streams. These findings show that future efforts to reduce water use and waste loads should focus on the egg breaking and aseptic processing unit operations.

Key Words: Egg processing, Wastewater, Egg loss

303 Effect of grow period stress and layer dietary TSAA levels on albumen and whole egg functionality. D. R. Jones*, 1, P. A. Curtis1, and K. E. Anderson1, 1 Dept. of Food Science, NC State, 2 Dept. of Poultry Science, NC State.

Hy-Line W36 hens were utilized in this study. At 13 weeks of age, half of the flock received an oil-immersion, intramuscular vaccine. These birds were then considered to be stressed (C). At 17 weeks of age, hens were randomly assigned to one of three dietary protein regimens: diet 1 - 650mg total sulfur amino acids (TSAA), diet 2 - 650mg TSAA until 23 weeks of age when changed to 750mg TSAA, and diet 3 - 750mg TSAA.

Eggs were collected every three weeks from 21 to 33 weeks of age. Subsequent collections occurred every four weeks until 65 weeks of age. Albumen was separated and pooled for each treatment and diet combination.

Samples were stomached and stored for one day before testing. Whole egg samples were pooled and stomached in the same manner. These samples were stored for two days before testing. Cracked eggs and those with deformities (double yolks, blood spots, and meat spots) were excluded. All samples were brought to room temperature and stomached before testing.

Angel food and sponge cakes were prepared. Specific gravity of the batter was monitored. Whipping heights were measured. Total solids of albumen and whole egg were determined.

A significant (P<0.05) treatment*diet*hen age interaction occurs for angel food cake volume. Angel food cake specific gravity had a significant (P<0.05) diet*period interaction. Average specific gravity decreased with hen age. Whipping height levels decreased with post-peak production. Albumen total solids decreased linearly for each treatment combination with hen age.

Sponge cake volume increased with hen age. Sponge cake specific gravity was highly variable. Average whole egg total solids increased with hen age.

Key Words: functionality, egg, stress, diet

304 Plasma Thyroid Hormone and Insulin-Like Growth Factor Levels, Liver Weights and Growth in Broilers Fed Diets Deficient in Isoleucine. L. B. Carew1, J. P. McMurtry2, and F. A. Alster1, 1 Dept. of Animal Sciences, University of Vermont, Burlington, VT, 2 USDA,ARS, Growth Biology Lab, Beltsville, MD.

We have shown that methionine (Met) and lysine (Lys) deficiencies cause elevations in plasma triiodothyronine (T3) but not thyroxine (T4) in broilers compared to pair-fed controls while in a Lys deficiency T3 levels are elevated above free-fed controls. Liver weights are heavier in the Met deficiency but not with Lys. In marginal deficiencies, feed intake increases in Met-deficient chicks but decreases in the Lys deficiency; more severe deficiencies always depress appetite. IGFs were not studied previously. Isoleucine (Ile) deficiency was studied in the present experiment. A control (0.08% Ile) and diets containing deficient levels at 80, 60 and 50% of control were fed to triplicate groups of male broiler chicks from 9 to 23 days of age. Each deficient group was pair-fed with a control group. Feed intake of chicks fed 80% of the Ile requirement was similar to the free-fed controls while in the more deficient treatments marked reductions in feed intake occurred. Body weights were reduced only in 60 and 50% Ile treatments and were significantly less than in their pair-fed controls. Plasma T3 was elevated in all Ile-deficient groups and with 60 and 50% Ile the levels were markedly higher compared to pair-fed controls. Plasma T4 was unaffected except with 50% Ile it was lower than in the pair-fed control. Neither IGF-I nor IGF-II levels differed significantly compared to free-fed or pair-fed controls. Relative liver weights were similar among treatments. We conclude that deficiencies of Ile like Met and Lys cause elevations in plasma T3, especially compared to pair-fed controls, but only Met affects liver size. With marginal deficiencies, feed intake patterns are different in all three deficiencies. Initial observations with Ile suggest no effect of an amino acid deficiency on plasma IGF levels.

Key Words: Isoleucine, Triiodothyronine, Insulin-like growth, Thyroid hormone, Chicken

305 Prior thyroid status and the broiler’s adaptation to triiodothyronine (T₃). R. W. Rosebrough* and S. Kahl, GBL-LPSI-ARS-USDA, Beltsville, MD USA.

There are conflicting results concerning the role of the thyroid hormones in lipid metabolism. For example, rat data indicate that T₃ severely restricts lipogenesis in chickens. The purpose of this experiment was to study the effects of T₃ on metabolic adaptations in hypothyroid or euthyroid birds. Seven-day-old chickens were fed diets containing 18% crude protein + 0 or 1 g methimazole/kg to produce either euthyroid or hypothyroid groups of birds at 28 d of age. These two groups were then offered diets containing either 0 or 1 mg T₃/kg diets. Birds were sampled at 0, 2, 5 & 8 d following the onset of the T₃ treatment. Measurements taken at these intervals included in vitro lipogenesis (IVL), growth and feed consumption, hepatic enzyme activities and plasma thyroid hormones and metabolites. Iodothyronine 5'-monodeiodinase (5'D; EC 3.8.1.4) activity was measured to determine if the native thyroid state would affect this regulatory enzyme’s response to thyroid hormone replenition. Pancreatic norepinephrine was measured to ascertain if central nervous system regulation could account for noted metabolic changes. Hypothyroidism decreased IVL at 28 d of age; however, T₃ supplementation for 2 d restored IVL. Paradoxically, continuing T₃ replenishment for an additional 3 to 6 days decreased IVL. In contrast, supplemental T₃ decreased IVL in euthyroid birds, regardless of the dosing interval. Hypothyroidism increased 5'D activity. Although T₃ replenishment for 8 d decreased 5'D activity, this activity was still greater than that of the controls. In conclusion, the thyroid state of the animal will determine responses to exogenous thyroid hormones. These data may help to explain some of the reported dichotomies in lipid metabolism elicited by changes in the thyroid state of animals.

Key Words: Thyroid, Lipogenesis, Metabolism

306 Use of cottonseed meal in coturnix quail diets formulated with reagent-grade mono-dicalcium phosphate. M. S. Ziehr*, M. Sattar1, M. C. Calhoun2, and C. A. Bailey1, 1 Dept. of Poultry Science, Texas A&M University System, College Station, Texas, 2 The Texas A&M University System Agricultural Research and Extension Center, San Angelo, Texas.

This study was conducted to determine the maximum safe level of an expander solvent cottonseed meal (CSM) in diets fed to Coturnix quail when reagent-grade mono-dicalcium phosphate (23.7% Ca, 18.3% P) was utilized as a source of inorganic phosphorus. This reagent grade phosphorous source was used to reduce the iron content of the diet. A total of 150 day-old chicks were placed randomly into 15 Petersime brooder pens (10 birds/pens). Corn-soybean meal diets were formulated with 0, 7, 14, 21 and 28% CSM (3 reps/treatment) and contained 24% protein and 2900 kcal ME/kg diet. Diets were formulated using true digestibility coefficients for essential amino acids. The CSM used in this study contained 1.21% total gossypol and 0.098% free gossypol with a (+) to (-) isomer ratio of 59.6:40.4. Estimated iron to free gossypol ratios ranged from 1.4:1 for the diet with 7% CSM, to 0.4:1 for the diet with 28% CSM. At the end of Week 6, blood plasma and heart and liver samples were obtained, frozen and subsequently analyzed for total, (+)- and (-)-gossypol by high performance liquid chromatography. At the end of Week 6, quail fed the diet containing 28% CSM had significantly lower body weights than all other treatments. However, by the end of Week 6, there were no significant differences in body weights, feed conversions or mortality. Total, (+)- and (-)-gossypol levels in plasma, heart and liver increased as the levels of gossypol in the diets increased. Relative liver weight, but not heart weight increased as CSM in the diet increased (P<0.09). These results suggest expander solvent cottonseed meal can be fed to Coturnix quail at up to 21% of the diet without adversely affecting performance when diets are formulated using true amino acid digestibility coefficients.
for essential amino acids using a low iron source of phosphorus. The 28% CSM diet was estimated to contain 99 ppm iron and 274 ppm free gossypol.

Key Words: Gossypol, Quail, Iron, Cottonseed Meal

307 Use of cottonseed meal in Coturnix quail diets formulated with feed-grade mono-dicalcium phosphate. M. Sattar1, M. S. Zieh1, M. C. Calhoun2, and C. A. Bailey1. 1 Department of Poultry Science, Texas A&M University System, College Station, TX, 2The Texas A&M University System Agricultural Research and Extension Center, San Angelo, Texas.

This study was designed to determine the maximum safe level of an expandable solvent cottonseed meal (CSM) in diets fed to Coturnix quail when using a feed-grade mono-dicalcium phosphate (21% Ca, 16% P) high in iron (15,000 ppm). A total of 105 day-old chicks obtained from the Texas A&M Department of Poultry Science hatchery were randomly placed into 15 Petersime brooder pens at the rate of 7 birds per pen. Corn-soybean meal diets were formulated with 0, 7, 14, 21 and 28% CSM (3 reps/treatment), then randomly assigned to pens and fed for 7 weeks. All diets contained 24% protein and 2900 kcal ME/kg diet and were formulated using true digestibility coefficients for essential amino acids. The CSM contained 1.40% total gossypol and 0.15% free gossypol with a (+) to (-) isomer ratio of 61.8:38.2. Estimated iron to free gossypol ratios ranged from 2.2 to 1 for the diet containing 7% CSM, to 0.5 to 1 for the diet with 28% CSM. Body weights and feed intakes were determined weekly. Mortality was recorded daily. After 7 weeks, blood plasma, heart and liver samples were obtained and stored frozen. Subsequently, they were analyzed for total, (+) and (-)-gossypol by high performance liquid chromatography. There were no significant effects of CSM on body weights, feed intakes, feed conversions or mortality. The CSM levels also did not significantly affect relative heart and liver weights. Total, (+) and (-)-gossypol concentrations in plasma, heart and liver increased as the levels of gossypol in the diets increased. These results indicate that when using true digestibility coefficients for essential amino acids and a high iron source of phosphorus, Coturnix quail can consume a diet with up to 28% expandable solvent cottonseed meal for 7 weeks without adversely affecting performance or mortality. The diet with 28% CSM was estimated to contain 200 ppm iron and 409 ppm free gossypol.

Key Words: Gossypol, Quail, Iron, Cottonseed Meal

308 Phosphorus availability for layers in purified graded, feed grade and rock phosphates. I. Mabe1, F. R. Lima1, A. P. F. Henriques2, C. X. Mendonça2, P. M. M. Leal3, and R. Albuquerque1. 1Faculdade de Medicina Veterinária e Zootecnia da Universidade de Sao Paulo, Pirassununga, SP, Brazil, 2Faculdade de Zootecnia e Engenharia de Alimentos da USP, Pirassununga, SP, 3Faculdade de Engenharia Agrícola da UNICAMP, Campinas, SP, Brazil.

Seven hundred and thirty six laying Babcock hens were fed 22 diets from 30 to 54 weeks of age to determine relative bioavailability of P (RBP) for egg production in six phosphates, using a pure calcium phosphate as the standard (SP). Phosphates were two purified grade (PP): monocalcium and tricalcium; two feed-grade dicalcium phosphates (FP): Tapira (1.28%P) and Araxá (2.23%P). Phosphates were added to the corn-soy basal diet (17%CP; 0.33% P) to provide 0.04, 0.08 and 0.12% supplemental P. Ca level was 3.4% for all diets. All birds were fed the basal diet for 8 weeks prior to the onset of the trial. Then birds were grouped according to weight, and the experimental unit was 8 birds placed in 4 adjacent cages, in a complete random block design (21 treatments and 4 replications). Egg production (EP), egg weight (EW), feed intake (FI), feed:food (FD) and feed:kg of eggs ratio (FK) were summarized for six 28d periods (P1 to P6). Tibia ash and breaking strength and internal and external egg quality parameters were evaluated at 30, 38, 46 and 54 weeks. RBP for each phosphate and for each period was determined by slope-ratio, with EP regressed on P added. In period 6, average RBP values were higher for PP and FP: 133% and 145%. Lowest RBP were for FP: 76% and 50%, respectively for Tapira and Araxá rocks. Performance for PP and FP did not differ (P > 0.05). EP and FI increased and FD and FK decreased with increasing dietary P regardless of source (P > 0.05). Bone and egg quality parameters were not affected by level or source of P. RP depressed performance (P < 0.05) as compared to SP. Depression was evident as the trial progressed. In period 6, overall averages for RP fed hens were 40% lower in EP (7884 vs 47.46%), and 15% lower in F1 (104.15 vs 88.05g/d), and 5% higher in FK (2.09 vs 3.20), as compared to hens fed the SP supplemented diet. Low P availability, and depression in performance, are signs of toxicity, and definite evidence that rock phosphates are materials not suitable for feeding animals.

Key Words: Phosphorus, Rock phosphates, P availability, Layers, Egg production

309 Effects of dietary chelated and inorganic zinc and manganese on metaIlothionein accumulation in layers. I. Mabe1, F. R. Lima1, A. P. F. Henriques2, C. X. Mendonca2, and S. M. F. Cozzolino2. 1Faculdade de Medicina Veterinária e Zootecnia da Universidade de Sao Paulo, Pirassununga, SP, Brazil, 2Faculdade de Ciências Farmacêuticas da Universidade de Sao Paulo, Sao Paulo, SP, Brazil.

One experiment was conducted to study the effect of Zn and Mn chelates (Availa-Zn and Availa-Mn), Zn oxide and Mn sulfate additional supplementations for laying hens on liver and pancreas metallothionein (MT). A corn-soybean control diet formulated to meet all nutrient requirements (NRC, 1994) of laying hens (17% PB: 3.80% Ca: 0.36% nonphytate P; 65mg Zn; 104mg Mn) was supplemented with 0 or 40ppm Zn, from Zn oxide or Zn chelate, and 0 or 40ppm Mn, from Mn sulfate or Mn chelate, in a 3x3 factorial arrangement of treatments. A negative control diet was used with no supplementation. A hundred and forty three week old layers (Babcock) were grouped according to weight, and the experimental unit was 8 birds placed in 4 adjacent cages, in a complete random block design (10 treatments and 8 replications). Hens were killed by cervical dislocation after 24 weeks, liver and pancreas were excised. MT concentration was determined by 109Cd-hemoglobin affinity assay. Data were analysed by the GLM procedures of SAS, and comparison of main effects were made by orthogonal contrasts. There was no effect (P > 0.05) of Zn or Mn additions, regardless of source, on MT concentrations in liver or pancreas. Single addition of Zn chelate increased (P < 0.05) pancreas MT as compared to the negative control (82.32 vs 53.51mcg/g fresh tissue). Averages for the Zn treatments, regardless of Mn, were 61.30, 65.03, and 74.45mcg/g fresh tissue (liver) for Zn oxide, Zn and Mn chelates, respectively for no Zn, Zn oxide and Zn chelates. Means for Mn treatments, regardless of Zn, were 63.46, 63.60, and 61.15mcg/g fresh tissue (liver); 74.02, 69.49, and 73.48mcg/g fresh tissue (pancreas), respectively for no Mn, Mn sulfate and Mn chelate. Although MT expression in many different tissues has been shown to increase in response to an increase in Zn intake of an animal, in this study additional Zn or Mn, regardless of chemical form, did not increase MT concentrations in the liver or pancreas. SPONSOR: FAPESP

Key Words: Zinc, Manganese, Chelate, Metallothionein, Layers

310 Supplemental manganese (Mn) and zinc (Zn) from inorganic and organic measurements. S. E. Scheideler1, N. Ceylan2, C. Novak1, U. Puthpangsirom1, and T. Sefon1. 1Dept. of Animal Sci. Univ. of Nebraska, Lincoln, NE, 2Ankara Univ., Ankara, Turkey, 3Alltech, Nicholasville, KY.

Two trials were conducted to test effects of supplemental Mn and Zn above basal levels in layer premixes. Trial one was a 2x2x2 factorial arrangement of 2 levels dietary calcium (4.0 or 3.5%), control (165 ppm Mn or 165 ppm Zn) or ES-49 supplemented at 270ppm Mn and 180 ppm Zn) and 2 time periods of ES-49 supplementation during 2 phases of feeding: 20-44 weeks or 44-60 weeks of age. Trial two was a 2x3 factorial arrangement of 2 levels calcium (4.0 or 3.5%) and 3 types of Mn and Zn supplementation - control (165 ppm Mn and 165 ppm Zn), supplemental Mn(180 ppm) and Zn (180 ppm) from Mn sulfate and Zn sulfate, respectively, or Eggshell-49 (180 ppm Mn and 180 ppm Zn). Trial two was conducted from 20 to 60 weeks of age. In each trial, each dietary treatment was assigned to 6 replicate pens with 6 Hyline W-36 hens per pen. Two phases of diet density were fed, from 20-44 weeks of age (Phase I) and 44-60 weeks of age (Phase II). In Trial one, ES-49 had no effect on feed intake (FI), egg production (EP), egg wt. (EW), or egg mass (EM) during either phase of feeding. A significant interaction between ES-49 and calcium level occurred for EP such that within the 4.0% Ca group, supplementation of ES-49 decreased percent EP compared to the 3.5% Ca. Treatment. Eggshell 49 supplementation from 20-44 and 44-60 wks improved % dry shell, shell strength (Newtons), % cracked eggs and eggshell gland carbonic anhydrate activity (in vitro) measurements. Higher calcium (4.0%) increased duodenal calcium uptake and carbonic anhydrate activity. In trial 2, egg mass was greater in the
311  Effect of sulfur amino acid in rations on breast meat yield for broilers raised in two stocking densities. J. H. Stringhini1*, J. Ariki2*, M. B. Cafe1, and M. Schaitt1, 1Universidade Federal de Goiás, 2FCAV/UNESP-Campus de Jaboticabal, 3Abatedouro Sao Salvador-Goias-Brazil.

This research purposed verify methionine+cystine effects on breast meat yield in densities 12 and 18 birds per square meter. The assay was done in experimental area of Super Frango, Goiás. Birds fed corn-soybean rations, initial (1 to 21 days), growing (22 to 38 days) and final (39 to 45 days) supplemented with 0, 5, 10, 15% met+cys above recommended by Rostagno et al. (1994), in a completely randomized design in a factorial 2 x 4. At the end, 320 broilers were weighed and killed and breast yield was calculated. Two samples per replicate were deboned, and meat was weighed and analysed for moisture, protein, and fat. The polynomial regression indicated a linear negative effect on meat yield reduced was wighed and analysed for moisture, protein, and fat. The parameters tested ranged from 1.10% to 1.44% during the 0-3 wk period and from 1.02% to 1.44% for the 3-6 week period. Treatments were made by titrating lysine into a low protein diet which was fortified with synthetic amino acids. The positive control was a typical corn and soybean diet based on NRC (1994) recommendations for the appropriate period. Bodyweight gain and feed conversion responses were measured at the end of each trial period. Lysine requirements were determined using the normal broken line model. The requirement for optimum bodyweight gain during the first growth period was found to be 1.31% on a digestible basis. For the 3-6 week period the requirement based on bodyweight gain was found to be 1.23% however this trial was conducted during a period of extremely high environmental temperatures and will be repeated.

Key Words: Turkey, Lysine, Digestible amino acids

314  The Performance of Broiler Chickens Fed Rations Formulated with Cottonseed Meal or Soyabean Meal as the Major Protein Source. M. H. Henry1*, G. M. Pesti, and R. I. Bakalli, Department of Poultry Science, The University of Georgia.

An experiment with a 2x3 factorial design was used to compare the performance of broiler chickens fed diets with three protein levels supplied by cottonseed meal (CSM) to those fed soybean meal (SBM). In this study a 23% protein starter diet based on corn with soybean meal as the major protein source was fed to Peterson x Arbor Acres male chicks from 0 to 21 d. At 21 d post-hatching, 35 chicks were placed in floor pens and fed the experimental grower diets. Three levels of protein, 17%, 20% and 23%, were fed to the chickens from 21 d to slaughter with either CSM or SBM as the major protein source. The minimum amino acid to protein ratios were fixed for lys, meth, meth+cys, thr, ile, and trp to ensure that these amino acids were not the most limiting. L-lysine was added to keep lys level at 5.22% of protein. Protein source and level had a significant effect on body weight (P<0.0001) and feed conversion ratio (FCR; P<0.0002), respectively. The average body weights were 2.34, 2.44 and 2.49 kg for birds fed CSM diets, compared to 2.48, 2.58, and 2.64 for SBM diets (17, 20, and 23% protein, respectively). There was a significant linear increase in body weight due to protein level for both CSM (P<0.0133) and SBM (P<0.0006). The FCR at 42 d was significantly affected by protein source (P<0.0001) and level (P<0.0001). The average FCRs were 2.44, 2.24 and 2.09 for CSM, and 2.22, 2.06, and 1.98 for SBM fed broilers. Feed consumption of 28 and 35 d-old birds was significantly affected by protein level (P<0.0002) and source (P<0.0174) respectively. At 42 d, feed consumption was not significantly affected by protein source (P>0.05) or level (P>0.072). Full substitution of CSM for SBM reduced body weight and feed efficiency at all protein levels. Increasing the protein level of diets formulated with either CSM or SBM improve feed to gain ratio of growing chicks. Broilers fed 23% protein finisher ration based on corn and CSM performed similarly to those fed 17% protein based on corn and SBM. The use of CSM in broiler rations will ultimately be determined by the cost structure of feed ingredients.

Key Words: Broiler chicken, Cottonseed meal, Soybean meal, Performance.
increased the circumference of the gastric isthmus, weight of the proventriculus and the incidence of lesions in the proventriculus and gizzard. Lesions included gizzard erosion, proventricular ulcers and a decreased prominence of proventricular papillae. The effects of histamine and cadaverine appear to be synergistic and cause pathologies associated with proventriculitis. Biogenic amine analysis of 66 commercially available animal by-product feedstuffs suggests that dietary inclusion of 10% animal by-products does not result in a level of biogenic amines necessary to induce proventriculitis. These data suggest that while biogenic amines can induce proventriculitis it is likely that they interact with other causative agents to induce the effects observed in commercial production.

Key Words: Biogenic amines, Histamine, Growth

316 Withdrawn by request.

317 Effect of amino acid supplementation of low protein diets on broiler growth. A. H. Cantor1, A. J. Pescatore1, R. S. Gates1, D. J. Burnham2, M. J. Ford1, and N. D. Paton1, 1University of Kentucky, Lexington, KY, 2Heartland Lysine, Inc., Chicago, IL.

Two studies were conducted to evaluate supplements of amino acids and energy to low CP diets on the growth of broiler chicks from 1 to 3 wk of age. In each study, 10 pens of six chicks were assigned to each of eight dietary treatments in a randomized complete block design, with average starting BW for all pens falling within a range of 1 g. High CP (23%) and low CP (16.8%) corn-soybean meal diets were fed as positive and negative control treatments. The low CP diet, which contained 3200 kcal TME/kg (calculated), had the following levels of digestible amino acids: 1.07% arginine (ARG), 0.69% isoleucine (ILE), 1.0% lysine (LYS), 0.75% TSAA, 0.68% threonine (THR), and 0.17% tryptophan (TRP).

Treatments in Experiment 1 consisted of feeding the high CP diet, low CP diet, and the low CP diet with one of the following: 5.5% glutamic acid (GLU) as a source of non-essential nitrogen, 2.8% GLU, 0.18% ARG, 0.1% ILE, 0.1% THR, and 0.02% TRP. Additions of ARG, THR or TRP, but not ILE nor GLU, to the low CP diet increased BW gain to 21 days and feed intake. Only supplemental THR improved gain to feed ratio (G/F). Treatments in Experiment 2 consisted of feeding the high CP diet, low CP diet, and the low CP diet with one of the following: 0.1% THR, 0.1% THR + 0.02% TRP, 0.1% THR + 0.02% TRP + 0.14% ARG, 0.1% THR + 0.02% TRP + 0.14% ARG + 2.8% GLU, 0.1% THR + 0.02% TRP + 58 kcal TME/kg, and 0.1% THR + 0.02% TRP + 0.14% ARG + 58 kcal TME/kg. In the second study, supplemental THR failed to improve BW gain and G/F. Weight gain and G/F were depressed by adding THR + TRP + ARG alone, but were increased when the three amino acids were combined with higher energy. The addition of THR + TRP + ARG + GLU also increased G/F. In both trials, the high CP diet resulted in higher BW gain and G/F, compared with all other treatments. The results of Experiment 1, but not those of Experiment 2, suggest that the low CP diet was not limiting in non-essential nitrogen but had insufficient THR. In Experiment 2, supplemental THR + TRP + ARG was only beneficial in the presence of extra energy or non-essential nitrogen.

Key Words: Low protein diets, Amino acids, Dietary energy, Broilers

318 Determination of the Methionine Requirements of Male and Female Broiler Chicks Using an Indirect Amino Acid Oxidation Method. M. Chamruspollert1, G. M. Pesti, and R. I. Bakali, Department of Poultry Science, The University of Georgia.

The methionine requirement of 250-to-300-gram broiler chicks was estimated from the oxidation of L-[1-14C] phenylalanine of chicks given meals containing 4 levels of DL-methionine, 0.36 (basal), 0.40, 0.51, or 0.66%. L-[1-14C] phenylalanine was used as an indicator amino acid for amino acid oxidation and, indirectly, protein synthesis. Two experiments were conducted using an incomplete block design with three replications. Chickens were directly fed with semi-fluid diets in the ratio of 1 g of diet per 45 g of bird weight. Two feedings two hours apart was used to reduce the variability and the sample collection period was 3 hours after the second feeding. Male and female Ross x Ross chicks were used in the first experiment. Increasing dietary methionine levels from 0.36 to 0.51% caused 14CO2 release from L-[1-14C] phenylalanine to decrease. However, increasing the dietary methionine level to 0.66% resulted in no further decrease in 14CO2 output. Regression analysis, using the model response = max + r*c*(req-x) [where max = plateau, r = rate constant, req = requirement, and l=1 when x less than req, otherwise l=0], showed phenylalanine oxidation was minimized with a dietary methionine level of 0.52% and 0.45% for male and female chicks, respectively. The second experiment was conducted using Arbor Acre High-Yield males and females. Phenylalanine oxidation stabilized at a low rate when dietary methionine levels reached 0.53+ 0.06% and 0.52+0.09% for male and female chicks, respectively. The results suggested that the methionine requirements of male chicks tended to be higher than that of females in both strains. However, no significant differences were found.

Key Words: Indirect amino acid oxidation, Indicator amino acid, Methionine requirement, Broiler chicks, L-[1-14C] phenylalanine


Linear regression (LR) has been used to predict amino acid (AA) profiles of feed ingredients, given proximate analysis (PA) input. ANN have also been used to predict AA levels, generally with better results. A general regression neural network (GRNN) with Iterative Calibration (GRNNIT) was used to predict AA levels with greater accuracy than either LR or other ANN architectures (1998 Poultry Sci. 77:53). Predictive performance was based on R2 values obtained when model predictions were compared to chemically analyzed AA composition values in the data base. Calibration of an ANN makes it able to generalize well and give good results for new data. This research investigated the potential of an advanced method of Calibration for GRNN ANN termed the genetic algorithm (GRNNGA). A Genetic Algorithm works by selective breeding of a population of ‘individuals’, each of which is a potential solution to the problem. The predictive ability of a GRNN ANN architecture (NeuroShell 22), with input scales of 0.1/-1/logistic or tanh, and either Iterative or Genetic Algorithm Calibration, was compared to that of LR (SAS Proc GLM). The AA levels (Met, Lys, TSAA, Tyr, Trp, Thr, Arg) from corn, soybean meal (SBM), meat and bone meal, fishmeal, and wheat were predicted based on PA input. In general, GRNNGA resulted in higher R2 values than LR, GRNNIT or any other ANN architectures previously tested. For example, the highest Met R2 values for SBM were 0.54 (LR), 0.92 (GRNNIT) and 0.98 (GRNNGA). Genetic algorithm Calibration of GRNN architecture led to improvements in ANN performance for AA level predictions in 26/28 cases studied.

Key Words: Artificial Neural Network, Genetic Algorithm

320 Alteration of incubation conditions and inocula volume to shorten the microbial assay time for quantitation of lysine by an Escherichia coli lysine auxotroph. X. Li*, A. M. Erickson, and S. C. Ricke, Poultry Science Department, Texas A&M University, College Station, TX.

Rapid and economic microbiological assays involving E. coli lysine auxotroph may be a possible alternative to animal standard assays for routine estimation of lysine bioavailability. Our objectives in this study were to improve the microbial assay by shortening the assay time via different bacterial inocula concentrations, and incubation conditions. Two defined minimal media, a salt medium were compared for fine media, a salt medium (M9) and a supplemented minimal medium containing 300, 300 and 500 µls which contained 1.4, 6.4 and 12 x 103 colony forming units/ml respectively were examined. Culture tubes were placed in a shaking water bath at 37°C. Increasing the size of the incubation tubes from 13 x 100 mm to 16 x 150 mm and growing in a shaker water bath generally decreased doubling time (average of

Four dietary treatments of thirty one-day old chick pullets each were employed in this study. All chicks were the progeny of the laying hens fed wheat-soybean based diets containing 5% of animal tallow, sunflower oil, flaxseed oil or fish oil for six weeks. Chicks were housed in separated floor pens with free access to feed (mash) and water. The diets of each group was the same kind with the corresponding maternal diet with certain adjustments to meet the nutrient requirements for early growing chicks. At the age of four and eight weeks, respectively the thymus and spleen lymphocyte proliferation, serum IgG concentration, lymphocyte subset and immune tissue weight were studied. High n-3 polyunsaturated fatty acids significantly suppressed ex vivo thymus and spleen lymphocyte proliferation in response to concanavalin A or pokeweed mitogen, significantly increased the serum IgG concentration. In contrast, high n-6 polyunsaturated fatty acids showed significantly higher thymus and spleen lymphocyte proliferative response to both mitogen stimuli and lower serum IgG concentration. Feeding chicks the diets containing 5% of flaxseed oil or fish oil significantly elevated the percentage of CD8+ cells. The immune tissue weights (thymus, spleen or bursa of Fabricius) were significantly higher in the chicks on the diet rich polyunsaturated fatty acids, in spite of n-6 or n-3 family at the age of 4 weeks. However, at 8 weeks of age, the differences in the weight of thymus or spleen disappeared across four dietary treatments. The bursa weights were influenced high significantly during the period of 4 to 8 weeks of age. The more n-3 polyunsaturated fatty acids the chicks had, the lower bursa weight they achieved.

Key Words: polyunsaturated fatty acids, chicks, lymphocyte proliferation, IgG concentration, lymphocyte subset proportion


Two experiments were conducted to obtain data on the biological effects of graded levels of glucosinolates in the diet of laying hens and to establish the “no effect” level of glucosinolates as an antinutritive factor in canola. A third production trial was conducted utilizing the biological parameters established in the first two experiments to determine the antinutritive effects of low-glucosinolate canola and evaluate its effectiveness as a protein supplement in laying-hen diets. Dietary glucosinolate levels were varied by blending control (non-canola) and canola meal (Exp. 1) or canola meal/canola seed (Exp. 2) diets. In Exp. 2 canola seed was used as a source of active myrosinase enzyme. Thyroid status (organ weight and plasma levels of T3 and T4), incidence of liver hemorrhage, liver glutathione levels and activities of xenobiotic metabolizing enzymes in liver tissue were biological parameters used to assess antinutritive effects. Hen-day egg production, feed consumption, feed conversion efficiency and mortality levels were parameters used to assess productive performance. Production performance was maintained at a high level (90% hen-day production over a 5-month experimental period ) in hens fed low-glucosinolate canola meal and no evidence of antinutritive effects of glucosinolates was evident. In this regard, low-glucosinolate canola meal may be used in diets for the laying hen without the need for an upper-limit constraint.

Key Words: Canola, Glucosinolates, Antinutritive effects, Laying hen

The source and production process of a commercial enzyme mixture can have a positive effect on the properties of an enzyme. Production of enzymes by solid-state fermentation (SSF) can result in side activities not seen from enzymes produced by submerged liquid fermentation (SLF). The genetic background of the organism may also influence the properties of an enzyme. Because of the complex nature of phytic acid and the intestinal environment in poultry, additional enzyme properties are beneficial for enzyme function. A study was conducted to compare enzyme activities of a phytase from a genetically modified organism (GMO) produced by SLF to a phytase from a nongenetically modified organism (NGMO) produced by SSF. The following substrates were tested incubating with 500 and 1000 phytase units: 1) control with no enzyme, 2) poultry starter feed, 3) soy flour, 4) wheat bran and 5) rice bran. The enzyme and substrates were incubated in a shaking water bath at 50°C for six hours. Assays compared the release of inorganic phosphate (PO₄), reducing sugars released, and release of alpha amino nitrogen. These assays indicate that the enzyme product contains phytase (PO₄), reducing sugars released, and release of amino nitrogen. These assays are indicative of the enzymes' various activities over the GMO for all substrates. The NGMO demonstrated a significant increase in PO₄ across all the substrates, but PO₄ activity was much lower in the control diet. Treatments were replicated in 10 pens with five hens per pen.

Key Words: Phytase, GMO, NGMO, Side activities, Solid-state fermentation

326 Evaluation of broiler breeder hen performance fed high levels of barley in two types of diets with or without multienzyme supplement through their prelaying and laying periods. A. Eldeek1*, A. Soliman2*, M. Asar3, and G. Hasan4.

Three by two factorial experiment was used to study the effect of using barley as an energy source to replace 0, 30 or 60% of the energy provided by yellow corn. Two types of diets were used, vegetable (corn-soybean diet) or practical (corn-soybean diet containing 10% protein concentrate), either with or without multi-enzyme (OPTIZYME-S®) supplementation. Also, to study the effect of treatments on productive and reproductive performance of broiler breeders hens through prelaying (22-27 wk) and laying (27-50 wk) periods and the performance of their progeny. Diets were iso-nitrogenous (17%) CP and iso-caloric (2750 kcal/kg). Results indicated that diets containing barley substitution up to 60% of yellow corn energy had no adverse effect on age at sexual maturity, egg production, and egg weight. Multi-enzymes addition improved egg production (p<0.06), feed per hatch (p<0.01) and number of hatched chicks per dam (p≤0.04) of the 60% barley containing diets. Treatments also showed that egg production, egg weight, fertility, hatchability and number of hatched chicks of broiler breeder hens fed vegetable diet were similar to those fed practical diet, which was also more economically efficient. Percentage shell, fertility, hatchability of total eggs set, embryonic mortality and ovary weight were not affected by dietary treatments. Meanwhile barley levels and their interaction with enzyme affected abdominal fat deposition. There was no effect of maternal diets on their progeny growth and feed conversion.

Key Words: Barley, Broiler breeder, Enzyme, Productive traits, Reproductive traits


A trial was conducted to determine the effect of phytase supplementation (ALLZYME® PHYTASE 115, Alltech, Inc.) containing 30% Callao barley formulated to contain graded levels of available phosphorus (％AP). Male broilers were allotted in a RCBD with 2 x 5 factorial arrangement of treatments. Phytase levels were 0 vs. 11,500 PTU/kg diet and %AP levels were .35, .30, .25, .20 and .15%. All diets contained supplemental β-glucanase (1% AVIZYME®, Finfeds, Inc.) and were formulated to contain 3200 kcal ME/kg and .9% calcium. All diets were fed in mash form. There were no significant effects of phytase or %AP on 21-42 day weight gains or gain/feed ratios (avg. of 757g and .338, respectively). Bone breaking strength (BBS) and % tibia ash were significantly (P<0.05) affected, however. BBS values without supplemental phytase were 15.38ab, 14.52ab, 16.83ab, 11.98ab and 9.79kg, respectively and 17.03ab, 16.17ab, 15.19ab, 13.16ab and 15.58ab kg, respectively, with supplemental phytase. Percent tibia ash values without supplemental phytase were 57.9ab, 57.4ab, 57.0ab, 56.6ab and 50.7ab, respectively and 57.5a, 56.3ab, 56.9ab, 56.8ab and 55.0ab, respectively, when supplemental phytase was added. These results suggest that supplemental phytase will improve phosphorus utilization in broiler containing diets formulated to contain less that NRC recommendations for available phosphorus.

Key Words: Phytase, Barley, Broilers

328 Effects of phytase supplementation on egg production parameters and amino acid digestibilities. M. A. Jalal1*, S. E. Scheideler2, and C. Wyatt3.

Hens were fed corn-soybean meal diets containing 0.35, 0.25, 0.15 and 0.10% available phosphorus (％AP)(40-60 wk). The phytases A and B were added at rates of 250 and 300 units of phytase/kg to 0.25, 0.15 and 0.10% AP in a factorial arrangement, with the 0.35% AP as the control diet. Treatments were replicated in 10 pens with five hens per pen. Results showed significant effect (P<0.06) on feed intake when hens were supplemented with phytase A or B compared to basal diets. Hens fed 0.25% AP and supplemental phytase B had the highest intake, while those fed 0.10% AP without phytase consumed the least. There were no significant differences in egg production, egg weight or eggshell quality. Egg mass was significantly greater for hens supplemented phytase B at all AP levels (P<0.05). Crude protein digestibility was not significantly different (P>0.05) in diets with phytase. The lowest percentage was 20% in the control diet. Treatments were replicated in 10 pens with five hens per pen.

Key Words: Hen, Phytase, Phosphorus, Eggs, Amino acids

329 Effects of microbial phytase on apparent ileal digestibility of amino acids in turkey poult feeds a corn-soybean meal diet formulated on an ideal protein basis. D. R. Ledoux1*, J. D. Firman1, J. N. Broomhead1, and Y. C. Li2.

A 21 day battery study using 240 day-old pouls was conducted to determine the effects of microbial phytase on apparent ileal digestibility of nitrogen and amino acids and on apparent metabolizable energy. Pouls were fed a corn-soybean meal diet formulated on an ideal protein basis. A completely randomized design was used with an ideal protein diet (25.0%, IP) supplemented with four levels of microbial phytase (0, 200, 400 and 600 FTU/kg diet) supplied by Natuphos®. Twelve replicate pens of five pouls were assigned to each dietary treatment. There was no effect of

Key Words: Hen, Phytase, Phosphorus, Eggs, Amino acids

330

ABSTRACTS OF PAPERS
dietary treatments on feed intake, body weight gain or feed conversion which averaged 756 g, 491 g, and 1.54 g/g, respectively. In contrast, there were linear increases in ileal nitrogen digestibility (P ≤ 0.05) and AME (P < 0.01) with increasing phytase levels. Increasing levels of phytase linearly increased (P ≤ 0.05) the apparent digestibility of the dietary essential amino acids phenylalanine, isoleucine, methionine, leucine, lysine and tryptophan. The increase in cysteine digestibility with increasing phytase levels contained both linear (P < 0.01) and cubic components (P ≤ 0.01). Increasing levels of phytase linearly increased (P < 0.01) the apparent digestibility of the dietary nonessential amino acid glycine. In contrast, the increase in apparent digestibility of tyrosine contained both linear (P < 0.01) and cubic components (P ≤ 0.01). Results indicated that supplemented phytase supplied by Natuphos® was effective in improving energy utilization and amino acid digestibility in turkey poulets fed an ideal protein diet.

Key Words: Turkey, Phytase, Amino acid digestibility, Ideal protein

330 Efficacy of phytase for increasing protein efficiency ratio (PER) values of feed ingredients. S. D. Boling*, C. M. Peter, M. W. Douglas, C. S. Strunk, C. M. Parsons, and D. H. Baker, University of Illinois, Urbana, IL USA.

Data previously reported by our laboratory suggested that phytase improves amino acid utilization in chicks fed soybean meal (SBM). It was the objective of the current study to determine the effect of phytase on the PER values (g weight gain per g protein intake) for several feed ingredients fed to chicks. Ingredients evaluated included: soybean meal, canola meal, cottonseed meal, peanut meal, corn gluten meal, wheat midds, wheat bran, rice bran, defatted rice bran and meat and bone meal. All ingredients, except soybean meal and meat and bone meal, are first limiting in lysine. Each feedstuff was analyzed for crude protein and included in a cornstarch/dextrose diet to provide 10% dietary protein. Casein was also evaluated in the assay to serve as a phytase-free control diet. The test ingredients were the only source of protein and were fed with 0 or 1200 units phytase/kg. Each of the dietary treatments was fed to four replicate groups of four chicks from 8 to 17 days of age. Graded doses of SBM protein (5, 10, 15% CP) were also fed with and without 1200 U/kg phytase to eight pens of four chicks over a 13-d assay period so that slope-ratio protein efficacy could be assessed. Phytase addition did not improve (P > 0.10) PER values for any of the ingredients evaluated. In the slope-ratio assay, weight gain and protein accretion increased linearly (P < 0.01) as a function of protein intake, but phytase supplementation did not increase the slope of the accretion curves. The results indicated that 1200 U/kg phytase did not increase amino acid availability in several phytate-containing feed ingredients as assessed by a PER or slope-ratio growth assay.

Key Words: Protein efficiency ratio, Amino acids, Phytase, Chicks


Data previously obtained from our laboratory indicated that citrate was very effective at releasing phytate-phosphorus (P) in a P-deficient, corn-soybean meal (SBM) diet fed to chicks. It was the objective of the current study to determine if citrate would have similar effects in a commercial strain of Single Comb White Leghorn laying hens (n = 432) fed a corn-SBM diet containing no supplemental P (0.10% AP). Dietary treatments consisted of the corn-SBM basal diet (0.10% AP, 3.8% Ca, 17% CP) supplemented with 0, 1, 2, 3 or 4% citrate and a positive control diet containing 0.45% AP. Each of the six dietary treatments was fed to six replicate groups of 12 hens from 22 to 40 weeks of age.

No significant differences in performance were observed among treatments during the first 15 weeks of the experiment. By 26 weeks of age, the 0.10% AP diet with 0, 1, 2, 3 or 4% supplemental citrate resulted in significantly lower (P < 0.05) body weight compared to all other dietary treatments. Hen-day egg production, feed consumption, feed efficiency, and egg yield were subsequently depressed in hens fed 0, 1, 2, 3 or 4% citrate by 30 weeks of age. Thus, the addition of citrate to the 0.10% AP diet did not support optimal performance. The mean daily AP intake of hens fed the 0.10% AP + citrate diets was 95 g. The results of this study indicate that citrate does not improve the utilization of P in corn-SBM diets for laying hens.

Key Words: Available phosphorus, Citrate, Laying hens

332 Influence of different cultivars of corn on nutrient digestibility and metabolizable energy value of broiler chick diets. Z. Lu*, C. Perera, J. Jane, and J. L. Sell, Iowa State University, Ames, Iowa/USA.

Two experiments (Exp.) were conducted to determine the influence of different cultivars of corn on digestibility of starch, CP, and fat and on the metabolizable energy (MEn) value of broiler chick diets. Normal corn (NC) and high-oil corn (HOC) cultivars were evaluated in Exp. 1, and NC, waxy corn (WC), and sugar-2 corn (S-2C) cultivars were studied in Exp. 2. Diets containing the corns were isocaloric and isonitrogenous and were fed to four replications of broiler chicks from 1 to 5 wk of age. Ileal digesta and excreta were collected when chicks were 2 and 5 wk old. Body weight (BW) and feed consumption data were recorded when chicks were at 1, 2 and 5 wk old. Starch type, amyllose-to-amylopectin ratio, starch viscosity and amylpectin chain-length and branch structure of the five different cultivars of corn also were determined. In Exp. 1, digestibility of DM (P < 0.01), CP (P < 0.01) and starch (P < 0.01) were increased compared with WC and NC diets at 5 wk age, showing the effect of starch crystalline structure on the starch digestibility. The starch of S-2C has different branch structure and less crystallinity compared with WC and NC. Thus, S-2C was more digestible than WC and NC. Also, greater digestibility of S-2C starch was probably related to its low viscosity compared with the high viscosity of starches in NC and WC.

Key Words: Corn starch structure, Digestibility, MEn, Ileal digesta, Broiler chickens

333 Effect of dietary conjugated linoleic acid on egg yolk fatty acids and hatchability in Japanese quail. R. Aydin¹, M. W. Pariza², and M. E. Cook¹,². ¹Animal Sciences Department, University of Wisconsin, Madison, ²Department of Food Microbiology and Toxicology, University of Wisconsin, Madison.

Conjugated linoleic acid (CLA) is a mixture of positional and geometrical isomers of linoleic acid that occurs naturally in animal products and has been shown to have biological effects. Our studies have indicated that dietary CLA increased the ratio of C16:0/C16:1 and C18:0/C18:1 in egg yolks and induced chick embryonic mortality in low fat diets. Hence, the objective of this study was to determine the effects of dietary CLA on egg fatty acid content and hatchability in quail. Eight male-female Japanese quail pairs per treatment were randomly assigned to one of the six diets containing 0 (diet A), 25 (diet B), .5 (diet C), 1 (diet D), 2 (diet E), or 3% CLA 90 (diet F) for 2 months. Eggs collected daily were stored at 15°C for 24 hours and then incubated. Three eggs from each group were obtained for fatty acid content analysis on the 45th day of feeding. At the end of the 2 month of the CLA feeding period, all male and female quails were killed and body, liver, heart, testicle, and oviduct weights were measured. Total CLA contents (%) of yolk from group A, B, C, D, E, and F were .3, .84, 1.39, 2.27, 5.59, and 10.66 %, respectively. The ratio of C16:0/C16:1 in yolk from group B, C, D, E, and F increased about 2, 2.5, 3, 3.5, or 3.5-fold compared to the ratio of C18:0/C18:1 in yolk from group A, B, C, D, E, and F was .28, .4, .48, .49, .69, and .83, respectively. Diet F, E, and D caused 100 % embryonic mortality after the 6, 10, or 12 days of feeding, respectively, whereas % hatch in group A, B, C was 66, 83, 50, respectively. Diet B increased egg size, but diet E and diet F significantly reduced the egg size when compared to control (p < .05). Dietary CLA had no effect on heart, testicle, oviduct and body weight. Liver as a percent of body weight from both male and female quail increased significantly in all CLA fed groups, except group B, compared to control (p < .01). These results suggested that dietary CLA has significant impact on fatty acid metabolism which results in increased yolk saturated fatty acids.

Key Words: Dietary CLA, Egg yolk, Fatty acids, Hatchability, Quail
Effect of different soybean meals and Avizyme® on growth performance and ileal digestible energy in chicks. M. W. Douglas1 and C. M. Parsons1, University of Illinois, Urbana, Illinois, USA.

Twelve soybean meals (SBM), obtained from commercial processing plants in the U.S. and foreign countries, were evaluated with and without the addition of Avizyme®. The analyzed values (%) of selected nutrients (mean and range) in the SBM were: CP: 45 (40 to 49); dry matter, 88 (87 to 89); lysine, 2.9 (2.57 to 3.27); methionine, 0.6 (0.60 to 0.75); cysteine, 0.6 (0.60 to 0.76); KOH protein solubility (%) in the SBM (mean and range) was 77 (71 to 83). In four chick assays, six groups of five one-week-old male commercial broiler chicks were fed from 8 to 21 d of age a corn-SBM reference diet or diets containing 37% of a test SBM. The control SBM reference diet was the same in all chick assay. Lawns of all ingredients except DL-Met were kept constant in all diets. Thus, diets were formulated to contain 3200 kcal TME/kg, 0.90% Met + Cys and at least 1.10% Lys based on amino acid analysis of the SBM. The CP level was allowed to vary among diets. Growth performance of chicks and ileal digestible energy of corn-SBM diets with and without the addition of Avizyme® were standardized among chick assays by dividing the mean parameter for the corn-SBM reference diet for all four chick assays by the respective value. This factor was then multiplied by the individual treatment value for each chick assay to obtain the standardized value. Growth performance and ileal digestible energy (DE) for chicks were affected by SBM source (P < 0.01). Addition of Avizyme® had no effect (P > 0.10) on chick performance but significantly increased ileal DE (P < 0.01). There was a significant interaction (P < 0.01) between SBM source and Avizyme®, for ileal DE, indicating that Avizyme® increased ileal DE more in some SBM than in others. Results of this study indicate that chick growth performance was greatly influenced by SBM source and that both SBM source and Avizyme® impacted ileal DE.

Key Words: Chicks, Soybean meal, Growth performance, Ileal digestible energy, Avizyme®


A multiple objective programming (MOP) model was applied to the feed formulation process. A conventional linear programming allows for only one objective. The MOP allows for several objectives. The model was constructed for a 0-3 week broiler ration as an example. The ration was formulated with a Microsoft EXCEL solver. There were 21 ingredients and 17 nutrients included in the process. Amino acids were based on digestible values. The following objectives were considered: (1) meeting the nutrient requirements; (2) meeting the ingredient restrictions; (3) meeting nutrient ratios including calcium to phosphorus and the ratio of amino acids to lysine (ideal amino acid ratios); (4) least cost ration; (5) minimal nutrient variances for protein, methionine and lysine. The only constraint was that the ingredient sum to unity. It was found that: (1) the MOP model gives more detailed information for cases of infeasible rations when compared to conventional least cost feed formulation; (2) the MOP model can handle several conflicting objectives simultaneously, where conventional least cost feed formulation can only solve for single objective; (3) the MOP model gives a best compromise solution that will satisfy multiple decision makers when trade-offs were made between ration cost and minimum variances of nutrients (e.g., protein, lysine, and methionine). The MOP model is assists in the decision making process through the interaction of the decision makers and the solution of a series of linear/nonlinear programs.

Key Words: Feed Formulation, Multiple Objective Programming, Nutrient Variance

Prediction of the effect of an enzyme on the chick performance when added to a cereal-based diet: use of a log-linear model equation. Z. Zhang*, R. R. Marquardt, and W. Guenter, University of Manitoba, Winnipeg, Manitoba, Canada.

In a previous study it was shown that a relatively simple equation could be used to predict the relationship between the amount of a crude enzyme added to a diet and chick performance. The objectives of the current study was to determine if a modification of the original equation would overcome some of its limitations. Specific objectives were to determine if the prediction equation was accurate when different cereals were used and to test the equation using a computer program. The modified equation that was developed was W = A + B log (CX + 1), where W is the estimated performance value [i.e. weight gain (g)]; A is the intercept (y-axis) which represents the performance under enzyme supplementation; B, the slope of the equation (performance change per log unit of an enzyme in the diet), is a measure of the efficacy of an enzyme preparation; C is an amplified factor; and X is the amount of enzyme in the diet. The results from several feeding trials demonstrated that the new model more accurately predicted chick performance than that of the original equation with correlations (r) between chick performance and amount of different enzymes added to the diet ranging from r = 0.80 to 0.99 (P < 0.05 to 0.001). The same trends were obtained when the model was used to assess the efficacy of a given enzyme added to corn-, wheat-, barley-, and rye-based diets, or for combinations of two dietary components (rye and wheat). The model proposed in this study provides a means of assessing the overall efficacy of an enzyme preparation. It can also be utilized in conjunction with a least-cost computer program to provide information on the most economical combinations of cereals and amount of enzymes that should be used in the diet. This model could be routinely used by enzyme and livestock producers to establish the best combination of different cereals and enzymes so as to maximize net returns.

Key Words: Prediction, Efficacy, Enzymes, Poultry

A simple dietary viscosity assay for evaluating the efficacy of enzyme preparations and predicting the performance of Leghorn chicks fed rye-based diets. Z. Zhang*, R. R. Marquardt, and W. Guenter, University of Manitoba, Winnipeg, Manitoba, Canada.

A study was carried out to determine if a simple dietary viscosity assay could be used to accurately evaluate the efficacy of an enzyme when added to a rye-containing poultry diet and to determine if its activity could be related to its ability to improve chick performance. The results indicated that there was a curvilinear relationship between the activity of enzyme (xylanase) added to the diet and log of the net viscosity change when tested in vitro. The sensitivity of the viscosity assay was high, as little as 0.19 units of xylanase per gram of diet could be detected. A feeding study was carried out to establish the relationship between chick performance and viscosity changes in a rye-based diet that contained different amounts of xylanase as determined by the new assay, and to evaluate the efficacy of two different dietary enzymes. There was a high correlation (r < 0.97, p < 0.01) between one week weight gain of chicks and the log of the amount of enzyme added to the diet or the log of its viscosity change (4 h) as determined by the in vitro viscosity assay. Further, all dose response data from both feeding studies and that obtained from the dietary extract viscosity assay fitted a modified model of a previously developed prediction equation. The study demonstrated that it was possible to accurately evaluate the efficacy of a xylanase preparation and estimate its ability to hydrolyse arabinoxylans in a rye diet using a newly developed viscosity assay. This assay when used with the model equation accurately predicted chick performance. This research should be of interest enzyme and feed manufacturers and livestock producers.

Key Words: Viscosity assay, Xylanases, Efficacy, Chicks, Rye-based diet

Evaluation of prediction equations for metabolizable energy requirements for broiler breeder pullets. R. da Silva3, N. Kazue Sakomura*1, O. M. Mack Junqueira1, and K. Tomás de Resende1, 1Faculdade de Ciências Agrárias e Veterinárias - Jaboticabal - UNESP.

The objective of this study was to evaluate three prediction equations for metabolizable energy requirements for broiler breeder pullets from 5 to 20 weeks old. These equations were determined at University Estadual Paulista - Jaboticabal-SP, Brazil. 576 broiler breeder pullets (Hubbard-Yield) of 5 weeks old were randomized in 4 treatments, 6 repetitions and 24 birds per repetition. The treatments were: 1-Feeding according to the nutritional requirements; 2- Feeding according energy requirements provided by Equations 1: 5 to 8 weeks - ME = W0.75(186.52 - 1.94T) + 2.76G; 9 to 14 weeks - ME = W0.75(186.52 - 1.94T) + 2.76G; 15 to 20 weeks - ME = W0.75(186.52 - 1.94T) + 3.59G; 3- Equations 2: 5 to 8 weeks - ME = W0.75(174 - 1.88T) + 3.59G; 9 to 14 weeks - ME = W0.75(174 - 1.88T) + 3.59G; 15 to 20 weeks - ME = W0.75(174 - 1.88T) + 2.83G; 4- Equations 3: 5 to 8 weeks - ME = W0.75(174 - 1.88T) + 2.83G; 9 to 14 weeks - ME = W0.75(174 - 1.88T) + 2.95G; 15 to 20 weeks - ME = W0.75(174 - 1.88T) + 2.83G. The results showed that the prediction equations significantly underestimated the ME for broiler breeder pullets.
The temperature effect on ME\textsubscript{m} requirements it was possible to determine was conducted to compare chick growth performance with trypsin in-activated soyflakes were substituted in place of the commercial SBM supplied the sole source of dietary protein. Each of the eight dietary treatments was fed to four replicate groups of five New Hampshire laying hens. In order to determine the influence of the temperature treatments was accomplished in different climatic rooms at temperatures of 12, 22 and 31°C (±2°C). The comparative slaughtering technique was used to estimate energy retention and heat production at different levels of energy intake. The starvation heat productions were 100, 80 and 60 kcal/kg\textsuperscript{0.75}/day while ME\textsubscript{m} requirements were 138, 112 and 93 kcal/kg\textsuperscript{0.75}/day at temperatures of 12, 22 and 31°C, respectively. By the temperature effect on ME\textsubscript{m} requirements it was possible to determine a linear relation: ME\textsubscript{m} = W\textsuperscript{0.75} (165.7 - 2.37T) \times 10\textsuperscript{7} where W is the body weight (kg) and T the environment temperature (°C). The ME\textsubscript{m} requirement for weight gain and egg production were determined by the body energy content, egg energy content and their energetic efficiencies. The results indicate 6.68 kcal/g and 2.4 kcal/g for weight gain and egg production, respectively. By considering our experimental results we have elaborated a prediction equation for daily ME\textsubscript{m} requirements as: ME\textsubscript{m} = W\textsuperscript{0.75} (165.7 - 2.37T) + 6.68G + 2.4E, where G is the weight gain (grams) and E is the egg mass (grams).

Key Words: metabolizable energy requirements, laying hens, prediction equation


Protein dispersibility index (PDI) was evaluated as an indicator of minimum adequate heat processing of soybean meal (SBM). An experiment was conducted to compare chick growth performance with trypsin inactivator level, urease activity, orange-G binding capacity, protein solubility in 0.2% KOH, and PDI. Solvent-extracted soyflakes were obtained from a commercial soybean plant (postexander) but prior to desolventized-toaster, and autoclaved (covered) at 121 C and 105 kPa for 0, 6, 12, 18, 24, 30, or 36 min. A dextrose-SBM diet was formulated to meet or exceed the NRC (1994) nutrient recommendations. The autoclaved soyflakes were substituted in place of the commercial SBM to supply the sole source of dietary protein. Each of the eight dietary treatments was fed to four replicate groups of five New Hampshire × Colombian chicks from 8 to 17 days posthatching. Body weight gains and gain to feed ratios increased incrementally (P < 0.05) when chicks were fed the soyflakes autoclaved for 0 to 18 min, but no additional improvement was observed with longer heating times. Trypsin inhibitor also decreased incrementally from 44 to 12 units/mg as autoclaving times increased from 0 to 18 min and further decreased to 2.6 units/mg at 36 min. In contrast, urease pH rise and KOH protein solubility remained high and relatively constant during the 0 to 18 min autoclaving times (1.8 to 2.4 pH units and 94 to 97%, respectively) and decreased at 24 min. The capacity of the soyflakes to bind orange-G decreased only slightly and inconsistently with heat treatment. PDI displayed greater sensitivity to heating time than the soyflakes were autoclaved from 0 to 18 min, PDI decreased incrementally from 76 to 47% and then decreased further to 24% by 36 min of autoclaving. These results indicate that PDI may be a more precise and sensitive indicator of minimum adequate heat processing of SBM than the urease, KOH protein solubility, or orange-G binding assays.

Key Words: Soybean meal, Protein dispersibility index, Urease

341 Influence of Dietary Calcium and Magnesium Contents on the Magnesium Deposition Models in Eggshells of Brown Tsaiya Duck and White Leghorn Hen. W. L. Chen and T. F. Shen*. National Taiwan University, Taipei, Taiwan.

Eggshells of Brown Tsaiya duck were stronger and thicker than White Leghorn hen, but magnesium content of duck eggshell was only 25%-30% of those in hen. Magnesium deposition models in eggshells between duck and hen were compared to investigate the effect of magnesium on the eggshell quality. Birds were fed four experimental diets, including (1) normal (Ca 3.42%, Mg 1984 ppm), (2) low-Ca (Ca 1.7%, Mg 1917 ppm), (3) low-Mg (Ca 3.40%, Mg 138 ppm) and (4) low-Ca-high-Mg (Ca 1.23%, Mg 5943 ppm), for 15 days. Magnesium concentration in uterine fluid at various stages of eggshell formation in both birds fed normal diet were also determined. Magnesium contents of chicken eggshell were 3.9, 4.7, 1.6 and 5.2 times higher than duck eggshell, respectively. Magnesium distribution appeared two peaks in chicken eggshell, one in the inner layer and the other at the outer surface of the eggshell, except low-Mg treatment which had only one peak in the inner layer. However, there was only one peak in the inner layer for duck eggshell. Hens given low-Ca or low-Ca-high-Mg diets resulted in higher magnesium content in eggshell and thinner eggshell, but those of ducks were not influenced by any experimental diet. There was a negative correlation between magnesium content of eggshell and eggshell thickness (r = -0.485 and P < 0.05 for hen; r = -0.523 and P < 0.05 for duck). It is interesting to find that the changes in magnesium concentration in uterine fluid during eggshell formation were greatly corresponded with the deposition models in eggshell of duck or hen. These results indicated that the magnesium deposition models in eggshells between duck and hen were different and magnesium may have adversely affect on the eggshell quality.

Key Words: Eggshell, Magnesium, Deposition, Brown Tsaiya duck, Leghorn hen


In previous trials, mannan oligosaccharide (MOS) has been shown to increase weight gain and improve feed conversion in poultry. Most of the studies of the microflora in chickens have looked at the protective effect of orally administered cecal cultures or MOS against a Salmonella challenge. The objective of this trial was to evaluate the effect of MOS (Bio-Mos™, Alltech, Inc.) and bacitracin methylene disalycylate (BMD) on the concentration of specific bacterial populations in the intestinal tract of growing turkeys. Turkeys were grown at Virginia Scientific Research, Inc. and the basic diet was formulated to meet NRC requirements. The treatments consisted of: 1) negative control (no antibiotic growth promoter, no MOS) 2) MOS (1 kg/T first three weeks, 0.5kg/T thereafter) 3) BMD (55g/T first three weeks, 27.5g/T thereafter) 4) BMD and MOS. During the sixth and eighteenth weeks of age the birds were sacrificed, the intestinal tracts removed and frozen in glycerin-salt solution. The bacterial groups cultured and quantified log\textsubscript{10} CFU/gram were coliforms, E. coli, Lactobacilli, Bifidobacteria, total anaerobes, Streptococci, Clostridium perfringens. Enrichment cultures for the detection of Salmonella was also performed, with negative results obtained in all birds examined. RESULTS: The only significant differences in microflora were found in the younger birds (six weeks of age). The MOS treatment group had a higher total anaerobe count (P < 0.05) (8.61 vs 7.92 log\textsubscript{10} CFU/gram) and a lower level of Clostridium perfringens than the control group (P < 0.05) (2.98 vs 4.22 log\textsubscript{10} CFU/gram). Clostridium perfringens has been implicated as an agent in necrotic enteritis in young poultry. MOS may be useful in maintaining a healthier balance in the microflora in young turkeys.

Key Words: Mannan oligosaccharide, Gut microflora, Turkey, Anaerobe, Clostridium perfringens
Modern broilers are fed up to five standard feeds, depending on breed, age, sex, and desired final body weight and conversion. Feed constitutes 55-65% of total production cost. Thus, savings on feed are significant to the grower. The objective of this study was to evaluate the effect of concurrently feeding nutritionally distinct feeds to male and female broilers to 42 days of age. A total of 720 one-day-old Pet X Arbor Acre broiler chicks were sexed and randomly assigned to twelve experimental floor pens containing 3 treatments with 4 replicates in a complete block design. Treatments consisted of ad libitum feeding of 1) standard feed as control (C), 2) low-density feed plus C (LC), and 3) low-density feed (L). L and C feeds were provided in separate tubular feeders when fed concurrently. All birds were individually weighed on days 1, 7, 14, 21, 28, 35, and 42 d of age. Feed conversions, mortality level, European Performance Efficiency Factor (EPEF) and the cost to produce a kg of meat were determined. LC body weights were slightly lower vs. C (2005 vs. 2014 grams) and 33 grams heavier vs. L (2005 vs. 1972 grams). Feed conversion and EPEF were improved in the LC treatment group. Production costs were increased by 2.57 cents per kg of meat when LC was fed. FC led broilers tended to consume the low-density feed during the day when ambient temperatures were higher and the control feed at night. Mortality was reduced when LC and L diets were fed. In conclusion, feeding two feeds concurrently to broilers reduced cost and mortality level, without adversely affecting production parameters.

**Key Words:** Broilers, Concurrent feeding, Conversion, Cost, Low-density

### 344 Effect Of Mash, Crumble And Pellet Feeds On Broiler Performance Parameters And Cost Of Production

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Rapidly growing broilers require high quality, balanced feeds. The feed texture, Mash (M), Crumble (C) and Pellet (P), also affects performance, depending on sex and age. A total of 1548 day of age (DOA) Pet X AA sexable broiler chicks were randomly divided into 36 treatments of 6 pens each. Each treatment consisted of 258 chicks, divided into 3 replicates of 83 male and 43 female chicks. Treatment groups were fed starter (0-20 DOA), grower (21-33 DOA) and finisher (34-42 DOA) diets. Diets were designated as CCP, MFM, MCM, CCP, and CMP, respectively. All birds were individually weighed on arrival and at 1, 7, 14, 21, 28, 35 and 42 DOA. Feed conversions, European Performance Efficiency Factor (EPEF) and the cost to produce a pound of meat were determined. The lowest production cost was obtained when fed MCP, followed by MFM and MMP. The most costly was the CPP regimen. Females fed MCP and males fed CPP had the heaviest body weights and best EPEF. Females were less affected when one mash feed was included. The combined lowest male and female feed conversion was obtained when the MCP regimen was utilized, and the highest feeding MFM. Body weights and conversions were consistently improved when crumble and pellets were utilized. However, due to high pelleting costs, the best economic performance parameters was obtained when MCP was fed, followed by MMM and MMP combinations. It was demonstrated that mash feeds can be included in broiler diets, especially to females to reduce production cost.

**Key Words:** Mash, Crumble, Pellet, Broiler, Production cost

### 345 Liver glycogen in birds: an enigma or the chicken is not a feathered mammal.

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Understanding the regulation of liver glycogen in birds requires the acceptance of certain conundrums. For example, insulin has no apparent effect on liver glycogen in birds, but has been strongly implicated in the regulation of glycogen synthesis in mammals subjected to periods of fasting-refeeding. Although birds display the classic rebound in liver glycogen following fasting, there is no high Km glucokinase in avian liver as in mammalian liver. Therefore, direct phosphorylation of plasma glucose does not appear to be a major pathway for providing substrates for glycogen synthesis. Virtually all the dietary glucose is converted to either alanine or lactate by the avian small intestine. Thus, nearly all the hepatic glycogen in birds must result from the "indirect" pathway described by Katz and others. This pathway requires carbon fragments to first traverse the step catalyzed by phosphoenolpyruvate carboxykinase (PEPCK) in gluconeogenesis. In vitro, the role of this pathway in glycogen synthesis can be validated by the PEPCK inhibitor, mercapto picolinic acid that depresses glycogen synthesis. Several experiments were conducted to determine the role of nutritional and hormonal regimens in glycogen synthesis. These experiments included chronic and acute bouts of fasting-refeeding ± T₃, different protein levels ± T₃ and thyroid hormone attenuation-replenishment. Switching birds from a control diet to diets containing either lower or higher protein levels resulted in greater or lesser levels of liver glycogen, respectively. Adding T₃ to diets decreased liver glycogen levels. The opposite was noted when methimazole was included in diets. Dietary T₃ during a replenishment period overcome some of the effects of prior methimazole treatments. These observations tend to support the tenet that hormonal regulation of hepatic glycogen probably involves permutations in the thyroid axis. Switching birds from a high to a low level of dietary crude protein produced about the same level of liver glycogen as did fasting-refeeding. The latter regimen changes the relative liver size such that total liver glycogen is increased on a relative body size basis. It is probable that liver glycogen in birds is regulated by alterations in the rate of degradation rather than by changes in synthesis as is the situation in mammals.

**Key Words:** Glycogen, Chickens, Regulation

### 346 The effect of diet dilution with lactose on the performance of turkeys.

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An experiment involving 96 turkeys was carried out in the conventional battery system cages. The purpose of this experiment was to determine the effect of lactose on the performance of turkeys and how this effect is brought about and also the optimum level of inclusion in the diet. The birds were housed two per cage from day old to six weeks old. Diets containing different levels of lactose and water were offered ad libitum for the duration of the trial. The highest weight gains were recorded in the birds on the 4% lactose diet. There was a significant difference (p < 0.01) in weight gain between the birds on the 4% and those on the 0% lactose diet (control). The other diets followed in the following order: 2%, 1%, 0.5%, 8% and 0% lactose. As lactose was increased from 1% to 4%, the feed efficiency decreased. All the birds on lactose diets were more feed efficient when compared to the control. The feed intake followed a normal distribution in following order: 0.5%, 1%, 2%, 4%, 8% and 0% lactose with the peak occurring at the 4% lactose diet. Lactose does improve Growth Rate and Feed Efficiency of turkeys when fed up to the 4% inclusion level. Beyond 4%, there is a decline in performance.

**Key Words:** Lactose, Feed efficiency, Growth rate, Feed intake, Turkeys

### 347 Ascorbic acid biosynthesis in fast and slow growing meat type chickens fed exogenous ascorbic acid.

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Poultry have the ability to synthesize ascorbic acid and do not normally require an exogenous source. A beneficial response has been reported under specific conditions but the results in general are inconsistent. Information on biosynthesis is limited and we have reported that itgradually declines with age and by food deprivation for 48 or more hours. The present study determined ascorbic acid biosynthesis in slow growing (SG)/Ottawa Strain K) and fast growing (FG) [Petersen x Hubbard] meat type chickens at 2 and 9 wk. of age after consumption of diets with and without 1000 mg/kg ascorbic acid for 1 and 9 weeks respectively. The activity of L-gulonolactone oxidase (GLO) [EC 1.1.3.8], with L-gulonolactone as substrate, was used to measure biosynthesis. A significant diet x strain interaction was not detected. In one week, dietary ascorbic acid at 1000 mg/kg increased plasma ascorbic concentration by 45% and reduced renal GLO activity by 5%. Estimated daily biosynthesis was 8% lower in FG than in SG birds and synthesis was reduced 11% by dietary ascorbic acid. The effect of dietary supplementation was more pronounced at 9 wk. of age. Activity expressed on a unit weight of kidney decreased by 25% as a result of supplementation. Strain and diet
348 Dietary phylloquinone (K1) requirement of young turkey poults. S. Jin* and J. L. Sell, Iowa State University, Ames, Iowa, USA.

In a preliminary experiment (Exp.), the inclusion of phylloquinone (K1) at a dietary level of 0.5 mg/kg was as effective as 1 or 2 mg K1/kg in reducing plasma prothrombin time (PT). A plasma K1 level of 0.211 nmol/l was not enough to maintain normal PT. To obtain an estimate of dietary K1 requirement of pouls four additional Exps. were conducted. In Exp. 1, a 2x3 factorial arrangement was used with two levels of neomycin (0 or 75 mg/L) in water and three levels of K1 (0.01 or 0.5 mg/kg) in diets. Each treatment was fed to two pens with eight pouls per pen, and individual pouls were used as experimental units for the determination of PT and prothrombin concentration (PC) in plasma. PT and PC in plasma were not influenced by neomycin. However, PT was reduced to a nadir and PC in plasma increased to a plateau when diets contained 0.1 mg of K1/kg. In Exp. 2, dietary treatments were comprised of K1 concentrations of 0.1, 0.45, 1.0 or 2.0 mg/kg. Dietary K1 levels tested in Exp. 3 were 0.08, 0.31 or 0.44 mg/kg and 0.1, 0.25, 0.5 or 2.0 mg/kg in Exp. 4. A similar protocol as that of Exp.1 was used in these three Exps. The results of Exp. 2 showed that PT was at its lowest when the diet contained 0.5 mg K1/kg and that a plasma phylloquinone level above 0.339 nmol/L was enough to support normal PT. The results of Exp. 3 indicated that the dietary K1 requirement was 0.079 mg/kg on the basis of PT. The K1 requirement was estimated, on the basis of PT and PC, to be 0.099 and 0.13 mg/kg, respectively in Exp. 4. Results of this research show that dietary K1 requirement of young turkeys is in the range of 0.079 to 0.1 mg/kg., and ingestion of neomycin did not affect estimates of the requirement. The break point between deficiency and adequate of K1 in plasma for maintaining normal PT was in the range between 0.211 to 0.339 nmol/L.

Key Words: Phylloquinone, Prothrombin time, Prothrombin concentration, K1 requirement, Turkey

349 Laying hen performance as affected by diets containing shark cartilage or chitosan. M. Fuentes*, J. Zapata, E. Freitas, C. Nogueira, and C. Aguiar, Universidade Federal do Ceará, Fortaleza, CE, Brazil.

Chondroitin-6-sulfate, a proteoglycan predominantly in shark cartilage (SC) has been reported to suppress cholesterol deposition in the aorta of rabbits fed cholesterol supplemented diets by decreasing plasma low-density lipoprotein cholesterol. Chitosan (CH), another marine product, has a potent hypcholesterolemic effect by excreting bile acids outside the intestinal tract following an oral ingestion, decreasing therefore the cholesterol pool in the body. This study was conducted to determine the effect of diets supplemented with shark cartilage or chitosan on laying hen performance. 80 laying hens with 28 weeks of age allotted in individual cages were fed for eight weeks. The experimental design followed a randomized block design with five treatments and four replications of four birds each. An isoprotein (17%) and isocaloric (2,800 kcal ME/kg) diet based on corn and soybean meal was formulated as basal diet (BD). Treatments were: T1 = BD; T2 = BD + 2% SC; T3 = BD + 3% SC; T4 = BD + 2% CH and T5 = BD + 3% CH. Hen day egg production, daily egg mass (g/bird/day), feed intake (g), feed conversion (kg feed/kg egg), egg weight (g) and bird weight variation (g) were measured every other week (14 day intervals). Supplementation treatments did not significantly affect any of the studied variables. It is concluded that shark cartilage and chitosan used as feed supplements up to 3% in the diet do not influence the general performance of laying hens.

Key Words: Shark cartilage, Chitosan, Egg mass, Feed intake, Feed conversion

350 The effect of shark cartilage and chitosan added to hen diets on egg yolk and plasma lipids. C. Nogueira, J. Zapata*, M. Fuentes, E. Freitas, and C. Aguiar, Universidade Federal do Ceará, Fortaleza, CE, Brazil.

Egg cholesterol content is a current dietary concern due to its relation to coronary diseases. Shark cartilage and chitosan are marine products with some potential benefits on plasma lipids and other lipids metabolism and have an effect on egg yolk lipids after inclusion in layers diet. The objective of this study was to evaluate the effect of the addition of shark cartilage (SC) or chitosan (CH) to laying hen diets on egg, white, yolk and shell weights, yolk cholesterol and fatty acids and hen plasma cholesterol and triglycerides. The experiment utilized 80 laying hens with 28 weeks of age. Treatments were: T1 = basal diet (BD); T2 = BD + 2% SC; T3 = BD + 3% SC; T4 = BD + 2% CH; T5 = BD + 3% CH. Egg analysis were performed with 14, 28, 42 and 56 days of experiment. On day 14 egg weight from birds in treatments containing CH (T4 and T5) was significantly lower that than from birds fed the basal diet (T1). Also, with 14 days of experiment cholesterol levels were significantly higher in eggs from treatments with SC (T3) and CH (T4 and T5) than in those from birds under the basal diet (T1). Furthermore, egg yolk from birds fed the SC diets (T2 and T3) and the CH diets (T4 and T5) were significantly higher in palmitic and stearic acids and lower in oleic acid than those from birds in the basal diet (T1). On day 56, however, yolk cholesterol from birds in diets with CH (T4 and T5) were significantly lower than that from birds fed the BD (T1). Also, with 14 days of experiment cholesterol levels were significantly higher in eggs from treatments with SC (T3) and CH (T4 and T5) than in those from birds under the basal diet (T1). Furthermore, egg yolk from birds fed the SC (T2 and T3) or the CH diets (T4 and T5) were significantly higher in palmitic and stearic acids and lower in oleic acid than those from birds under the basal diet (T1). Hen plasma lipids were not affected by the experimental diets. The progressive reduction of yolk cholesterol and saturated fatty acid levels observed in eggs from treatments T4 and T5 suggests that a significant decrease in these lipids could be achieved by increasing the level of CH in hen diet or by feeding the 3% CH diet for an extended period of time.

Key Words: Shark cartilage, Chitosan, Yolk cholesterol, Fatty acids, Plasma lipids