0.0 and 1.0% black cumin seed. Hens fed a layer diet containing 1.0% black cumin seed showed significantly the lightest egg yolk color compared to the other treatments. Egg weight per hen increased significantly for hens fed a layer diet containing 4.0% black cumin seed compared to those fed 1.0% black cumin seed. Results concluded that adding black cumin seed into layer diets at a level of 4.0% can improve the productive performance of laying hens.

Key Words: Black Cumin Seed, Egg Production, Egg Weight, Laying Hens, Productive Performance

T130 An Electron Microscopic Study of the Effect of Adding Dietary Baker Yeast (Saccharomyces cerevisiae) on the Ability of E. coli to Attach and Efface the Intestinal Cells of Broiler Chicks Challenged with E. coli
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To evaluate the effects of adding dietary baker yeast (Saccharomyces cerevisiae) on the ability of E. coli to attach and efface the intestinal cells of broiler chicks challenged with E. coli, 240 broiler chicks of 1 d old were used from 1 to 35 d of age. Chicks were randomly distributed among four treatments with three replicates of 20 chicks each. Chicks were fed either 0.00% yeast and unchallenged with E. coli (negative control), 0.00% yeast and challenged with E. coli (positive control), 0.75% yeast and challenged with E. coli, or 1.00% yeast and challenged with E. coli. Chicks were challenged with 1.9 x 10⁹ colony forming units of E. coli in 1.5 mL at 7 d of age by oral gavage. Three chicks from each replicate were sacrificed at 7, 14, 21, and 28 d post challenge and specimens of the gastrointestinal tract were collected for E. coli enumeration and adhesion assay by scanning and transmission electron microscopy. Results showed that the cecum of all challenged chicks were the only segment of the gastrointestinal tract that showed observable lesions. Challenged chicks fed 1.00% yeast showed drastic diminishing in bacterial enumeration compared to the other treatments. At 21 d post-challenge, about 87% of positive control chicks showed both cecal attachment and effacement, while 37% and 16% of challenged chicks fed 0.75% and 1.00%yeast showed cecal attachment, respectively. Results obtained from the present study suggest that adding 1.00% yeast to broiler diet resulted in a significant reduction in bacterial attachment and may enhance the productive performance of chicks via the inhibitory effect of yeast against E. coli pathogenic bacterium.

Key Words: Broiler, Electron microscopy, Escherichia coli, Saccharomyces cerevisiae, Yeast

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T131 Nucleotide supplementation in the diet of broiler breeders and their effect on hatchability and subsequent progeny performance
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This study was aimed to evaluate the effects of nucleotide supplementation on broiler breeders diets regarding egg hatchability and on progeny performance. The nucleotides were derived from a yeast source (Hilyses/ces cerevisiae) on the ability of E. coli to attach and efface the intestinal cells of broiler chicks challenged with E. coli, 240 broiler chicks of 1 d old were used from 1 to 35 d of age. Chicks were randomly distributed among four treatments with three replicates of 20 chicks each. Chicks were fed either 0.00% yeast and unchallenged with E. coli (negative control), 0.00% yeast and challenged with E. coli (positive control), 0.75% yeast and challenged with E. coli, or 1.00% yeast and challenged with E. coli. Chicks were challenged with 1.9 x 10⁹ colony forming units of E. coli in 1.5 mL at 7 d of age by oral gavage. Three chicks from each replicate were sacrificed at 7, 14, 21, and 28 d post challenge and specimens of the gastrointestinal tract were collected for E. coli enumeration and adhesion assay by scanning and transmission electron microscopy. Results showed that the cecum of all challenged chicks were the only segment of the gastrointestinal tract that showed observable lesions. Challenged chicks fed 1.00% yeast showed drastic diminishing in bacterial enumeration compared to the other treatments. At 21 d post-challenge, about 87% of positive control chicks showed both cecal attachment and effacement, while 37% and 16% of challenged chicks fed 0.75% and 1.00%yeast showed cecal attachment, respectively. Results obtained from the present study suggest that adding 1.00% yeast to broiler diet resulted in a significant reduction in bacterial attachment and may enhance the productive performance of chicks via the inhibitory effect of yeast against E. coli pathogenic bacterium.

Key Words: Black Cumin Seed, Egg Production, Egg Weight, Laying Hens, Productive Performance

T132 The effect of sexual maturity and egg production on protein turnover in broiler breeder pure lines
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Protein turnover in skeletal tissue for broiler breeders has been shown to increase at sexual maturity and then decline with increased egg production (Ekmay et al., 2012). The authors believe the increased protein degradation rate at sexual maturity is to provide amino acids for egg production. The objective of the present study was to evaluate protein turnover in two broiler breeder pure lines during sexual maturity transition and throughout production. Protein turnover was determined in two broiler breeder pure lines (Line 1 (L1) and Line 2 (L2)) at 22, 27, 32, 37, 44 and 50 weeks of age. A complete randomized design with a 2x6 factorial arrangement (2 lines, 6 ages) provided 12 treatments. There were 5 replicates per treatment and each hen represented a replicate. Analysis of variance was performed using JMP software. Five hens at each age were given an intravenous flooding-dose of 15N-Phe (150 mM, 40% APE) at 10 ml/kg. After 10 min, birds were slaughtered and the breast and leg muscle excised and frozen in liquid nitrogen. Excreta was also collected and frozen. The acid-soluble fraction (2% perchloric acid) containing free amino acids from muscle was separated from the protein precipitate. The ratio of 15N:14N of each fraction was determined via GCMS. Quantification of 3-methylhistidine in both muscle and excreta was also determined via GCMS. All birds were scanned for body composition before sampling. No statistical differences were found for the breast fractional synthesis rates (FSR) between lines and ages. There was a significant age effect on fractional breakdown rate (FBR). FBR in breast skeletal tissue increased from 22 wk of age (15.69%) to sexual maturity (19.64%). The rate significantly increased again from week 27 (first egg) to week 33 (peak) (19.64% (L1), 21.62% (L2) and 28.63% (L1),28.7% (L2) respectively; P value < 0.0001) and remained the same at week 37, then it decreased significantly at week 44 (14.45% (L1) and 15.92% (L2); P value < 0.0001) and again at week 50 (4.84% (L1) and 4.74% (L2); P value <0.0001). There were no significant differences for leg FSR rate between lines and ages. Leg FBR statistically increased from week 27 to week 37 (18.69% (L1), 18.51% (L2) and 24.82% (L2), 24.19% (L2), respectively;
P. value < 0.0001) and then it significantly decreased at week 44 (6.98% (L1) and 7.69% (L2) and again at week 50 (2.58% (L1) and 2.69% (L2); P. value < 0.0001). FDR in legs peaks at a lower rate at wk 33 and does not show a plateau from 33 wk to 37 wk. There is a large increase in FDR during the transition for the pullet to sexual maturity with increases in FFR through peak egg production, which is related to a decreased in lean mass body content during this period of time.

Key Words: protein turnover, sexual maturity, fractional synthesis rate, fractional breakdown rate, 15N- PHE

T133 Performance and Carcass Characteristics of Broiler Breeders Progeny Fed Canthaxanthin and 25-Hydroxycholecalciferol LUCIO ARAUJO¹, Cristiane Araujo¹, Rafael Hermes², Isaac Bittar¹ University of Sao Paulo, Pirassununga, SP, Brazil; ²DSM Nutritional Products, Sao Paulo, SP, Brazil

This research was conducted to evaluate performance and carcass characteristics of progeny from broiler breeders (Cobb 500) fed Canthaxanthin and 25 - Hydroxycholecalciferol (25-OHD₃). The breeder hens were fed either a basal diet or the basal diet supplemented with Canthaxanthin (6 ppm) and 25-OH-D₃ (69 mg/ton) from 25 to 62 wks. Breeders (80) were reared in a floor pen facility and randomly distributed in 10 replicates/treatment. Each pen was equipped with one nest, 1 bell drinker, and 1 female trough feeder on the slats. Each pen contained 4 females and males were reared separately. Hens were artificially inseminated with 50 μL of diluted semen 2 d prior to egg collection. Chicks were hatched at 3 different ages (35, 45, and 62 wk). From each hatchery batch, 300 chickens were placed into 20 pens (5 pens/treatment and 15 birds/pen) in a 2x2 factorial design, being: breeders fed or not to canthaxanthin and 25-OH-D₃ (CTX-25D₃) and progeny fed or not CTX-25D₃ until 21 days of age. After that, birds were fed a common diet. Broilers growth was weekly registered and at the end of trial, 2 birds/pen were sacrificed and carcass characteristics measured. Data ANOVA in a factorial design was performed, considering statistical significance when P<0.05. There were no effect (P>0.05) on feed intake and legs yield between treatments. The best weight gain was observed on interaction between use of CXT-25D₃ on breeders and progeny diets at 35, 45, and 62 wks (2.981; 2.994; and 2.989, respectively). The supplementation of CTX-25D₃ on breeders diets improved (P<0.05) feed conversion on progeny at 35 and 62 wks, when compared to the control treatment (1.69 vs. 1.72; 1.67 vs. 1.75, respectively). At 45 wk the best feed conversion was observed on interaction between treatments by use of CXT-25D₃ on the breeders and progeny diets (1.65). Broilers progeny presented the best carcass and breast meat yield at 35 (71.59% and 22.79%), 45 (72.34% and 22.94%) and 62 (72.23% and 23.03%) wks, respectively, on interaction between breeders and progeny fed CXT-25D₃. In conclusion, results showed the importance of the maternal supplementation of antioxidants (canthaxanthin) and adequate levels of Vit D3 metabolites on the broilers progeny, mainly when this supplementation is followed in the starter growth phases.

Key Words: broiler breeders, breast meat yield, canthaxanthin, 25-hydroxycholecalciferol

T134 Body composition, egg production and shell quality of eggs from four breeder genetic lines fed diets varying in calcium and non-phytate phosphorus content Phiphob Sodsee¹, Karen Vignale, Justina Caldas, Nirun Booninschai, Monticha Putsakum, Judith England, Craig Coon University of Arkansas, Fayetteville, AR

The effect of calcium (Ca) and non-phytate phosphorus (NPP) level in four breeder genetic lines from 21 through 50 weeks of age was determined. Pullets (246 from each of purelines A, B, C and D) were individually caged and light stimulated at 21 weeks of age. Hens from each line were fed with one of six diets varying in Ca and NPP: 1) 2.25% Ca with 0.25% NPP, 2) 2.50% Ca with 0.25% NPP, 3) 2.75% Ca with 0.25% NPP, 4) 3.0% Ca with 0.25% NPP, 5) 3.25% Ca with 0.25% NPP, and 6) 3.25% Ca with 0.40% NPP. Daily allotted feed intake was increased for every 8 percent increase in egg production going from 5% to peak. At peak feed intake the breeders consumed a minimum of 3.08 g Ca and 0.34g NPP and the maximum intake of 4.45g Ca and 0.55g NPP. Egg production and feed intake were recorded daily. Eggs were weighed 2 consecutive days a week. Body weight, body composition and egg quality parameters were measured monthly. Body composition was determined for 4 hens from each treatment (line x diet) using dual energy x-ray absorptiometry (DXA). Statistical analysis was done using two-way ANOVA with interaction from main factors (line and diet). Results showed that genetic line had a significant effect on all tested parameters. Level of Ca and NPP in the feed had no effect on egg production, age at first egg, mortality, or egg weight. However, hens fed diets 5 and 6 had significantly better egg shell quality compared to those fed diet 1, but not significantly better than from hens fed diet 2, 3, or 4 for shell:egg ratio, SWUSA, and %shell Ca. The % bone mineral content (%BMC) of hens decreased over the period of egg production whereas % body fat and %lean mass was stable. Both line and diet significantly affected %BMC. Shell quality corresponded to %BMC of hens. In conclusion, genetic line had significant effect on both egg production and shell quality. There was no significant difference in egg production and shell quality for breeder hens fed either 0.25% or 0.4% NPP (NPP intake ranging from 0.34 to 0.55g with peak feed) with 3.25% Ca in the diet.

Key Words: calcium, non-phytate phosphorus, shell quality, pureline breeder, dual energy x-ray absorptiometry (DXA)

T135 Use of Near Infrared Reflectance Spectroscopy (NIRS) compared to Table values as the source of information for determination of amino acids and apparent metabolizable energy (AME) for broiler feed formulation. CARLOS SOTO¹, ROB SHIRLEY², ERNESTO AVILA³, JOSE ARCE³, FERNANDO ROSAS³, DON MCINTYRE¹ ¹ADISSEO DE MEXICO S.A. DE C.V., GUADALAJARA, Mexico; ²ADISSEO USA, ATLANTA, GA; ³Universidad Nacional Autónoma de México, México D.F, Mexico; ⁴Universidad Michoacana de San Nicolas de Hidalgo, Morelia, Michoacan, Mexico; ⁵DAMOND V MILLS, CEDAR RAPIDS, IA

The following broiler trail evaluated the different strategies for feed formulation in broiler production based on Table values for Total Amino Acids (TAA) or NIRS values either for TAA or Digestible Amino Acids (DAA). A total of 1400 Ross 308 mixed-sex broiler chickens were fed starter (1-21 days) and finisher (22-48 days) corn-SBM-CDDGS based diets. Four treatments were used: T1 based on TAA from Table values; T2 based on TAA from NIRS values; T3 based on DAA from NIRS values and T4 based on DAA and apparent metabolizable energy (AME) from NIRS; only AME values for corn and SBM were used. Nutritional levels used for this experiment were based on NRC requirements. Variables measured were body weight (BW: kg/bird), feed intake (FI: kg/bird), feed conversion ratio (FCR), mortality% (M), carcass yield% (CY), breast yield% (BY) and breast/carcass ratio (BCR).

At 21 days of age, BW was heavier (P<0.05) in T3 and T4 (0.708 and 0.698) compared to T1 (0.688). FCR was lower for T3 (1.524) compared to T1 (1.611). No differences were observed for FI and M. At 42 days of age, BW was heavier for T3 and T4 (2.296 and 2.297) than for T1 (2.226). FI was higher in T3 (4.121) than T1 and T2 (4.039 and 4.038). No differences in FCR were detected. At 48 days of age, no differences were detected in BW, FI, FCR, M, CY, BY and BCR. T3 and T4 presented numerically higher BCR (p=0.13).

The improvements in broiler performance at 21 and 42 days-of-age demonstrate the benefits of broiler feed formulation that is based on DAA and AME information from NIRS.

Key Words: Broilers, Digestible Amino Acids, Near Infrared Reflectance Spectroscopy, Apparent Metabolizable Energy
T136 The effect of dietary electrolyte balance on ileal endogenous amino acid losses in 48-d old broiler chickens

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The objective of this study was to determine the effect of nitrogen-free diet formulated with different ratios of corn starch and dextrose and different levels of dietary electrolyte balance (DEB = Na + K – Cl, mEq/kg diet) on ileal endogenous amino acid (EAA) losses in 48-d old broiler chickens. Broilers were reared on deep litter for 43 d and fed corn-soybean meal based diets (starter: d 0-14, grower: d 14-28; finisher: d 28-42) that were adequate in all nutrients and energy. On d 43, 240 broiler chicks were individually tagged, weighed, sorted, and allotted to 4 diets with 6 replicate pens/diet in a complete randomized design. Each experimental diet was fed for 5 d (d 43-48). All diets were nitrogen-free diets with 2 ratios of corn starch-to-dextrose (0.31 and 1.04) and 2 levels of DEB (108 and 219 mEq/kg diet). Final BW and BW loss were not different (P > 0.05). Birds fed diets containing higher DEB consumed less (P < 0.05) feed. Mineral (Na, K, Cl) intake were different (P < 0.05). The high dietary dextrose level resulted in higher (P < 0.05) ileal dry matter digestibility. Endogenous nitrogen, Arg, Leu, Phe, Val, Ala, Gly, and Pro secretion into the gut increased (P ≤ 0.05) with increasing level of DEB. Iso-leucine, Thr, Asp, Cys, Glu, and Tyr showed a tendency towards higher (P < 0.1) EAA losses with high level of DEB. There were no effects of corn starch-to-dextrose on ileal EAA losses. The ratio (DEB 108/219) of the mean of ileal EAA losses for the indispensable and dispensable AA was 81 and 82%, respectively. The same values for the ratio of corn starch-to-dextrose (0.31/1.04) for indispensable and dispensable AA were 99 and 97%, respectively. Data from this study showed that ileal EAA losses in the ileum of 48-d old chicken are significantly affected by DEB and not by the ratios of corn starch-to-dextrose that were fed.

Key Words: broiler, corn starch, dextrose, endogenous amino acid, dietary electrolyte balance

T137 Effects of dietary lysine and methionine supplementation on growth performance and meat yield of male broilers

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A trial was conducted to determine the effects of dietary lysine (Lys) and methionine (Met) supplementation on growth performance and meat yield of male Ross × Ross 708 broiler chicks. A completely randomized block design with × 4 factorial arrangement of treatments was applied (10 blocks, 8 treatments/block, 12 chicks/pen). The diets, including 2 Lys levels (100 and 120% of recommended levels) and 4 Met levels (80, 100, 120, and 140% of recommended levels), were fed from 21 to 42 d of age. As recommended by NRC, the 100% Lys was set at 1.00% and 100% Met level was set at 0.38%, respectively. Data were analyzed by ANOVA of SAS 9.3 using the GLM procedure. When the chicks were fed diets with 100% Lys, the FCR from d 21 to 41 was the lowest when the chicks were fed diets with 120% Met. However, when the chicks were fed 120% Lys diets, the FCR was linearly reduced as Met inclusion in the diets increased (P < 0.0001). Similarly, BW on d 41 was increased and then plateaued when the diets of the birds were supplemented with 100% Lys and 100 or 120% Met; BW on d 41 increased linearly as Met supplementation in the diet was increased and when Lys was at 120% (P < 0.0001). Similarly, responses to Lys and Met supplementation were found in relative pectoralis major (breast fillet), and in wing and front half (P < 0.0001) yields. However, relative leg to carcass yield was decreased by an increase in Met supplementation (P < 0.0001). In conclusion, birds responded differently to dietary Met when Lys levels varied. In addition, the improvement in meat yield in response to Met supplementation was mainly due to improvements in relative front half rather than leg yields.

Key Words: broiler, growth, lysine, methionine, meat yield

T138 Digestible Thr to Lys ratio of male broilers from 21 to 35 days of age

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An experiment was conducted to ascertain digestible (dig) Thr to Lys ratio of male broilers from 21 to 35 d of age. Sixteen Hubbard × Cobb 500 male broilers were randomly distributed into 64 floor pens (25 birds per pen; 0.09 m²/bird) at 1 d of age and fed a common starter diet until 20 d of age. From 21 to 35 d of age, 2 diets consisting of corn, soybean meal, poultry by-product meal, and peanut meal were formulated to be surfeit in limiting amino acids and contained 0.49 or 0.77% digestible Thr. Digestible Lys was formulated to contain 0.95% in both diets. The 2 diets were mixed in varying proportions to create 8 titration diets. Calculated digestible Thr to Lys ratio ranged from 0.512 to 0.806 in increments of 0.04. Each treatment was represented by 8 replicate pens. Body weight gain, feed intake, feed conversion, mortality, carcass yield, total breast yield, and abdominal fat percentage were assessed. Male broilers fed gradient concentrations of dig Thr displayed significant (P ≤ 0.02) quadratic responses for BW gain and feed conversion from 21 to 35 d of age. Digestible Thr requirements were estimated using a quadratic broken-line model. Digestible Thr to Lys ratio for male Hubbard × Cobb broilers was estimated at 0.68 and 0.67 for BW gain and feed conversion. Progressive concentrations of dig Thr decreased (P ≤ 0.02) abdominal fat percentage, but did not affect carcass or total breast meat yields. These data indicate that dig Thr to Lys ratio for modern broilers from 21 to 35 d of age, based on growth performance, are higher than previously reported.

Key Words: amino acid, broiler, threonine

T139 Effects of dietary amino acid density, additional fat and xylanase levels on mineral utilization and bone traits of broilers

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Dietary amino acid density (AA), fat content and xylanase levels (X) may affect mineral utilization and bone strength. This study was conducted to evaluate the effects of AA, additional energy from fat postpellet (FL) and xylanase levels in corn-soybean diets with DDGS on broiler calcium and phosphorus utilization and bone biomechanical properties. A total of 2,112 d-old male Ross 708 broilers were placed in 96 pens. The 16 treatments consisted of diets formulated with 2 AA densities (High and Low, 10% difference), 2 FL (basal and additional fat to increase ME to 100 kcal/kg) and 4 levels of X (0, 8000, 16000 and 32000 BXU/kg). Starter, grower and finisher diets were fed from 1 to 16, 17 to 35 and 36 to 49 d of age, respectively. Fresh feces were collected for 2 d in the starter and finisher phases. Celite was used as an inert marker. Apparent phosphorus (P) and calcium (Ca) digestibility coefficients were obtained. At 16 and 42 d of age, 3 and 2 broilers, respectively, were sampled to evaluate femur, tibia and shank relative weights, length, density, ash and tibia strength (force, N; and Max stress, MPa). Data were analyzed as a CRBD with a 2×2×4 factorial arrangement of treatments. In the starter phase, three way interaction effects (P<0.001) were observed. Broilers fed Low AA, basal diets without additional FL and 8000BXU/kg had the best CaD and PD. Broilers fed High AA diets had longer, denser and stronger tibias with more ash than broilers fed Low AA. Even though, X inclusion increased CaP and PD, tibia biomechanical properties were not significantly affected. In the finisher phase, a quadratic effect of X (P<0.001) was observed both on CaD and PD. Levels of 8,000 and 16,000 BXU/kg improved both parameters. Furthermore, a three-way interaction (P<0.001) was detected on PD. No significant effects of treatments were observed on tibia properties at 42 d of age. In conclusion, X inclusion improved Ca
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and P utilization, and dietary AA density affected some bone parameters during early development.

**Key Words:** bone, broiler, calcium, phosphorus, digestibility

**T140 Evaluating the effects of feeding OVN and US industry-fed vitamin levels on growth performance, processing yields and profitability**

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A randomized complete block design study evaluated the supplementation of Optimum Vitamin Nutrition (OVN™) and US industry-fed vitamin levels on growth performance, processing yields and economic return over feed cost of broilers during a 48-day grow-out period. One thousand four hundred and forty Ross 344 × Ross 708 day-old male broilers were allotted to 24 pens of 60 broilers each. The 4-phase diets were composed of corn, soybean meal and meat and bone meal with the inclusion of a phytase enzyme, and formulated to simulate commercial nutritional specifications. There were eight blocks with three randomized treatments. Fed across all dietary phases, the treatments were (1) Low 25% of industry-fed vitamin levels; (2) Average industry vitamin levels; and (3) OVN™ levels. Industry vitamin levels were obtained from a 2011 DSM survey that accounted for approximately 70% of the US broiler industry. Broilers had ad libitum access to feed and water. Broilers and feed were weighed on d 13, 28, 42 and 48, and BW gain, feed consumption, and feed conversion ratio (FCR) were calculated. Additionally, at 49 d of age, 10 broilers per pen were processed, and weights were measured and yields were calculated. Mortality was unaffected (P>0.05) by the dietary treatments. BW gain and FCR were improved (P<0.05) when broilers were fed Average and OVN™ levels. Vitamin levels had no effect (P>0.05) on feed consumption. Breast meat yield, a parameter more sensitive than growth performance, was optimized (P<0.05) when broilers were fed OVN™ levels. Increasing vitamin supplementation levels in diets fed to commercial broilers optimized growth performance and processing yields. Based on an economic analysis of return over feed cost when the study was conducted, the most profitable diet was based on the OVN™ supplemented vitamin levels.

**Key Words:** vitamin, breast meat yield, survey, return over feed cost

**T141 Effects of 25-hydroxicolecalciferol (25-OH-D3) on performance and bone mineral deposition of broiler chickens**

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A study was conducted to evaluate the supplementation of 25-OH-D3 in broiler feeds. A total of 704 slow feathering 1 d-old Cobb 500 male broilers were randomly distributed into 4 treatments with 8 replicates (22 birds each). Treatments were distributed in a factorial of diet type (Basal or low absorption - LA, which had 6% raw soybeans added) and supplemented with 25-OH-D3 at 69 mg/Ton of feed (SUP) or not supplemented (NS). The study lasted until 40 d when 3 birds per replicate were sacrificed and tibia, femur and middle toes were collected for mineral deposition evaluation. Animal performance was weekly registered. There was no interaction between factors on animal performance, but birds fed LA diets had lower (P<0.05) body weight gain (BWG) at 2.85 kg and worse FCR at 1.59 when compared to birds fed Basal diets (2.95 kg and 1.55, respectively). The SUP treatment tended to increase BWG at 2.92 kg (P<0.08) and had improved FCR at 1.52 (P<0.001) when compared to NS diet (2.88 kg and 1.62, respectively). It was not observed any significant differences on tibia ash content. An interaction was observed for femur and middle toe ash contents, with LA-NS diet leading to losses in performance and bone ash; the effects of LA diet on bone ash were alleviated when 25-OH-D3 was supplemented.

**Key Words:** broiler, 25-OH-D3, mineral deposition