

in broilers fed the control diet. Within the alpha-beta TCR-expressing T cell population, the ratio of T helper cells (CD4+CD8-) to cytotoxic T cells (CD4-CD8+) was higher ( $P = 0.02$ ) in broilers fed the EC-DBCP diet compared to broilers fed the control diet. These changes in the proportions among TCR-defined T cells with DBCP supplementation were not observed in the thymus. Although these observations suggest

immunopotentiating effects of dietary supplementation with DBCP, the immunofunctional consequences of the observed shift in splenic T cell populations need to be examined.

**Key Words:** Lymphocyte, Broiler chickens, *E. coli*, *B. lactofermentum*, Lymphoid organs

## Nutrition

**41 In ovo feeding increases glycogen content in the liver and muscle size in broiler hatchlings.** Z. Uni\*<sup>1</sup> and P.R. Ferket<sup>2</sup>, <sup>1</sup>*Department of Animal Sciences, Faculty of Agricultural, Food and Environmental Quality Sciences, Hebrew University of Jerusalem, Israel*, <sup>2</sup>*Department of Poultry Science, College of Agriculture and Life Sciences, NCSU, Raleigh, NC 27695*.

The few days pre and post hatch are critical for the development of the broiler hatchlings. During this period, the bird utilizes their energy reserves to meet the high demands for glucose, which fuels hatchlings activities. The sources for glucose include glycogen, stored mainly in the liver, and muscle proteins and amino acids via gluconeogenesis. At day of hatch glycogen stores decrease substantially, and remain low until the newly hatched chick has full access to oxygen, necessary to mobilize and utilize body fat reserves, and its developing gut can digest and assimilate external dietary. When energy status is limited, hatchlings may lose weight, and the development of critical tissues is restricted. These limitations in early energy status may be alleviated by administering refined carbohydrates into the amnion (in ovo feeding) at 18 d of incubation. This hypothesis was tested by examining the effect of feeding broiler embryos (with 1 ml containing about 20% dextrin, 3% maltose and sucrose) and measuring liver glycogen and muscle size, from 3 d before hatch until 7 d post hatch. The in ovo feeding treatment increased body size at hatch through 7 days of age by 3% over controls, ( $P < .05$ ) liver glycogen content in embryos and hatchlings from in-ovo fed birds was significantly ( $P < .05$ ) higher than controls (13.62.7 mg/g vs 7.81.1 at 20 d of incubation, and 6.90.5 vs 4.80.5 at day of hatch). Moreover, relative breast muscle size (% of hatchling BW), was significantly ( $P < .05$ ) higher in the in ovo fed birds than controls (3.2% $\pm$ 0.1 vs 2.5% $\pm$ 0.08 on d 3 and 6.4% $\pm$ 0.3 vs 5.20.2 on d 7). The results indicate that in ovo feeding may improve the energy status of the hatchlings by increasing glycogen stores and preventing mobilization of muscle protein reserves for gluconeogenesis.

**Key Words:** Broilers, In ovo feeding, Liver glycogen, Breast muscle size

**42 The effect of in ovo feeding of carbohydrates and beta-methyl-beta hydroxybutyrate (HMB) on the development of the digestive tract.** E. Tako\*<sup>1</sup>, R.P. Ferket<sup>2</sup>, and Z. Uni<sup>1</sup>, <sup>1</sup>*Department of Animal Sciences, Agriculture Faculty, Hebrew University of Jerusalem Israel*, <sup>2</sup>*Department of Poultry Science, College of Agriculture and Life Sciences, NCSU, Raleigh, NC 27695-7608*.

Early function of the digestive tract is crucial for achieving the maximal growth and development of broilers. Studies showed that early feeding cause an acceleration of the intestine development during the first days of the chick's life. Therefore, in ovo feeding (inserting a nutrient solution into the amniotic fluid), might increase the digestive system development and enhance the growth of the chick. This research examined the effect of in ovo feeding solutions, which contains different amounts of carbohydrates and HMB, on the broiler embryos and chicks digestive system from d 18 of incubation until 4d posthatch. The following parameters were examined: 1) intestine epithelium morphological changes; 2) the ratio between yolk sac and embryo body weight; 3) brush border aminopeptidase (AP) and sucrase isomaltase (SI) activities and gene expression. The in ovo-fed birds exhibited greater villus surface area than controls (27<sup>2</sup> vs. 13<sup>2</sup> at d 20 of incubation and 500<sup>2</sup> vs 350<sup>2</sup> at 4 d posthatch,  $P < 0.05$ ) and greater yolk sac to BW ratio (36% vs 18% at d 20 of incubation and 13% vs 9% on hatch,  $P < 0.05$ ). Low SI and AP activities were observed at 18 d of incubation in both groups (0.07 mM glucose/g and 0.011 u/mg respectively, in the in ovo group; 0.05 mM glucose/g and 0.08 u/mg, respectively for the controls). SI and AP activities increased significantly at hatch, with the in ovo fed group exceeding the controls (0.23 mM glucose/g SI and 0.015 u/mg AP vs 0.20 mM glucose/g SI and 0.012 u/mg AP,  $P < 0.05$ ). SI and AP gene expression increased at 19 d of incubation in both groups, with the in ovo fed birds exhibiting higher expression than controls (13au SI and 0.35au AP vs 8au SI and

0.18au AP,  $P < 0.05$ ). In ovo feeding increases intestinal morphological development, brush border enzymes gene expression and activity.

**Key Words:** Broilers, In ovo feeding, Brush border enzymes

**43 The effects of In-Ovo feeding of protein and beta-methyl-beta-hydroxybutyrate (HMB) 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 27608*, <sup>2</sup>*Hebrew University of Jerusalem, Israel*.

In-ovo (IO) feeding, injecting dietary components into the amnion prior to internal pipping, may enhance early growth performance by altering glycogen status. Two experiments studied the effect of IO feeding protein and HMB on bodyweights, organ weights, total liver and pectoralis major muscle glycogen of poults. At 23 d of incubation, 100 eggs were each injected with 1.5 ml of a .4% saline solutions containing 4 nutritional treatments consisting of a factorial arrangement of two levels of protein (P) (0% or 18% egg albumen) and two levels of HMB (0% and .1%). All poults fed ad libitum within 24 hours after hatch. In exp. 1, all IO-fed poults (P, HMB, P-HMB) weighed significantly more than controls at hatch (6.1%, 3.4%, and 2.7%, respectively). P and P-HMB treated birds weighed significantly more than controls at 3 d (3.9% and 2.9%, respectively) and 7 d (3.9% and 7.1%, respectively). At hatch the pectoralis major muscle was larger in all IO-fed poults than controls. In comparison to controls pectoralis major (PM) muscle weight at 7 d was 7% and 5% greater among poults IO-fed HMB and P-HMB, respectively. At hatch, total liver glycogen in the P IO-fed poults was increased by 38% over the controls, total glycogen in PM muscle was 20.2% greater in HMB IO-fed poults than controls ( $P < .05$ ). At 7 d, total liver glycogen was not affected by IO feeding, but HMB increased total PM muscle glycogen by 12.3% over controls ( $P = .05$ ). In exp 2, total glycogen in PM muscle at hatch was improved by HMB IO-feeding ( $P = .05$ ). At 7d, all IO-fed poults had greater total glycogen in the PM muscle than the controls ( $P < 0.05$ ). These results imply that IO feeding of protein or HMB may improve glycogen status posthatch, which may enhance early growth and development of poults.

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

**44 Quantitative Computed Tomography as a tool for assessing bone quality in poultry.** J. Saunders-Blades\*, K. Nadeau, and D. Korver, *University of Alberta, Edmonton, Canada*.

Quantitative Computed Tomography (QCT) is used to measure bone density in humans, but its use in poultry research has not been validated. The present research was conducted to validate QCT as a tool for the determination of bone quality in poultry. In Experiment 1, breeder hens, accidentally fed a low Ca diet, were replenished with Ca, and subsequent QCT measurements at 7 regions of interest (ROI) along the length of the tibia, bone weight, bone ash, and ash and bone Ca were obtained on tibias at 0, 7 and 14 d after repletion. Most bone traits were affected by time ( $P < 0.05$ ). Bone weight ( $r^2$  of 0.08 to 0.34) and ash weight ( $r^2$  of 0.16 to 0.30) were linearly related with density ( $P < 0.05$ ) at all ROI. In Experiment 2, tibias from laying hens used in studying the effect of mid-night feeding on egg traits were examined for density by QCT at 7 ROI, ash and breaking strength. Treatment did not affect bone measurements ( $P > 0.05$ ). Ash weight ( $r^2$  of 0.14 to 0.29), % ash ( $r^2$  of 0.07 to 0.23), breaking strength ( $r^2$  of 0.20 to 0.66) and bone Ca ( $r^2$  of 0.07 to 0.23) were linearly related to bone density at the proximal end and middle of the bone ( $P < 0.05$ ). In Experiment 3, femurs from broilers fed varying dietary levels of vitamin D<sub>3</sub> or 25-OH vitamin D<sub>3</sub> were measured for density at the midpoint by QCT, breaking strength, bone ash and bone Ca at 42 d of age. Diet did not affect bone traits ( $P > 0.05$ ). Density

had a linear relationship ( $P < 0.05$ ) with breaking strength ( $r^2 = 0.48$ ). In Experiment 4, tibias from laying hens fed different Ca sources at different particle sizes were examined for density by QCT at the midpoint, bone breaking strength, bone ash and bone Ca. Density had a linear relationship ( $P < 0.05$ ) with bone ash ( $r^2 = 0.84$ ), % ash ( $r^2 = 0.04$ ) breaking strength ( $r^2 = 0.10$ ) and bone weight ( $r^2 = 0.20$ ). Bone density as measured by QCT, is linearly related to other common bone quality measurements used in poultry research. Although validated in excised bones, QCT has the potential to be used in live birds, allowing longitudinal tracking of bone density in individual birds.

**Key Words:** Quantitative Computed Tomography, Bone density, Breaking strength, Bone ash, Poultry

**45 Myonuclear apoptosis during early post-hatch starvation.** J. J. Evans<sup>\*1</sup>, S. Pophal<sup>1,2</sup>, and P. E. Mozdziak<sup>1</sup>, <sup>1</sup>North Carolina State University, <sup>2</sup>UFGRS (CAPES) - Brazil.

Any process, such as apoptosis, that decreases the number of pre-existing myonuclei, or a process that depresses myonuclear accretion is likely to reduce muscle growth. Recently, it has been shown that early post-hatch starvation in chickens results in a decrease in meat yield at market age. The objective of this study was to characterize myofiber size and myonuclear apoptosis during immediate post-hatch starvation. Male broiler chickens were either fed or starved for the 3 days immediately following hatching. Samples of the Pectoralis thoracicus were harvested from each group ( $n=5$ ), fixed, dehydrated, cleared and embedded in paraffin. Sections were processed using terminal deoxynucleotidyl transferase-mediated fluorescein-12-dUTP nick-end labeling (TUNEL) to identify apoptotic myonuclei (Promega, Madison WI catalog #G3250). All nuclei were counterstained with propidium iodide (PI). Images were collected using a CCD camera attached to an epi-fluorescence microscope, and they were analyzed for myofiber cross-sectional area, the number of PI labeled nuclei, and the number of TUNEL positive nuclei. An index of apoptotic labeling was calculated by expressing the number of TUNEL positive nuclei relative to the total number of nuclei. There was no significant difference in the labeling index or myofiber cross-sectional area between starved and fed chickens on days 1 or 2 post-hatch ( $P > 0.05$ ). However, there was a significant increase in the labeling index for starved chickens between 1 and 2 days post-hatch ( $P < 0.05$ ). Starved chickens on the third day post-hatch had a significantly higher apoptotic labeling index ( $P < 0.05$ ), and a significantly lower myofiber cross-sectional area ( $P < 0.05$ ) than fed chickens. Therefore, it appears that myonuclear apoptosis, during early post-hatch starvation, may have a significant effect on muscle growth.

**Key Words:** Skeletal muscle, Feed-deprivation, Apoptosis, TUNEL

**46 Applying urethral tubing method to replace colostomy for measuring amino acid digestibility in broilers.** H. S. Lee<sup>\*1</sup>, J. H. Choi<sup>2</sup>, J. Y. Youn<sup>2</sup>, H. S. Kim<sup>2</sup>, K. Y. Whang<sup>2</sup>, and K. M. Chee<sup>2</sup>, <sup>1</sup>American Soybean Association, Korea, <sup>2</sup>Korea University.

Broilers (Ross) with an average of 1.2 kg BW were divided into four groups to verify validity of applying a urethral tubing method for measuring amino acids digestibility of soybean meal. The groups consist of broilers intact, with cecal ligation, cecal ligation plus colostomy, and cecal ligation plus urethral tubing. For urethral tubing, PVC medical i.v. infusion set tubes with 3.75 mm outer diameter and 2.70 mm inner diameter were inserted into each urinary opening of broilers by about 2 cm in length to prevent urinary components from getting into intestine through cloaca. A PVC tube with 0.5 cm wide opening was attached to outer opening of the i.v. tube to induce urine out. Following 30 h of fasting, broilers were fed a volume of the soybean meal more than 2% of BW by force. Urethral tubing was set after feeding, and fecal samples were collected into plastic bag for 30 h. The fecal samples were then freeze-dried and analyzed for amino acids concentration. Intact broilers (93.3%) showed higher values in overall amino acids, except glycine, digestibility measurements than the broilers surgically treated ( $P < 0.05$ ) by 2.7-3.6% point. The digestibility of glycine from broilers intact (51.8%) and with cecal ligation (52.6%) were significantly lower than those (86.9 and 84.2%) of the other groups, indicating that the fecal samples were contaminated with urinary components. Overall digestibility values (89.7%) from broilers with cecal ligation plus urethral tubing appeared to be in good agreement with the data (90.6%) from broilers colostomized plus cecal ligation. This observations suggest that

urethral tubing was successfully conducted and can replace colostomy, introducing a simpler, less stressful to broilers and more convenient way to collect fecal samples without cecal and urinary contamination.

**Key Words:** Amino acid digestibility, Urethral tubing, Colostomy, Broiler

**47 Development of the indicator amino acid oxidation method in broiler chickens.** M. A. Leslie<sup>\*1</sup>, R. A. Coleman<sup>1</sup>, S. Moehn<sup>1</sup>, R. O. Ball<sup>1</sup>, and D. K. Korver<sup>1</sup>, <sup>1</sup>University of Alberta.

To use the Indicator Amino Acid Oxidation (IAAO) technique to determine amino acid requirements, the <sup>14</sup>C-phenylalanine (Phe) dose, period of adaptation to a new dietary amino acid level and bicarbonate retention factor must first be determined. In Experiment 1, the priming and hourly oral doses of <sup>14</sup>C-Phe required to result in rapid equilibration of Phe oxidation and low CV in % of <sup>14</sup>C-Phe dose oxidized was determined in birds 3-4 wk of age. Birds were fed a practical diet; oxidations were performed using combinations of priming (2, 3, and 4  $\mu$ Ci/kg BW) and half-hourly oral doses (2.5, 3.5, and 4.5  $\mu$ Ci/kg BW/h). A priming dose of 3  $\mu$ Ci/kg BW and an oral dose of 3.5  $\mu$ Ci/kg/hour were found to be optimal. In Experiment 2, the time required for 21-d old broiler chickens to metabolically adapt to diets of differing lysine concentrations was determined. Birds were fed a purified diet balanced for energy, nitrogen and essential amino acids, and containing lysine at either 1.056 or 0.480 g/100g. A priming dose of <sup>14</sup>C-Phe was given orally, followed by liquid purified diet with <sup>14</sup>C-Phe each half hour for 4 h. The CO<sub>2</sub> exhaled was collected and sampled at half hour intervals and analyzed for <sup>14</sup>C, and the % of <sup>14</sup>C-Phe dose oxidized was calculated. Oxidations were performed on day 0, the diets were changed and oxidations performed on days 1, 2, 3 and 7. One day was sufficient for the birds to adapt when the diet was changed from low to high lysine, and 2 days when changed from high to low lysine. In Experiment 3, the retention of orally dosed <sup>14</sup>C in body pools was determined at weekly intervals for broilers aged 0 to 28 d. Broiler chicks were fed a practical diet, and weekly weights were recorded. Each week, 4 birds were orally dosed with NaH<sup>14</sup>CO<sub>3</sub>, and the % dose retained was determined. The % dose retained was 45.0  $\pm$  5.9%, 30.0  $\pm$  4.2%, 49.9  $\pm$  2.5%, 52.9  $\pm$  2.5%, and 61.6  $\pm$  2.8% at 0, 7, 14, 21 and 28 d, respectively. The results obtained in these experiments will be used in future IAAO studies to efficiently and accurately determine amino acid requirements of broilers at different ages.

**Key Words:** Broiler chicken, Indicator amino acid oxidation, Bicarbonate retention, <sup>14</sup>C-Phenylalanine dose, Metabolic adaptation

**48 Tissue accumulation of positive and negative isomers of gossypol in broilers fed diets supplemented with gossypol acetic acid.** M. M. Lordelo<sup>\*1</sup>, A. J. Davis<sup>1</sup>, M. C. Calhoun<sup>2</sup>, and N. M. Dale<sup>1</sup>, <sup>1</sup>University of Georgia, <sup>2</sup>Texas A&M University.

Cottonseed meal can be used as a protein source for poultry diets, but concern over the presence of the toxic factor gossypol has limited its use. Gossypol is a polyphenolic compound that exists as two different isomers - positive and negative. A study was conducted to determine if gossypol would accumulate in the body tissues of broilers fed standard corn/soy diets supplemented with pure gossypol acetic acid, which contains a 50:50 ratio of the gossypol isomers. Cobb x Cobb day-old broilers were randomly divided into 30 pens of 4 birds each and raised in starter batteries from 0-3 weeks and grower batteries from 3-6 weeks. Gossypol was added at either 0, 100, 200, 300 or 400 mg/kg of the diet for the length of the experiment (6 replicate pens per treatment). Feed intake was monitored daily and body weights weekly. Plasma, liver, kidney, testis, heart and breast muscle samples were collected from all birds in half the replicate pens at 3 weeks of age and from the remaining replicates at 6 weeks of age. Tissue samples were pooled by pen for HPLC determination of gossypol isomers and total gossypol content. Feed consumption was reduced ( $P < 0.05$ ) at both 3 and 6 weeks in the groups receiving 300 and 400 mg/kg of gossypol. Weight gains were lower at 3 weeks for the birds fed 300 and 400 mg/kg gossypol and at 6 weeks for the 400 mg/kg treatment. Heart weight was reduced at 6 weeks in the birds fed the highest level of gossypol. At 3 weeks, the plasma, liver, kidney and heart concentrations of the (-) and (+) isomers and total gossypol increased linearly as the level of dietary gossypol increased. Interestingly, at 6 weeks of age, the levels of gossypol for these tissues were not different for the groups receiving 300 or 400 mg/kg gossypol supplements. From 3 to 6 weeks of age there was no increase in the levels of total gossypol in the heart, kidney

and plasma. The results suggest an existence of a maximum threshold for gossypol accumulation in body tissues of broilers.

**Key Words:** Gossypol, Broilers, Cottonseed meal

**49 Effects of diet essential amino acid formulation and delivery on manure nutrient content in broiler chickens.** L. R. Cooley\* and H. L. Classen, *University of Saskatchewan, Saskatoon, SK, Canada.*

Manure nutrient content, particularly N and P load, has important implications for environmental pollution and manure disposal. An experiment was conducted to study the effects of dietary essential amino acid (EAA) level and method of diet delivery on manure nutrient content. Utilizing a 4 X 2 factorial arrangement, iso-energetic diets of various EAA levels were fed in a three phase feeding program (starter, grower, finisher), or by blending diets daily to gradually reduce EAA content. Four wheat-soybean meal-based starter diets for the feeding programs contained 1.1, 1.2, 1.3, or 1.4% total lysine (Lys), while the Lys content of diets for subsequent phases (grower, finisher) was reduced by 0.1% per phase. Other EAA were maintained at a minimum ratio to diet lysine content. The experiment used 192 Ross 308 male chicks randomly assigned to battery cages, with six replications of four birds per treatment. Total fecal production per pen was determined daily from 7-41 d of age. Sub-samples from the daily fecal collections were pooled according to treatment into three periods, corresponding to age and feeding phase, and various analyses were performed to determine manure nutrient content. At a final average body weight of 2.70 kg for 1.1%, and 3.07 kg for 1.2, 1.3, and 1.4% starter Lys, both EAA level and feeding program significantly ( $P < 0.05$ ) affected the total g of N and P excreted per bird. EAA level also significantly affected the % of Mg, Na, K, S, Cu and the ppm of Cu and Mb. Total N and P excretion levels ranged from 68 to 88, and 16 to 18 g per bird, respectively. The blending feeding program significantly reduced total N excretion by 2 g per bird. Due to environmental concerns, both EAA content and method of nutrient delivery should be considered when formulating diets for broiler chickens.

**Key Words:** Environment, Nitrogen, Phosphorous, Broiler

**50 The energy cost of immune challenge.** A. Beker<sup>1</sup>, S. Yadalam\*<sup>1</sup>, M. Daskiran<sup>1</sup>, S. L. Vanhooser<sup>2</sup>, and R. G. Teeter<sup>1</sup>, <sup>1</sup>*Department of Animal Science, Oklahoma State University,* <sup>2</sup>*Oklahoma Animal Disease Diagnostic Laboratory, Oklahoma State University.*

Two trials were conducted to quantify energy costs of immune challenge. In the first trial, broilers were reared to 14 d and allocated to two groups (control vs. E. coli challenge) and three feeding levels (5, 9, and 13% of initial BW) in a factorial arrangement. Bird oxygen consumption, carbon dioxide production, and heat production were measured throughout the experiment. Body weight and body weight change were linearly affected by feeding level and indicated that maintenance energy requirements were 2.8% higher when broilers were challenged with E. coli. Oxygen and carbon dioxide consumption and production data were well correlated with both feeding and E. coli effects. During the second trial Cobb-500 pullets were vaccinated against Salmonella in two phases. In phase 1, pullets were limit fed (7.45 kg/100 birds/day) as recommended. During phase 2, pullets were limit fed 3.31, 4.97, and 6.63% of their initial BW. Water was offered for ad libitum consumption throughout. During phase 1, no treatment effects were noted for BW gain, and gain-to-feed ratio, as well as heat production. During phase 2, however, Salmonella injected pullets exhibited reduced BW gain, gain-to-feed ratio, and higher heat production compared to the control group. Increasing the level of feeding from 3.31 to 6.63% resulted in a linear increase in BW gain, gain-to-feed ratio, and heat production. Using regression analysis, it was estimated that salmonella injected pullets had increased ME need for body weight homeostasis by about 15% (441.7 kcal/kg vs. 517.0 kcal/kg). Increased HP and lower performance indicates a shift in energy balance by pullets to Salmonella immunization. It may be desirable to adjust pullet feed allowances during challenge periods to account for the increased maintenance energy need.

**Key Words:** Immune challenge, Energy, Growth

**51 The effects of feeding grains naturally-contaminated with *Fusarium* mycotoxins on performance and immunological status of laying hens.** S. R. Chowdhury\*, T. K. Smith, H. J. Boermans, H. V. L.N. Swamy, S. Sharif, and B. Woodward, *University of Guelph, Guelph, Ontario, Canada.*

A study was conducted to determine the effects of feeding grains naturally-contaminated with *Fusarium* mycotoxins to laying hens. One hundred and forty-four, 45-wk-old laying hens were fed: (1) control (2) contaminated grains (corn and wheat) (3) contaminated grains + 0.2% polymeric glucomannan mycotoxin adsorbent (GM) for 12 wks. Mycotoxins in the diets containing contaminated grains included deoxynivalenol, 15-acetyldeoxynivalenol, zearalenone and fusaric acid. The feeding of contaminated grains decreased feed consumption 0 - 4 weeks and increased feed consumption 4 - 8 weeks and 8 - 12 weeks compared to controls. Laying performance was also decreased after the feeding of contaminated diets 0 - 4 weeks, 4 - 8 and 8 - 12 weeks. The feeding of GM prevented these effects. Blood counts of B cells, T cells (CD3<sup>+</sup>), and heterophils were not affected by diet. Likewise, the percentage of B cells, CD3<sup>+</sup>, CD4<sup>+</sup> and CD8<sup>+</sup> T cells, the ratio of CD4<sup>+</sup> to CD8<sup>+</sup> T cells, and the ratio of heterophils to lymphocytes in peripheral blood were not affected by the contaminated diet. Finally, the delayed-type hypersensitivity (DTH) response to 1-chloro-2,4-dinitrobenzene (DNCEB) was also not affected by diet. Numerous indices of immune competence in the laying hen appear unaffected by diet containing combination of *Fusarium* mycotoxins at a level sufficient to impair several parameters of laying performance.

**Key Words:** Layer, *Fusarium* mycotoxins, T cells, B cells, DTH response

**52 In vivo antioxidant properties of vitamin E and chromium in cold-stressed Japanese quails.** N. Sahin<sup>1</sup>, K. Sahin\*<sup>2</sup>, M. Onderci<sup>1</sup>, M. Ozcelik<sup>1</sup>, and M. O. Smith<sup>3</sup>, <sup>1</sup>*Veterinary Control and Research Institute of Ministry of Agriculture,* <sup>2</sup>*Department of Animal Nutrition, Veterinary Faculty, University of Firat, 23119 Elazig, Turkey,* <sup>3</sup>*Department of Animal Science, The University of Tennessee, 2640 Morgan Circle, Knoxville, Tennessee.*

An experiment was conducted to determine if vitamin E (a-tocopherol acetate) and chromium (chromium picolinate, Cr Pic) supplementation attenuate the negative effects of cold stress on egg production, egg quality, serum metabolites, and antioxidant status in Japanese quails (*Coturnix coturnix japonica*). One hundred and fifty laying Japanese quails (50-d-old) were divided into 5 groups, 30 birds per group. The laying quails kept at 6 °C for 12 h /d (08:00 pm-08:00 am) were fed either a basal diet (low temperature-basal diet, CS group) or the basal diet supplemented with either 400 mg of Cr/ kg of diet (Cr group), 250 mg of a-tocopherol-acetate/kg of diet (Vit E group) or 400 mg of Cr plus 250 mg of a-tocopherol-acetate/kg of diet (Vit E + Cr group) while quails kept at 18 °C fed a basal diet (thermo-neutral-basal diet, TN group). Performance and egg quality were significantly reduced in CS group compared with TN group. Supplemental chromium and vitamin E significantly increased live weight change, egg production, and improved feed efficiency ( $P < 0.05$ ) in cold-stressed laying hens compared with group fed the basal diet at 6 °C. Egg production and egg weight were also greater ( $P < 0.05$ ) in each supplemental group compared with the CS group. However, a combination of vitamin E and chromium, rather than each separately, provided the greatest performance. Supplemental vitamin E and chromium also increased serum vitamin C and E but, decreased malondialdehyde (MDA) concentrations ( $P < 0.05$ ); the combination of vitamin E and chromium resulted in the highest levels of serum vitamin C and E within the cold-stressed quails. Results of the present study indicate that combined antioxidant supplements increased performance, egg quality and serum antioxidant levels while lowering MDA in cold-stressed quails.

**Key Words:** Cold stress, Vitamin E, Chromium, MDA, Quail

**53 Effect of citric acid administration in the drinking water on performance, ileal microbial counts and growth characteristics of broiler chickens.** J. Mahabadyani Nadaf\*, M. Reza Akbari, and H. Kermanshahi, *Ferdowsi University, Mashhad, Iran.*

This study was conducted to evaluate the effects of adding citric acid into drinking water, at the levels of 0.0, 0.1, 0.2, 0.3, and 0.4%, on performance, ileal microbial counts and growth characteristics of male broiler chickens. 300 day- old chicks (ROSS) were randomly housed to each of 25 floor pens. Each of the 5 treatments, was randomly assigned to five

replicate pens of 12 male chicks. There was only one diet in each growth period and all groups were fed the same free medicine corn-soy based diet formulated according to NRC requirements. At 14 and 28 days of age, one chicken from each replicate was weighed and killed by cervical dislocation. Ileal contents were collected to use for microbial evaluation. At 49 days of age, one bird from each pen was killed to weigh gastrointestinal tract, liver, pancreas and abdominal fat. The total number of aerobes and coliforms were enumerated by using plate count methods. Adding citric acid in drinking water did not significantly affect feed intake, gain and feed to gain ratio in any period of production. Also no significant difference was observed for liver, pancreas and body weight ( $p > 0.05$ ). However, treatment with citric acid at the levels of 0.1 and 0.2%, caused significant reduction in abdominal fat when compared with control birds ( $p \leq 0.05$ ). There was no significant difference among treatments in total aerobic and coliform numbers ( $p > 0.05$ ). Under the situations of this study, incorporation of citric acid into the drinking water could not affect the performance and ileal microbial counts of chickens, however it may reduce abdominal fat.

**Key Words:** Citric acid, Performance and ileal microflora, Broiler

**54 Effect of acetic acid administration in the drinking water on performance, growth characteristics, and ileal microflora of broiler chickens.** M. Reza Akbari\*, J. Mahabadyani Nadaf, and H. Kermanshahi, *Ferdowsi University, Mashhad, Iran.*

This trial was conducted to evaluate the effects of adding acetic acid (10% acid acetic-vinegar) into the drinking water on the performance and ileal

microorganisms of broiler chickens. In a completely randomized design with 5 treatments and 5 replicates, 300 day-old commercial mail broiler chicks (Ross) were divided into 25 groups, 12 chicks per group. Each of the five levels of acetic acid added to drinking water (0.0, 0.1, 0.2, 0.3, and 0.4%) was given to five replicates for a period of 21 days. All groups were fed a practical corn-soy based diet formulated according to NRC requirements. During the experiment, chickens were not fed any antibiotics or coccidiostats. The diet formulation for all groups was the same. At 14 and 28 days of age, one chicken of each replicate was weighed and killed by cervical dislocation. Ileal contents were collected and used for microbial evaluation. At 49 d of age, one bird from each pen was killed to weigh gastrointestinal tract, liver, pancreas and abdominal fat. The number of total aerobes and coliforms per gram of ileal contents were enumerated on the appropriate bacteriological media. There was no significant difference in feed intake, weight gain, feed to gain ratio, and the weights of body, gastrointestinal tract, abdominal fat, liver and pancreas ( $P > 0.05$ ). Also, the differences among treatments for total aerobic and coliform counts were not significant ( $P > 0.05$ ). Under the conditions of this study, addition of acetic acid as an organic acid into drinking water at the used levels, could not affect the performance and ileal microbial counts of chickens.

**Key Words:** Acetic acid, Performance and ileal microflora, Broiler

## Physiology

**55 Differences in skeletal muscle fibre growth in broiler and layer chickens: Association with myopathy?** V. E. Cooke\*<sup>1</sup>, S. Gilpin<sup>2</sup>, M. Mahon<sup>2</sup>, D. A. Sandercock<sup>1</sup>, and M. A. Mitchell<sup>1</sup>, <sup>1</sup>*Roslin Institute (Edinburgh), Midlothian, UK*, <sup>2</sup>*University of Manchester, Manchester, UK.*

Genetic selection for improved production traits in poultry may be associated with an increased incidence of spontaneous and stress induced myopathies. Increased muscle fibre diameter and reduced oxidative capacity of specific muscles may be linked with increased incidence of myopathology in broilers. This study compared the growth of skeletal muscles of differing fibre type composition in commercial broilers (B) and layers (L). In the latter, selection strategies have not focused upon increased muscle growth and altered conformation. 4 birds per line were weighed and euthanised at intervals between 4 and 22 weeks of age. Samples of *Pectoralis major* (*Pm*) (breast) and *Biceps femoris* (*Bf*) (thigh) muscles were frozen for cryostat sectioning and stained using histochemical techniques. The minimum fibre diameter (MFD) of 100 fibres was measured for each muscle sample. Qualitative analysis of fibre type composition demonstrated that in both lines and at all ages *Pm* consisted almost entirely of glycolytic fibres, whereas *Bf* had a large population of oxidative fibres. Body weight and mean MFD of both muscles increased with age ( $P \leq 0.05$ ) in both lines, and were greater in broilers at all ages ( $P \leq 0.05$ ). In B, mean MFD of *Pm* was greater than that of *Bf* at all ages ( $P \leq 0.05$ ) except for at 20 wks ( $P = 0.064$ ). In L there was no difference in mean MFD of the two muscles at any age. The larger muscle fibre diameters in B compared to L may reflect increased rates of hypertrophy in B from hatch or before. Previous studies in turkeys have demonstrated a threshold muscle fibre diameter, above which further hypertrophy is associated with an increased incidence of spontaneous myopathy. Genetic selection for increased breast meat yield in broilers may have caused the divergence in *Pm* and *Bf* fibre size and the commercially desirable high degree of muscle fibre hypertrophy may be associated with a predisposition towards spontaneous or idiopathic myopathy.

**Key Words:** Broiler, Muscle fibre growth, Myopathy

**56 Enhanced growth and muscle development of broilers by in-ovo photostimulation of green light.** I. Rozenboim\*, Y. Piestun, and O. Halevy, *Hebrew University of Jerusalem.*

Posthatch green monochromatic photostimulation enhanced body weight and muscle growth of broilers. The effects were observed already after 3 days of illumination, suggesting that photostimulation during embryogenesis may cause the same phenomenon. In experiment 1, the effect of

green light photostimulation on embryo development was studied. 250 fertile eggs were divided into 2 groups. Groups were placed in a commercial incubator. The first group was illuminated from the fifth day until hatch by LED green light (560nm, half band 15nm, intensity of 0.1 W/m<sup>2</sup> at egg shell level). The second group was incubated under dark conditions and served as control. Green light significantly increased embryo weight at days 14, 15, 17 and 20 of incubation. The percentage of breast muscle was significantly higher in the illuminated embryos on days 11 and 13, and from day 17 to hatch. Experiment 2 tested posthatch growth and muscle development of broilers in ovo photostimulated by green light, and the proliferation and differentiation of skeletal muscle satellite cells were tested. 60 fertile eggs were divided into 2 groups and treated as in experiment 1. Body weight was recorded at days 0, 1, 3 and 6 of age. Significant increase in body weight and percent of breast muscle was observed in birds photostimulated in ovo by green light. Satellite cells were separated from the breast muscle at various days posthatch. The number of satellite cells/gram of muscle was significantly higher in the illuminated group compared to the control on days 0, 1 and 3 posthatch. Myogenin levels were higher in the illuminated group on day 1 and 3 posthatch, suggesting that cell differentiation in the illuminated group began earlier than in controls. Indeed, the muscle tissue levels of IGF-I, which plays a pivotal role in muscle cell proliferation and differentiation, were two fold higher in the illuminated group related to those in the control group on day 3. Taken together, we suggest that embryonic green light illumination enhances body and muscle weight of embryos and chicks at early days posthatch. Satellite cell proliferation and differentiation are affected probably due to the local increase in IGF-I levels during the short-time period posthatch in which new muscle fibers are added.

**Key Words:** Broiler, Photostimulation, Muscle, Satellite cell

**57 The involvement of erythropoiesis in the development of ascites in broiler chickens - the role of corticosterone and triiodothyronine.** D. Luger and S. Yahav\*, *ARO The Volcani Center, Bet Dagan, Israel.*

Significant development in the genetic selection of broiler chickens, coupled with inferior response of the cardiovascular system, has led to a relatively low capacity to balance energy expenditure under cold conditions, resulted in ascites syndrome development. The present study examined a. the association between the blood system and the accumulated fluid in the abdominal cavity. b. The efficacy of erythropoiesis process in relation to corticosterone and triiodothyronine (T<sub>3</sub>) (inducers of pluripotent stem cells proliferation and erythroblast differentiation, respectively)