53 Effect of low phytate and normal phytate soybean meal varieties and corn particle size on male broiler performance and development of the gizzard and proventriculus to 21 days of age. B. Nusairat*, R. Qudsieh, C. R. Stark, S. Yahav, and J. Brake, Department of Poultry Science, North Carolina State University, Raleigh, Institute of Animal Science, ARO the Volcani Center, Bet Dagan, Israel.

Previously, addition of 50% coarse corn (CC) increased gizzard weight and decreased proventriculus weight at 21 d of age (P < 0.001), while low phytate (LP) soybean meal (SBM) reduced proventriculus weight at 21 d (P < 0.05) when compared with normal phytate (NP) SBM. The present objective was to repeat this experiment but determine organ weights at 8, 15, and 21 d of age to delineate the development of the response. From 1 to 8 d, all birds received 2 diets (0%CC or 50%CC) with the same commercial SBM, which was a NP type. From 9 to 21 d, NP-0%CC, NP-50%CC, LP-0%CC, or LP-50%CC diets were fed in a 2 x 2 design with 16 pens of 8 broilers each for each interaction. Broiler BW gain, feed intake (FI), feed conversion ratio (FCR), and gizzard and proventriculus weights were measured at 8, 15, and 21 d of age. The FCR was better (P < 0.05) for 0%CC (1.08 versus 1.10 g:g) from 1 to 8 d at similar FI and BW gain. From 9 to 15 d, BW gain (360 versus 355 g) and FCR (1.28 versus 1.30 g:g) were improved (P < 0.05) by the 0%CC diet, while from 16 to 21 d the 50%CC diet improved (P < 0.05) BW gain (418 versus 402 g) with numerically better FCR (1.26 versus 1.29 g:g). LP and NP SBM had no significant effect on performance to 21 d. The 50%CC diets produced a larger gizzard (P < 0.001) and smaller proventriculus (P < 0.05) when compared with 0%CC diets at 8, 15, and 21 d of age. There was no main effect of SBM on either gizzard or proventriculus weight at 15 d, but gizzard weight was reduced (P < 0.05) by the LP diets at 21 d and an interaction of SBM and CC for gizzard weight at 21 d was due to NP SBM resulting in a larger gizzard than LP SBM in the presence of 0%CC (P < 0.001). There was an interaction for proventriculus weight at 15 d due to greater weight with the NP SBM diet only in the presence of 0%CC (P < 0.05). These data confirmed that both dietary phytate and CC changed gizzard and proventriculus weights almost immediately and that the beneficial response to 50%CC was beginning to develop by the 0%CC diet, while from 16 to 21 d the 50%CC diet improved (P < 0.05) BW gain (418 versus 402 g) with numerically better FCR (1.26 versus 1.29 g:g). LP and NP SBM had no significant effect on performance to 21 d. The 50%CC diets produced a larger gizzard (P < 0.001) and smaller proventriculus (P < 0.05) when compared with 0%CC diets at 8, 15, and 21 d of age. There was no main effect of SBM on either gizzard or proventriculus weight at 15 d, but gizzard weight was reduced (P < 0.05) by the LP diets at 21 d and an interaction of SBM and CC for gizzard weight at 21 d was due to NP SBM resulting in a larger gizzard than LP SBM in the presence of 0%CC (P < 0.001). There was an interaction for proventriculus weight at 15 d due to greater weight with the NP SBM diet only in the presence of 0%CC (P < 0.05). These data confirmed that both dietary phytate and CC changed gizzard and proventriculus weights almost immediately and that the beneficial response to 50%CC was beginning to develop between 16 and 21 d of age.

Key Words: broilers, low phytate, soybean meal, corn particle size

54 Dietary calcium, phosphorus and phytase effects on bone ash and Ca and P digestibility of broilers exposed to a natural Clostridium perfringens challenge. D. Paiva*, C. Walk, J. Bradley, H. Wladecki, R. Daloul, F. Piersson, and A. McElroy, Virginia Polytechnic Institute and State University, Blacksburg, AB Vista, Marlborough, UK, Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg.

Diet composition and nutrient balance have a critical impact on intestinal integrity during exposure to enteric pathogens. The objective of this study was to evaluate dietary Ca, P, and phytase on bone ash and Ca and P digestibility during a necrotic enteritis (NE) outbreak. Day old, Cobb 500 male broilers were weighed and randomized into 8 treatment groups (9 pens/treatment; 32 birds/pen). The 35 d trial was designed as a 2 x 2 x 2 factorial, which included 2 levels (0.60% and 0.90%) of a highly soluble Ca source, 2 levels of available P (0.30% and 0.45%), and 2 levels of an E. coli phytase (0 and 1,000 FTU/kg). Birds were placed on dirty litter from a previous flock that exhibited clinical signs of NE. Tibias (3/pen) and ileal digesta (8 birds/pen) were collected on d 12, 19, and 35. Significance is reported at P < 0.05. Birds began exhibiting clinical signs of NE on d 9, and elevated NE-associated mortality persisted until d 26. Dietary Ca supplemented at 0.90% or 1000 FTU/kg phytase significantly increased mortality compared with 0.60% Ca or 0 FTU/kg phytase, respectively. Dietary Ca supplemented at 0.90%, P supplemented at 0.45%, and 1,000 FTU/kg phytase significantly increased tibia ash weight compared with 0.60% Ca, 0.30% P, and 0 FTU/kg phytase, respectively, on d 12. A 3 way interaction was observed on d 35 on tibia ash percentage; birds fed diets supplemented with 0.90% Ca and 0.45% P had a significant increase in tibia ash percentage, regardless of phytase supplementation. A 3 way interaction was also observed for Ca and P digestibility on d 35. Phytase supplementation significantly increased Ca digestibility regardless of Ca and P levels of the diets. In addition, diets containing 0.60% Ca and 1,000 FTU/kg of phytase resulted in a significant increase in P digestibility, regardless of P levels. Results showed improvements in Ca and P digestibility with lower dietary levels of Ca and P and the addition of phytase, which was likely consequent to improved performance when feeding lower Ca diets during the NE episode.

Key Words: calcium, phosphorus, phytase, tibia ash, digestibility


Vitamin E (VE) is an antioxidant with reproductive and immune functions. RRR-α-tocopherol (ATOC) has the greatest VE bioactivity and is referred to as natural VE (NVE). Synthetic vitamin E (SVE) is an equal mixture of 8 ATOC stereoisomers with differing VE activities. The objectives were to determine how VE form, hen age and chick age affect chick innate immunity. Ross 308 hens were fed 54 IU/kg of either SVE or NVE. At 31, 45 and 57 wk of hen age, yolk ATOC content and the effect of maternal VE source on chick innate immunity were assessed. Ex vivo E. coli bactericidal capacity, phagocytosis and oxidative burst (OB) at 1 and 4 d of age, and chick plasma antioxidant capacity (AOX) weekly to 21 d of age were measured. Differences were determined using PDIF of LSMMeans (SAS 9.2) and were considered significant at P < 0.05. Yolk ATOC decreased in eggs from SVE-fed hens as hens aged, but not in NVE-fed hens. Chick E. coli killing decreased as hens aged but increased as chicks aged, the latter being an indication of immune maturation. Natural VE increased E. coli killing in chicks from 45 wk old hens, at other hen ages hen VE form did not affect E. coli killing. Maternal VE form did not affect phagocytic ability of chick immune cells, nor OB in 1 d old chicks. Maternal NVE increased OB in 4 d old chicks from 45 and 57 wk old hens. In 4 d old chicks, OB in chicks from NVE supplemented hens was not affected by hen age, while OB in chicks from SVE hens decreased as hens aged. OB may not play a prominent role in E. coli killing in chicks. Plasma AOX increased from 0 to 21 d in chicks from 31 wk NVE hens and from 0 to 14 d in chicks from 45 wk hens. At 57 wk of hen age, chick plasma AOX from NVE hens decreased as chicks aged, but peaked at d 14 in chicks from SVE hens. AOX tended to be greater in chicks from NVE hens. The relatively high levels of dietary VE activity may have masked
differences in bioactivity related to immune function. NVE and SVE may be differentially transferred to eggs as hens age.

**Key Words:** immune function, vitamin E, hen age, chick age, broiler breeder

56  **Effects of selenium yeast and vitamin E supplementation in maternal and progeny diets on the tissue selenium concentration and growth performance of broilers.** A. D. Quan†,1, A. J. Pescatore1, A. H. Cantor2, T. Ao3, M. J. Ford1, W. D. King1, J. M. Unrine2, and J. L. Pierce1,1Alltech-University of Kentucky Nutrition Research Alliance, Lexington, 2Department of Plant and Soil Sciences, University of Kentucky, Lexington.

A study was conducted to evaluate the effect of maternal and progeny dietary selenium (Se) and vitamin E (Vit.E) supplementation on the performance and tissue Se status of progeny. The study utilized a split plot design, with maternal diet as the whole-plot factor and the progeny diet as the sub-plot factor. Broiler breeder hens (Cobb500TM) were fed 4 diets consisting of corn-soybean meal basal diet (with or without added Se or Vit.E), supplemented with 0.3 mg Se/kg diet as Se yeast (Sel-Plex®, Alltech, Inc., Nicholasville, KY), 30 IU Vit.E/kg diet as all-rac-α-tocopheryl acetate, or both. Progeny were hatchet out of eggs collected at 44 weeks of age and raised in floor pens (1.22 × 1.83 m). Chicks were fed 4 diets similar in treatment structure to the hen diets and were allocated within each block to account for all maternal and chick diet interactions (16 chicks/pen, 48 pens total). Liver and breast samples were collected from chicks at 0, 7, and 14d of age for analysis of tissue Se content. Breast and liver Se concentrations on d 0 were greater for the chicks originating from hens receiving Se yeast in the diet (P < 0.01). At 7d of age, Se yeast supplementation in either the chick or maternal diet increased breast and liver Se concentrations (P < 0.01), however there were no interactions between the 2. At 14d of age, breast and liver Se concentrations remained the highest for chicks supplemented with Se yeast (P < 0.01), however there was no effect of maternal Se supplementation. Average daily gain through 49d of age was not affected by dietary treatments, however, ADFI tended to be highest for chicks fed Se yeast + Vit.E (P = 0.07). Overall, Se supplementation in maternal diets appears to increase tissue Se deposition in the progeny at hatch, maintaining the maternal effect through 7d of age. Inclusion of Se yeast in chick diets effectively increases the tissue Se levels of chicks.

**Key Words:** Se yeast, vitamin E, broiler breeder, progeny, chicks

57  **Effects of in ovo injection of 25-hydroxycholecalciferol on bone development in Ross × Ross 708 broilers.** A. Bello†,1, P. D. Gerard2, W. Zhai3, S. K. Womack4, and E. D. Peebles1,1Mississippi State University, Mississippi State, 2Clemson University, Clemson, SC.

The effects of various levels of in ovo injected 25-hydroxycholecalciferol [25(OH)D3] on subsequent breaking strength (BS) and percentage ash content (PA) of tibiotarsae from Ross × Ross 708 broilers on d 0 and 21 post-hatch were investigated. Eggs were individually weighed and set on 10 replicate tray levels of a single-stage incubator. All treatment groups, each containing 21 eggs, were represented on each tray level. On d 18 of incubation, each egg was subjected to one of 6 treatments using a commercial multi-egg injector. Treatments included non-injected and 100 µL diluent-injected controls [0 IU of 25(OH)D3], along with those that received 100 µL of diluent containing either 6, 12, 24, or 48 IU of 25(OH)D3. On d 0 and 21 post-hatch, the left tibiotarsal bone was collected from 3 randomly selected chicks (at least 1 of each sex) within each treatment replicate group for BS and PA analyses. In females from injected eggs, 25(OH)D3 at 12 IU reduced (P ≤ 0.01) PA in comparison to 0 IU on d 0, and 25(OH)D3 at 48 IU decreased (P ≤ 0.02) PA in comparison to 24 IU on d 21. Furthermore, in males from injected eggs, 25(OH)D3 at 12 IU reduced (P ≤ 0.02) PA in comparison to 0 and 6 IU on d 21. These results suggest that increasing the levels of in ovo injected 25(OH)D3 between 12 and 48 IU may inversely influence PA on d 0 and 21 post-hatch. However, effects were dependent upon broiler age and sex. Nevertheless, the increases in the dosages of 25(OH)D3 described in this study did not affect BS on d 0 and 21 post-hatch in male and female Ross × Ross 708 broilers.

**Key Words:** 25-hydroxycholecalciferol, broiler, development, in ovo, tibiotarsae

58  **Broiler performance response from the supplementation of Hy-D (25-OH D3) in the starter diet versus all diets.** P. Post†, J. Bray1, and B. Turner2, 1Department of Agriculture, Stephen F. Austin State University, Nacagdoches, TX, 2DSM Nutritional Products LLC, Parsippany, NJ.

An experiment was conducted to compare performance and yield data between paired commercial broiler houses receiving the full recommended dose of Hy-D in either the starter diet or all diets over 2 consecutive flocks. Hy-D is a feed additive, with 25-hydroxyvitamin D3 (25-OH D3) as the active ingredient. A total of 26,900 straight run broilers were placed in each of the 4 (13.1 m X 152.4 m) broiler houses at the Stephen F. Austin Broiler Research Center, at a stocking density of 0.24m2 per bird and reared to 52 d. The study consists of 2 consecutive flocks, Farm #1 (Houses #1 & #2) contained Hy-D in the 3 diets (HyD-ALL), while Farm #2 (Houses #3 & #4) received Hy-D only in the starter diet (HyD-STR). For the second flock, treatment houses were switched, to limit house and environmental variation. Blood samples were collected at chick placement on d 18, 35, and 49 from 10 randomly selected broilers per house (20 per treatment) for both flocks to determine the serum 25-OH D3 levels. The right tibia was excised from 10 randomly selected broilers per treatment on d 18, 35, and 49. At the completion of each flock, a yield study was conducted on 200 birds (100 per treatment). Breast samples were tested for percent protein levels, no statistical differences were detected. Performance results varied from flock to flock. HyD-ALL was significantly different from HyD-STR for skin, total white meat and breast yield, yielding 0.77% more breast meat than HyD-STR, for flock one. In flock 2, HyD-STR had a significantly higher live weight, however HyD-ALL yielded 0.50% more breast meat as a percentage of body weight. Bone ash results were not significantly different. Blood work results indicated that there was a higher amount of 25(OH)D3 present in the HyD-ALL birds. The results of this study suggest that with the addition of Hy-D to the feed breast yields can be increased.

**Key Words:** 25-OH D3, performance, yield, blood, broilers


This study was conducted to evaluate the effect of adding different dietary levels of zinc (Zn) as zinc sulfate, copper (Cu) as copper sulfate,
and Roxarsone (3-Nitro) on BW, BW gain, feed intake, and adjusted FCR (AdjFCR) in broilers. A total of 1152 Ross 708 male and female broiler chicks were randomly assigned to 72 pens distributed over 4 blocks with 16 birds per pen, and 4 pens per diet and sex interaction, on used litter. Birds were fed 1 of 9 diet series; 8 diets had a 2 × 2 × 2 factorial arrangement of Zn x Cu x 3-Nitro x gender and contained: Zn (120 or 240 mg/kg), Cu (10 or 100 mg/kg), and 3-Nitro (0 or 45.5 mg/kg), and a negative control diet (no trace minerals or 3-Nitro added) fed to male and female pens as well. The 3-Nitro was added to the diets from 14 d of age. Monensin was used in place of 3-Nitro in all other diets. Data were analyzed in a randomized complete block design using the MIXED procedure of SAS to assess the differences between main effects of diet and gender. BW and BW gain at 14 d of age were greater (P < 0.001) in males regardless of diet consumed, but the feed intake was affected by levels of Zn (P < 0.05) and Cu (P < 0.05) in the diet, and was the greatest (P < 0.05) in males consuming 120 mg/kg Zn with 100 mg/kg Cu. There was a diet effect for AdjFCR at 14 d where birds consuming 240 mg/kg Zn with 10 mg/kg Cu had the best AdjFCR (P < 0.05), while increasing the level of Cu to 100 mg/kg at 240 mg/kg Zn level resulted in the poorest AdjFCR (1.24 versus 1.34). At 35 d of age, both BW gain and feed intake were higher (P < 0.001) in males with no diet effect, and AdjFCR was better (P < 0.001) for males (1.61 versus 1.52 for females and males, respectively). Current results suggested that raising broilers on used litter provided them with a trace mineral source sufficient to compensate for the trace mineral-deprived negative control diet. There was no significant effect of adding 3-Nitro to the diets.

Key Words: broiler, zinc, copper, Roxarsone

60 Effect of different sources and levels of selenium on performance, meat quality and tissue characteristics of broiler. T. F. B. Oliveira, E. C. Rodrigues, E. M. Ramos, and A. G. Bertechni, Federal University of Lavras, Lavras, Minas Gerais, Brazil.

Selenium (Se) is an essential nutrient in broiler diets and its concentration in ingredients can vary greatly from region to region. Therefore, some doubts still exist concerning the sources and the levels of supplementation for broilers. This study was conducted to evaluate the effects of dietary levels and different sources of Se (Sodium selenite (SS), Se Yeast (SY) and the combination of both sources (SS+SY)) on performance, meat quality (drip loss, cooking loss, pH and shear force), and tissue characteristics (concentration of Se in the liver and breast meat). A total of 2,880 male broiler chicks Cobb-500 were distributed in 96 floor pens with 30 birds per pen in a factorial arrangement of 4x3 (Se levels of 0.15, 0.30, 0.45, 0.60 ppm and the sources were SS, SY and SS+SY). A completely randomized design 12 treatments with 8 replicates each treatment were evaluated. Data resulting in a significant F-test were further analyzed by Tukey test (SAS). Significance level was set at P < 0.05. There was no interaction and no effect of levels and sources on performance parameters and mortality. The level of 0.15 ppm resulted in higher percentage of cooking loss. However, the cooking loss for SY was lower than the other sources. The source affected drip loss after 24 h, with lower percentage for SY. The drip loss after 48 h for SY was lower than the SS, and SS+SY did not differ from the other sources. The levels and the sources of Se did not affected pH and shear force. SY was the most efficient in deposit Se in the liver and in the breast meat. Nevertheless the feed supplemented with 0.30 ppm of SS+SY was enough to provide all the Se required for a human adult, when consuming 150 g of the meat. The results suggest that the supplementation level of 0.15 ppm of Se independent of the source can maintain the normal performance of the birds. In terms of meat quality and Se deposition, SY appears to have a greater influence. Regarding the enrichment of the meat with Se, the level of 0.30 ppm of SS+SY is better recommended.

Key Words: antioxidant, drip loss, cooking loss, organic, mineral deposition

61 Greater bioavailability of Mintrex Zn than Zn sulfate in the absence or presence of elevated Ca and P as antagonists. J. D. Richards,* P. Fisher, and K. J. Wedekind, Novus International Inc., St. Charles, MO.

Diets can contain antagonists that reduce trace mineral bioavailability and cause deficiencies. Two experiments (Exp) were conducted to compare the relative bioavailability of Mintrex Zn (Zn chelated with the methionine hydroxy analog) vs. Zn sulfate in the absence and presence of excess Ca and P as antagonists. In Exp 1, broiler chicks were assigned to 11 treatments, fed a common Zn-deficient starter (19 mg Zn/kg diet) through d8 and then fed a Zn-unsupplemented (21 mg Zn/kg diet; 0.82% Ca, 0.47% available P) corn-soy diet (basal), or the basal supplemented with 5, 10, 15, 20 or 30 mg Zn/kg diet as Zn sulfate or Mintrex Zn. Jejunum mucosa was collected on d11 to measure metallothionein (MT) mRNA expression. Tibias were collected on d14 for Zn analysis. For Zn sulfate, there was a linear relationship (P < 0.0001) between tibia Zn (μg) and supplemental Zn intake (mg). For Mintrex Zn, the relationship was quadratic (P = 0.006, inflection point at 17.4 mg supplemental Zn/kg diet). Common-interpret, multiple linear regression and slope-ratio analysis indicated significantly greater Zn bioavailability for the chelate relative to Zn sulfate for both tibia Zn (161%; P = 0.001) and MT expression (248%; P = 0.009). In Exp 2, chicks were fed a common Zn-deficient (24 mg Zn/kg diet) starter diet for 8 d, then placed on a corn-soy basal diet with elevated Ca and P (27 mg Zn/kg diet; 1.2% Ca, 1% available P), or the basal supplemented with 15 or 30 mg Zn/kg diet as Zn sulfate or 7.5, 15 or 30 mg Zn/kg diet as Mintrex Zn. Bioavailability of Mintrex Zn relative to Zn sulfate was 441% (P = 0.006, tibia Zn) and 426% (P = 0.004, MT). The rate of increase in tibia Zn concentration (mg Zn/kg tibia) as a function of supplemental Zn intake was comparable in Exp 1 and 2 for Mintrex Zn. In contrast, this rate of increase in birds supplemented with Zn sulfate was 40% lower in the presence of elevated Ca and P. These results suggest that Zn sulfate was antagonized to a much greater extent than was Mintrex. Supplementation with Mintrex Zn would be beneficial in diets containing excesses of dietary antagonists such as Ca and/or P.

Key Words: Mintrex, bioavailability, zinc, antagonism

62 Establishing the bioavailability of phosphorus in corn DDGS for D3-21 Cobb 500 male broilers. K. G. S. Wamsley,† R. E. Loar II, K. Karges, and J. S. Moritz, West Virginia University, Morgantown, POET LLC, Sioux Falls, SD.

The objective of the current study was to evaluate the bioavailability of phosphorus in corn distillers dried grains with solubles (DDGS) as DDGS inclusion in starter diets increased to assess if previously established available phosphorus (AP) values (0.65% AP) needed adjustment due to evolving DDGS production technology and broiler genotypes. A 5x3 factorial analysis was utilized with variations in diet formulations for
available phosphorus (0.21, 0.27, 0.33, 0.39, or 0.45%) and DDGS Level (0.8, or 16%). All diets were manufactured at West Virginia University’s pilot feed mill and fed as mash. Treatments were randomly assigned to one of 90 raised-wire pens in a randomized complete block design. Pens contained 5, 3-old Cobb 500 male broilers. The experimental period was D3–21 with measured variables including: average bird weight (BW), average live weight gain (LWG), pen feed intake (FI), and feed conversion ratio (FCR). On D21, birds were killed via cervical dislocation and left tibias were extracted from each bird to obtain tibia ash measurements. Live performance and tibia measurements improved with increasing levels of AP ($P = 0.0001$). There were no significant differences for the main effect DDGS Level, however trends were observed for LWG ($P = 0.067$), FI ($P = 0.06$), BW ($P = 0.1$), and percent tibia ash per chick ($P = 0.13$) demonstrating the most benefit when including 8% DDGS into diets, likely due to lower non-starch polysaccharide level relative to the 16% DDGS inclusion. Prediction equations were derived using the average calculated AP means from diets containing 0, 8 and 16% DDGS and corresponding performance variables. Based on these equations, AP was predicted for each measured performance variable. These data demonstrate that the current AP coefficient for DDGS is justified, but trends suggest it may underestimate availability by up to 0.02 percentage points.

**Key Words:** DDGS, available phosphorus, broiler performance, prediction equations

### 63 Calcium and phosphorus requirements for two strains of broilers from hatch to 10 days of age.

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More closely defining the Ca and P requirements of broilers is essential for the optimization of bone development as well as for optimum use of phytases in broiler diets. Requirements were determined for 2 strains selected based on differences in the growth curves their extensive use in the US. An experiment was done to determine the Ca and non phytate P (nPP) requirements for 2 strains: Ross 708 (R) and Hubbard 99 males by Cobb 500 females broiler (HC) from hatch to 10 d of age. Three Ca concentrations in combinations with 4 nPP concentrations were tested. The treatments were as follows: 0.83% Ca, and 0.25, 0.34, 0.42, and 0.50% nPP; 0.96% Ca, and 0.29, 0.34, 0.42 and 0.50% nPP; 1.13% Ca, and 0.34, 0.42, 0.50 and 0.58% nPP. Diets were analyzed and all data analysis was run based on analyzed values. A 2 way ANOVA was run with treatment and strain as fixed effects. Additionally an individual surface analysis was performed to determine optimal levels of Ca and nPP for each strain, based on analyzed Ca and P concentrations. There was a strain effect on BWG, FCR as well as toe and tibia ash and a treatment effect on all performance and bone measures. Based on the results of the surface analysis there was a linear effect of Ca on tibia ash and toe ash for both R and HC and on FCR only on R. The effect of nPP was quadratic for BWG, FCR, and tibia ash for both R and HC while nPP had a linear effect on toe ash in R and quadratic in HC. Regressions were run for nPP at each Ca level and nPP requirements were estimated only when the regression had a quadratic effect and an asymptote could be calculated. Based on the quadratic equations obtained from the data the nPP requirement for maximal BWG was estimated at 0.50% nPP for both 0.83 and 0.94% Ca for the R strain and 0.46% nPP when Ca was 0.83% in the HC strain. The nPP requirement for maximal tibia ash was estimated to be 0.59 and 0.62% for the R strain and 0.58 and 0.60% for the HC strain at 0.83 and 1.14% Ca, respectively.

**Key Words:** calcium, phosphorus, requirements, broilers, strains

### 64 Feeding laying hens the diets with supplemental chelated trace minerals improves shell quality, tibia breaking strength, and immune response.


A 56 wk (24 to 80 wk of age) study was conducted to determine the long-term effects of feeding Mintrex (metal methionine hydroxy analog chelate) vs. ITMs (inorganic trace minerals) in layers on performance, egg shell quality, tibia breaking strength, and immune response. A total of 216 Hy-Line W-36 laying hens were assigned to 6 treatments with 36 pens/treatment and 1 hen/cage. The study was carried out under random-ized complete block design. The data were analyzed using both 1-way ANOVA (including all 6 treatments) and 2x2 factorial design with 2 sources (chelated vs. ITMs) and 2 levels (20-5-20 vs. 40-10-40 ppm of Zn-Cu-Mn) of supplemental minerals. The treatments consisted of: 0-0-0 ppm supplemental Zn-Cu-Mn, T1; 20-5-20 ppm Zn-Cu-Mn as sulfates, T2; 20-5-20 ppm Zn-Cu-Mn as chelates, T3; 40-10-40 ppm Zn-Cu-Mn as sulfates, T4; 40-10-40 ppm Zn-Cu-Mn as chelates, T5; 80-10-80 ppm Zn-Cu-Mn as sulfates, T6. Measurements for body weights were taken at wk 24, 32, 48, 64, and 80; cumulative FCR on egg mass was calculated based on 3 d feed intake and egg weights measured for 14 individual periods of 28 d cycle each; cumulative egg production was measured based on daily production; shell strength and thickness measured at wk 44, 56, 68, 74, 76, and 79; tibia breaking strength at wk 80; immune response at wk 60, 61, 63, 65, 70, and 80. Overall results (1-way ANOVA) indicate a significant treatment effect ($P < 0.05$) only for shell thickness at wk 74. Factorial analysis data indicates an improvement in shell breaking strength (Source effect, $P < 0.05$ at wk 68), shell thickness (Source effect, $P = 0.08$ at wk 68; $P = 0.03$ at wk 74), and Ab titers (Source effect, $P < 0.05$ at wk 63) to SRBCs (sheep red blood cells) for hens fed chelated trace minerals compared with ITMs. Supplementing increased levels (Level effect, $P = 0.07$ at wk 80) of dietary minerals or chelates (Source effect, $P = 0.19$ at wk 80) increased tibia breaking strength. In summary, feeding laying hens the diets with supplemental chelated trace minerals compared with ITMs improved egg shell strength and thickness, and immune response.

**Key Words:** Zn, Cu, Mn, layer, chelates

### 65 Effects of dietary nonphytate phosphorus levels on thiram-induced tibia dyschondroplasia in broilers.

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This trial was conducted to investigate the effects of dietary levels of nonphytate phosphorus (nPP) on thiram-induced tibia dyschondroplasia (TD) in broilers. For starter period (1–21d), the experiment consisted of a 2×3 factorial arrangements with 2 levels of thiram (0.100 mg/kg) and 3 levels of nPP (0.33%, 0.48%, 0.63%). All diets were maintained the same Ca 1.0%. For grower period (22–42d), all the birds received the same diet containing 0.40% nPP and 0.90% Ca without thiram. Six
hundred day-old broilers were randomly assigned to 6 treatments with 5 replicate pens of 20 male chickens per treatment. The thiram diet was fed only at 1–5d to induce TD. Blood and tibia samples were collected at 5d, 21d, and 42d. TD scores increased with increasing nPP levels at 5d and 21d especially under thiram-induced condition ($P < 0.05$). Thiram significantly increased TD scores at 5d, 21d, and 42d ($P < 0.05$). Body weight and feed intake were optimized with 0.48% nPP ($P > 0.05$), and they were significantly affected by thiram at 5d and 21d ($P < 0.05$). Serum parathyroid hormone (PTH) level increased with increasing nPP levels under thiram-induced condition at 5d ($P = 0.099$). Thiram caused hyperparathyroidism that serum PTH, Ca and P levels at 5d and serum PTH level at 21d were significantly increased ($P < 0.05$). The birds fed diet containing 0.33% nPP showed lowest tibia ash, Ca, and P at 5d and 21d ($P < 0.05$). Thiram significantly decreased tibia ash, Ca, and P at 5d and decreased tibia strength and Ca at 21d ($P < 0.05$). Tibia ash, Ca, and P were optimized by 0.63% nPP under thiram-induced condition at 21d ($P < 0.05$). Growth performance and tibia parameters had recovered except TD scores during the grower period. In conclusion, TD scores increased with increasing nPP levels especially with thiram feeding. Thiram-induced TD was linked to hyperparathyroidism which caused calcium homeostasis dysregulation.

**Key Words:** thiram, nonphytate phosphorus, tibia dyschondroplasia, hyperparathyroidism, broiler

### Performance and carcass characteristics of broilers fed five different commercial vitamin-mineral premixes in Ibadan, Nigeria


The relative efficacy of 5 proprietary vitamin-mineral premixes on serum indices, hematological and physico-chemical properties of broiler meat was undertaken in a trial lasting 6 weeks. Two hundred eighty-eight 1-day broiler chicks of Arbor acre strain were randomly allotted to 6 treatments of forty-eight chicks each. Each treatment was a triplicate of 16 chicks per replicate. Six isocaloric and isonitrogenous diets were formulated. Diet 1 (T1) was the control without any premix added. Other diets were supplemented appropriately with 0.25% Daramvita (T2), Biorganics (T3), Hinutrients (T4), Optimix (T5), and DSM Nutripoults (T6). The experimental diets were assigned to the respective birds with water given ad libitum and the experiment - a completely randomized design. Serum cholesterol, albumin and alkaline phosphatase at the starter phase and total protein, albumin, globulin and high density lipoprotein at the finishers phase varied ($P < 0.05$). The packed cell volume obtained for birds on T1, T2, T3, T4, T5 and T6 were 26.67, 27.83, 29.50, 28.83, 28.83 and 28.00 respectively, at the starter phase, were significantly different ($P < 0.05$). The crude protein (%) of meat from T6 (31.95), T2 (30.91) and T3 (30.83) were higher ($P < 0.05$) compared with 29.75, 29.91 and 28.45 obtained for meat from T5, T4 and T1 respectively. Ash (%) was significantly lower ($P < 0.05$) with the type of premix used. The shear force of primal cuts of broilers were statistically similar ($P > 0.05$) while cooking losses was higher ($P > 0.05$) for thigh from T5 and T6. The chilling losses was higher for thigh from T3 and T4, and water holding capacity of thigh from T2 was higher ($P < 0.05$). The test premixes had varying effects on indices measured which invariably connotes unequal potency of the tested commercial vitamin-mineral premixes in Ibadan, Nigeria.

**Key Words:** meat chemical composition, hematology, primal cuts, physico-chemical properties, serum indices