The effects of replacing methionine hydroxy-analogue calcium salt with 65% dl-methionine on growth performance and carcass quality of broilers from 21 to 42 days of age. Emanuel Goes1,2, Maria Aparecida Iuspa1, Victor Naranjo1, Leopoldo Almeida2, Adhemar Oliveira1, and Alex Maiorka2, 1Evonik Nutrition & Care, Hanau-Wolfgang, Germany, 2Universidade Federal do Paraná, Curitiba, Brazil, 3Evonik Nutrition & Care, São Paulo, Brazil.

The objective of this study was to determine the effect of replacing MHA calcium salt 84% (MHA-Ca) with 65 parts of dl-methionine 99% (DLM) on growth performance and carcass parameters of broilers from 21 to 42 d of age. A total of 2,376 male Cobb 500 broilers were distributed in a completely randomized design with 11 treatments and 9 replicates of 24 birds each. Corn-SBM based diets were used and dietary treatments were shared in 2 phases feeding: grower (from d 21 to 35) and withdrawal (from d 36 to 42). The dietary treatments included a negative control deficient in Met+Cys (without supplementation of methionine) and 5 supplemental levels of MHA-Ca. The levels of MHA-Ca were determined by first formulating a diet with MHA-Ca to meet the 100% of the commercial Met+Cys requirement. Upon then, MHA-Ca levels were set at 25, 50, and 125% of the MHA-Ca supplemental level used in the 100% diet. Diets formulated with DLM were obtained by replacing MHA-Ca with 65% DLM on product basis for each supplemental level. Thus, a ratio of 65:100 of DLM: MHA-Ca was maintained in all treatment pairings (25, 50, 100, and 125%) for both feeding phases. Body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were evaluated for grower and withdrawal phases.

On d 42, 2 birds per experimental unit were euthanized by cervical dislocation and carcass yield (CV), breast meat yield (BMY) and abdominal fat were recorded. Overall (21 to 42 d), broilers fed the negative control diet had lower BWG (P < 0.01) and increased FCR (P < 0.01) compared with broilers fed the methionine supplemented diets. Replacing 100 parts of MHA-Ca with 65 parts of DLM did not affect BWG, FI, or FCR. CV and BMY were significantly lower (P < 0.05) in broilers fed the negative control compared with broilers fed the methionine supplemented diets. Overall, the calculated bioavailability of MHA-Ca in relation to DL-Met was 65% for BWG (P < 0.01), 67% for FCR (P < 0.01), 53% for CV (P < 0.01), and 55% for BMY (P < 0.01). Based on this study it can be concluded that diets deficient in Met+Cys negatively affect growth performance and carcass yields of broilers. Replacing 100 parts of MHA-Ca with 65 parts of DLM did not affect growth performance and carcass parameters of broilers from 21 to 42 d of age.

Key Words: bioavailability, methionine hydroxy analog, dl-methionine

Digestive valine requirements in practical diets for Ross 308 broiler chicks in growing period. Arash Hassanzadeh Seyedi* and Hossein Jannmohammadi, University of Tabriz, Tabriz, East Azarbijan, Iran.

The aim of this experiment was to estimate the digestive valine requirement of male Ross 308 broiler chicks. To evaluate valine requirement of male broiler chicks based on growth performance, 450 male broiler chicks from 8 to 21 days of age, was assigned to 6 treatments with 5 replicate using a completely randomized design. Corn-soybean meal-based diet was formulated (19% CP, 3000 kcal of ME/kg) to provide the all nutrient except valine base on Brazilian table for poultry and swine (2011). Dietary valine was supplied in 6 levels from 0.74 to 0.99% for the experimental period with successive additions of 0.05% of l-valine. As supplementation of l-valine increased, corresponding decreases in l-glutamic acid from the basal level provided isonitrogenous feeds. In the experimental period weight gain, feed intake, feed conversion ratio, feed efficiency ratio and valine consumption content were recorded. Result of this study showed that the quadratic broken line model were used for determine of digestive valine requirement for Ross 308 male broiler chicks. Two experiments were conducted to determine the relative bioavailability (RBA) of 2-methionine hydroxy analog-calcium salt (MHA-Ca) compared with methionine (DLM) during the starter (1 to 21 d, trial 1) and grower (22 to 42 d, trial 2) phases, independently. A total of 1,848 and 1,694 Cobb 500 male broiler chickens were used in trials 1 and 2, respectively which were distributed in a completely randomized design with 11 treatments with 7 replicate pens of 24 or 22 birds each. Dietary treatments included a basal diet deficient in standardized ileal digestible (SID) Met+Cys and 5 graded levels of each methionine source. In trial 1, MHA-Ca inclusion levels ranged from 0.114 to 0.570% and in trial 2 from 0.095 to 0.476%. Supplemental levels of DLM were at 65% of the MHA-Ca level (DLM:MHA-Ca ratio of 65:100) on product basis. A nonlinear exponential model was used to estimate the RBA of MHA-Ca in relation to DLM using the nonlinear regression models (NLIN) procedure of SAS. Supplemental methionine sources improved (P < 0.05) body weight gain (BWG) and feed conversion ratio (FCR) compared with broilers fed the basal diet in both feeding periods. Increasing levels of methionine sources resulted in a linear increase (P < 0.05) in breast meat yield (BMY) from d 22 to 42. The respective asymptotic responses demonstrated an improvement of 34% for BWG and 13% for FCR from d 1 to 21 due to supplementation of methionine sources; and an improvement of 16, 18, and 9% for BWG, FCR, and BMY of broilers from d 21 to 42. The RBA of MHA-Ca compared with DLM was 66 and 57% for BWG and FCR, respectively during the starter phase and 65, 61, and 63% for BWG, FCR, and BMY, respectively, during the grower phase. Overall, considering all parameters evaluated, the average RBA of MHA-Ca compared with DLM was 62 and 63% on product basis for broiler chickens from d 1 to 21 and d 21 to 42 post-hatch, respectively.

Key Words: bioavailability, broiler, methionine hydroxy analog, l-methionine
274 Effect of different ratios of valine and iso-leucine to lysine on growth performance, blood biochemistry and carcass characteristics in broilers. Zafar Hayat*, Gulbeena Saleem2, Anecea Hafeez1, Abd Rehman1, Zafar Ullah1, and Muhammad Arif1, 1University of Sargodha, Sargodha, Pakistan, Sargodha, Pakistan, 2University of Veterinary and Animal Sciences, Lahore, Pakistan.

Valine (Val) and isoleucine (Ile) having some similarities are considered as 4th co-limiting amino acids in broiler nutrition. However, data on the effects of different ratios of Val and Ile to Lys in broiler diets is scanty and inconsistent. The objective of this research was to determine the effect of different dietary ratios of digestible valine-isoleucine to digestible lysine on growth performance, carcass characteristics, and biochemical parameters of broilers. A total of 720 day-old Cobb500 chicks were randomly distributed to 72 replicate pens. Each of 9 dietary treatments (3 × 3 factorial arrangements) was fed to 8 replicates of 10 chicks each for 1–35 d of age. Starter, grower and finisher diets were fed from 1 to 10, 11–22 and 23–35 d of age, respectively. Results revealed that body weight (BW) of broilers fed diets having different ratios of dig Val-to-Lys varied significantly ($P < 0.05$). BW was higher (1570 g) when Val-to-Lys ratio was 81, 82, 83 in starter, grower and finisher phase, respectively, compared with lower ratios of Val-to-Lys. However, increasing ratios of dig Ile-to-Lys and interaction between Val- and Ile-did not influence ($P > 0.05$) BW of birds. Dressing percentage, breast meat, organs weight (liver, heart, gizzard), skin and feather weight and cooking losses were not affected ($P > 0.05$) by increasing ratios of dig Val- and Ile-to-Lys and their interaction except intestinal length and meat tenderness which were increased ($P < 0.05$) by increment in dig Val-to-Lys ratio. Insulin-like growth factor I (IGF-1) was not affected due to change in ratios of dig Val- and Ile-to-Lys ($P > 0.05$), however, interaction of Val to Lys and Ile to Lys influenced ($P < 0.05$) these values. Serum creatinine was influenced ($P < 0.05$) by varying dig Ile-to-Lys but not at dig Val-to-Lys and their interaction. The AST values were influenced by dig Val-to-Lys but ALT remained similar ($P > 0.05$) across all dietary treatments. Serum uric acid increased ($P > 0.05$) by increasing dig Ile-to-Lys ratio but was remained same ($P > 0.05$) at different ratio of Val-to-Lys and Val-to-Ile interaction. Based on the results of present study, it may be concluded that increasing digestible Valine to digestible Lysine ratios in broiler diets improve body weight of broilers. Thus Val to Lys ratio greater than the current recommendations may be beneficial to achieve better weight gain in broilers.

Key Words: valine, isoleucine, broiler

275 Dietary tryptophan requirement of laying hens fed corn-soybean meal diets. William Lambert*, Aude Simoniovanni1, Etienne Corrent1, and Jaap van Milgen2, 1Ajinomoto Eurolysine S.A.S, Paris, France, 2INRA UMR Pegase, Saint Gilles, France.

Reducing crude protein (CP) levels in layer feeds to improve economic and nutrient efficiency can only be achieved if the essential amino acid requirement levels are covered to ensure maximal laying performance. Tryptophan (Trp) is a potentially limiting amino acid in low CP layer diets, especially in corn-based diets. Determination of the Trp requirement by meta-analysis was undertaken based on published dose-response trials to L-Trp supplementation. Twelve publications including 20 trials were considered in this database. Dietary energy, CP and amino acid levels were recalculated based on the INRA tables. Trials originated mostly from US and Brazil using corn-soybean meal diets. Most trials were conducted after the peak of production between 40 and 70 weeks of age. The method of selection of the trials was adapted from van Milgen et al. (2012) who evaluated the growth response to L-isoleucine supplementation in pigs. In the present study, if performance did not present a linear or quadratic effect ($P > 0.10$), trials were not selected. In total, 16 trials were considered further for response modeling. A curvilinear plateau model allowed estimating the Trp requirements for laying rate, egg mass, and gain-to-feed ratio. Two units of expressing the Trp requirement were chosen: standardized digestible (SD) Trp/Lys and intake of SD Trp per gram of egg mass. Requirements were estimated to be 23.9, 25.0, and 25.4% SD Trp/Lys, or 2.95, 2.79, and 3.36 mg SD Trp / g egg mass for laying rate, egg mass, and gain-to-feed ratio, respectively. Besides required for egg protein, Trp has been shown to promote the anti-oxidant and immune response activity in laying hens and contributes to a stronger eggshell. Based on this study, practical recommendations of the Trp requirement are 24% SD Trp/Lys or 3.1 mg SD Trp / g egg mass.

Key Words: tryptophan, requirement, meta-analysis, laying hen

276 Optimum dietary level of digestible threonine for growing broilers determined by economic approach. Matheus Reis*, Nilva Sakomura, Juliano Cesar Dorigam, and Daniella Donato, Unesp, Jaboticabal, São Paulo, Brazil.

In the literature, there are many techniques proposed to estimate the requirement of amino acids for broiler chickens. However, the level of amino acid that estimates the maximum response is not always the most economically viable. For poultry industry, is so important to maximize the performance of the bird as the economic return, but not all studies present an economic evaluation as a criterion in choosing the best level. The objective of this study was to estimate the optimum digestible threonine level in diets for growing broilers based on economic analysis of the gross margins over feed costs. One dose-response assay was conducted, divided into initial (1–14 d), grower (15–28 d) and finisher (29–42 d) phases. Five hundred and 60 male Cobb 500 broilers were distributed in a completely randomized design consisting of 7 dietary levels of threonine, with 4 replicates and 20 birds per experimental unit. The diets were formulated by dilution technique resulting in the experimental threonine levels ranging from 0.150% to 0.999%, 0.130% to 0.889% and 0.120% to 0.819% in initial, grower and finisher phases, respectively. The broilers and feeds were weighed at the beginning and the ending of each phase to determine body weight gain and feed intake. The performance data were used to fit a segmented model as follows: $y = \alpha + \beta x + \gamma x^2$, if $x < x_0$; $y = \epsilon$, if $x \geq x_0$. Where $\alpha$, $\beta$ and $\gamma$ are the coefficients of the quadratic segment, and $\epsilon$ is the plateau of the function. Gross income (GI), total feed costs (TFC) and gross margin (GM) were calculated based in local costs to determine the optimum economic level for each amino acid (AA). At each phase, the optimum AA level was considered as one to provide the highest GM, which coincides with the plateau obtained for GI and TFC. Varying the AA prices affected the respective economic optimum intake of threonine only slightly. Thus, considering the price of L-threonine as US $3.00/kg, the optimum threonine intakes to optimize GM were 236, 696, and 1042 mg/d in starter, grower and finisher phases, respectively.

Key Words: amino acid, requirement, broken line, optimum economic, threonine

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An experiment was conducted to determine the effect of different levels of isoleucine on the egg production, egg quality, serum biochemistry and ileal digestibility of crude proteins in laying hens (LSL-LITE strain) from 23rd to 30th weeks of age in a commercial layer farm. A total number of 490 laying hens were randomly categorized into 7 dietary treatment groups; each included 7 replicates with 10 hens per replicate. The experimental diet was supplemented with different levels of isoleucine i.e., 0.66, 0.69, 0.72, 0.75, 0.78, 0.81, and 0.84% of feed with 2730 kcal/kg Metabolizable Energy. The control group was formulated with 0.66% isoleucine form the feed ingredients. The egg production data were statistically analyzed using repeated measure ANOVA by PROC GLM. The serum biochemistry parameters were statistically analyzed using one way ANOVA by PROC GLM. Significant effect of isoleucine levels, age and their interaction (levels x age) were observed for feed intake, body weight gain, egg production and FCR/dozily linearly. The isoleucine levels showed nonlinear effects on Haugh units of egg. Moreover, the different levels of isoleucine showed quadratic effect on egg weight with age. Serum glucose, total serum and globulin showed significant effect of different levels linearly. The study shows that synthetic isoleucine can be supplemented for significant effect on egg production, egg production and egg quality parameters.

**Key Words:** Haugh unit, isoleucine, ileal digestibility, laying hen

### 278 Determination of optimum dietary glycine and serine concentrations for broilers fed low protein diets with varying standardized ileal digestible threonine levels.

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A 21 d experiment was carried out to determine the optimum dietary glycine and serine (Gly+Ser) concentration in combination of varying levels of the standardized ileal digestible (SID) threonine (Thr) in low protein diets on performance, serum biochemistry and pectoral muscle creatine in broilers during the starter period. A total of 1,275 1-d-old Cobb-Vantress male broiler chicks were distributed in a completely randomized design of 5 × 3 factorial arrangement of 15 treatments with 5 replicate pens of 17 birds each. The diets consisted of 5 dietary levels of total Gly+Ser (1.72, 1.87, 2.02, 2.17, and 2.32%) in combination with 3 varying concentrations of SID Thr (0.69, 0.81 and 0.93%, corresponding to 85, 100 and 115% of the required dig Thr respectively). All diets were corn-soybean based and formulated to contain 1.24% standardized ileal digestible Lys and to meet or exceed the requirement of all nutrients except SID Thr levels. Experimental diets and clean water were provided ad libitum to the broilers from 1 to 21 d of age. All data were analyzed using the GLM procedure of SAS software. Interactions (P < 0.05) were observed for feed: gain ratio, serum uric acid (SUA), and ammonia concentrations. Feed:gain ratio decreased linearly (P < 0.05) in response to increasing Gly+Ser levels for 0.69% and 0.81% SID Thr diets while diet containing 0.93% Thr improved quadratically (P < 0.05) with an optimization point achieved at 2.0% Gly+Ser level. A decreasing linear effect (P < 0.05) of Gly+Ser was observed for SUA concentrations on diets with 0.69% SID Thr and serum ammonia concentration on diets containing 0.69 and 0.93% SID Thr levels. Main effect of increasing Gly+Ser levels in the diets of the birds responded quadratically (P < 0.05) on average daily gain, feed:gain ratio and pectoral muscle creatine with optimization points at 2.16, 2.14 and 2.16%, respectively while no effects (P > 0.05) were observed on serum metabolites. Birds fed diets containing 0.81% SID Thr recorded lower (P < 0.05) average daily feed intake with improved feed:gain ratio than those on 0.69 and 0.93% SID Thr diets. A similar pattern was recorded between the birds fed 0.81 and 0.93% SID Thr diets having lower (P < 0.05) concentrations of serum uric acid and ammonia than the group on 0.69% SID Thr diet. Results showed that the minimum level of Gly+Ser to optimize performance, muscle creatine and serum metabolites in low CP diet with varying levels of SID Thr was 2.0% for broilers up to 21 d of age.

**Key Words:** glycine+serine, threonine, performance, serum biochemistry, broiler

### 279 Effects of guanidinoacetic acid supplementation on carcass and cut up yields and meat quality on broilers fed diets with or without poultry by-products meal up to 56 d.

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Guanidinoacetic acid (GAA) supplementation has been reported to improve carcass yield and spare arginine in corn-based diets. This response may vary when including animal by products. This experiment was conducted to evaluate the effects of GAA supplementation in broilers fed corn-based diets with or without the inclusion of poultry by-products (PBP) on carcass and cut up yields, and meat quality of broilers raised up to 56 d. Treatments consisted of corn-based diets with or without inclusion of PBP (0 vs. 5%), supplemented or not with GAA (600 g/ton) as CreAMINO (min. 96% GAA). A total of 1,280 Ross 708 male chicks were randomly placed in 64 floor pens with 16 replicates per treatment combination. At 55 d, individual and group BW were recorded and average for each pen was calculated. Four broilers per pen were selected for processing. At 56 d, chickens were weighed, electrically stunned, and killed by exsanguination. Chicks were then scalded, picked, and manually eviscerated. Carcass and cut up weights were obtained after removal of organs and viscera. Carcass and cut up yields were calculated as percentages of live body weight and carcass weight, respectively. After processing breast meat was obtained to analyze drip and cook loss, shear force, and pH 6 and 24 h post-slaughter. Data were analyzed as a randomized complete block design from a 2 × 2 factorial arrangement of treatments with PBP inclusion and GAA supplementation as main effects. An interaction effect of treatments (P < 0.05) was observed on breast meat yield. Differences were detected in chickens that were fed diets containing PBP only. Broilers fed diets containing PBP and GAA had greater (P < 0.05) breast meat yield than chickens fed non-supplemented diets (38.68 vs. 38.09%). An interaction (P < 0.05) effect was observed on cook loss. In broilers fed diets without GAA, the cook loss was lower when diets contained PBP compared with broilers fed diets without PBP inclusion (16.76 vs. 19.95%). Drip loss, pH, and shear force were not affected (P > 0.05) either by GAA or PBP inclusion. In conclusion, GAA supplementation improved breast meat yield in diets containing PBP, but did not consistently affect meat quality.

**Key Words:** guanidinoacetic acid, poultry by-products, carcass and cut up, yields, meat quality

### 280 In vivo collagen and sarcoplasmic protein synthesis in pectoralis major at d-16 birds as determined by isotope flooding
technique. Pramir Maharjan*, Michael Schlumbohm, Garret W. Mul- lenix, Katie Hilton, Antonio Beitta, Maria Cortes, Judith England, Casey Owens, and Craig Coon, University of Arkansas, Fayetteville, AR.

Commercial broiler strains are reported to have increased incidence of the woody breast myopathy that results in replacement of muscle specific proteins with highly cross-linked collagen with the progress of age. A study was conducted to understand the rate of collagen and sarcoplasmic protein (CP and SP) synthesis occurring at d-16 male broiler chickens fed with Cobb standard starter diet, using stable isotope flooding method. On d-16, birds (n = 12) were infused with 1-13C Proline (20 atom percent excess) as tracer amino acids at the rate of 10 mL/kg BW. Blood (n = 3 birds) and breast tissue samples (n = 3 birds) were collected post infusion at 30, 60, 90 and 120 m. Three non-infused birds (Control) were also sacrificed for blood and tissue samples to know the collected post infusion at 30, 60, 90 and 120 m. Three non-infused birds (Control) were also sacrificed for blood and tissue samples to know the 13C baseline enrichment and were later DEXA scanned to characterize body composition of bird being studied for protein synthesis. SP and CP fractions were isolated from the collected tissue samples. Both the protein fractions separated were then acid hydrolyzed (0.1 M HCl) for 24h. Amino acids released were extracted with ion chromatography and then derivatized with tert-butylidimethyl silyl (t-BDMS) before they were read in GC-MS. Plasma was separated from blood samples, and free amino acids from blood were isolated and similarly derivatized with t-BDMS before it was run in GC-MS. The isotopic enrichment, 13C to 12C ratio for derivatized proline was measured using the ratio of fragments 287 to 286 generated from GC-MS. Fractional synthetic rates (FSR) for the protein fractions were calculated using the standard precursor–product equation: FSR (%h-1) = ΔEp/A * 1/t * 100, where ΔEp is the change in enrichment between baseline tissue sample and tissue sample taken at time ‘t’ post infusion of tracer, and A is the area under the curve derived from the decay in plasma enrichment over time ‘t’. DEXA results for birds showed the average lean mass of 359 g, protein mass of 63.39 g, fat mass of 17.55 g, and mineral content of 7.44 g. The FSR determined for SP was 0.0973 ± 0.0021% h−1, whereas for CP it was 0.4068 ± 0.1174% h−1, higher (P<0.05) than SP. The results indicate the possible higher in vivo collagen synthesis rate occurring in growing bird, provided the substrate is available.

Key Words: collagen, sarcoplasm, fractional synthetic rate, broiler

281 Metabolizable energy and standardized amino acid digestibility of soybean meals with protease supplementation in diets for broilers chickens. Felipe Santos Dalolio1, Diego Silva1, Vitor Faschina1, José Otávio Sorbara2, Rafael Gustavo Hermes1, Levy Teixeira*3, and Luis Albino1. 1Federal University of Viçosa, Viçosa, Brazil, 2DSM Nutritional Products, Basel, Switzerland, 3DSM Nutritional Products, São Paulo, Brazil.

Two trials were carried out to determine the energy values and the standard amino acid digestibility of 10 different soybean meals (SBM) in Brazil, without or with the addition of a protease (15,000 PROT/kg of feed, RONOZYME ProAct, DSM Nutritional Products). In the first experiment, to determine the energy values, a total of 756 male broiler chicks 14-d-old were weighed and randomly assigned in 10 × 2 factorial arrangement with 10 SBM samples without or with the addition of protease, totaling 20 treatments, with 6 replicates of 6 birds each. Total excreta were collected from 19 to 23d to determine AME and AMEn. In the second experiment, 756 male broilers 24-d-old were randomly allocated in 10 × 2 factorial arrangement, with 10 SBM, without or with the addition of protease, totaling 20 treatments with 6 replicates of 6 birds each. Acid insoluble ash (Celite) at 1% was added as an indigestible marker to determine the amino acid digestibility. At 28 d of age, all birds were euthanized by cervical dislocation to collect ileal content. Data were submitted to ANOVA, and means were compared by Tukey’s test (P<0.05). Overall, the protease enhanced values of AME and AMEn compared with those without addition, providing an average of 98 and 103 kcal/kg, which are 3.9 and 4.5% more energy in the SBM samples evaluated in this study, respectively. It indicates better utilization of crude protein from the SBM, providing greater amount of amino acids available for protein metabolism and other nutrients. The different SBM sources differs among them in the amino acid digestibility (P<0.05). The sample number 5 of SBM with or without protease supplementation showed higher Lys, Met, Thr, Val digestibility when compared with other SBM. Supplementation with protease led to improvements in the standard amino acid digestibility (P<0.05). Protease increases +4.86% Lys, +1.31% Met, +6.42% Thr, +3.28% Val in the limiting amino acids compared with diets without protease. In conclusion, protease supplementation improves AME, AMEn and the standard amino acids digestibility on different SBMs. It provides poultry nutritionists with an important tool to improve feed digestibility, reduce environmental pollution by nitrogen and lower feed costs, thus allowing more adjustability in diet formulation.

Key Words: enzyme, monocomponent, AMEn, vegetal protein, poultry