487  Relative effectiveness and toxicity of methionine sources in diets for White Pekin ducks.  M. Xie*1,2, S. S. Hou1,2, and W. Huang1,2, 1Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, 2State Key Laboratory of Animal Nutrition, Beijing, China.

All procedures of our experiments were approved by the animal care and welfare committee of the Institute of Animal Science of Chinese Academy of Agricultural Sciences. Two dose-response experiments were conducted to assess the bioefficacy and toxicity of DL-methionine hydroxy analog free acid (MHA-FA) relative to DL-methionine (DLM) in White Pekin ducks. In experiment 1, the methionine-deficient basal diets were supplemented with 5 levels of DLM (0.3, 0.6, 1.0, 1.5, and 2.1 g/kg) or 5 equimolar levels of MHA-FA (0.34, 0.68, 1.13, 1.70, and 2.39 g/kg), respectively. A total of 704 7-d-old male White Pekin ducklings were assigned to 11 experimental treatments, each containing 8 replicate pens with 8 birds per pen. These birds were reared in raised wire-floor pens from 7 to 42 d of age. On the other hand, excess DLM and MHA-FA caused significant decrease in weight gain and feed intake of ducklings (P < 0.05). However, according to the slope-ratio assay on equimolar basis, the bioavailabilities of MHA-FA relative to DLM for weight gain were 67%. On the other hand, excess DLM and MHA-FA caused significant decrease in weight gain and feed intake of ducklings (P < 0.05) but MHA-FA was less growth-depressing and lethal than equimolar DLM (P < 0.05).

Key Words: methionine, methionine hydroxy analogue, duck

488  Inevitable endogenous amino acid and CP losses in the terminal ileum of Pekin ducks as affected by cellulose supplementation.  O. Akinde*1, H. Kluth1, and M. Rodehutscord2, 1University of Halle-Wittenberg, Halle (Saale), Germany, 2University of Hohenheim, Stuttgart, Germany.

The objective was to study the effects of crude fiber (CF) on the inevitable losses of individual amino acids (AA) and CP measured in the terminal ileum of Pekin ducks. The study involved a 2 × 3-factorial arrangement of treatments with 2 CF levels (30 g/kg DLM or equimolar 33.9 g/kg MHA-FA, respectively) and 3 CP levels (20, 60 or 100 g/kg). Differences in CP and CF concentrations were achieved by inclusion of corn starch at the expense of an AA-balanced protein mix and α-cellulose. The AA pattern was the same in all diets and TiO2 was used as an indigestible marker. The data from the current study show that the ratio of corn starch to dextrose in a nitrogen-free diet may have affect estimates of ileal endogenous flow of AA and CP.

Key Words: inevitable loss, amino acids, fiber, Pekin duck, ileum

489  Estimation of ileal endogenous amino acid flow in broiler chickens fed various nitrogen-free diets.  C. Kong* and O. Adeola, Purdue University, West Lafayette, IN.

A total of 480 3-week-old broiler chickens were used in a 4-d trial to estimate ileal endogenous flow (IEF) of amino acid (AA) from feed containing nitrogen-free diets (NFD) with different ratio of cornstarch to dextrose. Cornstarch (849, 566, 283 or 0 g/kg) and dextrose (0, 283, 566 or 849 g/kg) were used in Diet numbers 1, 2, 3 or 4, respectively. All diets contained calculated dietary electrolyte balance of 115 mEq/kg, and solka flo, soybean oil, monocalcium phosphate, MgO, and limestone at 50, 35, 22, 0.9, and 17 g/kg, respectively. Vitamin-mineral premix was supplemented according to NRC (1994) recommendations and chromic oxide was incorporated into diets (5 g/kg) as an indigestible marker. The birds received a standard starter diet from d 1 to 22 post-hatch. On d 22 post-hatch, all the birds were weighed and allocated to 4 treatments in a randomized complete block design. The 4 diets were fed to 12 replicate cages with 10 birds per replicate cage. On d 26 post-hatch, birds were asphyxiated with CO2, ileal digesta from the distal section of ileum was collected. Ileal endogenous N flow was highest (P < 0.01) in Diet 4 (3,169 mg/kg DMI) but there were no significant differences among other diets. The IEF for all the indispensable amino acids were different (P < 0.01) among diets with the exception of Thr, which was not (P = 0.07). The respective IEF of AA (mg/kg of DMI) in birds fed Diets 1, 2, 3 or 4 were 630, 664, 646, or 1,235 for Lys, 173, 172, 177, or 361 for Met, and 68, 74, 70, or 166 for Trp. For the dispensable AA and total AA, IEF of most AA except for Cys and Pro was highest (P < 0.01) in Diet number 4. Ileal endogenous flow of Pro was not different among diets. Diet 4 has the lowest (P < 0.01) IEF of Cys, whereas there was no difference among other diets. In conclusion, the data from the current study show that the ratio of corn starch to dextrose in a nitrogen-free diet may have affect estimates of ileal endogenous flows of N and AA.

Key Words: amino acid, broiler chicken, ileal endogenous flow, N, nitrogen-free diet

490  Optimization of broiler performance fed diets varying in digestible protein and amino acids using response surface model.  H. Ahmadi* and A. Golian, Ferdowsi University of Mashhad, Mashhad, Iran.

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Response surface methodology (RSM) and 5-level-4-factor central composite design (CCD) were used to evaluate the response of broilers (BWG and FCR) to dietary digestible protein (dP), lysine (dLys), methionine+cysteine (dTSAA), and threonine (dThr). Eighty four cages of 5 birds each were assigned to feed diets contained 5 levels of dP (16, 17, 18, 19 and 20%), dLys (0.92, 0.98, 1.04, 1.10 and 1.16%), dTSAA (0.73 0.78, 0.83, 0.88 and 0.93%), and dThr (0.58, 0.63, 0.68, 0.73 and 0.78%) from 25 to 31 d of age. Diets were prepared using corn, soybean meal (45.2% CP), and corn gluten meal (48.6% CP). Protein and amino acid analyses were performed for these ingredients. All diets were formulated to have 3100 kcal/kg. The experimental results of CCD were fitted with the second-order polynomial equation. A ridge analysis was utilized to compute the optimum response for maximizing BWG and minimizing FCR. The fitted second-order polynomial equations for BWG and FCR are produced as follow:

\[ \text{BWG (g/bird/d)} = 570.1 - 46.7 \times \text{dP} + 1.6 \times \text{dP} \times \text{dTSAA} - 160.9 \times \text{dTSAA}^2 - 321.5 \times \text{dThr} - 289.4 \times \text{dThr}^2 - 8.2 \times \text{dP} \times \text{dLys} - 5.2 \times \text{dP} \times \text{dTSAA} + 4.3 \times \text{dP} \times \text{dThr} + 191.0 \times \text{dLys} \times \text{dTSAA} + 309.6 \times \text{dLys} \times \text{dThr} + 416.7 \times \text{dTSAA}^2 \times \text{dThr} ; R^2 = 0.57; \text{Root MS error} = 3.10. \]

\[ \text{FCR} = -4.26 + 0.80 \times \text{dP} - 0.04 \times \text{dP} \times \text{dTSAA} + 0.52 \times \text{dP} \times \text{dThr} - 2.92 \times \text{dLys} \times \text{dTSAA} - 0.84 \times \text{dThr} \times \text{dTSAA} - 8.84 \times \text{dTSAA} \times \text{dThr} ; R^2 = 0.73 \text{ and Root MS error} = 0.075. \]

The maximum BWG may be obtained with dP 19.9, dLys 1.05, dTSAA 0.73 0.78, 0.83, 0.88 and 0.93%, and dThr 0.58, 0.63, 0.68, 0.73 and 0.78% from 25 to 31 d of age. The aim of this paper was to determine the digestible lysine nutritional requirements for broiler breeder hens. Three hundred and 20 birds were distributed into 40 pens using a completely randomized design with 8 treatments and 3 replications on time. The treatments were: control diet (CD); CD + vaccine against coccidiosis; CD+ antibiotics growth promoter (AGP); CD+ glutamine and glutamic acid (Gln/Glu); CD+ phytogenics additive (FAs) and DC+ Gln/Glu+ FAs. Birds from CD + vaccine treatment were orally vaccinated at the third day old against coccidiosis. At the 16 d old, all birds were individually inoculated by oral via with 500,000 Eimeria acervulina oocysts. At 21th days old, 2 broilers from each repetition were sacrificed for intestinal sample collection. Birds from Gln/Glu and Gln/ Glu+FAs showed greater duodenum villi height compared with birds from CD treatment and these 2 treatments did not differ from the other treatments which also did not differ among them (P < 0.05). The ileum villi were greater in Gln/Glu and Gln/Glu+FAs treatments compared with CD and AGP and it did not differ from treatment FAs (P < 0.05). There was no difference for jejunum villi height and crypt depth. Duodenum crypts were greater for Gln/Glu treatment compared with control and vaccine and it did not differ from FAs, Gln/Glu+FAs and AGP (P < 0.05). Ileum crypts were greater in Gln/Glu+FAs-fed broilers compared with control, vaccine and AGP and it did not differ from Gln/Glu and FAs-fed broilers (P < 0.05). In general, the better results were observed in broiler chickens fed supplemented diets with Gln/ Glu combined or not with FAs. These additives can be an alternative to antibiotics growth promoter and can minimize the negative effects on the structure of intestinal mucous of broilers challenged with coccidiosis.

**Key Words:** coccidiosis, additives, poultry

492 Effects of glutamine added to glutamic acid and phytogenics additive on intestinal mucous morphology of broilers challenged with *Eimeria acervulina*. V. C. Pelicin*, J. R. Sartori, A. C. Stradiotti, P. C. Araujo, M. K. Maruno, T. C. Putarow, W. T. Silva, L. A. Madeira, and A. C. Pezzato, *São Paulo State University, Botucatu, SP, Brazil.*

This study evaluated the influence of glutamine added to glutamic acid and phytogenics additive supplementation on small intestine mucous morphology of broilers, experimentally infected with *Eimeria acervulina*. A total of 450 Cobb male chicks were distributed in a completely randomized design with 6 treatments with 3 replications on time. The treatments were: control diet (CD); CD + vaccine against coccidiosis; CD+ antibiotics growth promoter (AGP); CD+ glutamine and glutamic acid (Gln/Glu); CD+ phytogenics additive (FAs) and DC+ Gln/ Glu+ FAs. Birds from CD + vaccine treatment were orally vaccinated at the third day old against coccidiosis. At the 16 d old, all birds were individually inoculated by oral via with 500,000 *Eimeria acervulina* oocysts. At 21th days old, 2 broilers from each repetition were sacrificed for intestinal sample collection. Birds from Gln/Glu and Gln/ Glu+FAs showed greater duodenum villi height compared with birds from CD treatment and these 2 treatments did not differ from the other treatments which also did not differ among them (P < 0.05). The ileum villi were greater in Gln/Glu and Gln/Glu+FAs treatments compared with CD and AGP and it did not differ from treatment FAs (P < 0.05). There was no difference for jejunum villi height and crypt depth. Duodenum crypts were greater for Gln/Glu treatment compared with control and vaccine and it did not differ from FAs, Gln/Glu+FAs and AGP (P < 0.05). Ileum crypts were greater in Gln/Glu+FAs-fed broilers compared with control, vaccine and AGP and it did not differ from Gln/Glu and FAs-fed broilers (P < 0.05). In general, the better results were observed in broiler chickens fed supplemented diets with Gln/ Glu combined or not with FAs. These additives can be an alternative to antibiotics growth promoter and can minimize the negative effects on the structure of intestinal mucous of broilers challenged with coccidiosis.

**Key Words:** glutamine, eggs, poultry, broiler breeder

493 Dietary lysine levels for broiler breeder hens. C. F. S. Oliveira², N. K. sakomura¹, F. G. P. Costa², E. P. Silva¹, and L. Hauschild¹.¹ *Universidade Estadual Paulista - Faculdade de Ciencias Agrarias e Veterinarias, Jaboticabal, SP, Brazil. ²Universidade Federal da Paraíba, Areia, Paraíba, Brazil.*

The aim of this paper was to determine the digestible lysine nutritional requirements for broiler breeder hens. Three hundred and 20 birds were distributed into 40 pens using a completely randomized design with 8 treatments (0.220, 0.293, 0.367, 0.440, 0.513, 0.660, and 0.880). The aim was to check if the response of birds it would be in function of lys level. Data was analyzed by quadratic regres-
Crude protein requirement for egg production of free-range laying hens. M. M. A. Brainer1,2, C. B. V. Rabello*1, C. C. Lopes1, W. R. L. Medeiros1, and R. A. Lima1, 1Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brasil, 2IFET Goiano, Campus Ceres/GO, Ceres, Goias, Brasil.

The objective of the current study was to determine the crude protein requirement for egg production of free-range laying hens raised in a semi-intensive system. The experimental design was a complete randomized design with 4 pens of 30 birds, 120 birds of 33 weeks of age. The experiment lasted 9 weeks and the birds had access to paddocks areas from 7h to 17h daily. The diet provided ad libitum was formulated in accordance with the recommendations of the strain (Embrapa 051), the composition was: 2,800 kcal/kg metabolizable energy, 15.5% crude protein, 3.7% calcium and 0.42% available phosphorus. A sample of 6 eggs from each group was collected weekly, weighed and mixed in a blender for 3 min, frozen, lyophilized and analyzed for dry matter and nitrogen. The nitrogen requirements for egg production (Ne) was determined considering the average of the eggs composition divided by the nitrogen efficiency utilization, which when multiplied by 6.25 determined the crude protein requirement for egg production (CPe). The efficiency of the utilization of nitrogen for egg production (ke) was determined considering the nitrogen retained in the egg (NRe) divided by N intake (NI) minus the nitrogen designed for maintenance (Nm) and weight gain (Ng), then: ko = NRO/[NI-(Nm + Ng)]. The data of Nm and Ng were obtained by the authors in the previous tests. According to the values of mass and protein of eggs produced weekly during the experimental period, was observed that the protein content of eggs did not vary with the age of birds, with an average of 11.20% crude protein. The nitrogen efficiency utilization for egg production was 39%, a value lower than those found in the literature for commercial poultry. The crude protein requirement for egg production (CPe) was calculated by dividing the amount of egg protein (11.20%) by the protein efficiency utilization of production (39%), resulting in 0.289g of CP/g egg produced.

Key Words: egg production, factorial method, layers, protein requirements.

Threonine biomass as a source of amino acids for poultry. P. Utterback*1, E. Jimenez2, S. Block2, J. Less2, and C. Parsons2, 1University of Illinois, Urbana, 2ADM, Decatur, IL.

During the production of threonine, biomass occurs as a coproduct. Two trials were conducted to determine its value as an amino acid source for poultry. A precision-fed cecotomized rooster assay was conducted to determine digestibility of amino acids in drum-dried threonine biomass (TBM). The TBM contains 79% crude protein, 3.91% Thr, 0.71% Cys, 2.07% Met, 4.83% Val, and 5.13% Lys. Standardized amino acid digestibility of amino acids in the roosters was very high, averaging 96–98%. The lysine digestibility coefficient was found to be 95.8%. Threonine, Met, and Val digestibility coefficients were 97.9%, 98.6%, and 97.2%, respectively. A 14-d growth assay was conducted using 8-d old crossbred chicks to evaluate TBM as a source of amino acids, particularly valine, in chick diets. Treatments 1–4 evaluated TBM as a source of valine only. These treatments consisted of a semi-purified, valine-deficient diet as treatment 1 (T1) with 1, 2.5, and 5% TBM added to T1 for treatments 2–4, respectively. Treatments 5–7 evaluated TBM as a general source of amino acids. Treatment 5 (T5) had a 20% reduction of the NRC recommended values for Met, Lys, Thr, Trp, Ile, and Val. The T5 diet was supplemented with 1 and 2.5% TBM for treatments 6 and 7. There was a large and linear increase in weight gain and feed efficiency from adding 1, 2.5, and 5% TBM to the valine-deficient diet, T1. There was a significant improvement in feed efficiency when 2.5% TBM was added to T5, the diet containing reduced levels of several essential amino acids. This study shows that TBM is a good source of highly digestible valine and other amino acids for poultry.

Key Words: threonine biomass, amino acids, valine, chicks.

The effect of a low crude protein starter diet with different glycine + serine:lysine ratio on serum parameters and litter characteristics in broilers. I. C. O. Rojas1, A. E. Murakami1, R. V. Nunes2, F. J. Urgnani1, and C. Eyng1, 1Universidade Estadual de Maringá, Maringá, Paraná, Brazil, 2Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.

A study was carried out to evaluate responses of broiler chicks to essential crystalline amino acid supplementation of a low crude protein starter diet (1 to 21 d old) with different Gly + Ser:Lys ratio. A total of 1,050 one-day-old Cobb male broilers were distributed in a completely randomized experimental design into 6 treatments with 5 replicates of 35 birds each. Dietary treatments consisted: T1 (control) – corn-soybean meal based diet supplemented with DL-Met, L-Lys HCl, and L-Thr, formulated without crude protein (CP) restriction to meet or exceed ideal amino acids recommendations (Gly + Ser:Lys ratio of 150%); T2 – reduced-CP diet until the next limiting AA requirements were met containing supplemental L-Val (Gly + Ser:Lys ratio of 140%); T3 – T2 plus Gly (Gly + Ser:Lys ratio of 150%); T4 – T2 plus L-Ile and L-Arg (Gly + Ser:Lys ratio of 130%); T5 and T6 – T4 plus Gly (Gly + Ser:Lys ratio of 140 and 150%, respectively). Data were submitted to ANOVA and means were compared using Tukey's multiple-range test at 5% probability. At d 7 and 21, low CP diet supplemented with Val, Ile, and Arg but not with Gly (T4) resulted in chicks with worse feed conversion (P ≤ 0.05) than the control diet. Treatments with Gly + Ser:Lys ratio of 140 and 150% to low CP diets resulted in similar feed conversion (P ≥ 0.05) to that of chicks fed the control diet. Feed intake, BW gain, abdominal fat, carcass, and parts yields were unaffected by dietary treatments (P ≥ 0.05). The findings of this study suggest that nutritionists can reduce CP of the diets maintaining the Gly + Ser:Lys ratio not lower than 140% with no changes in chicken performance.

Key Words: amino acid, broiler, glycine, low-protein diet.
An experiment was conducted to determine the effect of a low crude protein starter diet (1 to 21 d old) with different Gly + Ser:Lys ratio on serum parameters and litter characteristics in broilers. A total of 1,050 one-day-old Cobb male broilers were distributed in a completely randomized experimental design into 6 treatments with 5 replicates of 35 birds each. Dietary treatments consisted: T1 (control) — corn-soybean meal based diet supplemented with DL-Met, L-Lys HCl, and L- Thr, formulated without crude protein (CP) restriction to meet or exceed ideal amino acids (AA) recommendations (Gly + Ser:Lys ratio of 150%); T2 – reduced-CP diet until the next limiting AA require exceed ideal amino acids (AA) recommendations (Gly + Ser:Lys ratio of 140%); T3 – T2 plus Gly (Gly + Ser:Lys ratio of 150%); T4 – T2 plus L-Ile and L- Arg (Gly + Ser:Lys ratio of 130%); T5 and T6 – T4 plus Gly (Gly + Ser:Lys ratio of 140 and 150%, respectively). At d 21, treatments T4, T5 and T6 caused in lower N contents and NH3 emission in litter (P ≤ 0.05) than the control diet. Broilers fed with low CP diets containing Gly + Ser:Lys ratio of 140 and 150% presented lower serum uric acid (SUA) (P ≤ 0.05). Low CP diet supplemented with Val, Ile, and Arg but not with Gly (T4) resulted in lower serum total protein and albumin (P ≤ 0.05) than T3 and control diet. According to the results, broilers fed low crude protein diet with Gly + Ser:Lys ratio not lower than 140% improve N utilization in terms of SUA, N contents and NH3 emission in litter. These advantages can improve the air quality into the poultry houses.

**Key Words:** amino acid, broiler, low-protein diet, poultry litter

**498 Digestible lysine requirement of broilers based on practical diet.** M. Shivaazad*, F. Alami, M. Zaghari, and H. Moravej, University of Tehran, College of Agriculture and Natural Resources, Animal Science Department, Karaj, Tehran, Iran.

This study was conducted to estimate the requirement of digestible lysine for broiler from 35 - 49 d of age. 240 chicks were used in a completely randomized design, consisted of 2 sexes and 6 digestible lysine levels. Experimental diets were formulated to be isoenergetic, isonitrogenous. Fitted broken lines on different responses indicated break points at 0.93, 0.93 for body weight, 0.98, and 0.92 for FCR for male and female, respectively. The results showed that digestible lysine requirement of male broilers for maximum breast yield percentage, plasma free lysine and antibody titer against Newcastle disease virus was exceeded the range of lysine levels tested. The result showed that the dietary lysine had a significant increasing effect on the plasma free lysine, albumin, total protein, immunoglobulin, antibody titer against SRBC and Newcastle disease virus and H/L. In conclusion, lysine requirements of broilers for performance were lower than breast yield percentage and immune responses. Broken-line analysis showed that the concentrations of plasma free lysine were useful physiological indicator for determining digestible lysine requirement of male and female broilers. The results from this experiment suggested that the estimated requirements based on exponential response curves were higher than estimated requirements by using broken-line model.

**Key Words:** digestible lysine, blood, immune response

**499 Effects of different dietary level of arginine, lysine and their ratios on performance and meat yield of broilers.** F. Sun*, H. Yan, and H. Cai, Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China.

This study was designed to evaluate the effects different dietary levels of lysine, arginine and arginine:lysine ratios on performance and carcass yield of broiler chickens. AA broilers (n = 672) were divided into 6 treatments, each treatment contained 8 replicates with 14 birds each. At each phases (0–21 day and 22 to 42 d) Lys was set up at low and high levels according to NRC Recommendation (1994) (low) and AA recommendation (high). In each level of Lysine, arginine was added according to arginine:lysine at 1:1, 1.2:1, and 1:4:1, respectively. At 0–21 d and 22–42 d, broilers had largest (P < 0.05) body weight and lowest (P < 0.05) feed efficiency in the treatment with high lysine level and high arginine and lysine ratio, while BWG was lower and feed efficiency was higher in the treatment with low lysine level and high arginine and lysine ratio. The results also showed that different lysine and arginine level and arginine and lysine ratios had different effect on carcass yield. At 0–21d high lysine level and high arginine:lysine ratio in broiler’s diet increased (P < 0.05) carcass weight, thigh yield and breast yield. While at 22–42 day, high lysine and high arg:lys ratio affected only breast yield, but not thigh. Effects of different dietary level of Arginine, Lysine and their

**Key Words:** lysine, arginine, broiler

An isotope dilution technique was developed to measure the jejunum or ileal endogenous lysine recovery in broiler chickens. Chicks were fed a diet high in non starch polysaccharides from 7 to 24 d of age. Previous fasting of 12 h, D4-lysine label were orally administrated to the chicks every day from 16 to 23 d of age at 2% of lysine intake (30 - 25 mg/kg BW/d). Two hours after the oral administration plasma, jejunum or ileal samples were taken every day. Real lysine digestibility was proposed as the ileal lysine digestibility plus endogenous lysine in jejunum or ileal. The isotopic steady state of D4-enrichment was reached at d 5 for both plasma and jejunum. The D4 enrichments of ileal samples were significantly similar among days of oral administration. Significant inverse allometric power-law relationships between D4-enrichments and lysine amount of jejunum and ileal show that when the amount of lysine is low the endogenous lysine is high and this effect was more marked in ileal samples. The endogenous lysine recovery (ENR) was higher in the jejunum than in the ileal (0.52 vs 0.19 g/kg dry matter, P = 0.034). The ileal lysine digestibility was 80.7% and the real lysine digestibility was greater in the jejunum than did in ileal (84.5 vs 82.1%). We concluded that the 5 d of oral administration and the jejunum are the best time and place to determine ENR in broiler chickens.

Key Words: D4-isotope dilution technique, endogenous lysine, oral label administration