control 14.50.96) as compared to control diets at 30 days-of-age. These studies suggest that dietary AM may enhance concentrations of putatively beneficial microflora in the intestinal tract of young turkeys, and that several important performance parameters may also be improved. Further studies are necessary to evaluate the role beneficial lactic acid bacteria and to characterize the persistence of these benefits prior to processing.

**Key Words:** Turkey poults, Prebiotic, *Aspergillus* meal

**283 Effects of different carbohydrates in the feed of newly hatched chicks on performance and organs allometric growth.** J. O. B. Sorbara\*, J. F. M. Menten, F. A. Longo, A. A. Pedroso, A. N. Figueiredo, A. M. C. Racanicci, and J. B. Gaiotto, *Escola Superior de Agricultura Luiz de Queiroz - USP Piracicaba - SP Brazil.*

The anatomic changes of the digestive tract of chicks during the first days of life are remarkable and can influence bird performance. The present work studied the effect of the quality alteration in the newly hatched broilers feed by different carbohydrates sources on the gastrointestinal tract development and on the initial performance. The trial was carried out on brooder batteries with six treatments: control diet and five test diets feed with 20% ME requirement from glucose, sucrose, corn starch, cassava starch and 5% of lactose; and four replications of 26 chicks. The birds received the treatments only in the first week of age. The performance was analyzed from 1 to 7, 8 to 21 days. Chicks were killed to evaluate the allometric growth of the gastrointestinal tract organs from the first to seventh day and on the 21st day. Only the feed consumption (P=0.0062) and body weight (P=0.0975) in the first week were affected by the treatments; birds receiving the diets with carbohydrates sources showed better results than the control. The yolk sack, proventriculus, and the small intestine density were not affected by the treatments. From the first to the seventh day the different sources of carbohydrates affected the development of the gizzard and the small intestine weight and length. The treatments did not affect any variable at 21 days. In conclusion the carbohydrates: glucose, sucrose, corn starch and cassava starch were beneficial for the performance of the birds from one to seven day-old. These carbohydrates sources resulted in better bird performance probably due to improvement of the gastrointestinal tract and absorbability capacity.

**Key Words:** Carbohydrates, Chicks, Gastrointestinal, Performance

**284 Effects of different protein sources in the feed of newly hatched chicks on broiler performance.** F. A. Longo\*, J. F. M. Menten, J. O. B. Sorbara, A. A. Pedroso, A. N. Figueiredo, A. M. C. Racanicci, and J. B. Gaiotto, *Escola Superior de Agricultura Luiz de Queiroz - USP Piracicaba - SP Brazil.*

Embryos have the ability to absorb amino acids through the intestine even before hatching, an ability that may justify the study of the effects of high quality protein in the feed of newly hatched chicks. This work was carried out to evaluate the effects of quality alteration in the newly hatched broilers' feed by different protein sources on the initial performance and gastrointestinal tract development. The birds were allotted in brooder batteries with six treatments: control diet and five test diets with 20% CP requirement from blood plasma AP 920 (BP), isolated soy protein (ISP), dried whole eggs (DWE), corn gluten meal - 60% (CGM), and sugar cane yeast (SCY); and four replications of 26 chicks. The birds received the treatments only from one to seven days. The performance was analyzed from 1 to 7, and 8 to 21 days. Chickens were killed to evaluate the allometric growth of the gastrointestinal tract organs from the first to seventh day and on the 21st day. The treatments BP, ISP, DWE and CGM decreased (P < 0.01) the birds feed intake from one to seven days, the weight gain was not affected by the treatments, and the birds on treatments BP and ISP showed the best values of feed conversion ratio (P < 0.01). The birds performance from eight to 21 days was not affected by treatments. The different protein sources affected organ development, but these effects were not enough to explain birds performance. In conclusion, the protein sources evaluated in this trial can be included in the feed of newly hatched chicks, and these sources should be evaluated under stressing conditions to verify some suggested beneficial properties of these ingredients.

**Key Words:** Protein Source, Chicks, Gastrointestinal, First week, Performance

**285 Metabolizable energy of carbohydrates for newly hatched broiler chicks.** F. A. Longo\*, J.F.M. Menten, J.O.B. Sorbara, A. A. Pedroso, A. N. Figueiredo, A.M.C. Racanicci, and J. B. Gaiotto, *Escola Superior de Agricultura Luiz de Queiroz - USP Piracicaba - SP Brazil.*

It has been reported that manipulation of early nutrition of chicks could modify subsequent growth and fatness of broilers. Feeding highly digestible carbohydrate diets to a post-hatched chick may be beneficial by increasing blood glucose and minimizing the protein utilization for gluconeogenesis, improving access to protein for body tissue formation. However, digestive organs and digestive enzymes are not fully developed at this age, attaining optimum function after 7 days of age. This work was carried out to determine the metabolizable energy of different carbohydrates sources for newly hatched chicks. The total excreta collection method was used, with 264 male chicks from four to seven days, allotted to a completely randomized design with six treatments (a reference diet and five diets with inclusion (20%) of the test ingredients) and four replicates of eleven birds. The ingredients evaluated were cassava starch (CAS), corn starch (COS), glucose (GLU), lactose (LAC) and sucrose (SUC). The analyzed composition for dry matter, crude energy, crude protein, and ether extract of the ingredients were in agreement with literature and industry values. The N-corrected apparent metabolizable energy (AMEn) of the ingredients determined for broilers in the first week were 3.690, 3.269, 3.427, 1.225 and 3.524 kcal/g (as feed-basis) for CAS, COS, GLU, LAC and SUC, respectively. The differences found between AMEn calculated and literature values could result from the anatomical and metabolic characteristics for post hatched chicks, which modify the energy utilization. The ingredients CAS, SUC and GLU showed the higher values for AMEn for chicks on first week.

**Key Words:** Carbohydrates source, Chicks, Energy, First week, Metabolism trial

**286 Metabolizable energy of alternative protein ingredients for newly hatched chicks.** J. F. M. Menten\*, F. A. Longo, J. O. B. Sorbara, A. A. Pedroso, A. N. Figueiredo, A. M. C. Racanicci, and J. B. Gaiotto, *Escola Superior de Agricultura Luiz de Queiroz - USP Piracicaba - SP, Brazil.*

The metabolizable energy content of the diet represents the sum of the contributions of carbohydrates, fat, and protein contained in the different ingredients. The study of nutrition and metabolism in early age broiler

chickens is an interesting area which may help in optimizing broiler production, but there is a lack of information on early nutrition of chicks and there are some conflicting reports on metabolism. A metabolism trial was carried out with the objective of determining the metabolizable energy of alternative protein ingredients for newly hatched chicks. The total excreta collection method was used, with 264 male chicks from four to seven days, allotted to a completely randomized design with six treatments (a reference diet and five diets with inclusion of the test ingredients) and four replicates of eleven birds. The ingredients evaluated were isolated soy protein (ISP), dried whole eggs (DWE), corn gluten meal - 60% (CGM), sugar cane yeast (SCY) and blood plasma AP 920 (BP). The analyzed composition of the ingredients was in agreement with literature values. The N-corrected apparent metabolizable energy (AMEn) of the ingredients determined for chicks in the first week were 2.110, 5.095, 3.374, 2.037, 3.831 kcal/g (as-fed basis) for ISP, DWE, CGM, SCY and BP, respectively. Compared to values found in the literature the AMEn values determined on the trial were higher for DWE and BP, lower for CGM and similar for SCY, showing the need of studies on the digestion and absorption processes and the feed utilization for chicks in this phase of rearing.

**Key Words:** Protein source, Chicks, First week, Metabolism trial, Metabolizable energy

**287 Metabolizable energy values of corn and soybean meal for newly hatched chicks.** F. A. Longo, J.F.M. Menten\*, J.O.B. Sorbara, A. A. Pedroso, A. N. Figueiredo, A.M.C. Racanicci, and J. B. Gaiotto, *Escola Superior de Agricultura Luiz de Queiroz - USP Piracicaba - SP Brazil.*

The anatomy and physiology of the digestive tract of broilers on the first week of age are different from the older birds; their nutritional needs are quite limiting as they have difficulty in digesting and absorbing certain nutrients. A metabolism trial was carried out with the objective of determining the metabolizable energy of corn grain and soybean meal for newly hatched chicks. The total excreta collection method was used, with 144 male chicks from four to seven days, allotted to a completely randomized design with three treatments (a reference diet and two diets with 60% of reference diet and 40% of the test ingredients) and four replicates of twelve birds. The ingredients evaluated were corn grain (CG) and soybean meal (SM). The analyzed composition of the ingredients was in agreement with literature values. The N-corrected apparent metabolizable energy (AMEn) of the ingredients determined for the chicks in the first week were 3.213 and 2.085 kcal/g (as-fed basis) for CG and SM, respectively. The AMEn values determined on the trial were lower than the values found in the literature, showing the need of studies on the digestion and absorption processes and the feed utilization for chicks during the first week of age.

**Key Words:** Corn, Soybean meal, Metabolism trial, First week, Chicks

**288 Comparison of the effect of protein, peptide or crystalline amino acids supplementation on the performance of broiler chicks.** K. Nakagawa\*, I. Shinzato, K. Watanabe, Y. Toride, and H. Sato, *Ajinomoto Co., Inc. Tokyo, Japan.*

A chick assay from 0 to 14 days of age was conducted to examine whether or not the performance of broiler chicks would be influenced by chemical bond of amino acids sources (protein, peptide or crystalline amino acids). Seventy-two broiler (Cobb) chicks at 0 days of age were allocated to one of three treatments with three replicates of eight birds per replicate. A basal diet mainly consisted of corn and soybean meal and formulated to be 18.5% CP and deficient in several essential amino acids (EAA). Three experimental diets were prepared by supplementing to the basal diet with either soybean meal (**PRO**), peptide (**PEP**), or mixture of crystalline amino acids (**AA**) to meet the requirements of all EAA. The peptide used in this trial was prepared by hydrolysis of soybean meal by protease from *Aspergillus oryzae* followed by freeze-drying process of hydrolysate. In the mixture of crystalline amino acids, 18 kinds of amino acids were used to simulate the amino acid profile of soybean meal. The trial diets for PRO, PEP and AA were formulated so that their amino acids contents would be identical and sufficient to meet the NRC recommendation (1994). Individual body weight of chicks and feed intake per replicate were measured at 7 and 14 days of age. On the final day of the trial, four chicks per replicate were bled for analysis of the contents of plasma free amino acids and metabolites, and another four were sacrificed and stored for analysis of carcass characteristics. Average daily

gain was 25.5, 26.1 and 25.3g, average daily feed intake was 32.7, 33.9 and 30.9g, and feed conversion ratio was calculated to be 1.28, 1.30 and 1.23, for PRO, PEP and AA, respectively. Any measured parameters were not significantly different among treatments. These results suggest that efficiency of utilization of amino acids is not influenced by chemical bond of their source and that supplementation of protein, peptide or crystalline amino acids has the similar effect on the performance of broiler chicks.

**Key Words:** Protein, Peptide, Amino acids, Broiler chicks

**289 Phosphorus bioavailability of distiller's dried grains plus solubles.** B. S. Lumpkins\*, A. B. Batal, and N. M. Dale, *University of Georgia.*

Increased emphasis on ethanol production in the United States has and will continue to lead to significant increases in the amount of distiller's dried grains plus solubles (DDGS) available to the feed industry. An experiment was conducted to evaluate the bioavailability of phosphorus in distiller's dried grains plus solubles. 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 8-22 d of age. The experimental treatments were: 1) Corn-soybean meal basal with 0.12% available phosphorus, 2) Basal + 0.05% P from K<sub>2</sub>HPO<sub>4</sub>, 3) Basal + 0.10% P from K<sub>2</sub>HPO<sub>4</sub>, 4) Basal + 5.0% DDGS, and 5) Basal + 10.0% DDGS. The basal diet was adequate in all nutrients except P and DDGS was added at the expense of cornstarch. A linear response (P < 0.05) was observed for weight gain and bone ash from the addition of K<sub>2</sub>HPO<sub>4</sub> to the basal diet. Both slope-ratio and standard curve methodology were used to estimate phosphorus availability. Multiple regression analysis produced the models: gain (g) = 324.0 + 0.27 P intake (mg) + 0.16 DDGS intake (g) (R<sup>2</sup> = 0.78) and bone ash (%) = 25.1 + 0.01 P intake (mg) + 0.005 DDGS intake (g) (R<sup>2</sup> = 0.81). The ratio of slopes indicated bioavailable concentrations of 0.59 and 0.50% in DDGS. The expressed values as a percent of total P (0.74%) in DDGS, yields availability estimate of 80 and 68% for weight gain and bone ash, respectively. The linear regression analysis produced the models: gain (g) = 319.1 + 0.28 P intake (mg) (r<sup>2</sup> = 0.81) and bone ash (%) = 25.0 + 0.01 P intake (mg) (r<sup>2</sup> = 0.86) and resulted in an estimated bioavailability of 0.72 and 0.67%. Based on the linear regression analysis, P availability expressed as a percent of the total P (0.74%) in DDGS was estimated at 97% for weight gain and 91% for bone ash.

**Key Words:** Phosphorus, Bioavailability, Distiller's dried grains plus solubles, Chicks

**290 Apparent metabolizable energy value of fat sources for broiler chickens.** J. B. Gaiotto\*, J. F. M. Menten, A. M. C. Racanicci, A. A. Pedroso, F. A. Longo, and J. O. B. Sorbara, *Escola Superior de Agricultura Luiz de Queiroz - USP Piracicaba - SP, Brazil.*

The objective of this research was to determine the apparent metabolizable energy (AME) and nitrogen corrected apparent metabolizable energy (AMEn) of soybean acidulated soapstock (AS), poultry fat (PF), soybean oil (SO) and 1:1 mixtures of soybean oil and soybean acidulated soapstock (SO/AS) or soybean oil and poultry fat (SO/PF). A total 600 male AgRoss birds were used in four trials corresponding to the pre-starter (1-7 d), starter (8-21 d), grower (22-35 d) and finisher (36-42 d) periods. They were allocated to a randomized design of six treatments with four replicates of 10, 8, 4 and 3 chickens per pen in each trial, respectively and were fed a basal diet or this diet substituted with 10% of fat sources. To determine AME and AMEn of fat sources the total excreta collection method was used. The results of AME of pre-starter, starter, growing and finisher diets, respectively, were 6,715, 6,973, 7,741 and 7,885 kcal/kg for AS; 7,950, 8,506, 8,910 and 9,044 kcal/kg for PF; 8,200, 9,028, 9,088 and 9,133 kcal/kg for SO; 8,094, 8,487, 8,793 and 8,897 kcal/kg for (SO/AS) and 8,126, 8,452, 8,694 and 8,730 kcal/kg for (SO/PF). The AMEn of the fats were 6,620, 6,768, 7,610 and 7,793 kcal/kg for AS; 7,815, 8,338, 8,743 and 8,991 kcal/kg for PF; 8,038, 8,861, 8,866 and 9,094 kcal/kg for SO; 7,993, 8,272, 8,480 and 8,700 kcal/kg for (SO/AS) and 7,860, 8,298, 8,479 and 8,640 kcal/kg for (SO/PF). The AME and AMEn of AS were inferior to those of other fat sources for pre-starter, starter, growing and finisher diets (p < 0.05). A synergistic effect was observed for the SO/AS

mixture. In general, the energy values for fats were lower for younger birds than for older chickens.

**Key Words:** Apparent metabolizable energy, Soybean acidulated soap-stock, Poultry fat, Soybean oil, Broiler chicken

**291 Meat and bone meal processed differently as an alternative protein source in broiler diets.** M. Moschini<sup>1</sup>, C. Cerioli<sup>1</sup>, L. Fiorentini<sup>1</sup>, M. Morlacchin<sup>2</sup>, and G. Piva<sup>\*1</sup>, <sup>1</sup>Università Cattolica del Sacro Cuore, Piacenza, Italy, <sup>2</sup>CERZOO, San Bonico, Piacenza.

The recent lifting of the EC ban for meat and bone meal (2002/1774/EC) could justify the use of the meat and bone meal in animal diets. Only meat and bone meal processed according to the 96/449/EC directive are allowed. The safety of the processing may be improved when an alkaline step is added to the heat treatment. Three hundred sixty Ross 1 d-old male Marek vaccinated chicks were randomly assigned to nine dietary treatments (4 pens per treatment/10 birds per pen). Chicks were floor housed, ad libitum fed isocaloric and isonitrogenous diets and had free access to water. Artificial light was provided 10 h/d. Four meat and bone meals (obtained as follows: 100°C, 20 minutes, 3.5% CaO w/w (A); 125°C, 20 minutes (B); 133°C, 20 minutes (C); 141°C, 20 minutes (D)) were used at two levels of substitution (L1 = 7%, L2 = 14%) of the protein from soybean in a base standard diet (control diet) (Ct). Bird mortality was recorded daily and dead birds were removed and weight was recorded. At the end of the trial (42d) the pen feed consumption and weight were recorded and the pen final weight was cleared from weight of removed birds. The pen average daily gain (ADG) was calculated and adjusted gain to feed ration (G:F) was obtained. Data were analyzed with the Dunnett Type I error comparison against the control and Mixed Procedure as a 4<sup>2</sup> factorial. The inclusion of meat and bone meal produced according to the EC directive (C) or at high temperature (D) had higher (P < 0.05) ADG than the Ct group (25 and 30%, respectively for C and D). The average daily intake (ADI) was 16% higher (P < 0.05) when feeding the D diets compared to the Ct group. The G:F was significantly (P < 0.05) increased (20%) in pens fed the CL1 compared to pens fed the Ct diet. No level or meat and bone meal by level interaction were observed. Animals fed diets with meat and bone meal prepared according to the EC directive or at higher temperature had better performance than animals fed a standard diet. No differences in ADG, ADI and F:G were observed in pens fed diets with alkali treated meat and bone meal compared to the Ct pens.

**Key Words:** Meat and bone meal, Alkali, Poultry

**292 Effect of dietary putrescine (1, 4-diaminobutane) on growth, gastrointestinal polyamine metabolism and dry matter digestibility in turkey poults challenged with a mixed coccidial infection.** S. R. Girdhar, J. R. Barta, and T. K. Smith, *University of Guelph*.

The use of raw soybeans in chick starter diets and the addition of isolated soy protein to milk replacer diets of neonatal pigs and calves prevents the normal development of the intestinal mucosa. Supplementing these diets with putrescine partially overcomes the adverse effects produced by anti-nutritional factors. An experiment was conducted, therefore, to determine the potential for dietary putrescine to overcome the effects produced by artificially induced subclinical coccidiosis, using a mixed infection. A total of 160 day-old poults were fed a corn and soybean meal-based starter diet supplemented with 0.0 (control), 0.1, 0.2 and 0.3% purified putrescine (8 birds per pen, 5 pens per diet) for 14 days. At 14 days of age, half the birds were infected with approximately 42,000 sporulated oocysts. The duration of the total experiment was 24 days. Ten birds per diet from each of the control and infected groups were sampled on day 6 and day 10 post-infection. Fecal samples were gathered from day 2 to day 5 post-infection by total collection. The induced infection produced a significant depression in growth and feed intake in the absence of mortality. The feeding of 0.3% supplemental putrescine alleviated the growth depression and reduction in feed intake caused by the infection and increased intestinal tissue putrescine concentration. Dry matter retention was significantly higher in infected birds fed 0.2 and 0.3% supplemental putrescine compared to those fed the unsupplemented diet. It was concluded that supplementation of poults

starter diets with up to 0.3% putrescine may be beneficial in alleviating the growth depressing effects produced by low level coccidial infections.

**Key Words:** Putrescine, Growth, Coccidia, Turkey

**293 The expression of calbindin-28 kd mRNA and protein differs in chicks that are divergently selected for either a low or high incidence of tibial dyschondroplasia.** R. B. Shirley<sup>\*1</sup>, A. J. Davis<sup>1</sup>, M. M. Compton<sup>1</sup>, and W. D. Berry<sup>2</sup>, <sup>1</sup>University of Georgia, Athens, GA/USA, <sup>2</sup>Auburn University, Auburn, AL/USA.

The incidence of tibial dyschondroplasia (TD) is strongly associated with an imbalance between dietary and physiological concentrations of Ca and P (low Ca:P ratio). Three experiments were conducted to test the null hypothesis that broiler chicks divergently selected for the expression of a low or high incidence of TD (LTD and HTD, respectively) have no difference in their expression of intestinal calbindin-28 kd (cal) mRNA or protein. In Experiment 1, the expression of cal mRNA between d-of-hatch LTD, HTD, and commercial broiler chicks (n=12) was investigated. In the next two experiments LTD and HTD chicks were fed a corn-soybean meal diet that was adequate in all nutrients except cholecalciferol (D<sub>3</sub>), which was titrated to 200 or 1,600 IU/kg diet in a completely randomized 2 x 2 factorial arrangement. Intestinal scrapings were taken from the proximal duodenum at day of hatch (Expt 1), 4 and 8 days of age (Expt 2) and 18 days of age (Expt 3) for subsequent Northern and Western analysis of cal expression. In Expt 1 the mRNA expression of cal was not different (P=0.564) between the three genetic strains of birds. At 4 d of age, both the LTD and HTD chicks fed 200 IU/kg D<sub>3</sub> diet had a lower (P<0.05) expression level of cal mRNA than the chicks fed the 1,600 IU/kg D<sub>3</sub> diet. In addition, the HTD chicks had a significantly lower expression level of cal mRNA than the LTD chicks when fed the 200 IU/kg D<sub>3</sub> diet. Intestinal expression of the cal protein was the lowest for the HTD chicks fed 200 IU of D<sub>3</sub> (P<0.05), and there was no difference between the LTD chicks fed 200 IU of D<sub>3</sub> and either the LTD or HTD chicks that were fed 1,600 IU of D<sub>3</sub>. The 8 d results mirrored those obtained at 4 d. In Expt 3, percent tibia ash was increased by 8% when the D<sub>3</sub> supplement was increased from 200 to 1,600 IU/kg diet, however, percent tibia ash between the two strains was similar at each of the two levels of D<sub>3</sub> supplementation (P = 0.0042). Similar effects were observed for the incidence of TD, however, the relative decrease in TD was greater (P=0.0065) for the LTD chicks than the HTD chicks when 1,600 IU of D<sub>3</sub> was fed. Cal mRNA expression levels at 18 d were similar to those observed in Expt 2. These data suggest that genetic selection may alter the broiler chick's response to lower levels of D<sub>3</sub>.

**Key Words:** Cholecalciferol, Calbindin-28 kd expression, Broiler chick, Tibial dyschondroplasia

**294 Effect of dietary 1,4-diaminobutane (putrescine) on performance and intestinal development in broilers.** F. Santoyo and T. K. Smith, *University of Guelph*.

Biogenic amines are biologically active low molecular weight organic bases which are synthesized by decarboxylation of amino acids during metabolism of animals, plants and microorganisms. Included is the mammalian polyamine putrescine (1,4-diaminobutane, DAB). DAB has been shown to play a regulatory role in organismal growth, cellular development and division and anabolic processes including synthesis of DNA, RNA and protein. An experiment was conducted with six day-old broiler chicks fed corn and soybean-meal based diets containing 0, 0.1, 0.2, 0.3, 0.4 and 0.5% supplemental DAB for 3 weeks. In a second experiment, 0, 0.1, 0.2, and 0.3% of supplemental DAB was fed for 6 weeks. At the end of the experiments, 10 - 12 birds fed each diet were killed and intestinal sections, liver, spleen, pancreas, breast, thigh and toe were excised. Toe ash and tissue concentrations of soluble protein, DNA and polyamines and metabolites were determined. Morphometric indices were obtained using computer-aided light microscope image analysis of intestinal samples. The feeding of 0.5% DAB was clearly toxic. Organ weight, intestinal DNA, and toe ash were not affected by diet. Linear responses to dietary DAB concentration were seen in feed efficiency in weeks 2, 3 and 4 in duodenal soluble protein content. Villus height, crypt depth, and thickness of muscularis was affected by diet in Duodenum (Duo), jejunum (Jej) and ileum (Ile). Villus width and submucosa were affected in Duo and Ile. Quadratic responses to dietary DAB were seen in crypt depth and muscularis in Duo, Jej and Ile. It was concluded that (1) dietary DAB supplementation may promote Duo development resulting in

increased polyamine deposition in edible tissues after 3 weeks although this effect was less pronounced after 6 weeks of feeding (2) some benefits may be seen in broiler production with the feeding of low levels of DAB (3) dietary DAB can influence the morphology of small intestine.

**Key Words:** Putrescine, Small intestine, Morphometrics, Broilers, Growth

**295 Amino acid digestibility in corn distillers dried grains with solubles.** T. Ergul<sup>1</sup>, C. Martinez Amezcua<sup>2</sup>, C. M. Parsons<sup>2</sup>, B. Walters<sup>3</sup>, J. Brannon<sup>1</sup>, and S. L. Noll<sup>1</sup>, <sup>1</sup>University of Minnesota, <sup>2</sup>University of Illinois, <sup>3</sup>University of Wisconsin-River Falls.

Samples of corn distillers dried grains with solubles (DDGs) were collected to determine the extent of variation in digestible amino acid (DAA) content. A second objective was to determine if any correlation exists between color of the sample and its digestible amino acid content. Samples (N=22) were obtained from four different commercial plants in Minnesota during spring, 2002. Digestible amino acids were determined with cecectomized roosters. Color (L\*(lightness), a\*(redness), and b\*(yellowness)) was measured with a Minolta Chroma Meter CR-300 (Minolta Co., Ramsey, NJ.) with five readings per sample. The DAA content and color was affected by source (P<0.05). Digestibility of all amino acids averaged 83.1% across all samples. Digestibility was lowest for lys, cys, and thr (71.0, 75.3, and 76.3%, respectively). Among sources, DAA content was different (P > .05) except for leu and ser. Digestible lys averaged .53% and source means ranged from .38 to .65%. Within sources, coefficient of variation (CV) for digestible lys ranged from 3.9 to 10.7% compared with a CV of 20.6% across all samples. Correlations (P<0.001) were found between digestible lys, cys, and thr and L\* values (r = 0.67, 0.67, and 0.51, respectively) and b\* values (r = 0.77, 0.74 and 0.58, respectively) but not with a\* values. Lighter color (L\*= 53.8) and more yellow color (b\*=42.8) were associated with product averaging .65% digestible lysine while a darker (L\*=41.8) and less yellow (b\*=32.9) color were associated with product averaging .38% digestible lys. Digestible amino acid content was found to vary among sources but was relatively consistent within a particular source. Color (L\*, b\*) as measured with a Minolta Chroma Meter was a good predictor of lys, cys, and thr digestibility. These results confirm that color can be a quick and reliable method of determining corn DDGs quality used as feed ingredient in poultry diets.

**Key Words:** Distillers dried grains with solubles, Corn, Color, Lysine, Digestibility

**296 Effects of dietary phytase addition, non phytate phosphorus levels and two different feeding programs on female broilers performance.** A. Ouyed\* and M. R. Lefrancois, *Universite Laval.*

This experiment was undertaken to evaluate the effects of phytase (Natuphos 5000<sup>TM</sup>), non phytate phosphorus (NPP) levels and phase feeding programs on female broilers performance up to 38 d of age. A total of 3240 1-d-old chicks (Ross x Ross) were randomly allotted to 40 pens according to a complete block factorial design (0 vs 500 FTU/kg x 3 vs 4 feeding phases x normal vs low NPP). The control NPP levels without phytase were 0.45, 0.42 and 0.40% and 0.45, 0.42, 0.40 and 0.38% for the 3 and 4 phases feeding programs respectively. The NPP content was reduced by 0.1% when phytase was added. Metabolizable energy, proteins, amino acids, calcium and phosphorus levels in the feeds were adjusted to take into account the increased availability of those nutrients when phytase was added to the diets. Feed intake (FI), final body weight (BW), weight gain (WG) and feed conversion (FC) were measured throughout the trial. Results showed no significant effects (P>.05) of dietary treatments on final BW (2346 to 2428 g), mean daily gain (60 to 63 g/d), overall FC (1.695 to 1.738). However, a significant (P<.05) phytase x NPP x feeding program interaction on daily FI was observed. This suggests a lower FI with phytase addition in the 3 phases feeding program with reduced NPP level (104 g/d) when compared to normal NPP level with added phytase (106 g/d). On the other hand, FI was higher in the 4 phases feeding program with reduced NPP level and phytase addition (107 g/d) or in the control group (107 g/d). It appears that under the experimental conditions female broilers performance can be maintained without phytase addition even at reduced NPP level and by using a simpler 3 phases feeding program.

**Key Words:** Broiler, Performance, Feeding program, Phytase, Phosphorus

**297 The effect of replacing ground sorghum with whole sorghum on the performance of broilers.** R. S. Beyer\*, M. Greenwood, and K. Cramer, *Kansas State University, Manhattan, KS.*

Past research has indicated that mash-fed broilers have reduced gizzard mass (GM) compared to broilers fed rations with grains that have not been processed. To prevent segregation and improve feed conversion and growth, most commercial broiler chickens are fed diets which have been finely ground then pelleted prior to feeding. In the crop, pellets absorb moisture and quickly dissolve into ground particles causing the gizzard to atrophy to a size similar mash fed birds. Gizzard function and its contribution to digestive function has not been fully defined. A study was designed to determine if ground sorghum could be replaced with whole sorghum and thus prevent gizzard atrophy in broilers. Three week old male broiler chicks were mass brooded and fed a common starter ration. The birds were then weighed and randomly assigned to 64 floor pens with 12 birds per pen. Each pen was randomly allotted a typical corn-SBM grower ration that was formulated to contain 20% sorghum. The control birds received a ration in which all the sorghum was ground. Three other groups received the same ration but with 25, 50, and 100% of the ground sorghum replaced with unground sorghum with 16 reps per trmt. After 3 weeks, pen data was recorded and birds were randomly sampled to determine GM, and % yield. Whole sorghum increased GM compared to the birds fed diets that were all ground. Birds fed rations with 100% whole sorghum had reduced BWT and FC, yet the other percentages compared favorably to the control group. Yield did not differ among the treatments. The results indicate that it may be possible to leave portions of rations unground to prevent gizzard atrophy and decrease grinding costs. Further work is needed to determine the effect of whole grains on the pelleting process to realize savings due to reduced grinding of a portion of the grain.

**Key Words:** Sorghum, Particle size, Whole grain, Broilers, Feed manufacturing

**298 Summary of body weight, feed conversion ratio, and mortality results from twenty-five broiler pen trials worldwide comparing mannan oligosaccharide diets versus unsupplemented or antibiotic diets.** D. M. Hooge\*, *Hooge Consulting Service, Inc.*

Saccharomyces yeast outer cell wall components known as phosphorylated mannan oligosaccharides (MOS; Bio-Mos<sup>®</sup>, Alltech, Inc., Nicholasville, KY) have been used commercially in broiler chicken feeds since 1993 as a natural, alternative growth promoter. Written reports from twenty-five broiler pen trials (1993 to 2002) from around the world were collected and analyzed statistically using the Paired T-test (Statistix 7.0, Analytical Software, Tallahassee, FL) "by treatments" and "by trials" to compare MOS-supplemented diets with negative control or positive (antibiotic) control diets. Some trials had more than one set of comparison treatments (for example, dose-response studies). Criteria for trial inclusion were: 1) MOS fed during the entire experimental period, 2) either feed conversion ratio or corrected (mortality-adjusted) feed conversion ratio (FCR) presented along with body weight (BWT), and 3) the name of the antibiotic was stated when used. Final ages ranged from 25 to 49 d. Mortality (MORT) results were evaluated when available. Pen trials were primarily on new or recycled litter, but some used wire or slats. Antibiotics fed were avilamycin, bacitracin (MD or zinc), bambermycins, or virginiamycin. Relative changes with MOS diets were expressed as % of control diets. Compared to negative control results: BWT improved with MOS addition by treatment (n = 34, P = 0.000, +1.88%, 42.2 d) and by trial (n = 24, P = 0.000, +1.70%, 40.4 d); FCR improved with MOS addition by treatment (P = 0.000, -2.25%) and by trial (P = 0.000, -2.27%); and MORT was reduced with MOS by treatment (n = 19, P = 0.014, -21.78%, 42.6 d) and by trial (n = 17, P = 0.016, -21.95%, 39.9 d). Compared to antibiotic control results: BWT did not differ due to MOS addition by treatment (n = 25, P = 0.381, -0.37%, 40.1 d) or by trial (n = 20, P = 0.444, -0.39%, 41.4 d); FCR did not differ due to MOS addition by treatment (P = 0.448, -0.45%) or by trial (P = 0.924, -0.07%); but MORT was lowered with MOS by treatment (n = 20, P = 0.007, -17.17%, 40.2 d) and by trial (n = 16, P = 0.008, -18.10%, 41.9 d). It was concluded that MOS addition to broiler diets improved BWT, FCR, and lowered MORT compared to negative control diets and gave similar BWT and FCR but lowered MORT compared to antibiotic diets.

**Key Words:** Alternative growth promoter, Antibiotic, Bio-Mos, Broiler, Mannan oligosaccharide

**299 Turkey body weight, feed conversion ratio, and mortality results summarized from twenty pen trials worldwide comparing mannan oligosaccharide diets versus unsupplemented or antibiotic diets.** D. M. Hooge\*<sup>1</sup>, <sup>1</sup>Hooge Consulting Service, Inc.

Mannan oligosaccharides (MOS; Bio-Mos<sup>®</sup>, Alltech, Inc., Nicholasville, KY) have been used in turkey feeds since 1993 as a natural, alternative growth promoter. Written reports from 20 market turkey pen trials (1993 to 2003) worldwide were collected and analyzed using the Paired T-test (Statistix 7.0), averaging "by treatments" and "by trials" to compare MOS-supplemented diets with negative or positive (antibiotic) control diets. Some trials had multiple treatments (for example, dose-response studies). Criteria for trial inclusion were: 1) MOS fed during entire study period (except one trial started at 3 d), 2) body weight (BWT) and age given, 3) either regular or corrected (mortality-adjusted) feed conversion ratio (FCR) acceptable, and 4) name of the antibiotic stated when used. Final ages ranged from 21 to 147 d, mostly males but some females. Mortality (MORT) results were evaluated when available. Pen trials were on new or recycled litter, or raised wire. Antibiotics fed were avilamycin, bacitracin (MD or zinc), bambermycins, terramycin, or virginiamycin. Relative changes with MOS diets were expressed as % of control results. Compared to negative control results: BWT improved with MOS addition when averaged by treatment (n = 27, P = 0.006, +2.25%, 68.7 d) and by trial (n = 17, P = 0.010, +2.09%, 84.2 d); FCR was not significantly improved with MOS addition by treatment (n = 23, P = 0.120, -1.62%, 72.9 d) or by trial (n = 14, P = 0.258, -1.32%, 91.0 d); but MORT was reduced with MOS by treatment (n = 16, P = 0.049, -24.64%, 72.1 d) and by trial (n = 11, P = 0.016, -25.13%, 87.0 d). Compared to antibiotic control results: BWT did not differ due to MOS addition when averaged by treatment (n = 20, P = 0.158, -0.60%, 105.6 d) or by trial (n = 18, P = 0.157, -0.56%, 104.9 d); FCR did not differ due to MOS addition by treatment (n = 19, P = 0.308, -0.39%, 106.7 d) or by trial (n = 17, P = 0.339, -0.39%, 106.1 d); and MORT was not significantly affected with MOS by treatment (n = 15, P = 0.074, -20.59%, 102.5 d) or by trial (n = 13, P = 0.202, -15.53%, 101.1 d). It was concluded that MOS addition to turkey diets significantly improved BWT and lowered MORT (with FCR nonsignificant, P = 0.120, compared to negative control diets and gave statistically similar BWT, FCR, and MORT compared to antibiotic diets.

**Key Words:** Alternative growth promoter, Antibiotic, Bio-Mos, Mannan oligosaccharide, Turkey

**300 Effect of reduced dietary non-phytin phosphorus (nPP) with or without phytase and 25-hydroxycholecalciferol (25OHD<sub>3</sub>) on performance in laying hens.** W. W. Saylor\*<sup>1</sup>, C. R. Angel<sup>2</sup>, J. A. Mills<sup>1</sup>, and J. A. Yon<sup>1</sup>, <sup>1</sup>Department of Animal and Food Sciences, University of Delaware, Newark, DE, <sup>2</sup>Department of Animal and Avian Sciences, University of Maryland, College Park, MD.

A study was conducted to determine the impact of feeding older laying hens a low nPP diet with or without added phytase and 25OHD<sub>3</sub> on egg production, shell quality, femur and humerus ash and livability. A total of 960 30-mo-old, Hy-Line W-36 hens that had just completed a second molt, were weighed and then assigned by weight to one of 240 cages, four hens per cage, in a windowless, ventilated caged-layer house. Ten experimental layer diets were assigned each to eight replicate groups of hens, each replicate comprised of three adjacent cages of four hens, and fed for 14 weeks. Diets contained formulated levels of either 0.30% or 0.08% nPP, 0 or 300 U/kg phytase and 0 or 70 µg/kg 25OHD<sub>3</sub>. Two additional diets containing 0.08% nPP, 600 U/kg phytase with or without 70 µg/kg 25OHD<sub>3</sub> were included in the design. Actual dietary nPP levels were determined from analyzed total and phytate P and averaged 0.340% and 0.076% nPP for the high and low nPP diets, respectively. Hen-day egg production, egg weight, % egg shell, feed consumption and efficiency, and mortality were determined throughout the study. Hens were weighed then euthanized at the conclusion of the experiment, and femurs and humeri were removed for ash determination. After wk 1 and through wk 14, egg production was reduced (P<0.05) in hens fed diets with reduced nPP. Egg production was restored in low nPP diets with phytase, but not with 25OHD<sub>3</sub>, addition. There was no additive effect of phytase and 25OHD<sub>3</sub>. Neither egg weight (67.10.7 g) nor % shell (8.8 0.1%) was influenced by diet. Femur ash (60.51.2%) and humerus ash (68.00.6%) were not reduced in hens fed reduced nPP levels. While hens fed diets with reduced nPP but without phytase addition appeared to have had increased mortality, the differences were not significant. These

results suggest that nPP levels can be reduced significantly in diets fed to older laying hens that have gone through molt when those diets are supplemented with phytase without altering egg production parameters, bone integrity or livability.

**Key Words:** Phytase, Non-phytin Phosphorus, 25OHD<sub>3</sub>, Laying Hens

**301 Nutrient composition of corn distiller dried grains with solubles.** S. L. Noll, C. Abe\*, and J. Brannon, University of Minnesota, St. Paul, MN.

Samples of corn distillers dried grains with solubles (DDGs) were collected to determine the nutrient composition and extent of variation relative to source. Samples (N=22) were obtained from four different commercial plants during spring, 2002. Samples were submitted for determination of proximate components, sugar, starch, amino acids, and minerals. Means (as fed) for ash, DM, fat, fiber, protein, starch and sugars were 3.97, 88.3, 10.0, 5.7, 27.5, 4.7, and 2.28%, respectively. Sources varied in fat, protein, and ash content (P < .01). Across sources, fat varied 9.4 to 11.1% and protein content varied from 26.2 to 30%. Sources also varied in amino acid content with the exception of ser (P < .05). Respective means for met, cys, lys, arg, trp, val, thr, and ile were .49, .52, .74, 1.08, .218, 1.32, .98, and .96. Lys content was the most variable across all samples (CV=11.2%). Within source, CV for lys averaged 4.6%. Respective means for Mg, Na, P, K, Cl, S, and Ca were .31, .107, .73, .95, .165, .65, and .03%. Sources varied in mineral content. Sodium content was the most variable across all samples (CV=33%) and showed considerable variation within sources as well. Analyses of DDGs indicated that differences in composition are related to source of production during the time period of sample collection in this survey. However, within source, composition was found to be relatively consistent with the exception of sodium content.

**Key Words:** Distiller dried grains with solubles, Corn, Composition

**302 The effects of In-Ovo feeding of protein and carbohydrate on early growth and glycogen status of turkey poults.** O. T. Foye\*<sup>1</sup>, Z. Uni<sup>2</sup>, and P. R. Ferket<sup>1</sup>, <sup>1</sup>North Carolina State University, Raleigh NC 27695-7608, <sup>2</sup>Hebrew University of Jerusalem, Israel.

Experiments were performed to determine the effects of in-ovo (IO) feeding on body weights (BW), organ weights and glycogen status. In ovo feeding, feeding the embryo external feed components (carbohydrate, protein) before hatch and prior to internal pipping, may improve the nutritional and glycogen status of young hatchlings. On day 23 of incubation 100 Hybrid turkey eggs were injected with 1.5mL of 0.4% saline containing 18% egg white protein, or 20% dextrin and 3% maltose (carbohydrate). BW, liver, pectoralis major (PM) muscle weights, and total glycogen content in liver and PM muscle glycogen status was determined at the day of hatch and 7 d. At hatch, the protein (P) and carbohydrate (CHO) IO treatments had 6.1% and 7.5% greater BW than the controls, respectively. Moreover, in-ovo feeding of CHO increased BW by 1.8% and 2.7% (P<.05) at 3 d and 7 d of age, respectively. At day of hatch the weight of PM muscle of the protein- and carbohydrate-IO treated poults was 18% and 10% greater than controls poults. At 7 d, only the carbohydrate-treated poults had 7% larger PM muscle than controls. IO feeding of protein increased total liver glycogen content at hatch by 38.1% over the controls (p<0.02), but not at 7 d. In contrast, the CHO treatment did not affect total glycogen in PM at hatch, but it increased total glycogen in PM by 11.1% over controls at 7 d of age (P<.05). In ovo feeding of protein or CHO increases early growth and glycogen status. Where IO-feeding of protein has greater effects at hatch, IO-feeding of CHO has a greater effect during the first few days post hatch. These data imply that early carbohydrate metabolism can be influenced by IO feed formulation.

**Key Words:** Turkey poults, In-ovo feeding, Liver glycogen, Muscle glycogen, Bodyweights

**303 Effect of feed form on lysine and nitrogen retention in broilers.** A. S. Kiess\*, N. J. Baker, A. S. Parsons, J. S. Moritz, and K. P. Blemings, West Virginia University Morgantown, WV United States.

A concern of the poultry industry is nutrient availability. Providing a diet of varying particle size and feed form can affect the digestive and absorptive process in broilers. In an experiment designed to test the effect of

feed form on performance, approximately 2000 birds were fed starter diets from hatch to 3 wks of age. Using the comparative slaughter approach, broilers were fed 7 dietary treatments from 3 to 6 wks of age. There were 13 pens for each treatment and approximately 21 birds/pen. A single bird from each of the 91 pens (13x7) was randomly selected for whole body analysis. The treatments consisted of a hard or soft pelleted diet, or 5 mash diets with corn particles of varying sizes (fine, small, medium, large, or coarse). At the end of the trial, birds were harvested and gastrointestinal tracts were stripped of digestive contents, and frozen until analysis. Whole birds were quick frozen in liquid nitrogen and homogenized. Subsamples were taken from powdered homogenized frozen birds and feed samples for nitrogen analysis by Kjeldahl and lysine analysis by HPLC. Feed form had an effect ( $p < 0.05$ ) on both efficiency of nitrogen (ENR) and lysine retention (ELR). The ENR ranged from 4.3-5.7% and the ELR ranged from 2.2-4.8%. Birds consuming hard pelleted diets and diets containing medium, and coarse particles had a greater ENR ( $p < 0.05$ ) than birds consuming soft pellets or diets containing fine or small corn particles with diets containing large particles being intermediate. The ELR was also greater for birds consuming hard pelleted diets and diets containing medium, large, and coarse corn particles ( $p < 0.05$ ) than birds consuming diets with soft pellets or mash diets containing small or fine particles. Results indicate that particle size and pellet construction play a role in the broilers ability to retain nutrients specifically nitrogen and lysine. Advances in feed manufacturing will lead to modulation of feed form to increase the efficiency of nutrient retention. ASK and NJB equally contributed to this work.

**Key Words:** Lysine, Nitrogen, Broilers, Feed form

**304 Broiler breeder hen metabolizable energy requirements for maintenance and efficiency of utilization for producing egg calories.** M. E. Reyes\* and C. C. Coon, *University of Arkansas.*

A total of 60 Cobb 500 broiler breeder hens, 53 weeks of age, were individually housed in cages in an environmentally controlled room at 21°C. Ten birds were slaughtered for carcass composition analysis at the beginning of the trial. Fifty hens were injected intramuscularly with doses of TAMOXIFEN™ ([Z]-1-[p-Dimethylaminoethoxyphenyl]-1,2-diphenylbutene) (TAM) (5 mg/kg body weight) at days 1 and 4. A 110 g /b/d of Broiler Breeder 2 diet was fed during the non-laying period for the maintenance experiment and 136 g/b/d of the same diet for the egg production period. Body weight as well as feed intake were individually recorded each day starting from 5<sup>th</sup> day of the trial for a period of 9 weeks. The first 10 hens that laid an egg were killed for carcass composition analysis. Egg production was individually recorded. Three eggs from each hen were used to determine fat and protein content. At the end of the trial, all birds were killed for carcass analysis. Egg production dropped to zero five days after the first TAM administration. Eighty percent of the hens resumed egg production three weeks after TAM injections. Metabolizable energy of feed was determined by using 2% of acid insoluble marker. All breeder hens were sacrificed for carcass analysis at the end of the 9 week experiment. Metabolizable energy (ME) intake was regressed against body weight change during the non-laying and laying period for each hen to estimate the ME for maintenance (MEM) and energy required for unit weight gain and egg production. The estimated daily ME requirement for maintenance was 99 kcal/kg<sup>0.75</sup> and the efficiency of utilization of dietary ME for egg calories was 65.7%. Tamoxifen treated broiler breeder hens provided an alternative for determining ME requirements for reducing the interdependency among factors during egg production.

**Key Words:** Broiler breeder hen, Metabolizable energy, Maintenance, Egg calories, Tamoxifen

**305 Amino acid maintenance requirements for broiler breeder hens.** N. K. Sakomura, M. Reys\*, J.B.K. Fernandes, and C. Coon, *Department of Poultry Science, University of Arkansas, Fayetteville, AR, USA.*

The approach used in the present study was to estimate the regression of daily protein accretion vs. daily amino acid intake for each amino acid when it was given at different rates. The amount of each amino acid needed to maintain nitrogen equilibrium was calculated as the x-intercept of the regression relating protein accretion to amino acid intake. Five hundred and sixty broiler breeder sexually immature pullets, 23-wk of age, were housed in individual cages in environmental rooms with a

8 hr light:16 hr dark period and fed purified amino acid experimental diets for a three week period. The maintenance requirements for lysine, methionine, threonine, tryptophan, arginine, valine, leucine, isoleucine, phenylalanine and histidine were determined. The purified basal diet contained 3506 kcal ME/kg and 6.78% protein equivalents from crystalline amino acids with 0.49% Ca to impede ova development. Ten individual breeder pullets were fed one of five amino acid levels ranging from 0 to 40% of NRC (1994) suggested requirement for each experimental amino acid. The coefficients for amino acid maintenance requirements were determined by the comparative slaughter method. Sixty breeder pullets were sacrificed at the beginning of the feeding study and all breeders were sacrificed at the end of the 3-wk feeding period for whole body carcass analysis. Using linear regression equations for body nitrogen accretion (Y) regressed on amino acid intake (X), the amino acid maintenance requirements in mg per day/kg of metabolic body weight and mg/d/kg of protein body mass were respectively estimated: lysine, 94.20 and 333.30; methionine, 56.46 and 188.30; threonine, 130.56 and 447.73; tryptophan, 10.71 and 35.71; arginine, 173.10 and 601.30; leucine, 117.14 and 400.46; isoleucine, 92.44 and 318.90; phenylalanine, 163.86 and 575.13; valine, 106.25 and 336.70 and histidine, 43.63 and 139.60.

**Key Words:** Amino acid requirement, Maintenance, Broiler breeder, Comparative slaughter technique

**306 The effects of feeding blends of grains naturally-contaminated with *Fusarium* mycotoxins on the efficacy of exogenous phytase in broiler diets.** M. Zaytoon\*<sup>1</sup>, T. K. Smith<sup>1</sup>, and A. E. Sefton<sup>2</sup>, <sup>1</sup>*University of Guelph, Guelph, Canada,* <sup>2</sup>*Alltech Biotechnology Center Nicholasville, Ky, USA.*

Chickens can not utilize dietary phytate-phosphorus unless diets are supplemented with phytase to catalyze hydrolytic cleavage of the phosphate group from phytic acid thereby liberating phosphorus from feedstuffs of plant origin. Trichothecene mycotoxins can cause intestinal villi disruption, which can lead to malabsorption and a subsequent decrease in weight gain. 2 experiments were conducted, therefore, to determine if the feeding of grains naturally-contaminated with *Fusarium* mycotoxins can reduce the efficacy of exogenous phytase in broiler diets. In the first experiment, dietary treatments were: 1- Adequate phosphorus 2- Phosphorus deficient 3- Phosphorus deficient + phytase 4- Phosphorus deficient + mycotoxins 5- Phosphorus deficient + phytase + mycotoxins 6- Phosphorus deficient + phytase + mycotoxin + mycotoxin binder (MTB-100® Alltech Inc.). A total of 252 day-old chicks (6 cages of 7 birds per diet) were fed experimental diets for 21 days. The feeding of a phosphorus deficient diet supplemented with phytase and containing grains naturally-contaminated with *Fusarium* mycotoxins significantly increased ( $P \leq 0.05$ ) phosphorus retention compared to the negative control in weeks 1 and 2. In a second experiment, a total of 540 day-old male broiler chicks (3 floor pens of 30 birds per diet) were fed similar experimental diets for 42 days. The feeding of a phosphorus deficient diet (0.24% total phosphorus) containing grains naturally contaminated with *Fusarium* mycotoxins and supplemented with phytase improved weight gain and feed consumption compared to the negative control group ( $P < 0.05$ ). The feeding of a phosphorus deficient diet without phytase supplementation to birds housed in floor pens resulted in the immobilization of 41.8% of the birds after 21 days compared to 19.8% of birds fed the phosphorus deficient diet contaminated grains + supplemental phytase. It was concluded that the feeding of grains naturally contaminated with *Fusarium* mycotoxin did not adversely affect the efficacy of exogenous phytase.

**Key Words:** Broiler, *Fusarium* mycotoxins, Phytase, Phosphorus Retention

**307 Effects of reduced dietary phosphorus level on broiler breeder production and egg quality.** B. Michaud\* and M. R. Lefrancois, *Departement des sciences animales, Universite Laval.*

To answer environmental concerns, diet modification and phytase addition to the diet have been used to reduce phosphorus (P) content in the litter. However, it is not clear to what extent a reduction in dietary total P (Pt) and available P (Pa) can affect egg production and egg characteristics in broiler breeders (BB) flocks. The aim of this study was to determine the BB response to a reduction in dietary P via feed modification throughout a complete production cycle. To this end, 24 wk old birds (1296 females and 144 males, Cobb 500) were allotted to 24 litter floored pens (54 females and 6 males/pen) according to a complete randomized block design with 6 replicates per treatment. Birds received either one of the following dietary treatments (Pa and Pt), respectively

from 24 to 46 wk and from 46 to 63 wk of age: 1) control .37 and .63%; .32 and .59%; 2) .27 and .53%; .22 and .49%; 3) .37 and .55%; .32 and .51%, both with 300 FTU/kg Natuphos 5000<sup>TM</sup>; 4) like 3) with formula adjustments for ME, proteins, EAA, and Ca contributed by phytase addition. Egg production and egg parameters (weight, hatchability, fertility, shell weight and thickness, yolk weight and colour, and albumen weight) were measured at 30, 40, 50, and 60 weeks of age and compiled on a pen basis. Egg shell weight was lower ( $P < .06$ ) in treatments 3) and 4) (6.10 g and 6.20 g) compared to treatment 1) (6.28 g) and shell thickness (.420 and .426 vs .431 mm) was lower ( $P < .06$ ) in diets with added phytase when compared to the control. Yolk colour was significantly ( $P < .05$ ) lighter (7.52 vs 7.82 to 7.86) in treatment 4). Overall mean hatchability was numerically higher in treatment 4) (76.52 vs 69.55 to 70.63%). Other parameters were not affected ( $P > .05$ ) by dietary treatments. Diet modifications had minimal negative impacts on egg production and quality. Except for Pa and Ca (to maintain Ca/Pa ratio), it is not required to adjust the formula to take into account the phytase contribution to the increased nutrients availability.

**Key Words:** Broiler breeder, Phosphorus, Phytase, Egg production hatchability, Egg characteristics

**308 Market tom turkey response to protein and threonine.** S. L. Noll<sup>1</sup>, V. Stangeland<sup>2</sup>, G. Speers<sup>3</sup>, C. M. Parsons<sup>4</sup>, and J. Brannon<sup>1</sup>, <sup>1</sup>University of Minnesota, <sup>2</sup>Stangeland Feed Consulting, <sup>3</sup>Poultry Nutrition Services, <sup>4</sup>University of Illinois.

A study was designed to examine performance of market turkeys to dietary protein and threonine in two types of diets: a) corn-soy-poultry by product meal and b) with distiller dried grains with solubles (DDGs). At 8 wks of age, 960 male turkeys (Large White, Nicholas) were randomized into 96 pens. Each treatment was fed to 8 pens of turkeys. The factorial study consisted of diet protein (P) (100, 95 and 90% of NRC thr), supplemental thr (T) (none, 10% NRC thr), and diet series (D) (without and with DDGs). Ingredients were analyzed for nutrient content and digestible amino acids using cecotomized roosters prior to the start of the trial. Diet protein was set by formulating to the estimated digestible thr requirement without the use of supplemental thr. Supplements of lysine and methionine were used as needed to meet those requirements. BW was measured at 3-wk intervals corresponding to diet changes. Parts and breast meat yield was determined at 19wk-1d. BW to 17 wks, parts as % of carcass weight (breast meat, thigh, drumstick, skin) and amount of breast meat were affected by P ( $P < .05$ ) with 90% NRC thr resulting in depressed performance in comparison to 95 and 100% NRC thr. Decline in response to lowered protein was similar for D. Three-way interactions for most measurements indicated the response to supplemental thr was dependent on D and P. For the corn-soy-poultry meal diet, gain (8-19 and 17-19 wks) and breast meat yield was improved in the 90% NRC thr diet with supplemental thr ( $P < .05$ ) to the level of the control (100% NRC thr). For DDGs series, gain (8-11 and 11-14 wks) was improved in the 95% NRC thr diet with thr ( $P < .10$ ) to the level of the control (100% NRC thr). Turkeys responded to declines in diet protein with decreased weight and breast meat yield. The inclusion of DDGs resulted in similar performance to the corn-soy-poultry meal diet series. However, the response to supplemental thr was dependent on diet protein and composition.

**Key Words:** Turkey, Protein, Threonine, Distillers dried grains with solubles

**309 Glucose and cationic amino acid transporter mRNA levels in broiler chickens after hatch.** B. D. Humphrey, C. C. Calvert, and K. C. Klasing, University of California, Davis.

Glucose and cationic amino acids are transported across the plasma membrane by glucose transporters (GLUT) and cationic amino acid transporters (CAT), respectively. To determine the tissue expression of GLUT & CAT isoforms at various ages post-hatch, tissue samples were analyzed for GLUT 1, 2, & 3 and CAT 1, 2, & 3 mRNA expression by quantitative PCR. In experiment one, brain, heart, gastrocnemius, pectoralis, liver, spleen, thymus, & bursa were collected from broiler chicks ( $n = 72$ ) at d 1 & 14 post-hatch. Expression of GLUT isoforms on d 1 was limited to the brain, heart, and liver. By d 14 all tissues expressed a GLUT isoform, particularly GLUT-3, which was ubiquitous and did not differ in expression across tissues ( $P > 0.05$ ). CAT-1 and CAT-2 were the only isoforms expressed by tissues on d 1. CAT-1 expression in the bursa was greater ( $P < 0.05$ ) than any other tissue, and CAT-2 was expressed in the liver and pectoralis only. By d 14 all tissues expressed a CAT isoform

and CAT-3 was detected in several tissues. In experiment two, tissues were collected from broiler chicks ( $n = 36$ ) at day 1, 3, & 7 post-hatch. GLUT expression was restricted to the brain, heart, and liver on d 1. Expression of GLUT-1 in the gastrocnemius, pectoralis, spleen, and bursa was present by d 7. GLUT-3 was expressed in the spleen on d 7. The thymus was the only tissue that did not express any GLUT isoforms at any age. Day 1 CAT expression was similar to experiment one, and CAT expression was detected in all tissues by d 7. CAT-3 expression was low in all tissues on d 1 and 3, but on d 7 higher levels were detected in the spleen, thymus, bursa, and heart. These results demonstrate that the ontogeny of GLUT and CAT isoform expression is both tissue and age dependent, and that major changes in nutrient transporters occur rapidly during the first 7 d post-hatch. Nutrient transporter expression differs between tissues, ranging from low expression tissues (e.g. thymus) to high expression tissues (e.g. brain).

**Key Words:** Glucose transporter, Cationic amino acid transporter

**310 Effect of protein level of the quinoa cultivar Real on growth performance of turkey poults.** N. P. Johnston\*, C. E. Martinez, J. Mamani, and B. L. Webb, Brigham Young University, Provo, Utah.

Quinoa is small grain (3mm) with a high lysine content (1.2%) that is produced in the Andean region of South America. Because of its small size, milling is problematic and its feeding is associated with an increased incidence of the bone deformity perosis. It was hypothesized that feeding a quinoa based ration of 26% or 22% protein would result in similar gains to a 28% corn-sbm control because of its high lysine content. In a 3-week trial, 72 day-old female turkey poults were divided into three treatments to test the effect of protein level of quinoa on growth performance. The treatments were as follows: 28% protein corn-SBM (control), 26% protein quinoa-SBM, and 22% protein quinoa-SBM. All treatments were iso-caloric and met or exceeded the lysine requirements for poults. Excreta were examined for the presence of phosphorus, manganese and nitrogen. The gains of the 28% protein control and the 26% protein quinoa group were statistically ( $P > 0.05$ ) similar (441 and 432g) but significantly ( $P < 0.05$ ) greater than the 22% protein treatment (319g). Significantly ( $P < .05$ ) more Mn (0.02% vs. 0.033% and 0.032%) and P (1.7% vs. 2% and 2.1%) were found in the excreta of poults fed the quinoa based diets compared to the controls suggesting high phytate binding of the minerals as a possible reason for the high incidence of perosis. Birds of both the quinoa based diets had significantly ( $P < 0.05$ ) less N in the excreta (5.9% vs. 4.5% and 4.2%). Results suggest 26% protein quinoa based diet is as effective as 28% protein corn-sbm diet in promoting poult gains.

**Key Words:** Quinoa, Poults, Protein

**311 Broiler ideal amino acid profile as determined with uric acid excretion, amino acid accretion, and nitrogen retention.** J. M. Sun\* and C. Coon, University of Arkansas, Fayetteville, AR.

The objective of the present study was to establish the ideal digestible amino acid profile relative to digestible lysine for broiler uric acid excretion, amino acid accretion, and nitrogen retention using broken line, exponential, and polynomial regression models. Eight hundred and ninety six 10-day old Cobb-500 male chicks were selected for uniformity (185 g BW  $\pm$  15) from the median weight range of 2800 chicks and placed in individual cages for a 10-21 day feeding study. The broiler chicks were fed a corn-soy basal diet (3160 kcal MEn, 19% CP equivalents) with an amino acid mixture fortified with all essential amino acids except the test amino acid (NRC amino acid profile relative to lysine X 1.15% digestible lysine + 5% margin of safety). The broiler chicks were fed 8 levels of test amino acid ranging from 50 to 130% requirement substituted for corn starch. The ideal digestible amino acid ratio relative to digestible lysine from broken line analysis for uric acid excretion was calculated to be 103% Arg, 117% Gly+Ser, 32% His, 78% Ile, 132% Leu, 32% Met, 28% Cys, 60% Met+Cys, 65% Phe, 64% Tyr, 129% Phe+Tyr, 65% Thr, 19% Trp, 84% Val. The ratios from broken line analysis for amino acid accretion and nitrogen retention were identical and were calculated to be 104% Arg, 122% Gly+Ser, 38% His, 81% Ile, 119% Leu, 42% Met, 30% Cys, 72% Met+Cys, 67% Phe, 57% Tyr, 124% Phe+Tyr, 73% Thr, 19% Trp, 81% Val. The requirement for digestible Lys based on exponential analysis was 1.108% for uric acid excretion and 1.125% for amino acid accretion. Compared with the requirements previously reported for wt gain and feed/gain ratio, the requirements of Gly+Ser, His, Thr, and Met

for amino acid accretion were higher than requirements for optimum uric acid excretion, wt gain, and feed/gain. The requirements of Cys, Leu, and Ile based on uric acid excretion and the requirements of Arg and Lys for feed/gain were higher than the requirements based on other three criteria.

**Key Words:** Ideal amino acid profile, Uric acid excretion, Amino acid accretion, Nitrogen retention

**312 Sensitivity of protein dispersibility index as a protein quality indicator of soybean meal.** H. S. Lee<sup>\*1</sup>, K. Y. Whang<sup>2</sup>, I. S. Shin<sup>1</sup>, and K. M. Chee<sup>2</sup>, <sup>1</sup>American Soybean Association / Korea, <sup>2</sup>Korea University.

Day-old, broiler chicks (Ross) were assigned to eight isocaloric and isonitrogenous diets to measure sensitivity of protein dispersibility index (PDI) as an indicator of protein quality of soybean meal. Each diet contains, as a sole protein source, either soy flakes (SF) heat-treated for five different time durations or commercial soybean meals (SBM) from three different origins. All feed ingredients were of purified types except protein sources. The unheated SFs after oil extraction were autoclaved for 0, 15, 30, 45 and 60 min at 121°C. The SBMs compared were a dehulled meal from U.S. and two non-dehulled meals from Brazil and India. Chicks fed the diets containing the SF heat-treated for 30 min or dehulled SBM tended to show better performances such as FCR and BW gain, protein efficiency ratio and net protein retention values than the chicks of the other groups. The longer or the shorter the duration of heat-treatment of the SF than 30 min, the poorer broiler performances were observed. The SFs and SBMs were also analyzed in vitro in terms of PDI, KOH protein solubility, urease activity, pepsin digestibility, and available lysine. The SF heat-treated for 30 min showed 92.8%, pepsin digestibility; 79.6 %, KOH protein solubility; 21.5%, PDI; 0.02, urease activity and 2.41%, available Lys. These values appeared in the ranges observed from the commercial SBMs. Most of those values except PDI of the SFs heat-treated for 15 or 45 min also matched pretty well with those of commercial SBMs. The PDI values of the SFs heat-treated for 15 or 45 min were 40.3 and 17.4%, respectively, meanwhile the values of the three SBMs were in the ranges of 17.5 - 22.2%. This observation demonstrates that the PDI value is more sensitive in differentiating protein quality of SBM than the other indicators.

**Key Words:** Protein dispersibility index (PDI), Protein quality indicator, Soybean meal, Heat-treated soy flake, Net protein retention (NPR)

**313 Increased feed intake in broiler breeder hens enhances saturation of yolk precursor lipoprotein fatty acids in association with reproductive dysfunction.** S. E. Chen<sup>\*</sup> and R. Walzem, *Department of Poultry Science, Texas A&M University.*

Commercially reared Cobb 500 Fast Feathering broiler breeder hens (n=35, age=35 wks) were provided with 145 g diet/day/hen (2750 kcal ME/kg breeder recommended intakes). Feed was placed each day between 08:30-09:00, water was freely available. Following a 5-day adaptation period, baseline organ and blood values were determined for 10 hens. On day-16, organ values were determined using 5 hens whose egg production rate equaled the flock average. The remaining 20 hens were fed 290g diet/day/hen until necropsy on day-26. Egg production dropped from 73.2±2.7 to 56.5±3.1 %, p<0.05, with increased metabolizable energy intake (MEI). Increased MEI increased body weight 4.2±0.09 vs 3.7±0.1 kg and liver weight (LW) 152±8 vs 61±4 g, p<0.05. Restricted birds (n=15) showed no ovarian abnormalities, but 10 of 20 overfed hens displayed ovarian abnormalities including atretic follicles, internal ovulation, and polycystic-like follicles (type-3). Increased LW was associated with massive triglyceride (TG) accumulation, 236.2±13.1 vs 77.1±2.2 mg/g tissue. Both plasma VLDL-PL (phospholipid) and VLDL-TG also increased (9.1±0.8 vs 5.9±0.3 and 26.9±1.2 vs 19.7 ±0.9 mg/ml plasma, respectively) in overfed hens. Fatty acid unsaturation, defined as  $\Sigma mi/100$ , where  $mi = \text{fatty acid mol\% total fatty acids}$ , and  $ni = \text{number of C-C double bonds in fatty acid } i$ , decreased from 0.58±0.06 to 0.50±0.03 in hepatic PL, 0.71±0.01 to 0.63±0.01 in hepatic TG, 0.22±0.03 to 0.10±0.01 in VLDL-PL, and 0.73±0.005 to 0.70±0.005 in VLDL-TG. Relative amounts of palmitate and stearate (mol P or S/mol total fatty acids x 100%) were increased in VLDL-PL at the expense of long chain unsaturated fatty acids, while increased saturation of VLDL-TG was not associated with decreased long chain unsaturates. These results suggest that hyperphagia dysregulates hepatic lipogenesis causing VLDL overproduction, and increased saturation of VLDL fatty acids,

a metabolic shift that may cause lipotoxic reproductive dysfunction in broiler breeder hens. Supported by TAEX # H-8738

**Key Words:** Fatty acid saturation, VLDL, Lipogenesis, Reproductive function, Lipotoxicity

**314 Influence of graded levels of dietary phytase on phytate phosphorus retention in broilers.** M. Manangi<sup>\*</sup> and C. Coon, *University of Arkansas, Fayetteville, Arkansas, USA.*

Eighty 21-d old Cobb 500 male broiler chicks were placed in individual metabolic cages and offered a broiler grower corn-soybean basal diet with 8 levels of phytase enzyme. The eight levels of enzyme tested were 0, 250, 500, 750, 1000, 1500, 2000 and 5000 units (FTU) of Finnfeeds test phytase /kg diet. The basal diet contained 0.64% Ca, 0.4% total P, and 0.12% non-phytate P (NPP) on "air dried basis". Two % acid insoluble ash (Celite) was used in the feed as a marker. After acclimatizing chicks to cages and test diets for 3-days, excreta from individual birds was collected for 2 days, frozen and freeze dried prior to analysis. Diets and excreta were analysed for total phosphorus by ICP analysis and acid insoluble ash (Celite) by AOAC method. Phytate phosphorus was analysed by using High Performance Liquid Chromatography (HPLC) procedure. The addition of phytase enzyme significantly (P<0.05) increased the feed intake, weight gain, feed conversion efficiency, total P and phytate P retention during the 5-day bioassay. The phytate P retentions (%) were 43.12, 68.12, 74.7, 85.02, 85.25, 92.77, 96.91 and 99.45 for groups fed basal diet with 0, 250, 500, 750, 1000, 1500, 2000, and 5000 units (FTU) of Finnfeeds test phytase /kg diet, respectively. The phytate P retention increased linearly as phytase enzyme level increased from 0 to 5000 FTUs in the feed. However, the total P retention for chicks fed the basal diet containing 0.12% NPP with 0.64% Ca reached a plateau of 0.24% retainable phosphorus with 1000 units (FTU) of Finnfeeds test phytase /kg diet. The additional phosphorus released by enzyme levels above 1000 units was not as efficiently retained with the present basal dietary conditions.

**Key Words:** Phytase, Broilers, Phytate P retention, HPLC

**315 Effect of phytase on phytate phosphorus retention in broilers fed diets containing different levels of Ca and P.** M. Manangi<sup>\*</sup> and C. Coon, *University of Arkansas, Fayetteville, Arkansas, USA.*

Two 5-d bioassay experiments were conducted to investigate the phytase effect on phytate P retention by broilers fed a corn soybean basal diet containing different Ca and P levels. In experiment 1, one hundred sixty 21-d old male Cobb 500 broiler chicks of uniform body weight were placed in individual metabolic cages and assorted into 16 groups with 10 birds each. The experimental diets consisted of a corn soybean meal basal containing 0.17% phytate P with 8 added levels (0.25, 0.3, 0.35, 0.40, 0.45, 0.5, 0.55, and 0.62%) of total P. The experimental levels of phosphorus were provided by adding reagent grade calcium phosphate, dibasic, monohydrate. The dietary calcium level was maintained at 0.5% by adjusting the limestone with each level of added calcium phosphate. One thousand units (FTU) of Finnfeeds test phytase /kg diet was added to provide 8 dietary treatments with added phytase enzyme and 8 dietary treatments without phytase enzyme. Excreta samples collected from each bird on day 4 and 5 were frozen, and freeze dried for further analysis. Two % acid insoluble ash (Celite) was used in the feed as a marker. Diets and excreta were analysed for total P and Ca by ICP analysis. Phytate P was analysed by using High Performance Liquid Chromatography (HPLC). Phytate P retentions (%) without addition of enzyme in 0.25, 0.3, 0.35, 0.40, 0.45, 0.5, 0.55, and 0.62% total P fed groups were 8.5, 27.6, 26.4, 28.9, 26.3, 17.1, 21.0, and 27.7, respectively. The addition of phytase increased (p<0.05) phytate P retention (%) to 80.9, 75.9, 73.5, 72.2, 68.4, 71.6, 58.3, and 62.5, respectively. Experiment 2 was conducted the same as experiment 1, however Ca was maintained at 0.9% for all diets. Phytate P retention (%) without addition of enzyme in 0.25, 0.3, 0.35, 0.40, 0.45, 0.5, 0.55, and 0.62% total P fed groups were 49.2, 19.6, 16.0, 8.0, 9.4, 2.1, 4.0, and 4.2, respectively. The addition of phytase increased (p<0.05) phytate P retention (%) to 85.3, 76.1, 70.0, 76.1, 62.6, 68.6, 67.4, and 63.7, respectively.

**Key Words:** Phytase, Broilers, HPLC, Ca, P

**316 Evaluation of soybean meal samples from different sources in the US using phytase enzyme.** M. Manangi\*, J. Lu, and C. Coon, *University of Arkansas, Fayetteville, Arkansas, USA.*

Twenty-five soybean meal samples were collected from active soybean crushing plants in the US and 18 of the samples were selected to evaluate the effect of Finnfeeds test phytase on phytate P retention in a 5-d bioassay. The ranges of analysed values in soybean samples for total P, phytate P, Ca, protein and neutral detergent fibre were: 0.60-0.87, 0.32-0.42, 0.28-0.54, 40.44-51.69 and 7.78-16.09 %, respectively. Experimental diets were prepared by mixing 18 different soybean meal samples with a standard synthetic premix. Each experimental diet consisted of 30% test soybean meal and 70% synthetic premix containing 2% Celite marker. Finnfeeds test phytase (1000 FTU/kg diet) was added to half of all experimental diets containing each of the test soybean samples. Three hundred and sixty 21-day-old male Cobb 500 broiler chicks of uniform body weight were sorted into individual metabolic cages (10 birds/treatment) for the feeding experiment. One hundred and eighty birds were fed diets with added phytase and the other 180 were fed diets with no added phytase. Excreta samples collected from individual birds on day 4 and 5 were frozen and freeze dried for further analyses. Body weight, feed consumption and FCR improved significantly ( $p < 0.05$ ) in some of the groups fed diets with enzyme compared to groups fed the same diet with no added enzyme. The ranges of % total P retention and % phytate P retention for groups fed diets with no enzyme were: 21.35-48.41 and 13.64-37.13, respectively. The addition of phytase increased retentions to 56.81-68.62 and 76.18-94.08, respectively. The results indicate no correlation between components (total P, phytate P, Ca, protein and neutral detergent fibre) of soybean meal samples and % phytate phosphorus retention and % total phosphorus retention for groups fed diets with and without added phytase.

**Key Words:** Phytase, Broilers, Retention

**317 Lysine requirements for maintenance and for tissue protein accretion in broiler breeders.** N. K. Sakomura, M. Manangi\*, J.B.K. Fernandes, and C. Coon, *Department of Poultry Science, University of Arkansas, Fayetteville, AR, USA.*

The daily dietary lysine requirement for 23 wk old Cobb 500 broiler breeder pullets was partitioned into maintenance and protein tissue accretion using the factorial method. Fifty broiler breeder sexually immature pullets were housed in individual cages in temperature controlled environmental rooms (22 C) with a 8 hr light:16 hr dark period for a three week period. The pullets were fed a purified basal diet containing 3506 kcal ME/kg and 6.78% protein equivalents from crystalline amino acids with 0.49% Ca to impede ova development. Ten individual breeder pullets were each fed one of five dietary lysine levels ranging from 0 to 0.40% of suggested NRC (1994) lysine requirement. The coefficients utilized for maintenance and protein accretion were determined by the comparative slaughter method. Twenty breeder pullets were sacrificed at the beginning of the feeding study and all breeders were sacrificed at the end of the 3-wk feeding period for whole body carcass analysis. Extrapolation of the linear regressions of lysine accretion as a function of lysine intake resulted in the estimated maintenance requirements for lysine: 167.89 mg/bird/d, 94.43 mg/kg<sup>0.75</sup>/d, and 331.13 mg/kgCP/d. The slope of the regression line,  $Y = -52.53 + 0.556 X$ ,  $r^2 = 0.76$  ( $Y$  = lys accretion and  $X$  = lys intake), indicated that 56% of the lysine intake above maintenance was recovered as lysine in whole body protein. According to the straight line:  $Y = 32.381 + 72.962X$ ,  $r^2 = 0.89$  ( $Y$  = lys accretion and  $X$  = protein accretion), the lysine concentration in the whole body protein is constantly accrued at 72.962 mg of lys per gram of protein. Assuming the efficiency of lysine utilization is 56% for protein accretion in the breeder hen, the lysine requirement per gram of protein accretion is 130.29 mg.

**Key Words:** Lysine requirement, Maintenance, Lysine accretion, Broiler breeder, Comparative slaughter technique

**318 Evaluation of dietary lysine levels on breast muscle growth in broiler lines.** J. M. Reddish\* and M. S. Lilburn, *The Ohio State University/OARDC.*

Two experiments using lines of broilers, a commercial line selected for breast yield (A) and an unimproved rapid growing line (C), were conducted to determine the effect of dietary lysine on breast muscle growth. In both experiments diets were formulated to contain lysine at 0.9%, 1.02%, 1.14%, 1.26% and 1.38% of the diet. Experiment 1 used male and

female chicks intermingled in randomly assigned grow out cages. Birds were fed a common starter diet until 7d then switched to experimental diets. Two pens per line and diet combination were sampled weekly for 4 weeks and BW, total Pectoralis major and total Pectoralis minor were recorded. At 7 d, there were no differences in BW between lines. From 14 d to 28 d, line A consistently had higher Pectoralis major and Pectoralis minor weights compared to line C, regardless of dietary treatment. Level of dietary lysine did result in linear increases of breast muscle in line A, but the same response was not observed in line C. With this preliminary data, experiment 2 was designed with diets formulated to the same levels to determine digestibility and feed intake. Males from lines A and C were started on a common diet and then switched to randomly assigned dietary treatments at 5 d. Birds were provided feed and water ad libitum until 18 days of age. At day 18, birds were sampled and BW and wt of the left Pectoralis major was recorded. BW and Pectoralis major weights were significantly heavier in line A than line C regardless of dietary treatment. Feed consumption by dietary treatment was not significantly different between diets or between lines A and C. Overall, this information suggests that increases in dietary lysine can result in increased breast muscle; however, different lines of broilers may not show similar responses to increased dietary lysine.

**Key Words:** Broiler, Muscle, Lysine

**319 Enzyme usage in pre-starter diets for the enhancement of growth and yield in straight run broiler chickens.** C. Novak\*<sup>1</sup>, A. McElroy<sup>1</sup>, J. Remus<sup>2</sup>, and E. Pierson<sup>2</sup>, <sup>1</sup>*Virginia Tech,* <sup>2</sup>*Danisco Animal Nutrition.*

Due to the inability of the chick to fully utilize feedstuffs such as corn and soybean meal post hatch, the objective of this study was to compare feeding programs based on enzyme supplementation for live performance and yield of commercial broilers. The feeding regimen consisted of a pre-starter, starter, grower, and two finisher diets in the 49-day trial. Chicks averaging 34g were randomly assigned to a treatment (trt). To 16 days, trts included a control (C) and C + 0.05% Avizyme1502 (n=1620/trt; 18 reps/trt). From 16 to 49 days, trts were C, negative control (NC # energy down spec), NC with 0.05% enzyme and NC without enzyme (n=720/trt; 9 reps/trt). The NC with or without enzyme trts were enzyme supplemented to day 16. Body weight (BW) and feed data were collected on days 0, 16, 30, 42, and 49. Yield analysis was performed on 6 birds/pen (n=54/trt) on days 42 (females) and 49 (males). In the starter period (7 to 16 days), enzyme supplemented chicks had higher ( $P < 0.05$ ) BWG and improved F:G (352.4 gm and 1.387) compared to C chicks (345.7 gm and 1.478). Chicks supplemented with Avizyme 1502 consumed significantly less feed and had improved cumulative F:G at 16 days. After 16 days, no differences in BW, BWG, and F:G were noted. No change in cumulative mortality or 42 day breast meat yield (females) was noted. At 49 days (males), birds with enzyme to 16 days of age had greater breast meat yield (21.19%) compared to the C trts (20.3 and 20.2% for C and NC), but not compared to the NC with enzyme (20.7%). The present data show improved BWG and F:G at 16 days as well as 49 day breast meat yield (males) with enzyme supplementation to day 16. Collectively, the data shows that chicks respond to enzyme supplementation in the first two feeds. Benefits in live performance, yield, and profit may be achieved by further understanding the responsiveness of enzyme supplementation.

**Key Words:** Broiler, Enzyme, Yield, Performance, Feed:gain

**320 Calcium limestone grain sizes and levels of calcium for commercial layers in second production cycle.** A. G. Bertechini\*, L. V. Faria, and E. J. Fassani, *Universidade Federal de Lavras.*

The present work was undertaken with a view to studying the adequacy of the limestone grain size associated with different levels of calcium on commercial layer performance and egg quality in the second production cycle. 576 Lohman-LSL commercial layers at the beginning of the second cycle of laying in an experimental completely randomized design in the 3 x 4 factorial scheme three grain sizes (0.15 to 0.6; 0.6 to 1.2; 1.2 to 2.0mm) and four calcium levels (3.2; 3.5; 3.8 and 4.1%) with split plot the treatments in the plot and in the subplots the four evaluation periods (28, 56, 84 and 112 days) were utilized. The performance and egg quality characteristics were evaluated. Two birds per plot were slaughtered for removal of left tibia, which was submitted to analyses for determining ash and calcium contents. The crop and gizzard of 24 birds were removed

for determination of the retained calcium. The results pointed out that: advance of the hen age influenced in a negative way shell thickness percentage of shell and specific weight of eggs; the level of 3.56% of calcium in the diet regardless of the grain size studied was the one which provided the best rate of egg yield. At the level of 3.5% of calcium in the diet egg losses were reduced and specific weight of eggs improved with the grain size of limestone between 1.22 to 2.0 mm. The limestone grain size influenced the thickness and % of egg shell and the furnishing of particles of diameter between 1.2 and 2.0 mm improved these parameters. The retention time of the particles in the gizzard was longer as the grain size of limestone increased bringing benefits to egg shell quality as it is stress

**Key Words:** Calcium levels, Limestone, Egg shell, Layers at second cycle

**321 Cobalt and vitamin B<sub>12</sub> in diets for commercial laying hens.** A. G. Bertechini\*, R. K. Kato, E. J. Fassani, and K. R. Soares, *Universidade Federal de Lavras, MG, Brazil.*

The aim of this experiment was to study the effects of cobalt and vitamin B<sub>12</sub> supplementation of diets of commercial laying hens. A total of 480 old commercial laying hens (Lohmann LSL) were randomly divided into one of the following treatments: five cobalt levels (0.00, 0.30, 0.60, 0.90 and 1.20 ppm), combined or not with 10 µg/kg of vitamin B<sub>12</sub>, in a factorial arrangement (5x2) with 4 replicates. The cobalt and vitamin B<sub>12</sub> sources were sulfate (CoSO<sub>4</sub>·7H<sub>2</sub>O - 20%) and cobalamin (0.1%), respectively. The results were analyzed in four periods (21, 42, 63 and 84 experimental days). Feed and water were provided for ad libitum consumption, and eggs were collected twice a day. The hen performance (egg production, feed intake, egg weight and feed conversion) and egg quality (egg shell, shell percentage, egg specific gravity, Haugh unit) parameters were evaluated. At the end of the experimental period, two hens from each treatment were slaughtered. Liver and blood samples were collected for analysis. The results showed that performance and egg quality were not influenced (p>0.05) by cobalt supplementation. The supplementation of vitamin B<sub>12</sub> resulted in an increase in egg weight. The cobalt concentration in liver and yolk, and blood analysis (hematocrit, hemoglobin, hematocyte, and leukocyte) were not influenced (p>0.05) by cobalt and vitamin B<sub>12</sub> supplementation in the diet. Based on these results it was concluded that commercial layers do not need cobalt supplementation, but that B<sub>12</sub> is important.

**Key Words:** Cobalt, Vitamin B<sub>12</sub>, Laying hens

**322 Carcass traits of French Guinea keet broilers fed diets with varying levels of crude protein and metabolizable energy.** S. N. Nahashon\*, N. A. Adefope, A. Amenyenu, and D. Wright, *Cooperative Agricultural Research Program, Tennessee State University.*

Guinea fowl production as a meat bird has gathered momentum in the United States such that its potential for food and profit appears quite promising. However, very little is known of their nutrient requirements. The objective of this study was to assess the effect of varying dietary crude protein (CP) and metabolizable energy (ME) on carcass traits of French guinea keet broilers. In a 3 x 3 factorial arrangement of dietary treatments, three hundred day-old guinea keets were assigned to experimental diets from hatch to eight weeks of age (WOA). Dietary treatments fed from hatch to four WOA were replicated three times and comprised 3050, 3100 and 3150 ME kcal/kg diet and 21, 23 and 25% CP. At 5-8 WOA, dietary ME and CP levels were adjusted to 3100, 3150 and 3200 kcal/kg diet and 19, 21 and 23%, respectively. Feed and water were provided at free choice. Body weights and feed consumption were measured weekly and carcass traits were determined at eight WOA. Eviscerated carcass (EC) and breast weights of birds on 3150 and 3200 ME kcal/kg diet at 5-8 WOA were not different, but were both 2-3% higher (P<0.05) than those of birds on 3100 ME kcal/kg diet. Breast and EC weights of birds on 21 and 23% CP diets at 5-8 WOA were significantly higher than those of birds on 19% CP diets. Drumsticks and abdominal fat weights were 4-6% and 9-14% higher, respectively, in birds on 3200 ME kcal/kg diet than those on 3150 and 3100 ME kcal/kg diet at 5-8 WOA. Increasing dietary CP from 19% to 21 and 23% increased abdominal fat weight by 8.5% and 12%, respectively. Differences in weights of thigh, neck, wings, heart, liver and gizzard among dietary treatments were not significant. Therefore, guinea broilers on 3100 and 3150, and 3150 and 3200 ME kcal/kg diet at 0-4 and 5-8 WOA, respectively, and 23 and 25,

and 21 and 23% CP diets at 0-4 and 5-8 WOA, respectively, improved EC, breast and drumstick weights of French guinea broilers.

**Key Words:** Guinea fowl, Metabolizable energy, Crude protein, Carcass traits

**323 Can broilers fed wheat-based diets free of animal protein sources benefit from inclusion of protease and amylase in combination with xylanase.** J. C. Remus\*<sup>1</sup>, E. E. Pierson<sup>1</sup>, and M. Hruby<sup>2</sup>, <sup>1</sup>*Danisco Animal Nutrition, St. Louis, MO,* <sup>2</sup>*Danisco Animal Nutrition, Marlborough, Wilts, UK.*

Antinutritional factors present in wheat-based diets are typically associated with high levels of soluble non-starch polysaccharides (e.g. arabinoxylans). Arabinoxylans are responsible for an increase in gut viscosity and reductions in nutrient absorption, uniformity, performance and litter quality. With a gradual move in some markets to animal protein free poultry diets, other antinutritional factors contributing to reduced nutrient digestibility may be necessary to consider. A study was conducted to evaluate the effect of different doses of xylanase/amylase/protease mixture (XAP) on wheat/soybean meal diets containing no animal protein. 2016 one-day-old Ross 308 male broilers were assigned to 6 treatments with 8 replicates of 42 birds each. Diets were supplemented with 5 levels of XAP (Avizyme<sup>®</sup> 1502, Trichoderma longibrachiatum, Bacillus amyloliquifaciens and Bacillus subtilis); at 0 (Negative control = NC), 0.013%, 0.025%, 0.038% and 0.050%. A treatment of a high xylanase and protease mixture (Avizyme<sup>®</sup> 1302) at 0.05% was considered as a positive control (PC). At 21 days of age, there was a significant response in weight gain and feed conversion (P<0.05) to increased levels of XAP compared to NC. At 42 days of age, only FCR was significantly improved with increased levels of XAP compared to NC and relatively low levels of XAP inclusion matched the FCR values observed with PC. This may have been due to the wheat viscosity level of 8.9 cPs (low to medium viscosity? Danisco Animal Nutrition - Avicheck<sup>™</sup> in vitro method), which was sufficiently covered by the lower levels of xylanase present in the XAP mixture. Under the conditions of this study, significant responses observed in performance at higher levels of XAP compared to NC and PC indicated that there was an additional advantage in using high levels of amylase and protease in combination with xylanase in wheat-based animal protein free diets

**Key Words:** Wheat, Animal by-product free, Xylanase, Amylase, Protease

**324 Glyceraldehyde-3-dehydrogenase expression in skeletal muscle is altered by nutritional status.** P. E. Mozdziaik\*<sup>1</sup>, J. J. Dibner<sup>2</sup>, and D. W. McCoy<sup>1</sup>, <sup>1</sup>*North Carolina State University, Raleigh NC,* <sup>2</sup>*Novus International, St. Louis MO.*

Glyceraldehyde-3-phosphate dehydrogenase (GAPDH) is a key enzyme in the glycolytic pathway, and it is a popular internal standard for Northern blot analysis. Male broiler chickens were provided a standard starter diet top-dressed with Oasis<sup>®</sup> (fed; Novus International, St. Louis MO), or they were not provided any feed (starved) for the first three d posthatch. Subsequently, the standard starter diet was provided to all chickens between 3 and 7 d posthatch. RNA was extracted from the Pectoralis thoracicus, and GAPDH expression was evaluated using quantitative Northern analysis. GAPDH expression was significantly (P < 0.05) higher in the fed compared to the starved birds at 3 d posthatch suggesting that nutritional manipulations can alter GAPDH transcription. Similarly, GAPDH mRNA levels were significantly (P < 0.05) higher at 7 d posthatch compared to all younger animals suggesting that GAPDH is developmentally upregulated with increasing age. GAPDH expression changes with age and nutritional status suggesting that GAPDH is not a proper internal control for muscle studies employing quantitative Northern analysis.

**Key Words:** Northern analysis, Early post-hatch, Starvation

**325 Effect of varying levels of dietary vitamins A and E and selenium and their interactions on performance, blood constituents, bone ash and immune response of broiler chicks.** M. A. Metwally, *Assiut University, Fac. of Agric., Animal Sci. Dept. EGYPT.*

A 2x2x2 factorial arrangement was carried out using 240 one-day old unsexed Hubbard broiler chicks. Chicks were randomly and equally divided into 8 groups to determine the effect of varying level of supplementation with dietary vitamins A and E and selenium. Two levels of selenium (0

and 0.3 mg/kg); two levels of vitamin A (800 as recommended by NRC and high level of 35,000 IU/kg) and two levels of vitamin E (10, as recommended by NRC and high level as 150 IU/kg). The experimental period lasted from hatch till 6 wks of age. The obtained results showed that there were significant ( $P < 0.05$ ) effects of selenium and vitamin E and A levels and their interactions on live body weight, body weight gain, feed intake and feed conversion ratio in broiler chicks. The absolute and relative weights of internal organs were significantly ( $P < 0.05$ ) affected either by selenium and vitamin A and vitamin E alone or their interactions, however, the relative spleen and bursa weight was significantly ( $P < 0.05$ ) increased by high levels of selenium and vitamins A and E. The results showed that selenium and vitamin A and E level significantly ( $P < 0.05$ ) affected plasma calcium, AST, ALT and albumin. The total number of lymphocytes was significantly ( $P < 0.05$ ) increased by vitamin E levels. Toe ash percentage was significantly decreased by high levels of vitamin A. The results of this study indicate that the current NRC requirements of selenium and vitamin E for broiler chicks are not adequate for optimal performance under Egyptian conditions.

**Key Words:** Vitamins A and E, Selenium, Broiler, Performance, Blood immunity

**326 The effect of dietary copper sulphate on yolk and plasma cholesterol and production traits of Dandarawi hens.** M. A. Metwally\*, *Faculty of Agric. Assiut University.*

192 local Dandarawi chickens (32 wks of age) were used to investigate the possibility of lowering the plasma and egg yolk cholesterol by supplementing the diet with different amounts of copper (control, 150, 300 and 450 mg/kg). The results showed that the addition of 300 mg Cu/kg diet improved the egg production and feed conversion compared with the control. A marked reduction was found in plasma and yolk cholesterol as the dietary copper content was increased. Yolk and albumen copper concentrations obviously increased when the level of copper increased. The level of 150 mg Cu/kg achieved the lowest residues of Cu in egg yolk and white. A significant reduction of the residues of copper and iron in the liver and kidney was seen when 150 mg/kg of copper was added compared to the other levels. It is concluded that the addition of 150 mg/kg copper might be beneficial in reducing the cholesterol content of the plasma and yolk and the residues of copper in liver and kidney.

**Key Words:** Dandarawi hens, Egg, Copper, Cholesterol

**327 The effect of step-up and step-down protein rearing systems on subsequent egg production performance during a hot climatic condition.** A. S. Hussein\*, *United Arab Emirates University, Al-Ain, United Arab Emirates.*

The effect of step-up and step-down protein levels in rearing diets on pullet development and subsequent egg production performance in a hot climate was studied using 200 Single Comb White Leghorn pullets of a commercial strain. Five replicate groups of 20 pullets, 1 day of age, were randomly assigned to each of two dietary protein treatments. Respective protein levels in rearing diets fed during Weeks 1-6, 7-14, and 15-18 were 13, 16, and 19% CP for the step-up protein treatment; and 19, 16, and 13% CP for the step-down protein treatment. Birds were moved to laying cages starting Week 19, at the beginning of the hot season, where the average temperature was 29°C low and 34°C high. Chicks in this study were hatched in late winter, developed in the spring and started laying eggs in the summer (May-August). The use of step-down protein levels on feeding pullets during the rearing period significantly ( $p < 0.01$ ) increased body weight through 18 wk of age compared to the step-up protein system. Also, pullets fed diets with 19% CP had significantly higher feed intake than those fed the 13% CP diet during Weeks 1-6. In the laying period, egg weight significantly increased during Weeks 19-22 in birds fed the step-down protein diet during the rearing period, compared to those fed the step-up protein system. Results of this study showed that average hen-day egg production during the first 4-month laying period (hot season) was significantly higher ( $p < 0.05$ ) in layers fed the step-down vs. step-up protein system during the rearing period.

**Key Words:** Rearing, Egg production, Protein

**328 Methimazole, thyroid hormone replacement and lipogenic enzyme gene expression in broilers.** R. W. Rosebrough\*, J. P. McMurtry, and M. P. Richards, *USDA, Beltsville, MD.*

The purpose of this experiment was to determine the possible relationship between certain indices of lipid metabolism and specific gene expression in chickens fed methimazole to produce a kind of artificial hypothyroidism. Male, broiler chickens growing from 7 to 28 days of age were fed diets containing 18% crude protein and either 0 or 1 g methimazole per kg of diet. At 28 days, these two groups were further subdivided into groups receiving 18% crude protein diets containing either 0 or 1 mg triiodothyronine ( $T_3$ ) per kg. Birds were sampled from at 28, 30 and 33 days. Measurements taken included in vitro lipogenesis (IVL), malic enzyme (ME) activity the expression of the genes for ME, fatty acid synthase (FAS) and acetyl coenzyme carboxylase (ACC). Hypothyroidism decreased IVL and ME at 28 d of age; however,  $T_3$  supplementation for 2 d restored both IVL and ME. Paradoxically, continuing  $T_3$  replenishment for an additional 3d decreased IVL without affecting ME activity. In contrast, supplemental  $T_3$  decreased IVL in euthyroid birds, regardless of the dosing interval, but had no effect on ME activity. Methimazole decreased plasma  $T_3$ ,  $T_4$ , and uric acid. Although methimazole decreased ME gene expression, there was only a transitory relationship between enzyme activity and gene expression when plasma  $T_3$  was replenished with exogenous  $T_3$ . These data may help to explain some of the apparent reported dichotomies in lipid metabolism elicited by changes in the thyroid state of animals. In addition, most metabolic changes in response to feeding  $T_3$  occurred within 2 to 5 d, suggesting that changes in intermediary metabolism preceded morphological changes. In conclusion, the thyroid state of the animal will determine responses to exogenous  $T_3$ .

**Key Words:** Thyroid, Gene expression, Lipid

**329 Further studies on protein reversals and metabolism in the broiler.** R. W. Rosebrough\*, M. P. Richards, and J. P. McMurtry, *USDA, Beltsville, MD.*

Although changes in dietary protein levels change metabolism in the broiler chicken, there is little information concerning the time course of the process of adaptation. Therefore, male Hubbard broiler chickens were fed diets containing either 12 or 30% crude protein from 7 to 28 d of age and then were switched to the opposite level for an additional 9 d. Birds were bled and killed at 0, 2, 5, 7 and 9 d following the reversals. Measurements taken at these intervals included in vitro lipogenesis (IVL), growth and feed consumption, hepatic enzyme activities and plasma metabolites. Birds fed the lower level of crude protein were smaller and less efficient in growth from 7 to 28 d. Feeding these birds a higher protein diet from 28 to 37 d improved both growth and feed efficiency. In contrast, all metabolic measurements reached steady state values by the 5th day following the reversals. Lipogenesis was also greater and plasma insulin-like growth factor-I (IGF-I) less in birds fed the lower protein diet. Switching dietary treatments increased and decreased lipogenesis as birds were switched from high to low and low to high protein diets, respectively. Half-maximal changes were observed two days after the reversal and maximal changes five days after the reversal. In contrast, switching dietary treatments decreased and increased plasma IGF-I, respectively, as birds were switched from high to low and low to high protein diets. Half-maximal changes were observed two days after the reversal. Of the three hepatic enzymes monitored, malic enzyme activity most closely followed the rapid changes in IVL. Plasma IGF-I may be a sensitive indicator of changes in dietary protein than changes in intermediary metabolism.

**Key Words:** Diet, Lipogenesis, Metabolism

**330 Effects of commercial probiotic or prebiotic supplementation on production, size, and quality of hen's eggs.** Y. C. Chen\* and T. C. Chen, *Mississippi State University, Mississippi State, Mississippi.*

Egg production is an important economic factor in egg industry. A higher egg production means higher profitability producers. Haddadin et al. (1996) reported that egg production, size, and egg quality were improved by the addition of a liquid culture of *Lactobacillus acidophilus* to the basal diet. Since prebiotics promote the development of probiotic microorganisms in the intestinal environment (Gibson and Roberfroid, 1995), the supplementation of layer diet with prebiotics would also benefit egg production. Hence, studies were conducted to investigate the

effects of probiotic or prebiotic supplementation on egg production and egg quality. Sixty White Leghorn hens (27-week age) were divided randomly into 3 groups. Twenty birds were assigned with 2 birds per cage to each treatment: 1) basal diet (control), 2) basal diet with 5% (w/w) of a commercial probiotic mixture (Ecozyme<sup>®</sup>), and 3) basal diet containing 1% (w/w) of a commercial prebiotic (Raftilose<sup>®</sup>, P95). Egg production, cumulative egg weight and average egg weight for each treatment were calculated weekly. Eggs were collected daily and randomly divided into 2 storage temperatures (12°C and 20°C). Haugh units of shell eggs were measured at 3-day intervals for 12 days. Data were analyzed statistically. The probiotic (6.94%) and prebiotic (5.02%) supplementation increased ( $P < 0.05$ ) weekly egg production when compared with those of the controls. Probiotic (5.6%) supplement increased ( $P < 0.05$ ) weekly cumulative egg weight after 2 weeks of feeding. Weekly cumulative egg weight was increased (6.10%,  $P < 0.05$ ) after 3 weeks of the prebiotic supplementation. No ( $P > 0.05$ ) differences in weekly average egg weight and Haugh units of shell eggs upon storage at either 12°C or 20°C among these three treatments were observed. It was concluded that the supplementation of either probiotics or prebiotics increased the egg production and cumulative egg weight but did not affect the weekly average egg weight and quality.

**Key Words:** Egg production, Cumulative egg weight, Probiotic, Prebiotic, Haugh units

### 331 Performance and carcass characteristics of broiler chicks as affected by different dietary types and levels of herbs and spices as non classical growth promoters. A. A. El-Deek\* and M. A. Al-Harhi, <sup>1</sup>Faculty of Meteorology, Environment and Arid land Agriculture, King Abdulaziz University.

The impacts of using different types and levels of herbs and spices as growth promoters on performance of broiler chicks were studied. Three trials were conducted in which, black or hot pepper, canella, carnation, and garlic were fed at different levels individually in trial 1 and in trials 2 and 3 as mixtures without or with Neomycin and compared to herbs and spices free-diet and antibiotic (Neomycin) supplemented-diet. Growth, feed intake and feed conversion ratio (FCR), percentage of dressing and internal organs were recorded. In trial 1, addition of 0.05% of black pepper, or 0.1% of hot pepper improved growth, FCR and economic efficiency compared to the control diet. Trial 2 indicated that 0.2% of black or hot pepper or 0.1 or 0.2% of carnation or 0.3% of canella resulted in the best growth, and FCR when compared within the same type of herbs and spices. They were also better than the control-unsupplemented group and comparable to Neomycin supplemented group. Results from trial 3, showed that Neomycin plus black or hot pepper improved growth by 3.9 and 2.7% and FCR by 3.6 and 3.7%, respectively, compared to the control group and growth by 2.7 and 1.6% and FCR by 3.1 and 3.2%, respectively compared to group supplemented with only Neomycin. In general, Neomycin and different types and levels of herbs and spices used herein had no adverse effects on dressing and internal organs of broilers. It is concluded that 0.1-0.2% of hot pepper or 0.05% of black pepper could be used as a non-classical feed additive in broilers diets.

**Key Words:** Chicken, Growth, Nutrition, Herbs, Dietary

### 332 Responses of laying hens to different levels of Amoxicillin, hot pepper and green tea as non conventional feed additives on productive performance, egg quality, chemical composition and cholesterol of yolk and plasma constituents. A. A. El-Deek\* and M. A. Al-Harhi, Faculty of Meteorology, Environment and Arid land Agriculture, King Abdulaziz University.

The impacts of adding 20 and 40 mg/kg Amoxicillin, hot pepper at 0.1, 0.2, 0.3% and green tea at 0.1, 0.2, 0.3 and 0.4% on productive performance, egg quality, chemical composition and cholesterol of yolk and plasma constituents were investigated. Thus there were 10 experimental groups. Each diet was fed to three replicates of 5 Hisex laying hens. The results showed that 0.1% green tea significantly improved egg weight by 7.3%, and, also, Amoxicillin, 0.2 and 0.3% of hot pepper and 0.2 and 0.4% of green tea significantly improved egg weight, but by a lesser extent. The addition of 0.2% hot pepper or green tea yielded significantly better egg production and egg mass than the control group and being equal potent as Amoxicillin. The use of 0.2% green tea had significantly higher oviduct weight than the control group. Supplementing the diet with 0.2% hot pepper resulted in significantly higher shell thickness than

the control group. Green tea significantly improved yolk color and albumen height of eggs of 40 wks old hens. Yolk cholesterol was significantly decreased with increasing levels of hot pepper and green tea in the laying diets. Yolk lipid was significantly decreased when 40 mg of antibiotic, 0.1 and 0.3% hot pepper were supplemented compared to the control group. Plasma lipids were significantly decreased when hot pepper was supplemented at any tested level. Plasma cholesterol was significantly decreased when 40 mg of antibiotic, and any tested level of hot pepper or green tea were included in the diets for laying hens. It is concluded that 0.2% of hot pepper or green tea could serve as non conventional feed additive in the diets for laying hens, moreover, plasma total lipids and cholesterol were significantly decreased when hot pepper and green tea were supplemented without adverse effects on liver and intestinal functions. Also, there were evidence indicating that hot pepper and green tea decreased yolk cholesterol.

**Key Words:** Chicken, Nutrition, Egg quality, Hot pepper, Green tea

### 333 Additive effect of Amoxicillin on performance, carcass characteristics, plasma constituents of broiler chicks fed diets containing black and hot pepper or their mixture. A. A. El-Deek\* and M. A. Al-Harhi, Faculty of Meteorology, Environment and Arid land Agriculture, King Abdulaziz University.

The objective of this work was to study the additive effects of antibiotic (amoxicillin) when added over black or hot pepper or their mixtures on performance of broilers chicks. One feeding trail was conducted in which black or hot pepper or their mixture (1:1; 1:3; 3:1) were supplemented at 0.1% without or with 40-mg/kg amoxicillin and compared to a spice and amoxicillin free-diet. Chicks were fed the experimental diets from 3 to 38 days of age, and then after 38 days spices and amoxicillin were withdrawn and all the experimental groups were kept on the control diet from 39-43 days of age. Growth of broilers, feed intake and feed conversion ratio (FCR), carcass characteristics, chemical composition of breast meat and liver, plasma constituents of birds slaughtered at 38 and at 43 d of age after 5 days of withdrawal of the additive were determined. Results indicated that hot or black pepper supplemented-groups had better growth and FCR than the control group and were equal to the group fed the control diet supplemented with amoxicillin or amoxicillin and a mixture of 3:1 of black and hot pepper, indicating that amoxicillin had no additive effect over black or hot pepper as natural feed additives. Results showed that 0.1% black or hot pepper, and their mixtures and amoxicillin had no adverse effects on front and hind parts or edible parts, as well as body organs of 38 and 43 d old broilers. Hot pepper significantly decreased plasma total lipid and cholesterol, which would be considered beneficial for human health. There was no significant negative impact of black and hot pepper or their mixtures on ALT and AST, indicating that these natural additives had no negative effect on intestinal and liver functions. It is concluded that 0.10% black or hot pepper could serve as non conventional feed additives in broiler diets. Moreover, plasma total lipids and cholesterol were significantly decreased when hot pepper was supplemented without adverse effect on carcass characteristics and internal organs of 38 and 43 d old broilers.

**Key Words:** Chicken, Nutrition, Egg quality, Hot pepper, Black pepper

### 334 Cholesterol and fatty acids in abdominal fat from broilers fed diets containing cashew nut meal and supplemented with an enzyme complex. M. Fuentes\*<sup>1</sup>, S. Militao<sup>1</sup>, E. Freitas<sup>1</sup>, and S. Morais<sup>2</sup>, <sup>1</sup>Universidade Federal do Ceara, <sup>2</sup>Universidade Estadual do Ceara.

An experiment was conducted to evaluate the effect of diets containing different levels of cashew nut meal (CNM) supplemented or not with an enzyme complex (Avizyme<sup>®</sup>) on cholesterol and fatty acids in abdominal broiler fat. One hundred and forty four day old broiler chicks were allotted in individual cages during a period of 42 days. Birds were distributed in a completely randomized block design with six treatments and six replicates of four birds in each experimental unit. A factorial arrangement 3x2 (CNM x Enzyme) was applied. Diets used in initial (1 to 21 days) and final (21 to 42 days) periods, were isoproteic and isocaloric and contained 22% and 20% crude protein and 3,000 and 3,100 kcal ME/kg, respectively. Treatments were: T1 = 0% CNM; T2 = 0% CNM + 0.1% enzyme; T3 = 7.5% CNM; T4 = 7.5% CNM + 0.1% enzyme; T5 = 15% CNM; T6 = 15% CNM + 0.1% enzyme. At the end of the experiment four birds of each treatment were sorted out, killed and abdominal fat was removed for cholesterol and fatty acids analysis. Results showed that

the inclusion levels of CNM in the diet significantly reduced cholesterol content and percentage of some fatty acids but there was no significant effect due to enzyme supplementation or to the interaction (CNM x Enzyme). Levels of cholesterol, palmitic acid and linoleic acid in abdominal broiler fat decreased oleic acid increased as the inclusion level of CNM increased in the diet.

**Key Words:** Cashew nut meal, Enzyme, Abdominal fat, Cholesterol

**335 Lipid oxidation decreases metabolizable energy value of dietary poultry fat for growing broilers.** A. M. C. Racanici, J. F. M. Menten\*, M. A. B. Regitano-D'Arce, J. B. Gaiotto, A. A. Pedroso, F. A. Longo, and J. O. B. Sorbara, *Escola Superior de Agricultura Luiz de Queiroz - USP - Piracicaba - SP - Brasil.*

In order to determine the apparent metabolizable energy (AME) and nitrogen corrected apparent metabolizable energy (AMEn) of fresh and oxidized poultry fat a metabolic assay with forty-eight AgRoss male broilers from 31 to 34 days of age was conducted. The birds were fed a basal

diet or this diet replaced by 10% of fresh or oxidized fat and the total excreta collection method was applied. The birds were housed in metabolic cages and each diet was supplied for four replications of four birds. Fresh poultry fat was supplied by a local rendering and then stored frozen (-18 OC). The oxidized fat was obtained by heating and specific absorbances were measured frequently to control fat quality. Specific absorbances at 232 and 270 nm were, respectively, 4.64 and 0.47 for fresh fat and 18.54 and 3.76 for oxidized fat, which suggest higher levels of conjugated dienes in the oxidized poultry fat. The results of AME and AMEn were 9,240 and 9,150 kcal/kg (as feed-basis) when fed as fresh poultry fat and 7,770 and 7,595 kcal/kg (as feed-basis) when fed as oxidized poultry fat. AME and AMEn values were statistically different ( $p < 0.0001$ ) and indicate a decrease from the fresh poultry fat to the oxidized fat due to the oxidation

**Key Words:** Metabolic assay, Oxidized dietary fat, Lipid oxidation, Peroxidation, Broilers

## Pathology

**336 Immortalisation of avian cells by ectopic expression of telomerase.** G. Michailidis\*, C.J. Nile, C. Townes, B. Brown, and J. Hall, *The University of Newcastle Upon Tyne, UK.*

Primary cultures of eukaryotic cells have a finite life span due to the process termed replicative senescence. This phenomenon is linked to progressive telomere shortening. Telomeres are found at the chromosome ends of most species and consist of tandem repeats of the sequence TTAGGG. Telomerase is a ribonucleoprotein that adds telomeric DNA repeats onto the 3' ends of chromosomes. It consists of a template RNA (TR) and the telomerase reverse transcriptase (TERT). Recent studies have shown that ectopic expression of (human) hTERT extends the life-span of human and other mammalian cells without causing a loss of differentiation. We attempted to investigate whether primary cultures of avian cells could be immortalised by ectopic expression of hTERT. Primary cultures of chicken embryonic epithelial (kidney and pancreatic acinar) cells, and fibroblast cells were established in vitro. Senescence of the cells was observed within 15 population doublings. Data from telomere length and TRAP (telomerase repeat amplification protocol) assays indicated that cell division was associated with telomere shortening and reduced telomerase activity. In addition RT-PCR analyses revealed reduced expression of the TR gene. To immortalise the cells the hTERT and avian TR genes were stably introduced into the cells by retroviral transfection. The resultant cell lines were analysed for telomere length, TERT activity, TR expression and cell survival. This system provides a novel approach to develop lines of immortalised avian cells.

**Key Words:** Immortalised Cells, Transfection, TERT

**337 Prevalence, distribution and diversity of pathogenic *E. coli* in commercial turkey poul production.** S. Banach\*, F. Lago, and T. Rehberger, *Agtech Products, Inc.*

Avian colibacillosis is a systemic infection caused by *Escherichia coli* and occurs most commonly in young broilers and poults. Previous research has identified virulence factors commonly associated with avian colibacillosis: *iss*, *iucC*, *tsh*, and *cvaC* and a multiplex PCR method to detect these factors. In this study, *E. coli* isolated from intestinal samples of poults were analyzed by multiplex PCR and randomly amplified polymorphic DNA (RAPD) PCR to determine the diversity of pathogenic *E. coli*. Three poults ranging from 17-36 days old were collected from each of 22 sites of an integrated turkey operation in Virginia. Intestinal scrapings of poults were plated onto CHROMagar for the enumeration of *E. coli*. Of the 22 sites, 19 contained one or more poults with *E. coli*

ranging from  $1.0 \times 10^3$  to  $7.7 \times 10^5$  cfu/g. The level of *E. coli* was not related to the age of the poul. *E. coli* levels varied between birds within a site and between sites. *E. coli* colonies from each poul were isolated for PCR analyses. Multiplex PCR analysis of the 147 *E. coli* indicated that 7.5% of the isolates had all four virulence genes present, while 32.0% had three of the genes, 24.5% had two of the genes, 30.6% had one of the genes and 5.4% had none of the four genes present. The *tsh* gene was the most common at 67.3% followed by the *iucC* gene at 64.6%, *cvaC* gene at 51.7%, and *iss* gene at 21.1%. RAPD PCR analysis using two primers indicated that the 147 isolates belonged to 75 clusters at a similarity coefficient of 80%. *E. coli* strains within a cluster did not contain the same pattern of virulence factors. Most sites contained pathogenic isolates with a variety of RAPD DNA fingerprints. These results indicate that the pathogenic *E. coli* at these sites were a heterogeneous population. Overall, the use of multiplex PCR combined with RAPD PCR was useful for studying the distribution and diversity of pathogenic *E. coli*.

**Key Words:** Poults, *E. coli*, Virulence

**338 Co-infection of hens with *Salmonella typhimurium* and *S. enteritidis* reduces *S. enteritidis* infection severity during induced molt.** P. S. Holt\* and R. K. Gast, *Southeast Poultry Research Laboratory, Athens, GA USA.*

It has been shown previously in the field that multiple *Salmonella* serovars can infect laying flocks simultaneously. Such co-infections can have dramatic effects on the survival and persistence of other salmonellae, including *S. enteritidis*. Prior studies in our laboratory demonstrated that *S. enteritidis* infections in hens undergoing molt via feed withdrawal were substantially more severe than in their unmolted counterparts and we have been investigating various situations which may ameliorate this problem. In the current study, hens were infected with *S. typhimurium* 7 days prior to feed withdrawal and then challenged with *S. enteritidis* four days into the molt. Hens receiving the *S. typhimurium* shed significantly less *S. enteritidis* at day 10 post challenge in Trial 1 and days 3 and 10 post challenge in Trial 2. Significantly fewer *S. enteritidis* organisms were detected in livers and spleens in hens receiving the *S. typhimurium* prior to *S. enteritidis* challenge in Trial 2. These results indicate that the presence of other serovars of *Salmonella* can reduce potential *S. enteritidis* problems that may occur in hens during molt.

**Key Words:** Induced molting, Salmonella, Food safety

## Physiology

**339 Development of a cannulation procedure for broiler breeder hens.** H.-K. Liu\*, J. A. Anderson, and W. L. Bacon, *The Ohio State University.*

Restricted feeding of broiler breeder hen candidates during growth and reproductive periods is a standard industry practice to achieve increased reproductive efficiency. High resolution patterns of concentration change

of hormones associated with reproduction in restricted-fed in comparison to full-fed hens are poorly documented. To monitor the concentration change patterns of these reproductive hormones associated with oviposition and ovulation, we have developed a jugular vein cannulation and serial bleeding procedure. After cannulation, the hens were returned to individual cages equipped with a tether and swivel system for serial