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The current studies were undertaken to assess the ability of humoral immune response in breeding hens and the protective immunity provided by administration of purified *Salmonella gallinarum* (SG) porins to the progeny. Two hundred and ten broiler breeder hens, 53 weeks old, were divided into three groups and subcutaneously immunized via multiple sites at 0 and 10 days with either: a) 10 µg SG porins; b) 30 µg of SG porins; or c) control, inoculated with phosphate buffer solution (PBS) without porins. Seven days after the second immunization, the levels of SG-specific antibodies were determined in the serum and fertile eggs collected from hens using an enzyme linked immunosorbent assay. Furthermore, fertile eggs were collected again from hens in all treatments and incubated for 21 days. On day of hatch, chicks were placed in groups of 30 birds per group and gavaged with 20, 100 and 500 LD₅₀ % of SG. Results indicated that purified SG porins induced the production of IgY class antibodies detected in the serum and eggs of SG porin-immunized hens ($P < 0.05$). In addition, SG porins cross-reacted with porins of *Salmonella typhi*. Compared to control unimmunized hens, the progeny of immunized hens were protected by 53 to 70% fold against challenges of 20 – 500 LD₅₀ % of SG ($P < 0.001$). These results suggest that porins of SG as well as those of other *Salmonella* species participate in the induction of protective immunity, and modulation of humoral immune response is one of the mechanisms involved.

Key Words: *Salmonella gallinarum*, porins, immunity, chickens

42 Effect of dietary *Cinnamomum cassia* and *Curcuma longa* on *Eimeria tenella* infection in broiler chickens. S-H. Lee*¹, S. Jang¹, D. Kim¹, M. Park¹, C. Ionescu², D. Bravo², and H. Lillehoj¹, ¹Animal and Natural Resources Institute, Agricultural Research Service-U.S. Department of Agriculture, Beltsville, MD, ²Pancosma S.A., Geneva, Switzerland.

The protective effect of dietary cinnamaldehyde (*Cinnamomum cassia*) and turmeric (*Curcuma longa*) on avian coccidiosis was evaluated in young broilers. One-day-old broiler chickens were continuously fed with a standard diet alone or standard diets supplemented with cinnamaldehyde or turmeric extracts for 3 weeks. Body weight gains, fecal oocyst shedding, antibody titers, splenocytes proliferation, and pro-inflammatory cytokine production were measured as parameters of protective immunity following infection with *E. tenella* at 14 day of age. There was no toxicity associated with feeding these two plant extracts. Chickens fed turmeric-supplemented diet showed significantly increased body weight gain and shed significantly reduced fecal oocysts compared with birds fed the standard diet alone or the cinnamaldehyde-supplemented diet following challenge infection with *E. tenella*. Both groups fed cinnamaldehyde- or turmeric-supplemented diet showed significantly improved splenocytes proliferation compared with control birds. Chickens fed cinnamaldehyde-supplemented diet produced higher serum antibody titers compared to the groups fed the standard diet or turmeric-supplemented diet. Finally, the levels of local cytokine transcripts of IL-1β and IL-15 were consistently higher in the turmeric-fed group compared to the groups fed the standard diet alone or cinnamaldehyde-supplemented diet. This study provides first immunological evidence that dietary supplementation of cinnamaldehyde and turmeric enhance local innate immunity and turmeric induces higher protective immunity against *E. tenella* infection.

Key Words: broiler, *Eimeria tenella*, *Curcuma longa*, dietary supplement, cytokine

Metabolism and Nutrition I: Vitamins and Minerals

43 Effects of different dietary copper sources at pharmacological levels on laying hen performance, egg yolk cholesterol and blood parameters. A. Y. Pekel* and M. Alp, *Istanbul University, Faculty of Veterinary Medicine, Istanbul, Turkey.*

An experiment was conducted using a total of 120, 16-wk-old, Lohmann Brown hens to compare three different supplemental dietary copper (Cu) sources at prophylactic levels (250 mg/kg) on hen performance, egg yolk cholesterol and blood parameters. Layers were randomly allocated to four dietary treatments with ten replications of three birds each per treatment. Layers were fed diets containing 0 (Control) or 250 ppm Cu from copper sulfate (Cu-sulfate), copper proteinate (Cu-proteinate) or Copper lysine (Cu-lysine) for 24 wk. There were no differences among copper sources for live weight, egg specific gravity, yolk cholesterol, plasma total cholesterol, high-density lipoprotein cholesterol (HDL), triglycerides and glutathione (GSH). Supplementation with 250 ppm Cu-sulfate improved egg production and feed conversion ratio but decreased egg weight ($P < 0.05$) and feed intake ($P < 0.01$) compared with other diets. Supplementation with Cu-proteinate resulted in decreased feed intake ($P < 0.01$) and improved feed efficiency ($P < 0.05$) but egg production and egg weight were not changed as compared with control. Cracked egg ratio of layers given Cu-proteinate was higher ($P < 0.01$) than those of birds fed other diets. Birds fed the Cu-lysine diet had lower egg shell thickness ($P < 0.001$) and lower egg shell weight ($P < 0.05$). Egg shell

thickness of layers given Cu-sulfate was also lower than control ($P < 0.001$). Copper content of the eggs and excreta were significantly ($P < 0.001$) increased regardless of copper source compared with birds fed the control diet. The results of this trial do not confirm previous findings that copper alters lipid metabolism resulting in reduced egg yolk cholesterol. However, the addition of 250 ppm copper from Cu-sulfate might be beneficial in improving the layer performance more so than Cu-lysine and Cu-proteinate.

Key Words: copper, layer, performance, cholesterol, egg quality

44 Selenium enrichment of table eggs. D. C. Bennett* and K. M. Cheng, *University of British Columbia, Vancouver, BC, Canada.*

Selenium (Se) is an essential micronutrient with a recommended dietary allowance for human adults of 55 µg/d. However, there is evidence that greater dietary intakes may have possible health benefits, including a reduction in the risk of cancer. Several studies have shown the feasibility of enriching eggs using organic sources of Se, and that Se-enriched eggs are an effective way to supplement human diets. However, few studies have examined the response of egg Se concentration to high (>1 ppm) dietary organic Se levels. Organic Se is less toxic than sodium selenite. The objective of the current study is to examine the effect of

higher dietary organic Se levels on production, egg mass and egg Se levels. These were assessed by feeding 3 strains of laying hens (Barred Plymouth Rock, Lohmann Brown, Lohmann White) a basal diet containing 0.3 ppm Se as sodium selenite. This diet was then supplemented with Se-yeast (SelenoSource AF, Diamond V Mills, Cedar Rapids, IA) at 1, 2.4, or 5 mg Se/kg diet. These three supplemented diets were fed to seven cages of hens (2.5 hens/cage) from each strain, respectively, for four weeks. Feed consumption, egg production and egg mass were not affected by the dietary Se concentration in any of the strains. At the end of 4 weeks, irrespective of strain, egg Se concentration was increased 190, 450, and 990%, respectively, over the initial 0.33 ug/g WM. Based on the results of this study and a survey of the literature, hens would need to be fed 1.4 ppm organic Se in the diet to achieve an egg containing 55 µg Se.

Key Words: selenium, laying hen, enriched egg

45 Use of the broiler (*Gallus gallus*) as an in vivo screening tool for Fe bioavailability. E. Tako*, M. A. Rutzke, and R. P. Glahn, USDA/ARS, Robert W. Holley Center for Agriculture and Health, Cornell, Ithaca, NY.

Iron fortification of foods and biofortification of staple food crops are strategies that alleviate Fe deficiency. The common bean (*Phaseolus Vulgaris L.*) is an attractive candidate for biofortification since it contains relatively high Fe concentrations. Beans are also high in polyphenols that may inhibit Fe absorption. In vitro studies using a Caco2 cell model have repeatedly shown that Fe bioavailability from white beans is higher than colored beans. However, there is a need to test the in vitro observations in animal model prior testing crops in human efficacy studies. The broiler may be a useful model for in vivo screening of Fe bioavailability in foods due to its growth rate, anatomy, size and cost. The objective of the present study was to assess the broiler as a model to link between in vitro observations and human nutrition. We compared Fe bioavailability between diets containing either white (Matterhorn) or red (Merlot) beans which differ in polyphenol content. One wk old chicks were divided into four treatment groups: 1. 'WB-': 40% white bean diet (58ppm Fe); 2. 'RB-': 40% red bean diet (53ppm Fe); 3. 'WB+': 40% white bean diet (176ppm Fe); 4. 'RB+': 40% red bean diet (181ppm Fe). Diets 1-2 had no supplemental Fe. For 8 wks, hemoglobin (Hb), feed consumption and BW were measured. After 8 wks, birds were anesthetized and duodenal sections were collected for analysis of expression of Fe transport genes and morphometric measurements. Cecal contents were collected for microbial analysis. DMT1, Dcytb and ferroportin expressions were higher ($P < .05$) and villus surface area was lower in the 'RB-' group compared to other groups. Cecal microflora did not differ btw groups. Hb, Hb-Fe and BW were lower and HRE was higher in the 'RB-' group compared to other groups ($P < .05$). In vitro analysis of Fe bioaccessibility showed lower ($P < .05$) ferritin concentrations in cells exposed to 'RB-' diet. We conclude that the in vivo results match the in vitro observations; white beans contain more bioavailable Fe than red beans. Results indicate that, the broiler model can serve as an intermediate screening tool for Fe availability.

Key Words: broiler, iron, screening tool, bioavailability

46 Performance effects of feeding broilers with diets containing low levels of supplemental Zn as Zn(HMTBa)₂ or inorganic Zn vs. industry levels of inorganic Zn. M. K. Manangi*, S. Richter,

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A 42 d experiment was conducted to determine the performance impact of feeding broiler chicks diets containing low levels of supplemental Zn in the form of organic {Zn(HMTBa)₂ as MINTREX[®] Zn} Zn or inorganic Zn (ZnSO₄) in comparison to industry level of inclusion of inorganic Zn. A total of 1680 Ross-708 male and female chicks were distributed separately into 70 pens with 24 chicks per pen. The experiment consisted of 6 treatments with 13 replicate pens per treatment for T1 to T5, and 5 replicate pens for T6. The treatments consisted of: 0 ppm Zn as -ve control, T1; 10 ppm ZnSO₄, T2; 20 ppm ZnSO₄, T3; 10 ppm Zn(HMTBa)₂, T4; 20 ppm Zn(HMTBa)₂, T5; 100 ppm ZnSO₄ as +ve control, T6. All the chicks were vaccinated with coccidiosis vaccine on d 18 (2x dose; oral gavage) and challenged with lipopolysaccharide (from *E. coli*; 1mg/kg BWT, S/C) on d 28. There was a treatment effect for cumulative weight gain (cGain), F:G ratio adjusted for mortality (adj F:G), and cumulative performance index (cPI) ($P \leq 0.05$). D 42 data for cGain, adj F:G, and cPI indicates that birds supplemented with diets containing 20 ppm Zn(HMTBa)₂ were not different from birds ($P > 0.05$) fed 100 ppm ZnSO₄. Birds fed 20 ppm ZnSO₄ yielded significantly ($P < 0.05$) lower cGain and cPI but similar adj cF:G ($P > 0.05$) than birds fed 20 ppm Zn(HMTBa)₂ or 100 ppm ZnSO₄. The cPI data shows that the -ve control performed poorly ($P < 0.05$) compared to all other treatment groups suggestive of Zn deficiency. In summary, bird performance was improved when supplementing Zn in the diet and this was more pronounced with Zn(HMTBa)₂ than ZnSO₄. Reducing dietary supplemental Zn from 100 to 20 ppm can be achieved without compromising bird performance when feeding solely Zn(HMTBa)₂ but not ZnSO₄. Future work will examine the impact of feeding lower levels of Zn(HMTBa)₂ on other functional aspects of health.

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Key Words: Zn(HMTBa)₂, mintrex, broiler, zinc

47 Zinc amino acid complex supplementation improves performance and influences intestinal immune response after coccidial vaccine challenge. C. Troche*, Z. Jiang, and T. J. Applegate, Purdue University, West Lafayette, IN.

Dietary incorporation of Zn sources complexes with amino acids has been shown to improve performance and alter certain immune functions. An experiment was conducted to evaluate the effects of Zn source on intestinal characteristics. Broiler chicks were fed in a two phase feeding program: 0 to 14d and 14 to 21d. Dietary treatments (8 pens/diet; 40 birds/pen) included: 90ppm of Zn from Zn-sulfate, 50ppm of Zn from Zn-sulfate and 40ppm of Zn from Availa-Zn (as a complex with amino acids; Zinpro Corp.), or 90ppm of Zn from Zn-sulfate and 40ppm of Zn from Availa-Zn. From 0 to 14d, feed intake and feed-to-gain was higher in birds supplemented with 90ppm Zn-sulfate compared to those supplemented with 130ppm total Zn. In order assess the immunomodulatory effects of Zn, 1 bird per pen was orally challenged with a 5X dosage of coccidial vaccine and challenged and non-challenged birds were sampled 5 d after challenge. Histological evaluation of oocyte infiltration, villus height, crypt depth, and numbers of goblet cells were not different between treatments from distal jejunal sections. Measures of active transport and jejunal electrical resistance using Ussing chambers and jejunal mucosal disaccharidase activity were not affected by diet. Cecal tonsils were analyzed for IL1β and IL10 using Taqman probes for qRT-PCR. A significant diet by challenge interaction for IL10 occurred

with Zn-sulfate supplemented chicks, wherein coccidial challenged birds had lower IL10 levels when supplemented with Zn-sulfate ($P=0.04$). The anti-inflammatory effects of IL10 with coccidial vaccine challenge were maintained with inclusion of a Zn amino acid complex.

Key Words: broiler, cytokine, zinc source

48 Effect of copper sulfate in the drinking water on egg production and other parameters in commercial laying hens. H. N. Albrecht*, D. M. Karcher, and R. J. Balander, *Michigan State University, East Lansing.*

This study looked at the effects of adding copper sulfate at 125 PPM to the drinking water of W-36 Hyline hens from twenty-four to forty-one weeks of age. The 1152 birds were randomly assigned to either the control group or the copper sulfate treatment. The experimental design was twenty-four rows of twelve cages per row with four birds per cage. Birds were weighed at the beginning of the trial and monthly thereafter. Egg production was analyzed weekly by row. Specific gravity and egg weights were measured on thirty eggs from each row (720 eggs total) starting at week five of production and every two weeks thereafter. Feed consumption was measured monthly and water consumption was measured weekly for the first five weeks and then biweekly for the remainder of the trial.

Bird weights by pen were slightly, but significantly heavier for the control birds at five, ten and fourteen weeks of production. Egg production was not significantly different between treatments with the exception of week nine. Egg weights and specific gravity were not significantly different at anytime. Feed and water consumption were not significantly different at any time.

Key Words: copper sulfate, laying hens, egg production

49 Effect of sources and levels of zinc on the carcass quality of broilers. H. M. Salim*, H. R. Lee, C. Jo, S. K. Lee, and B. D. Lee, *Chungnam National University, Daejeon, South Korea.*

A study was conducted to determine the effect of sources and levels of zinc on the performance and carcass quality of broilers. A total of 6,000 d-old straight-run broiler (Ross \times Ross) chicks were allotted randomly to four dietary treatments. A corn-wheat-soybean meal basal diet (Control) was formulated, and 40 ppm inorganic zinc (40 IZ), 40 ppm organic zinc (40 OZ), and 80 ppm organic zinc (80 OZ) were added to the basal diet to give four dietary treatments. During the 4-wk experimental period, feed and water were provided ad libitum. At the end of the feeding trial, five birds from each treatment were randomly selected for carcass evaluation and these five birds were considered as five replicates in each treatment. Results showed that the thickness of tibia skin epidermis was not affected by dietary zinc supplementation, but that of back skin in 40 OZ was significantly increased ($P<0.05$). Significant increases in the thickness of tibia and back skin dermis were observed in response to increased levels of dietary organic zinc supplementation. Collagen content in the back skin of 80 OZ was significantly higher than the other treatments; however, supplemental zinc had no significant effect on collagen content of breast and thigh muscle. The shear force values of back skin were not affected, but those of breast muscle were increased ($P<0.05$) in 40 OZ and 80 OZ compared to 40 IZ. It can be concluded that organic zinc increases dermis thickness of tibia and back skin of broilers.

Key Words: broiler, zinc source, zinc level, supplement, skin quality

50 Effects of maternal age, sex and dietary phosphorus level on broiler performance and bone strength. A. L. Shaw*, J. P. Blake, and E. T. Moran, *Auburn University, Auburn, AL.*

Two experiments were conducted to 1) assess differences in breaking force of tibia bones with or without flesh attachment and 2) determine effects of dietary non-phytate phosphorus (npP), maternal flock age and chick sex on broiler performance and bone strength. For Exp. 1, 60 chicks were placed in battery cages and weekly both tibiae were excised and flesh was either intact or removed (15 chicks/wk) to determine breaking forces with a texture analyzer. For Exp. 2, Ross 708 chicks (1220) were hatched of young (25 wk) and old (65 wk) maternal flocks, separated by sex, vaccinated for coccidiosis, and placed on used bedding across 64 floor pens (18 males or 17 females/pen, 8 reps/trt). All birds were fed a corn-soybean meal diet (22% CP, 3086 kcal/kg) adequate in all nutrients but npP. Diets were formulated to contain 0.50% (standard, SP) or 0.35% (marginal, MP) npP and were fed for 28 d. Individual body weights and pen feed consumption were recorded weekly and corrected for mortality. At hatch, both tibiae from 15 chicks per flock and sex were analyzed. Each week thereafter, 24 birds per treatment were sacrificed for evaluation of both tibiae. Exp. 1 resulted in no differences in breaking force, whether flesh remained on the bone or was removed.

Due to the lower npP level in Exp. 2, MP chicks weighed 6.6% less ($P<0.001$) than SP birds at 28 d. Bone breaking forces were improved ($P<0.001$) when chicks were fed SP (17.3 kg) rather than MP (14.9 kg). Weight gain (1033 vs. 1194 g), feed consumption (1773 vs. 2020 g), and breaking force (17.4 vs. 14.8 kg) differed ($P<0.001$) from 0-28 d for chicks hatched from the 25- and 65-wk-old breeder flocks, respectively. In comparison with females, male chicks had an increase ($P<0.001$) in final body weight (1089 vs. 1220 g), total feed consumption (1783 vs. 2010 g) and tibia breaking force (14.6 vs. 17.6 kg). These results indicate that broiler growth and performance can be affected by maternal flock age, chick sex, and dietary npP.

Key Words: phosphorus, bone strength, maternal age, broiler

51 The effects of dietary fluoride on growth and bone mineralization in broiler chicks. M. Y. Shim*, C. Parr, A. Liem, and G. M. Pesti, *University of Georgia, Athens.*

Fluoride (F) has been shown to have varying degrees of beneficial effects on bone mineralization and strength, despite its toxic effects on growth and leg disorders. Some studies have demonstrated an increase in bone ash due to F supplementation. The purpose of the present study was to determine whether low levels of dietary F had any beneficial effect on bone strength and leg disorders of young chicks. Effects on body weight and feed efficiency were also analyzed to monitor for F toxicity.

Day-old Cobb \times Cobb broiler chicks were weighed and randomly allocated into treatment groups with ten chicks per replicate. Chicks were identified by metal wing bands and were housed in electrically heated Petersime raised-wire-floor battery brooders. All chicks were provided with water and experimental diets ad libitum. Two control diets were formulated with two different phosphorus (P) sources in the two experiments (Exp 1 and 2): Treatment 1 contained purified dicalcium phosphate to represent a diet with zero F; Treatment 2 contained unpurified dicalcium phosphate to simulate a commercial diet with low-level F. Treatments 3 and 4 used purified dicalcium phosphate as the P source and contained 22 and 44 ppm F from NaF, respectively. Four more treatments were added for the Exp 2: Treatments 5, 6, 7 and 8 used purified dicalcium phosphate as the P source and contained 66, 88, 110 and 132 ppm F from NaF, respectively.

Chicks fed purified vs. commercial dicalcium Phosphate grew better in Exp 1 ($p < 0.05$) and had less incidence of P-deficiency rickets in Exp 2 ($p < 0.01$). Percent bone ash responded differently to F in Exp 1 vs. Exp 2 ($p = 0.046$). Percent bone ash was increased by increasing F level in the diets in Exp 1, but not Exp 2. It is important to note that even low levels of F like those used in our study have the potential to create a measurable effect.

Key Words: fluoride, broiler, bone ash, phosphorus rickets, body weight gain

52 Comparative effect of vitamin C and direct-fed microbial on the broiler performance, ileal microbial population profile, and gut morphology under heat stress condition. R. Poureslami^{1,5}, A. Yaghobfar², A. Karimi³, and A. Kamyab⁴, ¹Ghent University, Melle, Belgium, ²Animal Science Research Institute, Karaj, Iran, ³Tarbiat Modarress University, Tehran, Iran, ⁴University of Missouri, Columbia, ⁵Jirof Higher Education Center for Agricultural Sciences, Jiroft, Iran.

The objective of this study was to evaluate the effect of liquid vitamin C and direct-fed microbial (DFM) on the broiler performance, ileal microbial population profile, and gut morphology under heat stress (HS) condition. Four hundred eighty chickens were fed with either one of the 5 diets (1-42 d) in 6 replicates; basal diet as control diet (C), basal diet supplemented with either 0.1% *Saccharomyces cerevisiae* (S), 0.2% *Aspergillus oryzae* (A), 0.1% Primalac (P), or 4 ml/l liquid vitamin C (V). The room temperature was maintained 5 °C higher than the conventional temperature for 3 hours a day to induce HS. At 42 d of age, chickens were killed, and gastrointestinal tract was excised from 3 carcasses per pen for lab analysis. Plating method was used to count the total number of microbes in ileum. Morphometric analysis of small intestine was performed using PAS staining method. Dietary treatments did not have an effect on feed intake, FCR, and live weight ($P < 0.05$). Diets had no effect on ileal pH, and counts of *Enterococcus*, Coliforms, *Aspergillus*, *Saccharomyces*, *Lactobacillus*, *Bifidobacterium*, *Colstridium*, total anaerobic and anerobic bacterial ($P > 0.05$). Villus height, villus width (μm), crypt depth (μm), and villus height/crypt depth ratio in ileum, jejunum, and duodenum were influenced by the dietary treatments ($P < 0.05$). However, this effect was not consistent in different segments. For instance, villus height in ileum, jejunum, and duodenum was higher in C, S, and A respectively compared to the other groups ($P < 0.05$). In conclusion, low level of liquid vitamin C and DFM in the diet did not induce a significant effect on broiler performance under heat stress condition in this study however a moderate change occurred in the small intestine morphology.

Key Words: direct-fed microbial, broiler, heat stress

53 Effect of source and level of maternal vitamin D on carryover to newly hatched chicks. C. A. Coto*, F. Yan, S. Cerrate, Z. Wang, Y. Min, F. Perrazo, and P. W. Waldroup, University of Arkansas, Fayetteville.

Fraser and Emtrage (1976) found 5% of the vitamin D deposited in the egg as 25-hydroxycholecalciferol (25-OH). This suggests that 25-OH might not be effective in supplying vitamin D to the developing embryo. Maternal stores may play an important role in alleviating early-onset rickets. A study was conducted to evaluate the effect of maternal cholecalciferol (VitD3) and 25-OH on the progeny performance. Breeder pullets were fed during two months a vitamin D deficient diet

to deplete liver stores; samples were taken to evaluate the vitamin D status. Afterward, experimental diets were assigned in a 2 x 5 factorial arrangement with two levels of supplemental 25-OH (0 or 69 $\mu\text{g}/\text{kg}$) and five levels of Vit D3 (0, 300, 600, 1200, 2400 IU/kg). Records of body weight, egg production, egg weight, and egg shell thickness were maintained. At the end of two months on test diets, samples of eggs yolks were collected for VitD3 and 25-OH determination. Eggs were hatched by maternal diet. At day 1, livers and tibia samples were collected to determine vitamin D forms and mineralization, respectively. Chicks were fed a common diet containing 5500 UI/kg of VitD3 for 21 days. Body weight (BW), mortality and feed conversion (FCR) was determined at 7, 14 and 21 days. At day 21, samples of birds were collected for toe ash and TD determination.

Eggshell thickness, egg production and egg mass were improved by increasing levels of VitD3 and the addition of 25-OH. Interaction between VitD3 and 25-OH was found for these parameters, where 25-OH addition at low VitD3 levels improved performance with no effect at high VitD3 levels. Bone mineralization at day 1 was improved by increasing levels of VitD3; 25-OH was effective at low VitD3 levels with no effect at high VitD3 levels. Progeny FCR and BW were improved by increasing levels of VitD3 and the addition of 25-OH. Moreover, 25-OH improved mineralization and reduced the severity of TD. These results support maternal 25-OH supplementation as an effective means to supply vitamin D to the developing embryo.

Key Words: vitamin D, 25-hydroxycholecalciferol, breeder hens, leg weakness

54 Effect of dietary vitamin U supplementation on the growth performance of young broiler chickens. R. Thanissery*, K. S. Macklin, W. Zhai, J. P. Blake, and Y. O. Fasina, Auburn University, Auburn, AL.

Vitamin U (DL-Methionine methyl sulfonium chloride) is known to have intestinal healing effects in humans and swine, and improve growth performance in different animal species such as cattle and hog. The objective of this study was to evaluate the effect of vitamin U on the growth performance of young broiler chicks. Using a randomized complete block design, day-old male broiler chicks obtained from a commercial hatchery were randomly assigned to 36 pre-heated pens (14 chicks per pen) for 3 experimental treatments. Each treatment had 12 replicate pens. Experimental starter and grower diets were made up of corn-soybean meal basal (for the control group; CN) to which Bacitracin Methylene Disalicylate (BMD; 0.055g/kg) or vitamin U (1.993g/kg) was added for the CB and CV treatment groups, respectively. Duration of experiment was 2 weeks. Chicks were given ad-libitum access to feed and water throughout the study. Body weight, body weight gain, feed intake, and feed conversion were calculated weekly. Mortality was recorded daily. Data collected was subjected to one-way ANOVA using the General Linear Models procedure of SAS. Results showed no differences ($P > 0.05$) in growth parameters between chicks in CN and CV throughout the experiment. However, chicks in CB treatment had higher body weight ($P < 0.05$) compared to those in CN and CV. Lastly, mortality was lower for the CV treatment ($P < 0.05$) compared to both the CN and CB during the first week of experiment. It was concluded that dietary supplementation of vitamin U at 1.993g/kg level of the diet did not improve growth performance, but reduced early chick mortality.

Key Words: vitamin U, bacitracin methylene disalicylate (BMD), growth performance, broiler chicks

55 Egg folate concentration and indices of folate status in laying hens supplemented with dietary folic acid and 5-methyltetrahydrofolate. G. B. Tactacan¹, M. Jing¹, S. Thiessen¹, D. L. O'Connor², J. C. Rodriguez-Lecompte¹, W. Guenter¹, and J. D. House¹, ¹University of Manitoba, Winnipeg, MB, Canada, ²Hospital for Sick Children, Toronto, ON, Canada.

The deposition of dietary folic acid (FA) into the chicken egg is likely regulated by its conversion to 5-methyltetrahydrofolate (5-MTHF), the predominant form of this vitamin in eggs (>80%). Supplementation of 5-MTHF in the laying hens' diet may therefore enhance total egg folate concentrations. To this end, a study was conducted using equimolar concentration of either FA or 5-MTHF in diets fed to both Shaver White and Shaver Brown laying hens, to investigate their influence on total egg folate concentrations, and indices of performance and folate status. A total of 24 laying hens (24 weeks) from each strain were randomly assigned to receive 1 of 3 (n=8) dietary treatments: 1) basal diet with no supplemental folate and 2) basal diet + 10 mg/kg FA and 3) basal diet + 11.30 mg/kg 5-MTHF, for 21 days. Production performance, plasma homocysteine, liver, serum and egg folate concentrations were measured. Feed efficiency for birds consuming diet 3 improved (P<0.05) by 11.9 and 10.7% respectively, compared to hens consuming diet 1 and diet 2; while egg weight increased (P<0.05) by 6% compared to diet 1. Plasma homocysteine was lower (P<0.05) by 14.2%, while serum and egg folate were higher (P<0.05) by 78.3 and 61.8% in hens consuming either folate species as compared to control. Liver 5-MTHF was not affected by folate supplementation. Together, these data provide evidence that supplementation of FA and 5-MTHF have equivalent effects in enhancing egg folate concentrations and improving folate status in laying hens. Supplementation of 5-MTHF may improve production performance, but this remains to be determined in larger production studies. The data also support a point of regulation of egg folate deposition that is prior to hepatic folate metabolism, possibly at the level of intestinal folate uptake and metabolism.

Key Words: folate, folic acid, 5-methyltetrahydrofolate, egg, laying hen

56 Molecular characterization, tissue distribution and gene expression of reduced folate carrier in laying hens fed the folate supplemented diet. M. Jing*, G. B. Tactacan, J. C. Rodriguez-Lecompte, A. Kroeker, and J. D. House, University of Manitoba, Winnipeg, MB, Canada.

The Reduced Folate Carrier (RFC; SLC19A1) is regarded as an important folate transporter in humans and other mammals. However, its importance in avian systems is unclear. In the present study, the molecular cloning and tissue distribution of RFC and the impact of dietary folate supplementation on the mRNA expression of this transporter were investigated in the chicken. Twenty-four (n = 8/treatment) Shaver White laying hens were randomly divided to receive one of three dietary treatments: a) basal diet with no supplemental folate; b) basal diet + 10 mg/kg crystalline folic acid; or c) basal diet + 11.30 mg/kg 5-methyltetrahydrofolate (5-MTHF) for 21 d. RFC mRNA levels were analyzed by real-time PCR. The results showed that the RFC cDNA containing the full coding region was cloned from duodenum with 99% identity to the reference gene available in GenBank. RFC transcripts were detected in a variety of chicken tissues (e.g., brain, liver, kidney, intestine, etc). Real-time PCR analysis showed no differences (P > 0.05) due to diet in the duodenal and cecal RFC mRNA levels. However, compared with the basal diet, jejunal RFC mRNA was depressed (P < 0.05) in hens fed the 5-MTHF diet, and a reduction (P = 0.077) was also found in hens fed the folic acid diet. Taken together, these data showed that the RFC cDNA containing the entire coding region was successfully cloned from laying hens. A broad tissue distribution of RFC mRNA may indicate the importance of RFC in the folate transport process in chickens. Furthermore, jejunal RFC mRNA was down-regulated by dietary folate supplementation. These findings contribute to our understanding of folate transport in avian systems, including laying hens.

Key Words: reduced folate carrier (RFC), dietary folate supplementation, cloning and tissue distribution, mRNA expression, laying hens

Physiology, Endocrinology, and Reproduction

57 Proteomic assessment of poultry spermatozoa. J. Long*, T. Conn, and W. Garrett, Beltsville Agricultural Research Center, Beltsville, MD.

Fully characterizing the protein composition of spermatozoa is the first step in utilizing proteomics to delineate the function of sperm proteins. To date, sperm proteome maps have been partially developed for the human, mouse, rat, bull and several invertebrates. Here we report the first proteomic analysis of turkey and rooster spermatozoa, using MALDI-TOF and LC-MS/MS. Semen was centrifuged through a discontinuous Accudenz gradient to remove seminal plasma. Protein was extracted from isolated sperm cells and the soluble fraction separated by 2-D SDS-PAGE (pI 5-8). Excised spots were digested with trypsin and prepared for MALDI-TOF analysis. Proteins were identified from Peptide Mass Fingerprints using the MASCOT search engine (Matrix Science). Samples yielding non-significant Mowse probability scores were subjected to LC-MS/MS analysis. When necessary, homology searches were performed for unnamed protein products via BLAST searching. A total of 94 and 36 proteins were identified from turkey and rooster spermatozoa, respectively. All protein identifications were

limited to *Gallus gallus* and/or *Meleagris gallopavo*. For turkey sperm, 9 hypothetical proteins (6 matching to chicken chromosome open reading frames via BLAST search) were identified, while another 16 were predicted proteins of unknown function. For rooster sperm, 5 hypothetical proteins (2 matching to chicken chromosome open reading frames) were identified, and an additional predicted protein of unknown function was positively identified. Identified proteins were associated with the acrosome (pro-acrosin), mitochondria (enolase I, voltage-dependent anion channel 2, creatine kinase), and flagellum (capping protein, dynein, tektins 1-5). Several chaperone (heat shock protein 70) and calcium-binding (EF-hand protein) proteins also were identified. Three proteins not previously found in sperm were identified: dihydropyrimidinase, mitofilin and mitochondrial tri-functional protein. While the latter 2 mitochondrial proteins most likely exist in sperm from other species, the discovery of dihydropyrimidinase as a predominant soluble protein in poultry sperm poses interesting functional implications.

Key Words: turkey, rooster, sperm, proteome, dihydropyrimidinase