**Metabolism and Nutrition, Vitamins and Minerals**

**500P  Effect of digestible lysine levels and metal-amino acid complexes on performance and breast meat characteristics in broilers.** L. Linares*1, M. Rebollo1, A. Fireman1, D. Neves1, A. Grove1, D. Bourassa2, J. Hess3, and W. Pacheco2,3

One-day-old Ross 708 male broiler chicks (n = 1664) were used to evaluate performance, processing traits, blood parameters, and meat quality of 2 digestible Lysine (dLys) levels and 4 mineral treatments. Birds were fed in 4 phases: starter (1 to 13 d), grower (14 to 28 d), finisher (29 to 42 d), and withdrawal (43 to 56 d). Phytase was added to all diets at 1500 FTU/kg. During the grower phase birds were fed 100 or 85% recommended levels of dLys. Throughout the study birds were offered 1 of 4 mineral treatments: sulfates (100 ppm Zn from ZnSO4 and 40 ppm Fe from FeSO4); AvZn (40 ppm Zn from ZnSO4 + 60 ppm Zn from Zn amino acid complex and 40 ppm Fe from FeSO4); AvFe (100 ppm Zn from ZnSO4 and 40 ppm Fe from Fe amino acid complex); AvZnFe (40 ppm Zn from ZnSO4 + 60 ppm Zn from Zn amino acid complex and 40 ppm Fe from Fe amino acid complex). Data was analyzed by JMP13 as randomized complete block design with a 2 × 4 factorial arrangement. Birds fed 85% dLys had decreased (P < 0.01) body weight gain (BWG) and increased feed conversion ratio (FCR) during the grower phase, but no differences in performance were observed between birds fed dLys treatments during the finisher or withdrawal phases. At 56 d, footpad lesion score 1 was lower (P < 0.01) for birds fed 85% dLys during the grower period. Birds fed AvFe and AvZnFe had improved (P < 0.01) BWG and FCR during the starter phase compared with birds fed sulfates (475, 478 and 455 g BWG for AvFe, AvZnFe, and sulfates, respectively and 1.17, 1.18, and 1.20 FCR for AvFe, AvZnFe, and sulfates, respectively). At 43 d, birds receiving 85% dLys had a 21% decrease in severity of wooden breast (P = 0.01) compared with birds fed 100% dLys and there was a dLys × mineral treatment interaction (P < 0.05) for breast yield. Within each dLys level, breast yield did not differ (P > 0.10) among mineral treatments; however, birds fed AvZn and AvFe mineral treatments with 100% dLys had greater (P < 0.05) breast yields compared with birds fed these mineral treatments and receiving 85% dLys (29.32 and 28.19 for AvZn birds fed 100 and 85% dLys, respectively and 29.03 vs 28.0 for AvFe birds fed 100 and 85% dLys, respectively). Birds fed AvFe and AvZnFe had increased (P < 0.05) blood hematocrit at 49 d of age compared with birds fed sulfates. Cooking losses and oxidative status (TBARS) of meat did not differ (P > 0.10) between dLys levels or among mineral treatments. Reducing dLys by 15% in grower diets reduced performance and impaired FCR during the grower phase, reduced breast yield and severity of wooden breast on 43 d. Inclusion of Zn and Fe amino acid complexes in diets improved performance during the starter phase and improved breast yield when recommended levels of dLys were fed.

**Key Words:** broiler, digestible lysine, iron, metal-amino acids, zinc

**501P  Effect of low dose organic trace mineral complex on production performance, egg quality and fecal mineral excretion of laying hens.** J. Qiu1, X. Lu1, L. Ma1, C. Hou1, J. He1, B. Liu1, G. Lin2, T. Ao*, and D. Yu1,1College of Animal Sciences, Zhejiang University, Hangzhou, Zhejiang, China, 2Alltech Biological Products (Beijing) Co. Ltd., Beijing, China, 3Center for Animal Nutrigenomics and Applied Animal Nutrition, Alltech Inc., Nicholasville, KY.

Organic trace minerals have been shown to be more bioavailable than inorganic mineral salts and could be used at a lower rate in animal feed to minimize mineral excretion from animal waste that is a big concern in modern animal production. The objective of this study was to investigate the effect of low-dose organic trace mineral complex on production performance, egg quality, yolk and fecal mineral concentration of laying hens during the late laying period. A total of 405 healthy hens (HY-Line White, 52-week-old) with similar body weight and egg-laying rates were randomly divided into 3 treatments, with 9 replicates per treatment and 15 birds per replicate. The experiment lasted 56 d. Diets were arranged as follows: CON: a basal diet + inorganic Fe, Cu, Mn and Zn at 36, 90 and 90 mg/kg (commercial level), respectively; ITM: a basal diet + inorganic minerals equivalent to 1/3 levels of CON; OTM: a basal diet + organic minerals (Bioplex PP, Alltech Inc., Nicholasville, KY, USA) at 1/3 levels of CON. Compared with the layers from CON group, the layers from ITM group had lower (P < 0.05) egg production, eggshell strength and yolk Fe concentration, and higher (P < 0.05) feed intake, egg loss and feed to egg ratio. The layers from OTM group had equivalent values for egg production, eggshell strength, egg loss and feed to egg ratio, but higher (P < 0.05) total egg weight and feed intake compared with those from CON group. The layers from OTM group had higher (P < 0.05) total egg weight, feed intake, egg production, eggshell strength, and yolk Fe concentration and lower (P < 0.01) egg loss and feed to egg ratio compared with those from ITM treatment group. The fecal samples from layers fed ITM diet and OTM diet had equivalent, but lower (P < 0.01) mineral (Fe, Cu, Mn and Zn) concentration compared with those from layers fed CON diet. The data from this study indicated that dietary supplementation of low-dose organic minerals as Bioplex PP can significantly reduce fecal excretion of trace elements and not negatively impact hen egg production and egg quality.

**Key Words:** organic trace minerals, production performance, eggshell quality, fecal mineral excretion, laying hen

**502P  Influence of iron source, level of supplementation and phytase level on broiler performance—Three-trial summary.** J. Garrett1, G. Nunnery2, and M. D. Sims3, 1QualiTech Inc., Longmont, CO, 2QualiTech Inc., Chaska, MN, 3Virginia Diversified Research Inc., Harrisonburg, VA.

Three trials were conducted to evaluate the influence of supplemental iron level, iron source and phytase level in the diets of broilers. This is a summary of those 3 trials. Trials lasted 42, 42, and 45 d in length. A total of 6800 birds (Ross 708) were fed. Dietary treatments evaluated were inorganic iron (iron sulfate; IFe) vs organic iron (SQM Fe, QualiTech, Inc.; OFe), level of supplementation 20 vs 60 ppm, phytase level of supplementation (0, 0.2, and 0.6 lb/ton; Quantum Blue – AB Vista; OQB, 1×QB, and 3×QB). Stocking density was initially 0.6193 m2/chick. Three phase diets were formulated starter, grower and finisher. Bird performance was evaluated at 21d and at the end of the study for weight gain, mortality and feed conversion value. Data was analyzed using GLM procedure in NCSS (Utah). There were no significant 2-way interactions between the treatments combinations, while there was a tendency (P = 0.087) for an interaction between phytase level and source of mineral. Level of iron supplementation had no significant effect (P > 0.4) on any performance parameter measured. Phytase level had a significant effect (P < 0.001) on bird weight gain for the first 21 d and
tended ($P = 0.054$) be greater at the end of the feeding period for the 6xQB. No treatment had a significant influence on bird mortality. The use of an organic source of iron had a significant effect ($P < 0.001$) on bird weight at 21 d and tended to have an effect on final bird weight ($P = 0.108$). There was a significant influence ($P < 0.05$) of organic iron source on feed conversion value (straight conversion and conversions adjusted for mortality and final body weight: 1.945 vs 1.857, 1.889 vs 1.813, 1.874 vs 1.816 for IFe and OFe, respectively) improving the feed conversion. Initial hypothesis was that source would allow for lower inclusion and possibly lower phytase levels but this was not confirmed. Instead, the organic iron source improved bird performance independent of the other treatments. This suggests that other unmeasured parameters were influence by iron source allowing for better bird performance, such as pathogen load, since certain pathogens (e.g., *E. coli*) had a requirement for iron which could create a subclinical infection rate. Further research is being pursued to evaluate this independent effect.

**Key Words:** broilers, organic iron, Inorganic iron, Quantum Blue phytase

**503P** Mineral source supplied during initial and production phases affects performance and egg quality of laying hens. H. Oliveira*1, C. B. V. Rabello1, M. Barros1, M. do Carmo Ludke1, A. Faria1, W. Medeiros-Ventura1, C. Pereira1, A. Silva1, R. S. Júnior1, M. José dos Santos1, L. Souza1, L. H. Silva1, and A. Fireman2, 1Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil, 2Zinpro Corporation, Eden Prairie, MN.

Studies have demonstrated the benefits of amino acid complexed minerals (AACM) on laying hen performance. Nevertheless, few studies have been completed that fed pullets from the starter period through the full production phase. An experiment was conducted to evaluate the effect of zinc (Zn), manganese (Mn), copper (Cu), and iron (Fe) amino acid complexes in laying hen diets, on their performance and egg quality. A total of 800 laying hens (Lohmann Brown Lite; 30 to 50 weeks of age) were distributed to cages (0.45 × 0.40 × 1.00 m) in a completely randomized design, with a 2 × 4 factorial arrangement of treatments. Each treatment had 10 replicate cages, with 10 birds per experimental unit (cage). Initial treatments were fed from day one to 30 weeks-of-age, and were either: Inorganic (IM), 70 ppm Zn + 70 ppm Mn + 8 ppm Cu as ZnO, MnO, and CuSO₄·H₂O, respectively; or AACM-ZMC, 40 ppm Zn + 40 ppm Mn + 2.75 ppm Cu (from IM sources) and 30 ppm Zn + 30 ppm Mn + 5.25 ppm Cu (from AACM sources). During the production period, initial diet groups were divided into 8 treatments (4 groups per initial diet): IM; AACM-ZMC; AACM-ZMCFe (AACM-ZMC + 10 ppm Fe from FeSO₄ and 40 ppm Fe as Fe-AACM); AACM-Fe (IM + 10 ppm Fe from FeSO₄ and 40 ppm Fe-AACM). Data were submitted to ANOVA and Tukey’s mean separation test ($P < 0.05$). Supplemental Zn, Mn, and Cu as AACM increased egg mass (EM) with or without Fe-AACM. Including Fe-AACM in the AACM-ZMC diet improved feed conversion ratio (FCR, g/g eggs), when compared with the Control (IM) sources. An interaction was observed between feeding phases and treatments for FCR (g/dz eggs); birds showed better FCR when fed AACM-ZMC, from initial through production phase. Birds fed diets containing solely IM in initial phase presented an inferior FCR in the production phase, even if fed AACM during the production phase. However, inclusion of Fe-AACM in production phase, with or without AACM-ZMC, improved this parameter. There were no interactions between treatments and feeding phases, related to egg quality parameters. Birds fed AACM diets had increased eggshell weight, eggshell thickness, and weight of egg and albumen, compared with those fed IM diets. Eggshell color was affected by mineral source, where diets containing AACM-ZMC, with or without Fe-AACM, and diets containing Fe-AACM, even without AACM-ZMC, promoted darker brown eggshells, compared with eggs from IM diets. Supplementing laying hen diets with AACM mineral during the initial and production phases improved performance and internal/external egg quality of layers.

**Key Words:** egg quality, eggshell quality, laying hen, mineral amino acid complex, mineral source

**504P** Effects of different sources and levels of copper and zinc on bone quality and mineral content in broilers. T. Santos*1, K. Augusto2, M. M. Sartori1, P. Padilha1, J. Vieira1, R. F. Netto1, D. Souza1, L. Granero1, M. Poletto1, G. Barbosa1, R. Araujo1, and J. Sartori1, 1São Paulo State University (UNESP), Botucatu, Brazil, 2Trouw Nutrition, Campinas, Brazil.

Micro minerals are extremely important for bone development, and ideal supplementation prevents the incidence of locomotor problems in broilers. Thus, the objective of the present study was to evaluate the effect of different sources (sulfate and hydroxychloride) and different levels of copper (Cu) and zinc (Zn) on bone quality (breaking strength and bone ash) in the tibia and femur and mineral content in tibia, femur and liver at 42 d-old. The latest sources of copper (Cu) and zinc (Zn) in broiler nutrition are hydroxychloride (IntellibondC; IBC and IntellibondZ; IBZ), which are less reactive and more stable in the diet and in gastrointestinal tract conditions when compared with inorganic sources. A total of 1,792 1-d old male Cobb chicks were distributed in a completely randomized factorial design in a 2x3+2: IBC (15 ppm and 150 ppm) × IBZ (80 ppm, 100 ppm and 120 ppm); Cu sulfate (15 ppm) × Zn sulfate (120 ppm); and Cu sulfate (150 ppm × Zn sulfate (120 ppm) with 8 treatments and 8 replicates of 28 birds each. The diets were formulated with corn and soybean meal, according to the recommendations of each phase: pre-starter (d1- to 7), starter (d8- to 21), growing (d22- to 35) and finishing (d36- to 42). At the end of the experiment, 2 birds/replicate were slaughtered for collection of the liver, tibia and femur. The mineral content was determined by the technique of atomic absorption. Data were analyzed in a factorial 2x3+2 with the Minitab 16 statistical software, and the means were compared by the Tukey test ($P < 0.05$). The tibia breaking strength was higher ($P = 0.053$) for 150 ppm IBC × 80 ppm IBZ supplementation, while the level 150 ppm IBC × 120 ppm IBZ provided higher ash content in the tibia ($P = 0.027$). The copper content in the tibia ($P < 0.001$), femur ($P = 0.001$) and liver ($P = 0.008$) increased with 150 ppm IBC × 100 ppm IBZ, but the same treatment provided lower zinc content in the tibia. It was concluded that the supplementation of 150 ppm IBC was efficient for the parameters evaluated, whereas the IBZ supplementation showed variations with the levels used, therefore, 100 ppm IBZ can be chosen as an intermediate level. Acknowledgment: Trouw Nutrition, Fapesp (2017/00338-2), Capes (scholarship)

**Key Words:** bone resistance, bone ash, minerals, liver

**505P** Vitamin D₃ requirement for growing broiler chickens using a precision intubation intake bioassay. H. Leyva-Jimenez*, M. Khan, K. Gardner, R. Abdaljaleel, Y. AL-Jumaa, A. Alsadawi, and C. Bailey, Texas A&M University System, College Station, TX.

Vitamin D₃ ($D₃$) is obtained from the diet or is synthesized in vivo from the provitamin 7-dehydrocholesterol in the skin after exposure to UV-light. Current commercial facilities limit the access to sunlight. Therefore, $D₃$ supplements are used to prevent retarded growth and skeletal deformities. Classical $D₃$ requirement studies use graded levels
of dietary D₃ that are supplemented directly to the feed. Under this methodology, several sources of variation, including mixing error and selective feeding are frequent. The objective of this study focused on increasing the precision of D₃ delivery to the growing chick by performing a daily oral D₃ gavage. Using a completely randomized block design, commercial male d-old broilers were distributed in battery cages and fed a vitamin D₃-deficient corn-soy diet throughout a 21-d trial. The first 9 d of the study served to deplete the maternal stores of D₃, followed by a 12-h fasting period. From d-10 to the end of the trial, birds were orally gavaged with increasing levels of vitamin D₃. A highly purified pharmaceutical grade cholecalciferol standard (99.8%) was purchased from Sigma-Aldrich Chemical Company and dissolved in corn oil to create various D₃ treatments. Daily gavage treatments were based on estimated intake of 0, 50, 100, 200, 400, 800, 1,600 and 3,200 IU D₃/kg of feed consumed over the last 12 d of the study. The oral gavage was performed per treatment group from lower to higher IU concentration using an 18 gauge gavage needle and a 1 mL syringe graduated at 1/100 mL. Cholecalciferol intake per kg of diet was adjusted based on daily feed intake per pen of birds. Performance data were evaluated from d 10–21. Percent tibia bone ash (TBA), tibia breaking strength (TBS), total mineral content (BMC) and total bone mineral density (BMD) were obtained to evaluate bone mineralization at d 21. Data were subjected to ANOVA using the least squares function of JMP 13.0. Tukey’s Test was used to identify significant (P < 0.05) differences when appropriate. Broken-line regression was used to calculate D₃ at the point of intersection between ascending line and horizontal line. Performance analysis resulted in no difference (P > 0.05) in body weight or weight gain. TBA and TBS were improved (P < 0.05) with increasing levels of D₃. No difference (P > 0.05) was found for BMC or BMD. Linear broken-line regression suggested a D₃ requirement of 499 IU/kg for TBA and 574 IU/kg for TBS. Whereas the quadratic broken-line regression suggested that 499 IU/kg and 799 IU/kg were required to maximize TBA and TBS respectively.

**Key Words:** cholecalciferol, vitamin D₃, requirement, broiler, bioassay

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### 505P Effects of increasing manganese hydroxychloride level on male broiler growth performance and tibia strength. H. Williams*, A. Jasek¹, T. Parr², and J. Lee¹, Texas A&M University, Refugio, TX; Micronutrients USA LLC, Indianapolis, IN.

The objective of the current study was to evaluate the impact of increasing manganese (Mn) hydroxychloride on growth performance and tibia strength of male broilers fed corn-soy diets. A total of 2,100 broilers were assigned randomly to 5 dietary treatments consisting of 12 replicates of 35 Ross 708 broilers per pen. Dietary treatments contained manganese from Mn hydroxychloride (IntelliBond M; Micronutrients USA LLC) at 0, 40, 80, 120, and 160 ppm respectively. Broilers were fed starter (d 1–14), grower (d 14–28), finisher (d 28–42), withdrawal 1 (d 42–49), and withdrawal 2 (d 49–55) diets. Average body weight (BW), body weight gain (BWG), mortality adjusted feed conversion ratio (FCR), feed consumption (FC) and mortality (%) were determined on d 14, 28, 42, 49, and 55. On d 42 and 55, 5 birds per replicate pen were randomly selected and right tibias were excised for evaluation of bone breaking strength and inorganic matter. All data were analyzed via a one-way ANOVA with means considered significantly different if P < 0.05 and were further separated using Duncan’s multiple range test. Regression analyses for FCR were analyzed with increasing levels of Mn. No differences in body weight were observed among Mn level through d 49. On d 55, broilers fed 80 and 160 ppm Mn were heavier (P < 0.05) than those fed 40 ppm. Through d 42, 49, and at termination of the study, broilers fed diets containing elevated levels of Mn at 80, 120, and 160 ppm had improved (P < 0.05) FCR compared with the birds fed diets containing 0 ppm. The regression of FCR on dietary Mn had a negative slope which was significantly different from zero indicating positive impacts on FCR with increasing levels of Mn (P < 0.05) through d 14, 28, 42, 49 and 55. At the termination of the study, broilers fed Mn at 160 ppm exhibited improved (P < 0.05) tibia breaking strength as compared with broilers fed 80 and 120 ppm Mn. These data indicate that the dietary concentration of Mn needed to maximize growth performance is higher than the reported value in the NRC (1994) of 60 ppm. Additionally, the requirement to maximize bone strength is higher than the requirement to maximize body weight.

**Key Words:** manganese, broiler, performance, ash

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### 506P Evaluating vitamin premixes with various additives for vitamin and phytase stability in a commercial feed mill over six months. A. Levy* and N. Ward, DSM Nutritional Products, Parsippany, NJ.

Combining various additives into one premix allows for more flexible use of microbin space in feed mills. The objective of this study was to determine if inorganic minerals (oxides and sulfates), betaine, and NSP enzymes impact the stability of vitamins and phytase in a multicomponent vitamin premix over a 6-mo period in commercial feed mill conditions. Eight premixes were evaluated: 1) Vitamins + phytase (Control); 2) Control + NSP enzyme 1; 3) Control + betaine; 4) Control + Inorganic minerals (MIN); 5) Control + MIN + betaine; 6) Control + MIN + betaine + NSP enzyme 1; 7) Control + NSP enzyme 2; and 8) Control + MIN + betaine + NSP enzyme 2. The premixes were stored in a midwest US commercial feed mill for 6 mo under ambient conditions averaging 15°C (ranging from −18°C to 29°C). Samples were taken every 4 weeks from June through December 2016. The stability of vitamins A, D, E, thiamin, riboflavin, B₆, and phytase in the premixes were evaluated. After 2 mo of storage, all premixes had less than 10% vitamin loss except premix 3, which had a 14% loss in riboflavin. Premix 3 had the lowest recovery of vitamin A, which was 72% of target after 6 mo. Of the vitamins analyzed, vitamin A suffered the highest losses with recoveries ranging from 72 to 89% of target across all premixes. Premixes 6 and 8 were the most complex, containing all additives for maximum microbin space savings. Premix 6 vitamin recovery was good, ranging from 91 to 103% except riboflavin was 75% at the end of 6 mo. Premix 8 vitamin recovery was also good, ranging from 86 to 129% except vitamin A was 76 and 80% of target at 5 and 6 mo, respectively. Phytase loss ranged from 0 to 20% with the greatest reduction in stability in premix 4, which contained only MIN with vitamins. With the exception of vitamin A, there were minimal losses of premix vitamins stored for 6 mo under commercial feed mill conditions.

**Key Words:** vitamin, premix, enzyme, phytase, stability

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### 508P Effect of dietary addition of iron sulfate in broilers diet on water-soluble phosphorus excreted, minerals digestibility and bone mineralization. P. Floradin*, F. Guay, and M.-P. Létourneau-Montminy, Laval University, Quebec, QC, Canada.

Soluble P is highly bioavailable to macrophytes and algae and therefore readily affects water quality. Phosphates are commonly removed from municipal and industrial wastewater by precipitation with multivalent metals such as iron (Fe). In a previous trial it has been shown that the addition of iron sulfate encapsulated can reduced the excretion of water-soluble P (WSP) in excreta without modifying P retention and growth performance. The impact Fe encapsulated added in broiler diet on WSP
excretion in litter was the subject of the present trial. In addition, the effect of iron encapsulated or not using a spray-chilling method was also tested in terms of growth performance, apparent jejunal and ileal (AID) digestibility of calcium (Ca), Fe, P and phytic P (PP), kidneys and liver Fe content, and bone mineral content (BMC) of tibia (DXA, Discovery W; Hologic Inc., Waltham, MA, USA). The experiment was divided in 3-phases feeding program (0–10, 10–21, 21–34 d) using 5 diets that meet all nutritional requirements except Fe: a positive control (C+); C+ supplemented with 33 and 60 ppm Fe sulfate encapsulated (FeE1 and FeE2), and C+ supplemented with 33 and 60 ppm Fe sulfate non-encapsulated (FeNE1 and FeNE2). Two thousand 7 hundred (2700) 1 d-old Cobb-500 male broilers were assigned to 1 of 5 diets and distributed in 60 pens of 45 birds each. Six birds per pen were euthanized by cervical dislocation at d 30 and 31. Data were analyzed as a randomized complete block design with PROC MIXED of SAS to test the impact of 1) Fe addition (C+ vs other), 2) Fe Encapsulation (FeE1-FeE2 vs FeNE1-FeNE2), 3) Dose effect of FeE (FeE1 vs FeE2), and 4) Dose effect of FeNE (FeNE1 vs FeNE2). It should be noted first that iron in the C+ diet was higher than expected (~300 ppm). Overall ADG was reduced (C+ vs other, P < 0.05) by iron addition except in birds receiving FeE1 (FeE1 vs FeE2, P > 0.05). Similarly, BMC was reduced with iron addition (C+ vs other, P = 0.02) except in FeE1 (FeE1 vs FeE2, P = 0.009). A significant increase in AID of total P (P < 0.001), PP (P < 0.01), Ca (P < 0.001) and Fe (P < 0.001) was observed with the addition of Fe (C+ vs other). These effects were stronger with FeNE (FeE vs FeNE) for total P (P < 0.001) and PP (P = 0.01). Iron did not significantly affect WSP concentration in the jejunum, ileum, but increase WSP in the litter (C+ vs other, P < 0.001). These results suggest that Fe addition reduces growth performance and does not insolubilize the P in the litter. This is partly due to the adverse effect of high Fe concentration on bone mineralization and remodeling, inducing an increase in urinary excretion of P. The increase of P digestibility with iron addition needs further investigation.

Key Words: water soluble-phosphorus, iron sulfate, apparent ileal digestibility, broiler

509P Impacts of increasing level of a novel organic zinc complex on performance and bone mineral content in young male broilers. D. De Leon*, K. Brown1, F. Munoz2, R. Poureslami3, and J. Lee4, 1Texas A&M University, College Station, TX, 2Scott G. Williams LLC, Conyers, GA, 3ADM Animal Nutrition, Dallas, TX.

An experiment was conducted to determine the bioavailability of a novel zinc complex using tibia zinc concentration as the response criteria. The effect of the complex on growth and bone deposition was determined in Cobb 500 broiler chicks which were fed a semi-purified diet containing soy protein concentrate, dextrose, and corn starch (18 mg/kg of background Zn). Twelve replicate pens of 10 birds were permitted access to experiment diets from d 1 through 21 d of age in a battery trial. The control diet was supplemented with zinc complex at 10, 20, and 40 mg/kg. Parameters evaluated were feed consumption, body weight, mortality corrected feed conversion ratio and tibia zinc concentration. The data were analyzed via one way ANOVA using the GLM procedures and linear and quadratic regression was conducted to determine slope of evaluated parameters. Body weight was increased with all levels of zinc complex inclusion compared with the control diet which was related to an increase in feed consumption. No consistent dose-dependent improvements were observed in the mortality corrected feed conversion ratio. Using zinc deposition in bone as the response measurement, consistent dose-dependent improvements were observed in tibia zinc concentration, as significant increases in tibia zinc concentration was observed with each increase in zinc complex inclusion. Linear and quadratic regression confirms increasing levels of zinc complex resulting elevated BW and tibia zinc content. These data confirms the bioavailability of this novel zinc complex to broiler chickens.

Key Words: zinc complex, tibia, broiler

510P Interactive effects of probiotics and copper inclusion on 42 d male broiler performance. A. Brown1, M. Lemons1, K. Perryman2, A. Kiess3, and K. Wamsley3, 1Mississippi State University, Mississippi State, MS, 2Micronutrients USA LLC, Indianapolis, IN.

The recent rise in antibiotic-free production has led nutritionists to rely on feed additives such as probiotics and copper as potential antibiotic alternatives. Probiotics, such as those derived from Bacillus licheniformis (BL) have been found to alter the environment of the GIT, activate the immune system and promote colonization of beneficial microorganisms, ultimately improving overall performance. Copper, such as that supplied via Cu hydroxychloride (Micronutrients USA, LLC) (CU), is a micro-mineral with various roles in vivo, including regulating immune function; thereby promoting its use for antibiotic-free production. Research has explored their individual use (BL and CU) in diets, however research is limited on their combined effect on broiler performance. Therefore, the objective of the current study was to examine the individual/interactive effects of supplementing commercially available BL (Yes or No) or CU (0, 125, or 250 ppm) in an all-vegetable commercial diet on d 0–42 male broiler performance. This study used a 2 BL × 3 CU factorial arrangement of treatments within a RCBD. A total of 1,152 Ross × Ross 708 male broilers were obtained from a commercial hatchery and equally allocated to 96 floor pens containing used litter (16 replications/treatment). Birds were weighed and feed intake was recorded on d 18, 30 and 42 for determination of average BW, BW gain, bird uniformity, feed intake/bird (FI), % mortality, and feed conversion ratio (FCR). No differences were found for BL, CU or their combination at 0–18 or 42 d (P > 0.05). However, BL × CU interactions were established for 18–30 d BW gain (P = 0.01) and 0–30 d FI (P = 0.04). For 18–30 d, including BL+CU into diets decreased BW gain; however, for 0–30 d FI, CU alone increased FI while including BL+CU decreased FI. On 0–30 d, regardless of FI, FCR was not found to be significantly affected (P > 0.05). Copper inclusion was found to significantly affect d 30–42 BW gain with broilers receiving 250 ppm CU having the highest BW, while broilers fed all other CU inclusions performed similarly (P = 0.02). On d 42, 5 birds/treatment were randomly selected for cecal tonsil sampling to determine the presence or absence of Salmonella or E. coli. While Salmonella was not detected, birds fed diets containing CU had less E. coli as compared with birds fed diets without CU (P = 0.04); BL had no effect on E. coli (P > 0.05). Data from this study were more positive for CU inclusion and indicated some concern for the combination of CU and BL. It is possible that replicating this study under higher disease challenge could elicit different result, as overall flock health for this study was good (regardless of the use of used litter).

Key Words: copper, antibiotic-free, antibiotic alternative, probiotic, broiler

511P Effects of different selenium sources on egg quality of semi-heavy laying hens. F. P. Costa*, A. Ferreira de Brito1, M. N. Soares1, T. S. Ferreira1, J. V. Celestino da Silva1, D. T. Cavalcante2, J. C. L. Muniz1, J. G. Gonçalves3, and M. Ceccantini3, 1Federal University of Paraíba, Areia, Paraiba, Brazil, 2Academic Unit of Garanhuns, Garanhuns, Pernambuco, Brazil, 3Adisseo South America, Sao Paulo, Brazil.
Selenium is a essential mineral that is involved in several biochemical processes and is fundamental to the formation and production of eggs, exerting influence on their quality. This trial was carried out to evaluate the effects of different selenium sources on laying hen egg quality traits from 50 to 70 weeks of age. A total of 384 Dekalb Brown laying hens (average body weight of 1.86 kg) were randomly assigned to one of 2 dietary treatments with 12 replicates of 16 hens. Experimental treatments consisted of the same dietary level of Se (0.3 ppm) supplied by sodium selenite or hydroxy-selenomethionine (Selisseo). Both diets were isonutritive, being formulated to meet or exceed the nutrient recommendations described by the genetic strain guideline. Egg quality traits analyzed included weight and percentage of albumen (g, %), yolk (g, %), and eggshell (g, %), eggshell thickness (mm) and strength (kg/f), specific egg weight (g/cm3), Haugh unit, and yolk color. Data were analyzed as one-way ANOVA and means were compared using T student comparison test, considering statistical differences for $P < 0.05$. Selisseo increased ($P < 0.05$) egg weight (63.63 vs. 62.50g), albumen weight (40.37 vs. 39.40g), eggshell thickness (0.470 vs. 0.458mm), eggshell strength (3.335 vs. 3.092kgf) compared with sodium selenite. However, the other egg quality parameters were not influenced ($P > 0.05$) by selenium sources evaluated. The supplemented of 0.3 ppm of hydroxy-selenomethionine (Selisseo) improves eggshell quality traits of laying hens from 50 to 70 weeks of age compared with the traditional inorganic source sodium selenite.

**Key Words:** hydroxy-selenomethionine, eggshell strength, eggshell thickness, albumen

**512P Effect of Selenium supplementation on performance of laying hens.** F. P. Costa, A. Ferreira de Brito, T. S. Ferreira, J. V. Celestino da Silva, D. T. Cavalcante, J. C. L. Muniz, J. G. Gonçalves, and M. Ceccantini, *Federal University of Paraiba, Areia, Paraiba, Brazil, 2Academic Unit of Garanhuns, Garanhuns, Pernambuco, Brazil, 3Adisseo South America, Sao Paulo, Brazil. The supplementation of diets with Selenium is made to meet the nutritional requirements of poultry, with positive effects on performance. However, few studies about sources and levels of selenium for laying hens have been done and the results are contradictory. This experiment was carried out to evaluate the effects of different selenium sources on the performance of laying hen from 50 to 70 weeks of age. A total of 384 Dekalb Brown laying hens (average body weight of 1.86 kg) were randomly assigned to one of 2 dietary treatments with 12 replicates of 16 hens. Experimental treatments consisted of the same dietary level of Se (0.3 ppm) supplied by sodium selenite or hydroxy-selenomethionine (Selisseo). Both diets were isonutritive, being formulated to meet or exceed the nutrient recommendations described by the genetic strain guideline. Parameters analyzed were feed intake (FI, g/d), egg production (%), egg weight (g/egg), egg mass (g/d), egg mass conversion (g/g), egg dozen conversion (kg feed/dozen eggs), number of eggs per poultry housed (egg/poultry housed), viability (%) and final weight of hens (g/bird). Data were analyzed as one-way ANOVA and means were compared using T student comparison test, considering statistical differences for $P < 0.05$. It was observed that the use of Selisseo resulted in an increase ($P < 0.04$) in egg production and number of eggs per poultry housed, respectively, of 1.79% and 3.63%, relative to sodium selenite. In relation to egg weight and egg mass, it was verified that sodium selenite supplementation provided lower ($P < 0.02$) egg weight (63.63 vs. 62.50g) and egg mass (57.54 vs. 55.50 g) when compared with Selisseo supplementation. These results influenced the conversion values by mass and dozen eggs, which were lower ($P < 0.05$) with the use of Selisseo in the diets (1.945 kg / kg and 1.484 kg / dozen), compared with selenite sodium (2.053 kg / kg and 1.540 kg / dozen). The other variables of productive performance were not influenced ($P > 0.05$) by selenium sources evaluated. The supplementation of 0.3 ppm selenium from Selisseo improves the performance of laying hens aged between 50 and 70 weeks of age.

**Key Words:** hydroxy-selenomethionine, organic trace mineral, egg production