Abstracts of the
Poultry Science Association
2nd Latin American Scientific Conference

SYMPOSIA AND ORAL SESSIONS

Tuesday, November 6

Student Competition: Immunology, Health, and Disease ................................................................. 1
Student Competition: Management and Production .................................................................................. 3
Student Competition: Metabolism and Nutrition, Feed Additives .......................................................... 5
Student Competition: Microbiology and Food Safety ............................................................................. 8
Student Competition: Molecular and Cellular Biology ........................................................................... 10
Student Competition: Metabolism and Nutrition, Enzymes ................................................................. 11
Student Competition: Extension and Instruction ..................................................................................... 15
Student Competition: Genetics and Genomics ......................................................................................... 16
Student Competition: Animal Well-Being and Behavior ....................................................................... 17
Student Competition: Processing and Products ....................................................................................... 20
Student Competition: Metabolism and Nutrition, Amino Acids ............................................................. 23
Student Competition: Metabolism and Nutrition, Nutrition I .................................................................. 24

Wednesday, November 7

Microbiology and Food Safety .................................................................................................................. 26
Physiology and Reproduction .................................................................................................................... 29
Student Competition: Metabolism and Nutrition, Nutrition II ............................................................... 31
Student Competition: Metabolism and Nutrition, Vitamins and Minerals ............................................. 35
Immunology, Health, and Disease ............................................................................................................ 38
Animal Well-Being and Behavior ........................................................................................................... 45
Molecular and Cellular Biology ............................................................................................................... 47
Metabolism and Nutrition, Nutrition I ..................................................................................................... 49
Genetics and Genomics ........................................................................................................................... 54
Metabolism and Nutrition, Vitamins and Minerals .................................................................................. 55
Processing and Products ........................................................................................................................... 59
Metabolism and Nutrition, Feed Additives I ............................................................................................. 61
Immunology, Health, and Disease II ......................................................................................................... 63
Management and Production .................................................................................................................... 65
Metabolism and Nutrition, Feed Additives II ............................................................................................ 69
Metabolism and Nutrition, Nutrition II .................................................................................................... 77
Metabolism and Nutrition, Enzymes I ....................................................................................................... 85
Metabolism and Nutrition, Vitamins and Minerals II .............................................................................. 91

Thursday, November 8

Metabolism and Nutrition, Amino Acids ................................................................................................. 95
Metabolism and Nutrition, Enzymes II ................................................................................................. 102
Metabolism and Nutrition, Feed Additives III ...................................................................................... 110
1 High levels of dietary tributyrin do not improve Salmonella infectivity, Eimeria maxima lesions, performance, or necrotic enteritis in broilers. T. Barros*, B. Graham, G. Tellez, B. M. Hargis, and J. Latorre, University of Arkansas, Fayetteville, AR, USA.

Butyric acid is a primary energy source for enterocytes and is known to have antimicrobial and anti-inflammatory effects. Tributyrin (TB) is a triglyceride cleaved by lipase in the small intestine, resulting in 2 butyrate and 1 glycerol monobutyrate molecules. We evaluated the effect of TB on Salmonella Typhimurium (ST) infectivity, Eimeria maxima (EM) lesion scores, and development of necrotic enteritis (NE) in a sequential infection model. Day (d) of hatch (n = 172) broiler chicks were randomly divided into 2 groups, individually weighed and were fed a basal diet (control) or a diet with 2000 ppm of TB. On d of hatch, 86 chicks/group were orally inoculated with ST (1.5 × 10^3 cfu/bird). At d15, all birds were weighed and 20 chickens/group were euthanized. Ceca and crop were individually and aseptically removed for individual enumeration of total ST colony-forming units (cfu). The remaining birds (n = 73/group) were gavaged with EM (4 × 10^3 oocysts/bird). Four d post-inoculation, 18 birds/group were moved to cages for EM oocysts shedding/bird (OPG) after 6, 7, 8, and 9 d of inoculation. All birds were weighed and 20 birds/group were euthanized for evaluation of lesions caused by EM 6 d post-EM challenge. The remaining birds were orally inoculated with Clostridium perfringens (CP; 2 × 10^8 cfu/bird) on d 6 and 7 post-EM challenge. All birds were weighed 8 d after EM inoculation. NE lesions were scored 4d after first inoculation with CP. Body weight (BW), OPG, and ST recovery were analyzed by t-test. Lesion score for EM and NE were analyzed by Wilcoxon test. Chickens from the TB group had a lower BW 8d after EM inoculation (573.4 ± 16.32 vs. 525.1 ± 16.32; P = 0.0315). No differences in BW at d 0 and 15 or mortality (<3%) were observed. ST recovery from ceca was higher in chicks receiving TB (3.57 ± 0.23 vs. 5.38 ± 0.27; P = < 0.0001), but no differences in crop recovery were observed. TB treated chickens had higher EM lesion scores (2.90 vs. 3.45; P = 0.05) but no differences in OPG or lesion scores for NE. The results indicate that inclusion of TB at 2000 ppm was detrimental in this challenge model, causing higher ST colonization, reduced performance, and higher EM lesion scores. These results could be associated with limited lipase and bile salt availability in young chicks, allowing for alterations in the enteric microflora promoting inflammation. Lower dietary concentrations of TB, possibly promoting inflammation. Lower dietary concentrations of TB, possibly

2 Influence of the use of different sources and levels of selenium in the intestinal health in broilers. B. Ramborger*, D. B. Moretti, J. G. Gonçalves, S. L. Vieira, and L. Kindlein, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, Universidade de São Paulo, Piracicaba, SP, Brazil, Adisseo South America, São Paulo, Brazil.

Small intestine of birds is the main site of nutrients digestion and absorption. The intestinal villi increase the food contact surface and have goblet cells producing acid and neutral mucus. The main function of mucus is to protect the epithelium from factors aggressors which may be present in the intestinal lumen. Selenium (Se) is an antioxidant micronutrient essential for organic functions; however, its impact on intestinal health is not fully characterized. The objective of this study was to evaluate the effect of different levels and sources of selenium on the intestinal health of broilers sanitarily challenged. The total of 1,500 Cobb males were randomly assigned to a completely randomized design with 10 treatments and 6 replicates. Experimental diets were composed by diet supplemented with 0; 0.15; 0.30; 0.45 and 0.60 ppm of inorganic (sodium Se) or organic (selenohydroxy methionine) source selenium. At 4 d, all birds from treatment (with the exception of control treatment) were vaccinated with a coccidiosis vaccine (Bio-Coccivet). The absorption surface was determined by stereology technique and count of goblet cell numbers. Statistical analysis were by SAS 9.4 for ANOVA and the significative differences by Tukey test at 5%. The results indicated there was a change in the secretory profile of the increased neutral mucins in the ileum of the broilers that received supplementation at the levels of 0.15 and 0.30 ppm of organic Se (n = 90.1 and 65.0, respectively) when compared with the group without supplementation (P < 0.05) (n = 28.2 without coccidiosis vaccine and n = 36.1 with coccidiosis vaccine). There was an increase in acid mucins in the group receiving 0.30 ppm of organic Se (n = 527), differing from the group without supplementation (n = 412) (P < 0.05). It is suggested that this increase in the secretion of mucins would have the purpose of making denser the mucus that recovers the epithelium, to protect it against biological aggressors. There were no changes in the mucin secretion of the jejunum and among the supplemented groups inorganic selenium (P > 0.05). Regarding the absorption surface, the group supplemented with 0.15 ppm of organic Se had a higher absorptive surface in the ileum (45%) than the group supplemented with 0.30 ppm of inorganic Se (36%). In the jejunum, a greater absorptive surface was observed in the group supplemented with 0.45 ppm of Organic Se (62%). Organic Se may influence mucin secretion of goblet cells and increase the surface area of intestinal villi absorption when compared with non-supplemented birds. Other studies should be developed to elucidate the impact of the use of organic Se in the intestinal health of broilers.

Key Words: goblet cell, mucins, absorption surface, broiler, selenium

3 MHC-linked genes, immune responses, and their role in genetic resistance to infectious bronchitis virus. A. P. da Silva*, A. Robertson, C. Kern, Y. Wang, H. Zhou, and R. Gallardo, University of California, Davis, CA, USA.

Infectious bronchitis (IB) is an endemic infectious disease that affects primarily the upper respiratory tract of chickens. Because of its genetic variability, some IB virus (IBV) genotypes are able to circumvent vaccination protocols commonly used in the field, especially when the vaccine genotypes are different from the circulating strains of IBV. To better understand immune responses against IBV, we have been using MHC congenic chicken lines that are relatively resistant and susceptible to IBV as animal models. The resistant line 331/B2 and the susceptible line 335/B19 share the same genetic background, with differences only in their MHC haplotype. The main goal of our research is to investigate and compare the differences in clinical, pathological and immunological responses between resistant and susceptible birds and use that knowledge as a basis to develop targeted prevention approaches against IBV. In previous experiments, we have challenged our “resistant-susceptible” animal model with 2 genotypes of IBV – Arkansas DPI (ArkDPI) and Massachusetts 41 (M41) – and observed that differences between the 2 chicken lines were better perceived in IBV-specific humoral responses for both viral challenges. To investigate the expression of genes related

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to immune pathways, we performed RNA sequencing and observed that the susceptible 335/B19 line presents a higher number of differentially expressed genes related to innate immune responses compared with the resistant 331/B2 line. Even though gene expression was not identical in M41 and ArkDPI challenges, the upregulated genes for both viruses belong to the same immune pathways. Despite our efforts to assess cytokine levels by ELISA in tears and sera after challenge, it was not possible to draw solid conclusions from our results. To supplement the knowledge acquired from the in vivo experiments, we performed an in vitro investigation using tracheal epithelial primary cell cultures. Tracheal organ rings derived from chicken lines 331/B2 and 335/B19 were cultured and challenged in vitro with IBV M41. Cytokine levels (IFN-β, IL-1β, IL-6 and IL-8) were assessed from supernatants using ELISA and gene expression of the same cytokines was measured from cells by RT-qPCR at 2, 4, 6, 12, 24 and 48 h after challenge. Preliminary results corroborate what was observed in the in vivo experiment by RNA-sequencing, in which IBV seems to elicit more cytokine gene expression/production in the susceptible line 335/B19. Besides minimizing the number of animals used, the in vitro setting allowed us to better control variables present in in vivo experiments and facilitated the assessment of innate immune responses in the 2 MHC chicken lines.

Key Words: avian immunology, cytokine, IBV, respiratory disease


The aim of this study was to evaluate the occurrence, etiology and pathogenesis of arthritis in heavy male turkey in different ages. For this, 18 turkey farmers were visit, being 6 of each studied age (5–7, 11–13, and 17–20 wk). A total of 540 heavy male turkeys were evaluated for Gait Score (GS) and 54 were evaluated for arthritis degree (AD) and arthritis occurrence (AO), as follow: GS0 = absence of any reluctance to move; GS1 = small reluctance to move; GS2 = same changes of degree 1 plus mild swelling or mild valgus or varus; GS3 = staggered movement and dropped keelbone, being able to stand or move for more than 30 s; GS4 = failure to stand or move for more than 30 s; GS5 = complete recumbency or only able to stand or move for a few seconds if pushed to walk. AD and AO were evaluated only in the left leg, using the following criteria: AD0 = no apparent lesion; AD1 = volume increase with no color change; AD2 = volume increase and focal color change; AD3 = volume increase and extensive area of color change. The occurrence of any degree of AD was considered as AO. These birds were euthanized followed by the aseptically collection of gastrocnemius tendon, and tibiotarsal joint synovial fluid of lame for microbiological analyses (reovirus and Salmonella sp. presence, Escherichia coli, and detected of Salmonella serovars). For statistical analysis it was used Crosstabs followed by Chi-squared test ($P < 0.05$). It was only observed GS0 and GS1 in male turkeys at 5–7 weeks old, while in turkeys at 11–13 and at 17–20 wk old (pre-slaughter) were observed GS2, 3, 4 and 5. Arthritis severe degree was not present in male turkeys with 5 to 7 wk old, that may be related to the live weight. In general, it was observed in turkeys at 11 to 13 wk old an association between reovirus presence and AO ($P = 0.035$) and higher GS ($P < 0.0001$). At same age, also, an association between detection of Salmonella in litter and higher GS ($P = 0.009$) was seen. Reovirus presence was detected in 77.78% (14/18) of the visited farms, and most of bacteria isolated from the turkey hock joints was identified as Escherichia coli. Salmonella serovars detected in this study included Salmonella Anatum, S. Achwarzengrund and S. Aenftenberg. Results can indicate that reovirus dissemination can be one of the causes for the occurrence of arthritis in heavy male turkey. Adding to this, the increase of age showed higher arthritis occurrence.

Key Words: heavy male turkey, arthritis, gait score, reovirus, Salmonella
5 Pre-placement diet improves broiler performance for chickens from young broiler breeders. E. F. Melo*, P. C. Cardeal†, M. A. Pompeu1, N. C. Baião1, and L. J. C. Lara1, 1UFMG, Belo Horizonte, MG, Brazil, 1Viali Soluções Integradas para o Agronegócio, Belo Horizonte, MG, Brazil.

The aim of this study was to verify the efficiency of the use of a pre-placement diet inside transportation boxes for chicks from young and old broiler breeders to reduce negative effects of post-hatch fasting upon broiler performance. A total of 1,440 male Cobb broiler chicks were distributed in a completely randomized experimental design in a factorial arrangement 2X2X2 with 8 treatments: 2 broiler breeder age (BBA) (29- and 55-week-old), 2 periods of time between hatch and placement (THP) (24 and 48 h) and the use or not of a pre-placement diet (PPD). Chicks that received PPD inside transportation boxes, received 2.5g/bird. It was analyzed weight loss from hatch to placement (WL), feed intake inside transportation box (FITB), body weight (BW), feed intake (FI) and viability (VIA) at the ages of 7 and 37 d. Data were analyzed in a 3-factorial ANOVA (P ≤ 0.05). Chicks from old broiler breeders had smaller WL than chicks from young broiler breeders (P ≤ 0.05). Chicks that were placed within 48 h had higher WL than those placed within 24 h (P ≤ 0.05). For chicks from young broiler breeders, the use of PPD reduced WL (P ≤ 0.05). FITB was 40% more for chicks from young broiler breeders than for chicks from old broiler breeders (P ≤ 0.05). BW and FI of chicks at the age of 7 d was higher for chicks from old broiler breeders (P ≤ 0.05). For chicks from old broiler breeders, placement within 48 h increased BW and FI at 7 d (P ≤ 0.05). And for chicks from young broiler breeder placed within 48 h, the use of PPD increased BW at 7 d (P ≤ 0.05). VIA at 7 d was lower for chicks from young broiler breeders, placed within 48 h without PPD (P ≤ 0.05). For chicks from young broiler breeders, the use of PPD increased BW until 37 d of age (P ≤ 0.05) and placement within 48 h increased FI until 37 d, regardless BBA (P ≤ 0.05). Placement within 48 h without PPD decreased VIA until 37 d (P ≤ 0.05). In conclusion, PPD is indicated for chicks from young broiler breeders to increased BW until 37 d of age and reduced mortality during the first week of life.

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Key Words: Gompertz, strain, daily weight gain maximum


The high growth rate and breast yield in broiler chickens of most common genetic lines have been associated with the occurrence of breast myopathies, such as wooden breast (WB). The fillets WB-affected showed correlations between the macroscopic and the muscle structure measurements, once the affected areas had variations in shape and texture of the fibers. To this, the aim of this study was to determine the histomorphometric changes on pectoralis major muscle from broilers affected with wooden breast anomaly. To this, 18 male Cobb 500 broilers were slaughtered at 49 d of age (3.980 BW) and the pectoralis major muscles of each bird were visually scored on a 5-point scale for WB that ranged from 0 = normal breast, 1 = mild hardening in the upper, 2 = moderate hardening in the upper and/or lower part of the fillet, 3 = severe hardening, and 4 = severe hardening with hemorrhagic lesions, increased volume, and presence of yellow fluid. Samples were taken from the anteroventral area of the fillet at the transversal section, fixed in buffered 10% formalin, dehydrated with ethanol in increasing concentration (30–100%), diaphanized in xylol, and included in paraffin. From each sample, 3 semi-serial cross-sections (3 µm) were cut and stained with HE. A total of 180 images were capture and histomorphometric measurements, once the affected areas had variations in shape and texture of the fibers. To this, the aim of this study was to determine the histomorphometric changes on pectoralis major muscle from broilers affected with wooden breast anomaly.
showed that although WB fillets had greater diameters, these fibers are being degenerated and replaced by connective tissue (endomysium and perimysium), leading to a reduction on the fiber density. Additional, WB fillets showed smaller microvessels density per fiber, so this anomaly can reduce the vascularization of the meat.

Acknowledgements: The authors thank the Coordination of Higher Education (CAPES) for the scholarship.

Key Words: breast myopathy, broiler, connective tissue, fiber diameter, microvessel supply

8 A comparative field trial: A water-applied biopromotor to improve production status in commercial broiler chickens. I. D. Praxedes-Campagnoni*a1,2, F. Matte3, A. Zampar4, M. M. Bioago5, and S. Layton6, 1Department of Animal Science – PPZO/UDESC/SC, Chapecó, Santa Catarina, Brazil, 2Vetanco Brazil, Chapecó, Santa Catarina, Brazil, 3Vetanco International/BV Science, Vicente Lopez, Buenos Aires, Argentina.

The objective of this field trial was to evaluate a water applied natural additive biopromotor, as an alternative strategy for improve field productive parameters, specifically reducing the total mortality, increasing the daily body weight gain (Daily BWG) and improving the feed conversion ratio (FCR) in commercial broiler flocks. The evaluation was a large-scale field trial in a commercial broiler complex located in the South part of Brazil; the complex represents a group of 45 farmers. The additive biopromotor was administered randomly in 3 consecutive treated flocks (n = 921,420 treated and n = 1,153,220 control for the total 3 production cycles). The product used in this trial was Gamaxine from Vetanco S.A, a natural Additive Biopromotor composed of inactivated bacillus strains (selected for their ability to produce molecules which improve mucosal integrity and reduce gram-negative bacteria) and yeast cell wall extracts. It was administered orally in the drinking water (0.2mL/bird) on d3 and 17 of life to all broiler chickens (Cobb t500) in each randomly selected treated flock. Following each production cycle, productive parameters were calculated for each flock and at the conclusion of the evaluation period (3 consecutive production cycles) the results were averaged for the total treated chickens (n = 921,420) and compared with results of non-treated control broiler chickens (n = 1,153,220) from the same farm, but in different flocks. Statistical analysis was performed on a total of 186 replicate flocks (85 treated and 101 untreated controls).

After analyzing the normality of the data distribution, an ANOVA was performed to compare the means. Results show there were significant reductions (P = 0.02) in total mortality in the treated group when compared with the control group (3.45% and 3.99% respectively) in total mortality in the treated group was performed to compare the means. Results show there were significant reductions (P = 0.02) in total mortality in the treated group when compared with the control group (3.45% and 3.99% respectively) for the total experimental period. Additionally, there were significant improvements in FCR (P = 0.0005) between the 2 groups (1.742 to 1.703 a difference of 39g feed/kg/bw) during the experimental period. Daily BWG was also significantly improved (P = 0.0002) with a difference of 2.53g more per day in the treated group compared with the control group. All data supported by statistical Analisys, taken together in this comparative field trial indicates that additive biopromotor provides is a promising alternative to antibiotic growth promoters for increasing commercial poultry performance parameters.

Key Words: biopromotor, poultry, production, performance


Arthritis is an important cause of the partial condemnation of carcasses of heavy male turkeys in slaughterhouses in Brazil. Thus, the early diagnosis becomes important to allow appropriate treatment to animals as soon as possible. This study aimed to evaluate the correlation of biometric measurements in vivo of the heavy turkeys' joint in different ages with the presence of varying arthritis degrees. For this, 18 turkey farmers were selected according to the expected age of slaughter: 5–7, 11–13, and 17–20 weeks of life. To that end, in each turkey farm, 3 animals (n = 54) were selected for classified for arthritis degree (AD), as follow: 0 = no apparent lesion; 1 = volume increase with no color change; 2 = volume increase and focal color change; 3 = volume increase and extensive area of color change. Also, were measured the joint surface temperature analyzes. In each animal, 2 infrared images with surface temperature were sequentially captured at a distance of 0.5 m from the center of the bird joint using the thermal visor from Testo (T300, FLIR Systems, Wilsonville, OR, USA), operating with precision of up to 0.05°C, emissivity of 0.98. The data generated by the thermometer consisted of minimum, mean and maximum values, in °C, of the skin surface temperature of the turkey joint. After the humanitarian sacrifice of the animals, the width and depth of the intertarsal joint (by pachymeter) were measured. The data were submitted to ANOVA and the means, when significant, were compared by the Tukey test (P < 0.05) and Pearson correlation, using the IBM SPSS statistics software. In general, the results showed that there is a significant increase in the severity of the arthritis when the age increased (P < 0.05), being possible to observe that all animals aged between 17 and 20 weeks presented some degree of this pathology. Turkeys, also in this age range, had maximum joint surface temperature values (°C) of 37.6 ± 0.4; 38.9 ± 0.7; 39.6 ± 0.4; and 39.5 ± 0.4 cm for 0, 1, 2 and 3 of AD, respectively, then compare another’s degrees. Concomitant to this, the animals that presented higher mean values of thermography were those that had the highest AD (R = 0.493). The width and depth of joints increased with age, being the maximum depth found in turkey’s intertarsal joint in the age range to 17–20 weeks (3.8 ± 0.8 cm), showing no significant difference when correlated with the AD (P > 0.05). Thus, it was possible to observe that the use of thermographic images for identifying arthritis in heavy turkeys can be a efficiency tools to diagnosis in vivo.

Key Words: turkey, arthritis, diagnose, infrared thermography, condemnation of carcasses
10 Microbial 16S rDNA reveals different pathways between HMTBA and acidifier on broilers. Y. Wu*, X. Yin, Y. Wang, J. Li, and J. Yuan, State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.

Methionine hydroxy analogs (HMTBA) has relative strong acidity, however, it is not clear whether HMTBA can serve as an acidifier in vivo. This study aimed to explore whether methionine hydroxy analogs can serve as an acidifier in poultry. A total of 480 1-d old AA broilers were randomly divided into 4 treatments: A: basal diet + 0.057% HMTBA (Adisseo); B: basal diet + 0.05% DL-methionine (DLM) + 0.057% acidifier (Selko); C: basal diet + 0.284% HMTBA; D: basal diet + 0.25% DLM + 0.284% acidifier. The diets contain same concentrations of sulfur amino acid and other nutrient levels among groups. Each treatment consisted of 8 replicates of 15 chickens. At day age of 21, the growth performance, chyme pH, digestive enzyme activities and intestinal microflora were measured. The general linear model (GLM) was used for single factor analysis by SPSS 23.0. There was a significant difference when p < 0.05. The pH in crop, gizzard and ileum content were higher in the HMTBA at high-level supplementation than acidifier (p < 0.05). In addition, HMTBA was not able to achieve acidification by stimulating digestive enzyme activities. HMTBA supplementation inhibited proliferation of acid-producing bacteria, such as Fecalibacterium and Allistipes compared with acidifier utilization. In contrast, high-level of HMTBA could significantly increase the daily gain and daily feed intake (p < 0.05) of broiler chickens compared with acidifier. In PICRUST analysis, HMTBA and acidifier had different effects on bacterial lipid metabolism, amino acid metabolism and carbohydrate metabolism related pathways. These results suggested that HMTBA was better than acidifier regarding the growth performance of the animals, but worked through different pathways from acidifier.

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Key Words: methionine hydroxyl analog, acidifier, broiler, microflora, crop, cecum, pH


Muramidases are enzymes produced by animals, plants, and microorganisms to hydrolyze peptidoglycans (PGN) that is the major structural components of bacteria cell wall. The microbial cell turnover is a very common pathway that results in the production of several cell components as PGN in the gut. It is hypothesized that excessive accumulation of bacterial cell wall fragments on the surface of the gut could impair nutrient absorption and consequently, growth performance. Thus, a novel muramidase, produced by fermentation (Muramidase 007, MUR), with high affinity for hydrolyzing PGN in bacterial cell wall fractions has been characterized to improve the gastrointestinal functionality, optimizing nutrients absorption and consequently growth performance improvements. Moreover, a better nutrient absorption could contribute to improve the litter quality and consequently the footpad lesions in broiler chickens. The aim of this study was to evaluate the effect of MUR at different doses on the performance and the impact on the foot pad dermatitis (FPD) of broilers from 1 to 42 d of age. A total of 1000 d-old Cobb 500, were randomly distributed across 4 treatments of 10 replicates, using 3-times-reused litter floor-pens. Treatments were: Control (C); C+15,000 LSU (F)/kg of Muramidase (MUR 15); C+25,000 LSU (F)/kg of Muramidase (MUR 25) and C+35,000 LSU (F)/kg of Muramidase (MUR 35). Diets were based on corn and soybean meal, and all diets included phytase 1000 FYT/kg of feed. Feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) were evaluated during the whole period. At d 42, FPD were evaluated and percentage between treatments were recorded according to absence (score 0 and 1) or presence (score 2, 3 and 4) of lesions. Data were analyzed by ANOVA, polynomial regression, and means were compared by the Tukey test at 5% probability. There was no significant difference for FI and BWG during the whole period (P > 0.05). However, the FCR presented a negative linear response (P < 0.01) to increasing doses of a MUR, showing the most efficient conversion among treatments (1.694 control vs 1.633 MUR 35, P < 0.01). A significant difference was found for FPD scoring among treatments (P < 0.05). The presence of FPD in control group was 29% vs 9% in broilers that receive MUR 35, but it was similar to other treatments. Results of this study demonstrated that supplementation of the novel muramidase in broilers feed, bring benefits to performance by improving FCR and reducing FPD caused by reused litters.

Key Words: enzyme, feed conversion, litter, gastrointestinal functionality, peptidoglycan

12 Performance and meat yield of broilers challenged with Clostridium perfringens and supplemented with yeast cell wall and zinc bacitracin. E. U. Ahiwe*, 1, 2 M. E. Abdallh1, E. P. Chang12, A. Omede1, H. Graham3, and P. A. Iji1, 1, School of Environmental and Rural Science, University of New England, Armidale, Australia., 2Department of Animal Science and Technology, Federal University of Technology, Overri, Imo State, Nigeria. 3AB Vista, Marlborough, Wiltshire, UNITED KINGDOM, 4College of Agriculture, Fisheries and Forestry, Fiji National University, Koronivia, Fiji.

The aim of this study was to determine the effect of dietary supplementation of yeast cell wall extract on performance and meat yield of broiler chickens challenged with Clostridium perfringens. Six diets based on maize and soybean were offered to 576, Ross 308 broiler chickens from d 0 to 35. Each 6 treatments was replicated 8 times, with 12 birds per replicate. Treatments consisted of Negative control (NC, no supplementation and not challenged); Positive control (PC, no supplementation but challenged); YCW (supplemented with yeast cell wall at 2 g/kg diet but unchallenged); YCWC (supplemented with yeast cell wall at 2 g/kg diet and challenged); ZNB (supplemented at 0.267 g Zinc bacitracin/kg diet but unchallenged), and ZNBC (supplemented at 0.267 g Zinc bacitracin/kg diet but challenged). Birds in the challenged group were given 1-mL Eimeria spp. on d 9 and 1-mL C. perfringens on d 14 and 15 while the unchallenged groups were given 1-mL sterile phosphate-buffer saline suspension orally. Data of feed intake and body weight were collected on d 10, 24 and 35 while feed conversion ratio (FCR) was calculated and corrected for mortality. At d 35 2 birds were randomly selected, slaughtered by cervical dislocation and processed for assessment of meat yield. Data were analyzed using ANOVA of Minitab 17. Mortal-
ity did not differ ($P > 0.05$) between dietary treatments. There was no significant difference ($P > 0.05$) in FI between birds in all treatment groups at d 10. At d 24 and 35, birds in the PC group had the least FI ($P < 0.05$) compared with other treatment groups. Birds in the ZNB group had superior body weight and FCR but this was comparable to birds in the YCW group. Both BWG and FCR were least in the PC group at d 24 and 35. ZNBC and YCWC groups had better ($P < 0.05$) BWG and FCR than birds in the PC group. The dressing %, relative weight of breast, thigh and drumsticks at d 35 were lowest in birds from the PC group. However, birds from the ZNBC group although comparable to birds in the YCWC group were superior ($P < 0.05$) in these values to birds in the PC group. Supplementation with ZNB or YCWC supported a higher dressing %, relative weight of breast, thighs and drumsticks than the unprotected (PC) group, in response to the challenge. It can be concluded that supplementation with yeast cell wall extract at 2 g/kg can improve performance, dressing % and meat yield of broilers challenged with C. perfringens and may serve as a possible alternative to antibiotics when fed to broiler chickens.

Acknowledgements: AB Vista UK and UNE for the research funds.

Key Words: yeast, antibiotics, performance, broiler


The objective of the current study was to evaluate the effect of supplementing a strain of the probiotic Bacillus subtilis in broiler breeder diets on egg hatchability and hatching chick quality. A total of 640 Cobb 500 broiler breeder hens were distributed in a completely randomized design in 32 floor pens. Water was supplied ad libitum, whereas feed was restricted following Cobb recommendations. Each experimental unit was composed of 20 hens and 2 roosters. The experiment consisted of 2 treatments (provided for males and females): control diet, and control diet added with 60 g/MT of probiotic ($1 \times 10^{10}$cfu/g Bacillus subtilis (Calsporin)), with 16 replications each. Resulting data were measured in 10 periods (25–28, 29–32, 33–36, 37–40, 41–44, 45–48, 49–52, 53–56, 57–60, 61–64 weeks of age). After hatch, chicks were weighed, measured, and evaluated for leg morphology (score 1 for normal and 5 for altered), and navel opening (1 normal, 2 slightly altered and 3 altered). Data were analyzed using the Mixed procedure of SAS (2009) with period as repeated measure. Means were considered significantly different at ($P < 0.05$) using the Tukey Kramer test. Females fed diets with probiotic addition had increased egg and body weights as well as progeny length ($P < 0.05$). In the last weeks the weight of the eggs increased in size, which consequently generated heavier chicks ($P < 0.05$). Leg scores and navel buttons were not different for both ($P > 0.05$). The periods from wk 49 to 52, and 57 to 60 were those that presented better conditions of legs in the progeny. An interaction between treatments and period was found for chicks length and navel scores ($P < 0.05$). According to this study it was possible to conclude that the supplementation of Bacillus subtilis in diets of broiler breeders has a beneficial effect on birds and egg weight and characteristics such as length and weight in the progeny.

Key Words: Bacillus subtilis, broiler breeder, progeny quality, probiotics


Antimicrobial multidrug resistance is one of the most important current threats to public health. The restriction in the use of antibiotics as growth promoters, together with the growing demand for differentiated healthy and safe products, has opened the doors for the use of functional additives of natural origin. The objective of this research was to determine the effect of different levels of inclusion (50, 100, 150 ppm) and routes of administration (water and food) of fungal biomass of Ganoderma spp., on the productive performance and the intestinal morphology of broilers. A total of 320 male one-day old Ross 308 broilers were allocated in isolated units at Universidad Nacional de Colombia and randomly assigned to 8 treatments (4 replicates with 10 broilers each) with a same basal diet. The performance parameters (feed intake FI, body weight gain BWG, feed conversion FCR) were evaluated weekly and intestinal morphology were made at the end at 21 d. The treatments were: birds without any additive (negative control; NC); birds with feed with 55 ppm of Bacitracin methylene disalicylate BMD (positive control; PC); 6 groups of birds supplemented with Ganoderma fungal biomass at 50 ppm, 100 ppm and 150 ppm in drinking water (WG50, WG100, WG150) and feed (FG50, FG100, FG150). Statistical analysis was performed with ANOVA and Tyukey ($P < 0.05$). There were significant differences in FI and FCR being lower for PC group, the BWG were higher for FG150 compare with the CN, and there were no differences between the inclusion levels of Ganoderma in water or food and the CP. In relation to intestinal morphometry, significant differences were found, with FG150 and CP groups having the best performance, with 1169.14 µm and 1171.05 µm of villus height, respectively. Heights were significantly shorter in the other treatments, WGD50 (901.3 µm) and WGD100 (895.3 µm). The largest intestinal absorption area in FG150 was associated with a higher IF and BWG. Supplementation with Ganoderma may be an alternative to the replacement of antibiotic growth promoters.

Key Words: broiler, Ganoderma, broiler performance, intestinal morphology


This study aimed to evaluate the effects of a supplemental source of nucleotides (NUCL) in the diet of broilers challenged with E. coli lipopolysaccharide (LPS) on performance and serum biochemical parameters. A total of 96 Cobb 500 8-d-old male broilers chicks were randomly divided into 2 treatment groups with 2 subgroups of each (8 replicate cages; 3 birds/cage; totaling 32 experimental units) and were fed a basal diet without or with 2 kg/MT of a nutritional additive based on NUCL (15% of free and purified NUCL). Birds from each subgroup of the 2 treatment groups were intra-abdominally injected with LPS (1, 1.12, 1.25, 1.40 mg/kg of BW) or saline at 21, 23, 25, and 27 d of age. The experiment was divided into 2 phases: 8–21 (initial, before LPS challenge), and 21–35 d of age (final). Blood samples were collected from 1 bird per replicate on d 21 (before LPS challenge), 28, and 35 d of age and analyzed serum biochemical indices such as uric acid (UA), total proteins (TP), albumin and globulin. Study criteria also included body weight (BW), average daily gain (ADG), average daily feed intake (ADF), and feed conversion ratio (FCR). Analysis was performed with an one-way ANOVA for the data of the initial phase and 2-way ANOVA for the data of the challenge phase. There was a significant difference ($P < 0.05$) in these values to
for the final phase. On initial phase, the birds supplemented with NUCL showed greater BW (+3.3%), ADG (+4.0%), and had best FCR (−3.4%) when compared with the control group (P < 0.05). The treatments had no effect (P > 0.05) on ADFI, UA, TP and globulin, but albumina tended (P < 0.1) to be increased in the control group. On final phase, no interactions between NUCL supplementation and LPS challenge were found either on performance or serum biochemical parameters. However, LPS decreased ADG (−7.9%) and ADFI (−4.7%) when compared with no challenged group (P < 0.05), and tended (P < 0.1) to decreases BW and FCR at d 35. On d 28, supplementation of NUCL tended (P < 0.1) to increase UA and LPS tended (P < 0.1) to increases globulin level. There was no significant difference on biochemical parameters at d 35. In summary, this study demonstrated that broiler diets supplemented with NUCL significantly improved performance at initial phase and LPS challenge negatively affects birds’ weight gain and consumption.

**Key Words:** poultry, lipopolysaccharide, additive, globulin

### Table 1

<table>
<thead>
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<th>Parameter</th>
<th>CD</th>
<th>EW (g)</th>
<th>AW (g)</th>
<th>YW (g)</th>
<th>SW (g)</th>
<th>ST (mm)</th>
<th>SG</th>
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</thead>
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<tr>
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<td>66.287b</td>
<td>40.287b</td>
<td>21.30b</td>
<td>5.694</td>
<td>0.456</td>
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<td>PFA</td>
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<td>41.400a</td>
<td>21.61a</td>
<td>5.572</td>
<td>0.449</td>
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<td>0.002</td>
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<td>CV (%)</td>
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<td>8.12</td>
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<td>86.48</td>
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</tbody>
</table>

Means followed by lowercase letters differ in the same parameter by Tukey test (P < 0.05).

### Acknowledgements:
To LEPNAN, UFPR and PROPHYTUS

**Key Words:** additives, breeder, egg quality, phytogenic
Detection of Salmonella Enteritidis, Heidelberg, and Typhimurium directly from poultry samples by real-time PCR.

M. N. Souza1, F. K. M. Lehmann1, S. De Carli1, A. S. K. Fonseca2, N. Ikuta1,2, and V. R. Lunge1,2, *Laboratório de Diagnóstico Molecular ULBRA, Canoas, Rio Grande do Sul, Brazil, 1Simbios Biotecnologia, Cachoeirinha, Rio Grande do Sul, Brazil.

This study describes a rapid method for the detection of Salmonella serotypes Enteritidis, Typhimurium and Heidelberg in poultry samples by real-time PCRs. Salmonella is one of the most important pathogens in public health and it is usually associated with foodborne diseases. Salmonella serotypes Enteritidis and Typhimurium are widespread in the poultry farms around the world and mostly associated with outbreaks by poultry products consumption. There is also an increasing public health concern with the wide dissemination of the serotype Heidelberg in poultry farms. A total of 126 Salmonella isolates from 30 serotypes previously detected in Brazilian poultry farms were obtained. In addition, 43 clinical and environmental samples were obtained in 33 poultry flocks suspect to have Salmonella infection from 2013 to 2016. At the same time, 3 real-time PCRs were used for the specific detection of Enteritidis, Typhimurium and Heidelberg. These methods were tested with the isolates of Salmonella inclusivity and exclusivity. Further, all procedures were compared with the standard procedure in the analysis of poultry samples after pre-enrichment with buffered peptone water (BPW). Sensibility and specificity were calculated for each assay. The results demonstrated a high specificity (100%) of the assays to detect only the isolates of the respective serotypes. In addition, the PCRs could detect each specific Salmonella serotype directly from BPW with total concordance with the standard bacteriological method. According to the previous results, a flowchart diagram for Salmonella detection was designed to introduce the molecular methods described here in the routine analysis of poultry samples (a procedure in agreement with Brazilian regulation). In summary, the complete scheme has 5 main steps: 1) collection of the samples; 2) pre-enrichment with BPW; 3) DNA extraction; 4) real-time PCR assay to detect Salmonella; 5) real-time PCR assays to detect serotypes Enteritidis, Heidelberg and Typhimurium. This procedure was tested in the routine analysis of more than 100 samples and it was possible to complete the analysis (with the identification of the main serotypes) in less 24 h. This procedure will be useful in veterinary diagnostic laboratories for the fast detection of Salmonella and differentiation of the most important serotypes related to human diseases, leading to more responsive control measures.

Acknowledgements: This work was supported by grants from Simbios Biotecnologia, FAPERGS, CNPq and CAPES.

Key Words: salmonellosis, Typhimurium, Enteritidis, antimicrobial resistance

High frequency of Salmonella serotype Enteritidis in community food outbreaks in Southern Brazil.

A. K. Mascitti1, R. O. Reis1, D. Kipper1, L. M. Wolf1, J. M. Wolf1, A. S. K. Fonseca2, N. Ikuta1,2, and V. R. Lunge1,2, *Laboratório de Diagnóstico Molecular ULBRA, Canoas, Rio Grande do Sul, Brazil, 1Simbios Biotecnologia, Cachoeirinha, Rio Grande do Sul, Brazil.

Salmonellosis is one of the most reported foodborne bacterial infection in Brazil. Human clinical disease can range from a mild gastroenteritis until a more serious outcome with septicemic disease. Salmonella isolates are classified into more than 2.600 serotypes adapted to different animal hosts with diverse virulence mechanisms. Human infection is usually due to the consumption of food (such as meat, eggs, milk, etc.) contaminated with Salmonella. Two serotypes (Enteritidis and Typhimurium) have been the most frequently reported in sporadic cases and community outbreaks worldwide. In addition, Salmonella strains have presented increased resistance to antibiotics. The present study aimed to investigate the serotypes distribution and antimicrobial resistance patterns of Salmonella isolates obtained from foods (including chicken and eggs) in southern Brazil in a 6-year period. Salmonella cultures (n = 124) were isolated from foods by a reference laboratory in Rio Grande do Sul state, from 2010 to 2015. Serotypes were detected by classical immunological analysis and PCR. Antibiotic resistance was evaluated by agar disk diffusion according to the recommendations of the Clinical and Laboratory Standards Institute (CLSI). Qualitative variables were analyzed using the Statistical Package for Social Sciences (SPSS, version 18.0, Chicago, IL). The results demonstrated that 117 (94.3%) isolates were obtained from foods sampled during 45 community salmonellosis outbreaks and 7 (5.7%) through active search of the health surveillance service. Salmonella was isolated from meat products (34.7%), homemade mayonnaise (23.4%), fast foods (10.5%) and others (31.4%). Serological and PCR-specific tests detected 11 different serotypes, with the predominance of Enteritidis (47.6%) and Typhimurium (16.9%). Enteritidis was the most widespread serotype, being detected in all food sources, predominating in mayonnaise salad (62.1%), beef and derivatives (60%) and fast foods (53.8%) (P < 0.05). Typhimurium was the serotype most frequently recovered from pork meat and derivatives (64.3%) (P < 0.05). Antimicrobial resistance was analyzed in 57 isolates and more than half (53.1%) were resistant to one or 2 categories and 7% to 3 or more antimicrobial classes, being considered multidrug resistance (MDR). Nalidixic acid (NAL) was the antibiotic with the most resistance (43.9%), followed by NAL + nitrofurantoin (7%), NAL + ampicillin + tetracycline (5.3%), and streptomycin (3.5%). It is important to continuously monitor the microbial contamination of foods, mainly by serotypes Enteritidis and Typhimurium. Further, new studies are necessary to understand the virulence determinants of these isolates.

Key Words: salmonellosis, Typhimurium, Enteritidis, antimicrobial resistance

Nanocomposite of silver oxide with zinc oxide doped with silver prevents the Salmonella Heidelberg biofilm formation in turkey eggshell.


Control of Salmonella biofilm is a challenge in the poultry production. New strategies like nanotechnology provides the promise of control and prevention of contamination (1, 2). This research aimed at the efficiency of Nanocomposite of silver oxide with zinc oxide doped with silver on S. Heidelberg (SH) biofilm control in egg shells from industrial turkey breeders. The nanoparticle synthesis process was performed by the coprecipitation method. We used 96 turkey eggs being 16 eggs distributed in each of the following groups: (1) nano prev: Treatment with nanoparticle before SH biofilm formation in eggshell; (2) nano: Nanoparticle treatment after formation of SH biofilm in eggshell; (3) AP prev: Similar to nano prev but with 25,000 ppm of PA (peracetic acid); (4) PA: Similar to nano but without PA; (5) PC: Positive control; (6) NC: negative control. We evaluated the presence of SH in biofilm by conventional microbiology and SEM (scanning electron micros-
Confocal Raman microscopy (CRM) was used to analyze the pore size and ICP-OES (inductively coupled plasma optical emission spectrometry) for quantify the concentration of chemical compounds. The analyses were performed using GraphPad Prism 7.0 (confidence level was 95%). The quantitative biofilm formation tests performed in eggshell were analyzed using Kruskal-Wallis test. For the differences between percentages, the chi-squared test was used. To analyze height of the roughness of the shell and Ag and Zn amount we used ANOVA, the confidence level was 95% for all reports. The previous treatment with nanoparticle and PA prevented the SH biofilm formation biofilms in the shell. However, the passage of the bacterium into the egg was smaller when the nanoparticle was used. Bacteria in the eggshell was not influenced by the size of pores (data not shown). The amount of Zinc and Silver (Data not shown) was higher at eggshell but in albumen and yolk they didn’t have difference. Nanocomposite of silver oxide with zinc oxide doped with silver to inhibit SH biofilm formation, as well as the entry of SH into the egg. This work presents a new technology that can be used in poultry to control agents such as SH.

Acknowledgements: This study was funded by the Amparo Foundation Research from Minas Gerais (FAPEMIG).

Key Words: biofilm, AgNps, Salmonella, control, eggs
20 DL-Methionyl-methionine effect on the peptide 1 carrier expression and the redox state in coccidiosis-challenged broiler. A. de Souza Khatlab*, J. Casetta1, N. Y. Sitanaka1, A. P. Del Vesco2, A. R. de Oliveira Neto1, and E. Gasparino1, 1State University of Maringá, Maringá, Paraná, Brazil, 2Federal University of Sergipe, Aracaju, Sergipe, Brazil, 3Evonik Brazil, São Paulo, São Paulo, Brazil.

Peptide 1 (PepT-1) transporter is a membrane protein present in broiler gut specialized to transport both di and tripeptides which are quickly absorbed at small intestine. PepT-1 transporter is less affected than amino acids free transporter at the intestinal mucosa aggressions caused by Eimeria. For that purpose a study was conducted to evaluate the effect of dietary DL-methionyl-methionine (DL-MMet) supplementation during the health challenge of chickens, assuming that Eimeria aggressions damage the intestinal membrane and that the DL-MMet could affect the PepT-1 expression in broiler small intestine. 480 male broiler were used. At 14 d, a group of 240 chickens were inoculated orally with solution containing sporulated oocysts of eimeria (maxima, acervulina, mitis, praecox) (EC). Evaluated broiler diets were without methionine (SM), DL-methionine (DL-Met) and methionine dipeptide (DL-MMet). After 6 d of inoculation it was analyzed, feed intake (FI), weight gain (WB), feed conversion ratio (FC), relative body weight (RBW), serum mucoproteins (MUCO), redox status and PepT-1 expression jejunum. The data were analyzed by 2-way ANOVA and Tukey test (P < 0.05). We observed that Eimeria-challenged broiler group had worse performance (FI, WB, FC, P < 0.0001, respectively), Regarding to the relative weight it was observed higher values for intestine and spleen (P < 0.0001, respectively), and lower for heart and the bursa of the Fabricius (P < 0.0001, respectively). We also observed higher concentration of MUCO (P < 0.0001), nitrite (NO₂⁻) (P = 0.0011), thiobarbituric acid reactive substances (TBARS) (P = 0.0042) and greater activity of the enzyme superoxide dismutase (SOD) (P < 0.0001) in EC broilers. Birds fed DL-Met and DL-MMet diets presented better performance (WG, FC, P = 0.0059 and P = 0.0051, respectively).We also observed that DL-Met diets decreased NO₂⁻ concentration (P = 0.0003) and DL-MMet decreased SOD activity (P < 0.0001), compared SM. There was interaction effect for the content of carbonylated proteins (CP) (P = 0.0198). Coccidiosis-challenged birds receiving DL-Met and DL-MMet had lower CP contents. Regarding to the PepT-1 expression it was verified the lowest values for group of Eimeria-challenged birds (P < 0.0001) and we observed the highest gene expression for those broilers fed DL-MMet diets (P = 0.0467). Our results have showed for the first time the use of DL-methionyl-methionine, a methionine source for broiler under coccidiosis challenge. This dipeptide was able to increase the defense mechanisms, such as the system of glutathione that acts on oxidative stress in different situations of challenges.

Acknowledgements: UEM and CNPq

Key Words: dipeptide, Eimeria, stress oxidative

21 Morphological and Structural alterations in Eimeria tenella sporozoites under heat stress in vitro. G. H. Schneider*, A. L. Fuller1, R. Rekaya2, and S. E. Aggrey1, 1Department of Poultry Science, University of Georgia, Athens, GA, USA, 2Department of Animal and Dairy Sciences, University of Georgia, Athens, GA, USA.

Eimeria tenella infection is limited to the intestine and characterized by bloody or watery diarrhea, weight loss, poor feed conversion and moderate to high mortality. Heat stress (HS) is a major environmental stressor in poultry predisposing chickens to immunosuppression and rendering them susceptible to diseases. There are some suggestions that HS reduces Eimeria oocyst output in chickens, however, the relationship between HS and coccidiosis is not elucidated. The objective of this study was to investigate the effect of temperature on viability of E. tenella in vitro. We designed an experiment to assess the effect of temperature and duration of exposure to HS on viability of E. tenella sporozoites. Tubes containing 24 × 10⁵ sporozoites/mL in PBS were incubated at 40, 45, 50 and 55°C for 0 to 150 min, at 30 min intervals. Refrigerated live and lasalocid-dead samples were used as controls. Post incubation samples were refrigerated and stained with fluorescein diacetate (FDA) and propidium iodide (PI) overnight. Viability and morphology data were generated by ImageStream flow cytometry with 10,000 events acquired per sample and analyzed using 2-way ANOVA. According to the fluorescence emission data, E. tenella was affected by temperature. Incubation at 55°C induced a significant drop in sporozoite viability marked by increase in PI and decrease in FDA fluorescence emissions. Additionally, incubation at 55°C affected sporozoite shape, as noted by the increase in sporozoite aspect ratio, evidenced by rounded shapes which is associated with sporozoite damage. Since heat stress has been reported to reduce oocyte counts in Eimeria infected chickens, we can therefore conclude that, under HS, Eimeria sporozoites become damaged thereby significantly reducing their ability to recycle.

Key Words: coccidiosis, Eimeria tenella, viability, flow cytometry, poultry

The effects of a xylanase and β-glucanase enzyme product supplementation on the molar proportion of cecal short-chain fatty acids (SCFA), apparent ileal digestible energy (AIDE) and small intestine lengths and small intestine relative weight of broilers fed on corn-based diets were investigated. A total of 744 one-day-old male Cobb chicks were randomly assigned in a 2 × 2 factorial arrangement (high or low AMEn × 0 or 100 g of the enzyme product per ton of feed). Each treatment included 6 replicates with 31 broilers per floor pen. The diets were based on corn and soybean meal and formulated to contain: High AMEn, 3,025 kcal/kg (1 to 21d), and 3,025 kcal/kg (22 to 35d). At 35 d post-hatch, ileal digestible energy (IDE) and small intestine size of broilers fed on corn-soy diets led to improvements of nutrients and energy utilization and nutrient digestibility of broiler chickens. A total of 504 one-day-old Cobb x Cobb 500 male chicks were allocated in 63 cages using a completely randomized design with 7 treatments, 9 replications and 8 birds each. In the pre-experimental period, all birds were fed a common starter diet (3,050 of AME/kg; 21.7% CP, 1.05% Ca, and 0.53% Av. P). Experimental diets were fed from 8 to 28 d and consisted of one control diet (C) formulated with no enzyme supplementation, and 6 other diets supplemented with 5 or 10 ppm of BX, with or without the inclusion of 25 or 50 ppm of AG: C + BX (5 ppm); C + BX (10 ppm); C + BX (5 ppm) + AG (25 ppm); C + BX (5 ppm) + AG (50 ppm); C + BX (10 ppm) + AG (25 ppm); C + BX (10 ppm) + AG (50 ppm). All the diets were formulated with 1,000 FYT of phytase and celite at 1% was used as a marker. Total excreta collections were done between 14 and 17 d, twice a day, to evaluate the total-tract retention of dry matter (DM), crude protein (CP), and apparent metabolizable energy corrected for balance of N (AMEn). At 28 d, all birds were slaughtered to collect ileal content and determine the ileal digestibility of DM (IDM) and CP (ICP), and ileal digestible energy (IDE). Data were subjected to ANOVA and means, when significant, were compared by Tukey’s test (P < 0.05). Broilers fed diets with BX + AG had higher AMEn, and IDE when compared with C (P < 0.05). Dry matter metabolizability was higher in chickens fed with C + BX (10 ppm) + AG (50 ppm), when compared with those fed with C and C + BX (5 ppm) (P < 0.05). Crude protein metabolizability was lowest in chickens fed with C and C + BX (5 ppm) (P < 0.05). The supplementation of exogenous carbohydrases improved energy and nutrient digestibility in broiler chickens. Highest energy utilization were observed when supplemented the combination of both BX and AG enzymes at highest inclusion, with observed improvements of 4.8% and 5.2% kcal of AMEn, and IDE.

Key Words: corn-soybean meal, carbohydrase, growth performance, digestibility


A study was conducted to evaluate the effects of the combination of 2 exogenous enzymes, β-xylanase (BX) and α-Galactosidase (AG), supplemented on corn-soy diets on growth performance, energy and nutrient digestibility of broiler chickens. A total of 336 one-day-old male Cobb 500 slow feathering broilers were allocated into 48 experimental cages using a completely randomized design with 6 experimental diets and 6 replications of 7 birds each. A common corn-soybean meal-based starter diet was provided until 16 d of age. At 17 d, birds were randomly distributed in a 2 × 3 factorial arrangement of the 2 soybean meal (C) formulated with no enzyme supplementation, and 6 other diets supplemented with 25 or 50 ppm of AG: C + BX (5 ppm); C + BX (10 ppm); C + BX (5 ppm) + AG (25 ppm); C + BX (5 ppm) + AG (50 ppm). All the diets were formulated with 1,000 FYT of phytase and celite at 1% was used as a marker. Total excreta collections were done between 14 and 17 d, twice a day, to evaluate the total-tract retention of dry matter (DM), crude protein (CP), and apparent metabolizable energy corrected for balance of N (AMEn). At 28 d, all birds were slaughtered to collect ileal content and determine the ileal digestibility of DM (IDM) and CP (ICP), and ileal digestible energy (IDE). Data were subjected to ANOVA and means, when significant, were compared by Tukey’s test (P < 0.05). Broilers fed diets with BX + AG had higher AMEn, and IDE when compared with C (P < 0.05). Dry matter metabolizability was higher in chickens fed with C + BX (10 ppm) + AG (50 ppm), when compared with those fed with C and C + BX (5 ppm) (P < 0.05). Crude protein metabolizability was lowest in chickens fed with C and C + BX (5 ppm) (P < 0.05). The supplementation of exogenous carbohydrases improved energy and nutrient digestibility in broiler chickens. Highest energy utilization were observed when supplemented the combination of both BX and AG enzymes at highest inclusion, with observed improvements of 4.8% and 5.2% kcal of AMEn, and IDE.

Key Words: carbohydrase, exogenous enzyme, VFA
soybean meal and protease. Diets having north soybean meal type presented higher AME and IDE \((P < 0.05)\) when compared with the south soybean meal. Birds fed with the diets supplemented with exogenous proteases showed higher AME and IDE \((P < 0.05)\) when compared with those fed with the diet without supplementation. Diets with north soybean meal type presented higher AME and IDE \((P < 0.01)\) when compared with the south soybean meal, energy was increased by 193 kcal/kg and 170 kcal/kg, respectively. Relative to the basal diet, AME and IDE was increased \((P < 0.01)\) by 121 and 110 kcal/kg when birds were fed the diet supplemented with protease 1, and 113 and 106 kcal/kg for protease 2, respectively. In conclusion, the supplementation with protease presented a positive impact on energy utilization for broilers and it depends on different composition of soybean meal.

**Key Words:** broiler, digestibility, protease, soybean meal source

### 25 Effects of dietary supplementation of phytase and xylanase combination on broiler performance

P. R. de Oliveira*1, L. S. Bassi1, F. Moreno1, G. C. Senger1, E. C. Goe1, F. Valle2, and R. G. Machado1, 1Universidade Federal do Paraná, Curitiba, Paraná, Brazil, 2AB Vista, Curituba, Paraná, Brazil.

Phosphorus is an essential nutrient for poultry’s maintenance and growth, however on corn-soybean meal diets most part of phosphorus are in the form of phytate, that is not digestible for broilers and consequently reduce animal’s performance. The supplementation of phytase associated to other enzymes can overcome these anti-nutritional effects and improve broiler’s performance. Thus, the goal of this study was to evaluate different phytase (Quantum Blue, AB Vista, Marlborough, UK) inclusions associated or not to xylanase (Econase XT, AB Vista, Marlborough, UK) on broiler’s performance. A total of 1,120 Cobb one-day-old male were distributed in a completely randomized design, into 4 treatments (T) and 10 replicates of 28 birds on pen in a 2 x 2 factorial arrangement (2 levels of phytase: 500 or 1,500 FTU/kg; with or without 9,600 BXU/kg of xylanase). Feed and animals were weighed at placement and at 7, 14, 21, 35 and 40 d-old to determine feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR). The data were submitted to analyses of variance \((P < 0.05)\) and, when significant, means were separated by Tukey test at 5% of probability. The formulation of a common starter diet \((1.13 \text{ Ca:P})\) until 21d of age and at 22d the experimental diets were provided. At 42d, ten birds per treatment were slaughtered and two tibias were collected. The tibias were used to evaluate the bone-breaking strength (BBS), bone weight (BW), percentage of ash content (%AC), calcium (%Ca) and phosphorus (%P). The data were submitted to ANOVA and if significant the means were compared by the Tukey test at 5% of probability. The cockerel source of Ca resulted in higher %AC and %Ca compared to fine \((P < 0.05)\). The formulation with 2.06 Ca:P ratio with Phy resulted in lower %P compared to 1.70 Phy and 1.34 without Phy \((P < 0.05)\). Diets did not influence \((P > 0.05)\) BW and BBS. In conclusion, the coarse Ca source \((1354 \mu \text{m})\) result in better bone characteristics in broilers.

#### Table 1. Percentage of ash content (AC), calcium (Ca) and phosphorus (P), bone weight (BW) and bone-breaking strength (BBS) of the tibia of broilers at 42 days of age fed diets with three formulation strategies (FS) (1.34 Ca:P ratio, 1.70 ratio with Phy and 2.06 ratio with Phy) and two particle size of the source of Ca (Coarse 1354 and fine 428 μm).

<table>
<thead>
<tr>
<th>AC (%)</th>
<th>Ca (%)</th>
<th>P (%)</th>
<th>BW (g)</th>
<th>BBS (kgf)</th>
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<tbody>
<tr>
<td>1.34 Coarse</td>
<td>51.94</td>
<td>17.80</td>
<td>9.46</td>
<td>12.43</td>
</tr>
<tr>
<td>1.34 Fine</td>
<td>52.11</td>
<td>17.73</td>
<td>9.34</td>
<td>11.82</td>
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<tr>
<td>1.70 Phy Coarse</td>
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<td>17.98</td>
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<td>11.76</td>
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<td>9.02 a</td>
<td>11.95</td>
</tr>
<tr>
<td>2.06 Phy</td>
<td>52.38</td>
<td>19.07</td>
<td>8.41 b</td>
<td>12.31</td>
</tr>
<tr>
<td>Coarse</td>
<td>52.44</td>
<td>19.05</td>
<td>9.07</td>
<td>12.25</td>
</tr>
<tr>
<td>Fine</td>
<td>51.60</td>
<td>17.85</td>
<td>8.82</td>
<td>12.02</td>
</tr>
</tbody>
</table>

*Means followed by distinct letters in the same column differ by Tukey’s test \((P < 0.05)\)

**Key Words:** bone characteristic, animal nutrition, mineral

### 26 Bone characteristics of broilers fed different relation of calcium and phosphorus and two particle size of calcium source

1. J. de Camargo Dias*1, J. F. Durau1, L. M. De Almeida1, E. L. Krabbe2, M. Conceição dos Santos1, T. M. Rodrigues1, and K. Fonseca da Silva1, 1Universidade Federal do Paraná, Curitiba, PR, Brazil, 2Embrapa Suínos e Aves, Concórdia, SC, Brazil.

The aim of this study was to evaluate the bone characteristics of broilers fed diets with two particle size of calcium (Ca) source and different Ca and total phosphorus ratio (Ca:P). Sixty male broilers were distributed in a completely randomized design in a 3x2 factorial arrangement. The treatments comprised diets with three formulation strategies (FS): 1.34 Ca:P ratio formulated without phytase; 1.70 ratio with phytase (Phy); 2.06 ratio with Phy, and two particle size of calcium source (oyster shell), coarse and fine \((1354 \text{ and } 428 \mu \text{m})\). Corn and soybean meal-based diets were formulated to meet the same available P level. The birds received a common starter diet \((1.13 \text{ Ca:P})\) until 21d of age and at 22d the experimental diets were provided. At 42d, ten birds per treatment were slaughtered and two tibias were collected. The tibias were used to evaluate the bone-breaking strength (BBS), bone weight (BW), percentage of ash content (%AC), calcium (%Ca) and phosphorus (%P). The data were submitted to ANOVA and if significant the means were compared by the Tukey test at 5% of probability. The coarse source of Ca resulted in higher %AC and %Ca compared to fine \((P < 0.05)\). The formulation with 2.06 Ca:P ratio with Phy resulted in lower %P compared to 1.70 Phy and 1.34 without Phy \((P < 0.05)\). Diets did not influence \((P > 0.05)\) BW and BBS. In conclusion, the coarse Ca source \((1354 \mu \text{m})\) result in better bone characteristics in broilers.

#### Table 1. Percentage of ash content (AC), calcium (Ca) and phosphorus (P), bone weight (BW) and bone-breaking strength (BBS) of the tibia of broilers at 42 days of age fed diets with three formulation strategies (FS) (1.34 Ca:P ratio, 1.70 ratio with Phy and 2.06 ratio with Phy) and two particle size of the source of Ca (Coarse 1354 and fine 428 μm).

<table>
<thead>
<tr>
<th>AC (%)</th>
<th>Ca (%)</th>
<th>P (%)</th>
<th>BW (g)</th>
<th>BBS (kgf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.34 Coarse</td>
<td>51.94</td>
<td>17.80</td>
<td>9.46</td>
<td>12.43</td>
</tr>
<tr>
<td>1.34 Fine</td>
<td>52.11</td>
<td>17.73</td>
<td>9.34</td>
<td>11.82</td>
</tr>
<tr>
<td>1.70 Phy Coarse</td>
<td>52.48</td>
<td>19.03</td>
<td>9.11</td>
<td>12.14</td>
</tr>
<tr>
<td>1.70 Phy Fine</td>
<td>50.83</td>
<td>17.98</td>
<td>8.93</td>
<td>11.76</td>
</tr>
<tr>
<td>2.06 Phy Coarse</td>
<td>52.91</td>
<td>20.31</td>
<td>8.63</td>
<td>12.16</td>
</tr>
<tr>
<td>2.06 Phy Fine</td>
<td>51.86</td>
<td>17.82</td>
<td>8.19</td>
<td>12.46</td>
</tr>
<tr>
<td>1.34</td>
<td>52.02</td>
<td>17.76</td>
<td>9.40 a</td>
<td>12.13</td>
</tr>
<tr>
<td>1.70 Phy</td>
<td>51.65</td>
<td>18.51</td>
<td>9.02 a</td>
<td>11.95</td>
</tr>
<tr>
<td>2.06 Phy</td>
<td>52.38</td>
<td>19.07</td>
<td>8.41 b</td>
<td>12.31</td>
</tr>
<tr>
<td>Coarse</td>
<td>52.44</td>
<td>19.05</td>
<td>9.07</td>
<td>12.25</td>
</tr>
<tr>
<td>Fine</td>
<td>51.60</td>
<td>17.85</td>
<td>8.82</td>
<td>12.02</td>
</tr>
</tbody>
</table>

*Means followed by distinct letters in the same column differ by Tukey’s test \((P < 0.05)\)

**Key Words:** bone characteristic, animal nutrition, mineral

### 27 Growth modelling to estimate the efficiency of high doses of phytase enzyme in broilers diets

R. R. Lizana*1, R. M. Suzuki1, and C. V. Perales2, 1Sao Paulo State University, Jaboticabal, Sao Paulo, Brazil, 2National Agrarian University La Molina, La Molina, Lima, Peru.
Broiler potential growth is expressed under nutritional and environmental favorable conditions. In this sense, the objective of the current research was to estimate the efficiency of dietary addition of an exogenous phytase with the assistance of Gompertz growth function. Three hundred one-day-old Cobb 500 male chicks were randomly distributed in 12 floor pens, with 25 birds per pen. A basal diet (BD) was formulated for each phase: starter (0–21 d): 3050 kcal ME/kg, 22.85% crude protein, 0.815% Ca and 0.28% available P; grower (22–35 d): 3150 kcal ME/kg, 19.63% crude protein, 0.69% Ca and 0.25% available P and finisher (36–42 d): 3250 Kcal ME/kg, 18.69% crude protein, 0.63% Ca and 0.21% available P. Then, the BD for each phase was supplemented with 1500 FTU/kg of a thermostable phytase enzyme. Feed (Pellet form) and drinking water were offered ad libitum. Body weight (BW) and feed intake (FI) were measured weekly. BW data of each dietary treatment was adjusted to the Gompertz function: \( BW = BW_{m} \times exp(-k \times (Age - t)) \) where the parameters asymptotic maturity body weight (\( BW_{m} \)), growth rate (\( \ell \)) and time in days at maximum growth rate (\( t_i \)) were estimated by nonlinear regression analysis of the R-Project statistical software. Gompertz growth parameters of each dietary treatment converged for the Gauss-Newton iterative method (\( P < 0.001 \)). The BW per week was submitted to ANOVA one-way using the PROC LIN procedure. Variance analysis showed that birds fed of BD+1500 FTU/kg had better BW than those fed BD (\( P < 0.01 \)). Description of growth by parameters estimated for each dietary treatment evidenced that predictive \( BW_{exp} \) was higher for broilers fed BD+1500 FTU/kg than broilers fed BD. Broiler fed BD+1500 FTU/kg had a growth expressed by its growth rate (\( k = 0.057 \)) and early maximum growth rate (\( t_i = 27.6 \) d). In conclusion, the Gompertz nonlinear function of growth led describing the efficiency of phytase addition.

**Key Words:** Gompertz, phytase, broiler, modelling

### 28 Phytase superdosing in diets for broiler breeders with limestone in two particle size on productive performance. K. Fonseca, J. F. Duru, M. Santos, F. Marx, G. Dal Pont, F. Valle, and F. A. Moreno, Universidade Federal do Paraná, Curitiba, Paraná, Brazil. AB Vista, Curitiba, Paraná, Brazil.

The aim of this study was evaluated 2 limestone granulometry and superdosing of phytase in the diet of broilers breeders on productive performance. A total of 720 broiler breeders and 72 roosters were used from 30 to 61 weeks old, housed on wood shavings, on density of 3.6 birds/m². Lighting was provided 16 h of natural more artificial light. Treatments were distributed in a complete randomized design in a factorial arrangement, with 2 phytase levels (500 and 1500 FTU/kg, Quantum Blue, AB Vista, Marlborough, UK) and 2 limestone particle size (fine with GMD of 419 and GSD of 2.66 and coarse with GMD of 2661 mm) in broiler breeders diets for percentage of total egg production, for breeders on period of 30 to 61 weeks.

#### Table 1. Effect of the inclusion of phytase (FTU/kg) and GMD of limestone (419 or 2661 mm) in broiler breeders diets for percentage of total egg production (PT), number total of egg for female (OT), and percentage of hatching eggs (HE), during period of 30 to 61 weeks of age

<table>
<thead>
<tr>
<th>GMD</th>
<th>PT (%)</th>
<th>OT</th>
<th>HE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine 500</td>
<td>69.8</td>
<td>156.4</td>
<td>97.5</td>
</tr>
<tr>
<td>Coarse 500</td>
<td>69.8</td>
<td>156.4</td>
<td>97.0</td>
</tr>
<tr>
<td>Fine 1500</td>
<td>70.2</td>
<td>157.4</td>
<td>97.6</td>
</tr>
<tr>
<td>Coarse 1500</td>
<td>70.2</td>
<td>157.3</td>
<td>97.0</td>
</tr>
<tr>
<td>GMD</td>
<td>Fine</td>
<td>70.0</td>
<td>156.9</td>
</tr>
<tr>
<td>Coarse</td>
<td>70.0</td>
<td>159.8</td>
<td>97.0</td>
</tr>
<tr>
<td>Phytase</td>
<td>500</td>
<td>69.8</td>
<td>156.4</td>
</tr>
<tr>
<td>1500</td>
<td>70.2</td>
<td>157.3</td>
<td>97.3</td>
</tr>
<tr>
<td>P-value</td>
<td>GMD</td>
<td>0.963</td>
<td>0.963</td>
</tr>
<tr>
<td>Phytase</td>
<td>0.640</td>
<td>0.640</td>
<td>0.835</td>
</tr>
<tr>
<td>GMD + Phytase</td>
<td>0.982</td>
<td>0.982</td>
<td>0.870</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3.7</td>
<td>3.7</td>
<td>0.87</td>
</tr>
</tbody>
</table>

**Key Words:** nutrition, laying hen, egg production
values 21 d (80.25%), 35 d (63.62%) and 42 d (60.07%). Litter quality is a significant factor in FPD, remain in the wet the paw get soft and more prone to damage, predisposing the bird to develop FPD. Agreeing with this was founded higher values of pH (9.11) and humidity (39.93%) in higher scores of FDP (2.89). The effects of treatments were no significant on values means of litter pH and dry matter ($P > 0.005$).

Although the nutrition may interfere in the FDP incidence, there was no significant difference ($P > 0.005$) between the treatments (T2, T3, T4) when compared with the control group (T1).

**Key Words:** footpad dermatitis, litter quality, nutrition, chicken paw, welfare
Objective: To assess the internal validity of the traditional linear stability analysis (LSA) by studying the impact of non-diffusion terms on the results of a model for the electrochemical instability of metal surfaces.

Approach: We developed a model that includes non-diffusion terms and compared its results with those obtained from traditional LSA. The model was applied to a specific system, and the results were analyzed to assess the impact of non-diffusion terms on the stability of the system.

Results: Our model showed that the inclusion of non-diffusion terms significantly affected the stability of the system, leading to more accurate predictions of instability than those obtained from traditional LSA.

Conclusion: The traditional linear stability analysis may not be sufficient for understanding the stability of metal surfaces, and the inclusion of non-diffusion terms is crucial for obtaining accurate results. These findings highlight the importance of considering non-diffusion terms in the study of electrochemical instability.
Successful biobanking of an indigenous chicken breed with cryopreserved primordial germ cell lines. B. Lazar1,3, R. Toth1,2, M. Anand2, N. Sztan3, M. Molnar1, B. Vegi3, A. Drobnyak2,3, E. P. Varkonyi3, and E. Gocza1, 1NARIC, ABC, Animal Biotechnology Department, Godollo, Hungary, 2SZIU, Doctoral School of Animal Husbandry Science, Godollo, Hungary, 3Research Centre for Farm Animal Gene Conservation, Godollo, Hungary.

The economically important or indigenous chicken breeds are held in in situ populations, thus they are exposed to various risks, such as epidemics, environmental disasters or management failure. Therefore, it is increasingly important to protect the genetic information these breeds represent. From the available methods, cryopreservation of primordial germ cells (PGCs) is the most promising one. The goal of the present study was to establish a biobank based on PGCs for the indigenous Hungarian chicken breeds and to test the cryopreserved cells by creating germline chimaeras with one of them; the Partridge color Hungarian. The germline chimaeras were then back-crossed to recover the donor breed. We collected blood from each embryo individually, then the isolated blood, containing the PGCs, were cultured in a medium which was selective for the PGCs. Later, samples from the cell lines were collected for DNA, RNA isolation and immunohistochemistry to characterize the quality of the cells and to perform microsatellite analysis to evaluate the representation of the genetic variability of the original population. As a next step, parallel vials were frozen from each PGC line. To evaluate the freezing process and to prove the functional integrity and migrating ability of PGCs, some of the vials were thawed and the cells were injected into recipient embryos. First, the cells were labeled with an in vivo fluorescent dye, thus the migration of the injected cells was followed toward the developing gonads, and the ratio of the colonization was analyzed. As a second experiment, after injection with the frozen/thawed PG cells, the eggs were left to incubate until hatching. The hatched chicks were then kept until maturation and are going to be cross-tested with animals from the donor genotype to examine the germline transmission. During the study, 21 PGC lines from Partridge color Hungarian chicken were established with a derivation rate of 31.1%. Based on the general diversification indexes which were used for the microsatellite analysis the cell lines represent the genetic variability of the original population. The PGC lines were frozen and then successfully thawed with a cell viability of 50%. The preserved cells were capable of colonizing the gonads of the recipient embryos; furthermore, we have 24 adults (13 roosters and 11 hens) which presumably contain the donor PGCs. This is the first initiative in Hungary to establish a biobank based on PGCs. Acknowledgements: Horizon2020 (n°677353 IMAGE), VEKOP-2.3.2-16-2016-00012

Key Words: biobank, cryopreservation, primordial germ cell, germline chimaera
32 Eggshell as soundproofing insulation and the effect of egg content on the internal sound pressure level: A study prior to bioacoustics in artificial incubation. A. C. Donofre* and I. J. Oliveira da Silva, University of São Paulo, Luiz de Queiroz College of Agriculture, Piracicaba, São Paulo, Brazil.

Recent research has focused on the effect of bioacoustics on the embryonic development of domestic birds. However, it is worth addressing a question to complement the so far reported results: How much sound gets to the embryo? Therefore, the aim of the present study is to estimate the sound pressure level inside the eggs by taking into account the eggshell as soundproofing insulator and the internal content as the medium capable of changing the properties of a sound wave. A sensor coupled to a small-sized microphone was used in a sequence of tests with eggs presenting different contents: empty eggs, eggs full of water and whole eggs (egg yolk and albumen). The tests also included the way the eggshells were dried (inside or outside an oven). An external white noise at 2 sound pressure levels, 70 and 90 dB (A), was used in each treatment combination. The eggshell stopped approximately 35% of the sound at 70 dB (A) and 15% at 90 dB (A), regardless of the egg content. The whole eggs, incubated as usual, presented internal sound intensity higher than the other variations, fact that can be explained by the egg yolk and albumen density. Such result embodies great validity in research focused on bioacoustics in artificial incubation, since it allows stating that the sound pressure level in the chamber reaches magnitudes close to the external environment, thus it exposes the embryos to higher sound intensity values.

Acknowledgements: This work was supported by the São Paulo Research Foundation (FAPESP)

Key Words: sound level meter, albumen, precision, hatchery

33 Sound stimuli in artificial egg incubation: Their effects on the embryonic growth and hatching performance. A. C. Donofre* and I. J. Oliveira da Silva, University of São Paulo, Luiz de Queiroz College of Agriculture, Piracicaba, São Paulo, Brazil.

The physical factors that involve artificial incubation are determinant to the embryonic development, hatching and performance of chicks. Although many of them are highly regarded, there are other issues capable of improving or adapting the process to new animal-production demands. The current research addresses the bioacoustics as one of such issues; it is done to investigate its effects on artificial incubation. The herein assessed treatments associated 2 sound pressure levels (LSP), in the noise of experimental with 70 dB (A) and commercial hatcheries with 90 dB (A), which were added (or not) with vocalizations of the species. The following combinations set the herein adopted treatments: S1 [70 dB (A) without vocalizations], S2 [90 dB (A) without vocalizations], S3 [70 dB (A) with vocalizations], and S4 [90 dB (A) with vocalizations]. They were performed 8 hatching cycles (repetitions), which followed a randomized block design. The evaluated responses were divided in pre-hatching and hatching, such as: the embryonic weight and length on d 12, 15 and 18 of embryonic development and the hatching window, hatchability, embryonic mortality and the quality hocks and navel of the day-old chicks. The results showed that sound pressure level 90 dB (A) led to earlier hatching, higher hatchability and better quality chicks (hocks and navel) (P < 0.05). The effect of species vocalizations was only observed and significant (P < 0.05) in variables such as ‘time of hatching’ and ‘quality of the poultry’, when such stimulus was added to the 70 dB (A) noise; the natural stimulus was covered by 90 dB (A) hatcheries noise. In summary, the exposure to 90 dB (A) was better than 70 dB (A), that is, the greater sound stimulation favored the hatching and the quality of the chicks, independent of the addition of vocalizations of the species.

Acknowledgements: This work was supported by the São Paulo Research Foundation (FAPESP)

Key Words: bioacoustics, hatchability, hatch window, noise vocalization

34 Effects of LPS on central and peripheral catecholaminergic systems and behavior of chickens. J. G. D. S. Fonseca*, W. M. Q. Filho, C. Pereira, A. J. P. Ferreira, and J. P. Neto, Faculty of Veterinary Medicine and Animal Science, University of São Paulo, São Paulo, São Paulo, Brazil.

Poultry industry stands out due to its high productivity, however animals are frequently exposed to stressful stimuli that activate the hypothalamic-pituitary-adrenal axis (HPA) and the sympathetic autonomic nervous system (SANS). Cytokines released in inflammatory reactions act on Central Nervous System (CNS) and change neural activity, altering behavior and reducing immunity. Studies on nervous and immune systems relationship in chickens showed HHA axis and SANS maintain animals' welfare and its capacity to withstand stressful and microbiological challenges. The present study aims to clarify neuroimmune events that follow chickens exposure to E. coli lipopolysaccharide (LPS). One hundred twenty 28-days-old Ross chicks were separated into three groups: LPS received 0.2 mg/kg of LPS from E. coli, i.v; Saline (S): received the same volume of sterile 0.9% NaCl i.v; Control (C): received no treatment. Drinking water and feed were supplied ad libitum. Behavioral analysis was carried out by observations of the birds from 1 hour before to 24 hours after treatments. Frequencies of feeding, drinking, resting, standing, walking and grooming were quantified and compared as proposed elsewhere. 3 and 24 hours after treatments animals were euthanized and tissues were harvested for plasmatic catecholamines and brain amines levels and metabolites HPLC determinations. Data were analyzed by two-way ANOVA plus Bonferroni test. Significances were set at P ≤ 0.05. Feeding frequency was reduced in LPS and S groups in relation to group C (P < 0.05). LPS reduced motor activity since frequency of resting increased and frequencies of walking and stopping decreased at the same time (P < 0.05). Changes in resting or standing frequencies between the S and C groups were observed. An increase in dopamine turnover in the hypothalamus of LPS animals in relation to groups C and S was observed (P < 0.05). Serotonin levels increased in the birds of S and LPS P < 0.05. Norepinephrine concentrations increased in birds of group S 3 hours after treatment in relation to C and LPS groups; however, changes in turnover rate were not detected among the birds (P < 0.05). These alterations were accompanied by increased levels of plasma adrenaline in LPS treated animals in relation to birds of C and S groups 3 hours after treatments (P < 0.05). Altogether, our data show an increase in both CNS and peripheral catecholaminergic activity, accompanied by behavioral changes that characterize sickness behavior after LPS injection in birds.

Acknowledgements: We would like to thank FAPESP (Process 2017/02885-0 and 2017/22005-5) and INCT-NIM for financial support

Key Words: neuroimmunomodulation, LPS, behavior, stress, poultry

Poult. Sci. 97(E-Suppl. 2)
35 An analysis of the effect of broiler age on the environmental condition in the poultry farms in the extreme south of Bahia, Brazil. D. S. do Nascimento1, T. S. Ribeiro1, E. Bonfim de Oliveira2, R. G. da Silveira Deminicis2, M. L. Fernandes2, R. P. Silva3, D. V. Gonçalves Vieira2, F. G. P. Costa4, C. Meneghetti2, and M. Ramalho de Lima1,5.1Federal University of South of Bahia, Iabuna, Bahia, Brazil, 2State University Sata Cruz, Ilhéus, Bahia Brazil, 3Federal University of Tocantins, Araguaína, Tocantins, Brazil, 4Federal University of Paraíba, Areia, Paraíba, Brazil, 5Animal Science Program, Ilhéus, Bahia, Brazil.

The aim was to evaluate the effect of broiler age on the environment condition in the poultry farms in the extreme south of Bahia, Brazil. The data were collected in conventional and negative pressure poultry farms, like as air temperature [1.8m high and 0.10m high, °C], temperature of manure [superficial and internal (3cm deep), °C], relative air humidity (%), dry matter (%) and pH of manure. The data were compiled and organized in descriptive statistical analysis, obtaining correlation coefficient and regression analysis. As the broilers were growing, the temperature at 0.1m high of manure was reduced in both systems, however the control was more efficient in the negative pressure system with a correlation of 34% (y = −0.034 × day + 31.551; R² = 0.114). Likewise, in the 1.8m high of manure temperature, the negative pressure shed was higher in the temperature regulation according to the birds’ demand (y = −0.0732 × day + 31.656; R² = 0.4403). The age had a positive correlation in air humidity of 39 and 15%, respectively in the conventional and negative pressure systems, which induces reduction of environmental quality in the conventional system, especially between 28 and 42 d. Probably due to effects of humidity and temperature influenced the pH manure, where the correlation in the conventional system was 66%, while in the negative pressure system was 40%. The pH result indicates a higher probability of development of problems like pododermatitis, reduction of carcass quality, enteritis, and others, in the conventional system. In conclusion, to improve the broiler production with effectiveness in the extreme south of Bahia, Brazil, it is recommended the system of production with negative pressure.

Acknowledgements: All broiler farmers that allowed this study

Key Words: conventional system, negative pressure, production system, poultry manure conditions

36 Effect of artificial shade distances from aviary on egg quality in free-range and cage rearing systems. C. C. Mazocco1, E. Gopinger, R. V. Endres, N. Y. Botton, and R. Poletto, Federal Institute of Science and Technology Education, Sertão, RS, Brazil.

The aim of this study was to assess the effect of hen preference according to shade distance from the housing aviary on the quality of free-range eggs. Eighty H&N Brown laying hens with 28 weeks of age were allocated into either 3 sawdust bedded boxes (1.35 × 2.10 m) with 20 hen each or in battery cages with 2 hens each cage (control). Each one of the boxes had access to an outdoor area (8 × 2m) with 1 m high artificial shading screen set at different distances from the aviary; at box 1, shading screen was placed at 2 m, at box 2 it was placed at 4 m and at box 3, it was placed at 6 m from aviary exit door. The shade area had 2 m² and the entire outdoor area was covered with native summer grass. Hens were provided feed and water ad libitum indoors, in the bedded area from where they were daily released at 8am and closed up at 5pm. Fifteen eggs from each free-range box and cages (treatment = 4; 60 eggs total) were gathered at 21 d after hens were given outdoor access. Egg yolk color was measured using the colorimeter Chroma Meter CR-340 (Minolta, Osaka, Japan). Color was assessed by applying a tridimensional system, detecting color in 3 axis, where L* (light intensity) axis measures the sample from black (0) to white (100), the a* axis (red color intensity) that ranges from green (−60) to red (+60) and b* axis (yellow color intensity) from blue (−60) to yellow color (+60). For visual yolk color evaluation, the YolkFan DSM spectrum was used. Albumen height and whole egg weight was measured to determine Haugh unit, which was calculated with the following formula: UH = 100 Log (H + 7.57 − 1.7 W0.5), where: H = albumen height and W = egg weight. Data were computed with variance analysis at 5% significance level and mean differences were analyzed with Tukey post-hoc test. Colorimeter assessment showed that eggs from box 3 (shading at 6m) had greater yolk light intensity (61.40) compared with box 1 (58.80) (shading at 2m) and control (cage) eggs (57.50); the b* axis test showed this same pattern (P < 0.05) when comparing treatments. Eggs from hens reared with outdoor / grass access had stronger yolk coloration when it was assessed with DSM spectrum compared with cage eggs (P < 0.05); feeding of grass containing carotenoids turns yellow yolk color more intense. There was no evidence of significant differences from shading distances for a* parameter and Haugh unit. In summary, shading provided at close distances from aviary allow for hens using more frequently the outdoor area, feeding more often on vegetation, which in turns leads to greater yellow intensity of the egg yolk.

Key Words: welfare, laying, shading, color egg yolk

37 Application of image analysis to assess the activity of turkey poult exposed to different carbon dioxide concentrations. M. L. Cândido1, Y. Xiong2, R. S. Gates3, I. F. F. Tinoco4, and K. W. Koelkelbeck5.1University of Viçosa, Viçosa, MG, Brazil, 2University of Illinois at Urbana-Champaign, Urbana, IL, USA.

Air quality can affect growth, performance, and behavior of poultry in various production systems. Elevated concentrations of gases inside facilities can be harmful to the birds. High CO₂ concentrations can create drowsiness and unconsciousness by depressing the central nervous system of poultry and change their activity. Poultry behavior can be used as an indicator for possible abnormalities and/or decreased productivity. Several methods can be used to detect changes in their current behavior. A possible method to evaluate poultry behavioral movement can be image analyses. The aim of this study was to investigate 2 algorithms for measuring turkey poult movement, when subjected to 3 different constant levels of CO₂. A total of 372 tom turkey poulets were utilized in this study. In 2 consecutive replicate trials, 62 pouls (1 d of age) were randomly placed in each of 3 environmentally controlled chambers (2.74 × 2.13 m). In each trial, pouls were reared with standard temperature, humidity, and light levels for 3 wk (Day 1 to 21). The pouls were exposed to 3 different constant CO₂ concentrations of 2,000, 4,000, and 6,000 ppm throughout each trial. Video images of the pouls were recorded for 2 h during 3 periods of the day; morning, noon, and evening, at 3, 4, 5, 10, 11, 12, 17, 18, and 19 d of age. A digital video camera was placed in the center of the ceiling of each chamber, to record the entire floor area. An algorithm was applied to the recorded video to create a “movement index” (MI) and an “activity index” (AI). These indexes expressed the changes in pixel intensity produced by the pouls movement activity. The treatments were tested for differences using a 2-way ANOVA, and Tukey means separation was used to determine significant differences. The MI and AI indexes significantly changed between the treatments (P < 0.0001) for the 3 tested weeks independently of day period. For both indexes, pouls maintained at 2,000 ppm CO₂ demonstrated reduced activity when compared with the other 2 treatments. This means that pouls subjected to the 2,000 ppm CO₂ level had
the lowest behavioral movement activity throughout the chambers. Both indexes were efficient to show differences in the turkey poults behavior under different CO₂ concentrations.

**Acknowledgements:** We thank Hybrid Turkeys USA, Best Veterinary Solutions, Inc., for financial/technical support; Perdue Farms, Inc., GSI, Plasson Company, and Jones-Hamilton Co., for donating poults/feed, environmental controllers, replacement parts, and water acidification mix. We thank CAPES, CNPq, FAPEMIG, and USDA.

**Key Words:** carbon dioxide, behavior, image analysis, machine vision, turkey poults
Wooden breast (WB) is a common myopathy in the breast muscle of broiler chickens, which is difficult to diagnose in vivo. The present study was conducted to evaluate the effectiveness of ultrasound (US) images of breast muscle as a tool to predict WB myopathy in live broilers. A total of 350 Cobb x Cobb 500 male chicks were used in 2 experiments. Birds were neck banded with identification numbers at the first day. Birds were fed ad libitum with a pelleted diet formulated according to Brazilian commercial nutrient and energy practical levels in a 5-phases feeding program. Every week, from 7 to 49 d, all birds were evaluated by ultrasonography with a probe placed on the skin surface, parallel to the keel, as well as cranial and caudal to the ribcage. Obtained mean gray values were calculated from the obtained histogram (black to white scale from 0 to 255) to determine echogenicity and the breast depth was also taken through the images. Also weekly, 25 birds were selected according to the average body weight and slaughtered to provide the visual evaluation of WB: deboned breast fillets were submitted to a 4-subject panel evaluation to provide scores of WB: normal breast (score 0); mild hardening in the upper (score 1); moderate hardening in the upper and/or lower part of the fillet (score 2); severe hardening (score 3), and severe hardening with hemorrhagic lesions, increased volume, and presence of yellow fluid (score 4). Data were analyzed using the SAS software. Statistical blocks were used to remove the time effect from each experiment. The effect of age on WB score, echogenicity and depth was evaluated using the GLM procedure and the averages were compared at 5% of significance. The WB scores were also considered independent variables to evaluate its effects on US measurements. Estimations were done using linear regressions. Pearson correlations were also performed. Increased values of depth, echogenicity and WB with age evolution were observed (P < 0.05). Since 35 d the echogenicity for scores 3 and 4 were around 100.00 (±2.7). The R² values for the linear regressions were 0.71, 0.84 and 0.67 for WB score, depth and echogenicity according to the age of the birds (P < 0.0001). Correlation between WB and depth were 0.83, 0.82, 0.66 and 0.60 and for echogenicity 0.55, 0.53, 0.47 and 0.57 at 28, 35, 42 and 49 d, respectively (P < 0.0001). This study demonstrated that US be considered as a toll to predict changes in the breast muscle of broiler chickens in vivo according to age which could be related to the WB severity.

**Key Words:** broiler, breast yield, correlation, serum enzymes, wooden breast

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**The estimated correlation among wooden breast, body weight, breast yield and serum enzymes of broiler chickens.**

A study was conducted to evaluate the correlation among wooden breast (WB) myopathy, body weight, breast yield and serum enzymes in broiler chickens. A total of 1,620 Cobb × Cobb 500 slow feathering male chicks were fed a common basal diet, randomly distributed in 60 floor pens with 27 birds each. Growth performance was evaluated weekly from 1 to 44 d. At 45 d, 1,360 broilers were sent to a commercial slaughterhouse, weighted and the occurrence of WB scores was determined. At 46 d, 240 birds were slaughtered for carcass and breast yields, WB scores and serum was collected for enzyme profile. Birds and breasts were weighed and visual degrees of WB were provided as: 0 (normal), 1 (mild hardening in the upper), 2 (moderate hardening in the upper and/or lower), 3 (severe hardening), and 4 (severe hardening with hemorrhagic lesions and yellow fluid). Data were analyzed using the GLM procedure of SAS Institute. The scores of WB were considered as independent variables to evaluate serologic enzymes. Estimations for WB score and serum enzymes also were done using linear regressions. Pearson correlation analysis was conducted using the CORR procedure. Considering 1,600 slaughtered birds, WB score 0 were not found and the occurrences of scores 1, 2, 5, and 4 were 20.8, 34.1, 21.6, and 3.4%, respectively. The WB myopathy was positively correlated (P < 0.0001) with birds’ weight (0.40). At 45 d, broilers with WB scores 3 and 4 presented higher (P < 0.0001) body weight compared with scores 1 and 2. Birds with WB scores 3 and 4 presented higher (P < 0.0001) serum creatine kinase (CK), lactate dehydrogenase (LDH) and aspartate aminotransaminase (AST) compared with score 1. The WB myopathy was also positively correlated (P < 0.001) with breast weight and yield, CK and LDH of broilers where values were 0.22, 0.23, 0.35 and 0.40, respectively. Increased WB severity resulted in linear increases on serum enzymes of broilers at 46 d (P < 0.0001). In conclusion, the evaluation of WB from 1,600 birds in the present study indicated positive correlations among WB scores, body and breast weight and serum enzymes, providing more data for the poultry industry.

**Key Words:** broiler, breast yield, correlation, serum enzymes, wooden breast

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**Consumers’ purchasing intention for broiler breast fillets affected by wooden breast.**

Wooden breast (WB) is an emerging muscle abnormality found in the cutting higher commercial value to chicken industry. Although different studies have been performed to evaluate the effect of WB on meat quality, no data available on the influence of these changes on the consumer’s purchasing intention. Therefore, understanding the purchase behavior of consumers for broiler breast fillets affected by WB is essential in addressing the use this product by meat industry. So, the present study was intended to assess the consumer’s purchasing intention for broiler fillets with different degrees of wooden breast condition. Breast fillet samples were collected in commercial slaughterhouse after carcass water cooling, deboning, and refrigeration. The fillets were macroscopically classified according to the degree of WB: normal (without lesion), slight (hardened area in the cranial or caudal part of fillet), moderate (diffusely presence of hardened areas) and severe (diffusely presence of hardened areas with exudate and petechiae). After classification the samples were packed in trays according to usual commercial packing of cooled product, where each tray being composed of only of wooden breast degree. The key respondents of this study were household decision makers of the meat purchase. The 30 consumers received coded trays and were asked to express their purchase intent using a 5-point scale (5 = definitely would buy; 1 = definitely would not buy). The database were analyzed by SAS software with Kruskal-Wallis test (P < 0.05). The highest hedonic score was observed in the fillets classified as normal

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**38 Utilization of ultrasonography to predict wooden breast of broilers at different ages in vivo.**


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Soy protein has been studied as an edible coatings for different foods. These coatings act as barriers against moisture and oxygen to prevent rapid deterioration and increase product shelf life. In the current study, the effect of using soy protein coatings on the quality of eggs was evaluated during 6 weeks at 20°C. Forty 8 eggs from a Isa Brown laying line were used after washing under tap water. Egg quality was assessed in uncoated eggs (control treatment) and eggs coated once or twice with a solution containing 10% soy protein. Then, the eggs were stored at room temperature (20°C) for 6 weeks. The weight loss was evaluated weekly and the egg quality variables (Haugh unit - HU, pH, and yolk index - YI) were analyzed at the last week of the experimental period. Statistical analysis was performed using the SAS PROC GLM method (P < 0.05). Results indicated that soy protein coatings (single or double application) were able to reduce the loss of egg mass in comparison to uncoated eggs at the 6th week of storage (89 ± 1.3, 91 ± 1.4, and 86 ± 2.2%, respectively for uncoated or eggs coated once or twice). The use of the coatings preserved the internal quality of the eggs for up to 6 weeks longer than uncoated eggs. The HU and YI were higher in coated eggs (P < 0.001). Uncoated eggs had the worst (P < 0.001) HU (55.07), albumen pH (9.18), and YI (0.27) after 6 weeks of storage, compared with coated eggs. Additionally, the double application (HU: 63.86, pH: 8.86, YI: 0.31) did not improve the protection for egg quality maintenance (HU: 64.11, pH: 8.86, YI: 0.30) as both treatments showed similar results. In conclusion, the use of coatings based on soy protein influences the internal quality of eggs during storage and may be a promising technology to extend the eggs shelf life.

Key Words: eggshell, Haugh unit, protein coating, storage, yolk index


The shelf-life of eggs is one of the most important issues for the quality maintenance and the durability of the product. The expiration date of an egg is about 30 d from the day that it was produced. Interest in edible films and coating has been gaining ground because of consumers’ demands for higher quality foods with longer time of shelf life. Coating procedures can help extend shelf life. In preparation of edible films, plasticizer is incorporated into films to induce flexibility, and glycerol is one of the most widely used plasticizers. However, little information is available about possible replacements to glycerol in this process. This study aimed to compare different types of plasticizers on the shelf life of eggs coated with concentrate whey protein. The experiment counted with 336 non-fertile eggs collected from a commercial egg farm (Rio Grande do Sul, Brazil). All eggs were obtained from birds of the same age, maintained under similar environment, handling and feeding conditions. Eggs were washed and randomly divided into 4 treatments: uncoated eggs; eggs coated with glycerol; eggs coated with sorbitol; and eggs coated with propylene glycol. All plasticizers were used in combination to concentrate whey protein solutions (at 8%). Twelve eggs were immediately submitted to the quality analysis to represent the characteristics of fresh eggs (zero days of storage). Weekly during the study, 12 eggs from each treatment were randomly separated for quality evaluation: weight loss (%), Haugh unit (HU), yolk index (YI), albumen and yolk pH. The study lasted for 6 weeks. Statistical procedures were performed using Minitab 18 software (Minitab Inc., State College, PA). The data were submitted to ANOVA and differences among means were evaluated with Tukey test (P < 0.05). Uncoated eggs showed the highest weight loss (5.39%), while concentrate whey protein with glycerol (3.87%), sorbitol (3.34%) and propylene glycol (3.98%) coatings were effective in preventing weight loss (P < 0.001). Uncoated eggs had the worst (P < 0.001) HU (58.46), albumen pH (9.18), and YI (0.33) among all treatments after 6 weeks of storage. Among the coated eggs, the propylene glycol had the best values of HU (71.53) and YI (0.38) after storage. Eggs coated with whey protein concentrate combined with glycerol or sorbitol showed intermediate values of HU (66.58, 68.79) and YI (0.36, 0.35), after storage. There were no differences between treatments on the albumen and yolk pH in the end of the storage. In conclusion, the use of coatings based on whey protein concentrate with different plasticizer influences some internal quality characteristics of eggs during storage.

Key Words: glycerol, propylene glycol, quality, sorbitol

43 Effect of expeller extracted and solvent extracted rapeseed meal on the growth performance, nutrients digestibility and carcass characteristics in broiler chickens. M. M. Javed*, A. ur Rehman1, M. A. Mirza1, and M. Athar2, 1Institute of Animal and Dairy Sciences, University of Agriculture, Faisalabad, Pakistan, 2Hi-tech Feeds (Pvt.) Limited, Lahore, Pakistan.

It was hypothesized that protein quality of rapeseed meal is affected by high temperature and moisture in desolventization-toasting (DT) stage during solvent extraction process. During processing, eliminating the rapeseed meal at expeller stage before solvent extraction would result in product with better protein quality. Therefore, the objectives of the study were to evaluate the efficacy of expeller extracted rapeseed meal (ERSM) as compared with solvent extracted rapeseed meal (RSM) on the growth performance, nutrients digestibility and carcass characteristics in broiler chickens. The study was conducted at research and development farm Hi-tech Feeds, Lahore, Pakistan. Eight experimental diets (CP 20%; ME 2900 Kcal/kg) were formulated containing 5, 10, 15 and 20% ERSM and 4.37, 8.75, 13.12 and 17.5% RSM + supplemental oil @ 0.63%, 1.25%, 1.88% and 2.5%, respectively maintaining similar dietary oil contents. Day old broiler chicks (n = 3000) were randomly divided into 40 (40) replicates (75 chicks/ replicate). Each experimental diet was randomly allotted to 5 replicates in a completely randomized design. Results of study showed that the weight gain (WG) was higher (P < 0.05) in the birds that were fed with diets having 5% and 10% ERSM as compared with the similar dietary inclusion level of RSM (1871 and 1847 vs. 1737 and 1732, respectively). Like WG, feed conversion ratio was also better (P < 0.05) for ERSM as compared with the RSM at 5% and 10%
dietary inclusion level (1.70 and 1.71 vs. 1.80 and 1.85, respectively). The digestibility coefficients of crude protein, crude fat and dry matter were highest ($P < 0.05$) with the diets having 5 and 10% for both meals, which were decreased by increasing the level of meals above 10%. At the end of growing phase (21st day) and finishing phase (35th day), carcass response and relative weights of liver, kidney and gizzard were similar for both meals. The relative weight of heart was highest ($P < 0.05$) at 20% inclusion of expeller extracted meal at the end of growing phase, while the effect was diminished at the end of finishing phase. It was inferred that expeller extracted meal was better product than solvent extracted rapeseed for feeding to commercial broilers.

**Key Words:** solvent extracted, expeller extracted, rapeseed meal, broiler growth nutrient digestibility, carcass response

The objective of this work was to evaluate the effect of supplementation of DL-Methionyl-DL-Methionine (Met-Met) compared with DL-methionine (DL-Met) on performance, muscle fiber development and carcass composition of broilers at 21 d submitted to heat stress. A total of 216 male Cobb chicks were distributed in 3 diets: basal (below methionine exigence – 0.585), Met-Met and DL-Met (methionine digestible 0.856). At 21 d broilers were submitted to 0, 24 and 48 hs of heat stress (32°C). Broilers and diets were weighed weekly from 1 to 21 d to determine the productive performance. At each diet and stress period, 06 broilers were used to determine the relative breast weight and samples of pectoral muscle were frozen in liquid nitrogen, and crosswise cut in cryostat to determine the diameter of the muscular fibers and number of fibers/area in digital images (40x objective). Other 06 broilers were used for determination of body composition: dry matter, crude protein and ether extract (AOAC, 2016). Data were submitted to ANOVA, and the means were compared by Tukey test using the statistical program SAS (2011), to describe the effects of diets within each period of heat stress. For performance, broilers supplemented with DL-Met and Met-Met presented greater weight in relation to basal at 1 to 21 d. For the weight gain of 1 to 7 d, both diets supplemented with methionine had higher values, and from 7 to 14 d only birds supplemented with Met-Met had greater weight gain in relation to basal. Regarding the breast muscle, there was dietary effect for the weight, with birds with bigger chest when supplemented with methionine (Met-Met and DL-Met). Histologically, the muscle fibers of broilers fed DL-Met had a larger diameter than the other diets. In carcass composition analysis, the crude protein was superior for animals supplemented with methionine from both sources. At 21 d, DL-Met fed birds presented values higher than the basal diet and after 24 and 48 hs of stress, birds receiving methionine had crude protein levels higher than those of the basal diet. After 24 hs the percentage of ethereal extract was higher for the birds that received basal diet than those that received DL-Met. It is concluded that, even after 48hs of heat stress both methionine sources had similar muscles and carcass results. The use of Met-Met compared with DL-Met does not affect the performance and carcass composition and histologically broilers supplemented with DL-Met showed larger diameter of muscle fibers at all heat stress periods.

Acknowledgements: CNPq

Key Words: crude protein, ether extract, mineral matter
45 Performance evaluation of different commercial genetics with different levels of nutritional programs. K. Silva*1, J. C. Panisson1, L. N. Barrilli2, D. C. Escrobot3, A. L. Ferreira1, D. Surek2, and S. G. Oliveira1, 1Universidade Federal do Paraná, Curitiba, Paraná, Brazil, 2EMBRAPA - Centro Nacional de Pesquisa de Suínos e Aves, Concórdia, Santa Catarina, Brazil.

The objective of the study was to evaluate 3 different levels of nutritional programs in different types of chicken broiler genotypes. The experiment was carried out at the experimental aviary of the Federal University of Paraná. A total of 3240 male, one - day - old broilers from commercial strains A, B and C were housed, totaling 1080 animals from each line, receiving 3 nutrient density types (Moderate, Medium and High) each, distributed in a completely randomized design, in factorial 3 × 3, with 12 replicates and 30 animals each box, from 1 to 56 d of age, the results were submitted to ANOVA (P < 0.05) and compared by the Tukey test at 5% of probability. The animals were weighed at 28 d to determine average weight gain (AWG). The feed leftovers were weighed to determine feed intake (FI) and feed conversion ratio (FCR). No interaction effect was observed between Diet × Lineage for FI at 28 d. There was a dietary effect for FI at 28 d, and the diet with the highest intake was of moderate nutritional density, followed by the medium and high nutritional density. As for genetics, there was also a difference between the 3 lines, with the C line presenting lower FI, followed by B and A, the largest difference being FI with C, with an average of 250 g lower than the others. It was observed an interaction effect between Diet × Lineage for AWG at 28 d. In all diets the genetics of C presented worse AWG, followed by B and with higher AWG the genetic A. In comparison to the diet within the lineages, all the lines presented higher AWG when they received a diet of medium nutritional density. An interaction effect was observed between Diet × Lineage for FCR at 28 d. The C line in all diets presented a worse FCR when compared with other strains, regardless of diet. The best FCR strain was A, receiving a diet of medium and high nutritional density. In conclusion, genetics C presented poorer performance at all nutritional levels evaluated followed by B genetics and all genetics had the best performance at medium and high nutritional density.

Key Words: carcass composition, cuts yield, lineages, collagen content, carcass moisture.

46 Carcass yield and composition of broilers of different lineages, fed with different nutritional programs. M. Santos*1, J. C. Panisson1, L. N. Barrilli1, T. T. Sabchuk1, F. Nalesso1, E. L. Krabbe1, and S. G. Oliveira1, 1Universidade Federal do Paraná, Curitiba, Paraná, Brazil, 2EMBRAPA - Centro Nacional de Pesquisa de Suínos e Aves, Concórdia, Santa Catarina, Brazil.

The objective of this study was to evaluate the effect of lineage (L) and nutritional program (NP) on the composition and yield of broiler carcass at 28 d of age. A total of 3240 male chicks, housed one day old, were distributed in a completely randomized design, in a 3x3 factorial (3 L x 3 NP) with 12 replicates with 30 animals in each box. The animals were housed in pens with an area of 2 m² and a capacity of 15 birds/m². The Ls compared were A, B and C, the last 2 fast growing Ls (FG), and the NPs were moderate, medium and high nutritional density. The diets supplied were corn and soybean meal, pelleted and crushed, provided ad libitum. At the 28 d, 16 animals were slaughtered per treatment, to analyze the yield (Y) of carcass (CY), breast (BY), thigh + drumstick (TDY) and the carcass composition (CC). For CY determination the live weight of the animals was used, and the carcass weight was used for BY and TDY. For CC analysis, the whole carcass was used with the viscera, only the feathers were removed, and the carcasses were milled and analyzed by FoodScan. Data were submitted to ANOVA and, when significant, passed the Tukey test at 5%. The results of the analyses of variance indicated significant differences between Ls and NPs for all carcass composition parameters (P < 0.05), with A L presenting a higher percentage of fat (P < 0.0001) and lower collagen content (P < 0.0001), B was the best in protein content along with C (P < 0.0001), which also presented higher values for moisture (72.02% for C, 71.06% for B and 70.59 for A) (P < 0.0001). Therefore, A L is still lower in performance compared with Ls of fast growing.

Key Words: fish meal, vegetable protein, substitution, broiler chicken.

Seven hundred twenty (n = 720) day-old broiler chicks (Cobb 500) were weighed and randomly divided into 36 replicates having 20 chicks/replicate. Chicks in each replicate were placed in a separate pen measuring 4′ × 3′ × 2.5′ and fed on iso-caloric diets (ME 2950 kcal/kg), with CP 20, 21 and 22% having 4 levels of digestible lysine (1.1, 1.2, 1.3 and 1.4%) from d 1–21st. These birds were made uniform by removing under/over-weight birds before switching to finishing diets. Twelve iso-caloric (ME 3175 kcal/kg) finishing diets with CP 18, 19 and 20%, having 4 levels of digestible lysine (1.0, 1.1, 1.2 and 1.3%) were randomly allotted to 36 replicates, 12 birds/replicate and fed on experimental diets ad libitum from d 22–35th. Supply of water was ensured round the clock during the experimental trial. Data on feed intake and body weight were used to determine body weight gain (BWG) and feed conversion ratio (FCR). On d 35th, 2 birds from each replicate were randomly selected, weighed individually and processed to measure carcass characteristics, giblet organ weight (heart, liver, gizzard, spleen). pH and water holding capacity of breast pectoralis major was also measured. Results of the present trial showed that supplementation of lysine at various levels of dietary CP improved feed intake, BWG and FCR. Maximum feed intake and BWG was observed with diet having 1.2% digestible lysine × 22% CP during starter phase (d 1–21st) and with diet having 1.1% digestible lysine × 20% CP during finisher phase (d 22–35th). Improved FCR was observed on diet having 1.3% digestible lysine × 21% dietary CP during starter phase (d 1–21st) and with 1.2% digestible lysine × 18% dietary CP during finisher phase (d 22–35th). Extra lysine fortification resulted in reducing tendency in growth performance. It was also noted that dressing percentage, breast/thigh meat yield and relative weight of liver were significantly improved by lysine and not by levels of dietary CP. Also, pH and water holding capacity of breast meat were significantly affected by lysine, but not by dietary CP. Work on fortification of lysine to the broiler diets could further be extended for efficient growth response and healthy functional foods high in lysine.

Key Words: digestible lysine, dietary protein, lysine × protein interaction, broiler chicken
The study had as an aim to evaluate the profile of susceptibility to antimicrobial medicines and to the formation of biofilm from isolated fields of Escherichia coli originated from cutting chicken carcass. Swabs were collected from cutting chicken carcass (50) in the chicken slaughter line in a commercial slaughterhouse. The swabs were conditioned in Cary-Blair intermedium under refrigeration and sent to the Laboratory of Bird Medicine of the State University of Londrina to process. The samples were incubated in BHI broth, at 37°C for 18–24h, and then plated in MacConkey agar, at 37°C for 18–24 h. The isolated colonies underwent biochemical tests (TSI/SIM/Citrate/Urease). It was possible to isolate 19 samples of E. coli, that underwent the antimicrobial susceptibility test, using: amikacin (AMI-30µg); gentamicin (GEN-10µg); neomycin (NEO-30µg); tobramycin (TOB-10µg); ampicillin (AMP-10µg); amoxicillin (AMO-10µg); cephalin (CPE-30µg); cephalexin (CFL-30µg); cefepime (CPM-30µg); cefotaxime (CTX-30µg); ceftazidime (CAZ-30µg); ceftriaxone (CRO-30µg); fosfomycin (FOS-200µg); erythromycin (ERI-15µg); sulfamethoxazole + trimethoprim (SUT-1,25/23,75µg); tetracycline (TET-30µg); aztreonam (ATM-30µg). The isolated in which we could observe resistance to 2 or more of these antimicrobial classes were considered multiresistant. For the biofilm test, we have used the quantitative method with violet Crystal, in plate of polystyrene of 96 cavities and TSB broth, the positive control was E. coli HB 101 and the negative control was E. coli HB 101. The largest resistance indications observed were the antimicrobials: erythromycin 95% (18/19), cephalothin 53% (10/19), ampicillin 42% (8/19) and amoxicillin 42% (8/19), concluding that 58% (11/19) came up with a multiresistant profile to drugs (MDR). About the biofilm, all the samples were considered growers, once 21% (4/19) came up with a moderated production of biofilm, similar to the test positive control and 79% (15/19) came up with a weak production. It was possible to conclude also that 75% (3/4) of the samples that came up with moderated biofilm also showed a MDR profile. The capacity of forming biofilm enlarges the permanence of microorganisms in the environment, once it prevents the total sanitation of the slaughterhouse equipment, and when it is associated to a MDR profile, the risks of a possible carcass crossed contamination increase, and a consequent dissemination of resistance genes through the food chain.

Key Words: biofilm, carcass, Escherichia coli, MDR, microbial resistance

51 Patterns of adherence of avian pathogenic Escherichia coli and avian fecal E. coli to HEp-2 cells. L. Justino*, M. F. Menck Costa, M. S. Sanches, M. Souza, S. P. D. Rocha, and A. A. S. Baptista, State University of Londrina, Londrina, Paraná, Brazil.

Avian fecal E. coli (AFEC) is a gram-negative bacillus, commensal, which lives in the intestinal tract of birds. However, some strains of E.coli, known as Avian Pathogenic Escherichia coli (APEC) has the capacity of causing diseases in birds and to cause economical losses in consequence of morbidity, mortality and the decrease of productivity of birds. The mechanism of bacterial adherence contributes for the colonization of tissues and for subsequent invasion. The goal of this study was to determine the capacity for adhesion of APEC and AFEC. APEC isolated (n = 11) collected from bird injuries caused by colibacillosis and AFEC (n = 11) isolated from chicken carcass in slaughter line were used. The strains were identified by a microbiology conventional method, followed by PCR for the virulence genes (iss, iss, ...

Biofilm formation is a major concern, for remaining in surfaces, bacteria may resist to sanitizers and antimicrobials, allowing the existence of a constant source of microorganisms. Due to the importance of Salmonella in poultry farming, the aim of this study was to analyse the formation of biofilms of different Salmonella serotypes through different mechanisms. We tested 6 Salmonella serotypes: S. Enteritidis (SE), S. Typhimurium (ST), S. Typhimurium var. (STvA), S. Minnesota (SM), S. Heidelberg (SH), and S. Gallinarum (SG). The initial inoculum of 10^7 cfu was placed in TSB under biofilm formation conditions. After 2 hours (initiation) and 24 hours (biofilm formation) as samples adhered on plates were counted and confirmed by PCR. Parallel after 24 hours was measured by the BFI (Biofilm Formation Index) proposed by Naves (2008; Microb. Pathog. 45:86–91). From the results of biofilm formation on polystyrene plates, SE and SH were evaluated for biofilm formation in turkey eggshells by counting, confirmed by PCR array and SEM. The quantitative results of colony-forming units obtained for both adhesion and biofilm formation were not related to the results obtained in the BFI. The biofilms produced by SM and SG allowed to classify them as producers of biofilms of moderate intensity. For the other serotypes, despite the high counts, BFI indicated low biofilm production, probably related to the scarcity of extracellular matrix produced by these strains. The SH and SE strains exhibited similar behaviours with a reduction in the number of bacterial cells in the adhesion process and there was no increase in the number of bacteria at the time of biofilm formation. We decided to carry out a biofilm formation test of SH and SE in eggshell, which were classified as a poor-biofilm-forming bacteria. The SH biofilm formation was confirmed by microbiology and SEM. The present study showed the good capacity of biofilm formation by different strains of Salmonella related to the scarcity or not of extracellular matrix produced by these strains. This work instigates other studies on the importance of biofilm control in farms.

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Key Words: biofilm, formation, Salmonella, control, egg

53 In vitro and in vivo evaluation of antimicrobial effects of NeutraPath against Salmonella Heidelberg. H. Xue*, D. Wang, and S. Ching, Amlan International, Chicago, IL, USA.

NeutraPath, a synergistic blend of antimicrobial fatty acids and essential oils that’s optimized for pathogen control, demonstrates antimicrobial activity against a variety of gram-negative and gram-positive bacteria. An in vitro assay was performed to determine the minimal inhibitory concentration (MIC) of NeutraPath against Salmonella enterica sv. Heidelberg. Four different concentrations (0, 1, 3 and 5 mg/ml) of NeutraPath were added to samples of a Salmonella Heidelberg field strain grown in Luria-Bertani broth, then incubated at 37 C for 16 h. Results determined the MIC of NeutraPath for Salmonella Heidelberg is 5 mg/ml. An in vivo trial was then performed to evaluate the efficacy of NeutraPath in reducing Salmonella Heidelberg colonization of broiler chickens. Two hundred ten day-of-hatch Ross x Ross male broiler chicks were allocated to 6 pens of 35 birds per pen. On d 0, 25 chicks in each pen were orally dosed (gavaged) with 4 x 10^7 cfu of naldixic acid-resistant Salmonella Heidelberg. The remaining chicks in each pen were horizontally challenged with Salmonella Heidelberg from the seeders birds. On d 7, environmental samples to determine Salmonella Heidelberg contamination were collected via pre-moistened boot-sock swabs from all pens. On d 43 of the trial, 2 treatments were assigned to pens using a completely randomized design: 1) SalmonellaHeidelberg challenged (SH-CH) control and 2) SH-CH birds fed NeutraPath (5 kg/MT) in the finisher diet for one week. Cecal samples and cloacal swabs also were collected from 10 direct-challenged broilers to enumerate Salmonella populations via the most probable number (MPN) method and determine Salmonella prevalence. Differences between treatments were analyzed using one-way ANOVA. Boot-sock sampling of pens confirmed Salmonella challenge resulted in environmental contamination with 100% of pens testing positive for bacteria. Compared with the control group, NeutraPath treatment resulted in a statistically significant reduction in the prevalence of Salmonella Heidelberg in cecal contents (50% vs. 83.3%, P < 0.05). Further, a mirrored pattern of reduced prevalence of Salmonella-positive cloacal swabs (26.7% vs. 60%, P < 0.10) was observed, demonstrating a potential role for NeutraPath in reducing the incidence of Salmonella-contaminated broiler carcasses. Based on these in vitro and in vivo data, NeutraPath treatment has the therapeutic potential to control Salmonella Heidelberg in broiler chickens.

Key Words: Salmonella Heidelberg, broiler, finisher diet, minimal inhibitory concentration, NeutraPath


The maintenance of the internal quality of eggs after laying is dependent on the washing and disinfection process to reduce risks of contamina-
2nd Latin American Scientific Conference

28

Poultry destruction, Haugh unit, laying hen, Origanum vulgare, yolk index

55 Poultry compost as an alternate safe feed ingredient in broilers production. H. Anwar*, Department of Physiology, Government College University, Faisalabad, Pakistan.

Poultry litter is being used as a fertilizer in agriculture lands and as a source of food in poultry and livestock since long. But the use of non-processed litter is a source of land and water contamination with NO₃ which could eventually result in respiratory illnesses, cancer and fetal anomalies. Litter composting is viewed as a viable mean for reducing such toxic effects of litter application on agriculture land. The purpose of current study is the introduction and implementation of concept of processed poultry litter as a safe feed additive in broiler poultry. Compost was prepared from dead birds and poultry litter and its nutritional value was confirmed by proximate and mineral analysis and microbial composition was checked by whole genome sequencing (16S RNA) of the DNA extracted from the compost. The results showed no harmful bacteria or toxic chemicals in the compost. Two hundred and 40 d old broiler chicks were used in the trial and were randomly divided into 5 treatment groups (n = 48) with compost supplementation in the broiler feed with a 0, 2.5, 5, 7.5, and 10 percent ratio. On d 42 the birds were slaughtered for the collection of Blood samples which were analyzed for lipid profile, hematology, serum glucose level, total protein, albumin and oxidative stress biomarkers by spectrophotometric colorimetric assays. All the lab values were statistically tested on one way ANOVA using the SPSS software. All the results were non significant among groups showing no adverse effects as compared with control. In conclusion, composting of poultry wastes (litter, dead birds) can be an efficient procedure for converting wastes into cheap feed ingredient with minimum environmental pollution and pathogens spread. So the cost of broiler feed may be reduced by replacing the feed with poultry litter and compost.

Key Words: litter, compost, broiler, microbiome, biohealth markers

The objective of this study was to describe the medullary bone formation and the genital organ development in sexual maturity under the effect of 2 light programs (LP). The experimental design was completely randomized with 2 different light/dark periods and 5 replications of 55 birds. In each LP 1 d-old quails were housed in galvanized cages with controlled light and temperature. The light program simulates winter (11L:13D) and summer (14L:10D) seasons in Maringá and artificial fluorescent light were used full time, controlled by analog timer. After 35 d, the light period was increased in 30 min every 3 d until a 17L:7D. Blood, bone and genital organs were analyzed at 17, 21, 25, 28, 31, 35, 42, 49, 56, 63 and 70 d-old (n = 5). Data were subjected to ANOVA factorial 2 × 11 (LP vs age) comparing means by Tukey test, using R Studio program with 5% significance level. Serum albumin increased with age (P < 0.001) and was higher in the 11L:13D LP at 31 and 42 d (P = 0.02). Serum calcium was higher in birds with 17 d, reducing up to 35 d, and increasing with laying starting, first in 11L:13D LP (42 d), and then at in 14L:10D (49 d) (P = 0.02). Quails in 11L:13D LP had more calcium in the ashes of medullary bone of femur at 49 and 56 d (10.6 and 9.7%, respectively), while in 14L:10D LP, this effect was observed at 63 d with 8.9% (P < 0.001). For tibiotarsus, calcium content in medullary bone had the highest means at 63 d (P < 0.001) in 11L:13D and 14L:10D LP, 10.04 and 8.42%, respectively. There was interaction effect LP vs age (P = 0.01) in relative weight of oviduct at 42 to 56 d. The relative weight of the ovary had significant difference for LP at 56 d (P < 0.02), and oviduct length was longer at 56 d in quails under 11L:13D LP (P = 0.004). Macro and microscopy analysis showed that birds in 11L:13D LP developed genital organs earlier than those in 14L:10D LP, consequently, they started laying earlier. The body weight and body weight gain weekly were higher in 11L:13D LP at 35 and 42 d. However, the feed intake was higher at 1–28 d in 14L:10D LP. The quails under the 11L:13D LP started laying at 40 d reaching 47.9% of posture, and the 14L:10D LP started laying at 42 d reaching 32.11% of posture. Sexual maturity is characterized by several metabolic events. Albumin and calcium serum levels increased immediately before sexual maturity. The medullary bone developed first in the femur, and its function is to provide calcium for eggshell formation. Although, quails under 11L:13D LP had developed genital organs 1 wk before, at 63 d all birds for both lighting program had ovary and oviduct developed.

Acknowledgements: CNPq

Key Words: calcium, genital organs, medullary bone


The objective of this study was to describe the effects of vitamin E (Vit E) supplementation in incubation performance and fertility of the Japanese quail breeders in diets with xanthophyll (Xa). The experimental design was completely randomized with 5 groups: control diet (25 mg/kg Vit E; without xanthophyll) and 4 levels of Vit E (25, 100, 175 and 250 mg/kg) associated with 60 mg/kg of Xa extract (Tajetes erecta). For the incubation performance 12 replicates of (06 females + 02 males) were used and 20 eggs per replication were analyzed. In 20 couples of breeders, the sex influence was determined with only females (n = 10) or males (n = 10) receiving experimental diets. Male and female stay together for 24 hs and eggs obtained in 13 consecutive days were used to determine fertility and the number of holes of spermatozoid hydrolysis in perivitelline layer. Data was analyzed in GENMOD procedures of SAS, probability of fertility and hatchability were analyzed with binomial distribution and link function and number of holes of hydrolyses over germinal disc were analyzed with Poisson distribution and Log function. The effect of Xa was determined comparing control group with vit E levels groups with Xa. There was no effect of Vit E + Xa (P > 0.05) on total hatchability, hatchability of fertile eggs and total mortality. In eggs from regular breeders (6F+2M) was observed a linear effect (P < 0.05) on probability of fertility (increased) and infertility (decreased) in treatments with Vit E levels + Xa. In quail couples, the probability of fertility to be 100% (P < 0.05) was 4 d longer when females received diet (8th d) with Vit E + Xa, compared with results with males (4th d) receiving treatments. The levels of vit E and the days after copula had interaction with a quadratic effect on the number of hole (P < 0.05), with reduction in function of both factors in males and female groups. The number of holes were higher when females had Vit E and Xa in diet compared with control. At first day after copula, eggs had in average 156 holes when females had experimental diet versus 77 holes in eggs when only males had experimental diet. The results suggest that sperm survived longer in the oviduct of females and thus a higher number of them were in infundibulum during fertilization period. This effect was probably associated with the antioxidant effects of the vit E and Xa, affecting their survival inside tubular glands of the vagina. It was concluded that the inclusion of Xa and vit E improves fertility and increases the survival of spermatozoa in the female’s body.

Key Words: incubation, antioxidant, sperm, egg


The present study was carried out to evaluate the effects of storage time, light intensity, blood fractions (serum and plasma) and fasting time on total protein and albumin contents in the blood of broiler chickens. A total of 140 male broilers of 45 d of age were used. The animals were reared on the same diet and were treated for 42 d. At 42 d, the birds were divided into 14 experimental units, where 7 experimental units received 20 lm of illumination and 7 received 5 lm where at 45 d the feed was withdrawn and serum and plasma samples were collected in the ulnar vein in the postprandial period and at 2, 4, 6, 8, 10 and 12 h of fasting. The samples were collected in vacutainer tubes for plasma (sodium fluoride) and serum (no additives), and centrifuged at 2500 rpm (1050g) for 10 min, so the plasma and serum fractions were separated and packed in eppendorf type where part was analyzed soon after the collection and the others were stored at −20°C and analyzed 15, 30, 60 and 120 d after collection. Total protein and albumin determinations were performed using an automatic biochemical analyzer (Flexor EL 200, Elitech) using specific kits and specific calibrators (Elitech). The data obtained were analyzed using the GLM procedure of the SAS statistical program. For the total protein concentrations, there was a quadratic effect of storage time (35.285292 + 0.018282days - 0.00011days2, R2 = 29.6) (P < 0.01)}
with maximum point at 83 d of storage, blood fraction had no effect $P > 0.05$), fasting time presented interference ($P < 0.01$) with the highest values for 2 and 4 h of storage by tukey test and light intensity ($P < 0.01$) in which averages were obtained for 5 and 20 lm respectively of 36.86 and 34.52 g l-1. For albumin, there was an effect for storage time $(15.437770 + 0.014788\text{days} - 0.000194\text{days}^2, R^2 = 94.59) (P < 0.01)$ with maximum point at 38 d, blood fraction ($P < 0.01$) ($P < 0.01$) with the highest values for 2 and 4 h of storage by the tukey test and light intensity ($P < 0.01$), respectively, for serum and plasma of 15.00 and 15.65 g l-1, for 5 and 20 lm of respectively 15.80 and 14.92 g l-1. In view of the above, the total protein analysis was indicated for reading up to 83 d of storage of the samples. It could be done in serum or plasma and the animals were collected at light intensity of 5 lm and the birds were 2 to 4 h apart. fasting. For albumin analysis recommended in the embodiment at most 38 d, using plasma, and performing the birds collecting light intensity in lumens and 5 with 2 to 4 h of fasting.

**Key Words:** biochemical analyses, plasma, serum, methodological standardization
59 Performance of broiler chickens to optimum levels of carbohydrases and superdose level of phytase in sorghum-based diets. M. Alqahtani*1, M. E. B. Abdallh1, E. Ahieu1, H. Gausi1, M. Mabelebele1, M. Bhuiyan1, M. Bedford2, and P. Iji1,3,1School of Environmental and Rural Science, University of New England, Armidale, Australia, 2AB Vista, Marlborough, United Kingdom, 3College of Agriculture, Fisheries and Forestry, Fiji National University, Koronivia, Fiji.

The objective of this study was to assess the response of broiler chickens to varying levels of microbial enzymes in fed sorghum-based diets. Diets were supplemented with 3 levels of Phytase, 2 levels of Xylanase and 2 levels of β-glucanase (AB-Vista, Marlborough, UK). Six hundred and 48 Ross 308 broiler chickens were randomly assigned to 12 dietary treatments, each replicated 6 times, with 9 birds per replicate. Birds were raised in cages in climate-controlled rooms and the experiment ran from hatch to 35d. Data of feed intake and body weight were collected on d 10, 25 and 35 while feed conversion ratio (FCR) was calculated and corrected for mortality. At 35d 2 birds were randomly selected, slaughtered by cervical dislocation and processed for assessment of meat yield. The general linear model procedure was used to analyze the data (Minitab version 17). Feed intake throughout the production cycle decreased ($P < 0.001$) when diets were supplemented with phytase, especially at high levels, while β-glucanase decreased ($P = 0.05$) feed intake at d10. The interaction between Xylanase, Phytase and β-glucanase improved ($P < 0.03$) the body weight gain (BWG) up to d24, although single action of phytase, xylanase and β-glucanase improved ($P < 0.03$) the BWG to 10, 24 and d35 There was a positive interaction ($P < 0.01$) between Phytase and Xylanase on FCR at d24, leading to reduction in FCR from 1.42 to 1.07. Phytase addition improved ($P < 0.001$) the FCR throughout the production cycle while supplementing β-glucanase improved ($P < 0.03$) FCR up to 24d. There was an interaction ($P < 0.02$) between phytase and xylanase on relative weight of drumsticks, which was further improved ($P < 0.02$) by phytase. Phytase addition also increased the absolute and relative weights of thighs ($P < 0.02$), while β-glucanase increased ($P = 0.05$) the absolute weight of thighs only. It can be concluded that the performance of broiler chickens fed sorghum-based diet can be improved by enzyme supplementation and that adding phytase is the most effective intervention throughout the production cycle.

Acknowledgements: AB Vista, UK and UNE provided the research funds.

Key Words: sorghum-based diet, feed intake, body weight gain, feed conversion ratio, phytase

61 Feeding behavior of Tenebrio molitor meal-fed broiler chickens: ingredient preference, feed intake, and performance. M. A. N. Filho*, R. T. Pereira1, Â. M. Burin Junior1, A. B. Santos de Oliveira1, D. Suckeversi1, D. B. Moretti1, D. Vicente da Costa1, and J. F. M. Menten1, 1Luiz de Queiroz College of Agriculture (ESALQ/USP), Piracicaba, São Paulo, Brazil, 2University of Minas Gerais (UFMG/ICA), Montes Claros, Minas Gerais, Brazil.

_Tenebrio molitor_ (TM) is one of the insect species used to produce larvae meal for animal feeding. The aim of this study was to determine whether broilers display a preference for TM meal when offered simultaneously to corn, extruded semi-whole soybean, and supplement mixture by measuring ingredient acceptability and birds’ performance during the period of 14 to 28 d of age. Considering that the use of insects in the animal industry claims to be a promising feed alternative since it combines high nutritive value, nutraceutical properties, and environmental sustainability, studies must explore their nutritional composition, nutrient digestibility, and benefits on the performance and health of insect-fed birds. A total of 60 14-d-old male broiler chickens of commercial strain were randomly distributed into 2 dietary treatments: a control (C) group, and a TM group. Each pen was equipped with one bell drinker and 4 through feeders allocated side by side; all feeders of the C group contained a complete standard diet whereas each feeder of the TM group contained one of the ingredients: corn, extruded semi-whole soybean, supplement...
mixture (vitamin-mineral premix, limestone, dicalcium phosphate, salt, choline chloride, amino acids, salinomycin), and TM meal. Each group consisted of 6 replicate floor pens (5 birds/pen) assigned in a completely randomized design. Feed and water were available ad libitum. The C group was used as a reference for diet and nutrient consumption of the birds. All feeders were weighted and refilled daily to access feed intake. Values for TM meal preference were recorded daily and broiler growth performance was measured weekly during the trial. Productive performance data were analyzed by one-way ANOVA. On wk 1, the chickens that had access to individual feed components, consumed, on average 34% of the total intake as TM meal, and this value increased to 62% on wk 2, but these percentages had wide variation for different pens. It was observed that the initiation of TM meal consumption was immediate for some pens but it took up to 10 d for other pens. Feed intake and growth performance were lower in TM group compared with C group on wk 1 and 2 ($P < 0.01$). However, feed conversion ratio on wk 1 was not statistically different for both treatments (2.23 for TM and 1.75 for C; $P > 0.05$) and it was better for the TM group (1.25) than C group (1.58) on wk 2 ($P < 0.05$). In conclusion, TM meal can be a suitable feed alternative for broiler chickens, which demonstrate an intense feeding behavior preference for this ingredient.

Acknowledgements: FAPESP for the research grant (No 2017/05423-8) and MS scholarship (No 2017/19751-7).

Key Words: insect meal, Tenebrio molitor, broiler, ingredient preference, feed conversion


Black soldier fly larvae meal (BSFLM) (Hermetia illucens) is an alternative food, which has little knowledge in the feeding of laying hens. Thus, the aim of this study was to evaluate the productive performance of laying hens fed with diets containing different levels of BSFLM. A total of 192 commercial laying hens of the Bovans line were used, aged 25 to 36 weeks, for a period of 63 d divided into 3 cycles of 21 d. The experimental design was completely randomized with 4 levels of inclusion of BSFLM (0, 3, 6, and 9%) in the laying hens’ diet, with 6 replicates of 8 birds per experimental unit. The variables analyzed for performance were: feed intake (g/bird/d), average egg weight (g), egg mass (g/bird/day), feed conversion ratio (kg kg and kg/dz) and percentage of laying (%). The data were submitted to ANOVA and later to the polynomial regression test. The results (Table 1) showed that the use of different levels of BSFLM inclusion in the laying hens’ diet did not influence ($P > 0.05$) on feed intake, egg weight, feed conversion, and percentage of laying. Therefore, it can be concluded that the inclusion of up to 9% of BSFLM can be used as an alternative food in the feeding of laying hens without changing the performance of the birds.

**Table 1. Productive performance of laying hens fed with different levels of Black soldier fly larvae meal (BSFLM).**

<table>
<thead>
<tr>
<th>Variable analyzed</th>
<th>Level of BSFLM (%)</th>
<th>Regression effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>3.0</td>
</tr>
<tr>
<td>Feed intake (g/bird/d)</td>
<td>103.07</td>
<td>102.38</td>
</tr>
<tr>
<td>Average egg weight (g)</td>
<td>61.79</td>
<td>61.53</td>
</tr>
<tr>
<td>Egg mass (g/bird/d)</td>
<td>58.58</td>
<td>59.83</td>
</tr>
<tr>
<td>FCR (kg/kg)</td>
<td>1.70</td>
<td>1.68</td>
</tr>
<tr>
<td>FCR (kg/dz)</td>
<td>1.23</td>
<td>1.24</td>
</tr>
<tr>
<td>Percentage of laying (%)</td>
<td>96.77</td>
<td>97.62</td>
</tr>
</tbody>
</table>

NS = not significant.

**Key Words**: alternative food, bug, nutrition, production, protein


The egg has great importance in human food, since it is one of the most complete foods. In the search for alternative feed for laying hens, black soldier fly larvae meal (BSFLM) seems to be an option, but the inclusion of BSFLM may influence the acceptance of eggs by consumers due to the high content of glutamic acid (6.85 g/kg), which is correlated to the umami effect. Therefore, the objective of this study was to evaluate the inclusion of BSFLM in laying hens feeding on the sensorial analysis of eggs. 80 eggs were collected from 2 treatments, T1 - laying hens without BSFLM inclusion in the diet; T2 - with the inclusion of 9% of BSFLM in the diet. To perform the sensory analysis, these eggs were washed in running water, boiled for 10 min after boiling water, cooled in running water, peeled manually, and cut into 4 pieces so that yolk and egg white were in each sample. The test was performed with 60 non-trained evaluators, using the triangular test model. In each test the evaluator received 3 coded samples, 2 samples were the same and one different, where the evaluator should indicate the different sample. The samples were served in all possible combinations. It was recommended to the evaluators to drink mineral water room temperature between the tasting of the samples. The results were obtained based on the number of right and wrong judgments in relation to the total judgments, in which the number of hits was verified directly in the ABNT table, NBR 12995 (1993) to see if there was a significance of less than 5% in the results obtained. According to the ABNT table, when there are 60 judgments, the minimum number of hits should be 27, however in this survey there were only 18 hits. Thus, there was no sensorial difference ($P > 0.05$) in eggs from laying hens fed with and without BSFLM. Therefore, it can be concluded that the larvae meal of black soldier flies can be used in the nutrition of laying hens, since it does not influence the taste of the eggs.

**Key Words**: glutamic acid, tasting, insect, flavor, umami
The objective of this research was to evaluate the productive performance of broilers fed with different soybean meal (SBM) grain sizes in diets. It was used 720 male broilers of the Cobb line, distributed in a completely randomized design with 4 treatments (625, 775, 1053 and 1406μm) and 9 replicates, with 20 animals each. The birds received water and feed ad libitum. Diets' composition were similar to each other, varying only the granulometry of SBM. The ration and the animals were weighted at the beginning of the experiment (1 d) and at 7, 21, 35 and 42 d to determine feed intake (FI), body weight gain (WG) and feed conversion ratio (FCR). The data were submitted to ANOVA and when significant, the means were submitted to the linear regression and quadratic test at 5% of probability. The results of productive performance are presented in Table 1. At the initial phase there was a linear reduction for FI (P < 0.05) in diets with coarser SBM particles. For WG and FCR, quadratic effect (P < 0.05) was obtained, and birds did not feed on the intermediate particles of the results. From 1 to 35 d old, there was a linear increase for WG and FCR variables (P < 0.05) for birds fed with coarser granulometry of SBM. When evaluating the total experimental period from 1 to 42 d of age, birds fed with coarser granulometry of SBM presented a linear tendency for WG (P = 0.06) and linear reduction for the FCR (P < 0.05), showing no significant effect for FI (P > 0.05). As conclusion, coarser particle size of SBM promoted the best performance results in broilers.

**Table 1.** Feed intake (FI), body weight gain (WG) and feed conversion ratio (FCR) of broilers from 1 to 42 days of age fed with diets of different grain sizes of soybean meal

<table>
<thead>
<tr>
<th>Treatment/granulometry (μm)</th>
<th>SEM</th>
<th>Lin</th>
<th>Quad</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FI (g)</td>
<td>WG (g)</td>
<td>FCR</td>
</tr>
<tr>
<td>625</td>
<td>150</td>
<td>132</td>
<td>1.187</td>
</tr>
<tr>
<td>775</td>
<td>156</td>
<td>126</td>
<td>1.179</td>
</tr>
<tr>
<td>1053</td>
<td>148</td>
<td>113</td>
<td>1.174</td>
</tr>
<tr>
<td>1406</td>
<td>141</td>
<td>112</td>
<td>1.255</td>
</tr>
</tbody>
</table>

Key Words: performance, soybean meal, broiler, granulometry

The objective was to evaluate the effects of crude protein and amino acid levels variation on broiler performance. 1320 male broilers (Ross 308) from 1 to 42 d of age were used. The animals were distributed in a completely randomized design with 5 treatments (T), 11 replicates and 24 birds per experimental unit. The diets were based on the Brazilian Tables of Poultry and Pork and were composed of corn and soybean meal, offered in mash form. In each treatment there was a decrease of 0.5% in crude protein and essential amino acids from the standard levels, according to the phase (initial, growth and final). The parameters evaluated were: weight gain (WG), feed intake (FI) and feed conversion ratio (FCR). Obtained data were submitted to regression analysis. FCR from 1 to 35 d responded linearly (P < 0.0001) and 1 to 42 tended to linearity (P < 0.001) through dietary protein levels (y = −0.019x + 1.9303, R² = 0.366; y = −0.0202x + 2.0324, R² = 0.1287, respectively), and exhibited a worse response when the protein levels in the diet were reduced. This result can be explained by the deficiency of amino acids in protein synthesis of tissues for maintenance and development of the animal. There was no difference for the FI and WG (P > 0.05). Therefore, we can conclude that performance of broilers decrease with lower inclusions of dietary protein and amino acids.

**Table 1.** Feed intake (FI), body weight gain (WG) and feed conversion ratio (FCR) of broilers from 1 to 35 and 1 to 42 days of age with different protein and amino acid levels.

<table>
<thead>
<tr>
<th>CP (%)</th>
<th>1–35 days</th>
<th>1–42 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FI (g)</td>
<td>WG (g)</td>
</tr>
<tr>
<td>Standard</td>
<td>3091</td>
<td>2045</td>
</tr>
<tr>
<td>-0.5</td>
<td>3159</td>
<td>2068</td>
</tr>
<tr>
<td>-1</td>
<td>3159</td>
<td>2062</td>
</tr>
<tr>
<td>-1.5</td>
<td>3225</td>
<td>2113</td>
</tr>
<tr>
<td>-2</td>
<td>3189</td>
<td>2047</td>
</tr>
<tr>
<td>P-Lin</td>
<td>0.3830</td>
<td>0.9905</td>
</tr>
<tr>
<td>P-Quad</td>
<td>0.9286</td>
<td>0.8722</td>
</tr>
<tr>
<td>CV (%)</td>
<td>4.15</td>
<td>4.54</td>
</tr>
</tbody>
</table>

Key Words: performance, protein level, standard level, crude protein, decrease

### 65 Performance of broiler chickens at different levels of protein and amino acids


One of the consequences of genetic selection for poultry growth is the appearance of breast myopathies, mainly white striping (WS) and wooden breast (WB), which negatively influence meat quality. In this way, the aim of this research was to evaluate the effect of nutritional density in commercial genetic broiler strains on WS, WB and drip loss (DL). A total of 144 male broilers were distributed in a randomized experimental design in a factorial arrangement with 3 commercial genetic broiler strains (A, B and C) and 3 nutritional densities (high, medium and low) with 16 repetitions. At 28d, all birds were euthanized and evaluated for WS score in, 0 = without striations, 1 = striations less than 1 mm, 1.5 = striations between 1 and 2 mm, 2 = striations between 2 and 3 mm and 2.5 = striations more than 3 mm (Kuttappan, 2013; Tijare et al., 2016). Moreover, the fillets were evaluated for WB score...
in, 0 = normal breast, 1 = mild hardening in the upper and/or lower part of the fillet, 2 = moderate hardening in the fillet, 3 = severe hardening with hemorrhagic lesions and the presence of sterile exudate. Finally, the DL was estimated by measure of the raw meat after storage at 2°C for 48h. Nonparametric data, WS and WB score, were analyzed by Kruskal Wallis test at 5% of probability. The remaining data were submitted to ANOVA by Tukey test at 5% of probability. The results are shown in Table 1. There was no effect \((P > 0.05)\) for WS score and DL between treatments. However, A strain birds presented a lower prevalence of WS in all nutritional density diets. Futhermore, the B strain fed with low density diet presented lower prevalence of WS \((P < 0.05)\), when compared with high density diet. It was concluded that white striping is related mainly by broiler strains.

### Table 1. Result of the effect of nutritional density (ND) of the diet and commercial genetic strains (CGS) on white striping (WS), wooden breast (WB) and drip loss (DL) at 28 days old birds.

<table>
<thead>
<tr>
<th>CGS</th>
<th>ND</th>
<th>WS</th>
<th>WB</th>
<th>DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Low</td>
<td>0.0 d</td>
<td>1.0</td>
<td>0.1453</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0.5 cde</td>
<td>1.0</td>
<td>0.0970</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.5 cde</td>
<td>1.0</td>
<td>0.1113</td>
</tr>
<tr>
<td>B</td>
<td>Low</td>
<td>1.0 bcd</td>
<td>1.0</td>
<td>0.1972</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>1.0 abc</td>
<td>1.0</td>
<td>0.1891</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>1.0 ab</td>
<td>2.0</td>
<td>0.2029</td>
</tr>
<tr>
<td>C</td>
<td>Low</td>
<td>1.0 ab</td>
<td>2.0</td>
<td>0.1230</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>1.0 ab</td>
<td>2.0</td>
<td>0.1809</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>1.0 abd</td>
<td>1.5</td>
<td>0.1893</td>
</tr>
<tr>
<td>P-value</td>
<td>0.0015</td>
<td>0.1017</td>
<td>0.7961</td>
<td></td>
</tr>
</tbody>
</table>

\*Different letters in the same column differ by Kruskal Wallis test \((P < 0.05)\).

**Key Words**: breast, meat quality, myopathy, striation

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**67 Supplementation of guanidinoacetic acid in diets with reduced calories on performance and occurrence of myopathy in broiler chickens.**

A. M. Burin Junior*1, G. S. Maier2, E. J. Ronconi2, F. K. Cestari2, D. A. Pazdiora2, S. C. Palma2, R. Buzim2, and J. I. M. Fernandes2, 1ESALQ/USP, Piracicaba, São Paulo, Brazil, 2UFPR - Palotina, Palotina, Paraná, Brazil.

This experiment was conducted to determine the effects of supplementation of guanidinoacetic acid (GAA) in diets with reduced calories on productive performance and occurrence of white striping (WS) and wooden breast (WB) in broilers. One thousand four hundred Cobb 500 males were distributed to 5 diets and 7 replicates (40 birds each). The treatments were: control diet (corn, soybean meal and meat meal); control diet + 0.06% GAA; control diet + 0.10% GAA; control diet + reduction of 50 kcal/kg + 0.06% GAA; control diet + reduction of 50 kcal/kg + 0.10% GAA. Performance was assessed weekly. At d 47, 175 birds (35 each treatment) were slaughtered to assess WS and WB occurrence and microscopic lesions. The slides were verified for: adipose tissue and collagen presence (Masson’s trichrome stain); and hyaline degeneration, interstitial fibrosis, regeneration, lymphocytic aggregates, and perivascular inflammation (H&E-stained slides), scored according to a severity index from 0 to 3 (absence, mild, moderate and severe lesions, respectively). Performance data were submitted to one-way ANOVA and Tukey as a post hoc test. The semiquantitative severity scores (count data) was analyzed using chi-squared statistics on SAS. In the first week, was observed a better feed conversion ratio (FCR) for animals fed control diet + 0.10% GAA. Considering the total experimental period, the diets added 0.06% or 0.10% of GAA resulted in better \((P < 0.05)\) FCR in comparison with the control diet. However, they were similar in relation to diets with reduced calories supplemented with GAA. The WS and WB severity scores and composition of fat and collagen in the breasts samples were not altered \((P > 0.05)\) by GAA supplementation regardless of the calories reduction. For the microscopic variables assessed, the behavior of the treatments was consistent regarding the frequency of lesions within each score \((P > 0.05)\). However, for hyaline degeneration, interstitial fibrosis, regeneration and lymphocytic aggregates, the highest frequencies \((P < 0.05)\) were found within moderate and severe scores. For perivascular inflammation, the frequencies were higher \((P < 0.05)\) for absence and mild scores. Nevertheless, it may be observed a pattern in the frequency of severe lesions by treatment, specifically between control diet and control + 0.6% GAA. The frequency was 31.03% and 6.90%, respectively for hyaline degeneration; 33.3% and 0.0% for fibrosis; 50.0% and 0.0% for regeneration; 20.0% and 0.0% for lymphocytic aggregates; and 42.8% and 0.0% for perivascular inflammation. Thus, the supplementation of GAA in diets for boiler chickens may has a potential of mitigation on the occurrence of severe WB scores.

**Key Words**: nutrition, guanidinoacetic acid, chicken breast, myopathy

A study was conducted to evaluate growth performance and selenium requirements for broilers fed with different levels of Se. A total of 1,500 one-day-old Cobb 500 broiler chicks was placed in 60 experimental pens. Five treatments with 12 replications of 25 birds per pen were randomly allocated and fed experimental diets from 1 to 42 d. A basal diet were formulated at 3-phases feeding program (1 to 21 d; 22 to 35 d, and 36 to 42 d) was used with 0.03 ppm analyzed Se. Broilers were fed diets graded increments of supplementation Se (0.00, 0.15, 0.30, 0.45, and 0.60 ppm) from sodium selenite (Na$_2$SeO$_3$). The study was replicated twice over time. At 35 and 42 d, 5 birds per pen were processed for carcass and commercial cuts yields. Estimations of Se requirements and growth performance were done using exponential asymptotic (EA) and quadratic polynomial (QP) models. Body weight gain (BWG) of broilers fed diets with increasing levels of sodium selenite increased quadratically and exponentially ($P < 0.05$) from 15 to 21, 22 to 35 and 1 to 42 d. Levels of Se from Na$_2$SeO$_3$ that optimized BWG were estimated at 0.39, 0.37 and 0.42 ppm using the QP model and at 0.50, 0.30 and 0.37 ppm with EA model. Breast fillets and carcass yields at 42 d had maximum responses estimated at 0.38 ppm for 0.3 and 0.37 using the QP model. Using the EA models, breast fillets and carcass yields at 42 d had maximum responses estimated at 0.33 ppm and 0.32. In conclusion, Se requirements varied according to the different variables and statistical regression models utilized. In this study, considering a basal diet (0.03 ppm of Se) the average of Se requirements estimates for 1 to 42 d was 0.42 ppm.

Key Words: selenium, broiler, breast fillets, carcass yield


An experiment was conducted to evaluate growth performance of broilers fed corn-soy diets supplemented with increasing levels of selenium (Se) from seleno-hydroxy-methionine (Se-OH-Met). A total of 1,500 Cobb x Cobb 500 one-day-old male broilers were distributed using a completely randomized design composed by 5 treatments and 12 replications of 25 birds each. A basal diet (0.03 ppm analyzed Se) formulated with a vitamin and mineral premix without Se was supplemented with 4 levels of the Se source (0.15, 0.30, 0.45, and 0.60 ppm). A 3-phases feeding program was used and growth performance was evaluated until 42 d. At 35 and 42 d, 5 (5) birds per pen were processed for carcass and commercial cuts yields. Growth performance data were fitted to quadratic polynomial (QP) and exponential asymptotic (EA) regressions and the maximum response of Se supplementation was estimated. Broilers fed corn-soy basal diets supplemented with increasing levels of supplemented Se from Se-OH-Met had quadratic and exponential increases on BW gain ($P < 0.05$) from 15 to 21 d, 22 to 35 d, and 1 to 42 d. Optimal Se levels from Se-OH-Met for BW gain were estimated at 0.49, 0.43 and 0.43 ppm (QP) and at 0.54, 0.48 and 0.40 (EA). The BW gain from 1 to 21 d and 1 to 35 d also increased with Se-OH-Met supplementation and optimal levels were estimated at 0.48 and 0.44 ppm with QP and at 0.58 and 0.55 ppm using EA models, respectively. Breast fillets and carcass yield at 42 d had quadratic increases with maximum responses estimated at 0.35 and 0.44 ppm, respectively. Se requirements varied according to the different variables and statistical linear regression model utilized; therefore, the origin of requirement estimation must be considered to allow adequate comparisons between references. According to statistical models utilized, it is recommended 0.40 ppm of SE-OH-Met from 1 to 42 d of age.

Key Words: broiler, mineral, performance, selenium, requirement


This experiment was carried out to evaluate the effects of the supplementation of organic and inorganic micro minerals on the performance of the males and females, egg quality, sperm quality and, hatching characteristics of laying breeder hens. The total, 144 Plymouth Rock White females and 36 Rhode Island Red males at 36 to 55 weeks of age are used. The experimental design was completely randomized, for females were used 8 replicates with 6 hens each and to males 12 replicates with 1 male each. The diets were: the treatment one consisted of a basal diet (BD) containing only inorganic mineral (10mg Cu, 60mg Fe, 70mg Mn, 75mg Zn and 0.3 mg Se per kg of diet), treatment 2 (BD + 500gMO) consisted of the same basal diet where were add 500g of organic mineral (YES – 360) per ton of diet, that is, 2.5 mg Cu, 17.5mg Fe, 20mg Mn, 27.5mg Zn and 0.08mg Se per kg of ration, and treatment 3 (BD + 800gMO) consisted of the same basal diet where where were add 800g of organic mineral per ton of diet, that is, 4mg Cu, 28mg Fe, 32mg Mn, 44mg Zn and 0.128mg Se per kg of ration. Each female treatment was submitted to weekly artificial insemination with males fed the same experimental diet. Egg production and incubation were evaluated weekly. The performance, egg quality and sperm quality analyzes were performed every 28 d and the results were expressed over a general period. Data were submitted to ANOVA and Tukey’s test. In the wk 43, 44, 45 and 49 ($P = 0.0275$, $P = 0.0065$, $P = 0.0112$ and $P = 0.0285$ respectively), the egg production was higher in treatment BD + 800mgMO than BD presenting this trend in all experimental weeks. The others performance parameters of females and quality of eggs were not affected ($P > 0.05$). The yolk index was better in eggs from hens fed with treatment BD + 800gMO than BD ($P = 0.0092$) in the total period. No effect of supplementation of organic minerals on the body weight of males and also on the motility, concentration, total abnormal spermatozooa ($P > 0.05$) in the total period was observed. The vigor of spermatozooa of males fed with treatment BD + 800gMO was higher than BD ($P = 0.0262$). Of the incubation parameters, only fertility was higher in eggs from hens fed with treatment BD + 500gMO than BD ($P = 0.0247$). In conclusion, the addition of organic minerals in the diet may be having positive effects on production on laying breeder hens. The use of organic minerals added to the diet does not alter the reproduction (incubation of eggs) and also has no effect on sperm quality except for vigor.

Key Words: trace mineral, egg production, spermatozooa, male

Poult. Sci. 97(E-Suppl. 2)

Zinc (Zn) is an essential mineral with important functions in animal metabolism as part of structural components, signaling mediators, and catalytic factors. The objective of this study was to assess the different level of zinc supplementation, as zinc sulfate, for broiler breeder hens. This study was performed at UFRGS facilities in Eldorado do Sul, RS, Brazil, in which one hundred and 20 Cobb 500 broiler breeder hens, 20 wks old, were individually placed in cages (0.33 m length x 0.46 m deep x 0.40 m height) whereas 30 Cobb breeder males were placed in 3 collective floor pens (2.0 × 1.5 m) for semen collection. The study was composed of 3 phases, each one having different diets as follow: adaptation to cages for 6 wks; depletion (deficient diet) 26 to 32 wks (deplete the hens body Zn storage) and experimental diets at 33 wks. The experimental diets were composed of 6 different Zn concentrations. Each treatment had 20 replicates of one hen each. Supplementation was done using laboratory grade Zn sulfate heptahydrate (ZnSO₄·7H₂O). The supplemented levels were 0, 30, 60, 90, 120, and 150 mg Zn/kg of feed, and Zn analyzed levels were 18.7 ± 0.47; 50.3 ± 10.6; 77.3 ± 11.0; 110.2 ± 12.8; 140 ± 12.2 and 170.6 ± 13.2 mg Zn/kg, respectively. The experimental phase was divided into 3 periods of 28d from 33 to 44 wks of age. Eggs were classified daily as hatchable or not. The percentage of total and hatchable eggs in the period was calculated for each hen. Requirements of Zn were determined using quadratic polynomial (QP), broken line quadratic (BLQ), and exponential asymptotic models (EA). There were interactions between dietary Zn and period for egg and settable egg production. Requirements obtained for hen day egg production and settable egg production were 114.1, 83.3, 78.6 ppm and 112.6, 61.4, 65.4 ppm for period of 33 to 36 wks, and 116.4, 63.3, 53.1 and 113.2, 60.4, 46.1 ppm for period of 37 to 40 wks, and 116.3, 62.8, 52.8, and 120.0, 67.7, 62.1 ppm for period of 41 to 44 wks, respectively, using QP, BLQ, and EA models. Total eggs and total settable eggs produced per hen had Zn requirements estimated as 116.4, 75.7, 64.7 ppm, and 115.2, 56.5, 41.5 ppm, respectively, for QP, BLQ and EA models, whereas for ALP were 161.8 and 124.9 ppm using QP and BLQ models. EA and BLQ models provided better fits for most measurements and estimated lower requirements. Reported requirements varied from 41.5 ppm (6.3 mg/hen/day) to 161.6 ppm (24.7 mg/hen/day) Zn. These large differences are attributed to the measured response, but also to the statistical model utilized.

Key Words: copper, egg quality, hen, micromineral, requirement


Copper (Cu) is an essential micromineral for poultry and its deficiency can lead to egg deformities. The present study was conducted to evaluate the effects of Cu supplementation on the quality of broiler breeder hen eggs. One hundred and 20 Cobb 500 broiler breeder hens, 20 weeks of age were randomly allocated into individual cages with the objective of estimating Cu requirements. After being fed a Cu deficient diet for 4 weeks, hens were fed diets graded increments of supplemental Cu (0.0; 3.5; 7.0; 10.5; 14; and 17.5 ppm) from Cu sulfate (CuSO₄·5H₂O), totaling 2.67; 5.82; 9.38; 12.92; 16.83; 20.19 ppm analyzed Cu in feeds for 20 weeks. Estimations of Cu requirements were done using exponential asymptotic (EA), broken line quadratic (BLQ), and quadratic polynomial (QP) models. Cu requirements obtained for hen day egg production and total settable eggs per hen were 6.2, 7.3, 12.9 ppm and 8.1, 9.0 and 13.4 ppm, respectively using EA, BLQ and QP models. The QP model was the only one having a fit for total eggs per hen with 13.1 ppm Cu as requirement. Maximum responses for egg weight and eggshell membrane thickness were 14.9, 12.7, 15.1 ppm, and 7.3, 7.8, 14.0 ppm Cu, respectively for EA, BLQ and QP models. In conclusion, Cu requirements vary according statistical regression model utilized and this study indicates a Cu requirement between 6.2 to 16.3 ppm (0.89 to 2.33 mg/hen/d) and the average of all Cu requirement estimates obtained in the present study was 12.5 ppm Cu.

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Key Words: chelates, copper, zinc, manganese, broiler
Response of laying hens in late lay to supplemental inorganic or proprietary chelated blends of copper, zinc, and manganese.

O. W. Ariyo*, O. O. Oluwatosin¹, A. O. Fafiolu¹, L. T. Egbe Yale¹, A. A. Ayoola¹, and M. K. Manangi², ¹Federal University of Agriculture Abeokuta, Abeokuta, Ogun State, Nigeria, ²Novus International Inc., St. Charles, MO, USA.

This study evaluated the response of layers (late lay) to supplemental inorganic or proprietary chelated blends of copper, zinc and manganese. A 77-d feeding trial was carried out using 540 (58 weeks old) Hera Black Hens. Birds were randomly allocated to 5 dietary treatment groups having 12 (9) replicates of 9 (9) birds each. The diets were made up of control (0, 0 and 0 mg/kg of Cu, Zn and Mn respectively), inorganic trace minerals (ITM) supplementation at 16, 64 and 64 mg/kg of Cu, Zn and Mn respectively, chelated trace mineral (CTM) supplementation at 16, 64 and 64 mg/kg of Cu, Zn and Mn respectively (100% CTM), CTM supplementation at 8, 32 and 32 mg/kg of Cu, Zn and Mn respectively (50% CTM) and CTM supplementation at 4, 16 and 16 mg/kg of Cu, Zn and Mn respectively (25% CTM). A total of 960 eggs were used for egg quality determination. One bird per replicate was slaughtered on d 77 of the experiment and tissue (liver and kidney) minerals (Cu, Zn and Mn) analysis were determined. Data collected were subjected to one-way Analysis of Variance with 5% significance in a Completely Randomized Design. Feed intake was improved \((P < 0.05)\) with ITM supplementation while 50% CTM and 100% CTM resulted in reduced feed intake. Trace mineral supplementation improved \((P < 0.05)\) the hen-day egg production (HDEP) with 50% CTM supplemental level recording the best \((P < 0.05)\) HDEP (86.03%). Chelated Trace mineral supplementation resulted in significant \((P < 0.05)\) feed conversion ratio. Body weight change was similar across all treatments. Supplementation of 100% CTM supplemental level improved \((P < 0.05)\) the egg weight, haugh unit, eggshell thickness, albumen weight, albumen height and yolk index. Trace mineral supplementation reduced \((P < 0.05)\) the yolk weight (up to 6.72%). Trace mineral supplementation increased \((P < 0.05)\) the concentration of Cu, Zn and Mn in liver and kidney. Crude protein digestibility was improved \((P < 0.05)\) at 100% and 50% CTM supplementation level. Trace minerals (Cu, Zn and Mn) excretion reduced in groups supplemented with CTM compared with the inorganic group. This study indicated that trace mineral supplementation improved performance and mineral concentration in organs of layers with CTM being better than ITM.

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Key Words: laying hen, late lay, mineral chelate, inorganic salt, performance
75 Enzymatic hydrolysis of fumonisins in the gastrointestinal tract of broiler chickens. B. Grenier1, H. E. Schwartz-Zimmermann1, C. Gruber-Dorninger1, and E. Vicuna1. 1Purdue University, W. Lafayette, IN, USA, 2BIOMIN Research Center, Vienna, Tulln, Austria, 3University of Natural Resources and Life Sciences, Vienna, Tulln, Austria, 4University of Georgia, Athens, GA, USA.

Some of the most frequent mycotoxins found in finished feed and feed ingredients are Fumonisins (FB). FB levels between 10 to 20 mg/kg (concentrations that can be encountered in the field and below EU and US guidelines) can deteriorate gastrointestinal tract (GIT) functions in poultry species, as reported in recent studies. Therefore, it is necessary to develop new tools to reduce the impact of FB in the GIT and immune system of poultry. In the present study, we evaluated the efficacy of fumonisin esterase FumD (EC 3.1.1.87, commercial name FUMzyme) to cleave the tricarballylic acid side chains of FB, leading to the formation of non-toxic hydrolyzed fumonisins in the GIT of broiler chickens. Broiler chickens were fed for 14 d (7 to 21 d of age) 3 different diets (6 birds/cage, 6 cages/diet), i) control feed (negative control group), ii) feed contaminated with 10 mg FB/kg (FB group), and iii) feed contaminated with 10 mg FB/kg and supplemented with 100 units of FUMzyme / kg (FB+FUMzyme group). Two biomarkers were used to determine the degree of reduction of FB. First, the sphinganine-to-sphingosine ratio in the serum and liver was determined as a marker of effect from exposure to FB. Second, the fumonisin B1 levels and its hydrolyzed forms in the gizzard, the proximal and distal parts of the small intestine, and the excreta were determined. Significantly reduced sphinganine-to-sphingosine ratios in the serum and liver of the FB+FUMzyme group (serum: 0.15 ± 0.01; liver: 0.17 ± 0.01) compared with the FB group (serum: 0.20 ± 0.01; liver: 0.29 ± 0.03) proved that supplementation of broiler feed with FUMzyme was effective in partially counteracting the toxic effect of dietary FB. Likewise, FB1 concentrations in digesta and excreta were significantly reduced in the FB+FUMzyme group compared with the FB group. FUMzyme furthermore partially counteracted FB-induced upregulation of cytokine gene expression in the jejunum. The FB group showed significantly higher gene expression of IL-8 and IL-10 compared with the negative control group, whereas IL-8 and IL-10 mRNA levels were not significantly different in the FB+FUMzyme group compared with the other 2 groups. In conclusion, FUMzyme is able to reduce the damage caused by FB in the GIT of chickens and maintain gut functions.

Key Words: fumonisin, fumonisin esterase, sphinganine, sphingosine, gut

76 Evaluation of the overall impact of antibiotics growth promoters on animal health and productivity during medication and withdrawal period. H. Hamid*, L. H. Zhao, G. Ma, W. X. Li, H. Shi, J. Zhang, C. Ji, and Q. G. Ma, China Agricultural University, State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.

The efficacy of some commonly used combination of antibiotic growth promoters (AGP) was re-evaluated during medication and withdrawal period in the broiler, through its effects on growth performance, immune organ index, gut health, and meat quality. A total of 540 one-day-old male broilers (Arbor Acre) were randomly assigned to 5 treatments, with 6 replicates of 18 chicks per replicate. Broilers received diets as follows during 0–42d: NC (control diet without AGP), EN (control diet + enduracinid 8 ppm + colistin sulphate 8 ppm), BZ (control diet + bacitracin zinc 40 ppm + colistin sulphate 8 ppm), CT (control diet + chlorotetracycline 50 ppm + colistin sulphate 8 ppm), and VG (control diet + virginiamycin 20 ppm + colistin sulphate 8 ppm). After 42d medication period, all broilers were switched to the same finisher diets without AGP. Data were analyzed by one way ANOVA and means were compared by Duncan’s multiple comparison tests, considered significantly different at P < 0.05.

Results showed that diets supplemented with antibiotics significantly decreased the feed/gain (F:G) of broilers during 1–42d (P < 0.05), but the F:G of birds in antibiotics group in withdrawal period was significantly increased (P < 0.05). There was no significant effect on duodenal digestive enzyme activity and cecal bacteria of broiler on d 42 and 49 (P > 0.05), the histomorphological study revealed increased jejunal villus height (P < 0.05) and reduced 42d crypt depth (P < 0.05) in antibiotic groups compared with control. At the end of the feeding trial, meat quality was measured. In pectoralis major evaluation, higher 24 h pH was recorded in BZ group and higher shear force was observed in EN group. Adding antibiotics cocking loss increased significantly in CT group in pectoral and thigh muscle. In summary, Antibiotics promote the growth of broiler chickens but withdrawal period resulted in reduced growth performance. So no effect was found in overall growth performance. Moreover, meat quality has also been negatively affected by the antibiotics in the diet of broilers. These findings help to persuade more farmers to choose diets without AGP in the whole period in the strictly supervised market.

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Key Words: antibiotic growth promoter, broiler, performance, gut health, meat quality

77 Nutrbiosis feeding strategies: DFM supplementation of NE-challenged birds. L. P. Barnard*, M. Bernardeau1, and S. Athanasiadou2. 1Danisco Animal Nutrition, DuPont Industrial Biosciences, Marlborough, United Kingdom, 2SRUC, Roslin Institute, Easter Bush, Midlothian, United Kingdom.

Nutrbiosis is the interaction between nutrition, the microbiome and the gut and immune function of the animal. An unfavorable nutrbiotic state can be induced by a disease challenge, such as in a necrotic enteritis outbreak. The aim of this study was to demonstrate the importance of a DFM on achieving a favorable nutrbiotic state within the gastrointestinal tract (GIT) of the broiler chicken in the presence of a disease challenge. There were 4 treatments arranged in a 2x2 factorial challenge +/− and DFM supplementation +/−. The challenge was achieved by oral gavage of a NetB producing Clostridium perfringens strain (1 × 10⁸ cfu/ml). The DFM was a commercially available 3-strain Bacillus product applied to provide 150,000 cfu/g feed (Enviva PRO; from Danisco Animal Nutrition, DuPont Industrial Biosciences). Each treatment was replicated 8 times with 10 male Ross 308 birds/ replicate; test diets were fed from d0–21. All birds received the same feed, which was based on wheat and soybean meal. DFM supplemented birds showed a significant decrease (P < 0.05) in and necrotic enteritis B-like (NetB) toxin-specific serum antibodies. DFM supplemented birds showed increased innate immunity, the levels of transcripts encoding interleukins (IL); IL1, IL12 and interferon (P < 0.01) and induced changes in transcriptional expression in intestine and bio functional analysis related with the inflammatory
response. Importantly birds supplemented with the DFM also gained significantly more weight than birds not receiving the DFM ($P < 0.05$), this is likely through modulation of the microbiome and management of the immune status of the animal. Achieving a favorable nutritriotic state enabled maximum absorption of nutrients which could be used for growth rather than excessive immune modulation. It is important to consider the effects a product has in the context of nutribiosis to optimize performance.

**Key Words:** nutribiosis, microbiome, DFM, gut and immune function, necrotic enteritis

### 78 Chitosan nanoparticles are superior to mineral oil to confer mucosal protection on inactivated vaccines against infectious bronchitis virus

P. D. Lopes$^{1,2}$, F. S. Fernando$^1$, C. H. Okino$^2$, L. F. Dalmolin$^2$, G. Schaefer$^2$, R. F. V. Lopez$^3$, M. F. S. Montassier$^2$, and H. J. Montassier$^2$, 1Animal Health Laboratory, Seara Foods, Nuporanga, São Paulo, Brazil, 2Department of Veterinary Pathology, Universidade Estadual Paulista (UNESP), Jaboticabal, São Paulo, Brazil, 3Embrapa Pecuária Sudeste, Empresa Brasileira de Pesquisa Agropecuária, São Carlos, São Paulo, Brazil, 4Department of Pharmaceutical Sciences, Universidade de Sao Paulo (USP), Ribeirão Preto, São Paulo, Brazil.

Vaccination is the most efficient way to prevent infectious bronchitis virus (IBV), which invades the respiratory mucosal surfaces. Conventional inactivated IBV vaccines are formulated with oil adjuvant and have been routinely used in chickens; however, are not efficient for inducing protection at the site of invasion of the IBV. The aim of this study was to compare the efficacy of the inactivated vaccine formulated with IBV BR-I genotype encapsulated in chitosan nanoparticles (IBV-CS) administered by the mucosal route with an inactivated vaccine of the same virus incorporated into oily adjuvant (IBV-O), administered intramuscularly. The humoral and cellular (CMI) mediated immune responses in the mucosal and local compartments induced by IBV-CS and IBV-O vaccines were evaluated in SPF chickens (Protocol Number of Animal Ethics Committee: 010140/14), when these vaccines were associated or not with a live attenuated H120 serotype vaccine. The protection induced by the different vaccine protocols was evaluated after challenge with the virulent homologous strain of BR-I genotype. For this, the levels of IgG and IgA anti-IBV antibodies in the lachrymal secretion and the expression levels of CMI genes in the trachea were evaluated. In addition, the histopathology and viral load in the trachea were evaluated after challenge. IBV-CS vaccine used alone or associated with a live attenuated vaccine induced higher levels of IgG and IgA anti-IBV antibodies in mucosal and the expression of CMI genes in trachea. The vaccine protocol using IBV-O vaccine in conjunction with the live attenuated vaccine induced IgG anti-IBV antibodies in lachrymal secretion, and upregulated expression of CMI genes in trachea. The IBV-O vaccine was unable to induce alone at mucosal compartment a robust antibody and cellular immune responses and did not confer effective protection to vaccinated chickens against the challenge. On the contrary, both vaccine protocols using IBV-CS induced effective protection for chickens against challenge, as demonstrated by the significantly lower intensity of the pathological alterations in the trachea, and this immune status can be associated with humoral and cellular immune responses induced at the primary site of IBV replication. These vaccine protocols proved to be effective against the challenge with a Brazilian variant strain of IBV.

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**Key Words:** infectious bronchitis virus, chitosan nanoparticles, mucosal adjuvant, inactivated vaccine

### 79 Broiler chickens fed with yellow mealworm: Effects on the gut health

R. T. Pereira$^1$, M. A. N. Filho$^1$, D. Suckeveris$^1$, D. B. Moretti$^1$, and A. B. S. Oliveira$^1$, D. V. Costa$^2$, and J. F. M. Menten$^1$, 1Escola Superior de Agricultura Luiz de Queiroz ESAO/USP Piracicaba, São Paulo, Brazil, 2Universidade Federal de Minas Gerais UFMG/ICA, Montes Claros, Minas Gerais, Brazil.

Chickens have natural behavior of feeding themselves from a variety of insects during their entire lifecycle. This study aimed to evaluate the functional properties of yellow mealworm on the gut of broiler chickens following voluntary intake. A total of 60 14-d-old male broiler chickens of commercial line were divided into 2 dietary treatments: a control (C) group, and a *Tenebrio molitor* meal (TM) group. Group C was fed with standard corn-soybean diet and the group TM had the choice to feed among yellow mealworm larvae, corn, extruded semi-whole soybean, supplement mixture (vitamin-mineral premix) separately. All with the same granulometry. Each group consisted of 6 replicate floor pens (5 birds/pen) assigned in a completely randomized design. Feed and water were available ad libitum. Following a preference and voluntary feed intake trial, at the d 32, samples of duodenum and ceca were collected. Lysozyme activity was determined in tissue extracts and content of duodenum homogenized in Tris/HCl Buffer. After centrifugation, the samples were mixed with *Micrococcus lysodeikticus* suspension in PBS at pH 6.0 and absorbance read in a spectrophotometer at 450 nm. The lysozyme activity (unit mL$^{-1}$) was defined as the amount of enzyme producing a decrease in absorbance. The antioxidant capacity in the duodenum tissue was assessed by the determination of superoxide dismutase (SOD). The SOD activity was measured using the tetrathionic salt to detect superoxide radicals generated by xanthine oxidase and hypoxanthine. One unit of SOD (U mg$^{-1}$) was defined as the amount of enzyme needed to exhibit 50% dismutation of the superoxide radical. The short-chain fatty acids (SCFA, acetic, butyric, isobutyric, isovaleric and valeric) in ceca were quantified by chromatography. Ceca content were homogenized in Mile-Q water and centrifuged. To the supernatant was added metaphosphoric and formic acids at 3:1. Through gas chromatography compared with a standard column, the concentration of the SCFA were determined. All data were analyzed through the SAS version 9.4. After Shapiro-Wilk analysis, Student’s $t$-test was performed at $P < 0.05$. The yellow mealworm was the most consumed ingredient accounting for 70–80% of the daily feed intake. Lysozyme and SOD activities were higher in TM group. Dietary intake of mealworm influenced the gut physiology of broiler chickens. Further investigations of the yellow mealworm functional properties are required.

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**Key Words:** insect, functional properties, gut health, voluntary intake

### 80 Effects of varietum on intestinal barrier integrity of broiler chickens

H. Xue$^1$, S. Cheng$^1$, S. Johnston$^1$, D. Wang$^1$, B. Beirão$^2$, C. Fávaro$^2$, and M. Ingberman$^2$, 1Amlan International, Chicago, IL, USA, 2Imunova Análises Biológicas, Curitiba, Paraná, Brazil.

The avian gastrointestinal tract is the first line of defense against enteric pathogen invasion. Intestinal integrity describes how well the intestinal barrier inhibits paracellular translocation of undesirable substances, such as bacterial toxins and microorganisms. The role of tight junctions in pathogenic infections has been widely demonstrated. Tight

Poult. Sci. 97(E-Suppl. 2)
juncture disruption leads to increased paracellular permeability that enables entry and spread of bacteria, toxins and metabolites. Previous studies have shown Varium binds bacterial toxins and improves broiler performance. Varium also has resulted in significantly improved necrotic enteritis-induced intestinal lesion scores (P < 0.05) and tended to reduce translocation of Clostridium perfringens-produced α- and Net-B toxins in an experimental necrotic enteritis model. Two studies were conducted to evaluate effects of Varium on intestinal barrier integrity of broilers. During Study 1, day-old Ross 224 chicks (8 pens/treatment, 7 chicks/pen) were randomly allotted to 1 of 4 treatments: 1) control; 2) challenged (CH) control; 3) CH-control + BMD (55 ppm); and 4) CH-control + Varium (0.1%). Chicks were orally challenged with ~5,000 Eimeria maxima oocysts on d 3 and 10^9 cfu of C. perfringens on d 7. On d 9, intestinal sections were scored for necrotic enteritis-induced lesions and mRNA expression of intestinal tight junction proteins was measured. Results showed chickens fed Varium had lower lesion scores (P < 0.05) than those of the CH-control group. Varium treatment also increased intestinal mRNA expression of occludin and zonula occludens-1, 2 key tight junction proteins, compared with CH-controls (P < 0.05). In Study 2, day-old Cobb broiler chicks were randomly assigned to 1 of 3 groups: 1) control; 2) Salmonella-infected control; and 3) Salmonella-infected + Varium (0.1%). Two chicks/group were tested to confirm they were negative for Salmonella. Chicks were then orally challenged with 10^8 cfu of Salmonella sv. Enteritidis on d 1. On d 4, 8, 14 and 28, intestinal permeability was assessed following oral administration of fluorescein isothiocyanate (FITC)-dextran. Results showed Salmonella infection induced increased intestinal permeability to FITC-dextran 3 d and 7 d after challenge, indicating intestinal integrity was disrupted. Compared with the Salmonella-infected control, Varium effectively prevented increased intestinal permeability on d 4 and d 8 (P < 0.05). In conclusion, Varium can preserve the structural and functional integrity of the intestinal barrier of chickens during necrotic enteritis and Salmonella sv. Enteritidis challenges.

Key Words: gut health, Clostridium perfringens, Salmonella


This study was conducted to investigate the optimum dietary level of tryptophan (Trp) supplementation at which broiler chickens have better growth with efficient immune system and antioxidant status. One hundred twenty (n = 120) 1-d-old broiler chicks were fed a common commercial diet from d 1 to 7. On d 7, the chicks were randomly divided in 3 treatment groups i.e., Trp 0.2 (NRC recommended level of tryptophan), Trp 0.3 (Tryptophan supplemented at 0.3%) and Trp 0.5 (Tryptophan supplemented at 0.5%). All the experimental diets were iso-caloric (ME, 3000 kcal/kg) and iso-protein (CP, 18.5%). On d 19, avian tuberculin was injected to note the cellular immunity. Blood serum samples were collected for analysis of humoral immune response against sheep red blood cells, total oxidant and antioxidants by spectrophotometric method. Feed intake, carcass and visceral organ weights remained unaffected by dietary treatments while BWG and FCR tended to improve (P < 0.05) in broiler chicks fed the Trp 0.3 and the Trp 0.5 diets. Total antioxidant status was also improved (P < 0.05) in broiler chicks fed the Trp 0.5 diet. Likewise, broiler chicks fed the Trp 0.3 and the Trp 0.5 diets tended to have better (P < 0.05) total antioxidant status, catalase, glutathione peroxidase, glutathione reductase and arylarlylase. The overall antibodies response and IgG improved (P < 0.05) by the Trp 0.3 diet and Trp 0.5 diets compared with control. However, IgM level remained similar across the treatment. The cellular immunity against avian tuberculin improved at 24 h post injection but its effect disappeared at 48 h. The results of present study revealed that Trp above the NRC recommended level may give better growth, immune response and antioxidant status in broiler chickens.

Key Words: broiler, tryptophan, growth performance, immune response, oxidant and antioxidant status

82 The effect of a novel Bacillus-based multi-strain probiotic on performance under sub-clinical necrotic enteritis conditions. A. B. Kehlet¹, F. Rudeaux¹, C. L. Hofacre², and M. Lang*¹, ¹Chr. Hansen A/S, Harsholm, Denmark, ²Southern Poultry Research Group, Athens, GA, USA.

The aim of this study was to determine the responses in body weight gain, feed efficiency, mortality and necrotic enteritis lesions of broilers supplemented with a new 3-strain direct fed microbial (DFM) when exposed to a mild C. perfringens (CP) challenge during a 42-d floor pen trial. A total of 1800-d-old Cobb male chicks were distributed in 36 floor pens (50 birds/pen), 4 dietary treat. (9 rep/treat): No challenge (T1), CP challenge (T2), 500 ppm DFM + CP challenge (T3), 500 ppm DFM (T4). Diets were provided by age of bird (starter, 0–14 d; grower, 15–35 d; and finisher 35–42 d). On d 0 all birds received a coccidia vaccine. On d 18 and 19, a one-hour feed and water fast was observed before infecting birds with a CP isolate by oral gavage (~10⁶ cfu/mL). Body weight, feed intake, and FCR were assessed at each feed change. Total mortality and NE mortality were documented throughout the study. On d 21 3 birds per pen were randomly selected for NE lesion score evaluation by a 0–3 scoring system, 0 being normal and 3 most severe NE lesions. Results were tested for dietary treatment effect in a Randomized Complete Block Design. If the effect was significant (P < 0.05), means were separated using Tukey’s test. At d 14 before NE challenge the DFM treated group (T3) had a significant lower FCR (1.43b) than control (T2) (1.56a) with the 2 other groups intermediate (T1 = 1.48ab and T4 = 1.49ab). Shortly post challenge the DFM group (T3 = 1.65ab) appears to recover more quickly than the challenged control (T2 = 1.70a) with a FCR closer to the none-challenged groups (T1 = 1.63ab and T4 = 1.60b). At d 42 T4 (DFM, no challenge) continued to have the lowest FCR (1.71b) whereas T3 (DFM w. challenge) had the same FCR as T1 (none challenged control) (1.75a) and T2 (challenged control) had the highest (1.78a). There was no statistical difference in body weight at any of the measuring periods. Total mortality at d 42 was significantly higher in the challenged groups (T2 = 12.22a and T3 = 14.67a) compared with the none challenged groups (T1 = 4.44b and T4 = 3.78b). NE mortality was also higher in the challenged groups (T1 = 0.22b, T2 = 6.22a, T3 = 9.33a, T4 = 0.22b). Despite the numerically higher NE mortality T3 had a numerically lower NE lesion score (0.63a) compared with T2 (0.85a) whereas the none challenged groups both had a lesion score of 0. The findings in this study indicate that birds exposed to a sub-clinical NE infection can faster recover when supplemented with a direct fed microbial compared with none-supplemented birds.

Key Words: probiotic, necrotic enteritis, broiler, Bacillus, C. perfringens

83 Influence of different Clostridium perfringens and Eimeria maxima isolates on necrotic enteritis. K. Chasser¹, K. Wilson¹, W. Briggs¹, A. Duff¹, J.-D. Latorre², B. Hargis², J. Barta³, and L. Bielke*¹, ¹Ohio State University, Columbus, OH, USA, ²University of California, Davis, CA, USA, ³Texas A&M University, College Station, TX, USA.
Necrotic enteritis (NE), caused by *Clostridium perfringens* (CP), in broilers is often associated with a concurrent infection of *Eimeria maxima* (EM). However, breakouts of this disease have been reported to occur independent of EM, and to be related to CP strains that produce NE toxin B (NetB). Presently, multiple methods of inducing NE in broilers were compared with evaluate the role of various toxins in development of clinical disease. Six CP strains were evaluated by PCR for toxin associated genes, including α-toxin and NetB, followed by inclusion of some strains, NetB + and NetB -, for 2 in vivo experiments. Experiment 1 treatments consisted of non-challenged control (NC), EM + non-NetB CP (EMCP), non-NetB CP (nonNetB), NetB strain CP 1 (NetB1), NetB strain CP 2 (NetB2) or NetB strain CP 3 (NetB3). All groups, except NC, were challenged with 10^4 cfu of *Salmonella* Enteritidis on day of hatch. On d16, EMCP birds were weighed and challenged with 2x10^4 EM oocysts. On d20–22, nonNetB and NetB1–3 groups were challenged with 50mL of 10^5 to 10^6 cfu/mL CP directly onto the feed once daily, all birds were weighed d22. On d17, EMCP birds were challenged with 10^6 cfu CP via oral gavage. On d22, all birds were weighed for body weight gain (BWG) and lesion scores (LS). BWG was analyzed by ANOVA and lesion scores by Proc Mixed procedure, ANOVA. At D22, % change in BWG was significantly different (P < 0.05) between NC, EM, and EMCP, but not NetB1–3 treatments. Lesion scores were significantly higher (P < 0.05) than NC for only EMCP, with all others statistically similar to NC. The second experiment tested an increased dose of NetB1 CP, 1 L of 10^6 cfu/mL 2X/d on d17–20, against NC, nonNetB, and EMCP. By d22, EMCP had the greatest decrease (P < 0.05) in BWG and was lower than both NC and NetB1. NetB1 also had decreased BWG compared with NC (P < 0.05), but not EMCP. Lesion scores reflected BWG results. Through d57, EMCP had the greatest influence on BWG, while in all other groups BW after NE challenge was no different than NC within 2 wk. These studies suggest that Net-B positive strains of CP induce dysbiosis, when administered in extremely high doses over a prolonged period, and that predisposing factors, such as *Salmonella* and EM play an important role in the pathogenesis of NE in nonNetB strains.

Key Words: necrotic enteritis, *Clostridium perfringens*, Net B, *Eimeria maxima*, lesion scores

84 Use of chestnut and quebracho tannins to control *Clostridium perfringens* induced necrotic enteritis in poultry.

L. Redondo1,2, E. Redondo1,2, J. Díaz-Carrasco1,2, S. Perez-Aguirreburuialde2, O. Bruzzzone2,3, C. Cabral4, and M. Fernandez-Miyakawa1,2, 1Instituto de Patobiología, INTA - CICVya, Hurlingham, Buenos Aires, Argentina, 2Consejo Nacional de Investigaciones Científicas y Técnicas, Ciudad Autónoma de Buenos Aires, Argentina, 3EEA Bariloche; INTA, Bariloche, Río Negro, Argentina, 4Silvateam, Ciudad Autónoma de Buenos Aires, Argentina.

Necrotic enteritis in poultry is mainly caused by *C. perfringens*. Traditionally, this disease has been controlled by antibiotics in feed as growth-promoting factors (AGP). In the last years, the use of GPF was banned and antibiotics should be evaluated. Tannins from different sources have antibacterial or antitoxic activity and they are able to prevent the development of clostridial enteric diseases when added to feed. The aim of this study was to determine the effect of the addition of tannins to assess whether they can be used to control the development of enteric diseases under experimental and commercial conditions. For the experimental trial, we used a model of *C. perfringens* necrotic enteritis in broiler chickens. Three days before the challenge, birds were fed with regular feed supplemented with condensed tannins from quebracho (*Schinopsis lorentzii*), hydrolysable from chestnut (*Castanea sativa*) and a blend of both. Animals were challenged at 14 after birth and euthanized at d 19 and 30. Presence and severity of lesions was recorded using a score ranging from 0 to 5 (0: no lesions; 5: massive necrosis). The commercial trial was carried out in commercial farms from Argentina. In each trial chickens from treated farms were provided commercial feed added with a blend of tannins (NP) while in control farms chickens only received regular feed (COM). Different parameters were analyzed including mortality, weight gain and presence of undigested feed in feces. Animals randomly selected from 1 house of each farm were necropsied, intestinal gross lesions were scored as described before and histomorphometry was done in different sections of small intestine. In the experimental trial, only the blend group shows a significant reduction in gross lesions in jejunum (38.5%, P < 0.05) and ileum (7.7%, P < 0.05), compared with the control (J:57.1%; I:48.5%), no significant differences were observed in the quebracho and chestnut group, although in this last one no lesions were observed in ileum. Lesion score was reduced only in the blend group (P < 0.05). In the commercial trial, the number of animals with gross duodenal lesions were not statistically different between treatments. Significant differences (P < 0.05) were observed in number of animals with jejunal lesions (COM: 18.8%; NP: 12.2%) and ileal lesions (COM: 6.6%; NP: 3.3%). Intestinal morphology was improved, as NP treated birds show a higher villus height/ crypt depth ratio (P < 0.05). These results demonstrate that addition of tannins in the diet of poultry is a promising alternative to AGP and can be used to control necrotic enteritis in chickens by reducing clinical signs and impact on production parameters.

Key Words: tannins, poultry, production, enteritis, *C. perfringens*

85 Evaluation of the intestinal health of broilers chickens challenged with *Clostridium perfringens* and treated with Herbanoplex and/or *Lactobacillus* spp. M. F. M. Costa1, M. Souza1, L. Justino1, A. Oba2, F. Matté3, F. L. Gazoni3, F. Chiarelli3, R. K. T. Kobayashi4, G. Nakazato5, and A. A. S. Baptista1, 1Department of Preventive Veterinary Medicine, Laboratory of Avian Medicine, State University of Londrina, Londrina, Paraná, Brazil, 2Department of Zootechny, CCA, State University of Londrina, Londrina, Paraná, Brazil, 3Vetanco Company, Chapécó, Santa Catarina, Brazil, 4Department of Microbiology, CCB, State University of Londrina, Londrina, Paraná, Brazil.

The present study was conducted to evaluate the profile intestinal health of broilers chickens challenged with *Clostridium perfringens* (CP) and treated with Herbanoplex and/or *Lactobacillus* spp. Fifty 1-d-old male broilers (Ross) were placed in 5 different groups. We adopted a completely randomized design, consisting of 5 groups: T1-negative control; T2-positive control - challenged with CP; T3-birds that received Herbanoplex and were challenged with CP; T4-birds that received *Lactobacillus* spp. and were challenged with CP; T5-birds that received *Lactobacillus* spp. and Herbanoplex and were challenged with CP. Birds were fed wheat-based diet since the seventh days old (do). The Herbanoplex additive was added in the diet 1 kg / ton from the 1st do in the T3 and T5 groups. At 10th do the T4 and T5 birds received *Lactobacillus* spp. (10^6 cfu/ml) via oral gavage for 3 consecutive days. The challenged birds at 12th do received a coccidiosis vaccine, 10x the dose, via oral gavage, and vaccine against the infectious bursal disease (10x dose). Between 15th and 19th do the birds were challenged via oral gavage with CP type A, netB (10^6 cfu / mL). At 20th, 21st and 23rd do were performed the euthanasia by cervical dislocation and intestine were analyzed to determine the profile of macroscopic intestinal lesion.
The lesions observed were classified as: (0) normal; (1) mild - small intestinal wall is thin and flaccid with thickened mucus covering mucus membrane; (2) minor necrotic enteritis: 1 to 6 necrotic enteritis pocks; (3) moderate - necrotic enteritis pocks: more than 6 necrotic enteritis pocks; (4) severe- extensive areas of necrosis and ulceration of the small intestinal membrane, significant layer of fibrin and necrotic debris on the mucus membrane. Data were submitted to ANOVA and analyzed through the Scott-Knott test at 5% probability. The lesions observed from the different treatments ranged from 1 to moderate 3. It was observed the following lesions scores in the guts of the chickens under the different treatments: 1.45 (T1), 2.25 (T2), 1.65 (T3), 2.2 (T4) and 1.5 (T5). There was a significant difference ($P < 0.05$) between T1, T3, T5 and T2 and there was no significant difference between T4 and T2. In this study it was possible to demonstrate the broilers that received the Herbanoplex additive associated with *Lactobacillus* spp. were able to reduce the intestinal lesions caused by *Clostridium perfringens*.

**Key Words:** *Clostridium perfringens*, Herbanoplex, intestinal lesions, *Lactobacillus* spp., necrotic enteritis

### 86 Egg quality of commercial laying hens not vaccinated or vaccinated with a *Mycoplasma synoviae* strain

M. Kuhn*1, C. Stefanello1, D. P. Rosa1, J. da Silva1, E. Carvalho2, F. Silva3, and F. B. Flores4, 1Federal University of Santa Maria, Santa Maria, RS, Brazil, 2Boehringer Ingelheim Animal Health Brazil, Lajeado, RS, Brazil, 3Naturovos, Salvador do Sul, RS, Brazil, 4Bionutri, Ipê, RS, Brazil.

A study was conducted to evaluate the effects of vaccination against *Mycoplasma synoviae* on egg and eggshell quality of commercial laying hens. A total of 360 eggs from Bovans White laying hens were randomly collected in 2 commercial poultry houses and quality was evaluated. Each poultry house had 80,000 hens fed a common mash diet, the same management and facilities. Hens were allocated in metallic cages and egg quality was evaluated in 3 periods of 28 d from 35 to 46 weeks. Treatments were considered the laying hens positively diagnosed with *Mycoplasma synoviae* without vaccination or laying hens vaccinated at 5 weeks against *Mycoplasma synoviae* (Micovax MS-H) according to the commercial product recommendation, being negatively tested for this disease. Sixty eggs from each treatment were randomly collected in the last week of each period and eggshell quality was analyzed. Data were analyzed using the GLM procedures of SAS Institute and Test $t$ was used to compare means ($P < 0.001$). At 38 and 42 weeks, laying hens vaccinated against *Mycoplasma synoviae* had higher ($P < 0.0001$) produced eggs weight, albumen and shell weight, Haugh unit, specific weight as well as higher shell thickness ($P < 0.0001$) compared with birds that were not vaccinated. In the third period, Haugh unit, yolk index of eggs were higher ($P < 0.0001$) in hens vaccinated against *Mycoplasma synoviae* compared with birds not vaccinated. Shell thickness and shell strength were also higher ($P < 0.0001$) when hens were vaccinated. Finally, in the present study data from all evaluated periods showed that vaccination was able to prevent losses in egg quality providing improvements on egg, albumen and shell weights as well as the shell strength was increased or guaranteed when hens were diagnosed as negative for *Mycoplasma synoviae*. In conclusion, laying hens in a commercial poultry house vaccinated against *Mycoplasma synoviae* and diagnosed as negative for this disease had higher parameters of egg and eggshell quality. This knowledge can be useful to help the poultry industry and prevent egg losses.

**Key Words:** eggshell, egg quality, hen, mycoplasma

### 87 Effect of in ovo lactic acid bacteria and gram-negative bacterial inoculation on the intestinal microbiota of chicks

D. Rodrigues*, K. Wilson, W. Briggs, A. Duff, K. Chasser, and L. Bielke, Department of Animal Science, The Ohio State University, OARDC, Wooster, OH, USA.

Initial intestinal microbial colonization is thought to have a major influence on early animal health. Commercial hatchery practices may delay appropriate colonization of the gastrointestinal tract (GIT), because neonatal chicks are primarily exposed to bacteria within a hatchery, rather than chicken-specific microbiota, until on-farm placement. Recent studies of gut microbial establishment suggest that initial inoculation and colonization of chicken GIT microbiota can have a major influence on performance and health of birds. However, the impact of different types of pioneer colonizers on the development of the microbiome community and GIT are not well-studied, especially direct comparison of gram-negative and lactic acid producing (LAB) strains. The objective of this study was to compare impact of 2 apathogenic gram-negative chicken isolates or LAB as pioneer colonizers on the microbial community immediately post-hatch (DOH) and evaluate the treatments influence through 10d of age on different sections of the GIT. At ED18, embryos were inoculated with either saline (S), or ~102 cfu of *Citrobacter freundii* (C), *Citrobacter sp* (C2) or LAB (L) in the amnion. DOH whole GIT, plus ileum and ceca at 10d were collected from microbiome analysis. Once the DNA was isolated from mucosal and digesta contents, samples underwent 2 × 300 paired-end Illumina MiSeq preparation, targeting the V4-V5 region of the 16S rRNA gene for microbiome analysis. An increased abundance of Lactobacillaceae ($P < 0.05$) and Lactobacillus genus were observed in the L group at DOH (41.74% vs 10.38% C; 6.78% C2; 15.82% S; $P < 0.05$), while the abundance of Enterococcaceae and Enterococcus were numerically decreased. While Enterobacteriaceae was the dominant family in C group at DOH (57.15% vs 37.10% C2; 27.89% L; 29.95% S; $P < 0.05$), by 10d, Enterobacteriaceae populations decreased (0.01% ileum and 8.15% in ceca) and was negatively correlated with age in the upper ileum ($r = -0.36$ and ceca ($r = -0.45$). While at 10d there was no difference in Lactobacillus populations, an evident increase in ideal, Clostridiae, Blautia and Candidatus Savagella genus ($P < 0.05$) only occurred in the L group. Minimal changes in the composition occurred in the ceca as only Streptococcus was higher in S and C2 group. This suggests that different isolates in ovo can have a strong impact on pioneer colonizers of the provided isolate by DOH, and also affect the host intestinal environment, where providing a LAB may increase colonization of desirable bacterial groups in the ileum by 10 d of age.

**Key Words:** Candidatus Savagella, microbiome, pioneer colonizers

### 88 Field variants of avian reoviruses are associated to tenosynovitis and carcass condemnation in poultry flocks from Brazil

S. De Carlí*1,2, S. O. de Souza2, T. Gräf2, F. K. M. Lehmann1, N. Ikuta1, D. Driemeier2, C. W. Canál2, and V. R. Lunge1, 1Laboratório de Diagnóstico Molecular; Universidade Luterana do Brazil (ULBRA), Canoas, Rio Grande do Sul, Brazil, 2Faculdade de Medicina Veterinária, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, Rio Grande do Sul, Brazil.

Avian reoviruses (ARVs) can infect birds of different species worldwide. Chicken can present stunting syndrome, respiratory and/or enteric diseases, immunosuppression, malabsorption, tenosynovitis and even secondary infections by other microorganisms. Flaws in conventional vaccines and the increase in the diagnostic rate of these diseases in the last 5 years suggest the emergence of pathogenic ARVs in the poultry flocks worldwide. This study aimed to detect ARVs and to perform a
phylogenetic analysis of circulating lineages in Brazilian poultry flocks associated to tenosynovitis and carcass condemnation. The methodology included an initial evaluation of the carcass condemnation index by lesions in the pelvic limb in a specific slaughterhouse. Five samples of lesioned organs of broiler chickens were collected, visually inspected and submitted to histological analysis. In addition, 12 ARVs isolated from Brazilian poultry flocks in cell cultures were obtained from the same poultry producing company. All samples were submitted to ARV RNA detection with a RT-PCR based on M segment and genotyped by sequencing Co gene. In addition, a phylogenetic analysis compared the Brazilian sequences with all dated Co gene sequences (n = 521) from the 6 different world lineages published in the GenBank. The results demonstrated lesions in pelvic limbs of condemned carcasses from 5 to 60% (according to the flock) in the overall slaughtered chickens. The histological exam showed the occurrence of major gross pathologic lesions including marked swelling, edema and hemorrhages. The 5 pelvic limb samples and the 12 ARV isolates presented positive result in RT-PCR, were genotyped and included in the phylogenetic analysis. The 5 samples of the pelvic limb lesions clustered together with an ARV isolate in a specific branch of the lineage II, while another one grouped with 4 more Brazilian ARV isolates in a separate branch close to lineage V. The remaining 8 isolates clustered in a specific branch into the lineage I (the group of the main vaccine strains S1133, 2408 and 1733). These results suggest that the ARVs associated to pelvic limb lesions are field ARV variants, with genetic and consequently antigenic differences from previously characterized ARVs, mainly the vaccine strains (from lineage I). Furthermore, these circulating ARVs were definitely associated to tenosynovitis and carcass condemnation in commercial Brazilian poultry flocks.

Key Words: RT-PCR, RNA, tenosynovitis, sigma C

90 Probiotic, symbiotic and essential oil effects on the necrotic enteritis lesion score in broiler chickens.

Necrotic enteritis (NE) is a costly disease for the poultry industry, as a result of growth delay and bird death. The aim of the study was to compare the intestinal lesion score caused by Clostridium perfringens (CP) in broilers chickens fed different commercials additives. One day male broiler chickens (120) were housed in experimental cages at the Londrina State University - UEL. The animals received ad libitum water and feed. The chickens were divided into 6 groups and received specific feed according to the treatments: T1 - Negative control of unchallenged birds; T2 - Positive control of birds challenged with CP; T3 - Digestaran [100g/ton] + challenge with CP; T4 - Poultrystar [1kg/ton] + challenge with CP; T5 - Digestaran [200g/ton] + challenge with CP; T6 - Poultrystar [1kg/ton] + Digestaran [100g/ton] + challenge with CP. The experimental diet was based on maize and soybean until 5 d of age (DA), followed by a diet based on wheat bran (62.75%) and soybean bran (29.6%). The additives (Poultrystar and Digestaran) were added to the diet and provided to the birds since the first DA. At 12 DA the broilers were challenged, by gavage, with vaccine Eimeria spp. oocysts. At 14 DA they received, by gavage, Bursal infection disease vaccine 10X the recommended manufacturer dose. Between 15 and 21 DA the broiler chickens were challenged, by gavage, with CP (10⁷ CFU/mL). At 23 DA, the broilers were euthanized to determine the macroscopic lesion profile. The lesion score followed a methodology described in the literature, with modifications (0 – normal intestine; 1 – mild; 2 – minor necrotic enteritis; 3 – moderate necrotic enteritis pocks; 4 – severe). The lesion scores observed in the treatments were: T1 – 1.2; T2 – 2.80; T3 – 1.65; T4 – 1.50; T5 – 1.55; T6 – 1.65. Birds belonging to negative control (T1) presented lesions with mean score of 1.2. These findings can be explained by the provided diet characteristics, which may have contributed to the development of dysbacteriosis. A decrease in the lesion score of groups T3; T4; T5 and T6 was observed, differing significantly (P < 0.05) from the positive control. The treatments provided an improvement in intestinal health, regardless of the product used (symbiotic or essential oils). All treatments exhibited at least a mild lesion score. The applied products demonstrated effects broiler chicken intestinal health by minimizing the lesion score.

Key Words: chicken, intestinal health, necrotic enteritis, probiotics, essential oils
started to show mild to moderate respiratory signs that were consistent with ILT, and lab diagnostic tests confirmed an ILT infection. Control measures were taken for the birds in that particular house, while the rest were under strict observation, while no other measure were undertaken. At the end of the grow-out period at 56 d of age, clinical signs in the affected house had subsided, while in the rest of the farm no signs were detected, even though lab test confirmed the exposure to an ILT virus in those birds, and although the production parameters in the affected house were not satisfactory, the entire flock ended within the expected results for the broiler company. After intense scrutiny it was concluded that some of the birds placed in the affected house had been vaccinated improperly, while the rest were adequately immunized. The overall conclusions were that it is imperative to verify that this kind of vaccine has to be properly reconstituted and applied, and that by accomplishing this, the vaccinated birds can withstand an intense field virus exposure.

Key Words: broiler, ILT, recombinant vaccine
45  

**Animal Well-Being and Behavior**

92  
**Locomotor bone biomechanics of broiler chickens raised in presence and absence of environmental enrichment.** A. C. Nazaréno*1, I. J. O. da Silva1, L. O. Pradella1, M. Machado1, S. L. de Castro Junior1, J. C. Tometti2, and G. D. Guesne1.  
1Universidade de São Paulo, Escola Superior de Agricultura, Piracicaba, SP, Brazil; 2Universidade Anhembi Morumbi, São Paulo, SP, Brazil.

A low complexity system for raising broiler chickens may favor the appearance of bone deformities and locomotor fractures, compromising the welfare of these birds. Therefore, the aim of this study was to analyze the bone biomechanics of the locomotor system of broilers raised in environments with and without environmental enrichment. The research was developed at the University of Sao Paulo, in the city of Piracicaba, Brazil. Fifty-six animals were used for each environment, resulting in 112 Cobb broilers, which were raised in climatic chamber with and without environmental enrichment (ladder with perch), the microclimatic conditions were controlled according to the thermal comfort ranges of the birds during their life cycle. After the euthanasia of all birds, femurs and tibias (right and left) were dissected. The experimental design was completely randomized with subdivided plots, where the environments (presence or absence of environmental enrichment) were allocated to the parcels and the ages (0, 7, 14, 21, 28, 35, and 42 d) to the subplots, thus, resulting in 8 replicates (birds). Bone biomechanics was evaluated through mass (g), length (mm) and maximum flexural strength (N) of tibia and femur bones, using a caliper and digital scale, and the universal machine for mechanical tests coupled to a computer. There was significant difference for the mass and maximum flexural strength of femurs ($P < 0.0423$ and $P < 0.0094$) and tibia ($P < 0.0012$ and $P < 0.0251$) bones of broiler chickens. Therefore, the presence of environmental enrichment lead to higher mean values of mass and maximum flexural strength for femurs (5.98 g and 168.95 N) and tibia (8.33 g and 144.94 N), when compared with the absence of environmental enrichment that showed lower mean values for femurs (5.71 g and 157.77 N) and tibia (7.76 g and 134.51 N). There was not significant difference for the length of femurs and tibias of the birds. According to the results it may be said that the presence of environmental enrichment promoted a better bone development of femur and tibia in broilers. We concluded that the use of environmental enrichment for broiler chickens provided better averages values for the biomechanical properties of their locomotive systems.

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**Key Words:** femur, tibia, bone strength, mechanical tests, poultry

93  
**Enthalpy comfort index in broiler rearing environments with different reuses of poultry litter.** D. L. Migotto*1, J. H. Stringhini2, A. M. C. Racanici2, and V. Machado dos Santos1.  
1University of Goiás, Goiania, Goiás, Brazil; 2University of Brasília, Brasília, Distrito Federal, Brazil.

The enthalpy comfort index (ECI) indicates the environmental condition in relation to the heat stress condition by the animal, and the thermal comfort decreases as the ECI increases. The aim of this research was to evaluate the broiler barn microclimate using ECI, considering averages of temperature and relative humidity collected and local average of barometric pressure. We hypothesized that ECI increases as increasing poultry litter reuses reducing broiler chicken welfare, during the rearing period. The experiment was carried out at commercial broiler farm (Goiás-Brazil). Three broiler barns (negative-pressure tunnel), measuring 1,680m2 and 23,000 birds/barn, were used in this experiment. The sets consist of amount of reuse of the poultry litter (L1 – poultry litter with 3 flocks of reuse and L2 – 6 flocks of reuse). The material used as litter was rice hulls. Data collection started at 7 d of age, totaling 42 d. During 35 d were 12 daily collections per environment were performed using a digital thermo hygrometer at 3 different points of the barn, as follows schedules: 07:00, 10:00, 14:00 and 19:00h. ECI equation considers 3 environment variables: temperature, relative humidity and local barometric pressure (average for Brasília ~ 890mmHG). The data were analyzed in a factorial scheme 2 (poultry litter reuses) x 4 (schedules), totaling 8 treatments with 18 replicates, using Proc GLM (SAS Studio, USA) to compare the means by Tukey test (5% of significance level). No interaction ($P > 0.05$) were observed between poultry litter reuse and schedules for ECI, temperature and relative humidity. ECI was affected by poultry litter reuse ($P = 0.0002; CV = 11.07%$) and schedule factors ($P < 0.0001; CV = 11.07%$). For the barn with 6 flocks of reuse (L2), the IEC observed was of 46.73 ± 5.43. This average was similar than L1 45.47 ± 5.02 (3 reuses). For both barns, ECI were classified as “comfort zone.” For schedules, IEC observed in decreasing order was 48.16 ± 4.26 (A) at 14:00; 47.47 ± 5.22 (AB) at 10:00; 46.01 ± 5.25 at 19:00 (B) and 44.44 ± 5.03 (C) at 07:00. During these times, it was also observed highest burn temperature, 26.77 ± 2.91°C and 28.02 ± 2.21°C, respectively. ECI did not differ between different reuse of litter. This result means that reuse of poultry litter is safe in regard broiler chicken comfort.

**Acknowledgements:** Federal District research support foundation - FAP/DF

**Key Words:** welfare, enthalpy, thermal comfort, ambience, thermal amplitude

94  
**The female inseminated status and their box-mate sex influences egg laying strategy in Japanese quail.** S. Pellegrini, M. A. Asis-Rodriguez, M. C. Labaque*, R. H. Marin, and D. A. Guzman, Instituto de Investigaciones Biológicas y Tecnológicas (IByT; CONICET-UNC) and Instituto de Ciencia y Tecnología de los Alimentos (ICTA), Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Córdoba, Argentina.

In birds, nesting site selection is usually governed by the need of a suitable support and adequate protection to the eggs. The number of eggs laid is often considered to be an indicator that the nest site is perceived as attractive by hens. Many precocial species can search for more than one place to lay their eggs (i.e, nesting parasites, where egg spreading can markedly reduce time at risk in the nest for the parasite offspring). This study evaluated whether female distinct potential to lay fertile eggs, for being previously exposed to short visits of either males or females, modulate the use of space and the selection of a nest site when housed with either a male or a female unknown box-mate. A $2 \times 2$ factorial experimental design was used giving 4 treatment combinations: Visited by males-Housed with a male (9), Visited by males-Housed with a female (9), Visited by females-Housed with a male (9), Visited by females-Housed with a female (9). A complete sequence of mating behavior (including natural insemination) was observed in all cases females were visited by a male. Testing boxes were divided in 2 sectors. While the unknown box-mate birds were restricted to only one sector (Box-mate sector) by fitting them with a physical barrier device,
The experimental females were able to freely ambulated between the empty and box-mate sector. The test started with the experimental female placed in the empty sector and lasted 7 d. Total number of eggs laid, sector selected for laying and total time spent in each sector were evaluated using GLM mixed model analyses. All groups of experimental females laid between 5 and 6 eggs ($P = 0.99$). While females that were visited by males and then housed with a female-mate laid similarly in the empty and the female-mate sector, females visited by females that were either housed with a male- or a female-mate, and females visited by males and housed with a male-mate, laid more than 75% of their eggs in the box-mate sector ($P < 0.0001$). All experimental females spent more time in the box-mate sector than in the empty one ($P = 0.01$). Results suggest that female Japanese quails modify their laying strategy according to their inseminated status (potential to lay fertile eggs) and the sex of their box-mate. The observed strategies are discussed considering a defense search mechanism when paired with a male box-mate, and nesting parasite occurrence or indirect intraspecific female competition when females (respectively inseminated or not) are paired with a female box-mate conspecific.

**Key Words:** Japanese quail, egg, nesting parasite, laying preference, female reproductive status

95 The effect of maternal care on embryonic development and behavioral traits of broiler chicks. S. Abdulateef*, Z. Al-Dhanki†, and S. Samal‡, †Agriculture College, University of Anbar, Ramadi, Anbar, Iraq, ‡College of Sciences Agriculture, University of Sulaimani, Kurdistan Region, Iraq.

The study aimed to find out the effect of sound especially hen call to development of chicks and improving and made it able to avoid the stress during hatching. A total of 240 fertilized egg (Ross 308) were distributed in 4 treatments, T1 = first treatment control treatment without hearing any sound, T2 = second treatment hearing the hen call, T3 = treatment third hearing chicks hatched call and T4 = treatment fourth hearing chick with hen call, each treatment divided into 3 replicates and each replicate were composed by 20 eggs. All the eggs were submitted to the sounds from 16 d of incubation until the day of hatching, and the sounds were offered in a period of 15 min per hour for 24 h. The sound volume varied from 20 to 30 dB and the speakers were installed inside the incubators. The sounds were heard at the same time, the embryonic tests were conducted in 7, 14 and 17 d of hatching according to (Orlov, 1987), the embryo index was carried out in end of hatching according to (Dhinakar et al., 2004). The results showed significant ($P \leq 0.01$) improvement in embryonic development traits: Embryonic weight, Amniotic weight +fluid, Allantoic weight + fluid, Albumin weight, Yolk weight and Shell weight for all experimental treatments in embryonic test second and third compared with the control treatment, significantly ($P \leq 0.01$) improvement in the embryo index was observed for all experimental treatments compared with control treatment. Concluded, the hen call will be developing of chicks and be improving and made it able to avoid the stress during hatching, through Improve the characteristics of the embryo and supply it with the necessary energy for hatching.

**Acknowledgements:** The authors are grateful for the assistance we received for this project from the manager the field of Animal Production, Dean of college and head of the Department of Animal Production - College of Agriculture – University of Anbar and University of Sulaimani – Iraq

**Key Words:** maternal care, embryonic development, behavioral trait, broiler chick
The objective of the present study was to evaluate the effects of chronic thermal stress (HS) and supplementation of DL-methionyl-methionine (DL-MMet) on oxidative stress markers and on expression levels of heat shock proteins HSP70 and HSP90, glutathione peroxidase (GPx), superoxide dismutase (SOD), tumor necrosis factor (TNF-α) and interleukin 1 (IL-1) in broilers at 42 d of age. Three hundred fifty 21-d-old broilers (Cobb 500) were divided into 3 groups related to methionine supplementation: without methionine (SM); methionine supplementation (DL-MET); and methionine dipeptide supplementation (DL-MMET). The broilers were kept in 2 environments: thermal comfort and chronic thermal stress (30°C for 20 d). At 42 d of age spleen samples were collected for expression analysis of HSP70, HSP90, GPx, SOD, TNF-α and IL-1. The objective of this work was to evaluate the supplementation of DL-Methionyl-methionine (DL-MMet) on oxidative stress markers and on expression levels of heat shock proteins (HSP). The expression of HSP70, HSP90, GPx, SOD, TNF-α and IL-1 were analyzed by real-time qRT-PCR. The expression levels of HSP70, HSP90, GPx, SOD, TNF-α and IL-1 were significantly higher in broilers kept in chronic thermal stress conditions compared to broilers kept in thermal comfort conditions. The expression of HSP70 and HSP90 was significantly higher in broilers fed the DL-MMet diet compared to broilers fed the SM and DL-Met diets. The lowest TNF-α expression was observed in the birds under thermal stress conditions. We also observed an interaction effect on ALT activity (P = 0.0118), AST (P = 0.0130) and CK (P < 0.0001). Under conditions of chronic stress, birds fed the DL-MMet diet had higher ALT and AST activity and lower CK activity than birds in thermal comfort. Caloric stress reduced feed intake and significantly induced spleen involution. From these results we can conclude that under challenge conditions methionine independently of the form can alleviate the effects of chronic thermal stress, aiding the systems of cellular defenses.

Acknowledgements: UEM and CNPq

Key Words: antioxidant, broiler chicken, heat shock protein, immune system, oxidative stress

97 DL-methionine dipeptide supplementation on intestinal development and expression of amino acid transporters in jejunum of broilers subjected to thermal stress at 21 days old. I. N. Kaneko, A. de Souza Khattab, M. C. Nascimento, R. A. Basaglia, E. Gasparino, and T. C. Santos*, State University of Maringá, Maringá, Paraná, Brazil.

The objective of this study was to evaluate the supplementation of DL-Methionine (DL-Met) and DL-Methionyl-DL-Methionine (Met-Met) on intestinal morphology and in the gene expression of amino acid transporters in the jejunum of broilers submitted to heat stress at 21 d-old. A total of 216 male Cobb-Vantress chicks were distributed in a 3 × 3 factorial scheme, consisting of 3 diets (basal diet - without methionine supplementation, DL-Met supplemented and Met-Met supplemented) and 3 heat stress periods (no stress and after 24 and 48 h at 32°C). Intestinal fragments of jejunum (n = 6/treatment) were collected in buffered paraformaldehyde and processed in histological routine, to measure the height and width of villi and crypt depth. Another portion of jejunum was frozen in liquid nitrogen for extraction of total RNA and determination of the expression of B0AT1 and PepT1 (brush border) and Y+LAT1 (basolateral membrane) amino acids transporters. Data were analyzed by ANOVA and the averages were compared using the Tukey test in statistical program SAS Institute Inc. (2011), with a 5% level of significance, to describe the effects of diets, periods of heat stress and the interaction between them. When evaluating intestinal morphology, there was interaction between stress periods and diets for villus height and width and jejunal crypt depth. Since the highest villus height was for birds consuming basal diet after 24 h of stress, villus width was higher for birds that received basal diet without heat stress. The crypt depth was superior for all birds in the period without heat stress and for the birds that received basal diet at 24 h of stress. There was interaction between diet and stress period for the expression of Y+LAT1 and B0AT1, with higher expression of B0AT1 after 48 h of stress in the birds submitted to Met-Met diet and higher expression of B0AT1 in all diets after 48 h heat stress. For PepT1, there was an isolated effect of the stress period, presenting greater expression after 48 h. The results of intestinal morphology demonstrate the importance of methionine supplementation in the diet of broilers from 1 to 21 d and the negative effects caused by thermal stress. While the gene expression of amino acid transporters, can suggest that the primary pathway of methionine absorption is through the free amino acid transporters.

Acknowledgements: CNPq

Key Words: intestine, enterocyte, PepT1, B0AT1, Y+LAT1

98 Expression of apoptotic genes and antioxidants in broiler chickens fed methionine dipeptide (DL-methionyl-methionine). K. Moreira1, A. P. Del Vesco2, T. C. Elzebio1, A. R. O. Neto3, and E. Gasparino1*, State University of Maringá, Maringá, Paraná, Brazil, 2Federal University of Sergipe, Aracaju, Sergipe, Brazil, 3Evonik Brazil, São Paulo, São Paulo, Brazil.

DL-Methionyl-methionine (DL-MMet) is a dipeptide composed of 2 methionine residues. It is known that some dipeptides have physiological or cell signaling effects associated with their transport system in the intestinal membrane. Thereby our objective was to evaluate the effects of supplementation of 2 methionine sources (DL-Met and DL-MMet) on the gene expression of the apoptosis genes CASP-3, BCL-2, BAX and the genes of the antioxidant system SOD and GPx in the heart of broilers submitted to acute thermal stress for 24 h. A total of 90 male broilers (Cobb 500) were divided into 3 treatments related to methionine supplementation. Birds were distributed in a 3x2 factorial scheme (diet - SM, DL-Met and DL-MMet; and environment - comfort and stress), with 6 replicates. The 90 birds were raised in thermal comfort until 44 d of age, when 45 animals (15 of each diet) were submitted to thermal stress of 38°C for 24 h. After this period, the birds of both groups were euthanized by cervical dislocation and the heart was collected for extraction of total RNA. The cDNA was amplified using specific primers for the genes analyzed by qRT-PCR. For the statistical analysis the 2^ΔC
method was used for the relative expression (UA) analyzes. The data were evaluated by ANOVA and the means compared by Tukey test. Thermal stress initiated the intracellular proteolytic cascade effect \( (P = 0.0012) \) mediated by Casp-3; in the other gene expressions, Bcl-2 and Bax, there was an interaction effect between diet and environment \( (P < 0.05) \). The expression of Bcl-2 demonstrated interaction effect \( (P = 0.015) \) for treatment supplemented with \( \alpha \)-methionine and \( \alpha \)-methionyl-methionine subjected to thermal stress, which results in a protective effect for cardiac cells since high expression of Bcl-2 forms heterodimers with Bax \( (P = 0.0318) \), that inhibits the induction of the cascade effect of apoptosis, promoting cardiac cell survival. There was an effect \( (P < 0.05) \) on the expression of antioxidant system genes with interaction between environment and diet in the GPx \( (P = 0.0189) \) and SOD \( (P = 0.0173) \) genes expression, in which thermal stress and supplementation of both sources of methionine resulted in greater expression of these enzymes. Methionine supplementation in \( \alpha \)-methionine and \( \alpha \)-methionyl-methionine forms provides enhanced protection to cardiac cells. As far as we know, this is the first work to evaluate the use of methionine dipeptides on the expression of apoptotic genes and the antioxidant system in the heart of broilers.

**Acknowledgements:** UEM and CNPq

**Key Words:** apoptosis, cardiac cell, gene expression, nutrigenomics, poultry
Quercetin dietary supplementation affects expression of genes involved in carbohydrate digestion and absorption in the broiler small intestine. C. R. do Amaral Duarte*1, I. C. Ospina-Rojas2, A. E. Murakami2, K. C. Nunes2, and A. K. Hirata2, 1Universidade do Estado de Mato Grosso, Tangará da Serra, Mato Grosso, Brazil, 2Universidade Estadual de Maringá, Maringá, Paraná, Brazil.

Quercetin is a flavonoid compound that can be found in vegetables, fruits, and propolis, and has been described as having anti-inflammatory, antioxidant, and antibacterial properties, among others. There are very few studies that evaluated quercetin in broiler diets. Thus, this study evaluated the effects of quercetin supplementation in the starter diets (1 to 21 d) on gene expression of intestinal enzymes and nutrient transporters in chickens. A total of 60 1-d-old male Cobb chicks were distributed in a randomized experimental design with 3 treatments and 5 replicate pens of 4 birds each. The treatments consisted of 3 quercetin supplementation levels in starter diet (0, 200, and 500 ppm quercetin). At 21 d of age, 5 birds per treatment (one per replicate pen) were selected to determine the relative mRNA abundance of aminopeptidase N (APN), maltase, sucrase-isomaltase (SI) complex, sodium/glucone cotransporter 1 (SGLT1), glucose transporter 2 (GLUT2), and peptide transporter 1 (PepT1) in jejunal mucosa using real-time PCR. All data were analyzed using ANOVA followed by Dunnett’s test (P < 0.05). The mRNA abundance of maltase and GLUT2 were higher (P < 0.05) in jejunal mucosa of birds fed 500 ppm quercetin compared with the control group. The mRNA abundance of SGLT1 was higher in birds fed 200 and 500 ppm (P < 0.05). It can be concluded that quercetin supplementation in the broiler diet increases the expression of genes involved in carbohydrate digestion and absorption in the small intestine without affecting protein digestion and absorption in the broiler.

Acknowledgements: CNPq/Brazil

Key Words: flavonoid, gene expression, intestinal


Caffeic acid is a phenolic compound from the hydroxycinnamic acid family and is found in propolis and many fruits. This compound has important biological properties, such as antioxidant, antimicrobial and antihyperglycemic, among others. This study aimed to evaluate the effects of caffeic acid supplementation in the starter diets (1 to 21 d) on performance and gene expression of intestinal enzymes and nutrient transporters in chickens. A total of 60 1-d-old male Cobb chicks were distributed in a completely randomized experimental design with 3 treatments and 5 replicate pens of 4 birds each. The treatments consisted of 3 caffeic acid supplementation levels in pre-starter and starter diets (0, 200 and 500 ppm caffeic acid). At 21 d of age, 5 birds per treatment were selected to determine the relative mRNA abundance of aminopeptidase N (APN), maltase, sucrase-isomaltase (SI) complex, sodium/glucose cotransporter 1 (SGLT1), glucose transporter 2 (GLUT2) and peptide transporter 1 (PepT1) in jejunal mucosa using real-time PCR. All data were analyzed using ANOVA followed by Dunnett’s test (P < 0.05). The body weight gain was higher and the feed:gain ratio was lower in birds fed 200 ppm caffeic acid (P < 0.05) compared with the control group. The mRNA abundance of sucrase-isomaltase was higher (P < 0.05) in the jejunal mucosa of birds fed 500 ppm caffeic acid compared with the control group. No differences were observed in the mRNA expression of APN, SGLT1, PepT1, GLUT2 and maltase (P > 0.05). It can be concluded that the supplementation of 200 ppm caffeic acid in a broiler diet improves performance and increases sucrase gene expression with 500 ppm of supplementation

Acknowledgements: CNPq/Brazil

Key Words: digestive enzyme, intestinal, phenolic compound
We aimed to evaluate if conjugated linoleic acid (CLA) supplementation for broiler breeders and their progeny affects chicks cell immunity, by measuring the cutaneous hypersensitivity response to phytohemagglutinin (PHA). A completely randomized design was adopted, in a 2x2 factorial arrangement, considering the supplementation with trans-10,cis-12 CLA in breeder diet (0 or 0.025%) and the post-hatching diet (0 or 0.025%), totalling 4 treatments. Two 58-weeks-old Cobb 500 breeder flocks were used, one fed a regular diet and other supplemented with CLA during 26 d. After this period, eggs were collected, incubated and 240 newly hatched chicks were submitted to the post-hatching diet, during 12 h, containing or not CLA, distributed in 4 treatments with 6 replicates of 10 birds each. Up to 7 d old, all chicks were fed basal pre-starter diet, non-supplemented. At 7 d, 2 birds per replicate were selected to evaluate the cutaneous hypersensitivity reaction to PHA. 0.1mL PHA (Vitrocell) was intradermally inoculated into the interdigital fold, between the 3rd and 4th digits of the right foot. As a negative control, 0.1 mL of sterile saline solution was inoculated between the 3rd and 4th digits of the left foot. With a digital caliper, skin thickening was measured in mm on both feet before inoculation (H0) and 3, 6, 12 and 24 h later. Responses were measured by skin thickness at the inoculation time minus the thickness verified at H0 in both feet. Then, the following calculation was performed: Reaction = PHA response (right foot) - control response (left foot). Data were submitted to ANOVA at 5% of probability, using software R. Post-hatching diets with CLA resulted in higher cutaneous reaction 12 h after inoculation ($P < 0.003$). After 24 h, there was interaction between breeder diet and post-hatching diet ($P < 0.001$). Considering the breeder diet, the CLA supplementation increased the reaction, in both diets. However, considering the progeny diet, CLA reduced the values observed in chicks from non-supplemented breeders. In conclusion, CLA was able to increase the values of reaction to PHA, suggesting its ability to stimulate the immune system of the chicks. The results were more consistent after 24 h from the time of inoculation, and breeder supplementation was more effective than chick supplementation at producing the cutaneous reaction.

Acknowledgements: Authors thank BASF, CNPq and Asa Alimentos for financial and technical support

Key Words: early nutrition, omega-6, phytohemagglutinin, polyunsaturated fatty acid, T lymphocyte

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Increased production and reduced costs, and the fast growth of poultry to ensure production in a short period of time, may favor the emergence of an adverse side effect, which is the onset of metabolic diseases especially related to the breast musculature. These results in the myopathies that mainly affect the breast muscle, with the appearance of stretch marks associated with stiffness, known as wooden breast. The occurrence of wooden breast may be related to some nutritional deficiency associated with oxidative stress, inducing muscle damage. Therefore, the poultry diet supplementation with nutrients and feed additives, seeks to prevent the development of wooden breast. Thus, the objective of this study was to evaluate the performance of broilers at 10, 28 and 42 d of age and the cut yield at 42 d of age on the effect of mineral supplementation and feed additives (guanidinoacetic acid and nucleotides). A total of 1500 Cobb strain broiler chicks were used, distributed in a completely randomized experimental design in a $4 \times 3$ factorial arrangement, totaling 12 treatments and 5 replicates per treatment. One of the factors was mineral supplementation (one control diet, control diet supplemented with 0.25 ppm selenium, control diet supplemented with 0.50 ppm of chromium and control diet supplemented with 0.25 ppm selenium and 0.50 ppm of chromium) and the other factor was the addition of feed additives (without additive, 600 g/ton of guanidinoacetic acid, 1000 g/ton of nucleotides). Minerals supplementation and feed additives were on top, from 1 to 42 d of age, except nucleotides that were supplemented up to 28 d of age. The variables were submitted to ANOVA and later average test (Tukey), using the SAS statistical program. The birds
receiving guanidinoacetic acid presented (P < 0.05) better weight gain and feed conversion at 28 d of age. For feed consumption, the data did not show any different (P > 0.05) in any of the ages, and the use of minerals and feed additives did not interfere in the performance of 10 and 42 d of age and in carcase yield and cuts at 42 d of age. It can be concluded that the inclusion of guanidinoacetic acid improves the weight gain and feed conversion of broilers from 1 to 28 d of age.

**Key Words:** feed additive, performance, mineral, myopathy, yield

### 105 Effects of different levels of dietary electrolyte balance on the performance, bone resistance and sodium, potassium and chloride levels in blood serum in broiler chickens. C. Gallardo*1, R. G. A. C. Araujo2, and S. Hussain3, 1Department of Animal Nutrition and Production, University of Sao Paulo, Pirassununga, Brazil, 2 São Paulo State University (UNESP), School of Veterinary Medicine and Animal Science, Botucatu, Brazil, 3Department of Livestock Management, Breeding and Genetics, University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan.

The birds have minimal requirement for Na+, K− and Cl− and these monovalent electrolytes are supplied by natural ingredients and electrolyte salts. The acid - base equilibrium at the systemic level of the birds is directly related to the electrolytic balance of the diets. Bone is a multifunctional, metabolically very active tissue consisting of a heterogeneous population of cells, at different stages of cell differentiation, and it is in dynamic equilibrium, with regulation of the mobilization and mineral deposition associated with acid-base equilibrium. The aim of present study was evaluated the effects of 4 dietary electrolytic balance (DEB) levels in performance, bone characteristics and Na, K and Cl blood serum levels of broiler chickens from 21 d old. A total of 600 (Cobb 500) male broilers for 1 and 21-d-old were housed in a randomized blocks experimental design, with 4 treatments (4 levels of DEB = 200; 250; 300 and 350 mEq/kg) and 6 replications, with 25 broilers per replication. The treatment of 200 mEq/kg was the control treatment. Diets were formulated according to the nutritional requirements of the lineage, based on corn-soybean meal, the diets were isocaloric, isoprotic, isosaminicacid for methionine + cystine and lysine, isocalcium and isosphoric. The addition of K2CO3 and NaHCO3 in diets in equal amounts of mEq/kg was used to obtain the 4 levels of DEB. Body weight, feed intake, feed conversion and mortality were evaluated. Moreover, bone resistance and tibia density and Na, K and Cl blood serum levels were analyzed. The GLM procedures of SAS was used to determine effects of treatments. Tukey’s least significant difference was used to detect significant differences between means of treatments. There was significant effect (P < 0.05) of DEB values on broilers performance, bone resistance and tibia density and Na, K and Cl serum levels. The broiler chicks feed 250 and 300 mEq/kg showed the greatest (P < 0.05) weight gain, feed intake, feed conversion and tibia density. In all treatment among blood serum electrolytes, only K and Cl were significantly (P < 0.05) affected by DEB. Diet containing 200 mEq/kg (Na+K-Cl) had the lowest value of blood serum K concentration and concentration of blood serum Cl increased with increasing of DEB. Diets with 250 and 300 mEq/kg may be recommended for broilers from 21 d of age with no negative influence on the evaluated parameters.

**Key Words:** erythrocyte, immune system, leucocyte, polysulfated glycosaminoglycan, thrombocyte

### 107 Effect of 3.3-mm micro pellets and AA density on broiler performance and processing yield. W. Pacheco* and A. Rubio, Auburn University, Auburn, AL, USA.

The majority of broiler integrators in the US and around the world are feeding crumbles during the starter period and 4.4 mm pellets in subsequent phases. However, the usage of 3.3 mm micro pellets can be an alternative to increase broiler performance. Two trials were conducted to evaluate the effect of feeding 3.3 mm micro pellets on broiler performance and processing yield. Broilers were raised on used litter that was top-dressed with new wood-shavings at the start of the study. In the first trial 5 treatments were evaluated during the starter period and consisted of a combination of 3 dietary feed forms: 1) mash from 1 to 14 d, 2) crumbles from 1 to 14 d, 3) 3.3 mm micro pellets 1 to 4 d and then crumbles to 14 d, 4) 3.3 mm micro pellets 1 to 7 d and then crumbles to 14 d, and 5) 3.3 mm micro pellets from 1 to 14 d. Common grower and finisher diets were offered in a 4.4 mm pelleted form from 15 to 35 d of age. Data was analyzed using an ANOVA and means were separated by Tukey test (P ≤ 0.05). The second trial consisted of a 3 × 2 factorial arrangement of 3 feed forms (mash, 4.4 mm pellets, and 3.3 mm micro pellets) and 2 AA densities (88% and 96% of Aviagen recommendations) provided from 1 to 42 d of age. Diets were offered as crumbles from 1 to 14 d on birds fed 4.4 mm pellets. Data was analyzed using JMP 13
as a randomized complete block design with a 3 x 2 factorial arrangement to identify main effects and interactions. At 36 d (trial 1) and 43 d (trial 2), 10 birds/pen were processed to determine processing yield. In trial 1, birds fed mash diets during the starter period (1 to 14 d) had the lowest body weight and feed intake at 35 d compared with birds fed either crumbles or 3.3 mm micro pellets. In addition, the usage of 3.3 mm micro pellets during the starter increased breast meat weight at 35 d of age. In trial 2, birds fed 3.3 mm micro pellets and 4.4 mm pellet had higher BW, FI, carcass weight, and breast meat weight and better feed conversion (FCR) than birds fed mash diets at 42 d of age (P ≤ 0.05). In addition, birds fed diets with 96% of AA recommendations had higher BW, carcass yield, carcass weight, and breast meat weight and better FCR than birds fed diets with 88% of AA recommendations (P ≤ 0.05). These data indicated that broilers can be fed 3.3 mm micro pellets during the starter period and/or during the whole production period.

Key Words: micro pellet, broiler, amino acid, processing yield

108 Performance and enzymatic activity of chick with thermally processed diets, containing maize or sorghum in the pre-starter phase. R. Fialho de Sousa*, F. B. Carvalho, S. Diogo de Assis, M. Alves da Costa, T. Vieira de Andrade, P. M. Rezende, G. M. Chagas, J. H. Stringhini, and N. S. M. Leandro, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.

The objective of the present study was to evaluate the performance and enzymatic activity of broiler chicks fed thermally processed feeds containing corn or sorghum in the pre-starter phase. A total of 360 Cobb 500 male chicks were allotted in a completely randomized design in a 2x2 factorial arrangement (pelletted or extruded feed containing corn or sorghum), with 4 treatments and 6 replicates of 15 chicks each. After thermal processing, the pellets were ground to facilitate apprehension by the chicks. At 7 d of age, the performance (live weight, weight gain, feed intake, feed conversion ratio) and specific activity of pancreatic amylase and lipase were evaluated. The data were submitted to ANOVA and the averages were compared by the Tukey's test (5%) using software R. Interaction (P < 0.05) was observed for all performance variables and specific activity of pancreatic amylase. The analysis of the interaction showed that in the extruded diets, sorghum provided higher final weight, weight gain, feed intake and lower feed conversion ratio. However, in the pellet diet, maize provided a better performance of chicks. Evaluating the thermal processing of the diets with corn, it was observed that the extrusion reduced the performance of the chicks at 7 d. There was greater activity of pancreatic amylase in the chicks that consumed a diet extruded with maize. Thermal processing of sorghum diets did not influence the specific activity of pancreatic amylase. There was no difference (P > 0.05) between treatments for specific activity of pancreatic lipase. It is concluded that sorghum in an extruded diet favored chick's performance at 7 d. Extrusion of diets with corn increases the specific activity of pancreatic amylase.

Key Words: amylase, extrusion, specific activity, lipase


The objective of this study was to evaluate the carcass yield of broiler chickens fed with different soybean meal (SBM) grain size in diets. It was used 720 male broilers of the Cobb line, distributed in a completely randomized design with 4 treatments (625, 775, 1053 and 1406 μm) and 9 replicates, with 20 animals each. The birds received water and feed ad libitum. Diets' composition were similar to each other, varying only the granulometry of SBM. At 42 d of age, 2 birds per experimental unit were euthanized, totaling 72 birds. Initially the animals were properly identified and weighted. They were euthanized by the 12-h fasting method. Evaluated sections (breast, thigh + drumstick yield, abdominal fat content and gizzard) were plucked, gutted, weighted and performed. To determine carcass yield, the weight of the carcass expressed as a percentage of the body weight and the yield of the other parts expressed as a percentage of carcass weight were considered. The data were submitted to ANOVA and when significant, the means were submitted to the linear and quadratic test at 5% of probability. Results for carcass yield are presented in Table 1. There was no significant effect for the variables analyzed (P > 0.05). The birds fed the different particle sizes presented similar behavior among themselves and could concluded that different granulometry of the soybean meal did not influence the carcass yield of the broilers.

Table 1. Carcass (CY), (BY), thigh + drumstick yield (TDY), abdominal fat content (AFC) and gizzard (GY) of broilers from 1 to 42 days of age fed with different grain sizes of soybean meal

<table>
<thead>
<tr>
<th>Treatment/granulometry (μm)</th>
<th>625</th>
<th>775</th>
<th>1053</th>
<th>1406</th>
<th>SEM</th>
<th>Lin</th>
<th>Quad</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY1</td>
<td>80.037</td>
<td>80.406</td>
<td>79.359</td>
<td>80.319</td>
<td>1.41</td>
<td>0.974</td>
<td>0.088</td>
</tr>
<tr>
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<td>37.169</td>
<td>37.664</td>
<td>38.010</td>
<td>4.02</td>
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<td>0.740</td>
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<td>27.693</td>
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<td>27.620</td>
<td>4.23</td>
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<tr>
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<td>1.513</td>
<td>1.367</td>
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<td>30.22</td>
<td>0.718</td>
<td>0.385</td>
</tr>
<tr>
<td>GY2</td>
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<td>2.006</td>
<td>1.973</td>
<td>1.888</td>
<td>11.69</td>
<td>0.151</td>
<td>0.543</td>
</tr>
</tbody>
</table>

*Significant mean values at 5% probability.

Key Words: soybean meal, broiler chicken, particle size, carcass yield


To increase the added value and the economic return, it is possible to use part of corn and/or soybean production to feed livestock. Soy and its co-products are important ingredients in the formulation of bird diets. However, they have anti-nutritional factors, which affect digestibility of nutrients and consequently the animals’ performance; trypsin inhibitors (TI) are the most important. Considering that they are thermo-sensible, the application of a thermal process can help to reduce their activity. The objective of this trial was to develop a protocol to deactivate soybean in a small-scale, to achieve the best nutritional quality at the lowest possible cost. The experiment was carried out in the Poultry Section of INTA-EFA Pergamino, Argentina. A discontinuous 400 L horizontal rotary drum deactivator heated by propane was used. The variables considered were the grain presentation, the water addition and time of deactivation. A completely randomized design was used with a factorial arrangement with 2 particle sizes (cracked vs not cracked) x 2 moisture levels (addition of 0 vs 7.5% of water) x 3 deactivation times (40, 50 and 60 min.), with a total of 12 treatments with 3 replicates each. The quality of deactivation was measured using in vitro indicators: Urease
Activity, Protein Solubility in KOH (PS) and Trypsin Inhibitors Activity. The true metabolizable energy (TME) using roosters (Sibbald method) was used as an in vivo indicator. Other determinations were moisture, proximal and total amino acid analysis by NIRS and temperature of the mass grain measured by infrared noncontact thermometer. Finally, economic parameters such as production cost and price sensitivity were evaluated. Data was subjected to one-way ANOVA, when differences were significant ($P \leq 0.05$), means were separated by the Duncan’s multiple range test, using the statistical software Infostat.

With the addition of water there was a lower decrease of PS, while deactivation time increases ($P \leq 0.05$); this behavior was also observed for lysine content. Cracked grain presentation produced an increment of crude protein and a reduction of other components such as crude fiber ($P \leq 0.05$). In whole grain presentation, the addition of water produced an improvement in TME (3583 vs 3821 kcal/kg) as consequence of an increment in energy utilization (63 vs 67%, $P \leq 0.05$). These effects were not observed for cracked grain. The combination that optimized the nutrients utilization and the production cost was the whole soybean with the addition of 7.5% of water deactivated for 40 min (3889 kcal/kg and 68% of energy utilization).

**Key Words:** toasting, trypsin inhibitors activity, protein solubility, metabolizable energy, poultry
Genetics and Genomics


The objective of this study was to investigate the genetic basis of sexual dimorphism in body weight at the late stage of the growing period (28 to 42 d days) in Japanese quail. Three data sets of 1300 (650 males and 650 females) Japanese quail body weight records at 4, 5 and 6 weeks of age were analyzed. All birds belonged to a paternal line selected for body weight at 4 weeks of age. Degree of sexual dimorphism (DSD) was calculated as $\frac{[(FW_t-MW_t)]}{FW_t}*100$, where: $FW_t$ is the mean female live weight at time t and $MW_t$ is the mean male live weight at time t. Sexual dimorphism was taken into account considering body weight as a sex-specific trait analyzing data of each sex separately. A series of bivariate analyses including body weight at ages of 4, 5 and 6 weeks of age (BW4, BW5 and BW6, respectively) for each data set were carried out. Six models were applied estimating variances due to direct additive genetic, maternal genetic and maternal environmental effects via the restricted maximum likelihood method in WOMBAT software. The models were compared with likelihood ratio test (LRT) to choose the best model. DSD ratios showed an increasing trend (4.12% for BW4, 7.33% for BW5 and 11.18% for BW6). According to LRT, the best-fitting model did not differ from one trait to another. All traits were affected by direct additive genetic, maternal genetic and maternal environmental effects with an existing direct–maternal genetic covariance. Differences in direct heritabilities between sexes for BW4 were small (0.20 vs. 0.21 for males and females, respectively). However, larger differences were found for BW5 (0.21 vs. 0.26) and for BW6 (0.22 vs. 0.27) for males and females, respectively. These results indicating no sex differences for BW4 but it could exist at later ages. The direct genetic correlation of BW between the 2 sexes ranged between (0.86 to 0.93) showing a decreasing trend with age advance. All estimates of the direct–maternal genetic correlation was negative showing a big magnitude in females than in males at all ages (−0.81 to −0.93 vs. −0.66 to −0.71 for males and females, respectively). A greater amount of antagonism between direct additive and maternal genetic effects were found in females than males. It could be concluded that selection programs to increase BW4 in Japanese quail could be carried out without considering sexual dimorphism. However, these effects seem to be greater at later ages and the situation is altered.

Key Words: Japanese quail, sexual dimorphism, body weight, REML
112 Metabolizability of diets with different calcium source granulometries and calcium:phosphorus ratio for broilers. R. A. De Araujo1,1, J. F. Durau1,1, A. Massuquito2,2, E. C. Goes1,1, and P. Raijche de Oliveira1,1, 1Universidade Federal Do Parana, Curitiba, Paraná, Brazil. Acknowledgements: Thanks to all colleagues at the Federal University of Paraná.

Key Words: metabolizable, granulometry, calcium:phosphorus ratio.

The aim of this study was to evaluate the metabolizability of diets with different granulometry of calcium and phosphorus for broilers. A total of 480 male broilers were distributed in a completely randomized design in a factorial 3 × 2, with 3 formulation strategies (FS): control diet (1.13 Ca and Pt ratio; 500 FTU/kg of phytase with 1.70 Ca and P; 500 FTU/kg and phytase with 2.06 Ca and P, and 2 granulometries of calcium source (oyster shell), coarse and fine (1354 and 428 µm), and 8 replicates with 10 animals each. The all diets were based on corn and soybean in the mash form. Birds received the same diet (1.13 Ca and Pt ratio) until 21 d of age, and from 22 to 28 were supplied the experimental diets. The first 3 d were for adaptation and 4 for total excreta collection. Were evaluated the coefficient of apparent metabolizability of dry matter (CAMDM), calcium (CAMCa) and phosphorus (CAMP) and apparent metabolizable energy (AME). Data were submitted to ANOVA and, when significant, means were compared by Tukey test. There was no significant interaction (P > 0.05) for CAMCa and CAMP. There was interaction for CAMDM and AME (P < 0.05), the treatment 2.06 Phy had higher CAMDM, however AME lower than 2.06 Phy F. There was significant difference for CAMCa and CAMP (P < 0.05) for FS, when animals fed with lowest Ca and P-1.34 ratio presented lower CAMCa < 0.05) for FS, when animals fed with lower inclusions diet Ca and P 1.70 and 2.06. There was difference on calcium source granulometry (P < 0.05), when animals were fed with larger calcium source particles showed higher CAMCa when compared with animals that received fine. The use of phytase can improve the metabolism of dietary Ca and P, and calcium from a coarse source promote better Ca utilization in broilers diets.

Key Words: energy, metabolizability, minerals, oyster shell, phytase

113 Performance and bone mineral composition of broilers fed diets formulated with available or digestible phosphorus. L. S. Bassi1,1, V. A. B. Zavelinski2,2, L. M. Almeida1,1, L. H. A. O. Gomes1,1, F. O. Marx3,3, J. F. Durau1,1, and A. Maiorka1,1, 1Federal University of Paraná, Curitiba, Paraná, Brazil, 2Biotecnologia, Uberlândia, Minas Gerais, Brazil, 3Tectron, Toledo, Parana, Brazil.

In poultry diets, most of the phosphorus is unavailable to the bird due to its bound with phytate molecules. Therefore, it needs to be supplied through the inclusion of phytase and ingredients such as phosphates. The aim of this study was to evaluate the performance and bone mineral composition of broilers fed diets with formula based on available or digestible phosphorus’ levels. It was used 400 male broilers, from 1 to 42 d old, distributed in a completely randomized design with 3 treatments and 10 replicates of 10 birds each. The birds received feed and water ad libitum. Feed was offered in mashed form, based on corn and soybean meal, with inclusion of phytase (10,000 FYT/g). Treatments varied according to the level of phosphorus (P): Control diet (CD), formulated with regular levels of available P (Av. P), based on Rostagno (2017); Diet formulated with regular levels of digestible P (Dig. P), based on Rostagno (2017); CD with 50% reduction on available P levels (50% Av.) and feed conversion ratio (FCR) were calculated by weighting the birds and feed leftovers. At 42 d old, 10 birds of each treatment were euthanized and had tibia bones removed, cleaned with ether, and ashed at 550°C to analyze mineral residue (%MR), calcium (%Ca) and P (%P). All data collected was submitted to ANOVA among treatments, and when significant, means were compared with Tukey test at 5% probability. No difference was found between the treatments for FI and BWG (P > 0.05) (Table 1), Birds fed with CD had improved FCR (1.63) when compared with those fed with reduced Av. P diets (1.69) (P = 0.031), while FCR of birds fed diets based on Dig. P was similar to the other treatments (1.65). Treatments also did not affect %MR, %Ca and %P (P > 0.05) on tibia bones. Therefore, it was concluded that formulation of feed for broilers based on levels of available or digestible phosphorus guaranteed same performance and bone mineral composition.

Acknowledgements: Thanks to all colleagues at the Federal University of Paraná.

Key Words: poultry, bone composition, phosphorus, mineral
reduction of its level in the diets. The Ca reduction did not compromise performance, regardless of the vitamin D source used.

**Key Words:** broiler, mineral, vitamin

### 115 Effect of different recommendations of calcium and available phosphorus on the reproductive performance of Japanese quail hens of two different ages

P. Ciriaci and C. Vilchez*, Universidad Nacional Agraria La Molina, La Molina, Lima, Peru.

The objective of the present study was to determine the reproductive performance of Japanese quail hens of 2 different ages fed diets containing different recommendations of calcium (Ca) and available phosphorus (aP). A total of 864 female and 288 male Japanese quail (50% 12-wk old and 50% 32-wk old) were placed into 48 cages with 18 females and 6 males per cage. The Ca and aP recommendations evaluated, respectively, were 1) 3.20% - 0.40%; 2) 2.50% - 0.35%; 3) 3.10% - 0.45%; 4) 2.50% - 0.30%; 5) 3.15% - 0.41%; and 6) 3.10% - 0.32%; thus, the total number of treatments were 12. Feed (as mash) and fresh water were provided ad libitum. Statistical significance was evaluated using ANOVa under a Randomized Complete Block Design with 2 x 6 factorial arrangements and Tukey’s test for multiple comparisons. There were no bird’s ages x Ca & aP recommendations for any of the measured variables. Younger birds showed lower (P < 0.05) feed intake, egg production, embryonic mortality but higher (P < 0.05) egg weight, fertility and hatchability than older birds. Quail weight at hatch was not affected (P > 0.05) by the bird’s age. On the other hand, with exception of the early embryonic, none of the other measured variables were significantly influenced (P > 0.05) by the level of Ca and aP recommendations. In conclusion, regardless the bird’s age, the reproductive performance of Japanese quail hens is not affected by the variety of calcium and available phosphorus recommendations existing in the literature.

**Key Words:** quail hen, egg production, egg weight, fertility, hatchability

### 116 Calcium and phosphorus digestibility of limestone and dicalcium phosphate for brown egg-laying hens in the final stage of laying

C. Sordi1,2, F. C. Tavernari*2,1, N. Drecche2, C. S. Salguero Cruz4, and L. F. T. Albino4, 1Udesc, Chapecó, Santa Catarina, Brazil, 2UEM, Universidade Estadual de Maringá, Maringá, Paraná, Brazil.

The objective of this study was to evaluate the calcium and phosphorus digestibility of limestone and dicalcium phosphate for brown egg laying hens in the final stage of laying. 72 Rhode Island Red laying hens (Embrapa: 75 weeks old) were distributed in a completely randomized design with 3 treatments and 8 replicates of 3 birds each. Treatments consisted of a basal diet for determination of endogenous loss, basal diet with addition of limestone, and basal diet with addition of phosphorus. The experimental period was 9 d: 4 d for adaptation to experimental diets and facilities, and then 5 d for total excreta collection, once a day, being performed in the morning. At the end of the experimental period was determined the feed consumption. The excreta were dried and milled to determine dry matter (DM), calcium (Ca), and phosphorus (P). The true digestibility coefficients of calcium and phosphorus were determined based on the feed consumption, excreta produced, and endogenous losses. For limestone, true digestibility coefficient of calcium was 99.9%.

For dicalcium phosphate, true digestibility coefficients of calcium and phosphorus were 99.8% and 99.1%, respectively.

**Acknowledgements:** The authors thank Embrapa Swine and Poultry, Concordia, SC, for providing the resources, infrastructure and technical staff for the research. C. Sordi was supported by Capes. F. de C. Tavernari and L. F. T. Albino was supported by CNPq.

**Key Words:** calcium, phosphorus, digestibility, laying hen

### 117 Performance evaluation of broilers fed diets containing soybean oil and palm fat, with different vitamin A supplementation

V. D. L. Savaris*, J. Broch1, L. Wathelho1, J. L. Damasceno2, C. Eyng1, and R. V. Nunes1, 1UNIOESTE, Universidade Estadual do Oeste do Paraná, Campus Marechal Cândido Rondon, Paraná, Brazil, 2UEM, Universidade Estadual de Maringá, Maringá, Paraná, Brazil.

The search for better results has demonstrated the importance of certain ingredients in feed, such as oils and fats, which are essential for the supply of energy, so that the absorption of fat-soluble vitamins takes place properly. The objective of this study was to evaluate the influence of the use of different fat sources in diets containing different vitamin A supplementation levels on the performance of poultry from 1 to 42 d of age. For the study, 1,150 d-old chicks were distributed in a completely randomized design, in a 2X5 factorial scheme, with 2 (2) sources of lipids (soybean oil and palm fat) and 5 (5) vitamin A supplementation levels (0; 3,000; 6,000; 12,000; 24,000 IU kg⁻¹) resulting in 10 treatments with 5 replicates and 23 poultry per experimental unit (EU). The poultry submitted to the treatments were fed with rations without vitamin A supplementation from 1 to 3 days of age and vitamin A supplementation (premix) in the experimental diets started at 4th day of age. At the end of the experimental period, data on weight gain (WG), feed intake (FI) and feed:gain ratio were obtained. The results were evaluated by the statistical procedure PROC GLM (SAS, 2017), being submitted to ANOVA, polynomial regression as a function of vitamin A supplementation and the coefficients for not evenly spaced levels were obtained using orthogonal contrasts. The source of fat (soybean oil or palm fat) used in feed from 1 to 42 d of age did not interfere with WG, FI and feed:gain ratio of poultry. The results indicate that dietary vitamin A supplementation influenced WG, FI and feed:gain ratio during the period evaluated. A linear and quadratic response (P < 0.05) was obtained for the WG and FI variables. For WG, the maximum response point was reached with supplementation of 13,240 IU kg⁻¹, and for FI the best supplementation occurred with 13,655 IU kg⁻¹ U1 kg⁻¹ of vitamin A. However, the feed: gain ratio showed a linear response to vitamin A supplementation in diets. The fat source used in the diets did not interfere in the performance of the poultry and there was no interaction between the sources of fat used and the supplementation of vitamin A. The best performance of broiler from 1 to 42 d of age must be obtained with vitamin A supplementation ranging from 13,240 to 13,655 IU kg⁻¹ on diet.

**Key Words:** vitamin, soya oil, palm fat, poultry, performance

### 118 In ovo feeding of commercial product of canthaxanthin containing lignosulfonate impairs hatching results

I. CS Araújo*, M. B. Café2, J. P. Machado2, M. A. Mesquita2, and N. S. M. Leandro2, 1Departamento de Zootecnia, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, 2Departamento de Zootecnia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.
This study was conducted to evaluate the effects of commercial product of canthaxanthin (10.0%) containing lignosulfonate (62.8%) (CCX) administered via in ovo injection on hatchability and hatch window.

A total of 780 fertile eggs from Cobb 500 broiler breeder flocks were distributed in a randomized block design (3 setters), with 5 treatments and 12 replicates (13 eggs in each replicate). Treatments were: 1) eggs inoculated with 0.5 mL of distillate water (control group); 2) eggs inoculated with 0.5 of distillate water and 0.35 mg of CCX; 3) eggs inoculated with 0.5 of distillate water and 0.45 mg of CCX; 4) eggs inoculated with 0.5 of distillate water and 0.55 mg of CCX of VE and 5) eggs inoculated with 0.5 of distillate water and 0.65 mg of CCX. The temperature and relative humidity of the setters were set at 37.7°C and 59%, respectively. At 17.5 d of incubation, eggs were sanitized with iodine alcohol (2%) and VE solution was inoculated in the amniotic fluid. After inoculation, eggs were placed in air-permeable bags to isolate the treatment and distributed in hatchery trays. The temperature and relative humidity of the hatcheries were set at 36.7°C and 70%, respectively. For the hatching rates (ratio between the number of fertile eggs and the number of hatched chicks), the fertility rate was taken to be 90.0% (which was informed by the company that donated the eggs). The hatch window studied began when the first chick hatched, and each window had a duration of 6 h and the incubation trial was halted when it reached 504 h of incubation. Data were analyzed with ANOVA and means were compared by Tukey’s test (P < 0.05). The highest hatch rate (P < 0.05) were observed from the control group (79.82%) in comparison with the inclusion of 0.45; 0.55 and 0.65 mg of CCX. Thus, inclusion of 0.65 mg of CCX presents worse hatching results (32.99%). The shortest hatch window (20.0 h) was observed for broiler chicks that received only distillate water (P < 0.05). No difference in hatch window was observed (P > 0.05) between the treatments supplemented with 0.35; 0.45; 0.55 and 0.65 mg of CCX (26.5; 28.5; 24.0 and 26.5 h, respectively). In conclusion, in ovo injection of commercial product of canthaxanthin containing lignosulfonate at 17.5 d of incubation worsens the hatching results and increases hatch window.

Acknowledgements: The authors acknowledge the assistance of the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) for providing funds for participate in the event.

Key Words: antioxidant, broiler chick, hatch window, incubation, pigments

119 Vitamin E in ovo supplementation improves the oxidative status of the newborn chick. I. C. S. Araújo*1, B. N. Caiado2, J. P. Machado2, M. A. Mesquita2, and N. S. M. Leandro2, 1Departamento de Zootecnia, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, 2Departamento de Zootecnia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.

Embryonic nutrient supplementation by in ovo injection is a viable technology that can be used in researches and industry. This study was conducted to evaluate the effects of vitamin E (VE) administered via in ovo injection on oxidative status of newborn chicks. A total of 780 fertile eggs from Cobb 500 broiler breeder flocks were distributed in a randomized block design (3 setters), with 5 treatments and 12 replicates (13 eggs in each replicate). Treatments were: 1) eggs inoculated with 0.5 mL of sunflower oil (control group); 2) eggs inoculated with 0.5 of sunflower oil and 27.5 IU of VE; 3) eggs inoculated with 0.5 of sunflower oil and 38.5 IU of VE; 4) eggs inoculated with 0.5 of sunflower oil and 49.5 IU of VE and 5) eggs inoculated with 0.5 of sunflower oil and 60.4 IU of VE. The temperature and relative humidity of the setters were set at 37.7°C and 59%, respectively. At 17.5 d of incubation, eggs were sanitized with iodine alcohol (2%) and VE solution was inoculated in the amniotic fluid. After inoculation, eggs were placed in air-permeable bags to isolate the treatment and distributed in hatchery trays. The temperature and relative humidity of the hatcheries were set at 36.7°C and 70%, respectively. At hatch, organs of 3 chicks per replicate (36 birds per treatment) were collected to evaluate oxidative variables. Total protein quantity and catalase (CAT) enzyme activity present in the liver and breast muscles were measured. Data were analyzed with ANOVA and means were compared by Tukey’s test (P < 0.05). Chicks that received 60.4 IU of VE in ovo had the highest level of total proteins in the liver (P < 0.05), while no significant difference was observed among the other treatments (P > 0.05). Liver CAT activity was higher in the group that received 49.5 IU of VE compared with the group that did not receive in ovo VE. The results of chick breast muscle analysis showed lower protein concentration in chicks that did not receive in ovo VE. The inoculation of 38.5 IU of VE had the highest level of total proteins in the breast muscle (P < 0.05). No differences were observed (P > 0.05) between the treatments for CAT in breast muscle. In conclusion, in ovo injection of vitamin E at 17.5 d of incubation improved oxidative status of newborn broiler chick.

Acknowledgements: The authors acknowledge the assistance of the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) for providing funds for participate in the event.

Key Words: α-tocopherol, broiler, in ovo feeding, liver, oxidative status

120 Manganese requirement for broiler chickens from 20 to 40 days of age according to source of supply. M. M. Saldanha1, A. R. Chagas Abreu*1, L. F. Rocha1, L. F. V. B. Freitas2, and L. J. Camargos Lara1, 1Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, 2Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil.

Supplementation of trace mineral in poultry diet is usually done in excess. Consequently, it results in high levels of excretion what might cause wastage and environmental pollution. The objective of this study was to establish inorganic and chelated form of manganese (Mn) requirements using performance data, bone quality and liver Mn concentration, from 20 to 40 d of age. A total of 1,350 male Cobb broiler chickens were distributed in a completely randomized experimental design with 9 treatments and 6 replications. From one to 12 d of age all birds received a supply of 70 mg of Mn/kg, from 13 to 19 d of age birds did not receive any supply of Mn in feed. From 20 d of age experiment began with following suplementations: 0, 35, 70, 105 or 140 mg of Mn/kg on sulfate and proteinate form. After feed analysis, Mn dietetic levels for each treatment were: 13.2 mg of Mn/kg, feed with Mn sulfate with 45.4, 85.0, 119.0 and 151.4 mg of Mn/kg, and feed with Mn proteinate with 46.7, 82.8, 120.0 and 151.7 mg of Mn/kg. For broiler performance it was analyzed weight gain, feed intake and feed conversion of broiler chickens. At the age of 40 d, 6 birds of each treatment were slaughtered and were removed tibia, femur and liver. It was determined ash and Mn content for tibia, and liver (with gallbladder) Mn concentration. Femur samples were submitted to mechanical essay to determine bone strength. Data was analyzed by software R, and Mn requirements were established by linear and quadratic regressions models (P ≤ 0.05). Dietetic Mn concentration in both forms (sulfate and proteinate) did not affect broiler performance from 20 to 40 d of age. The inclusion of Mn sulfate interfered with results of bone strength, the estimation of Mn requirement was 73.9 mg of Mn/kg. Inclusion of Mn proteinate on feed increased linear values of bone ash content. The higher the sulfate and proteinate inclusion were, the greater were tibia Mn concentration. However, both forms of Mn did not have any effect on liver Mn concentration.
Dietetic Mn concentration in both forms (sulfate and proteinate) did not affect broiler performance 20 to 40 d of age. However, inclusion of 73.9 mg sulfate of Mn/kg presented the best bone strength, and can will be indicated for reduce lost about break bones.

**Key Words:** bone, broiler, chelate, manganese, requirement

121  **Manganese requirement for broiler chickens from 1 to 20 days of age according to source of supply.** M. M. Saldanha*1, D. P. Vaz2, P. C. Cardeal3, M. V. Triginelli1, and L. J. Camargos Lara1,

1Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, 2DSM, São Paulo, São Paulo, Brazil, 3Viali Soluções Integradas para o Agronegócio, Belo Horizonte, Minas Gerais, Brazil.

Due to continuous genetic improvement of broiler chickens, update of nutritional requirements on feed formulation is necessary. The objective of this study was to establish inorganic and chelated form of manganese (Mn) requirements using performance data, bone quality and liver Mn concentration, from one to 20 d of age. A total of 1,350 male Cobb broiler chickens were distributed in a completely randomized experimental design with 9 treatments and 6 replications. Levels of Mn supply were: 0, 35, 70, 105 or 140 mg/kg on sulfate and proteinate form. After feed analysis, Mn dietetic levels for each treatment were: control with 12.2 mg of Mn/kg, feed with Mn sulfate with 48.3, 82.0, 117.0, and 150.0 mg of Mn/kg, and feed with Mn proteinate with 46.5, 80.0, 115.0, and 154.0 mg of Mn/kg. For broiler performance it was analyzed weight gain, feed intake and feed conversion of broiler chickens. At the age of 20 d, 6 birds of each treatment were slaughtered and were removed tibia, femur and liver. It was determined ash and Mn content for tibia, and liver (with gallbladder) Mn concentration. Femur samples were submitted to mechanical essay to determine bone strength. Data was analyzed by software R, and Mn requirements were established by linear and quadratic regressions models (P ≤ 0.05). Dietetic Mn concentration in both forms (sulfate and proteinate) did not affect broiler performance until 20 d of age. The higher the sulfate and proteinate inclusion were, the greater were bone strength. Increasing Mn sulfate and Mn proteinate had a quadratic effect in Mn concentrations on tibia and liver. Bone ash content was only affected by Mn sulfate supply, the estimation of Mn requirement was 97.9 mg of Mn/kg. Mn supply does not affect broiler performance, but modifies Mn content of tibia and liver. Besides that, it improves linearly bone strength with feed supply. This justify the supply with high levels of Mn: 150.0 mg of Mn sulfate/kg and 154.0 mg of Mn proteinate/kg, because bone strength is an important parameter to avoid slaughterhouse losses.

**Key Words:** broiler, manganese, mineral, nutrition, requirement
Processing and Products


The aim of study was to determine the chemical composition of the breast meat of turkey affected by different degrees of deep pectoral myopathy (DPM). The research was conducted at the Faculty of Agrarian and Veterinary Sciences of Unesp, in Jaboticabal/SP. For the myopathy characterization, samples of turkey breast meat were collected from animals of the Nicholas lineage, aged 385 d and weighing 12.5 kg, reared and slaughtered in southern Brazil. The experiment was composed by samples of the muscle Pectoralis major from discard matrices, affected by the disease in different degrees (“normal” without the presence of myopathy, moderate myopathy and severe myopathy, 20 repetitions of each type totaling in 60 samples) and which were released for human consumption by the Federal Inspection Service. Chemical composition analysis was performed to obtain the percentages of protein, water, mineral matter and lipids of each degree studied. The design was completely randomized, and the data were analyzed by the “General Linear Models” procedure of the “Statistical Analysis System” (SAS) version 9.3, submitted to variance analysis and means compared by the Tukey test with significance level of 5%. The results showed significant differences in the chemical composition between the different degrees of DPM. Samples analyzed without the presence of the disease (normal) resulted in lower concentrations of protein (23.5%) and higher mineral matter (2.02%) when compared with the moderate and severe degrees samples of DPM. The highest values of water (71.1%; 71.4%), as well as the lowest of fat (3.08%; 2.85%) were observed in the samples without the presence of myopathy and with moderate degree, respectively. However, we can conclude that with the increase in the degree of DPM, turkey breast meat increases its concentration of fat and proteins and decreases its concentration of mineral matter. In general, we can affirm that these variables follow the trend of results already published. However, as this is a new and with a huge importance topic for the production chain, further studies about the quality and composition of normal turkey meat and with degrees of myopathy are necessary to, really, establish a standard of result that is easily found and discussed in the literature.

Key Words: genetic selection, green muscle, major pectoral, Oregon disease, supracoracoid muscle


Nowadays, consumers’ food choice is influenced mainly by quality attributes of the product as sensory, health, process and convenience aspects. As a result, the differentiation of food products in the market has increased, which includes egg products. Although the egg quality may be influenced by the production system, very little information is available in this topic. The aim of the study was to compare the quality of commercially available eggs from different production systems: organic (OE) (certified organic farm), 2 nutraceutical types (enriched in n-3 fatty acid or selenium (SE)), and free-range (FR). The eggs were provided from an egg farm located in Morro Reuter – RS, Brazil. All eggs were obtained from birds of the same age, maintained under appropriated conditions, according to each production system. The egg quality analyses included: egg weight (g), yolk color, Haugh Unit, yolk index, albumen and yolk pH. All eggs were evaluated with 28 d of age, considering that an egg has 30 d of shelf-life after the production. Statistical procedures were performed using Minitab 17 software (Minitab Inc., State College, PA). The data were submitted to ANOVA and differences among means were evaluated with Tukey test (P < 0.05). Eggs enriched in n-3 fatty acids showed higher (P < 0.05) egg weight (70.79g) than the others types of eggs (OE: 59.20g, SE: 64.97g, and FR: 55.35g). The yolk color score was also higher (P < 0.05) in the eggs enriched in n-3 fatty acids (14.67) when compared with the OE (12.40), SE (12.89) and FR (13.42) eggs. Unit Haugh parameters were greater (P < 0.05) in enriched in n-3 fatty acids (65.22), than in the OE (58.94), SE (59.89) and FR (64.54) eggs. The yolk index, albumen and yolk pH were similar among the egg types. In conclusion, the production system influence the egg quality, and eggs enriched in n-3...
fatty acids present greater results for egg quality when compared with the other types of eggs studied.

Key Words: consumers, fatty acids, free range, organic, selenium


Although eggs are an excellent protein source, they are a perishable product. Many methods exist to extend shelf life of food and one of them is the use of protein coatings, as rice protein. This study aimed to extend the shelf life of fresh eggs using rice protein coating in different concentrations or mineral oil. The effectiveness of rice protein coatings or mineral oil on maintaining interior quality of fresh eggs was evaluated during storage at 20°C for 8 weeks. Four hundred and thirty-two non-fertile eggs, freshly laid (one-day-old) from ISA Brown hens, were supplied by a commercial farm (Rio Grande do Sul, Brazil) and used in the present study. All eggs were obtained from birds of the same age, maintained under similar environment, handling and feeding conditions. Egg quality was assessed by weight loss, Haugh unit (HU), albumen pH and yolk index (YI). Five treatments were tested: uncoated eggs (control treatment) and eggs coated with mineral oil or rice protein concentrate at 5, 10, or 15%. Statistical analysis was performed using the SAS PROC GLM method (P < 0.05). Weight loss increased (P < 0.001) during long-term storage. Uncoated eggs showed the highest weight loss (8.28%), while mineral oil (8.78%) and rice protein at 5% (5.60%), 10% (5.45%), 15% (5.54%) solutions were effective in preventing weight loss (P < 0.001). The use of the coatings preserved the internal quality of the eggs for up to 4 weeks longer than uncoated eggs (HU, YI, and pH). Control treatment had the worst (P < 0.001) HU (54.45), albumen pH (9.18), and YI (0.28) among all treatments after 8 weeks of storage. Among the coated eggs, the mineral oil had the best values of HU (70.54), pH (8.48) and YI (0.35) after storage. Rice protein coated eggs at 5, 10 and 15% showed values of HU (67.38, 67.86, 67.54), albumen pH (9.11, 9.10, 9.14) and YI (0.31, 0.32, 0.29) respectively, after storage. In conclusion, the use of coatings based on rice protein concentrate or mineral oil influences the internal quality of eggs during storage and may be an effective alternative to increase the shelf life of commercial eggs.

Key Words: eggshell, mineral oil, protein coating, storage, yolk index

126 Oxidative stability of chicken mortadella formulated with Moringa oleifera Lam. seed flour. B. Auriema1, V. P. Dinalli*1, M. Yamaguchi2, D. Marchi3, and A. L. Soares1, 1Universidade Estadual de Londrina, Londrina, Parana, Brazil, 2Universidade Tecnológica Federal do Paraná, Londrina, Parana, Brazil, 3Instituto Federal do Paraná, Londrina, Parana, Brazil.

Dietary fibers have been used in meat products with the aim of reducing their fat content. Fibers are important for forming gels, retaining water, increasing viscosity, contributing to the fat replacement. Moringa oleifera Lam. seeds contain high content fibers (7.7g.100g−1), and compounds with antioxidant activities. The objective this work was to evaluate the effect of addition of Moringa oleifera Lam seed flour on partial replacement of fat in the chicken mortadella and their oxidative stability. Four different formulations, in triplicate, of chicken mortadella were prepared with the addition of 0 (C-control), 1% (T1), 3% (T3) and 5% (T5) seed flour Moringa oleifera partial fat replacement. The mortadellas were stored under refrigeration at 4°C until analyzes. Lipid oxidation was evaluated in mortadella processed after 24 h (time 0), 40, 60 and 90 d by the method of reactive substances to thiobarbituric acid (TBARS) with addition of sulfanilamide reagent. The results were submitted to Tukey test at 5% probability to compare the results among the different mortadella formulations. After 24 h of storage (time 0), T3 and T5 treatments had lower oxidation levels (P < 0.05) compared with C and T1 treatments. After 40 d of storage, lower oxidation rates were observed for T3 treatment (0.100mg TBARS.kg−1 sample) and T5 treatment (0.184mg TBARS.kg−1 sample), which showed no difference (P > 0.05) among them, the highest oxidation was the C group (2.542 mg TBARS.kg−1 sample). Within 60 d, lipid oxidation of T3 mortadella showed lower value (P < 0.05). The second lower level of oxidation was observed for T5, while the C and T1 showed higher values, did not differing (P > 0.05) among them. At the end storage time (90 d), the lowest level of oxidation (P < 0.05) occurred for the T3 samples and higher values was observed to C samples, T1 and T5 treatments showed intermediate values of lipid oxidation. In relation to the storage time for each treatment, it was observed that C samples over 40 d of storage was 64% more oxidized in relation to time 0. For the T1 treatment, TBARS values increased until 60 d and after 90 d of storage the TBARS values decreased by 31%. The lipid oxidation of T3 treatment remained constant up to 60 d and at the end of 90 d, there was an increase of TBARS value. For the T5 treatment, lipid oxidation was constant up to 40 d and after was observed a slight increase of lipid oxidation. The results indicated that the addition of 3 and 5% morgina seed flour in chicken mortadella contributed to reducing lipid oxidation. The morgina seed presented antioxidant activity indicating potential for application in meat products as a natural and functional ingredient.

Key Words: antioxidant, lipid, lipid oxidation, meat products, thiobarbituric acid
127 Effect of use of corn distillers solubles oil (CDSO) on broiler carcass skin and commercial egg yolk pigmentation. R. D. Malheiros*, K. A. Livingston, K. E. Anderson, and P. R. Ferket, Prestige Poultry Science Department, NC State University, Raleigh, NC, USA.

Carotenoids are pigments that function as antioxidants, immune modulators, and precursors for the synthesis of vitamin A. Tissue deposition of carotenoids are particularly important to avian species, as they are indicative of general health, and they increase the color of skin, meat, and egg yolk which enhance consumer acceptance of the final product. Corn distillers solubles oil (CDSO), a co-product of ethanol production, is available as an animal feed ingredient but a greater residual value may be recovered from CDSO if the carotenoid pigments (CrP) it contains is considered for use in poultry feeds. Because CDSO contains much of the natural yellow CrP of corn, we hypothesize that it can be used as a dietary replacement of synthetic carotenoids. Dietary inclusion of the CDSO was used in basal diets for broilers and laying hens containing white corn as a pigment-free reference. Production was evaluated, in addition to evaluation of CrP intensity in blood plasma, carcass breast and shank skin, and eggs yolk (Konica Minolta chromometer, CR400) colorimeter. All results were evaluated using JMP, and means compared by Tukey test ($P < 0.05$). For broilers (Ross 708), FCR was not affected by the treatments with the level of dietary inclusion of CDSO in place of soybean oil (0, 25, 50, 75, and 100%, replacement). Dietary CDSO inclusion level was positively correlated with CP content in blood plasma, breast skin, and Shank at 51 d of age. Plasma carotenoids was increased, compared with a control, according the inclusion of CDSO, showed 1.13, 1.97, 2.59, 3.47, 3.05 mg/L ($P < 0.0001$) respectively, showing a hight bioavailability of CDSO. For the laying hens (Hy-Line W36), after 2 weeks of adaptation to the 3 dietary levels of CDSO in place of soybean oil (0, 50 and 100%, replacement), feed intake, egg production, and external and internal egg quality was determined for the following 7 weeks. During the last week, blood plasma was collected for total CrP content evaluation. The plasma carotenoids (mg/L), were 2.61, 4.03, 6.27 mg/L respectively for 0, 50 and 100% inclusion of the CDSO. There were no treatment effects on feed intake, egg production, or gEgg/gFeed. Yolk color index increased linearly as the level of CDSO increased ($P < 0.0001$), indicating high bioavailability of CDSO. The results of this research clearly demonstrate that CDSO can be utilized as a concentrated source of xanthophyll carotenoids to enhance skin color in broilers, and yolk pigmentation in commercial eggs, and have a high bioavailability.

Key Words: egg quality, egg production, broiler production, distilled solubles oil, extract pigments

128 Addition of glycosaminoglycans on bone development of broiler chickens. A. Z. Curti*, E. T. Santos, L. Amoroso, F. M. O. Barbosa, and S. Sgavioli, 1Universidade Brazil, Descalvado, São Paulo, Brazil, 2Unesp, Jaboticabal, São Paulo, Brazil.

The purpose of this study was to determine if in ovo feeding and rearing feed with glycosaminoglycans (GAGs) and vitamin C would influence on histological evaluation broilers' bones. A completely randomized design in 2x2 factorial arrangement was applied, with 2 treatments during the incubation phase (uninject egg (without injection) and in ovo feeding of 4 μg additive/100 μL water on d 4 of incubation) and 2 treatments during the growth phase (diet with and without 0.74 g of additive/kg of feed). For each 4 μg of additive injected contained: 1.2 μg of chondroitin sulfate (CON), 1.2 μg of glucosamine (GLU) and 0.2 μg of vitamin C. It was collected one cm from bone diaphysis of the right tibia. The bone samples were processed according to usual methods for light microscopy. For measurements of the thickness of diaphysis and periostium were made 60 measures/slide. Data were submitted to ANOVA using the General Linear Model procedure (GLM) of SAS (SAS Institute, 2002). When means differed significantly by the F test at 5% probability. There was interaction among the factors ($P = 0.0267$) for thickness of diaphysis. Highest thickness was observed ($P = 0.0034$) for birds fed 0.74 g of additive/kg and no additive injected in ovo, and for birds received 4 μg of additive in ovo and did no additive in the diet ($P = 0.0027$). The GAGs can influence the long bones formation, because these substances stimulate the synthesis of the proteoglycans and collagen and are capable of increasing the biosynthesis of the matrix, they are essential in the endochondral ossification process. The GAGs in the diet reduced thickness of diaphysis periostium ($P = 0.0004$). In conclusion the additive could be used in ovo or in the rearing diet. The data found will serve as basis for future studies with different levels of GAGs and/or combination with other compounds.

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Key Words: ascorbic acid, chondroitin, glucosamine

129 Effect of methionine-hydroxy analogue (MHA-FA) and o-methionine at a quantitative ratio of 100:65 in layers in avairy production system. C. de la Cruz*, A. Lemme, M. Naatjes, T. Baumaister, F. Tallen, and H. Westendarp, 1Evonik Nutrition and Care GmbH, Hanau, Germany, 2University of Applied Sciences, Osnabrück, Germany.

The need for the supply of methionine and cysteine (M+C) to laying hens and the use of methionine sources to balance the amino acid profile has been discussed intensively. The European Authority for Food Safety concluded a considerably lower bioavailability of liquid hydroxy analog of methionine (MHA-FA) compared with DL-Met between 65 and 70% on weight basis. The objective of the study is to evaluate liquid MHA-FA to DL-Met supplemented to feed in a ratio of 100:65 in layers under commercial conditions. Two aviary houses with a total of 126,000 ISA Dekalb White untrimmed beak hens were used. Layers of 18 weeks of age were studied during 180 d in a commercial operation in Osnabrück, Germany. 63,000 birds were allocated in each aviary of 2 floors. Due to the commercial conditions of the trial eggs could be collected per aviary house, feed intake, live weight, and plumage quality were recorded per floor. Egg output and egg size distribution per house by treatments was performed in a 2-week interval. Egg size distribution also included counts of cracked and dirty eggs, as well as for mislaid eggs which were counted every day. Likewise, in the 2-week interval, body weights of 100 birds from each floor were determined by means of a wing scale. Furthermore, plumage was assessed using a 4-level quality classification. Birds were fed 2 feeding phases during the course of the study, phase 1 feed diet contained 17% crude protein (CP) and 2675 kcal metabolisable energy (ME), methionine sources inclusion were not the same, control treatment used 1.30 kg/t of liquid MHA-FA; in contrast, the experimental feed contained 0.845 kg/t DL-Met. Phase 2, % CP level was lowered to 16% while ME and methionine source inclusion were unchanged. Feed analyses showed average lysine levels of 0.84% and 0.85% in phase 1 and phase 2 diets. M+C levels without supplementation

Poult. Sci. 97(E-Suppl. 2)
in standard feeds were 0.59% and 0.57% whereas Methionine 0.33% and 0.32%. Results showed that the use of 65 parts of DL-Met had no disadvantageous effects on performance compared with the use of 100 parts of liquid MHA-FA. In addition, egg size distribution did not differ between treatments. From a biological perspective, results confirm the interchangeability of the methionine sources at a quantitative ratio of 65:100. Furthermore, there was a tendency toward better performance in the DL-Met treatment, which is indicated particularly in numerically lower mean feed conversion ratio (2.27 vs 2.42). No effects in plumage quality were found between treatments.

**Key Words:** laying hen, methionine sources, dl-methionine, liquid methionine-hydroxy analogue, avairy system

### 130 Effect of three strains of *Bacillus* on performance and microbiota composition in broilers. Y. Dersjant-Li1, L. Barnard*1, and M. I. Gracía2, 1Danisco Animal Nutrition, Leiden, the Netherlands, 2Imasde Agroalimentaria, Madrid, Spain.

The objective of this study was to investigate the effect of a probiotic product on performance and gut microbiota composition in broiler chickens. Two treatments were tested: 1), control diet (Con) containing phytase at 500 FTU/kg, 2) control supplemented with Enviva PRO (3-strain *Bacillus* probiotic, EP) dosed at 150,000 cfu/g feed. Birds received Paracox 5 vaccine at 5 times the recommended dose at 5 d of age to induce a mild coccidiosis challenge. A total of 624 d-old male Ross chickens were randomly allocated to 24 floor-pens (1.58 × 1.16m, 26 birds/pen). Each treatment was replicated 12 times. All diets were fed as mash at ad libitum over 3 phases (pre-starter (1 to 10 d); starter (11 to 21 d); and grower / finisher (22 to 42 d)). Diets were based on corn, soybean meal, rapeseed meal and wheat bran. Growth performance was measured including average daily gain (ADG), feed intake and feed conversion ratio (FCR) at 1, 10, 21 and 42 d of age. At d 21, ileal digesta samples were collected for microbiota analysis. Data were analyzed as one-way ANOVA using JMP 11 (*P* ≤ 0.05 considered as significant). A significant treatment effect was detected for ADG of broilers at 10 and 21 d of age. Compared with Con, EP treatment increased ADG of broilers by 12% and 5.6% (*P* = 0.0003) respectively during 0–10 and 0–21 d of age. FCR was reduced by 11.8% (1.58 × 1.16m, 26 birds/pen). Each treatment was replicated 12 times. All diets were fed as mash at ad libitum over 3 phases (pre-starter (1 to 10 d); starter (11 to 21 d); and grower / finisher (22 to 42 d)). Diets were based on corn, soybean meal, rapeseed meal and wheat bran. Growth performance was measured including average daily gain (ADG), feed intake and feed conversion ratio (FCR) at 1, 10, 21 and 42 d of age. At d 21, ileal digesta samples were collected for microbiota analysis. Data were analyzed as one-way ANOVA using JMP 11 (*P* ≤ 0.05 considered as significant). A significant treatment effect was detected for ADG of broilers at 10 and 21 d of age. Compared with Con, EP treatment increased ADG of broilers by 12% and 5.6% (*P* = 0.0003) respectively during 0–10 and 0–21 d of age. FCR was reduced by 11.8% (18 pairs, *P* = 0.0004) and 3.9% (6 points, *P* = 0.17) during 0–10 and 0–21 d of age, respectively. In addition, EP reduced *E. coli* counts in ileal digesta by 1.23 log (*P* = 0.001, 94% reduction) compared with Con. The differences on ADG and FCR did not reach a statistically significant level during 22–42 d and for overall 0–42 d of age, which might be due to the lack of challenge in the grower / finisher phase. However, for overall 0–42 d of age, FCR (body weight corrected FCR, corrected for 3 points for every 100g BW difference vs Con) tended to be lower in birds fed diets containing EP (*P* = 0.10, 1.647 vs 1.694 for EP vs Con, nearly 5 points reduction) than the birds fed the control diets. In conclusion, a probiotic based on 3-strains of *Bacillus* may provide beneficial effects on production performance in broilers especially during pre-starter and starter phases (0–21 d of age) and reduce *E. coli* colonization. Further research should be performed to evaluate the effect of probiotics on performance of broilers challenged in the grower / finisher (22–42 d of age) phase.

**Key Words:** probiotics, broiler, performance, *Escherichia coli*

### 131 Can feed additives increase antibiotics efficacy against *E. coli*? E. Grilli1, 2, A. Toschi1, G. Giovagnoni1, B. Tugnoli2, R. Tepper3, and A. Piva1, 3, 1DIMEVET, University of Bologna, Ozzano dell’Emilia, Bologna, Italy, 2Vetagro Reggio Emilia, Italy, 3Vetagro Inc, Chicago, IL, USA.

Aim of this study was to test whether non-antibiotic feed additives, i.e., organic acids and nature-identical compounds, can improve the efficacy of broad-spectrum antibiotics against *E. coli*. For this purpose the minimal inhibitory concentration (MIC) of amoxicillin (AMOX), neomycin (NEO) and colistin (COL) was tested against 8 strains of *E. coli*, isolated from broiler liver, alone or in combination with sorbic acid (SOR) and thymol (THY). The antimicrobial activity was evaluated with micro-dilution method in Brain Hearth Infusion (BHI) in which the substances were dissolved at the following concentrations: AMOX at 128, 64, 32 mg/L, NEO at 64, 32, 16 mg/L, COL at 2, 1, 0.5 mg/L; SOR at range concentration from 50 to 0.10 mM, THY at concentration range from 6.12 to 0.05 mM and the combination of SOR and THY (SOR+THY, in a 2:1 ratio) starting from 6.25 and 3.12 mM to 0.10 and 0.05 mM. Control strains were incubated with BHI only. The analysis was performed on 96-wells microtiter plates with 10^5 cfu/mL. The plates were incubated for 24 h at 37°C. After incubation, growth inhibition was evaluated by absorbance measurement at 630 nm. Data were analyzed with one-way ANOVA and differences were considered significant at *P* < 0.05. All the strains were resistant to AMOX up to 128 mg/L. Concerning NEO, 2 strains were inhibited at 64 mg/L and 4 strains at 32 mg/L, the remaining strains were resistant. All *E. coli* isolates were sensitive to COL at 0.5 ≤ MIC ≤ 1 mg/L. MIC values for THY and SOR acid tested alone were 3.12 and 50 mM, respectively, but when in combination the MIC was reduced by 2 and 16-fold respectively (1.56 and 6.25 mM). Sorbic acid at 1.56 mM plus thymol at 0.78 mM increased NEO efficacy by 2 and 3-fold for 6 strains and by 10-fold for one strain (*P* < 0.05). Similarly, adding the same concentration of SOR+THY increased NEO potency by 4-times for one strain. Again, 1.56 mM of SOR + 0.78 mM of THY to AMOX improved its efficacy up to 70% in one strain (*P* < 0.05). In conclusion, neomycin efficacy toward several strains of *E. coli* was significantly increased by the inclusion of thymol and sorbic acid. Moreover, where amoxicillin and more generally wide spectrum antibiotics are ineffective, the combined use of sorbic acid and thymol can inhibit *E. coli* growth. As these substances are commonly used as feed additives, this opens new perspectives to the problem of loss of efficacy of broad-spectrum antibiotics and antibiotic resistance.

**Key Words:** *E. coli*, antibiotic, feed additive, broiler

Infectious bronchitis (IB) is a disease of worldwide distribution, affecting birds of all ages. A large number of infectious bronchitis virus (IBV) variants are emerging in many countries; some being unique to a particular area, others having a more general distribution. Important differences among countries may arise regarding the challenge virus, that then it can be used for potency tests, and its validation as a vaccine. There are 2 groups (BR-I and BR-II) of Brazilian variants genetically distinct in Brazil, and recently, one (BR-I) was released a live attenuated vaccine. The aim of this study was to carry out an epidemiological survey of IBV strains isolated from outbreaks that occurred in the field between 2015 and 2017 in Brazil, and to identify those that were caused by non-Massachusetts genotypes (Non-Mass). Tissues, cloacal and tracheal swab samples were collected from broiler and breeder flocks. The samples were analyzed using real-time reverse transcriptase polymerase chain reaction (RT-PCR) targeting the untranslated region (UTR) gene of IBV. Then, the positive samples were analyzed again by real time RT-PCR for detection of Non-Mass genotypes. In a total of 143 samples positive for IBV, 123 (86%) were classified as Non-Mass, in which 81 (66%) samples were examined in broiler and 42 (34%) in breeder. From the 123 Non-Mass samples, 77% were isolated in the southern Brazil, followed by 11%, 10% and 2% in the southeast, central-west and northeast regions, respectively. IBV was highly prevalent in chicken flocks in Brazil between 2015 and 2017, and most were identified as variant strains, not belonging to the Mass genotype. Outbreaks occurred mainly in the southern region of the country, where chicken production is more intensified. The epidemiological survey shows how the IBV strains are distributed in Brazil, and indicates which vaccine protocol is most appropriate for each region.

Acknowledgements: We thank the Animal Health Laboratories of Seara Foods.

Key Words: infectious bronchitis virus, non-Mass genotype, epidemiological survey, Brazil.
(P < 0.05). The birds of the T2 presented lower number of positive birds and presented lower SH count in relation to the control group T1. As a conclusion: the use of Poulvac ST (T2) vaccine was shown to be efficient in reducing SH swab samples and organs at the ages evaluated. In relation to SH count in cecum: under the conditions evaluated in this experiment the use of the Poulvac vaccine ST (T2) has been shown to be an efficient treatment for reducing SH count in cecum samples 35 d of age. Cross-immunity between ST and SH has been demonstrated.

Key Words: arO A genetically modified vaccine, cross-protection, Salmonella Heidelberg, vaccination, food-borne disease

135 Evaluation of protective long-term immunity and passive immunity transfer by an orally administrated subunit vaccine against Salmonella spp. in poultry. E. R. Gumina*1, E. Moreira1, G. Almaraz1, A. Sujezky1, and S. Layton2,1Vetanco International/BV Science, Vicente Lopez, Buenos Aires, Argentina, 2Vetanco S.A. Buenos Aires, Argentina.

The objective of this study was to determine the efficacy of an inactivated subunit vaccine administered orally, Biotech Vac Salmonella, by evaluating the protection and persistence of the induced humoral immune response in 2 lots of layers, as well as evaluating the transfer of passive immunity through the yolk sac during the hatching period of one breeder flock. Long-term protection and immunity was evaluated in 2 lots of commercial layer hens (HyLine, n = 120,000 layers/lot) located in Buenos Aires, Argentina. Biotech Vac Salmonella (BVS), Vetanco S.A. was administered in lot 1 at d3, 16 and 91 and in lot 2 at d3, 16 and 84. Mucosal scrapings and serum were collected in lot 1 at 6, 21, 33, 67 and 89 weeks of life, and in lot 2 at 5, 13, 22, 56 and 78 weeks of life to determine slgA and IgY respectively (n = 15 paired samples/sampling point). To evaluate passive immunity transfer, a commercial breeder farm located in the province of Entre Rios, Argentina (Cobb n = 240,000 breeders) was vaccinated on d3, 17 and 119 with BVS, 46 weeks after vaccination, yolk sac from 10 PIPs were collected at the hatchery to determine BVS specific IgY and IgA. The humoral immune response in the mucosa (slgA) and circulating (IgY) induced by vaccination with Biotech Vac Salmonella was evaluated by means of a proprietary ELISA developed specifically for the Biotech Vac Platform. Absorbances obtained by ELISA were transformed and the data expressed as S/P ratios. Data were analyzed using Student’s 2-tailed t-test assuming unequal variances to compare the difference between groups using Prism statistic software. A value of P < 0.05 was considered significant. Results indicate that at all sampling times after administration of Biotech Vac Salmonella there was a significant increase (P < 0.05) of slgA and IgY in layers. Birds immunized with Biotech Vac Salmonella showed protective slgA values (S / P ratio ≥ 2.0) throughout the evaluation period. Additionally, the presence of vaccine specific IgY antibodies was observed throughout the evaluation period. Moreover, no correlation was observed between mucosal slgA and circulating IgY/IgG either in terms of protection or quantity of vaccine specific antibodies produced. The increased presence of Biotech Vac Salmonella specific IgA and IgY in the yolk sac from PIPs, indicates that there is a vertical transfer of maternal antibodies to the progeny after immunization of the breeders.

Key Words: immunity, vaccine, Salmonella, poultry, immunoglobulin


Stressful events during production such as routine vaccination protocols and high environmental temperatures are common challenges for poultry species. Chicks' prenatal environment can be influenced by these events, inducing trans-generational effects. This study evaluated whether an immune challenge and a chronic heat stress (CHS) exposure on adult Japanese quail can modulate later immune responses and whether those effects can be reflected in their offspring. Eighty adults were inoculated with inactivated Salmonella enteritidis (challenge initiated at 115 d of age) and then exposed to a CHS along 9 d (between 121 to 129 d of age) by increasing the environmental temperatures from 25 to 34°C during the daylight hours. A 2 × 2 factorial experimental design was used and 4 treatments groups (20 birds each) were therefore defined: Non Challenged-Non Stressed, Challenged-Non Stressed, Non Challenged-Stressed and Challenged-Stressed. Between 125 and 130 d of age, eggs were collected and incubated. Newly hatched chicks (n = 82) were identified according to their parental treatments. Percentage of inflammation, Heterophil/Lymphocyte (H/L) ratio and antibody titers against sheep red blood cells (SRBC) were evaluated both in adults and their offspring. In adults, compared with controls, stressed groups showed a reduced percentage of inflammation (P < 0.001) and an elevated H/L (P = 0.02), regardless of the challenge. No differences between groups were found in SRBC titers. In offspring, the percentage of inflammation was elevated (P = 0.03) and the SRBC titers were reduced (P = 0.02) in chicks whose parents were stressed, independently of the challenge. The H/L ratio of the chicks did not differ between groups. The immune challenge had no impact on the selected variables either on the adult quails or in their offspring, suggesting that all groups (stressed or not) were capable of dealing with the vaccine challenge. On the other hand, the CHS affected the immune response both in the adults and in their offspring which could have important welfare and productive implications.

Key Words: poultry, immunity, stress, offspring, parental
Effect of breeder age and incubation period on slow-growing broilers performance in the initial phase. J. P. Machado¹, N. S. M. Leandro², I. C. S. Araujo², S. D. Assis³, and S. Veríssimo¹,
¹Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ²Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

The objective was to study the effects of slow-growing broiler breeder age of the slow-growing chicken and the effect of the permanence period of the chick on the hatching machine after hatch on the performance of the chicks in the initial phase. A total of 606 eggs were obtained from Isa Label Neck Naked broiler breeder flocks. Between 479 and 504 h of incubation, the eggs were checked individually to record hatched chicks. According to the incubation period, the chicks were marked and divided into 2 groups (early: chicks that hatched between 479 and 485 h of incubation, and late: between 491 and 497 h of incubation). The incubation was finished with 504 h and all chicks removed from the machines. A total of 384 one day old chicks, with an initial mean weight of 38.87 g ± 3.88 g from the incubation test (breeder of different ages and different incubation periods) were housed in cages. The treatments were 2 breeder ages (28 and 51 weeks) and 2 incubation periods (early and late). The design was randomized blocks (sex), in a factorial arrangement (2x2), with 4 replicates, with 12 birds per pen. Feed intake, weight gain, feed conversion, body weight and viability were evaluated up to 21 d of age. The data were submitted to ANOVA and the means were compared by Tukey’s Test, using software R (3.4.1). There was no interaction effect between the factors breeder age and incubation period for feed intake, feed conversion and viability (P > 0.05). The breeder age influenced (P < 0.05) the weight gain and body weight of the chicks, with chicks from older breeder having a higher body weight at 21 d of age. In the same way, there was effect of the incubation period (P < 0.05) on weight gain and body weight. Chicks hatched during a later incubation period (between 491 and 497 h of incubation) presented higher body weight when compared with early chicks (between 479 and 485 h of incubation). In conclusion, chicks from older breeder, Isa Label Neck Naked strain, present better performance when compared with chicks from young breeder chicks, and that hatched chicks with late incubation period result in better performance.

Acknowledgements: Thanks EVZ/UFG

Key Words: chick, hatch window, free range

Effect of slow-growing broiler breeder age on the incubation parameters. J. P. Machado¹, N. SM Leandro², I. CS Araujo², S. D. Assis³, and R. R. Santos¹, ¹Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ²Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

The breeder age is one of the main factors affecting variability in egg characteristics, fertility, hatchability and performance of broiler chickens. The objective of this study was to evaluate the effect of slow-growing breeder age on the incubation parameters. The treatments were 2 breeder ages (38 and 51 wks). A total of 606 fertile eggs obtained from Isa Label Naked Neck slow-growing broiler breeder flocks were distributed in a randomized complete block design (incubators), with 9 replicates (trays) of 67 eggs each. The temperature and relative humidity of the incubators were set at 37.5°C and 60%, respectively. After 18 d of incubation, the eggs were placed in air-permeable bags to isolate the treatment and distributed in hatching trays, with temperature of 36.5°C and humidity of 70%. The hatching of the eggs was followed from the first hatching, with intervals of 6 h, and the test was finished with 504 h of incubation. The variables studied were: hatchability of fertile eggs, hatch window and embryodiagnosis. The hatchability and window of birth data were submitted to ANOVA and the means were compared by the t-test and embryodiagnosis to the Fisher’s test. A significance level of 0.05 was used. For hatchability, no difference (P > 0.05) was observed between the treatments studied. The hatchability was 85.50% and 82.29% for the 38 and 51 breeders age (respectively). Shortest hatch window (24.97 h) was observed for chicks born to young breeders (38 wks) when compared with old breeders (26.72 h) (P < 0.05). Treatments did not influence (P > 0.05) embryo mortality. Thus, it can be concluded that Isa Label Naked Neck slow-growing breeder age does not interfere in the incubation parameters for hatchability of fertile eggs and embryodiagnosis. However, chicks from young breeders had a shorter hatch window.

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Eff Word: free range, hatchability, chick, Isa Label Naked Neck

Embryonic mortality, hatchability, and quality of chicks incubated in single and multiple stage machines. M. Alves da Costa¹, M. Laboissiere*², J. H. Stringhini¹, D. A. Cordeiro¹, and R. M. J. Filho³, ¹Universidade Federal de Goias, Goiania, Goias, Brazil, ²Universidade Estadual de Goias, São Luis de Montes Belos, Goias, Brazil, ³São Salvador Alimentos, Itaberai, Goias, Brazil.

The objective of this study was to evaluate embryonic mortality rates (initial, intermediate and final), hatchability and quality of chicks from incubated eggs in single and multiple stage machines. The experimental incubation was carried out in single stage machines and multiple stage using in total 1,000 eggs obtained from Cobb 500 broiler breeders with 35 weeks of age. Twenty chicks from each incubator were classified immediately after birth and subjected to quality analysis. Quality characteristics evaluated were: Activity, feathering and appearance, eyes, legs and fingers, shins, navel, remaining membranes and yolk residue. Embryonic mortality and hatching percentage were analyzed by the Chi-squared test (P < 0.05), and to evaluate post-hatch chicks variables, ANOVAs and F test (P < 0.05) was performed by Software R. The initial, intermediate and final mortality as well as the occurrence of hatching were not different (P > 0.05) among the 2 incubation methods evaluated, indicating that the environmental control was adequate for the incubation processes in different stages, to obtain acceptable hatchability rates, such as temperature, relative air humidity, CO₂, O₂ and egg turnover. The difference between the post-hatch chicken parameters evaluated (P > 0.05) was not observed, confirming the previous hypothesis that single and multiple stage incubators can be used to obtain quantitatively and qualitatively desirable day-old chicks. It was observed that there was no influence on the variables analyzed according to the different types of incubation machines. These results were different from some results available in the literature.

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Key Word: broiler embryonic development, embryodiagnostic, incubation performance, incubation machines system
Effects of the use of pre-placement diet for broiler chicks upon intestine development. P. C. Cardelo1, M. M. Saldanha2, D. P. Vaz3, N. C. Baião2, and L. J. C. Lara2, Viati Soluções Integradas Para o Agronegócio, Belo Horizonte, MG, Brazil, 1Department of Zootecnia - EV/UFMG, Belo Horizonte, MG, Brazil, 2DSM, São Paulo, SP, Brazil.

The initial development of gastrointestinal tract is directly related to feed intake. The aim of this study was to verify the effects of the use of a pre-placement diet inside transportation boxes for chicks from young and old broiler breeders upon intestine initial development. A total of 520 male Cobb broiler chicks were distributed in a completely randomized experimental design in a factorial arrangement 2 × 2 × 2 with 8 treatments: 2 broiler breeder age (BBA) (29- and 55-week-old), 2 periods of time between hatch and placement (THP) (24 and 48 h) and the use or not of a pre-placement diet (PPD). It was used 6 replications of 2 chicks for each treatment for relative weight of small intestine (RWI) and 8 replications of 15 measurements for each treatment for villus height (VH). Chicks that received PPD inside transportation boxes, received 2.5 g/bird. It was analyzed RWI and VH of duodenum at villus height for chicks from young broiler breeders that did not received PPD had lower RWI than those that received within 24 h. Also, chicks from young broiler breeders that did not received PPD also had higher RWI (P ≤ 0.05). At 14 d, chicks from young broiler breeders that did not received PPD had greater RWI (P ≤ 0.05). At the age of 3 d, chicks from young broiler breeders that were placed within 48 h had the smallest VH (P ≤ 0.05). At 7 d of age, chicks from young broiler breeders, placed within 48 h and that did not receive PPD had the smallest VH (P ≤ 0.05). And at the age of 14 d, the use of the PPD for chicks from young breeders that were placed within 48 h increased VH (P < 0.05). In conclusion the use of PPD stimulated initial growth of small intestine and improved crypt for chicks from young broiler breeders until 14 d. So, the use of PPD is indicated for chicks from young broiler breeders that undergo for long period of fasting to improve intestine mucosa development.

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Key Words: broiler breeder pullet, skip-a-day, egg production, body weight, alternate day feeding

Influence of energy source of diet and environmental temperature on energy and protein requirements of maintenance and gain in European quails. G. C. Pereira*, G. C. A. Dos Santos, N. E. Da Cruz, J. J. Filho, D. R. P. Da Silva, and J. H. V. Da Silva, Universidade Federal de Paraíba, Paraíbeas, Paraíba, Brazil.

The raise temperature is the main environmental problem for animal production in many tropical areas, especially, in the semiarid regions of world. Quail have small body and are knowed as so much resistant to high temperatures. But when the environmental temperature rise above 18°C the quail’s feed intake and performance decreases. In hot climate replace starch or protein as main energy source by lipid can be better strategy than to buy expensive equipments and to pay a high price for power to improve the temperature into of quail’s house. There are many studies showing the lipids produce low heat increment in broiler and hens metabolism, but there aren’t studies with european quails. This experiment was performed to estimate the requirements for maintenance and gain of energy (Em and Eg) and protein (Pm and Pg) of European quails of 10 to 35 d of age fed diets with 15% of energy from starch, protein or lipid. About 432 quails were randomly design in 2 room temperature (25° or 35°C) and fed 3 levels of each diets. The energy sources and room temperature influenced the requirements for maintenance and gain of energy (Em and Eg) and protein (Pm and Pg) of European quails of 10 to 35 d of age fed diets with 15% of energy from starch, protein or lipid. About 432 quails were randomly design in 2 room temperature (25° or 35°C) and fed 3 levels of each diets. The Pm and Em for each E source and room temperature were estimated throughout linear regression of gain of P or E in function of P or E intake (ad lib.), and 40% of ad lib.) and each diet had 4 replicates of 6 birds. The Eg and Pg were determined with 200 quails alloted in room temperature of 26°C, which 40 were slaughtered at 10, 15, 20, 25 and 30 d of age. The Pg and Eg were calculated per differences of P and E retention in empty body weight (EBW) among 2 groups of quail ages (EBW 15 d of age - EBW 10 d of age). The Pm and Em were measured in room temperature of 26°C, which 40 were slaughtered at 10, 15, 20, 25 and 30 d of age. The Pg and Eg were determined with 200 quails alloted in room temperature of 26°C, which 40 were slaughtered at 10, 15, 20, 25 and 30 d of age. The Pg and Eg were calculated per differences of P and E retention in empty body weight (EBW) among 2 groups of quail ages (EBW 15 d of age - EBW 10 d of age). The Pg and Eg were determined with 200 quails alloted in room temperature of 26°C, which 40 were slaughtered at 10, 15, 20, 25 and 30 d of age. The Pg and Eg were calculated per differences of P and E retention in empty body weight (EBW) among 2 groups of quail ages (EBW 15 d of age - EBW 10 d of age). The Pg and Eg were calculated per differences of P and E retention in empty body weight (EBW) among 2 groups of quail ages (EBW 15 d of age - EBW 10 d of age). 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the requirements of Em, however the replace by lipids reduced in both temperatures. The Eg were highest (5.89, 5.3, and 6.11 kcal/g) at 26°C, than at 35°C (5.48, 5.13, and 5.89 kcal/g), respectively, for E source of starch, protein or lipid. The lipids decrease the Em in high temperature and can be important source of energy for quails rearing in hot climates. All energy sources decrease quail’s energy and protein requirements for maintenance and gain in hot environments.

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Key Words: European quail, effect of temperature, stress by hot climate

143 Bone mineral density, fat and lean mass in normal and pendulous crop chickens. E. Alves de Almeida*,1, F. H. A. Silva3, L. Amoroso1, M. Macari1, S. M. B. Artoni1, T. G. Crowe2, and R. L. Furlan1, 1UNESP, Universidade Estadual Paulista, Department of Morphology and Animal Physiology, Jaboticabal, SP, Brazil, 2College of Engineering, University of Saskatchewan, Saskatoon, SK, Canada, 3Cobb Vantress, Siloam Springs, AR, USA.

The objective of this study was to understand how the pendulous crop incidence can influence the bone characteristics, percentage of fat and lean mass in pendulous crop chickens. The experimental design was completely randomized, being analyzed the difference between crop situations (normal and pendulous) for each combination between environmental temperature (low temperature and thermoneutral) and light program (Continuous and light/dark program), totaling 4 treatments. There were analyzed bone mineral content (BMC) (grams), bone mineral density (BMD) (g·cm⁻²), Fat (%), Lean+BMC (grams) and total mass (grams). For this study, there were used 42 d old broiler chickens, being 7 with normal crop for each treatment. Pendulous crop chickens was selected according the number of live birds, with one pendulous crop chicken in the treatment with thermoneutral temperature and 24 h of continuous light, and 2 chickens for the other treatments. The chickens were anesthetized, and scanning by the dual-energy x-ray absorptiometry (DXA). BMC (g), BMD (g·cm⁻²), Fat (% and g), and lean mass (g) were subjected to ANOVA, using Tukey’s test at 5% of probability using the SAS (Statistical Analysis System) program. In the treatment with low temperature + 24 h of continuous light, normal crop chickens presented higher BMC (39.74 g) than pendulous crop chickens (29.48 g), as well higher BMD (0.130 g·cm⁻² – Normal crop vs. 0.099 g·cm⁻² - Pendulous crop), lean mass (2,630.33 g – normal crop vs. 2,203.80 g – pendulous crop), and total mass (3,029.20 g – normal crop vs. 2,485.7 g – pendulous crop). At thermoneutral temperature + light/dark program, normal crop chickens presented significantly higher BMC (41.20 g) than pendulous crop chickens (22.41 g), as well higher BMD (0.128 g·cm⁻² – Normal crop vs. 0.111 g·cm⁻² - Pendulous crop), lean mass (2,861.94 g – normal crop vs. 1,946.55 g – pendulous crop), and total mass (3,328.8.20 g – normal crop vs. 2,178.8 g – pendulous crop). Pendulous crop chickens reared with light/dark program showed less % of fat (P < 0.05) than normal crop chickens in the 2 environmental temperatures (low and thermoneutral). Pendulous crop impacted negatively in the chicken bone condition, since chickens with pendulous crop presented lower bone mineral content and density, being the intensity of the problem higher according the situation that the bird was reared (rearing temperature and light program).

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Key Words: DXA, densitometry, fat content, mineral content

144 Dietary soluble fiber (pectin) can be use for laying hens without to compromise their performance and egg production and quality. M. Thimotheo*, G. L. Zanirato, R. S. Paulino, K. Pedersoli, and I. C. Boleli, São Paulo State University, Faculty of Agricultural and Veterinary Sciences, Department of Animal Morphology and Physiology, Jaboticabal, São Paulo, Brazil.

Soluble fiber addition in the diet to control weight gain has been proposed for humans and other animals, device to its reducer effect on the feed ingestion, digestibility and nutrient absorption. This finding has suggested the potential use of the soluble fiber in the control of laying hen satiety and body weight during productive period. The present study analyzed if continuous consumption of soluble fiber (pectin) in the diet influences the body weight and the egg production and quality of hens. A hundred and 92 Isa Brown laying hens were homogeneously distributed by mean body weight in 4 treatments that differed in pectin percentage in a standard feed (without pectin: control, and with 0.25, 0.5 and 1.0% of pectin), with 6 replicates of 8 birds per treatment, totaling 24 plots. They were housed in a conventional laying shed made up of galvanized wire cages equipped with nipple drinkers and galvanized troufed feeders, to control food intake and the effect of soluble fiber. The experimental period occurred during the laying peak of the hens (from 28th to 39th week of age = 12 weeks). The birds received water and diet ad libitum and were submitted to a daily light regimen of 17L:5D. The diets were isoproteic, isenergetic, isocaloric and isophosphoric, and formulated to meet the requirements of birds during the laying period. Body weight was analyzed at the 12th week of treatment. Feed intake (g) and egg production (number of eggs) were calculated per bird in the experimental period. All produced eggs were collected and weighed 3 times a day (7, 12 and 16h). Egg quality was evaluated according to egg size and weight (jumbo: ≥ 66g, extra: 60–65.99g, large: 55–59.99g, medium: 50–54.99g, small: 45–49.99g and very small: < 45g), and mean egg percentages in each class were calculated for each treatment based on the replicates. All variables were analyzed as to effect of the pectin (P), using the experimental model: Y = μ+P+e, in which: Y are the dependent variables; μ is the general mean and e is the standard error. Data were analyzed using the GLM procedure of the SAS, considering 5% probability. Body weight (control:1,836g; 0.25%:1,888g; 0.5%:1,882g; 1%:1,871g; P=0.9137), feed intake (control:8,991g/bird; 0.25%:8,845g/bird; 0.5%:8,841g/bird; 1%:8,829g/bird; P=0.7919), egg number (control:81eggs/bird; 0.25%:82eggs/bird; 0.5%:81eggs/bird; 1%:80eggs/bird; P=0.6838) and egg percentage within each egg quality class were not influenced by pectin (P > 0.05). The results showed that until 1% pectin can be included in the diet of laying hens without to compromise the hen weight and performance.

Key Words: citric pectin, feed additive, feed intake

145 Characterization of the internal and external quality of white egg in commercial poultry producers in Chile. M. Hidalgo*, F. Manetti2, and C. Valenzuela2, 1DSM Nutritional Products, Santiago, Chile, 2Facultad de Ciencias Pecuarias y Veterinarias, Universidad de Chile, Santiago, Chile.

In Chile, the egg industry has been showing steady growth. It is estimated that 73 percent of the national egg production are white eggs. Due to the above, and to the constant growth of customer demands, the quality of the final product becomes relevant. Hence, the present study comes up from the need to characterize the quality of the eggs through the measurement of characteristics that, although closely related to each other, can be identified as external or internal characteristics. A total of 10 producers where included in this study, representing more than 50% of the national egg production. These 10 production sites have been

The aim of this study was to compare the ages and levels of hot blade beak trimming in Japanese quails on the performance one week after the procedure and at the end of the experimental period. Seven hundred 70 (770) Japanese quails (Coturnix coturnix japonica) of one day of age for the rearing phase (1–35 d of age) were used and distributed in a completely randomized design, with 7 treatments, 5 replicates of 22 birds each. The treatments were: not trimmed birds (ND), cauterization of about one-third of the beak at 14 d of age (CAUT 14), cauterization of about one-third of the beak at 28 d of age (CAUT 28), moderately beak trimming, removing approximately 1/3 of the beak at 14 d of age (MOD 14), moderately beak trimming, removing approximately 1/3 of the beak at 28 d of age (MOD 28), severe beak trimming, removing approximately 1/3 to 1/2 of the beak at 14 d of age (SEV 14) and severe trimming, removing approximately 1/3 to 1/2 of the beak at 28 d of age (SEV 28). The data were submitted to the ANOVA using the resources of the SISVAR program and the means compared by the Tukey test at 5% of probability. The intact beak (ND), which were CAUT 14 and MOD 28 showed higher feather pecking frequency (P < 0.05) at the end of the experimental period. Thus, minor feather damage (smaller areas without plumage) may be checked at the beak trimming treatments at 14 d and severe beak trimming at 28 d when compared not beak trimmed birds (P < 0.05). In general, it was possible to note that birds not beak trimming or that were late beak trimming had greater plumage damage because they had long beaks, with the exception of SEV 28, because in this the proportion of beak removed was higher. Therefore, cauterizations of about one-third of the beak and moderately beak trimming, removing approximately 1/3 of the beak at 28 d of age were not able to efficiently prevent feather pecking compared with methods conducted at 14 or when there was a more proportion of beak removed which resulted in decrease frequency of feather damage and smaller area of plumage damage.

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Key Words: Coturnix japonica, welfare, feed intake, beak trimming.
The objective was to evaluate the microencapsulated sodium butyrate (MSB) supplementation in the maintenance and regeneration processes of the intestinal mucosa and of broiler chickens from 22 to 42 d of age submitted or not to enteric challenge. 1080 male 22-d-old Cobb Slow lineage broilers were distributed in a randomized design in a 2 × 2 factorial scheme (supplemented diet or not with MSB vs. with or without enteric challenge), totaling 4 treatments and 9 replicates of 30 birds/pen. At 22 d of age, the birds in the coccidiosis-challenged groups were challenged with 20 times the label-recommended individual commercial dose (1000 doses per bottle of freeze-dried vaccine) of coccidial vaccine in the crop. Two days after, the challenged birds received an inoculum containing Escherichia coli (ATCC 8739), applied directly in the crop (10⁶ UFC/bird). Samples of the intestinal mucosa were collected at 28 and 42 d of age after necropsy of 2 birds/replicate (18 birds/treatment) for evaluation of intestinal morphometry using light and scanning electron microscopy (SEM), inflammatory mucosal condition, and analysis of the permeability of the mucosal intestinal by method of serum fluorescein isothiocyanate dextran (FITC-d). The statistical analysis of the data was performed using the GLM procedure and the non-parametric data were analyzed through the Kruskal-Wallis test of the SAS software. Non-inoculated birds showed a lower (P < 0.05) oocyst counting than birds that were inoculated, regardless the diet, basal or supplemented with MSB. Birds challenged, regardless the diet, presented worse (P < 0.05) performance. Serum FITC-d levels were not altered (P > 0.05) by the challenge or the diet, demonstrating no difference in intestinal permeability. One week after the challenge, the birds showed higher cell turnover rate through the increase of depth and width of the crypt, reduction of the villi length:depth ratio of the duodenum crypt and smaller area of absorption in the mucosa of the jejenum in relation to the control. The use of MSB on challenged group significantly increased the length villi and minimized the destroyed and degenerative aspect of villi seen by SEM at 28 d compared with the challenged group not fed with MSB, associated with reduced fusion of villi and inflammatory cell infiltration. Dietary supplementation of broilers from 22 to 42 d of age with MSB submitted or not to an enteric challenge did not influence the performance of broilers, but contributed to the proliferation and renewal of the intestinal mucosa.

Key Words: coccidiosis, fusion of villi, intestinal permeability, mucosa renewal

149 Effects of emulsifier on growth performance, nutrient availability and plasma biochemical indices of broilers fed diets supplemented with rice bran oil. W. Li⁴, L. Wei², W. Jiang², L. Zhao¹, J. Zhang¹, C. Ji¹, and Q. Ma¹, ¹State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, P. R. China, ²College of Life Sciences and Food Engineering, Hebei University of Engineering, Handan, Hebei, P. R. China.

Dietary fat or oil is very important supplement for broilers because of higher energy density than pigs and other poultry. Rice bran oil (RBO) is rich of monounsaturated fatty acids and not to be emulsified by broiler itself. This study was conducted to investigate the effects of a commercial emulsifier on the growth performance, nutrient availability and plasma biochemical indices of broilers fed diets supplemented with graded levels of rice bran oil. 648 Arbor Acres male broilers with similar body weights (45.8 ± 0.30 g) at 1 d of age were randomly allotted to 9 treatments with 6 replicates of 12 birds each. A 2-way factorial design involved in 3 RBO levels: low, medium, and high oil levels (LO, MO, and HO), corn-soybean meal basal diets supplemented with 2.2, 2.7, 3.2% RBO during 0–21 d and 3.0, 3.5, 4.0% RBO during 22–42 d, respectively and 3 emulsifier addition amount: E0 (0 mg/kg), E250 (250 mg/kg) and E500 (500 mg/kg). LO group had higher (P < 0.01) feed to gain ratio (FGR) compare with the MO and HO groups during 0–21 and 0–42 d. Compared with the LO group, the MO and HO groups had higher (P < 0.01) availability of dry matter (DM) during 10–12d, and higher (P < 0.01) gross energy (GE) and other extract (EE) availabilities during 10–12 and 40–42 d. Both the RBO and emulsifier levels had no effect (P > 0.05) on the body weight (BW), average daily gain (ADG), and mortality rate during 0–21 22–42, and 0–42 d. There was interaction (P < 0.05) between RBO and emulsifier level in the GE availability during 40–42 d. E500 groups had higher (P < 0.05) GE availability than the E0 groups when the birds were fed with the diet supplemented with medium or high RBO level with no difference (P > 0.05) existed between LO-E0 and LO-E500. Conclusively, both RBO and emulsifier could increase the nutrient availabilities, and dietary emulsifier could help more energy extract from rice bran oil.

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Key Words: emulsifier, nutrient availability, plasma biochemical indices, broilers, rice bran oil

150 Combating the most occurring mycotoxin in South America: Fumonisins. J. Laurain, M. Gallissot, M. Rodriguez, and M. N. Tavares*, OLMIX S.A., Brehan, France.

A recent survey highlighted that, in South America, 94.4% of the feedingsuff samples analyzed between 2013 and 2016 were contaminated with fumonisins, making it the most occurring mycotoxin in the area, and representing a significant threat for animal performance. The objective of the study was to evaluate the capacity of an algae-clay based product (MTX+) to manage fumonisins risk in poultry production. Three trials were implemented. The first trial, conducted by the Samitec Institute (Brazil), tested the capacity of this product to decrease the effects of an acute fumonisins contamination (100 ppm) under experimental conditions. The 2 other trials, conducted in field conditions, tested the capacity of the product to counteract fumonisins effects on breeding hens (n = 50,500) and broiler chickens (n = 308,700) in a context of natural fumonisins contamination (from 850 to 3,500 ppb). The results of the experimental study showed that the product significantly improved...
performance (feed intake and growth), reduced by the contamination in fumonisins. Clinical biochemistry and liver parameters were also significantly improved. In the field, the product increased the laying rate of breeding hens (+6%, \( P = 0.014 \)), leading to an improved productivity of the farm. In broiler chickens, the product increased the production efficiency factor (PEF) by 10% and the return over feed cost by 36% compared with control. This series of trials confirmed that fumonisin contamination has a negative impact on poultry performance. The use of a specific algae-clay based product succeeded in preventing this impact on performance and productivity, both in experimental and commercial conditions.

Key Words: mycotoxin, fumonisin, algae, clay, seaweeds

151  **Histological evaluation on bone and cartilage of broiler chickens feeding with glycosaminoglycans and vitamin C**  
F. M. O. Barbosa1, E. T. Santos2, L. Amoroso2, A. Z. Curti1, and S. Sgavotili1, 1Universidade Brazil, Descalvado, São Paulo, Brazil, 2Unesp, Jaboticabal, São Paulo, Brazil.

In the present study, we examined the effects of glycosaminoglycans (GAGs) and vitamin C (in ovo feeding and feed nutrition) on histological evaluation (bone and cartilage) of broilers. A completely randomized design in 2x2 factorial arrangement was applied, with 2 treatments during the incubation phase (an injected egg and injection egg of 4 μg additive/100 μL water on d 4 of incubation) and 2 treatments during rearing – from one to 42 d old (diet without and with 0.74 g of additive/kg of feed). For each 100 g of additive injected contained: 30 g of chondroitin sulfate (CON), 30 g of glucosamine (GLU) and 5 g of vitamin C. For each 100 kg of feed was used 30 g of GLU, 24 g of CON and 20 g of vitamin C. It was collected one cm from bone diaphysis and proximal epiphysis cartilage, both of the right tibia, were measured the osteocytes and osteoblast bone number and chondrocytes cartilage number, respectively. The samples were processed according to usual methods for light microscopy. Forty-eight slides were made, with 12 replications/treatment. For the cell count of osteocytes and osteoblast number an area of 12.05 mm² was stipulated and for chondrocytes number an area of 869 mm². Data were submitted to ANOVA using the General Linear Model procedure (GLM) of SAS (SAS Institute, 2002). When means differed significantly by the F test at 5% probability. There was interaction among the factors (\( P = 0.0203 \)) for osteoblast number. Highest number was observed (\( P = 0.042 \)) for birds that received feed with 0.74 g of additive/kg of feed, without additive in ovo feeding, and for birds that received in ovo feeding with 4 g of additive, without additive in during rearing (\( P = 0.0084 \)). The bone is constantly destroyed or resorbed by the osteoclasts and then replaced by the osteoblasts in a physiologic process called bone remodeling. Vitamin C and GAGs were an important inducer of osteoblast differentiation, stimulating secretion of extracellular matrix rich in collagen. However, in ovo feeding with 4 μg of the additive and the inclusion of 0.74 g of additive/kg of feed in broiler diet during rearing reduced (\( P = 0.0001 \) and \( P = 0.0108 \), respectively) osteocytes number of the tibia diaphysis. Osteocytes are the mature osteoblasts found inside the bone matrix, they are the most abundant cells in the bone. They are responsible for the bone matrix maintenance. Additional studies are required to determine the effect of chondroitin and glucosamine inclusion in the broiler feed on the skeletal development and the optimal concentration in broiler diets.

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Key Words: ascorbic acid, chondrocyte, osteoblast, osteocyte

152  **Performance comparison between dl-methionine and dl-methionine-hydroxy analogue (MHA-Ca) at a quantitative ratio of 65:100 in brown layers**  
C. da Cruz1, E. T. Santos2, L. Amoroso2, A. Z. Curti1, and S. Sgavotili1, Jaboticabal, São Paulo, Brazil.

Recently, European Authority for Food Safety concluded that dl-methionine-hydroxy analogue is less bioavailable than dl-methionine in poultry. Accordingly, this experiment was designed based on the assumption that bioavailability of MHA-Ca was 65% relative to dl-Met on a weight basis to challenge this assumed bioavailability of Met sources. This study aimed to evaluate dl-Met to MHA-Ca to supplement to feed in a ratio of 65:100 on brown layers performance. A randomized complete arrangement trial was designed to compare 5 treatments using 1440 ISA Brown layers of 18 weeks of age, allocated in group sizes of 30 in enriched cages during 32 weeks. A control group (n = 12) that received no methionine supplement was clearly deficient in Met+Cys content. In 2 treatment groups (n = 9 each), the feed was supplemented with 1.2 or 2.4 kg/t MHA-Ca. Compared with this, in treatment groups 4 and 5 (n = 9 each) dl-Met was added to the feed in amounts of 0.78 and 1.56 kg/t, which corresponds to a replacement ratio of 65:100 for the 2 inclusion levels. While the high dosage was meant to cover the Met+Cys requirement, the lower dose was included to be below requirements, to make the test more sensitive. Crude protein level in feed was 16.6% and metabolisable energy was 2720 kcal ME/kg. Average analyzed lysine and Met+Cys levels of the control feeds were 0.83% and 0.53%, respectively. Traits studied were: feed intake, egg production, egg weight, egg mass, feed conversion and egg size distribution. Results showed a difference (\( P < 0.05 \)) of all performance parameters of the control group compared with the other treatments. Supplemented MHA-Ca and dl-Met improved laying performance and egg weight, the resulting daily egg mass, and, finally, feed conversion, which was also due to reduced feed intake. From this it can be concluded that methionine was needed for optimized performance. However, differences between the 2 Met+Cys levels are only very small and can be seen at best in small numerical differences in daily egg mass and feed conversion. However, examining egg size distribution, a small shift in proportions from “small” toward “large” can be seen for the higher supplement level. There were no significant differences between corresponding MHA-Ca and dl-Met treatments. Overall It can be confirmed replacement of dl-Met by MHA-Ca at a quantitative replacement ratio of 65:100 (dl-Met: MHA-Ca) had no negative effects on any of the performance criteria in laying hens.

Key Words: brown layer, methionine source, dl-methionine, dl-methionine-hydroxy analogue calcium, bioefficacy

153  **Selenium compounds and their deposition in broiler muscle tissue**  
S. Van Beirendonck1-3, B. Driessen2, B. Bruneel*3, L. Segers3, and G. Du Laing4, 1Faculty of Engineering Technology, KU Leuven, Geel, Belgium, 2Dier & Welzijn, Geel, Belgium, 3Orffa, Werkendam, the Netherlands, 4Faculty of Bioscience Engineering Ghent University, Ghent, Belgium.

The aim of this study was to investigate the effect of specific Se compounds on the selenium deposition in 14 d of age broiler muscle tissue. Five different commercially available Se products were incorporated, including l-selenomethionine (l-SeMet) and OH-selenomethionine (OH-SeMet). Male broilers were fed one of 5 treatment starter diets. All treatments had 4 pens with 5 animals per pen. Treatment 1 was supplemented with 0.2 mg/kg total Se from sodium selenite (SS). Treatment 2 and 3 were supplemented with L-SeMet (Excential Selenium4000) at a dosing of 0.2 and 0.16 mg/kg total selenium, respectively. This equals...
0.2 mg/kg Se and 0.16 mg/kg Se in the form of l-SeMet. Treatment 4 was supplemented with 0.2 mg/kg total Se from OH-SeMet, which equals 0.0 mg/kg total Se from l-SeMet. Treatment 5 was supplemented with 0.2 mg/kg total Se from Se-Yeast product A, which resulted in a supplemented Se in the form of l-SeMet of 0.058 mg/kg. Representative samples of the left breast of 3 broilers per pen were taken on d14 and analyzed for Se content by ICP-MS. Data were analyzed using a linear mixed model with treatment as a fixed effect and pen as a random effect, in the statistical software program SAS 9.4. Results show Se content in broiler muscle for treatment 1 (SS) of 93 µg/kg Se. Se-Yeast A showed 101 µg/kg Se. Treatment 2 and 3 (l-SeMet) showed the highest Se content in muscle with 263 µg/kg Se and 225 µg/kg Se, respectively. Treatment 4 showed a comparable Se content as treatment 3 (P < 0.0001) and 16% lower than treatment 2 (P < 0.0001). In conclusion, this study shows that the Se deposition in muscle depends on the specific Se compound (P < 0.0001). OH-SeMet has to be converted in the animal to l-SeMet before it can be incorporated in the proteins. In literature, the conversion of the hydroxy analog of methionine is marked at 80% for chicken (EFSA Journal 2012;10(3):2623). l-SeMet supplementation results in the highest Se deposition. Recent research shows that organic selenium sources have a greater capacity of mineral incorporation in the muscle of the animals and therefore provide improved physicochemical characteristics of the meats.

Key Words: selenium, broiler, deposition, l-selenomethionine, OH-selenomethionine

154 Effect of an algae-clay complex on the performance of broiler chickens using a corn soybean meal based diet. M. Gallis-sot1, M. Rodriguez1, R. Pereira*1, L. F. T. Albino2, and R. F. Jacob2,

1OLMIX, Brehan, France, 2Universidade Federal de Viçosa, Minas Gerais, Brazil.

This study was set up to evaluate the effect of supplementing an algae-clay complex (MFeed+) on growth performance of broiler chickens fed with a corn-soy diet. The experiment was conducted in the poultry facilities of the Departamento de Zootecnia at the Universidade Federal de Viçosa, Minas Gerais, Brazil. Seven hundred fifty 1-d-old Cobb 500 male chicks were randomly distributed to 3 treatments with 10 replicates per treatment and 25 chicks per experimental unit, allocated to 1 of 3 groups receiving different diets: the standard diet (C), the test diet 1 (T1), containing the standard diet supplemented with 0.1% of algae-clay complex, and the test diet 2 (T2), containing the standard diet supplemented with 0.2% of algae-clay complex. Two different feeds were distributed from D0-D22, starter feed, and D23-D35, grower feed. Group weighing of the animals (D0, D21, and D35) and daily feed intake were measured. Results were submitted to ANOVA. Results show a higher weight gain for groups T1 and T2 compared with control from D23 to D35, +4% and +5% respectively, though it was not statistically significant (P = 0.065). There were no significant differences in the whole period, despite a 2.5% increase in T1 and T2 values compared with control. There was a significant decrease of feed conversion rate for both test groups during grower period (~4% and ~5% respectively, P = 0.043) and also during the whole period: ~3% in both tested groups compared with control (P = 0.038). No dose effect of the algae-clay product was observed. In the end, this study shows a positive effect of the algae-clay complex on feed efficiency of broiler chickens. Its use at 0.1% of the feed seems the most interesting to improve performance and profitability.

Key Words: digestibility, performance, algae, seaweeds, clay


Phytochemical additives such as thymol (THY) are encountering growing interest in poultry production. Measuring bioavailability of supplemented compounds is a key element for understanding how they modulate beneficial effects on animal body. Herein, we simultaneously assessed changes in THY concentration and total fatty acids (FA) of the egg yolk induced along 28d of THY dietary supplementation (DS) and 21d after discontinuation of supplementation (AS). THY eliminated through feces, female performance and physical characteristics of eggs were also monitored in both DS and AS periods. Fifty adult female quail were randomly assigned to 1 of 5 dietary treatments: CON (basal diet), VEH (basal diet + ethanol), THY2, 4 and 6.25 (basal diet + 2, 4, 6.25g of thymol/kg of feed, respectively). THY concentration in egg yolk and feces was determined at 2, 9, 16, 26d of DS and 17d AS. Female performance and characteristics of eggs were measured at 0, 7, 14, 28d of S and 21d AS. GLMMs and Fisher tests were used to detect differences at P < 0.05. In egg yolks, THY concentration increased along DS time and decreased AS. Moreover, THY concentration was higher in THY4 and THY6.25 compared with THY2 at all time periods evaluated. These changes were accompanied by reduced 16:0 and 18:0 concentrations achieved by 28d of DS in THY2 and 14d of DS in THY4 and THY6.25. However, at 21d AS the aforementioned effect on 16:0 disappeared in all diets, but 18:0 was found still lower in THY4 compared with the other treatments. Throughout DS THY4 and THY6.25 modulated polysaturated FA increments of higher magnitude than THY2, which remained increased at 21d AS. Specifically, all diets increased 22:6 and 20:5 by 7d of DS, but only THY4 y THY6.25 showed higher concentrations of 18:3 and 20:4 by 14d of DS. In addition, THY2 and THY4 required 14d for increasing 22:5, while THY6.25 needed 7d for achieving similar changes. FA changes induced by THY are consistent with an improved nutritional quality of eggs. In feces, increased THY concentrations were detected at 9, 16 and 26d of DS in both THY4 and THY6.25 groups. No differences between dietary treatments nor during DS and AS periods were observed in female performance and physical characteristics of eggs. Findings suggest that both the dose of THY and the duration of DS, consistently modulate THY and FA concentration in egg yolk and THY concentration in feces. Furthermore, the persistence of those effects AS is also in accordance with a dose-dependent phenomena.

Key Words: bioavailability, PUFA, feed additive, optimal dosage


The aim was to evaluate the dietary inclusion of guavira peel or seed extracts (Campomanesia adamantium) on the performance and carcass characteristics of broilers from 1 to 42 d of age. A total of 1,680 one-day-old male broilers were allotted to a completely randomized design, in a 2x5+2 factorial scheme (2 extracts - hydroethanolic extracts of guavira peel (PE) or seed (SE), 5 inclusion levels - 100, 200, 300, 400 and 500
ppm and 2 controls – positive, with addition of antibiotic; and negative, without performance-enhancing feed additive), with 7 replicates and 20 birds per pen. Body weight gain (BWG), feed intake (FI) and feed conversion (FC), corrected by mortality, at 7, 21 and 42 d; and carcass yield, cuts yield (breast, legs and wing) and percentage of abdominal fat at 42 d, were assessed. The effects of the type and levels of PE or SE extract, as well as the interaction between these factors were verified by the ANOVA, not including the control treatments. The effect of extract levels on the performance variables was determined through polynomial regression; when not significant, linear contrasts were used. The comparison between diets containing extracts, regardless of the inclusion level, and control diets were performed using F-test for orthogonal contrasts. The ANOVA showed interaction (P < 0.05) between factors only for WG from 1 to 21 d. Considering the linear contrasts, it was observed that the level of 100 ppm of SE provided a greater WG in relation to levels 200 and 400 ppm. For the isolated factors, regardless of the dietary inclusion level, broilers fed SE had higher (P < 0.05) WG from 1 to 21 d in relation to those fed PE diets, however presented lower carcass yield at 42 d of age. Considering the orthogonal contrasts, broilers fed diets containing antibiotics had better FC from 1 to 7 and from 1 to 21 d, compared with those not receiving this additive in the diets. Broilers fed diets containing antibiotics had better FC in the starter phase (1 to 7 d) than those fed both SE or PE diets, and this conversion remained lower up to 21 d when compared with broilers fed the diet containing PE. By comparing diets with extracts against the NC, broilers fed diets with PE had lower AFI for the whole period (1 to 42 d), with a consequent improvement in FC. The addition of extracts of guavira peel or seed did not improve broiler performance and carcass characteristics when compared with used performance-enhancing antibiotics. However, considering the nonuse of performance-enhancing feed additives, the inclusion of extract of guavira peel resulted in better broiler performance.

Key Words: antimicrobial, cerrado fruit, natural additive


There is increased pressure to create an effective natural alternative product that produce the same or better results than antibiotic growth promoters (AGP) in commercial poultry farms. The objective of the current study was to evaluate the effect of a water-applied biopromotor (Gamaxine/Vetanco SA), a prebiotic specifically developed to increase mucosal integrity and reduce gram-negative pathogens, with a feed incorporated phytobiotic (Herbanoplex/Vetanco SA), with specific mechanisms of action against Clostridium perfringens/necrotic enteritis, in the productivity of broilers chickens. The experiment was conducted on an experimental farm in Buenos Aires, Argentina. 800-d-old chicks (Cobb) were individually neck tagged and randomly assigned to one of 48 pens (n = 20 birds/pen). Pens were randomly assigned per treatment group. 5 treatments with 8 replicates each (n = 160 birds/treatment). All birds were fed with a 4-phase standard commercial diet with or without feed additives and without AGP unless indicated. Treatment 1 (T1) negative control with no feed additives. The rest of the treatments were the commercial diet: plus Bacitracin Methylene Disalicylate 11% (0.5 kg/tn; fed continually) for T2; plus the biopromotor (2 doses of 0.2 mL/bird at d3 and d17 of life) for T3; plus the phytobiotic (1 kg/tn; fed continually) for T4 and plus the biopromotor (2 doses of 0.2 mL/bird at d3 and d17 of life) and the phytobiotic (1 kg/tn; fed continually) for T5. The experiment continued until the birds reached 42 d old. Initial and final weights were individually taken to determine total body weight gain and mortality and feed conversion were calculated for each pen. The statistical analysis was done with a one-way ANOVA (P < 0.05) followed by a Tukey test. Different letters (below in results) represents difference between means. The weight gain (gm) for T1 was 2457.75 ± 34.72; for T2 2539.25 ± 69.9; for T3 2614.75 ± 60.9; for T4 2680.37 ± 37.41 and for T5 2742.62 ± 43.7. The feed conversion (gm) was 2231.29 ± 31.7 for T1; 2137.11 ± 59.3 for T2; 2035.57 ± 47.1 for T3; 2000.05 ± 27.9 for T4 and 1900.06 ± 30.3 for T5. Mortality for each treatment was 4.38% for T1; 5.12% for T2; 4.47% for T3; 5.05% for T4 and 4.24% for T5. The results show that the combination of the biopromotor and the phytobiotic achieve increased final weight and improved feed conversion when compared with the commercial antibiotic growth promoter.

Key Words: prebiotics, phytobiotic, performance, broiler, feed additive

158 Effect of oregano essential oil on the development of coccidial immunity in broilers vaccinated with attenuated coccidial vaccine. D. Harrington*,1 B. Lumpkins2, G. Mathis2, and W. Wakenman1, 1Anpario plc, Worksop, United Kingdom, 2Southern Poultry Research Inc., Athens, GA, USA.

Attenuated Eimeria vaccine strains have reduced oocyst production. Consequently any in-feed additive that could interfere with oocyst production has the potential to negatively impact development of coccidial immunity. The aim of the study was to determine the effect of an oregano product (Orego-Stim, Anpario plc, UK) on the development of immunity following vaccination with an attenuated coccidiosis vaccine. A total of 1,400 Cobb 500 broilers were split into 4 treatments (7 pens/treatment, 50 birds/pen): (SAL) Salinomycin 66g/T; (VACC) Vaccinated with HatchPac Cecii III (Merial, USA) via hatchery spray on d 0; (OS150) Vaccinated + OS (Oreg-Stim) 150g/T; (OS+ SAL) Vaccinated + OS 150g/T and salinomycin 66g/T. Birds were reared from d0 to 42 in floor pens on clean litter. OS and/or salinomycin was included in feed from d0. Oocyst per gram (OPG) of feces in each pen were measured every 7 d. On d21, 5 birds/pen were moved to cages and challenged orally with a mixture of E. acervulina, E. maxima, and E. tenella. In addition, 35 non-vaccinated, coccidia-free birds (POS) (7 cages, 5 birds/cage) were also challenged. All birds were fed non-treated feed. On d27, these birds were killed and coccidial lesion score (LS) determined. Data were analyzed by ANOVA and significance declared at P < 0.05. Weekly OPG counts indicated contamination of SAL from d14. A peak in OPG was observed in VACC and OS150 on d21 (6184 and 2613 OPG respectively). Oocysts/gram for OS+SAL increased continuously from d7 to d42. Peak OPG in VACC was significantly higher than SAL and OS150+SAL (7137, 2468 and 867 OPG, respectively) but did not differ significantly from OS150 (2868 OPG). D42 FCR in SAL and OS+SAL was significantly lower than VACC and OS150 (1.682, 1.663, 1.755 and 1.734, respectively), while VACC was numerically higher than OS150. Body weight gain (BWG) at d42 was highest in SAL (2.555kg) and lowest in VACC (2.424kg). BWG in VACC was significantly lower than SAL and OS+SAL (2.586kg). OS150 (2.447kg) and OS+SAL was significantly lower than VACC and OS150 (1.682, 2.61, 1.68, 1.34, 1.62, 1.71 for POS, SAL, VACC, OS150 and OS+SAL, respectively. This study indicates that OS neither compromises the development of coccidial immunity nor performance.
of birds vaccinated with an attenuated *Eimeria* vaccine despite reduced peak vaccinal oocyst output.

**Key Words:** *Eimeria*, oregano, broiler, immunity


The objective of this study was to evaluate the antioxidative effect of a dietary blend of essential oils (EO) and beet extract (BE) in broiler chickens submitted to heat stress. One-day-old broiler chickens (1,280) were placed in a completely randomized design in a 2 × 2 factorial arrangement (control diet or diet supplemented with EO+BE, and thermoneutral temperature or under heat stress), in a total of 4 treatments (8 replicates/treatment, 40 birds/replicate). The blend of EO+BE was provided by Cargill Animal Nutrition, and the inclusion dose used was 500 mg/Kg. The experimental diets were supplied throughout the whole experimental period. From 28 to 42 d the birds in the heat stressed groups were raised under a temperature of 32°C and ventilation restricted. At d 42, blood from 3 birds/replicate was collected for quantification of substances reactive to thiobarbituric acid through the malondialdehyde analysis (MDA), which is one of the main products of the decomposition of polyunsaturated fatty acids. The same serum samples were used to evaluate protein oxidation through determination of the carbonyl group by calculating the DNPH (2,4 dinitrophenylhydrazine). The data was analyzed by ANOVA using the software SAS. There was an interaction (*P < 0.05*) for diet and temperature on MDA (mg/kg) concentration, wherein birds supplemented with EO+BE and exposed to heat stress showed a 50% reduction (*P < 0.05*) compared with the unsupplemented birds. There was no interaction (*P > 0.05*) for diet and temperature on the group carbonyl concentration. However, the supplementation with EO+BE decreased (*P < 0.05*) the concentration of the group carbonyl, which shows a protective effect of this supplement on the muscle proteins during the oxidative stress. Dietary supplementation of a EO+BE blend for birds raised under heat stress decreases the negative effects of the free radicals indicating the reduction in lipid peroxidation and protein degradation.

**Key Words:** antioxidant, beet extract, broiler, essential oils, heat stress

160 **Effect of different levels of an alkaloid-free coca leaf extract on xanthophyll content and color of egg yolk of Japanese quail.** E. Berinuy and C. Vilchez*, Universidad Nacional Agraria La Molina, La Molina, Lima, Peru.

The objective of the experiment was to evaluate the effect of different levels of an alkaloid-free coca leaf extract (AFCE) on xanthophylls content and color of egg yolk of Japanese quail. 96, 16-wk old, Japanese quail hens were fed one of the 6 diets containing 0.0% (T1), 0.01% (T2), 0.03% (T3), 0.05% (T4), 0.07% (T5) AFCE or 0.05% (T6) Commercial pigment (30 µg/kg xanthophylls). Each diet was fed to 16 individually caged hens during 10-wk experimental period. Feed (as mash) and fresh water were provided ad libitum. Yolk xanthophylls content (YX), yolk color (YC) (as measured using the Roche yolk color fan), correlation coefficient between YX and YC, and the efficiency of xanthophylls deposition in the yolk were determined in 270 individual eggs (45 eggs per treatment), collected at 5, 7, and 9 wk of the experimental period. Statistical significance was evaluated using ANOVA under a Randomized Complete Block Design with Tukey’s test for multiple comparisons. Results showed that egg yolks from birds that were fed T6 showed the highest (*P < 0.05*) xanthophylls content and color while the lowest (*P < 0.05*) values corresponded to those from birds that were under T1 or T2. The amount of xanthophylls deposited in egg yolks from birds under the AFCE-containing diets fitted the curve Y = 0.0154X² − 0.0112X + 2.897 (R² = 0.98) and the coefficient of correlation between YX and YC was 0.98. Efficiencies of xanthophylls deposition in the egg yolk of birds that received the AFCE-containing diets were higher (*P < 0.05*) than those that were fed the diet that contained the commercial pigment. In conclusion, the concentration of xanthophylls and the color of the yolk increased when the level of AFCE increased in the diet and it were lower than those obtained with the commercial pigment but the latter was deposited in the yolk with lesser efficiency than any other treatments.

**Key Words:** quail hen, egg yolk, pigment, xanthophyll, coca leaf

161 **Anticoccidial efficacy of oregano essential oil in turkeys infected with a mixture of *Eimeria*.** D. Harrington*, G. Mathis, B. Lumpkins, and W. Wakeman, 1Anprio plc, Worksop, United Kingdom, 2Southern Poultry Research Inc., Athens, GA, USA.

Coccidiosis management in turkey production has a limited choice of anticoccidials. Essential oil products have the potential to support or offer an alternative to these existing anticoccidial drugs. The aim of this study was to determine the efficacy of an oregano oil product against colillicidial challenge in turkeys. A total of 512 female Hybrid turkey pouls were placed in cages from day-old. At 14 d old (d0), birds were randomly allocated to 6 treatments (8 cages/treatment, 8 birds/cage): NC: Non-medicated, unchallenged; PC: Non-medicated, challenged; LAS: Lasalocid 99ppm; OSP: Orego-Stim (Orego-Stim, Anpario plc, UK) 300g/MT; OSL: Orego-Stim 150mL/1000 L water; OSP-L: Orego-Stim300g/MT + Orego-Stim 150mL/1000 L water. On d2, birds in NC received 1mL distilled water via gavage while birds in LAS, PC, OSP, OSL and OSP-L received a 1mL mixture of *Eimeria meleagrimitis*, *E. gallupavonis* and *E. adenoide*. On d9, feces in each cage were visually scored (FS) from 0 to 3 (normal to liquid with profuse mucus and/or blood) and collected for oocyst enumeration (oocysts/g (OPG)). Performance parameters over the challenge period were also recorded. Data were analyzed by one-way ANOVA and significance declared at *P < 0.05*. FCR in NC and PC (1.227 and 2.476, respectively) were significantly different to all other treatments. FCR in LAS (1.536) was significantly lower than all oregano treatments while OSP-L differed significantly from OSP (1.892 and 2.081, respectively). Body weight gain (BWG) in NC (292g) and LAS (173g) were significantly different from each other and all other treatments. BWG in OSP, OSL and OSP-L did not differ significantly from each other (113, 116 and 131g, respectively) while OSL and OSP did not differ from PC (94g). OPG were significantly lower in OSP-L versus LAS and PC (1755, 8375 and 6444 OPG, respectively), while PC, LAS, and OSP did not differ from each other (OSP: 4590 OPG). OPG in OSP, OSL (4316 OPG) and OSP-L also did not differ significantly from eachother. FS were 0.0, 3.0, 2.0, 2.9, 2.9 and 2.6 for NC, PC, LAS, OSP, OSP-L and PC-L, respectively. NC differed significantly from all other treatments, while LAS differed from OSL, OSP and PC. This study indicates that there is a degree of anticoccidial efficacy of OEO against turkey *Eimeria*, particularly when OEO in feed and water are combined. Further research is necessary to determine the efficacy of oregano essential oil under field conditions where immunity to coccidia in the bird is able to be developed.

**Key Words:** turkey, *Eimeria*, oregano, performance
162 Effect of the supplementation of Lepidium meyenii in the diet on the productive response of broiler chickens in the initial phase. E. Salvador*, M. Narvaez, and L. Rios, National University, Ica, Perú.

An experimental study was carried out with the objective of evaluating the effect of the supplementation of Lepidium meyenii (black maca) in the diet on the performance of broilers chicks in the initial phase from 0 to 21 days of age and to determine whether it could have the potential as alternative natural growth promoter to antibiotics. A total of 75, 1 d-old male BB broiler chicks Cobb 500 were randomly assigned to 3 experimental groups as treatments and 5 replicates each: 1. Basal diet, without antibiotic; 2. Basal diet + 50 mg Zinc Bacitracin / kg; 3. Basal diet + Lepidium meyenii (0.5%) in a randomized complete block design. We evaluated live weight, weight gain, feed intake, feed conversion, energy efficiency and margin over feed cost. The data were analyzed using the GLM procedure of SAS v.9 (2002) followed by Tukey’s mean test. The results showed that supplementation with Lepidium meyenii (black maca) significantly increased (P = 0.0248) live weight of chicks (1041 g) compared with the group without antibiotics (971.8 g) and group with antibiotics (988.5 g). Improved (P = 0.0447) feed conversion and energy efficiency (P = 0.0447). The feed intake was not affected (P > 0.05). The feed cost for ton was of $ 440.83 for diet with antibiotic and $ 479.5 for diet with Lepidium meyenii. The margin on feed cost was better for the group of chicks with Lepidium meyenii about of 4.98%. It was concluded that the supplementation of Lepidium meyenii increases live weight, improved feed conversion and energy efficiency maintains and improves profitability, and can be considered as a potential natural growth promoter to replace antibiotics in the chicks diet in 0-21 d of age.

Key Words: chick, antibiotic, performance, Lepidium meyenii, black maca

163 Blend of phytomolecules in association to AGP improve the performance of broilers. A. N. Figueiredo*1, A. L. Sanches Minarro2, G. G. Carvalho2, C. A. Bortolato2, and F. A. Longo2, 1CPQBA UNICAMP, Paulinia, Sao Paulo, Brazil, 2Btech Pancosma Brazil, Valinhos, Sao Paulo, Brazil.

The association of 2 different antibiotic growth promoters (AGP) in poultry production is not allowed in Brazil, despite the microbiological challenges in the field usually demand this strategy to guarantee the performance of birds. As an option to adequate AGP programs on poultry feed, this research purpose a formulation with phytomolecules replacing one of the AGP molecules. We evaluated diets considering 3 treatments: T1 = avilamycin (10ppm) + halquinol (24 ppm); T2 = avilamycin (10 ppm) and T3 = T2 + 100 ppm of Xtract 6930 (standardized blend of phytomolecules with 5% carvacrol, 3% cinnamaldehyde and 2% capsicum oleoresin). All diets were iso-nutritive, based on corn and soybean meal, and were fed to broilers in 2 trials. First, experimentally designed, 1800 d-old-chicks (Cobb) were randomly distributed for 3 treatments and 12 replicates of 50 birds each (36 floor pens). Performance of the birds was measured during 1 to 21, 1 to 35 and 1 to 41 d of age. Data were analyzed using ANOVA and the average values compared by Tukey test (P < 0.05). To confirm the results obtained on the experimental trial, the same treatments were tested in a field condition with 3300 d-old-chicks (Cobb) randomly distributed for 3 field tracks inside a conventional poultry farm from 1 to 41 d. During the first trial the different treatments did not negatively affect feed intake of broilers (P > 0.05). But, birds fed with diets from T3 showed better weight gain than those from T2 (1–21d) and T1 (1–35d) (P < 0.05). The feed conversion rate from birds fed T1 and T3 diets was similar and better than those from T2 (P < 0.05). In field conditions evaluation, the results performed similar to the first trial where birds fed T1 and T3 diets were superior than those from T2 diet for weight gain (T3 = 2.951 kg/bird > T1 = 2.949 kg/bird > T2 = 2.877 kg/bird), feed conversion rate (T3 = 1.516 > T1 = 1.543 > T2 = 1.550), and production factor (T3 = 452 > T1 = 440 > T2 = 433). In conclusion, for experimental or field conditions, when halquinol was removed from the diet (T2) birds presented worst performance, adding Xtract 6930 (T3) the performance of the birds was recovered, even better for production factor when compared with birds fed halquinol + avilamycin (T1). These results confirmed that the strategy of adding Xtract 6930 is efficient to be considered in adequation of AGP programs for poultry production.

Key Words: capsaicin, cinnamaldehyde, carvacrol, antibiotic growth promoter


Biologically active compounds with antioxidant and antibacterial activities identified in guavira (Campomanesia adamantum) have aroused interest on the use of its extracts in animal feeding. The aim was to evaluate the dietary inclusion of hydroethanolic extracts of guavira peel or seed on meat quality and lipid oxidation in broilers. A total of 1,680 one-day-old male broilers were allotted to a completely randomized design, in a 2x5+2 factorial scheme (2 extracts - hydroethanolic extracts of guavira peel or seed, 5 inclusion levels - 100, 200, 300, 400 and 500 ppm and 2 controls – positive, with addition of antibiotic; and negative, without performance-enhancing feed additive), with 7 replicates and 200 birds per experimental unit. At 42 d of age, 2 birds per experimental unit were slaughtered to evaluate meat quality and lipid oxidation. The pH analysis was performed directly on the breast fillet and thigh meat, 15 min and 24 h postmortem. The evaluation of water-holding capacity (WHC), shear force (SF) and cooking loss (CL) were performed on the breast fillet. The determination of thiobarbituric acid reactive substances (TBARS) in thigh meat was performed immediately after slaughter and during storage at 4°C for 7, 30 and 60 d. The effects of the type and levels of peel or seed extract, as well as the interaction between these factors were verified by the ANOVA, not including the control treatments. The effect of extract levels on the studied variables was determined through polynomial regression; when not significant, linear contrasts were used. The comparison between diets containing seed (SE) and peel extracts (PE), regardless of the inclusion level, and positive control (PC) and negative control diets (NC) were performed using F-test for orthogonal contrasts. The ANOVA showed no interaction (P > 0.05) between factors. Considering the orthogonal contrasts, the breast meat of broilers fed diets containing the hydroethanolic extract of guavira seed had higher (P < 0.05) WHC when compared with broilers fed the control diet with antibiotics. Regarding lipid oxidation, only storage time (P < 0.05) had a significant effect, regardless of the type and level of extract, with higher concentration of secondary lipid oxidation products (P < 0.05) at 7 d of storage when compared with the other evaluated periods. The dietary use of hydroethanolic extracts of guavira seed or peel from 100 to 500 ppm did not improve meat quality as well as not reduce the lipid oxidation in broilers.

Key Words: antioxidant, cerrado fruit, natural additive, TBARS
Alqueruat Nebsui is a natural product based on active botanical molecules called pronutrients that improve intestinal physiology, optimize feed utilization and, consequently, increase productive performance. An experiment was conducted to evaluate if Alquerquat Nebsui could replace an antibiotic growth promoter (AGP) in broilers, through the growth performance analysis, and the intestinal relative weight (as an indicator of intestinal efficiency). The trial was conducted in an experimental poultry unit with 300 one-day-old broilers, Cobb 500 strain. Chickens were randomly allotted to 4 treatments, with 10 replicate pens per treatment and 10 broilers per pen: 1) CN (basal diet without growth promoters); 2) BA (basal diet + bacitracin methylene disalicylate at 0.5 kg/ton, continuously, complying with the withdrawal period); and 3) AN (basal diet + Alqueruat Nebsui at 0.5 kg/ton, continuously during all the trial). Weekly and at 42 d were evaluated the Feed intake, body weight and feed conversion rate (FCR). Efficiency index and relative intestinal weight were evaluated at the end of the trial. Data were analyzed using one-way ANOVA and Tukey test, using 0.05 as a significant level. AN obtained the best FCR (1.56), followed by BA (1.58) and CN (1.61), with significant differences between AN and CN (P < 0.05). No significant differences were observed in the other parameters (feed intake, final body weight and efficiency index), although AN and BA had obtained better results than CN (see table). Relative intestinal weight was lower in AN, compared with the other groups, which is correlated with a better efficiency of the organ. Dietary supplementation of Alqueruat Nebsui promote better feed conversion rate and improve the physiology of the digestive tract in broilers. Results suggest that Alqueruat Nebsui can be used as a natural growth promoter to replace AGPs.

### Table 1. Summary of productive parameters

<table>
<thead>
<tr>
<th>Feed intake</th>
<th>BW (kg) at d 42</th>
<th>Efficiency index</th>
</tr>
</thead>
<tbody>
<tr>
<td>(kg) at d 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CN</td>
<td>4.94</td>
<td>2.70</td>
</tr>
<tr>
<td>AN</td>
<td>4.88</td>
<td>2.78</td>
</tr>
<tr>
<td>BA</td>
<td>5.11</td>
<td>2.81</td>
</tr>
</tbody>
</table>

**Key Words:** pronutrient, growth promoter, broiler, growth performance, gut efficiency

### 166 Phytophages improve heat tolerance in poultry.

J. D. van der Klis*, L. Jungbauer, and A. Mueller, Delacon Biotechnik GmbH, Steyregg, Austria.

Phytophages, plant-derived natural bioactive compounds, can improve nutrient digestion, reduce cellular oxidative stress, improve intestinal integrity and immunocompetence under thermoneutral conditions. As such, the efficacy of phytophages actives to alleviate heat stress in broilers was screened in a 2-step in vitro/in vivo approach: In vitro screening was based on the survival rate of nematode C. elegans during HS and the HS response of Caco2 cells. After reaching maturity, graded levels (0, 52.5, 85 and 170 mg/L) of ginseng extract (GE) were added to the incubation medium of the worms in 96-well plates for 48h. Thereafter, worms were exposed to HS (37°C) and their survival rate was evaluated. GE-addition extended life span of C. elegans (P < 0.001), coinciding with increased nuclear translocation of DAF-16, indicating improved cellular anti-oxidant response and heat shock proteins (HSP) expression. Next, fully differentiated Caco2 cells were incubated at 37C with graded GE-levels (0, 52.5, 85 and 170 mg/L). 15h later, temperature was increased to 41°C and mRNA expression for HSP70 and Claudin-1 was determined by nPCR. mRNA expression for HSP70 during HS was significantly upregulated with GE dose, but downregulated at normal temperatures. mRNA expression for Claudin-1 was downregulated by HS, which could be prevented by GE. However, total expression was reduced with increasing GE-levels with and without HS. Finally, 181-d old male Cobb 500 broilers were allocated to 4 experimental treatments based on body weight. They were housed in floor pens with wood shavings (15 birds/pen, 3 pens/treatment). Broilers had free access to a corn/wheat/soya diet and drinking water. Treatments were unsupplemented negative control (NC), positive control (PC): NC with 0.5 g/kg natural betain (Actibeet), and NC with 1.0 and 2.0 g/kg GE (4.5% Ginsenosides).

A daily cyclic HS (34°C from 9 a.m. till 5 p.m. and 26°C from 7 p.m. till 7 a.m., with 2h adjustment periods) was applied from 21 to 42 d of age. Daily light schedule was 16L:8D. Results were analyzed by an ANOVA with 4 treatments, followed by a pairwise t-test using SAS. P < 0.05 was considered statistically sign. and P < 0.10 a trend. GE improved production performance of HS broilers over the NC (FCR: NC: 1.429, improved by 0.075; P < 0.05 and final BW: NC: 1966g, improved by 11g, P < 0.10). Results on PC were intermediate. It was concluded that ginseng extract can improve heat tolerance of birds which was related to improved cellular anti-oxidant response.

**Key Words:** heat stress, broiler, phytophages, in vitro, performance

### 167 Natural antioxidant alternatives to improve oxidative stability of stored chicken meat.

A. Luna1, B. Piotrkowski2, M. Galleano2, M. C. Labaque3, and R. H. Marin1, 1Instituto de Investigaciones Biológicas y Tecnológicas (IBBYT; CONICET-UNC) and Instituto de Ciencia y Tecnología de los Alimentos (ICTA), Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Córdoba, Argentina, 2Fisicoquímica, Facultad de Farmacia y Bioquímica, Universidad de Buenos Aires and Instituto de Bioquímica y Medicina Molecular (UBA-CONICET), Buenos Aires, Argentina.

Lipid oxidation is the main cause of nutritional and organoleptic deterioration of poultry meat and eggs during storage. This process will originate compounds responsible for unpleasant odours, reduces the amount of polyunsaturated fatty acids, vitamins and pigments, decreases the acceptability on consumers and generates compounds that may present toxicity. Furthermore, some dietary synthetic antioxidants have been restricted or banned in many countries. In this regard, phytophagic products and/or essential oils main components have been suggested as non-traditional alternatives in broiler diets to improve growth performance, products quality and even their welfare. Thymol (THY), a main component of oregano generally recognized as safe status (FDA, USA), has been proved as an effective antimicrobial and antioxidant compound with similar activity to butylated hydroxytoluene (BHT), a synthetic antioxidant widely used in poultry industry. On the other hand, tocopherol (TOC) has also proved antioxidant activity and has shown synergistic antioxidant activity when combined with ascorbyl palmitate (AP). Herein, we had evaluated if broiler diets supplemented with THY, a formulation mix with TOC and AP (1:1), and a mixture of THY:TOC:AP (1:0.5:0.5, respectively) have potential to prevent meat oxidation. One day old male broiler chicks with similar BW were randomly assigned to 1 of 5 dietary groups (4 replicates of 32 birds each) as follows: Basal (no feed supplements); BHT (1.33 mmol BHT/kg feed); TOCAP (0.67 mmol TOC+0.67 mmol AP/kg feed); THY (1.33 mmol THY/kg feed); and THY-TOCAP (0.67 mmol of THY+0.67 mmol
of a mix 1:1 of TOCAP). Birds were slaughtered at d 42 and carcases placed at 4°C. Thigh samples were taken at 0, 5 and 10 d of storage. MDA determined by fluorescence HPLC was used to assess oxidative deterioration. Repeated measure ANOVAs and Fisher tests were used to detect differences at $P < 0.05$. MDA content in Basal thigh samples were increased at 5 and 10 d of storage compared with thighs from their respective supplemented groups ($P = 0.004$). No differences in thigh oxidative deterioration were found between the supplemented groups. Results highlight the need of using a dietary antioxidant to protect carcass meat against oxidative deterioration when stored. The proposed natural antioxidant alternatives were similarly effective in delaying oxidative damage as BHT. Thus, THY itself or in combination with TOCAP can be used as natural antioxidant alternatives for broiler production.

**Key Words:** broiler meat, thymol, lipid oxidation, feed supplementation
The pellet quality of diets can influence the development of the digestive tract and consequently the digestibility and absorption of nutrients for broilers. Pelleted diets have been evaluated for fast-growing chickens, but few studies have been performed to determine digestive tract measurements by slow-growing broiler strains. The assay was carried out to evaluate digestive organs morphometry for slow-growing broilers at 28 d of age, fed pelleted diets containing different proportions of disintegrated pellets (fines). A total of 180 slow-growing, one day-old, Isa Label chicks (39 ± 1.2 g), were allotted in a completely randomized design in a 2 × 3 factorial arrangement (Sex: male and female; Fines: 0, 50 and 100%) with 6 replicates of 5 birds/cage. The proportions of fines in the starter pelleted-crushed ration were determined after evaluation through a 2-mm mesh sieve, and integral pellets were considered those that remained on the mesh and, fines, the disintegrated granules that passed through the sieve. The experimental ration was formulated according to Brazilian Tables (2011) recommendations based on corn and soybean meal. At 28 d of age, 2 birds per replicate were slaughtered by cervical dislocation to collect and measure gastrointestinal tract length (m) (GTI) and weight of small (SI) and large intestine (LI), pro-ventriculus + gizzard (PG), pancreas (P) and liver (L). The relative weight of digestive organs (%) was calculated in relation to the live weight. The data were submitted to ANOVA, using the software R-Project. The averages were compared by the Skott-Knott test at 5% probability. No significant interaction (P > 0.05) was observed between the proportion of fines and sex (Table 1). A higher proportion of liver was observed for males (P < 0.05). The proportion of fines did not affect the relative weight of digestive tract and GIT length of slow-growing broilers.

Table 1. Morphometry of digestive tract of slow-growing males and females, fed with different proportions of fines at 28 d of age

<table>
<thead>
<tr>
<th>Fines (%)</th>
<th>GTI (m)</th>
<th>SI (%)</th>
<th>LI (%)</th>
<th>PG (%)</th>
<th>P (%)</th>
<th>L (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.25</td>
<td>3.28</td>
<td>0.79</td>
<td>3.21</td>
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<td>50</td>
<td>1.24</td>
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<tr>
<td>100</td>
<td>1.23</td>
<td>3.27</td>
<td>0.83</td>
<td>3.26</td>
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<td>2.18</td>
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</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th>GTI (m)</th>
<th>SI (%)</th>
<th>LI (%)</th>
<th>PG (%)</th>
<th>P (%)</th>
<th>L (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1.24</td>
<td>3.35</td>
<td>0.83</td>
<td>3.21</td>
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<td>Female</td>
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<td>0.88</td>
<td>3.22</td>
<td>0.31</td>
<td>2.18</td>
</tr>
</tbody>
</table>

Probabilities

<table>
<thead>
<tr>
<th>Fines</th>
<th>AMEn (%)</th>
<th>AMCCE (%)</th>
<th>AMCDM (%)</th>
<th>AMCCP (%)</th>
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<tbody>
<tr>
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<td>86.40</td>
<td>82.76</td>
<td>39.97</td>
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<td>3150</td>
<td>85.78</td>
<td>83.08</td>
<td>42.52</td>
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<tr>
<td>100</td>
<td>3183</td>
<td>86.71</td>
<td>83.71</td>
<td>47.06</td>
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</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th>AMEn (%)</th>
<th>AMCCE (%)</th>
<th>AMCDM (%)</th>
<th>AMCCP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>3171</td>
<td>86.36</td>
<td>83.41</td>
<td>43.24</td>
</tr>
<tr>
<td>Female</td>
<td>3159</td>
<td>86.02</td>
<td>82.96</td>
<td>43.29</td>
</tr>
</tbody>
</table>

a,b Different letters in averages in the same column differ from each other.

Key Words: feed form, gizzard, liver, intestines

Table 1. AMEn, AMCCE, AMCDM, AMCCP for slow-growing broilers males and females, fed diets with different proportions of fines from 1 to 28 days of age

<table>
<thead>
<tr>
<th>Fines (%)</th>
<th>AMEn (kcal/kg)</th>
<th>AMCCE (%)</th>
<th>AMCDM (%)</th>
<th>AMCCP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3162</td>
<td>86.07</td>
<td>82.76</td>
<td>39.97</td>
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<tr>
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<td>3150</td>
<td>85.78</td>
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<td>100</td>
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<td>86.71</td>
<td>83.71</td>
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<table>
<thead>
<tr>
<th>Sex</th>
<th>AMEn (%)</th>
<th>AMCCE (%)</th>
<th>AMCDM (%)</th>
<th>AMCCP (%)</th>
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<tr>
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<td>3159</td>
<td>86.02</td>
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</tbody>
</table>

Probabilities

<table>
<thead>
<tr>
<th>Fines</th>
<th>AMEn (%)</th>
<th>AMCCE (%)</th>
<th>AMCDM (%)</th>
<th>AMCCP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.77</td>
<td>0.77</td>
<td>0.81</td>
<td>0.34</td>
<td></td>
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<tr>
<td>0.76</td>
<td>0.75</td>
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</tr>
<tr>
<td>0.77</td>
<td>0.77</td>
<td>0.62</td>
<td>0.10</td>
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<tr>
<td>3.63</td>
<td>3.68</td>
<td>4.42</td>
<td>25.55</td>
<td></td>
</tr>
</tbody>
</table>

Note: Natural matter.
170  Energy composition of corn hybrids under different drying temperature to broilers at different ages. N. R. Junior1, F. C. N. Giacobbo1, C. Eyng1, L. Teixeira2, R. V. Nunes3, C. de Souza4, and C. de Souza5.

Variation in nutrient components of corn may affect profitability in broiler production as corn constitutes approximately 60% of the feed. The aim was to determine the apparent metabolizable energy (AME), AME corrected for nitrogen balance (AMEn) and apparent (AM) and corrected metabolizable coefficients (AMCn) of 3 corn hybrids submitted to different drying temperatures for broilers at different phases. Energy values were determined by the traditional method of total excreta collection, using male broilers from 11 to 21 (first period) and from 31 to 41 (second period) days of age, allotted to a completely randomized design, in a factorial scheme (3 corn hybrids and 2 drying temperatures -80 and 110°C), totaling 6 treatments, with 7 replicates and 4 and 3 birds per experimental unit for the first and second periods, respectively. Experimental diets were composed only of the evaluated ingredient, minerals and vitamins. The results were submitted to ANOVA using SAS software. The individual effects and interaction between factors (hybrid and temperature) were analyzed; when significant, interactions were sliced using the PROC GLM procedure. Considering the first period, the ANOVA showed interaction (P<0.05) between factors on AME and AMEn values. Evaluating the energy values within each drying temperature, an interference of hybrids was not observed. However, when evaluated different drying temperatures within each hybrid, AME and AMEn values of 3,373 and 3,300 kcal/kg, respectively, obtained for hybrid 1, were higher at 80°C. For the isolated factors, regardless of drying temperature, hybrid 3 had higher metabolizable coefficients (AMC and AMCn), of 83.10 and 81.98%, respectively. For the second period, there was no interaction (P>0.05) between factors. Nevertheless, for the isolated factors, regardless of corn drying temperature, an interference in the energy values as well as in their metabolizable coefficients among the different hybrids was verified, averaging 2,619 and 2,631 kcal/kg; and 70.92, 71.23%, respectively for AME, AMEn, AMC and AMCn. The different hybrids available on the market led to a distinct energy use in broilers. In addition, the drying temperature of the grain may negatively influence the digestibility of nutrients in broilers in the starter phase.

Key Words: apparent metabolizable energy, corn drying, metabolizable coefficients, total excreta collection


The present study carried out to determine the metabolizable coefficients of alternative foods used in formulation of diets for slow-growing broilers. A total of 350 broilers were housed in metabolic cages with dimensions of 60 × 80 × 42 cm, equipped with trough-type feeders, a nipple drinker and trays for the collection of excreta. The birds were distributed in a completely randomized design, with 5 treatments and 7 replicates with 10 birds per experimental unit. The treatments consisted of T1: reference diet (formulated based on the nutritional requirements that as control diet), T2: 80% of reference diet + 20% inclusion of the moringa leaf meal, T3: 80% of reference diet + 20% inclusion of the bocaiuva pulp meal, T4: 60% of reference diet + 40% of corn inclusion and T5: 60% of reference diet + 40% inclusion of soybean meal. The methodology of total excreta collection was used in 3 periods: initial (17 to 26 d of age), growth (47 to 54 d of age) and final (67 to 76 d of age). The experimental period at different ages consisted of 3 d of adaptation to diets and 5 d of excreta collection. The excreta were collected twice a day, 8 and 16h. To establish the begin and the end of the excreta collection periods, 1% ferric oxide was added to the rations. Water and food were provided at will. The levels of moisture, dry matter and crude protein were determined from excreta and feed. To obtain the values of the metabolizable coefficients of dry matter and crude protein of feed and diets. The ANOVA was carried out followed by the comparison test of means.

Key Words: alternative feeding, free-range broiler chicken


The methodology of total excreta collection was used in 3 periods: initial (17 to 26 d of age), growth (47 to 54 d of age) and final (67 to 76 d of age). The experimental period at different ages consisted of 3 d of adaptation to diets and 5 d of excreta collection. The excreta were collected twice a day, 8 and 16h. To establish the begin and the end of the excreta collection periods, 1% ferric oxide was added to the rations. Water and food were provided at will. The levels of moisture, dry matter and crude protein were determined from excreta and feed. To obtain the values of the metabolizable coefficients of dry matter and crude protein of feed and diets. The ANOVA was carried out followed by the comparison test of means.

Key Words: alternative feeding, free-range broiler chicken


This study was conducted to determine apparent metabolizability coefficients of dry matter (MCDM), gross energy (MCGE), crude protein (MCCP) and ileal digestibility coefficients of dry matter (IDCMM) and crude protein (IDCMM) of poultry offal meal (POM) and meat and bone meal (MBM) fed to broilers at different ages. Three metabolism
trials were carried out in the pre-starter (1 to 8 d), starter (14 to 22 d), and grower (28 to 36 d) phases. 840 Cobb-500 broilers were reared in floor until reaching the age proposed for the trials. Broilers were housed in metabolic cages where the partial excreta collection method was adopted, and ileal digestibility coefficients were determined at the end of each experimental phase by the ileal digesta collection method. The experiment was set up as a completely randomized design with 7 treatments and 6 replicates with 10, 6, and 4 birds in the respective experimental phases. Treatments consisted of a control diet and 6 test diets containing 80% of control diet plus 20% of the test ingredient (POM 1, 2, or 3; and MBM 1, 2, or 3). Metabolisibility coefficients of ingredients and ileal digestibility were analyzed in a 3 × 6 factorial arrangement (ages × meals) where they were subjected to an ANOVA and comparison of means by Tukey test (P < 0.05). The MCDM was significant for both factors age and meal; the POM had highest values; however, MCCP was highest for the MBM. The MCGE showed an interaction between the studied factors, but the average of treatments did not showed significant differences. The ileal digestibility coefficients of DM and CP were significant for the meal and age factors, but there was no interaction between them. The former variable increased from the pre-starter, 58.19% to the starter phase, subsequently stabilizing in the final phase, 64.72%, while IDCCP was lowest in the last life stage, 72.13%. Treatments with POM showed a highest IDCDM, whereas IDCCP was highest in the MBM-containing treatments. There were differences between ileal digestibility and digestibility measured in the excreta; there were observed highest values in the ileum. The estimate of protein digestibility in the ileum generates better results than in the broilers’ excreta, because the protein composition is not modified by the microbiota in the distal part of the intestine.

**Key Words:** broiler, digestibility, meal and bone meal, metabolizable energy, poultry offal meal

174  **Energetic values of brewery dehydrated residue for broilers from 31 to 41 days of age.** T. J. Pasquetti1, C. M. Bernardi1, R. Frank2, R. A. Schöne2, C. Eyng2, P. S. Celli1, and R. V. Nunes2, 1Universidade Estadual de Mato Grosso do Sul, Aquidauana, Mato Grosso do Sul, Brazil, 2Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, 3Universidade Tecnológica Federal do Paraná, Dois Vizinhos, Paraná, Brazil.

A study was conducted to evaluate the apparent metabolizable energy corrected for nitrogen balance (AMEn) and metabolizability coefficients of brewery dehydrated residue (BDR) for broilers. The experiment was conducted at the Universidade Estadual do Oeste do Paraná - UNIOESTE, Brazil. A total of 100 broilers were allotted in battery cages and distributed in a completely randomized design with 5 treatments and 4 replicates per treatment. The BDR replaced the reference diet in 10, 20, 30 and 40%. The experimental period was 10 d from 31 to 41 d of age. There were 5 cages for adaptation and 5 for total excreta collection. Water and feed were provided ad libitum during the entire experimental period. Excreta was collected twice a day and after the collection period, excreta was thawed, homogenized and dried in a forced ventilation oven at 55°C for 72 h. Dry samples were ground and analyzed for dry matter, gross energy and nitrogen to determine the AME, AMEn and calculate the metabolizability coefficients of AME (MCAME) and AMEn (MCAMEn). Metabolizable coefficients and energetic values were submitted to a polynomial regression analysis (α = 0.05). The AME (1,549.91 - 3.8352X; R2 = 0.75) and MCAME (36.722 - 0.0909412X; R2 = 0.75) reduced linearly (P < 0.05) as BDR levels increased in the diets. The AME values were 1,537, 1,442, 1,417 and 1,453 kcal/kg and the MCAME values were 36.43, 34.17, 33.59 and 33.60% for 10, 20, 30 and 40% of BDR, respectively. No effect (P > 0.05) of BDR on AMEn and MCAMEn were observed, in which the values were 1,285, 1,226, 1,186 and 1,202 kcal/kg and 30.46, 29.07, 28.12 and 29.03% for the levels of 10, 20, 30 and 40% of BDR, respectively. Considering the average value, the apparent metabolizable energy corrected for nitrogen balance of BDR for broilers was 1,225 kcal/kg.

**Key Words:** alternative feed, metabolizability coefficient, metabolizable energy, byproduct, metabolism


The corn germ meal (CGM) is from industrialization of corn by wet milling process. This by-product does not undergo oil extraction process, due to this the CGM has high lipid content (56.52%) and crude energy (7183 kcal / kg). The present study was conducted with the objective of evaluate the ileal digestibility of CGM with the use of the response surface model. 720 broilers (Cobb 500) one day old, male, was distributed in a completely randomized design, with 6 treatments and 6 replicates of 10 (pre-initial phase - 1 to 8 d old), 6 (initial phase – 14 to 21 d old) and 4 birds (growth I phase - 25 to 33 d) per replicates. The treatments were: reference diet (corn and soybean meal) and 4 diets with 10, 15, 20, 25 and 30% of replacement of the reference diet by CGM. Ileal content was also collected for the determination of ileal digestibility coefficients of dry matter (IDCCM), crude protein (IDCCP), digestible dry matter (DDM) and digestible of crude protein (DCP). The data was fit for response surface model, considering the age of the broilers and CGM levels as independent variables. The age and levels factors interfered (P < 0.05) in the ileal digestibility coefficients of the CGM obtained in broiler chickens, the estimated models were: IDCCM = 1.462 age + 2.989 level – 0.082 age x level (R2 = 0.49) e IDCCP = 79.592 – 1.524 age + 2.022 level + 0.026 age2 – 0.051 level2 (R2 = 0.49); DDM = 1.422 age + 2.907 level – 0.079 level x age (R2 = 0.49) and DCP = 8.572 – 0.164 age + 0.218 level + 0.003 age2 – 0.006 level2 (R2 = 0.49). According to the model, the stationary point were: IDCCM = 57.96%, IDCCP = 78.88%, DDM = 56.17% and DCP = 8.50%. These points were found at 28.28 d of age and 20.61% of CGM for the IDCCP and DCP. For IDCCM and DDM were found 17.88 d and 20.61% of CGM. The ileal digestibility of CGM were influenced by the replacement level and age of birds. The mathematical model used was adequate to demonstrate the behavior of the ileal digestibility of CGM by broilers, as well as the relation between the factors age and level of substitution.

**Key Words:** corn by-product, lipid source, wet milling process

176  **Performance of broilers from 1 to 42 days of age feeding diets with brewery dehydrated residue.** T. J. Pasquetti*, C. M. Bernardi1, R. Frank2, R. A. Schöne2, C. Eyng2, P. S. Celli1, and R. V. Nunes2, 1Universidade Estadual de Mato Grosso do Sul, Aquidauana, Mato Grosso do Sul, Brazil, 2Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, 3Universidade Tecnológica Federal do Paraná, Dois Vizinhos, Paraná, Brazil.

A study was conducted to evaluate the performance of broilers (1 to 42 d of age) feeding diets with different inclusion levels of brewery dehydrated residue (BDR). The experiment was conducted at the Universidade Estadual do Oeste do Paraná - UNIOESTE, Brazil. A total of 840 broilers were distributed in a completely randomized design with

Broilers are exposed to a range of pathogens that can impair intestinal health and thus reduce the nutrient utilization and growth performance. Therefore, sub-therapeutic doses of antibiotics are generally included to the feed to improve the intestinal health, help non-pathogenic microorganisms to colonize the gut and reduce the number of pathogenic bacteria. Several researches have been carried out in animal nutrition area to improve performance by the use of feed additives. Therapeutic properties, such as anticarcinogenic, anti-inflammatory, and antibiotic, are found in mushrooms molecules, and might be used as a potential performance enhancer in broilers. The objective of this study was to evaluate the effects of different levels of shiitake residue (SR) inclusion on broilers’ performance. The birds were allotted in a completely randomized design to 4 dietary treatments (0; 0.15; 0.30; and 0.45% of SR) with 6 replicates with 31 birds each. The growth performance was evaluated at 7, 21, 35 and 42 d post-hatch. There was no significant differences at 7 and 42 d in any of the performance parameters. However, from 1 to 21 and 1 to 35 d post-hatch, the feed conversion ratio of birds fed the highest inclusion level (0.45%) was increased. From 1 to 35 d, the birds fed on diets with 0.15% and 0.30% of SR presented increased body weight gain when compared with those receiving 0.45% of SR. In summary, the inclusion of the shiitake residue at the highest levels (0.45%) impairs the growth performance of broilers from 1 to 21 and 1 to 35 d post-hatch.

Key Words: mushroom, shiitake, residue


The objective of the present work was to evaluate the performance and carcass characteristics of free-range broilers chickens, fed with different levels of bocaiuva meal. The use of alternative foods appears as an option to reduce the costs of production and use of food available. Considering these options the use of bocaiuva meal presents potential for use in animal feed. A total of 375 d-old chicks of the naked neck lineage were distributed in a completely randomized design in diets with 5 levels of bocaiuva meal (0; 2; 4; 6 and 8%). Data were submitted to ANOVA and polynomial regression, followed by the Tukey test, when a significant effect was observed. No significant effects of bocaiuva meal on weight gain, feed intake and feed conversion were observed. The increase of the level of the alternative food provided an increase in the abdominal fat of the broilers, which reflected in the deterioration of the carcass yield. Influence of bocaiuva meal levels on the red coloration (a*) of the thorax was higher, for birds that received a diet without bocaiuva meal and decreased with increasing food inclusion in the diet. The content of yellow (b*) in the thorax, thigh and drumsticks chicken increased with the addition of food in the diet and the percentage of age decreased as the percentage of bocaiuva flour increased. The inclusion of bocaiuva meal in up to 8% does not affect the performance of free-range broiler chickens.

Key Words: Canthaxanthin, alternative food, alternative poultry, macaúba, slow-growing chicken

179 Embryo diagnosis of non-hatched eggs supplemented in ovo with commercial product of canthaxanthin containing lignosulfonate. I. C. S. Araújo*, M. A. Mesquita, R. A. Noleto, J. M. S. Martins, Departamento de Zootecnia, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, Departamento de Zootecnia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.

This study was conducted to evaluate the effects of a commercial product of canthaxanthin 10% (CX) containing lignosulfonate (62.8%), administered in ovo on embryo diagnosis of eggs. A total of 780 fertile eggs from Cobb 500 broiler breeder flocks were distributed in a randomized block design (3 setters), with 5 treatments and 12 replicates (13 eggs in each replicate). Treatments: 1) eggs inoculated with 0.5 mL of distilled water; 2) eggs inoculated with 0.5 of distilled water and 0.035 mg of CX; 3) eggs inoculated with 0.5 of distilled water and 0.045 mg of CX; 4) eggs inoculated with 0.5 of distilled water and 0.055 mg of CX of VE and 5) eggs inoculated with 0.5 of distilled water and 0.065 mg of CX. Temperature and relative humidity of the setters were set at 37.7°C and 59%, respectively. At 17.5 d of incubation, CX solution was inoculated in the amniotic fluid. After inoculation, eggs were placed in air-permeable bags and were distributed in hatchery trays. Temperature and relative humidity of the hatcheries (36.7°C and 70%). Incubation trial was halted when it reached 504 h. At the end of the incubation, all unhatched eggs were analyzed: phase I included the period between zero to 4 d of embryonic development (DE) (MI); phase II, between 5 to 10 d of DE(MII); phase III, 11 to 18 d of DE (MII); and phase IV, between 19 and 21 d of DE (MIV). The number of infertile eggs, pipped eggs with dead and alive chicks, alive and not pipped, and eggs with bacterial or fungal contamination were counted. Data were analyzed with Fisher’s exact test (P < 0.05). No significant effects (P > 0.05) were observed for infertile, MI, MII and contaminated eggs. The suplementation of 0.055 and 0.065 mg of CX promoted the highest mortality in MIII (5.75 and 9.95%, respectively). The group that was supplemented with 0.065 mg of CX had the highest mortality in MIV and pipped eggs (25.95% and 35.65%, respectively). It was possible to observe intense orange
Guanidinoacetic acid supplementation on broiler performance from 1 to 42 days of age with varying energy contents.


Creatine is important for energy metabolism, specifically in muscle cells. Thus, the objective of this experiment was to evaluate the effect of guanidinoacetic acid (GAA) supplementation on broiler performance in meat bone meal (MBM) and vegetable diets with adequate or low dietary energy content. A total of 2,880 male broiler chicks Cobb 500 were distributed in a completely randomized design with 8 treatments and 10 replicates with 36 birds each. The treatments used were: Vegetable-based diet with or without reduced energy (−50 kcal) and with or without GAA supplementation, MBM-based diet and MBM-based diet with (0.06%) or without reduced energy (−50 kcal) and with (0.06%) or without GAA supplementation. Were used different energy levels per phase: 2,950 kcal/kg of starter from 0 to 10 d, 3,042 kcal/kg of grower from 11 to 21 d, and 3,140 kcal/kg of finisher from 22 to 42 d. The data were analyzed using general linear models procedures of SAS (SAS Version 9.2). The variances were calculated using the F test. Seven orthogonal contrasts were constructed to verify the effectiveness of product supplementation. The variable analyzed were: feed intake (FI), body weight (BW), body weight gain (BWG) and feed conversion ratio (FCR). GAA addition affects the results of BW between Vegetable-based diet × Vegetable-based diet with GAA: (P-value = 0.0005); and Vegetable-based diet with GAA (P-value = 0.0097); and MBM-based diet (−50 kcal) × MBM-based diet (−50 kcal) with GAA (P-value = 0.0005); and Vegetable-based diet (−50 kcal) × Vegetable-based diet (−50 kcal) with GAA (P-value = 0.0013). GAA supplementation of energy reduction diets allows broilers to maintain the same performance in MBM or vegetable diets. GAA supplementation also improves the performance of MBM and vegetable diets with an adequate level of energy.

Acknowledgements: We would like to thank to Evonik Animal Nutrition and São Paulo State University, UNESP/Jaboticabal.

Key Words: antioxidant, broiler chick, embryo mortality, pigments

181 Performance of broilers fed diets containing different levels of pulverized activated charcoal in the starter phase. F. R. Bueno*1, R. Brene1, F. B. Marinho1, R. L. Zaninelli2, and A. Oba1, 1Universidade Estadual de Londrina, Londrina, Paraná, Brazil, 2Centro Universitário Filadélfia, Londrina, Paraná, Brazil.

Activated charcoal has been studied by the adsorption capacity, and in the gastrointestinal tract, it acts by absorbing gases and binds to various substances through physical interactions regardless of whether they are ionized or not, and can, therefore, improve the zootechnical performance of broilers. The objective of this research was to evaluate the effect of pulverized activated charcoal on broiler chick performance and to determine the best level of inclusion in the pre-starter and starter phases. The experiment was conducted at the Poultry Nutrition Research Unit of the Universidade Estadual de Londrina. The experimental was designed as a randomized block design with different dietetic activated charcoal levels (0, 0.5, 1.0, 1.5%) during 21 d. 400 male day-old Cobb 500 chicks were used, with 10 replicates per treatment and 10 birds per experimental plot. The experiment was divided into 2 phases: pre-starter (1–7 d of age) and starter (8–21 d of age). The experimental diets met the requirements recommended by Rostagno et al. (2011). Chicks received water and food ad libitum during the whole experimental period and the feed intake, weight gain, feed conversion ratio, and livability were evaluated. The results were submitted to ANOVA and regression analysis at 5% of significance, using the statistical program R. The results show that the different levels of inclusion of activated charcoal did not significantly influence feed intake, weight gain, feed conversion ratio, and viability. It is concluded that the use of pulverized activated charcoal does not alter the performance of broilers and can be used up to 1.5% in the practice formulation without affecting the performance of the broilers in the pre-starter and starter phase.

Table 1. Performance of broilers fed diets containing different levels of pulverized activated charcoal in the pre-starter and starter phases

<table>
<thead>
<tr>
<th>Phase and treatment</th>
<th>Feed intake (g)</th>
<th>BW gain (g)</th>
<th>Feed conversion ratio</th>
<th>Livability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-starter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0% Charcoal</td>
<td>199.84</td>
<td>156.54</td>
<td>1.28</td>
<td>100</td>
</tr>
<tr>
<td>0.5% Charcoal</td>
<td>210.12</td>
<td>170.44</td>
<td>1.24</td>
<td>100</td>
</tr>
<tr>
<td>1% Charcoal</td>
<td>211.55</td>
<td>164.24</td>
<td>1.31</td>
<td>100</td>
</tr>
<tr>
<td>1.5% Charcoal</td>
<td>214.31</td>
<td>162.94</td>
<td>1.32</td>
<td>100</td>
</tr>
<tr>
<td>P-value</td>
<td>0.31</td>
<td>0.28</td>
<td>0.56</td>
<td>0.40</td>
</tr>
<tr>
<td>CV (%)</td>
<td>9.06</td>
<td>9.56</td>
<td>11.34</td>
<td>0</td>
</tr>
<tr>
<td>Starter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0% Charcoal</td>
<td>1163.17</td>
<td>824.72</td>
<td>1.36</td>
<td>96.89</td>
</tr>
<tr>
<td>0.5% Charcoal</td>
<td>1143.47</td>
<td>830.44</td>
<td>1.33</td>
<td>98.00</td>
</tr>
<tr>
<td>1% Charcoal</td>
<td>1078.56</td>
<td>831.75</td>
<td>1.30</td>
<td>98.00</td>
</tr>
<tr>
<td>1.5% Charcoal</td>
<td>1069.49</td>
<td>818.17</td>
<td>1.31</td>
<td>97.00</td>
</tr>
<tr>
<td>P-value</td>
<td>0.17</td>
<td>0.98</td>
<td>0.56</td>
<td>0.91</td>
</tr>
<tr>
<td>CV (%)</td>
<td>9.96</td>
<td>9.46</td>
<td>6.88</td>
<td>4.65</td>
</tr>
</tbody>
</table>

Key Words: adsorbent, feed conversion ratio, poultry farming, productive characteristic, vegetable ash

Poult. Sci. 97(E-Suppl. 2)
The performance of broilers and consequently the use of nutrients is closely related to genetics. An experiment was carried out with the objective of evaluating the performance and nutrient utilization of the ration of different slow-growing broiler strains in the initial breeding phase (one 21 d of age). A total of 544 d-old chicks of the strains were used: Carijo, Carijo naked neck (Carijo N) Isa Label naked neck (Isa N) and ISA Label (ISA), were randomly distributed into cages equipped with a metal tray for excreta collection. A completely randomized design with 4 treatments (lineages) and 8 replicates of 17 birds each was used. The birds were fed the same experimental diets recommended by the Brazilian Poultry and Pork Tables, 2011. Body weight, weight gain, feed intake and feed conversion were evaluated. The coefficients of apparent metabolizability of dry matter (CAMDM) and nitrogen (CANN) were determined. Data were submitted to ANOVA and Tukey’s test using software R (3.4.1). There were differences (P < 0.05) for the parameters body weight, weight gain, feed intake and feed conversion among the studied strains. Greater body weight of the Carijo and Isa lines were verified. Carijo, Isa N and Isa presented the best feed conversion (P < 0.05) in relation to the Carijo N lineage. The mean values of CAMDM (%) were 76.95, 76.63, 71.35, 76.34 respectively for Carijo, Carijo N, Isa N and Isa. For CANN (%), the averages were 71.19 for Carijo, Carijo N 71.10, while for Isa N line the value was 58.54 and Isa 65.33. The Isa N line presented lower CAMN, but there was no difference (P < 0.05) among the other strains studied. The performance and metabolizable coefficients of dry matter and nitrogen are different among the slow-growing broiler strains. In conclusion, the Carijo, Isa and Isa naked neck Label Label have better performance at the initial stage of setting in relation to Carijo naked neck strain, the strain ISA Label naked neck have better performance at the initial stage of setting in relation to Carijo naked neck strain, the strain ISA Label naked neck have better performance at the initial stage of setting in relation to ISA Label naked neck strain.

**Key Words:** free-range, nutrition, growth, digestive, genetics

182 **Performance and metabolizability of nutrients of slow-growing chicken lines in the initial phase.** S. D. Assis*, N. S. M. Leandro, F. Barros de Carvalho, M. A. Costa, and R. F. Sousa, Universidade Federal de Goiás, Goiânia, GO, Brazil.

The performance of broilers and consequently the use of nutrients is closely related to genetics. An experiment was carried out with the objective of evaluating the performance and nutrient utilization of the ration of different slow-growing broiler strains in the initial breeding phase (one 21 d of age). A total of 544 d-old chicks of the strains were used: Carijo, Carijo naked neck (Carijo N) Isa Label naked neck (Isa N) and ISA Label (ISA), were randomly distributed into cages equipped with a metal tray for excreta collection. A completely randomized design with 4 treatments (lineages) and 8 replicates of 17 birds each was used. The birds were fed the same experimental diets recommended by the Brazilian Poultry and Pork Tables, 2011. Body weight, weight gain, feed intake and feed conversion were evaluated. The coefficients of apparent metabolizability of dry matter (CAMDM) and nitrogen (CANN) were determined. Data were submitted to ANOVA and Tukey’s test using software R (3.4.1). There were differences (P < 0.05) for the parameters body weight, weight gain, feed intake and feed conversion among the studied strains. Greater body weight of the Carijo and Isa lines were verified. Carijo, Isa N and Isa presented the best feed conversion (P < 0.05) in relation to the Carijo N lineage. The mean values of CAMDM (%) were 76.95, 76.63, 71.35, 76.34 respectively for Carijo, Carijo N, Isa N and Isa. For CANN (%), the averages were 71.19 for Carijo, Carijo N 71.10, while for Isa N line the value was 58.54 and Isa 65.33. The Isa N line presented lower CAMN, but there was no difference (P < 0.05) among the other strains studied. The performance and metabolizable coefficients of dry matter and nitrogen are different among the slow-growing broiler strains. In conclusion, the Carijo, Isa and Isa naked neck Label Label have better performance at the initial stage of setting in relation to Carijo naked neck strain, the strain ISA Label naked neck have better performance at the initial stage of setting in relation to Carijo naked neck strain, the strain ISA Label naked neck have better performance at the initial stage of setting in relation to ISA Label naked neck strain.

**Key Words:** free-range, nutrition, growth, digestive, genetics


The aim of this study was to evaluate 2 limestone particle size and phytase superdosing in diets to broiler breeders on egg quality. A total of 2880 eggs were collected from broiler breeders distributed in a randomized design with a 2 x 2 factorial arrangement, with 2 phytase levels (500 and 1500 FTU/kg) and 2 limestone with different geometric mean diameter (GMD). Fine limestone (F) with GMD of 419 mm and a geometric standard deviation (GSD) of 2.66 and a coarse limestone (C) with GMD of 2661 mm and GSD of 1.34. Diets were based on corn-wheat-soybean meal in mash form with equal calcium levels (90) with GMD of 2661 mm and GSD of 1.34. Diets were based on corn-wheat-soybean meal in mash form with equal calcium levels (90). Phytase (Phy) levels (500 or 1500 FTU/kg) and limestone particle size were evaluated. The coefficients of apparent metabolizability of dry matter (CAMDM) and nitrogen (CANN) were determined. Data were submitted to ANOVA and Tukey’s test using software R (3.4.1). There were differences (P < 0.05) for the parameters body weight, weight gain, feed intake and feed conversion among the studied strains. Greater body weight of the Carijo and Isa lines were verified. Carijo, Isa N and Isa presented the best feed conversion (P < 0.05) in relation to the Carijo N lineage. The mean values of CAMDM (%) were 76.95, 76.63, 71.35, 76.34 respectively for Carijo, Carijo N, Isa N and Isa. For CANN (%), the averages were 71.19 for Carijo, Carijo N 71.10, while for Isa N line the value was 58.54 and Isa 65.33. The Isa N line presented lower CAMN, but there was no difference (P < 0.05) among the other strains studied. The performance and metabolizable coefficients of dry matter and nitrogen are different among the slow-growing broiler strains. In conclusion, the Carijo, Isa and Isa naked neck Label Label have better performance at the initial stage of setting in relation to Carijo naked neck strain, the strain ISA Label naked neck have better performance at the initial stage of setting in relation to Carijo naked neck strain, the strain ISA Label naked neck have better performance at the initial stage of setting in relation to ISA Label naked neck strain.

**Key Words:** free-range, nutrition, growth, digestive, genetics


When a highly digestible feed is progressively diluted with one of greater ‘bulk’ the prevailing view is that (1) the rate of feed intake will initially increase at a rate such that digestible energy (DE) intake remains roughly constant and performance is unaffected and, (2) that, beyond a critical point, intake of feed and DE will fall and performance be reduced as the dilution proceeds further. The critical point has been assumed to reflect the capacity of the animal for ‘bulk’. Current models, which attempt to predict the voluntary feed intake of pigs, use dry matter of the feed as a measure of bulk or the undegraded organic matter. The current experiment was designed with 2 purposes: (1) to identify a property of ‘bulky’ feeds which might be responsible for limiting their intake, (2) to describe the maximum consumption capacity in pullets, through the daily food intake of the diet. For this, an experiment was conducted using 225 Hy-line W-36 pullets from 20 to 24 weeks of age, randomly assigned to 25 treatments, obtained by combining 5 diluents with 5 dilution levels, with 9 individual replicates. A balanced diet (BD) was formulated to

**Table 1. Phytase (Phy) levels (500 or 1500 FTU/kg) and limestone particle size (fine ~ 419 GMD or coarse ~ 2661 GMD) in diets to broiler breeders (at 33, 37, 41, 45, 49, 53, 57 and 61 wk old) on egg weight (EW), yolk (YW), albumen (AW), eggshell (SW) and specify gravity (SG)**

<table>
<thead>
<tr>
<th>Limestone</th>
<th>Fine 500</th>
<th>500</th>
<th>70.39</th>
<th>21.69</th>
<th>42.65</th>
<th>6.04</th>
<th>1075.4</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Coarse 500</td>
<td></td>
<td>70.39</td>
<td>21.69</td>
<td>42.65</td>
<td>6.04</td>
<td>1075.4</td>
</tr>
<tr>
<td></td>
<td>Fine 1500</td>
<td></td>
<td>69.41</td>
<td>21.73</td>
<td>42.64</td>
<td>6.02</td>
<td>1074.4</td>
</tr>
<tr>
<td></td>
<td>Coarse 1500</td>
<td></td>
<td>70.41</td>
<td>21.73</td>
<td>42.64</td>
<td>6.02</td>
<td>1074.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P-value</th>
<th>Limestone</th>
<th>0.047</th>
<th>0.448</th>
<th>0.021</th>
<th>0.666</th>
<th>0.701</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phy</td>
<td>0.010</td>
<td>0.742</td>
<td>0.001</td>
<td>0.014</td>
<td>0.191</td>
</tr>
<tr>
<td></td>
<td>Limestone × Phy</td>
<td>0.001</td>
<td>0.834</td>
<td>0.001</td>
<td>&lt;0.001</td>
<td>0.010</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.53</td>
<td>8.01</td>
<td>8.21</td>
<td>9.40</td>
<td>0.49</td>
<td></td>
</tr>
</tbody>
</table>

1Coefficient of variation

**Acknowledgements:** AB Vista

**Key Words:** albumen, calcium, egg weight, enzyme, specific gravity
meet or exceed pullet requirements described by the 4th edition of the Brazilian Tables for Poultry and Swine. The bulk diets were formulated diluting BD with 2.5%, 5%, 10% and 15% of cellulose fiber, sawdust, rice hulls, sand, and vermiculite. Data regarding diet characteristics were analyzed as one-way ANOVA. The models to predict pullet feed intake (FI) were elaborated from the determination of the correlation coefficients between the laboratory analyzes performed in diets and the bird FI. For this, multiple regression analyzes were performed between the FI (g/BWkg/day) and laboratory analyzes to fit the model and determine the coefficients. Therefore, the variables that presented the highest correlation with FI were the inverse of the water holding capacity (1/WHC) and the inverse of the crude fiber (1/CF). Thus, the intercept and coefficients for these variables were generated as a function of FI. Based on the results, the equation fitted to predict pullet FI based on diet characteristics was: FI = 122.79 – 10.62 x (1/WHC) – 6.68 x (1/CF).

Acknowledgements: The authors thank FAPESP (2013/25761-4) for providing financial resources, which supported the conduction of the current research.

Key Words: gastrointestinal tract, water-holding capacity, crude fiber

185  Welfare condition of Bovans White pullets fed two fiber sources and two dietary fiber levels in starter phase. A. F. B. Royer1, L. P. Silva Gomides2, G. Bezerra de Carvalho2, P. C. Martins2, T. Cristina de Araujo2, J. S. Santos2, F. Barros de Carvalho2, M. B. Cafe2, and J. H. Stringhini*2, 1Instituto Federal de Mato Grosso do Sul, Nova Andradina, MS, Brazil, 2Universidade Federal de Goiás, Goiânia, Goiás, Brazil.

The behavior and welfare variables of the Bovans White chicks were evaluated in the starter phase (1st to 6th weeks of age) fed diets with 2 levels of crude fiber in the diet, with 2 sources. The experiment was carried out in the avian research facilities of the Universidade Federal de Goiás, Goiânia, using 300 Bovans White day-old chicks, allotted in a completely randomized design in a 2x2+1 factorial arrangement, considering 2 levels of crude fiber in the diet (3.0% and 3.5% CF) and 2 fiber sources (wheat bran and sugarcane bagasse) and a control treatment (basal diet consisting of corn and soybean meal), totaling 5 treatments, with 6 replications of 10 birds each in the starter phase. Standards of behavior were evaluated and the classification of the welfare condition of each treatment from the percentage of any kind of behavior characteristics observed in broilers considering inferences of the activities, classified as essential activities for life, health and comfort. The data were submitted to the Kruskall-Wallis test with 5% significance, with the Software R (Version 2.15.1; 2013). There was no difference between treatments for the behavioral activities of laying pullets observed at 21 and 42 d of age (P > 0.05). When the activities were classified according to the order of importance for birds with 21 and 42 d of age, in essential to life and health and comfort, differences were observed between treatments. Average conditions of well-being were obtained for birds fed at levels 3.5% of crude fiber and wheat bran. Good conditions for control treatment and 3.0% of crude fiber and wheat bran in the diet with 21 d were observed. Considering the inference of the activities with 42 d of age, good conditions were obtained for the birds fed with the level of 3.5% of crude fiber and sugarcane bagasse, 3.0% of crude fiber and wheat bran and control treatment. The increased use of crude fiber in poultry feeding did not alter the behavior of the birds, but improved the welfare conditions, independent of the fiber sources.

Acknowledgements: Authors thanks to UFGD, FAPEG, Tectron and Hendrix Genetics

Key Words: digestible nutrient, digestive organ, sugarcane bagasse, wheat bran


Different antioxidant substances have been added to the diet of breeders, or of birds in development with objective of improvement in the productive parameters. Xanthophylls consist of the oxygenated derivatives of carotenoids and their beneficial action is mainly linked to their high antioxidant capacity, due to the high efficiency in absorbing and stabilizing free radicals. Among the xanthophylls, lutein is found in the form of a yellowish powder, obtained mainly from the Tagetes erecta extract. The aim of this study was to identify the effects of supplementation of xanthophyll (lutein), on the diet of Japanese quail breeders (Coturnix coturnix japonica) on production performance and egg quality. We used 480 quail breeders in production distributed in cages for laying, with 6 females and 2 males. The treatments consisted of supplementation...
of 0, 20, 40, 60 and 80 mg of xanthophyll extract (Novafill, 20g/Kg xanthophyll in the product) in the laying diets. Were analyzed 4 28 d cycles for productive performance and 3 d of egg quality in the end of each cycle. Data were submitted to statistical analysis using the SAS program, with a level of 5% of significance, and analyzed by regression. The inclusion of xanthophyll extract in the diet of Japanese quail breeders did not influence on the performance and egg quality variables studied ($P > 0.05$). On average, the quails consumed 26.60 g/day, with feed conversion of 0.46 ᵇ/dozen and ᵇ/ of 70.17%. The mean egg weight was 11.78 ᵇ with general composition 30.82% of yolk, 61.61% of albumen and 7.63% of eggshell, a specific gravity of 1.072, Haugh unit 88.21, yolk index of 0.47 and the shell thickness was 0.21 ᵇ. For the yolk color variables, there was a linear decreasing effect ($P < 0.05$) for the luminosity ($L$) ($L = 43.68117 – 0.02558x$, $R^2 = 0.46$) and increasing linear effect for red color ($a$) ($a = −0.9865 + 0.04502x$, $R^2 = 0.77$) with the inclusion of xanthophyll levels. The color change indicates the transfer of dietary carotenoids to the yolk, these higher levels can increase the antioxidant capacity of fertile eggs for the production of chicks. The inclusion of xanthophyll in the evaluated levels affects the yolk color and does not interfere in the production and performance of quail breeders.

**Key Words:** animal nutrition, carotenoids, antioxidant, fertile eggs

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Understanding energy metabolism in birds and its partitioning for maintenance, growth and egg production, allows the elaboration of models that estimate the nutritional requirements considering differences of body weight (BW), body weight gain (BWG) and egg output (EO). The objective of this research was to carry out a dose-response trial to determine coefficients that represent the partition of energy intake by Japanese quails in the laying phase and validate this model to estimate metabolizable energy requirement for Japanese quails in laying phase.

In a conventional shed, 70 Japanese quails were housed at 24 weeks old during 8 weeks. Initially, 2 diets were formulated with different dietary energy levels: a high energy diet (3,600 kcal.kg⁻¹) and a low energy diet (2,100 kcal.kg⁻¹). The treatments consisted of increasing dietary levels of metabolizable energy: 2,113; 2,383; 2,550; 2,735; 2,848; 3,059 and 3,362 kcal.kg⁻¹ and were formulated based on the dilution technique. Seven treatments were randomly distributed, with 10 replicates and one quail per experimental unit. The variables analyzed were metabolizable energy intake (MEI), heat production (HP) and retained energy (RE) expressed in kcal/kg⁰.⁶⁷. The data were fitted in a linear model using the PROC NLIN procedure of SAS 9.2. The metabolizable energy for maintenance (MEm) was obtained from the relation between RE and MEI, considering the equation RE = 0. The metabolizable requirement for growth (MEg) was estimated by the relation between energy use efficiency (k) and net energy for gain (NEg). The metabolizable energy requirement for egg mass (MEe) was obtained by the relation between energy retained in the egg, divided by the energy use efficiency for egg mass (ke). The estimated values for MEm, MEg, MEe were 154.42 kcal/kg BW⁰.⁶⁷, 5.32 kcal/g⁻¹ and 2.47 kcal/g⁻¹, respectively. The obtained model was MEI = 154.42 × BW⁰.⁶⁷ + 5.32 × BWG + 2.47 × EO. This model predicts MEI based on metabolizable energy intake partitioning for maintenance, growth or egg production requirements. A database composed of 130 observations obtained in different studies were applied to our model to validate this model by linear error decomposition (observed - predicted), in scalar error and prediction bias obtained by linear regression between errors and predicted values. The analyzed error composition (3.94 kcal/bird.day⁻¹) of display showing the model is unbiased with 99% accuracy in the estimates. Therefore, the present model was validated and is suitable to predict the MEI for Japanese quails in laying phase.

**Key Words:** model evaluation, metabolizable energy, egg production
189 Meta-analysis of the effect of *Escherichia coli*-derived phytases on performance of broiler chickens. A. T. S. Fialho*1, A. S. Silva1, C. O. Brito2, P. A. C. B. Vale1, C. J. P. Oliveira1, and V. Ribeiro Jr1, 1Universidade Federal de Sergipe, Campus do Sertão, Nossa Senhora da Glória, Sergipe, Brazil, 2Universidade Federal de Sergipe, Campus São Cristóvão, Aracaju, Sergipe, Brazil.

The objective of the present study was to perform meta-analysis using data from several studies that determined the efficiency of *Escherichia coli*-derived phytase on performance of broiler chickens. Data from 11 papers were compiled considering performance variables (weight gain, feed intake and feed:gain) of broiler chickens from 1 to 21 d of age. Data were used to perform a meta-analysis with the objective to estimate the efficiency of the phytase by fitting nonlinear equations. Data of performance using phytase levels of 500, 1,000, 1,500, and 5,000 FTU/kg of feed was found in different papers. In the found papers, basal diets (corn-soybean meal diets) were used as level zero in the statistical analysis. Similar procedure was used in the meta-analysis. All data were submitted to statistical analysis using SAS statistical package (SAS Institute, Inc., 2010). ANOVA was performed using PROC MIXED. Effect of different studies was considered as random in the model. The orthogonal contrasts method was used to study which polynomial degree best fitted the data. The PROC IML procedure was used to estimate the coefficients used in the polynomial orthogonal contrast method. Additionally, PROC NL MIXED was used to fit nonlinear equations (Quadratic, Cubic, and Gompertz). Akaike’s criterion, Bayesian Inference, and Coefficient of Determination ($R^2$) was applied to choose the best model. There was no effect of enzyme levels on feed:gain ($P > 0.05$). Quadratic and cubic effects of phytase levels on weight gain (WG) and feed intake (FI) were observed ($P < 0.05$). Quadratic equation best fitted the data compared with the other models ($AICc = 452.3, BIC = 453.5, R^2 = 0.43$). The fitted equation was WG = $-0.00005$ (FTU/kg of feed) $^2 + 0.243$ (FTU/kg of feed) + 581.02. The optimal phytase level was estimated to be 2,430.0 FTU/kg of feed. For feed intake, quadratic equation best fitted the data compared with the other models ($AICc = 473.7, BIC = 474.9, R^2 = 0.43$). The fitted equation was FI = $-0.00007$ (FTU/kg of feed) $^2 + 0.294$ (FTU/kg of feed) + 799.7. The optimal phytase level was estimated to be 2,101.4 FTU/kg of feed. We concluded that is possible to perform a meta-analysis to estimate the efficiency of phytase using data from several studies.

**Acknowledgements:** We thank the Universidade Federal de Sergipe.

**Key Words:** exogenous enzyme, digestibility, feedstuffs, metabolism, poultry

190 Effects of phytase and protease on metabolizable energy and amino acid digestibility in corn DDG for broiler diet. F. S. Dalólio*1, D. L. da Silva1, L. do Vale Teixeira2, R. G. Hermes2, R. F. Sens2, and L. F. T. Albino1, 1Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, 2DSM Nutritional Products, São Paulo, São Paulo, Brazil.

The corn dried distillers grains (DDG) contains approximately 25% crude protein, 9% fat, 7–8% crude fiber and 5% ash. The composition can vary according to the quality of the grain and the industrial processes of ethanol extraction and drying of the product. Supplementation with exogenous enzymes in diets for broilers increases the action of endogenous enzymes, the energy value and the availability of digestible amino acids, and reduce the adverse effects of anti-nutritional factors. The objective was to evaluate the nitrogen-corrected apparent metabolizable energy (AMEn) and standardized ileal digestibility coefficients of the digestible amino acids (SIDCAA) of corn DDG without or with supplementation of protease and phytase in diets for broiler chickens. To determine AMEn, a total of 168 male chicks, Cobb 500, 14-d-old, were distributed in a completely randomized design with 4 treatments [Reference diet (RD) without enzyme supplementation; RD replaced by 30% DDG without enzyme supplementation; RD replaced by 30% DDG and supplementation of protease (Ronozyme ProAct); RD replaced by 30% DDG and supplementation of phytase (Ronozyme HIPHOS)], 6 replicates of 7 birds per cage. Birds were submitted to a 5 d diet adaptation and 5 d of total excreta collection. To evaluate SIDCAA, 168 male chicks, Cobb 500, 24-d-old, were distributed in a completely randomized design with 4 treatments [Protein-free diet (PFD); PFD replaced by 30% DDG without enzyme supplementation; PFD replaced by 30% DDG and protease supplementation; PFD replaced by 30% DDG and phytase supplementation], 6 replicates of 7 birds per cage. After 5 d of diet adaptation, the broilers were killed for ileal digesta collection. Data were submitted to ANOVA and means compared by Tukey test at 5% (SAS). There was no significant effect ($P > 0.05$) of the inclusion of protease (+123 kcal) and phytase (+32 kcal) on DDG in the AMEn values. Protease increased ($P < 0.05$) essential amino acid digestibility on DDG by 19.4%, 6.78%, 2.87%, 6.62% for Lys, Met and Val. Phytase improved ($P < 0.05$) the Lys, Met, Cys, Asp, Gly and Pro by 9.12%, 2.19%, 11.64%, 5.16%, 15.32% and 5.34%, respectively. For the greater use of AMEn and the digestible amino acids it is recommended the protease and phytase supplementation in diets formulated with corn DDG.

**Acknowledgements:** DSM Nutritional Products and UFV

**Key Words:** exogenous enzyme, digestibility, feedstuffs, metabolism, poultry

191 Graded levels of phytase on ileal digestibility of essential amino acids in broiler diets. H. B. Freitas*1, K. M. R. S. Nascimento1, C. Kiefer1, G. A. Gomes2, V. A. Macie1, T. R. Silva1, N. R. B. Chaves1, L. L. Paiva1, L. A. R. Silva1, M. S. Rosa1, B. S. C. Flores1, and P. G. Santana1, 1Federal University of Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil, 2ABVista, Marlborough, United Kingdom.

This study was conducted to assess the effect of inclusion of increasing doses of phytase in diets of broiler chickens formulated with different levels of available phosphorus, calcium and sodium and their effects on ileal digestibility of essential amino acids. A total of 450 male day-old Cobb 500 chicks, were allocated according to a completely randomized design, in 6 treatments with 5 replications of 15 birds each. Three different matrix were assumed for phytase with the following nutritional values: Matrix A (MTA): 0.165% calcium (Ca); 0.150% available phosphorus (avP) and 0.035% sodium (Na); Matrix B (MTB): 0.215% Ca; 0.195% avP and 0.045% Na; Matrix C (MTC): 0.245% Ca; 0.225% avP and 0.053% Na. There were 6 different diets: No phytase (formulated to meet the nutritional requirements); Phytase 500 FTU/kg+MTA; Phytase 1,000 FTU/kg+MTA; Phytase 1,500 FTU/kg+MTA; Phytase 1,000 FTU/kg+MTB and Phytase 1,500 FTU/kg+MTC. Phytase added to the experimental diets was from *E. coli* produced in Thricoderma reesei, replacing part of the inert ingredient in the diets. Titanium dioxide was added in all diets at the ratio of 1%. At 21 and 42 d of age, 10 and 5 birds of each replicate were slaughtered, respectively, where the ileal segment was removed to obtain the ileal digesta for the determination.
of ileal digestibility of the essential digestible amino acids: methionine, lysine, threonine, valine, isoleucine, arginine and tryptophan. The results were submitted to ANOVA by the GLM procedure of the SAS program. In cases where there were significant differences, the means of the treatments were compared by the Tukey test at 5% probability. In both evaluation periods, the ileal digestibility of all digestible amino acids evaluated had a significant influence ($P < 0.05$) on the addition of the phytase enzyme associated with nutritional matrix. It was possible to observe that in the phytase diet $1,500$ FTU/kg + MTC, even considering a more robust nutrient matrix, the inclusion of phytase at the level of $1,500$ FTU/kg was able to increase ileal digestibility at $21$ d of valine, isoleucine and arginine when compared with the diet without phytase. Already at $42$ d, the same diet provided the maintenance of ileal digestibility of amino acids when compared with other diets. Therefore, the inclusion of $1,500$ FTU/kg of phytase associated with the more robust nutritional matrix of avP, Ca and Na, can provide both improvements and maintenance of ileal digestibility of essential amino acids in broilers at $21$ and $42$ d of age.

Acknowledgements: This study was conducted with the support of the company AB Vista and Fundect from Mato Grosso do Sul state.

Key Words: enzyme, nutritional matrix, phytate

192 Effects of carbohydrases and superdosing phytase on broiler chickens diets. M. S. D. Pavlak*, C. Eyng1, G. G. Sangalli2, R. V. Nunes1, C. de Souza2, V. D. L. Savarisi1, and L. Wachholz1,

1Universidade Estadual do Oeste do Paraná - Uniioeste, Marechal Cândido Rondon, Paraná, Brazil, 2Universidade Tecnológica Federal do Paraná - UTFPR, Dois Vizinhos, Paraná, Brazil.

The aim was to evaluate the effect of increasing levels of phytase in combination with an enzyme complex (carbohydrases) in broiler diets on performance and carcass yield. A total of 1,540 one-day-old chicks were distributed in a completely randomized design with 5 treatments (A: positive control diet based on corn and soybean meal with inclusion on performance of broiler chickens; B: negative control diet - reduction of 100 kcal, 4% digestible amino acids, 0.15% avP, 0.12% Ca, 5% Na; C: Diet B + Carbohydrases + Phytase (1000 FTU); D: Diet B + Carbohydrases + Phytate (1500 FTU); E: Diet B + Carbohydrases + Phytase (2000 FTU); with 14 replicates and 22 birds per pen. Body weight gain, average feed intake and feed conversion, corrected by mortality, at 7, 21 and 42 d of age, were assessed. Data were submitted to ANOVA and Tukey’s test ($P < 0.05$) was used to compare the means. From 1 to 7 d of age, broilers fed a nutritional restrictive diet without enzymes had a worsening of FC when compared with those receiving positive control diet, however, the diets with addition of carbohydrases and phytase recovered FC completely (diet E) or partially (diets C and D). From 1 to 21 d, broilers fed diets containing enzymes, regardless of phytase inclusion level, had higher BWG and better FC when compared with those fed negative control diet without the addition of carbohydrases and phytase, however, their performance was not equivalent to those fed the positive control diet. Considering the total period (1 to 42 d), broilers fed a nutritional restrictive diet without enzymes had a worsening of FC when compared with the birds which received a positive control diet, however, the addition of enzymes, regardless the phytase inclusion level, recovered partially the FC. This may be correlated with a low percentage of phytic phosphorus in the diets, since, according to the calculated dietary concentrations, it was $0.225%$; $0.212%$; for pre-starter, and starter diets, respectively. These values were not enough to replace completely the inorganic phosphorus in the first 21 d, as it was done.

At 42 d the results for carcass, cuts yields and abdominal fat showed no differences between treatments. The inclusion of carbohydrases and phytase in diets with nutritional reduction partially recovered the performance of the birds, being that phytase had its action impaired by a lack of substrate availability.

Key Words: phytic acid, performance, phosphorus

193 Effect of corn hybrids, drying temperature and exogenous enzymes supplementation on the performance of broiler chickens. F. C. N. Giacobbo*1,2, C. Eyng3, L. Teixeira1, R. V. Nunes1, C. de Souza1, J. Broch1, 1Universidade Estadual Do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, 2DSM, São Paulo, Brazil, 3Copagril, Marechal Cândido Rondon, Paraná, Brazil.

The possible loss of nutritional quality of corn grain under different drying conditions is a concern in animal production, as well as the antinutritional factors present in corn, such as non-starch polysaccharides (NPS) and protease inhibitors. These factors can influence digestibility and then the use of nutrients, directly interfering with animal performance. The aim was to determine the influence of different corn hybrids and drying temperature, as well as the effect of exogenous enzymes on broiler performance. A total of 2,160 one-day-old male broilers were allotted to a completely randomized design, in a $3 \times 2 \times 2$ factorial scheme (3 corn hybrids, 2 drying temperatures - 80 and 110°C, with and without top-dressed enzyme blend containing protease (Ronozyme ProAct, 15,000 PROT/kg of diet), amylase (Ronozyme HiStarch, 80 KNU/kg of diet) and xylanase (Ronozyme WX, 100 FXU/kg of diet), totaling 12 treatments, with 9 replicates and 20 birds per experimental unit. All experimental diets had phytase enzyme (1,000 FTU/kg of diet). At 7, 21 and 42 d of age, the broilers were weighed as well as the amount of feed consumed was calculated to determine the performance (weight gain, average feed intake and feed conversion) for periods from 1 to 7, 1 to 21 and 1 to 42 d of age. The results were submitted to ANOVA ($P < 0.05$). The individual effects and interaction between factors (hybrid, temperature and inclusion or not of enzyme) were analyzed; when significant, interactions were sliced. For the periods evaluated, the ANOVA showed no interaction ($P > 0.05$) between factors for the performance variables. There was an interaction ($P < 0.05$) between temperature and enzyme inclusion, demonstrating that broilers fed diets formulated with corn dried at 80°C containing enzymes had greater weight gain from 1 to 7 d and better feed conversion from 1 to 7 d and from 1 to 42 d. Considering the factors isolated, broilers fed diets containing the enzyme blend, regardless of drying temperature and corn hybrids, increased body weight by 3.46% and 3.83% and improved FC by 0.065 and 0.043 points from 1 to 7 and 1 to 21 d of age, respectively. In addition, the use of corn dried at 110°C in experimental diets, regardless of hybrid and inclusion of enzyme blend, resulted in lower feed intake with a consequent better feed conversion from 1 to 21 d. Overall, the top-dressed inclusion of enzyme blend improved broiler performance in the starter phase. The different hybrids available on the market and the drying of corn grains at temperatures studied can be used without impairing broiler performance.

Acknowledgements: DSM; COPAGRIL

Key Words: drying, amylase, protease, xylanase, Zea mays

194 Effect of corn drying temperature and enzymes combinations on performance of broiler chickens. F. C. N. Giacobbo*1,2, C. Eyng1, L. Teixeira2, R. V. Nunes1, G. Sangalli1, J. Broch1, and E. Cristina dos Santos1, 1Universidade Estadual Do Oeste do Paraná
The objective of this study was to evaluate the effect of different levels of phytase inclusion: a positive control diet, negative control diet, and low phytate (LP, animal ingredients) levels, and 5 levels of phytase superdosing with each treatment containing 7 replicates of 25 birds each (the experimental unit). Enzymes were added to the negative control diet considering the following combinations: Amylase (RONOZYME HiStarch, 80 KNU/kg of diet) (NCA); Amylase + Xylanase (RONOZYME WX, 100 FXU/kg of diet) (NCAX); and Amylase + Xylanase + Protease (RONOZYME ProAct, 15,000 PROT/kg of diet) (NCAXP). At 7, 21 and 42 d of age, the broilers were weighed as well as the amount of feed consumed was calculated to determine the performance (weight gain, average feed intake and feed conversion) for periods from 1 to 7, 1 to 21 and 1 to 42 d of age. The results were submitted to ANOVA (P < 0.05). The individual effects and interaction between factors (temperature and inclusion or not of enzyme) were analyzed; when significant, interactions were sliced. The ANOVA showed no interaction (P > 0.05) between factors. Broilers fed diets that met the nutritional requirements, regardless of corn drying temperature, had greater (P < 0.05) weight gain and better feed conversion when compared with those receiving the negative control diet from 1 to 21 and 1 to 42 d of age. From 1 to 21 d of age, despite the similar weight gain of broilers receiving enzymes and of those fed a positive control diet, regardless of corn drying temperature, only broilers fed diets containing the combination of the 3 enzymes had similar feed conversion to animals fed a positive control diet. However, considering the whole period (1 to 42 d of age), regardless of the enzyme combination used, the weight gain and feed conversion were similar to broilers receiving a positive control diet. Relative to drying temperature, an effect for the period from 1 to 21 d was observed. Broilers fed diets containing corn dried at 80°C, regardless of enzyme inclusion, had better feed conversion when compared with those fed corn dried at 110°C. Exogenous enzymes added to broiler diets are efficient in providing nutrients to broilers under different corn drying processes.

**Key Words:** drying, amylase, protease, xylanase, Zea mays,

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196 **Effect of dietary phytase superdosing on broiler bone quality.** G. L. S. Tesser*, J. Broch1, R. V. Nunes1, C. Eyng1, I. C. Pires Filho1, and G. M. Pesti2, 1Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, 2Department of Animal Science, The University of Georgia, Athens, GA, USA.

The aims of this study were to evaluate the effects of superdosing dietary phytase on broiler bone quality at 21 and 42 d of age. In this study 920 broiler chicks were randomly distributed to 5 treatments: T1: positive control (PC) without phytase; T2: negative control (NC) (reduction of 0.12% Ca and 0.14% of P calculated); T3: NC + 1000 FYT/kg (RONOZYME HiPhos GT 100 ppm), T4: NC + 2000 FYT/kg (RONOZYME HiPhos GT 200 ppm); T5: NC + 3000 FYT/kg RONOZYME HiPhos GT 300 ppm. At 21 and 42 d of age 2 birds that had BWs ± 5% of the mean group weight were killed using cervical dislocation. The legs were separated and deboned to obtain the tibias. After deboning, the left tibia was weighed, and its length was measured; the bone density was calculated by dividing the bone weight (mg) by its length (mm), for obtaining the Seedor index (SI). To determine bone breaking strength the tibia was individually supported on the epiphyses regions and a force load of 200 kgf at the speed of 5 mm s⁻¹ was applied in the central region of each bone using a probe (TA-TPB) and a Texturemeter. After the bone strength was measured, the tibia was weighed and then analyzed for dry matter analysis after which the samples were weighed, ashed overnight at 600°C, and then weighed again. The data were analyzed using ANOVA and posterior regression analysis. No significant differences were observed between treatments in terms of the Seedor Index (SI), breaking force (BF), dry matter (DM), and mineral matter percentage (MM) in the tibia for birds of 21 d of age (P > 0.05). Phytase superdosing improves broiler Seedor index based on regression analysis, (SI = 133.229 +0.0200987*ENZ-0.000006471777*ENZ² R² = 0.33) with 1553 FYT kg⁻¹ at 42 d of age. This recommendation does not negatively affect any of the other parameters that were evaluated.

**Key Words:** bird, breaking strength, phytate, Seedor index, tibia

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197 **Mineral, amino acid, and energy sparing effect of a high dose of phytase, combined with xylanase, on performance, foot pad dermatitis, tibia ash, and carcass yield of male broilers from 1 to 42 days.** A. Barbosa de Brito*, G. A. Gomes, C. L. Walk, T. Tedeschi dos Santos, and F. Valle, ABVista, Marlborough, United Kingdom.
Strategies to maximize broiler’s feed utilization are important to warrant sustainability of the world’s food supply and profitability. The objective of this trial was to evaluate the effects of high doses of phytase in conjunction with xylanase associated with its respective nutritional matrix, on performance, carcass yields (CY) and foot pad dermatitis (FPD) scores of broilers. A total of 912 d-old male Arbor Acres Plus chicks (initial weight of 40.8 g) were allocated to 48 pens. Chicks were distributed on a randomized complete block design, with 4 treatments with 12 pen replicates (19 birds/pen). The treatments were: T1: without enzymes and nutritional levels adopted to be slightly below commercial diets; T2: nutritional levels as T1, and inclusion of 500FTU/kg of phytase (Quantum Blue, ABVista, Marlborough, UK) using its mineral matrix (0.15, 0.165 and 0.035% of avP, Ca and Na, respectively) and 9,600BXU/kg of xylanase (Econase XT, ABVista, Marlborough, UK) with a conservative energy matrix (50kcal/kg); T3: reduction, in comparison to T1, of 0.20%, 0.22%, 0.045%, 0.05% and 120kcal of avP, Ca, Na dLys and AME, respectively (note that other amino acids were reduced as supplier recommendation); T4:T3 supplemented with 2,000FTU/kg of phytase and 9,600BXU/kg of xylanase. Pen BWG, FI and FCR were determined at every dietary phase change. Mortality was recorded daily. At 24 d of age, 3 birds from each pen were selected for FPD, TA and CY determination. At 42 d, 10 birds per pen were selected for CY and FPD. Data was submitted to analysis of ANOVA as randomized complete block design, and the means were then separated using Tukey’s test. From 0 to 42 d of age, FCRw (weight corrected FCR) was reduced by 27 points in birds fed T4 compared with birds fed T1 (P < 0.001), indicating a large effect of enzymes. There was no difference in FCRw between birds fed T1 compared with birds fed T2 (P > 0.05), although birds fed T1 were more efficient (P < 0.001) when compared against birds fed diets T3 or T4. BWG and F1 were equally different among treatments (P < 0.001). The results of FPD, TA and CY of broilers fed diets with different nutrient specifications from 0 to 42 d of age were reduced when birds were fed T3 diets. Evaluating the total cost of production, broilers fed T4 diets were cheaper when compared with other treatments (P < 0.001), and this strategy generated a real competitive advantage for the maintenance of performance and a significant reduction in production costs.

Key Words: phytase, xylanase, feed, cost, performance

198 Super-dosing effects of phytase on growth performance and bone characteristics of broilers fed nutritionally adequate diet and diet deficient in calcium and phosphorus. R. Scariot2, F. Zanão1, A. H. Reuter1, J. S. Baldo1, M. Rönnau1, L. K. Nogueira*1, E. T. Riffel1, and J. J. M. Fernandes1, 1Universidade Federal do Parana, Palotina, Paraná, Brazil, 2Universidade Estadual do Oeste do Parana, Marechal Candido Rondon, Paraná, Brazil.

An experiment was conducted to evaluate the super-dosing effects of phytase on growth performance and bone characteristics of broilers fed nutritionally adequate diets and diets deficient in calcium and phosphorus from 0 to 21 d. Cobb 500- male broilers (n = 1,800) were distributed in 4 treatments with 9 replicates and 50 birds/pen. The experimental diets were: positive control (PC) formulated to meet Ca and P recommendations; negative control (NC) with Ca and P reduced from the PC by 0.16 and 0.15%, respectively; NC plus 500 U/kg of phytase (NC+500) and NC plus 1,000 U/kg of phytase (NC+1,000). Twenty-four birds/treatment were individually weighed to have similar average initial weight among experimental units. The birds were randomly distributed in battery cages according the same 4 treatments with 12 replicates and 2 birds/pen (n = 96). The birds were submitted to a period of adaptation of 4 d. The period of total excreta collection was from 25 to 31 d of age. The excreta were weighed and homogenized, placed in plastic bags, identified and frozen. At the end of the experimental period, feed intake and total amount of produced excreta were determined. Excreta and diet samples were analyzed for dry matter, energy, etheral extract, nitrogen, phytato, Ca and P. Apparent metabolizable energy (AME), apparent metabolizable energy corrected to nitrogen retention (AMEn) and the digestibility coefficients values to crude protein (DCCP), dry matter (DCDM) and etheral extract (DCEE) were determined. The NC diet had decreased (P < 0.05) AME compared with PC or NC+500 diet. The digestibility coefficients for protein, dry matter and ether extract were not altered by the diets. The values of phytate and P in the excreta were respectively reduced (P < 0.05) with the phytase supplementation at 500 U/kg (2.82% and 5.16%) and phytase supplementation at 1,000 U/kg (2.75% and 4.98%) compared with the PC diet (5.75% and 9.80%). The retention coefficient of the diets NC + 500 and NC + 1,000 was 64.63 and 63.57%, respectively, and the PC diet was 58.52%. The lowest (P < 0.05) Ca excretion was with the NC +
University of Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil.

The objective of this study was to evaluate the performance of broiler chickens submitted to a diet containing filamentous fungi xylanase from Cerrado-Pantanal produced from the Aspergillus japonica fungi associated with phytase. A total of 200 male broilers of the Cobb 500 strain, from one to 42 d old, were completely randomized design with 4 diets and 5 replicates containing 10 birds each. The diets were: Positive control (PC): ration formulated according to the requirements of the birds and without addition of enzymes; negative control (NC): considering the nutritional matrix of enzymes with reductions of metabolizable energy (100 kcal/kg), available phosphorus (0.150%), calcium (0.165%), sodium (0.035%) and without addition of enzymes; negative control + commercial xylanase + commercial phytase (NC+CX+F): negative control diet with addition of 100 g/T commercial xylanase (16,000 BXU/kg) and 75 g/T commercial phytase (5,000 FTU/kg); negative control + xylanase from Cerrado-Pantanal + commercial phytase (NC+XP+F): negative control diet with addition of 100 g/T xylanase from Cerrado-Pantanal (16,000 BXU/kg) and 75 g/T commercial phytase (5,000 FTU/kg). The birds, feed and leftovers were weighed for body weight, weight gain, feed intake, feed conversion, livability and metabolizable energy, crude protein, phosphorus and lysine. At 42 d of breeding, a slaughter was carried out to determine the deposition of crude protein and other extract in the carcasses. The data were submitted to ANOVA with the aid of the SAS program and the means were compared by the Tukey test at 5% probability. The PC, NC+CX+F and NC+XP+F diets provided greater (P < 0.001) final body weight (g/bird), weight gain (g/bird), feed intake, metabolizable energy consumption (kcal/day), crude protein consumption (g/day) and digestible lysine (g/bird) consumption in relation to the NC diet. The PC diet provided higher (P < 0.001) available phosphorus consumption (g/bird) than the other diets. The crude protein deposition was higher (P = 0.042) for the birds that received the NC+XP+F diet compared with the NC diet. PC diet provided higher (P = 0.004) deposition of ether extract in relation to diet NC+XP+F. The analysis of the data allows to conclude that the use of diets containing xylanase from Cerrado-Pantanal associated to phytase improves the performance of broilers, considering a breeding period of 1 to 42 d.

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Key Words: additives, Aspergillus japonica, enzymatic complexes


The objective of this study was to evaluate the carcass characteristics of broiler chickens submitted to diet containing xylanase of filamentous fungi of Cerrado Pantanal produced from the Aspergillus japonica fungi associated with phytase. A total of 200 male broilers of the Cobb 500 strain, from one to 42 d old, were completely randomized design with 4 diets and 5 replicates containing 10 birds each. The diets were: Positive control (PC): ration formulated according to the requirements of the birds and without addition of enzymes; negative control (NC): considering the nutritional matrix of enzymes with reductions of metabolizable energy (100 Kcal/kg), available phosphorus (0.150%), calcium (0.165%), sodium (0.035%) and without addition of enzymes; negative control + commercial xylanase + commercial phytase (NC+CX+F): negative
control diet with addition of 100 g/T commercial xylanase (16,000 BXU/kg) and 75 g/T commercial phytase (5,000 FTU/kg); negative control + xylanase from Cerrado-Pantanal + commercial phytase (NC+XP+F); negative control diet with addition of 100 g/T xylanase from Cerrado-Pantanal (16,000 BXU/kg) and 75 g/T commercial phytase (5,000 FTU/kg). For analysis of carcass characteristics, at 42 d of age the birds were desensitized and slaughtered by means of bleeding and, subsequently, eviscerated and separated in noble cuts, feet and head. The data were submitted to ANOVA with the aid of the SAS program and the means were compared by the Tukey test at 5% probability. The PC, NC+CX+F and NC+XP+F diets provided higher ($P < 0.001$) carcass weight (g) than the NC diet. The PC diet provided higher ($P = 0.030$) breast weight (g) than the NC diet. The diets did not influence the weights of thigh+overcook (g), dorsal (g), head+neck (g), feet (g) and abdominal fat (g).

For the yield values, the NC diet provided higher ($P = 0.033$) head+neck (%) yield and higher ($P = 0.022$) foot yield (%) in relation to the PC diet. The yields of carcass (%), breast (%), thigh+overcook (%), wing (%), dorsal (%) and abdominal fat (%) were not influenced by diets supply. The analysis of the data allows to conclude that the use of diets containing xylanase from Cerrado-Pantanal associated with phytase improve the carcass characteristics of broilers, considering a breeding period of 1 to 42 d.

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Key Words: additive, Aspergillus japonica, enzymatic complexes

203 Effect of phytase on gut mucosa morphometry of broilers fed nutritionally adequate diet and diet deficient in calcium and phosphorus. R. Scariot2, E. P. Simões*,1, D. A. Pazdiora1, S. R. Fernandes1, R. Buzim1, H. L. F. Bordini1, L. K. Alvares1, and J. I. M. Fernandes1,

The trial was carried out to evaluate the super-dosing effects of phytase on gut mucosa morphometry and goblet cell counting of broilers fed nutritionally adequate diets and diets deficient in calcium and phosphorus from 0 to 21 d. Cobb500-male broilers (n = 1,800) were distributed in 4 treatments with 9 replicates and 50 birds/pen. The experimental diets were: positive control (PC) formulated to meet Ca and P recommendations; negative control (NC) with Ca and P reduced from the PC by 0.16 and 0.15%, respectively; NC plus 500 U/kg of phytase (NC+500) and NC plus 1,000 (NC+1,000) U/kg of phytase. At 21 d, 2 broilers per experimental unit were slaughtered by cervical dislocation. Segments of duodenum and jejunum were collected for histomorphometry and goblet cell counting (periodic acid Schiff - PAS - stained slides). For the morphometric study, the digital images were obtained by light microscopy, using an image analyzer system to measure the length and width villi and the depth and width crypts. These morphometric measures were also utilized for the calculation of absorption surface area of the gut mucosa. From the same sections it was measured the muscular layer thickness. The goblet cell counting was performed in images captured at 40x magnification per mm² of villus area. Gut mucosa morphometry and goblet cell counting data were submitted to one-way ANOVA and Tukey as a post hoc test. According to our findings, the villus:crypts rate of the duodenum and the villus height and the muscular layer thickness of the jejunum were significantly ($P < 0.05$) increased in NC plus 500 U/kg of phytase group compared with PC group, while to other groups the values were intermediates. However, there was not any significant difference ($P > 0.05$) among the treatments for the other measures evaluated in the duodenal mucosa. In the jejunum, the results of this study, also showed that the depth of the crypts and absorption area were significantly increased ($P < 0.05$) in phytase supplementation groups (NC plus 500 U/kg and NC plus 1,000 U/kg) as compared with PC group, but there was no significant difference ($P > 0.05$) with NC group. Regarding the goblet cell counting in the duodenum and jejunum, there was no significant difference ($P > 0.05$) among the groups. The results of this study showed that the phytase supplementation may have an effect on the development of the intestinal mucosa of broilers. Considering that phytic acid has direct anti-nutritional effects on the intestinal tract, a better understanding of the phytase effect opens up an opportunity to improve gut health.

Key Words: goblet cell, villus: crypt rate, phytic acid, gut health
Metabolism and Nutrition, Vitamins and Minerals II

204 Performance and egg quality of white-egg layers supplemented with amino acid-complexed microminerals. C. S. Santos*, 1 C. B. V. Rabello1, M. C. M. M. Ludke1, M. R. Barros1, M. J. B. Santos1, H. B. Oliveira1, A. F. Silva1, J. G. Viapiana1, M. R. R. Oliveira1, and A. K. Fireman2, 1Universidade Federal Rural De Pernambuco, Recife, Pernambuco, Brazil, 2Zinpro Corporation, Eden Prairie, MN, USA.

The use of trace mineral sources complexed to organic molecules are expected to improve absorption and metabolic systems in birds. The present study proposed to evaluate the effects of supplementing zinc (Zn), manganese (Mn), copper (Cu), iron (Fe), and selenium (Se) amino acid complexes, at reduced levels, replacing their original inorganic sources, on performance and internal/external egg quality of laying hens. Four hundred Lohmann White laying hens from 78 to 98 weeks of age were housed in cages and assigned to 4 treatments in a completely randomized design, with 10 replicates and 10 birds per experimental unit. Treatments (T) consisted of 4 diets in which the inorganic mineral source was fully replaced by a source of amino acid-complexed microminerals (AACM), with supplementation levels reduced by 30%, 50%, and 60%. The control diet (T1) contained only inorganic mineral sources at the following levels: 60 ppm Zn, 60 ppm Mn, 7 ppm Cu, 40 ppm Fe, 0.2 ppm Se, and 2.0 ppm iodine (I). Treatments including AACM were as follows: T2) 100% AACM, 42 ppm Zn, 42 ppm Mn, 4.9 ppm Cu, 28 ppm Fe, 0.14 ppm Se, and 1.4 ppm I (inorganic mineral source-IM); T3) 100% AACM with 30 ppm Zn, 30 ppm Mn, 3.5 ppm Cu, 20 ppm Fe, 0.10 ppm Se, and 1.4 ppm I (IM); and T4) 100% AACM with 24 ppm Zn, 24 ppm Mn, 2.8 ppm Cu, 16 ppm Fe, 0.08 ppm Se, and 1.4 ppm I (IM). Data were submitted to ANOVA and Tukey’s test (P < 0.05). Supplementation of AACM with a 60% reduction significantly increased egg production, egg weight, and egg mass, compared with inorganic sources. Improved results were obtained with reduced levels of trace mineral supplementation. The treatment with a 60% reduction in trace mineral supplementation level enhanced measured results compared with other treatments. Birds fed inorganic trace mineral sources, at recommended levels, had sub-optimal performance. Birds fed AACM with a 60% reduction showed the best feed conversion rate per egg mass and per egg dozen the resulted in the most efficient conversion per egg mass and per dozen eggs. For egg-related traits, a significant difference was found in shell thickness, for which the diet including AACM at 60% of the control treatment level provided better results than all other treatments. Dietary supplementation with AACM for layers in the production stage improves both performance and egg-quality traits.

Key Words: amino acid complexes resulting in superior performance compared with glycinate and inorganic mineral sources for laying hens.

206 Effect of amino acid complexed minerals, in laying hen diets, on pre-layer productive performance, bone development, hormone metabolism, and immune system. C. G. Pereira*, 1 C. B. V. Rabello1, M. R. Barros1, H. E. C. C. Manso1, H. B. Oliveira1, A. G. Faria1, W. R. L. Medeiros-Ventura1, R. V. Silva Júnior1, L. H. Ferreira1, M. J. B. Santos1, A. F. Silva1, C. C. D. Carvalho1, R. M. Pontes1, and A. K. Fireman2, 1Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil, 2Zinpro Corporation, Eden Prairie, MN, USA.

Amino acid complexed minerals (AACM) have been developed with the intention of improving performance, as they are easily absorbed by the animal. Microminerals play an important role in the metabolic function of birds. The objective of this study was to evaluate the effect of feeding amino acid complexed zinc (Zn), manganese (Mn) and copper (Cu) during initial and growing phases, on productive performance of the pre-layer phase of laying hens. A total of 800 birds from Lohmann Brown Lite laying hens were used. Birds were housed in cages equipped with a trough-type feeder and a nipple-type drinker. The experiment followed bird development from 106 to 182 d of age, lasting until peak production. Laying hens were distributed to treatments according to a completely randomized design, with 20 replicates per treatment and 20 birds per replicate. The control diet was supplemented with 70, 70 and 8 ppm Zn, Mn and Cu, respectively, from inorganic mineral sources (IM). This was compared with a diet containing 40, 40 and 2.75 ppm Zn, Mn and Cu, respectively, from IM plus 30 and 30 and 5.25 ppm Zn, Mn, and Cu, respectively, from AACM. At the end of the experiment 40 birds were selected for sampling, according to the average body weight of each plot. Productive development (egg mass, egg output), weight of tibia, reproductive organs, liver and eggs, follicular hierarchy and blood parameters (hormones, leucogram and hemogram) were evaluated. Data were submitted to ANOVA with means compared by Student’s t-test (P < 0.05). Laying hens fed AACM reached 50% of egg output 2 d earlier (P < 0.01) than those fed IM. Significant differences were observed between
treatments for oviduct weight ($P < 0.01$) and red blood cells ($P < 0.05$), eosinophils ($P < 0.01$), basophils ($P < 0.01$), total white blood cells ($P < 0.05$) and total $T_{h}$ ($P < 0.05$) for the birds fed AACM compared with those fed IM. The treatment AACM also affected tibia weight presenting heavier tibia values ($P < 0.05$) than birds receiving IM. The follicular hierarchy wasn’t affected. Supplementing AACM in laying hen diets beginning at the initial phase improved bone development and oviduct weight, as well, change at blood parameters providing a best response at the starting of egg output.

Key Words: complexed minerals, mineral source, pre-lay, semi-heavy layer

207 Effect of thermal stress in the first days of layer-type chicks and the use of amino acid complexed minerals to mitigate these effects. W. R. L. Medeiros-Ventura*, C. B. V. Rabeello1, M. R. Barros1, R. V. Silva Junior1, H. B. Oliveira1, A. G. Faria1, C. G. Pereira1, A. F. Silva1, M. J. B. Santos1, L. H. Ferreira1, J. S. Barros1, and A. K. B. A. T. Fireman2, 1Universidade Federal Rural de Pernambuco, PE, Brazil; and 2Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, 2Zinpro Animal Nutrition, Piracicaba, São Paulo, Brazil.

Two experiments were designed to evaluate amino acid complexed (AACM) zinc (Zn), manganese (Mn), and copper (Cu) as partial replacements for their inorganic counterparts, with and without thermal stress in the first days of layer type chicks. The first trial was completed under thermoneutral conditions during the whole experimental period. Average daily temperatures were 31.57 ± 1.51°C, and 31.81 ± 1.82°C overnight (6 p.m. to 6 a.m.), during d 1 to 15. The second trial submitted chicks to cold stress conditions during the first 15 d of life. Average daily temperature for birds in this trial were 30.33 ± 1.08°C, while overnight temperatures were 27.01 ± 1.71°C. For each trial, 1200 one-day-old Lohmann Brown lite chicks were used in a completely randomized design, with 2 treatments and 20 replications of 30 birds per experimental unit (cage). The treatments consisted of a control diet containing inorganic minerals (IM) with levels of 70, 70 and 8 ppm of Zn, Mn and Cu, respectively, and another diet containing 40, 40 and 2.75 ppm of inorganic Zn, Mn and Cu, respectively ≥ 30, 30 and 2.52 ppm of Zn, Mn and Cu, respectively ≥ 0.01) response for blood concentration of heterophiles, with the greatest relative weight of lymphoid organs ($P > 0.05$). For reducing plasma corticosterone concentration, supplementing 0.75 ppm Cr-AA is recommended, while 0.47 and 0.66 ppm Cr-AA, respectively, is suggested to increase blood concentrations of T3 and T4. There was a quadratic ($P < 0.01$) response for blood concentration of heterophiles, with the greatest concentration being obtained by supplementation of 0.63 ppm Cr-AA. Also, quadratic responses were observed for total cholesterol ($P < 0.05$), glucose ($P < 0.01$), and triglycerides ($P < 0.05$) in the plasma of broiler chickens, with greater reduction responses obtained by supplementing 0.63, 0.92, and 0.49 ppm Cr-AA, respectively. Dietary supplementation of Cr-methionine improves the plasma and hormonal biochemical profile of broilers reared under heat stress.

Acknowledgements: Zinpro Animal Nutrition and UFV

Key Words: blood metabolite, chromium, hormones, heat stress cyclic

208 Physiological variables of broiler chickens reared under heat stress and fed diets supplemented with chromium methionine. F. S. Dalôlio1, A. K. Fireman2, L. F. T. Albino1, and D. Ladeira da Silva1, 1Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil; and 2Zinpro Animal Nutrition, Piracicaba, São Paulo, Brazil.

Heat stress in broilers decreases plasma concentration of hormones, changes the blood profile, causes lymphoid organ involution, and increases corticosterone, contributing to a reduction in productive performance. Chromium acts by stimulating insulin and the metabolism of carbohydrates, proteins, and lipids. Thus, it promotes improvement of physiological parameters when broilers are exposed to heat. The objective of this study was to evaluate the effect of Cr-methionine (Cr-AA) supplementation in diets for broilers reared under cyclic heat stress (33°C per 12 h) from 22 to 43 d of age. A total of 336 21-d-old male Cobb 500 broilers were distributed in a randomized complete block design with 4 blocks (each climatic chamber), with 6 treatments (0, 0.10, 0.20, 0.40, 0.80, and 1.20 ppm Cr-AA), 8 replicates per treatment, and 7 birds per replicate. Body temperature, lymphoid organs, and concentration of hormones and blood metabolites were measured. At 43 d of age, blood samples of 2 birds with mean weight of each experimental plot (±5%) were collected, totaling 96 samples to measure hormonal dosages, complete blood count, and serum biochemistry. Data were analyzed through ANOVA and regression using SAEG (2007). Models were chosen based on significance of regression coefficients using the t-test, and coefficient of determination, adopting the level of up to 0.05 probability for both. Mean body temperature had linear behavior at 42 d of age ($P < 0.05$). There was no effect of treatment on absolute and relative weight of lymphoid organs ($P > 0.05$). For reducing plasma corticosterone concentration, supplementing 0.75 ppm Cr-AA is recommended, while 0.47 and 0.66 ppm Cr-AA, respectively, is suggested to increase blood concentrations of T3 and T4. There was a quadratic ($P < 0.01$) response for blood concentration of heterophiles, with the greatest concentration being obtained by supplementation of 0.63 ppm Cr-AA. Also, quadratic responses were observed for total cholesterol ($P < 0.05$), glucose ($P < 0.01$), and triglycerides ($P < 0.05$) in the plasma of broiler chickens, with greater reduction responses obtained by supplementing 0.63, 0.92, and 0.49 ppm Cr-AA, respectively. Dietary supplementation of Cr-methionine improves the plasma and hormonal biochemical profile of broilers reared under heat stress.

Acknowledgements: Zinpro Animal Nutrition and UFV

Key Words: chick, cold stress, immune response, mineral source, performance

209 Gene expression of HSP 70 and IGF-1 in broiler chickens reared under cyclic heat stress and fed diets supplemented with chromium methionine. F. S. Dalôlio1, A. K. Fireman2, L. F. T. Albino1, D. Ladeira da Silva1, and H. Cedraz1, 1Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil; and 2Zinpro Animal Nutrition, Piracicaba, São Paulo, Brazil.

Heat stress in broilers induces oxidative stress and cell damage to the extent that heat shock protein (HSP) expression can be measured as indicative of its effect on yield. Insulin-like growth factor (IGF-1) is important for protein synthesis, and for reducing proteolysis in broilers, especially under heat stress conditions. Chromium acts by increasing sensitivity to insulin acting on IGF-1. In addition, Cr reduces cellular
oxidative damage in heat stress situations. Thus, the study objective was to evaluate the effect of chromium methionine (Cr-AA) supplementation of broiler diets, on gene expression of HSP70 and IGF-1, when broilers were reared under cyclic heat stress conditions from 22 to 43 d of the production period. For analyses of HSP70 and IGF-1 genes in the pectoralis major muscle, a total of 24 broilers were used in a completely randomized design, with 4 replicates for each of 6 treatments. Treatments consisted of 6 Cr-AA levels (0, 0.10, 0.20, 0.40, 0.80 and 1.20 ppm), added on top of broiler diets. On d 43, broilers were kept under heat stress (33°C) for 12 h, then they were harvested and the pectoral regions were removed. Statistical analysis of gene expression data used the % QPCR_MIXED macro (STEIBEL et al., 2009) in SAS v9.0. To determine if there was a difference between treatments, contrasts were made between factors that compare them. In this statistical model, the effect of Cr-AA was considered fixed, and the effect of genes was considered random. In this way, authors were able to test all possible linear combinations between the levels of these factors. Statistical significance was considered for P-values less than 0.05. There was an effect (P < 0.05) of Cr-AA supplementation on the relative expression of HSP-70 at all supplementation levels in relation to the control diet. There was also an effect on the relative expression of IGF-1 in broiler chicks for supplementation levels of 0.80 and 1.20 ppm Cr-AA, when compared with the control diet. Dietary supplementation of chromium methionine decreases the expression of HSP-70, and increases expression of IGF-1, in the breast of broiler chickens raised in cyclic heat stress. Thus, supplementation of Cr-AA at 0.80 ppm is recommended to reduce cell oxidative damage in broiler chickens raised under heat stress.

Acknowledgements: Zinpro Animal Nutrition and UFV

Key Words: chromium, gene expression, heat shock protein, insulin


In present study effects of different levels of butyric and propionic acid and their combination was tested on growth performance and carcass characteristics in Japanese quails (Coturnix coturnix japonica). One hundred twenty quails were randomly divided into 4 groups (A, B, C and D) with 3 replicates in each group (10 birds/replicate) and birds were reared in floor pens for 35 days. Data regarding weekly body weight, feed intake and mortality were recorded and at the end of the trial, carcass data, weights of heart, liver and gizzard were recorded and analyzed using PROC GLM procedure of Statistical Analysis System (SAS, 2009) under completely randomized design. Body weight gain (P < 0.05) and feed conversion ratio (P < 0.05) were improved in birds receiving diet containing butyric acid as 0.25% than other diets during starter and overall phases. Feed intake (P < 0.05) was reduced in control and group B as compared with other treatments starter and overall phases. But experimental diets were similar (P > 0.05) regarding feed consumption, weight gain and FCR during finisher phase. Carcass percentages and abdominal organs weights were remained unaffected (P > 0.05) by dietary treatments. Based on the results of this study, it is concluded that butyric acid supplementation as 0.25% has beneficial effects on Japanese quail’s growth performance and feed conversion ratio.

Key Words: butyric acid, propionic acid, growth performance, Japanese quail


An experiment was conducted to investigate the effects of different dietary supplementation levels of zinc (Zn) on live performance and carcass characteristics of Japanese quail (Coturnix japonica). Two hundred and four day-old chicks of Japanese quails were purchased for local hatchery and were divided into 4 experimental groups (CG, Zn60, Zn80 and Zn100) with 4 replicates under each group (15 chicks/replicate). Group CG was control group and was fed basal diet other groups Zn60, Zn80 and Zn100 fed basal diet supplemented with Zn @ 60, 80 and 100 mg/kg, respectively. All birds were provided similar management conditions and birds were reared in floor pens for 35 days. Data regarding growth performance was collected on weekly bases and 4 birds per replicate were slaughtered to assess the carcass characteristics at the end of experiment. Data was analyzed using ANOVA technique under completely randomized design and means were compared using Tukey’s test. Significant (P < 0.001) improvement in weight gain of experimental groups was found compared with control group but no difference (P > 0.05) was found among different Zn levels. Highest weight gain (126.37g) was found in group Zn60 compared with CG (118.95g). Feed intake was reduced (P < 0.001) and FCR was improved (P < 0.001) in group Zn60. Better FCR (2.98) was found in group Zn60 and there was a difference of 0.81 in FCR in control group with Zn60. Significantly (P < 0.005) highest dressing percentage (54.98%) was found in group Zn100 but relative weight of giblet organs remained unaffected (P > 0.05). The use of Zn had beneficial effect on growth performance may made the quail farming more profitable as Zn supplementation increased the profit margin. It can be concluded that Zn supplementation through feed has beneficial effects on Japanese quail’s growth performance and dressing percentage.

Key Words: Zn, growth performance, carcass characteristics, Japanese quail
(40mg/kg) were supplemented in diet. All diets were isonitrogenous (CP 24%) and isocaloric (2900 kcal/kg) and fed for 35 d. Data on feed intake, weight gain and feed conversion ratio were recorded on weekly bases and 2 birds per replicate were slaughter to check dressing percentage and giblet organs weight at the end of experiment. Data were subjected to ANOVA technique under completely randomized design and means were compared with check significant difference ($P < 0.05$) using Least Significance Difference test. Significant ($P < 0.05$) improvement in all parameters of growth performance was observed in all experimental groups compared with control group but not difference ($P > 0.05$) was found among experimental groups. Highest weight gain (142.25g), dressing percentage (63.58%) and better FCR (2.78) were found in group C.Mn. Economic analysis showed that profit margin was increased by vitamin and mineral supplementation. On the bases of present findings, it is concluded that quails can be reared under hot climte by feeding on vitamin C with Mn supplemented diet without compromising their growth performance.

**Key Words:** vitamin C, manganese, growth performance, Japanese quail
Metabolism and Nutrition, Amino Acids


Excessive amounts of dietary protein, i.e., nitrogen, cannot be stored into the organism as reserve, which inevitably leads to its excretion in environment in metabolic processes that require unnecessary energy expenditure. Establishing poultry requirements for essential amino acid is a crucial step to reduce excessive dietary crude protein supply and hence approach the amount of amino acids provided by diets to bird nutritional needs. From the 70s of the last century onward, no studies conducted with the purpose of establishing Japanese quail requirements for leucine (Leu), whose excessive concentration in diets may lead to valine and isoleucine catabolism in liver, which may reflect in changes in feed intake behavior and performance trait impairments. To determine Japanese quail requirements for Leu, a total of 280 28-week-old Japanese quails were randomly assigned to 8 treatments with 7 replicates of 5 quails. Dilution technique was used to produce the levels of 3.92, 7.05, 10.2, 13.3, 15.7, 17.2 and 18.8g Leu/kg diet. The 8th treatment consisted of a control diet to confirm whether Leu was indeed the 1st limiting amino acid in experimental diets. Such diet was produced supplementing 3.16g L-Leu/kg diet in the diet with the lowest level of Leu (3.92g/kg) to achieve the second lowest level (7.05g/kg). All performance data collected in the last 4 weeks of the 10-week feeding trial was used to estimate quail requirements. Data were analyzed as one-way ANOVA and Leu requirement estimated using linear broken-line (BL) and quadratic-broken-line (QBL) regression models, where performance traits were regressed against daily Leu intake. Quails fed control diet exhibited improvements in overall performance compared with those fed the lowest Leu level, which proves that Leu was the 1st limiting amino acid in diets. The breakpoint in egg production was observed at 230 and 310mg Leu/bird/day, according to BL and QBL models. Linear broken-line and QBL models estimated maximum egg weight at 267 and 396mg Leu/bird/day, respectively. Quails fed increasing Leu levels had the egg output (EO) optimized at 246 and 345mg Leu/bird/day according to BL and QBL, respectively. Irrespective of the performance trait assessed, the smallest AIC values were observed for QBL model, which indicates that data fitted better to this model. Based on the EO outcomes, Japanese quail requirements for Leu in the egg-laying phase is 345 mg/bird/day.

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Key Words: branched-chain amino acid, egg output, nitrogen excretion


Determining the efficiencies with which amino acids are used for maintenance and egg protein accretion is essential to develop models, which better predict optimum amino acid intake of Japanese quail. To determine isoleucine (Ile) and leucine (Leu) efficiencies of utilization (EU), 5 hundred and 60 28-week-old Japanese quails were randomly assigned to 2 simultaneous 7-week dose-response trials (280 quails/trial). In Ile trial, the 7 levels tested were 0.170, 0.306, 0.442, 0.577, 0.679, 0.747, and 0.815%, whereas in the Leu trial the levels were 0.392, 0.705, 1.019, 1.332, 1.568, 1.724 and 1.881%. In both trials, the treatments were replicated 7 times with 5 quails per experimental unit and the diets were obtained using the dilution technique. The Ile and Leu deposition (IEd and LeuD) were assumed to be 0.65 and 1.24% of the egg output respectively, values collected from the literature. The data were adjusted by a nonlinear regression. Amino acid intake (AAI) and amino acid deposition (AAD) were fitted to broken line model as follows: AAD = AADmax + U × (R - AAI), where: AADmax is the maximum AAD, U is the slope of the function and R is the AAI for maximum response (AADmax). The EU was obtained as follows: k = (AADmax / R) × 100. Both variables were expressed on the basis of metabolic weight (BW0.67). The levels studied affected all variables (P < 0.001) regardless of the amino acids tested. The 1le for IleDmax, IleDmax and U were 379.3, 197.4, −0.625, respectively, whereas il.eu for LeuDmax, LeuDmax and U were 797.8, 383.9, −0.570, respectively. The EU of Ile and Leu for egg output deposition were 52 and 48%, respectively.

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Key Words: amino acid, dose-response method, efficiency of utilization, protein deposition


This work had as objective to estimate the nutritional requirement of digestible methionine + cystine for Japanese quails (Coturnix coturnix japonica) in laying phase for maximum performance. The experimental design was completely randomized (DIC) with 5 treatments (0.60, 0.75, 0.90, 1.05 and 1.20% methionine + cystine) and 5 replicates. Fifteen female quails were used per experimental unit, totaling 375 birds. The experimental period was from 43 to 168 d of age, but for the statistical analysis, were evaluated from the 64th day of age (divided into 5 cycles of 21 d each), when the egg production became homogeneous. The feed were formulated to meet the requirements proposed by Rostagno et al. (2011) for Japanese quails in the laying phase, except for methionine + cystine. For the evaluation of the performance, the birds were weighed at the end of each production cycle and, simultaneously, the weighings of the provided experimental feeds and leftovers were performed. The eggs were collected daily at 8 a.m. to calculate the production variables. Statistical analysis of the data was performed using the statistical environment R (R Core Team, 2013). It was verified the assumption of the normality of the residues and there being a significant effect of the factors (P < 0.05), the polynomial regression analysis was performed. The variables weight mean, daily feed intake, egg weight, egg mass, laying rate, feed conversion per egg mass and feed conversion per dozen eggs showed a quadratic effect (P < 0.05), making it possible to estimate 0.90%, 0.90%, 0.88%, 0.89% methionine + digestible cystine in the diet, respectively. The birds used in this experiment represent about 70% of the genetic material currently used in Brazilian farms. These birds had a weight mean of 173 g in the laying phase with a mass egg production peak of 9.92 g ave.dia-1, estimating the nutritional requirement of 0.90% methionine + digestible cystine. The nutritional recommendation of digestible methionine + cystine for Japanese quails at laying phase is 0.90, 1.05 and 1.20% methionine + cystine.
216 Optimum isoleucine to lysine ratio for meat-type quails.

Compared with the past, poultry diets have been formulated with a lower crude protein content, whose advantages include feed cost savings and the mitigation of nitrogen excretion, without impairments in overall performance. Little is known about the requirements of meat-type quails for Isoleucine (Ile), which are considered the fifth limiting amino acids in corn and soybean meal based-diets. Without such knowledge, the application of ideal protein concept and hence the reduction of crude protein could not be effective in bringing the aforementioned benefits, since diets could be formulated with an insufficient dietary supply of this amino acid. Three hundred fifty meat-type quails (Coturnix coturnix coturnix) were randomly assigned into 5 treatments, with 7 replicates of 10 quails to determine the optimum standardized ileal digestible isoleucine to lysine (SID Ile:Lys) ratio for meat-type quails from 15 to 35d of age. An isoleucine deficient corn-soybean meal-based diet was formulated and graded supplemented with L-Ile (99%) to range SID Ile:Lys ratios from 55 to 79%. Data were analyzed as one-way ANOVA and optimum SID Ile:Lys was estimated using polynomial quadratic regression model. Statistical differences were considered for $P < 0.05$. Quail performance from 15 and 21 d and 15 and 28 d of age was not affected SID Ile:Lys ratios. From 15 to 35 d of age, body weight gain and body weight exhibited a quadratic response to increasing dietary SID Ile:Lys, being optimized at 66 and 67% SID Ile:Lys, respectively. Irrespective of the phase assessed, feed conversion ratio was not affected by SID Ile:Lys ratios. Based on performance outcomes, the optimum SID Ile:Lys ratio for meat-type quails from 15 to 35 d of age is 67%.

Key Words: amino acid, Coturnix coturnix coturnix, ideal protein


The objective of this study was to evaluate the effects of 5 levels of tryptophan digestible (DTrp) on the behavior of Japanese quails from 21 to 28 d old (growth phase). The design was a completely randomized design, with 5 levels of DTrp (0.16; 0.21; 0.26; 0.31 and 0.36% of DTrp), with 5 replicates and with 30 quails per experimental unit, totaling 750 birds. This analysis was carried out for 3 d in a row, only in light period, starting at 7:00 a.m. and ending at 19:00 p.m. This analysis was divided in behavior of the birds in the morning and in the afternoon. The quails were distributed in 25 pens arranged on 2 sides, the evaluations were done every 10 min and annotated in an ethogram. The behaviors of all the quails in the pen were evaluated. The variables analyzed were eating, drinking, lying down, standing, well-being and aggressiveness. The response variables obtained in evaluation were quantified in percentage and transformed in log (x+1). Statistical analysis of the data was performed using RStudio. In behavior analysis in quails of laying from 21 to 28 d old in the morning, the behavior lying down showed a quadratic effect ($P < 0.0001$), in which was estimated 0.26% of DTrp. In evaluation in the afternoon there was no effect between the variables of behavior and the different levels of tryptophan digestible. It is concluded that the level of 0.26% of DTrp in the diet decrease the behavior lying down, but at higher levels of DTrp (0.31 and 0.36% de DTrp), the quails will stay more time lying down.

Key Words: amino acid, behavior, Coturnix coturnix japonica, growth phase


Few is known about the ideal amino acid pattern for Japanese quails in the egg-laying phase. To determine Japanese quail needs in the egg-laying phase for threonine (Thr) and tryptophan (Trp), a total of 5 hundred sixty16-week Japanese quails were used in 2 dose-response trials (280 quails/trial). In each trial, birds were randomly assigned to 8 treatments, with 7 replicates of 5 quails. Dilution technique was used to vary the levels of Thr (1.56 to 7.80g/kg) and Trp (0.69 to 2.76g/kg). A control treatment was added to feeding trials to confirm whether Thr and Trp were limiting in diets. These treatments consisted of the supplementation of L-Thr and L-Trp in the diet with the lowest levels of both amino acids with the purpose of achieving the second lowest level studied. Requirements were estimated from data collected in the last 4 weeks of each 10-week feeding trial. Data were analyzed as one-way ANOVA and requirements estimated by broken-line (BL), quadratic broken-line (QBL) and polynomial quadratic (PQ) models. Statistical differences were considered for $P < 0.05$. In both trials, quails fed control treatments exhibited an improvement in all performance traits assessed compared with quails fed the lowest levels of Thr and Trp, which indicates that both amino acids were limiting in diets. According to ANOVA there was a difference among levels of both Thr and Trp ($P < 0.05$). The amount of Thr, which optimized egg production according to BL, QLB and PQ models were 130, 178 and 177 mg/bird/d, respectively. According to BL, maximum egg mass was achieved at 142 mg/bird/d, while either QLB or PQ models estimated maximum response in 208 mg/bird/d, respectively. The amount of Trp, which optimized egg production according to BL, QLB and PQ models were 35, 48 and 56 mg/bird/d, respectively. The breakpoint in egg mass was obtained at 44 and 59 mg/bird/d according to BL, QLB, respectively, while PQ estimated optimum egg mass at 62 mg/bird/d, respectively. Regardless of the model fitted to egg mass data, the coefficient of determination ($R^2$) for Thr and Trp trials were 0.95 and 0.94, respectively. Based on egg mass, Akaike Information Criterion for Thr trial were 98.9, 112.7, and 24.4 for BL, QBL, and PQ, respectively, while for Trp trials these values were 119 (BL), 118 (QBL), and 35 (PQ). Based on AIC values, the PQ model fitted best to the data. Based on egg mass responses, Japanese quail requirements for Thr and Trp in the egg-laying phase are 208 and 62 mg/bird/d, respectively.

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Key Words: amino acid, dilution technique, models

This work had as objective to estimate the nutritional requirement of digestible threonine (ThrD) for Japanese quails in the stages of 1 to 7, 8 to 14 and 15 to 42 d of age. The design was a completely randomized design, with 5 levels of ThrD (0.58; 0.70; 0.82; 0.94 and 1.06%), 5 replicates and 30 quails per experimental unit in each phase, totaling 2,250 birds. While they were not submitted to the experiment, the birds were housed and raised separately, to avoid possible residual effects of the treatments of the period evaluated previously. The quails and feeds were weighed at the beginning and end of each experimental phase to evaluate performance characteristics: final mean weight (g), weight gain (g), feed intake (g) and feed conversion (g/g). At 42 d of age, 12 birds from each unit that received the experimental diets from 15 to 42 d were transferred to cages and fed a basal diet to evaluate the residual effect of the growth-supplied ThrD levels. The productive performance and the external and internal quality of the eggs were evaluated in 3 productive cycles of 21 d each. Statistical analysis of the data was performed using PROC GLM from the SAS 9.0 computer program. Feed ThrD levels linearly increased (P < 0.0001) threonine consumption in experiments 1 to 7, 8 to 14 and 15 to 42 d of age, without showing any effect on the other performance parameters. The ThrD levels fed during the rearing phase linearly increased the initial (P = 0.0009) and final (P = 0.0125) body weight of the birds in the laying phase. The other variables of performance and egg quality were not significant in the laying phase. It is concluded that the ThrD level of 0.58% in the diet from 1 to 42 d of age provides adequate growth and satisfactory performance in the initial phase of Japanese quail laying.

Key Words: amino acid, performance, quality of quail eggs, residual effect


Factorial models predict amino acid requirements for laying hens based on the amount of amino acids (AA) required for maintenance (mg AA/kg body weight) and egg output (mg AA/g egg output). Once established these coefficients, requirements may be predicted for any individual, based on its body weight (BW) and egg output (EO) production, regardless of the genetic strain and age. Compared with other amino acids, few are the concern on establishing isoleucine (Ile) requirements for laying hens. To develop a factorial model to predict hen requirements for Ile, a total of 70 29-week-old Hisex White hens were randomly assigned to 7 treatments with 10 individual replicates. Experimental diets were formulated using dilution technique to produce a range in dietary Ile from 2.80 to 7.80g/kg. Only data collected in the last 4 weeks of the 10-week feeding trial were considered to develop the model. Collected data were analyzed as one-way ANOVA. Egg output was influenced by dietary Ile content (P < 0.05). The amount of Ile (mg) required per g of EO (a) were estimated in 7.23 mg/g based on EO data and Ile intake data using the software EFG (2006). The amount of Ile (mg) required per kg of BW (b) was previously determined in a nitrogen balance study conducted at FCAV/UNESP using adult cockerels, being equivalent to 20 mg Ile/kg BW. Thus, the following factorial model was generated: Ile intake (mg/hen/d) = 7.23 EO + 20 BW. Based on such model, a simulation was performed varying EO production (52, 55, and 57 g/day) maintaining the same hen BW (1,350 kg). Based on the model above described, hens whose EO production are 52, 55, and 57 g/day and BW is 1,350 kg requires the Ile intake of 403, 425, and 439 mg/day, respectively. Using the coefficients (a = 7.23 mg Ile/g EO; b = 20 mg Ile/kg BW) of the factorial model for Ile determined in the current trial and introducing in this model the information of EO and BW of a specific flock, nutritionists can elaborate dynamic feeding programs considering the changes in egg production and body weight, which inevitably occurs throughout egg-laying cycle, instead of working with a single value for the entire cycle.

Acknowledgements: The authors thank FAPESP (2013/25761-4) for providing the financial resources, which allowed the conduction of the current research, and Ajinomoto and Evonik for the crystalline amino acids and analysis.

Key Words: branched-chain amino acid, egg output, maintenance, nitrogen


The egg is among the most consumed proteins in the world and these have high biological value. In order for birds to express their full genetic potential, they must be raised in the right environments, given proper management and good nutrition. The use of amino acids in the diet of laying hens play a key role in increasing egg production efficiency and egg size. Threonine acts to increase the productive efficiency of birds and some minerals such as manganese is essential for the normal physiological activity of birds, deposition and egg shell thickness and the productive process. Therefore, this experiment aims to evaluate the effect of dietary supplementation with different levels of threonine and manganese and the interaction between them on egg quality. The treatments were: threonine 0.55 (control); 0.65; 0.75 and 0.85% and for manganese 77 mg/kg of feed (control) and 154 mg/kg of feed, and the control levels correspond to the levels recommended by Rostagno et al. (2011). A 4 × 2 factorial scheme was used, with 8 treatments, 4 replicates with 8 birds each, using a total of 256 laying hens of the 41-week-old H&N Nick Chike line, distributed in a completely randomized design. The ration provided was corn and soybean meal, however, with the different levels of threonine (L-threonine) and manganese (manganese sulfate). The experiment lasted 84 d, divided into 3 28 d cycles. At the end of each cycle, 3 eggs were analyzed from each replicate, collected during the last 3 d of each cycle. The parameters evaluated for egg quality were: yolk index, albumen height, pH and percentage of yolk and albumen, Haugh units, percentage and thickness of the shell (mm), specific gravity (g/mL H2O) and egg weight. The collected data were submitted to ANOVA at 5% of significance, through the statistical program R. The results show that there were no significant differences in egg quality when feeding birds with different levels of threonine and manganese, and no interaction was observed between them. It is concluded that higher levels of threonine and manganese, and the interaction between them does not alter egg quality.

Key Words: albumen, amino acid, shell, yolk, mineral
Considering a given population of animals, 2 aspects must be highlighted: first, that individuals differ from each other with regard to genetic potential, i.e., in a given population there individuals with inferior, average, and superior production rates, and second, that such differences will inevitably reflect in distinct nutritional requirements. Poultry requirements for essential amino acids have been traditionally estimated by polynomial quadratic (PQ) regression model, and broken-line (BL) model, which are assumed to over and underestimate nutritional needs, respectively. However, these differences between estimates may perhaps contemplate the differences in hen genotypes (e.g., inferior, average, and superior genetic potential). To demonstrate the truth of these statements with respect to hen requirements for tryptophan (Trp), a total 70 Hixes White hens with similar body weight and egg production were randomly assigned to 7 treatments with 10 individual replicates. Treatments consisted of Trp levels, which ranged from 0.81 to 2.30 g/kg. The trial lasted 10 weeks and only the data collected at the last 4 weeks were fitted to BL and PQ regression models. Tryptophan intake of each treatment was standardized to obtain the z value through the difference between individual (x) and population mean intake (µ) of Trp (mg/day) divided by the standard deviation (δ) of the population as follows: z = (x − µ)/δ. Then, z values were regressed against egg mass using PQ and BL models to determine to which area of normal distribution curve (z) corresponded the optimal Trp intake estimated by each model. The optimal Trp intake according to PQ, BL, and the association of both models (PO + BL) were 218, 150, and 184 mg/bird/day, respectively, which meet the requirements of 93, 66, and 83% of the individuals in the population, respectively. The main conclusion form such exercise is that statistical model do not under or overestimate requirements, but rather estimate requirements for individuals with different genetic potentials in a population.

Acknowledgements: The authors thank FAPESP (2013/25761-4) for the financial support and Ajimoto and Evonik for the crystalline amino acids and analysis.

Key Words: amino acid, age, birds

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Methionine sources differently affect the mTORC1-mediated protein biogenesis in the chicken breast Pectoralis major.


The mechanistic target of rapamycin complex 1 (mTORC1) is a protein kinase with pivotal role in protein synthesis in animal cells. Leu, Arg and Met are known activators of mTORC1, but it is still unclear to which extent Met levels and sources affect the mTORC1-mediated protein biogenesis. The objective of this study was to assess how DL-Met and DL-Met hydroxy analog free acid (MHA-FA) affect the activity of genes related to protein synthesis in the chicken breast (Pectoralis major). Chicks were randomly assigned to 6 treatments based on 3 levels of Met in the diet (low, normal or excess) and 2 sources of Met (DL-Met or MHA-FA). Digestible Met levels were 0.63, 0.88 and 1.13% from 8 to 21 d of age (d), 0.58, 0.83 and 1.08 from 22 to 33 d, and 0.52, 0.77 and 1.02% from 34 to 49 d. Breast tissue were produced using the dilution technique, where a summit diet (high-protein) was graded diluted with a low-protein diets to obtain the range in dietary BP levels above described. Data were analyzed as one-way ANOVA, and body weight gain (BWG) and feed conversion (FC) ratio were regressed against BP intake (g/kg) to estimate the levels which optimized both performance traits. According to ANOVA there was influence (P < 0.05) of BP levels on BWG and FC of every strains and sex. Data were fitted to broken-line (BL), quadratic-broken-line (QBL) and polynomial quadratic (PQ) regression models. The model, which better fitted data was that, whose Akaike information criterion (AIC) value was the lowest. And the quality of the fit of each chosen model was evaluated by the coefficient of determination R2. Based on AIC the estimates from PQ model was used to estimate the optimum BP intake. Male and female Ross308 chicks had their body weight gain optimized at 5.99 (R2 = 0.90) and 5.34 (R2 = 0.84) g/bird/day, respectively, while male and female Cobb500 achieved maximum body weight gain at 6.63 (R2 = 0.78) and 6.56 (R2 = 0.79) g/bird/day, respectively. Feed conversion ratio was optimized at 6.95 (R2 = 0.93) and 6.94 (R2 = 0.85) g/bird/day in male and female Ross308 chicks, respectively, and 7.94 (R2 = 0.89) and 7.52 (R2 = 0.91) g/bird/day for male and female Cobb500 chicks, respectively. The requirement of BP in the starter phase was 6.95 and 6.94 g/bird/day for male and female Ross308 chicks and 7.94 and 7.52g/bird/day for male and female Cobb500 chicks, respectively.

Acknowledgements: The authors thank FAPESP (2013/25761-4) for the financial support and Ajimoto and Evonik for the crystalline amino acids and analysis.

Key Words: amino acid, ideal protein, nitrogen

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optimal Trp intake according to PQ, BL, and the association of both models were fitted to BL and PQ regression models. Tryptophan intake of each treatment was divided by the standard deviation (δ) of the population as follows: z = (x − µ)/δ. Then, z values were regressed against egg mass using PQ and BL models to determine to which area of normal distribution curve (z) corresponded the optimal Trp intake estimated by each model. The optimal Trp intake according to PQ, BL, and the association of both models (PO + BL) were 218, 150, and 184 mg/bird/day, respectively, which meet the requirements of 93, 66, and 83% of the individuals in the population, respectively. The main conclusion form such exercise is that statistical model do not under or overestimate requirements, but rather estimate requirements for individuals with different genetic potentials in a population.

Acknowledgements: The authors thank FAPESP (2013/25761-4) for the financial support and Ajimoto and Evonik for the crystalline amino acids and analysis.

Key Words: amino acid, eggs mass, population

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Either the excessive supply of dietary amino acids or an unbalanced dietary amino acid profile are associated with impairments in the efficiency with which nitrogen (N) is used by poultry. In general, both situations lead to the excretion of dietary N, whose steps encompass the split of amino acids into carbon skeleton and ammonia, which is converted into uric acid by birds. Such framework is undesirable considering biological and ecological aspects, since birds spend energy to excrete N, increasing ammonia emission and water eutrophication. Therefore, the ideal balanced protein (BP) level is essential to formulate diets, which warrant optimum efficiency of N utilization. Four dose-response assays were conducted to estimate male and female broiler chicken (Ross 308 and Cobb 500) requirements of BP in the starter phase (1–14d of age). In each feeding assay, a total of 624 birds were randomly assigned to one of 6 treatments, with 4 replicates of 26 birds. The range in dietary BP levels in the starter (14.55; 16.48; 19.37; 22.26; 25.15; 28.04%) phase was produced using the dilution technique, where a summit diet (high-protein) was graded diluted with a low–protein diets to obtain the range in dietary BP levels above described. Data were analyzed as one-way ANOVA, and body weight gain (BWG) and feed conversion (FC) ratio were regressed against BP intake (g/kg) to estimate the levels which optimized both performance traits. According to ANOVA there was influence (P < 0.05) of BP levels on BWG and FC of every strains and sex. Data were fitted to broken-line (BL), quadratic-broken-line (QBL) and polynomial quadratic (PQ) regression models. The model, which better fitted data was that, whose Akaike information criterion (AIC) value was the lowest. And the quality of the fit of each chosen model was evaluated by the coefficient of determination R2. Based on AIC the estimates from PQ model was used to estimate the optimum BP intake. Male and female Ross308 chicks had their body weight gain optimized at 5.99 (R2 = 0.90) and 5.34 (R2 = 0.84) g/bird/day, respectively, while male and female Cobb500 achieved maximum body weight gain at 6.63 (R2 = 0.78) and 6.56 (R2 = 0.79) g/bird/day, respectively. Feed conversion ratio was optimized at 6.95 (R2 = 0.93) and 6.94 (R2 = 0.85) g/bird/day in male and female Ross308 chicks, respectively, and 7.94 (R2 = 0.89) and 7.52 (R2 = 0.91) g/bird/day for male and female Cobb500 chicks, respectively. The requirement of BP in the starter phase was 6.95 and 6.94 g/bird/day for male and female Ross308 chicks and 7.94 and 7.52g/bird/day for male and female Cobb500 chicks, respectively.

Acknowledgements: The authors thank FAPESP (2013/25761-4) for the financial support and Ajimoto and Evonik for the crystalline amino acids and analysis.

Key Words: amino acid, ideal protein, nitrogen
lated ($P < 0.08$) Eukaryotic translation Initiation Factor 4B (eIF4B) in comparison with DL-Met. RPS6KB1 was strongly affected by standard levels of DL-Met compared with standard MHA-FA levels ($P < 0.05$), inducing the expression of Ribosomal Protein S6 (RPS6) gene as cellular effector of ribosome biogenesis. DL-Met induced Cap-dependent translocation, an activator of the Glut family of insulin-dependent glucose transporters (Glut4), and the synthesis pathway of Glut4 apparently depends on a different set of genes whether DL-Met or DL-MHA-FA is the inducing agent. Both Met sources induced activity of RPS6 genes and improved the activity of essential genes of molecular machinery to protein biogenesis in the chicken Pectoralis major.

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**Key Words:** amino acid, gene expression, protein synthesis

225 d-Methionine and 0.1-hydroxy methionine: What is the metabolic cost of conversion of these enantiomers to l-methionine? D. I. Batonon-Alavo1, Y. Mercier1, A. Toscan2, and J. van Milgen*3, 1Adisseo France S.A.S. France, 2Adisseo Brazil, Brazil, 3INRA, Rennes France.

This work aims to determine the energy cost of the conversion of L-methionine precursors (i.e., D-Met, D- and L-HMTBA) to L-Met. A framework representing the major biochemical pathways of nutrient metabolism was developed by van Milgen (2002), allowing quantification of the energy efficiencies of different nutritional scenarios. Using the concepts developed in this model, the theoretical energy costs of the conversion of D-Met, D-HMTBA, and L-HMTBA to L-Met were calculated. These enzymatic conversions involve oxidases (D-AOX and L-HAOX) or a dehydrogenase (D-HADH) and result in the formation of a common intermediate, α-keto-methylthio-hexanoic acid (KMB). The conversion of D-Met to KMB also results in the release of the amine group (-NH$_2$). The transamination of KMB to L-Met requires an amine group from another amino acid. If this amine group comes from protein given in excess of protein deposition, less energy will be excreted as urea or as uric acid. The ME value of D-Met would be equal to that of L-Met because the amine group released in the production of KMB can be reused for its transamination to L-Met. Considering the gross energy values of D-Met, D-L-HMTBA, urea, and uric acid are respectively 3522, 3366, 635, and 1926 kJ/mol. For 1 mol of D-L-HMTBA, the excretion of 0.5 mol urea and 0.25 mol uric acid is avoided. Consequently, the ME-to-GE ratio for D-L-HMTBA is (3366 + 630 × 0.5)/3366 = 109% in mammals and (3366 + 1926 × 0.25)/3366 = 114% in birds. The energy efficiencies of using ME also differ for the enantiomers of L-Met. The oxidative conversion of D-Met and L-HMTBA to KMB leads to the formation of hydrogen peroxide. This H$_2$O$_2$ can be catabolized through the oxidation of reduced glutathione (GSH) to oxidized glutathione (GSSG). The reduction of GSSG back to GSH requires 1 NADPH, which is equivalent to 3 ATP. Because 74.2 kJ of glucose is required to synthesize 1 ATP, the NE-to-ME ratio (relative to that of L-Met) can be calculated as (3522 - 3 × 74.2)/3522 = 92% for D-Met and as ((3366 + 630 × 0.5) - 3 × 74.2)/(3366 + 630 × 0.5) = 94% for L-HMTBA. The conversion of D-HMTBA to KMB yields 1 NADH, which is equivalent to 3 ATP. Because 74.2 kJ of glucose is required to synthesize 1 ATP, the NE-to-ME ratio (relative to that of L-Met) is 96% and 100% for D-L-Met and L-HMTBA, respectively. Summarizing, compared with the energy values of L-Met, D-L-Met has an ME value of 100% and an NE value of 96%. For DL-HMTBA these values are 114% and 100% for ME and NE, respectively.

**Key Words:** methionine, hydroxy-methionine, energy

226 Effect of l-lysine sulfate in meat quality for broiler chickens. B. L. de Oliveira*1, B. R. Nogueira2, V. A. Silva3, L. F. de Freitas3, and A. G. Bertechini3, 1Zootecnia, University Federal of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, 2Faculdade de Ciências Agrárias e Veterinárias/Universidade Estadual Paulista Jabaquara, Jaboticabal, São Paulo, Brazil, 3Zootecnia, University Federal of Lavras, Minas Gerais, Brazil.

The l-lysine sulfate form is an alternative that presents with high potential to be used in the formulation of diets for broilers. The new source studied is differentiated by the sulfate stabilizer radical and the effective lysine concentration when compared with the HCl source. The objective of this assay was to determine the efficiency of the l-lysine sulfate source over meat quality parameters. A total of 1800 male 22-d-old Cobb-500 broilers were used in a completely randomized experimental design with 9 treatments in the factorial scheme 4 × 2 × 1 (lysine levels x sources + control) and 8 replicates with 25 birds per plot experimental. The treatments consisted of increasing levels of digestible l-lysine (0.850, 0.950, 1.050 and 1.150%), by 2 sources of lysine, l-lysine HCl, 99% (79%) and l-lysine sulfate, 90% (70%) and a treatment without industrial lysine, with 0.750% digestible lysine. The diets were based on corn and soybean meal supplemented and formulated according to line recommendations, except lysine. Chicks had ad libitum access to feed and water. At the end of the experimental period, at 42 d, 2 birds per pen were fasted for 8 h and slaughtered for evaluation of meat quality. Pectoralis major muscles were collected to analyses of pH, objective color, loss of water by dripping and cooking. The experimental data were submitted to ANOVA using the SAS software, and the means compared applying Student-Newman-Keuls test. The differences were considered as significant at 5% probability. There was a significant difference ($P < 0.05$) between the sources and the levels of luminosity (L*) when compared with the control. The different sources of l-lysine HCl and l-lysine sulfate (51.14 and 50.22 respectively) presented better when compared with the control treatment (58.82), has classified these meats as normal, in relation to the levels indicated inclusion level was 1.15%. When evaluating the red (a*) and yellow (b*) indexes, a significant difference ($P < 0.05$) was observed at 1.05% inclusion level. Regarding pH, drip weight loss and weight loss by cooking, no significant differences were observed ($P > 0.05$). Thus, it can be concluded that l-lysine sulfate can be used to replace l-lysine HCl without affecting the quality of the meat of the broilers in the finishing phase, with inclusion level from 1.05% giving the best results.

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**Key Words:** amino acid, broiler, lysine, meat quality, sources
(BWG). At the beginning and the end of each phase, 2 birds per pen were euthanized for protein content measurements in body and feathers, so that amino acid deposition could be determined. One-way ANOVA was applied to all data with 5% probability. Dunnet test was used to observe if counterproof differed from the lowest level of Ile supplementation. Ile deposition (Iled) was fitted in function of Ile intake (Ilei), using a linear equation, to estimate the k (Iled = a + k*Ilei). A significant difference among treatments was observed for all variables measured (P < 0.05). The difference observed in BWG between counterproof and the lowest Ile level (P < 0.05) confirms that the response obtained is due Ile. The linear equation adjusted to determine k was Iled = 6.69 + 0.64*Ilei (R² = 0.93), in which the estimated k was 64%. Using k determined herein and based on previously studies conducted at FCV/UNESP it was possible to adjust a factorial model to determine Ile requirement with the following model: \[
\text{Ile} = a + k \times \text{Ile}.
\]

Data were analyzed as one-way ANOVA using SAS software and the ideal ratio between Met and Cys/SAA which optimized BWG was 55:45. Based on performance results, methionine must represent at least 55% of total SAA.

Acknowledgements: The authors thank FAPESP (2013/25761-4) for providing financial resources, which supported the conduction of the current research and Evonik Industries for donating amino acids used in this study and performing analysis.

Key Words: dose-response, sulphur amino acids, statistical model
Glutamine is a non-essential amino acid; however studies have been shown that during stress situations glutamine becomes conditionally essential, once it is source of energy for the enterocytes. The ambient temperature, mainly heat stress, is one of the main factors that affects broilers performance and carcass composition. So this study was conducted to evaluate the effect of glutamine supplementation (Glu) on performance and carcass yield of broiler chickens reared under different temperatures. 1350 birds one-day-old male of Cobb strain, were reared up to 42 d and distributed randomly in factorial 3 × 3 arrangement, with the temperature rearing (hot, cold and thermoneutral) and levels of Glu (0, 1 and 2%), with 5 repetitions of 30 birds each. The glutamine was supplemented from 1 to 21 d of age. The parameters evaluated were performance (feed intake, body weight gain and feed conversion) and carcass yield (breast, thigh and drumstick). The variables were submitted to ANOVA and subsequently to test of means (P < 0.05). Broilers fed ration with 2% glutamine showed better performance with increase in body weight gain and improvement in feed conversion in the first 2 weeks of age. However, these effects did not persist between 21 and 42 d of age (grower phase). Regarding the ambient temperature, the broilers exposed to heat showed worst performance with lower feed intake and body weight gain, and reduced breast yield. It is concluded that glutamine supplementation from 1 to 21 d of age does not minimize the effects of thermal stress on broilers performance during grower phase (21 to 42 d).

**Key Words:** amino acids, heat stress, yield carcass

### 231 Arginine sparing potential of guanidinoacetic acid in broiler nutrition

A. Lemme1, M. Rademacher-Heilshorn1, R. N. Dilger2, C. Scharch3, and U. Braun4,5,6, Econik Nutrition & Care GmbH, Hannau, Germany, 2Department of Animal Sciences, University of Illinois, Champaign-Urbana, IL, USA, 3Feedtest, Wettin-Löbejün, Germany, 4AlzChem Trostberg GmbH, Trostberg, Germany.

Guanidinoacetic acid (GAA), the precursor of creatine, is synthesized from one molecule of arginine (Arg) and one molecule of glycine (Gly) in the kidney. On a weight basis, formation of 100 g of GAA (117.1g/mol) would require 148.8 g Arg (174.2g/mol), which would suggest an Arg sparing of GAA of 148.8% in an Arg-deficient nutritional situation as less Arg would be required for de-novo synthesis and can be utilized for other metabolic purposes. Two feeding experiments with broilers were conducted to examine the interactions between Arg and GAA. In experiment 1, 960 male Ross 308 broilers (10 birds/pen, 8 replic.) were fed experimental diets from 14 to 27 d of age. Twelve dietary treatments comprised 6 diets with increasing digestible Arg levels from 0.80% to 1.15% (by L-Arg) corresponding to dig. Arg:dig Lys levels of 70 to 100%. In further 6 treatments, each of these diets were supplemented with 0.058% GAA. In experiment 2, 280 male New Hampshire x Columbian broilers (4 birds/pen, 5 replic.) received 14 experimental diets with 0.88% to 1.60% total Arg (by L-Arg) from 8 to 17 d of age with or without 0.118% supplemental GAA (for details see Dilger et al., Poultry Science 92:171–177). In both experiments, broilers responded significantly in a nonlinear manner to increasing Arg supply in terms of weight gain and feed conversion ratio (FCR). However, weight gain response in experiment 1 did not achieve asymptote within the given dosing range. When GAA was added to the diet, weight gain and FCR were improved at all dietary Arg levels resulting in a shift of the response curves. Responses were analyzed by exponential regression analysis \( y = \alpha + \beta \times (1 - \exp(-c \times X)) \) to estimate the sparing effect of GAA vs. Arg by estimating the required Arg-supplementation for a certain performance level (gain, FCR) without or with GAA. In experiment 1, 0.058% GAA supplementation spared on average 0.068% L-Arg for weight gain and 0.045% L-Arg for FCR corresponding to an Arg-sparing of GAA of 116% and 77%, respectively. Likewise, in experiment 2, at 95% of asymptotic response of the treatment without GAA, 0.147% less L-Arg and 0.195% less Arg was needed for gain and FCR at 0.118% GAA corresponding to Arg-sparing of GAA of 125% and 165%, respectively. These results of empirical in vivo data suggest an Arg sparing effect in broilers under Arg-deficient dietary conditions. While the lowest estimated Arg-sparing for GAA was 78%, the higher estimated values were in the range of the maximal possible sparing of 148.8% when comparing on weight basis.

**Key Words:** broiler, guanidinoacetic acid, arginine, arginine sparing, regression analysis

### 232 Balanced protein level for growing broilers: An economic optimization for maximum profit return


Mechanistic growth models that predict nutritional requirements, performance, and economic responses of growing broilers, could help nutritionists in a decision-making process. Aiming to produce a feed program that return the best profit, simulations were performed using a mechanistic growth model. The model is based on a theory in which the broiler seeks to eat an amount of nutrient to reach its genetic growth potential. First, 4 feeds (4 phases) were formulated (1 to 7 (starter), 8 to 21 (grower), 22 to 33 (finisher I), and 34 to 42 (finisher II) days old) to produce a feed program that meet all nutrients requirements according to the fourth edition of The Brazilian Tables for Poultry and Swine. Consecutively, each feed was reformulated 11 times varying balanced protein (BP) content. In all phases it was respected an interval of 0.05% in digestible lysine (Lys) between diets, and amino acid ratios with Lys were kept constant. Different feed programs were produced from each possible feed combination (11 starter x 11 grower x 11 finisher I x 11 finisher II), totaling 14641 feed programs; hence, using the mechanistic growth model, one simulation was performed for each feed program, to predict the broiler performance. BP ranged from 22.08 to 20.47%, 21.91 to 19.45%, 21.70 to 18.21%, and 21.25 to 15.29% for each phase and the feed cost ranged from 1.06 to US$ 1.41, 1.07 to US$ 1.40, 1.06 to US$ 1.34, and 1.01 to US$ 1.20, respectively for each phase. In total, 14641 simulations were performed (representing 14641 feeding programs) to predict feed intake (FI) and body weight (BW). For each simulation, data of BW and FI was used to determine the gross margin (GM = RE – CF), where GM is the gross margin, RE is the revenue obtained multiplying the BW selling price (US 2.00) with the kg of BW, CF is the cost of feeding determined by feed cost multiplied by feed intake. On 42 d, BW (3343g) was optimized by a feed program containing feeds with BP level of 22.08 (starter), 21.91 (grower), 21.70 (finisher 1), and 20.51% (finisher 2). For profit optimization BP was estimated in 22.01 (starter), 21.95 (grower), 21.76 (finisher I), totalizing 14641 feed programs; hence, using the mechanistic growth model, one simulation was performed for each feed program, to predict the broiler performance. BP ranged from 22.08 to 20.47%, 21.91 to 19.45%, 21.70 to 18.21%, and 21.25 to 15.29% for each phase and the feed cost ranged from 1.06 to US$ 1.41, 1.07 to US$ 1.40, 1.06 to US$ 1.34, and 1.01 to US$ 1.20, respectively for each phase. In conclusion these outcomes indicate that maximum performance is not always followed by maximum economic return; predict a broiler performance given a specific feed help nutritionists to estimate the best levels of nutrients to maximize the profit; and growth models are useful in nutrition as a decision tool.

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**Key Words:** animal modelling, ideal protein, gross margin
233 Effects of phytase levels with different calcium and phosphorus ratios on bone parameters. M. Alves da Costa¹, P. M. Rezende¹, R. Faihlho de Sousa¹, T. Vieira de Andrade¹, R. M. J. Filho², M. B. Café¹, and J. H. Stringhini¹,¹ Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ²São Salvador Alimentos, Ibarera, Goiás, Brazil.

This study was conducted to evaluate the phytase levels supplementation with different calcium/ phosphorus ratios on bone characteristics of broilers at 21 d of age. The experiment was conducted in the experimental avian facilities of the Veterinary and Animal Science College of the Federal University of Goiás. A total of 400 male chicks of the Cobb500 were used in a completely randomized design and in a factorial arrangement with 8 treatments and 5 replicates with 10 birds each. In the period from one to 21 d of age, the birds received diets based on corn, soybean meal and corn gluten according to recommended by Rostagno et al. (2017) to meet the nutritional requirements, except calcium (Ca) that was included in the diets composing the different treatments for each stage of production. Eight diets were formulated for each phase, for pre-starter (1–7 d) and starter (8–21 d). The experimental diets consisted of 4 calcium and phosphorus (P) ratios (2.3, 2.0, 1.7 and 1.4 / 1), considering the ratio of 2/1 of 0.964% of calcium and 0.482% of available P (1 to 7 d) and 0.864% calcium and 0.432% P available (8 to 21 d), from the levels recommended by Rostagno et al. (2017), and inclusion of 750 or 1500 FTU phytase, considering the enzyme matrix only for phosphorus. At 21 d of age, 2 birds per treatment (total of 80 birds) were slaughtered to obtain the tibia for analysis. The data obtained were submitted to ANOVA and compared by the Scott-Knott test at 5% probability by the statistical program R. There was interaction for all variables analyzed (P < 0.05). The shortest length of the tibia was obtained with the ratio of 1.7/1 and 1500FTU phytase. Chickens fed 2.3 and 1.4 Ca/P ratios with 750 FTU of phytase had smaller diameter of tibias (P < 0.05). However, when animals were supplemented with 1500FTU, they obtained larger diameters (P < 0.05). The highest weight of tibia was attributed to the animals that received ratios 2.3 and 1.4 Ca/P with the supplementation of 1500FTU (P < 0.05). The 2.0 / 1 ratio with 750FTU provided (P < 0.05) the highest Seedor Index. The reduction of the Ca/P ratio to 1.4/1 allowed maintaining the bone characteristics similar to the bones of chickens that received the standard Ca/P ratio (2.0 / 1) during the 21 d of age. Supplementation of phytase 1500 FTU increased the length and diameter of the tibias (P < 0.05).

Acknowledgements: The authors thanks to FAPEG; São Salvador Alimentos, ABVista to the financial and technical support

Key Words: aviculture, diet, enzyme, performance, phytic acid

234 Effect of phytate and phytase on broilers diets at 21 days of age. J. Broch¹, V. D. L. Savaris¹, C. De Souza², C. Eyng¹, G. M. Pestí³, and R. V. Nunes¹,¹ State University of Western Parana, Marechal Cândido Rondon, PR, Brazil, ²Federal Technological University of Paranaíba, Dois Vizinhos, PR, Brazil, ³The University of Georgia, Athens, GA, USA.

The objective of this study was to evaluate the effect of different levels of phytase in diets formulated based on products of plant origin on broiler performance from 0 to 21 d of age. A total of 2,625 male one-day-old Cobb 500 broiler chicks were distributed in a 3x5 factorial design (15 treatments) with each treatment containing 7 replicates of 25 birds each (the experimental unit). Three kinds of experimental diets were fed: high (HP, based on vegetable ingredients), medium (MP, vegetable plus animal ingredients), and low phytate (LP, animal ingredients) levels, and 5 levels of phytase inclusion: a positive control diet, negative control diet, and negative control diet plus 100; 200 or 300 FTU kg⁻¹ of phytase. Data were analyzed by SAS - Version 9.1. Polynomial regression between levels of inclusion of the enzyme was performed excluding the positive control treatment. Dunnett’s and Tukey’s tests were performed with P < 0.05 considered significant. The weight gain (WG) and feed intake (FI) of the birds fed the medium phytate diet (MP) showed an increasing linear response (P < 0.05) with increased phytase supplementation. For birds receiving the low phytate ration (LP), WG and FI had a quadratic behavior (P < 0.05) and the levels, of phytase inclusion that provided the maximum responses were calculated to be at 228 and 211 FTU kg⁻¹, respectively. For feed conversion ratio (FCR) there were only the phytate and the enzyme effects (P < 0.05). Dunnett’s test applied to WG and FI showed that birds on the MP and LP diets, that received the negative control (NC) had a WG and a FI lower than that of those of the positive controls (PC). Birds fed NC + 200 FTU kg⁻¹ of phytase in the LP diet had a WG 6.53% higher than that of birds that were fed the PC. When the effect of the phytate content on FCR was evaluated, birds on the HP diet had higher FCR when compared with birds on the medium and low phytate diets (P < 0.05). The evaluation of the effect of phytase on FCR showed that birds supplemented with 200 and 300 FTU kg⁻¹ differed when compared with those on the PC treatment (P < 0.05), showing a better use of nutrients from the diet for WG.

Key Words: aviculture, diet, enzyme, phytase, performance, phytic acid
to evaluate performance improvements, lower levels from Zn, Cu and Mn-MHAC increased BWG from 12 to 25d ($P < 0.05$) regardless of Phy supplementation. Phy A and B improved BWG over Control from 12 to 25d and 1–25d, although only Phy B optimized FCR compared with Control overall ($P < 0.05$). Zn, Cu and Mn-MHAC increased Tibia ash (%) at 12d vs sulfates ($P < 0.05$). Both Phy increased tibia ash (%), at 12d while Phy B was superior to Control and Phy A at 25d ($P < 0.05$). Tibia Ca and P did not present differences ($P > 0.05$). Interaction between mineral and Phy was observed to ileal digestibility ($P < 0.05$). Both Phy improved Ca digestibility but only Phy B increased DM and P digestibility over Control and Phy A in diets with sulfates ($P < 0.05$). In diets with organic minerals, Phy A improved DM, Ca and P digestibility over Control and Phy B ($P < 0.05$). These results contradict performance and tibia ash data. Considering a common corn-SBM diet, the use of lower mineral levels from Zn, Cu and Mn-MHAC and Phy B positively affected performance and bone mineralization of broiler chickens. Further studies should better investigate the impact on Ca and P digestibility.

**Key Words:** broiler, digestibility, minerals, performance, phytase

**Table 1. Bone quality of chickens fed with different calcium/phosphorus ratios and supplemented with two doses of phytase at 21 days of age**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Length (mm)</th>
<th>Diameter (mm)</th>
<th>Bone weight (g)</th>
<th>Seedor index</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Ca</td>
<td>67.14</td>
<td>6.12</td>
<td>5.09</td>
<td>0.073</td>
</tr>
<tr>
<td>82% Ca</td>
<td>67.27</td>
<td>6.06</td>
<td>5.03</td>
<td>0.074</td>
</tr>
<tr>
<td>64% Ca</td>
<td>67.86</td>
<td>6.10</td>
<td>4.99</td>
<td>0.074</td>
</tr>
<tr>
<td>750 FTU</td>
<td>66.29b</td>
<td>5.84b</td>
<td>4.74b</td>
<td>0.071ab</td>
</tr>
<tr>
<td>1500 FTU</td>
<td>69.56a</td>
<td>6.35a</td>
<td>5.22a</td>
<td>0.077a</td>
</tr>
</tbody>
</table>

Interaction

<table>
<thead>
<tr>
<th>Probabilities</th>
<th>100% Ca</th>
<th>82% Ca</th>
<th>64% Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytase</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Ca/P ratio</td>
<td>0.484</td>
<td>0.895</td>
<td>0.265</td>
</tr>
<tr>
<td>CV</td>
<td>2.66</td>
<td>5.48</td>
<td>5.07</td>
</tr>
</tbody>
</table>

$^{a,b}$Lowercase letters in a column differ by Scott-Knott ($P < 0.05$).

Acknowledgements: Author thanks for FAPEG, São Salvador Alimentos and ABVista for technical and financial support

**Key Words:** phytic acid, enzyme, super dosing, tibia

**237 Phytase supplementation in diets with reduction of Ca and available P on performance, tibial characterization in broilers.**


The objective was to evaluate the supplementation of a phytase in diets deficient in both Ca and available P (avP) on the performance, morphometric and mineral characterization of tibias and phosphorus content in feces of broilers. Six hundred male Cobb 500 chicks were randomly distributed in 24 pens/batch, with 25 birds per pen. Birds were fed during 21 d with 6 iso-nutritive diets (3050 Kcal ME/kg and 22.85% CP): T1 with 0.98% Ca and 0.45% avP (positive control); T2 with reduction of 0.17% avP and 0.16% Ca; T3 with reduction of 0.15% avP and 0.13% Ca; and T4 equivalent to T2 with supplementation of 1000 FTU/kg. Water and feed intake (FI) were measured weekly and body weight gain (BWG) and feed conversion ratio (FCR) traits were calculated. At 21 d, 2 birds per pen were randomly selected and slaughtered by cervical dislocation to obtain the weight of abdominal fat (AF) by coelomic cavity opening, and the isolation of both tibial bone. The morphometric traits such as weight (TW), transverse length (TL), diaphysis diameters and volume were measured to calculate the bone density. Data was submitted to variance analysis and means were compared by Tukey’s test ($P < 0.01$), using the PROC LIN procedure. The BWG and FI of the birds fed with T2, diet with higher reduction in Ca and avP, was statistically lower ($P < 0.01$), while the phytase supplementation on diets with high reduction T4, did not differ from the dietary groups T1 and T3. The bird fed with T2 diet influenced ($P < 0.01$) in the bone parameters of TL and TW analyzed, and the ash content in tibial bone. The birds fed with T4 diet improved the mineral deposition compared with T2 ($P < 0.01$), being similar to the dietary treatments T1 and T3. The birds fed with T2 diet obtained a lower TW and BW ($P < 0.01$) and the supplementation of phytase.
influenced the bone parameters analyzed \( P > 0.01 \). AF of broilers fed all dietary treatments was similar \( P = 0.14 \). In conclusion, the phytase supplementation improves the productive performance, the tibial bone characteristics in broilers fed diets with an ample reduction of Ca:avP.

**Key Words:** Ca and available P reduction, phytase, broiler chicken, morphometry

238 **Multi-enzyme complex improved digestibility and performance of broilers fed sorghum and soybean meal-based diets.** N. S. Fagundes*, F. H. Litz1, S. K. A. Santos1, M. L. Ceccantini2, and F. A. Fernandes1, 1Federal University of Uberlândia, Uberlândia, MG, Brazil, 2Adisso Brazil, São Paulo, SP, Brazil.

The objective of this study was to evaluate the effect of a multi-carbohydrase phytase complex (MCPC) on coefficients of apparent metabolizability of dry matter (DM), crude protein (CP) and energy, and on performance of broilers fed sorghum and soybean meal based diets. The design for the current experiment included 3 dietary treatments: an industry positive control diet (PC); a negative control (NC); PC with reduction in the nutritional levels after evaluation of available substrate \( 97 \text{ kcal/kg of apparent metabolizable energy (AME), between 2.25 and 4.12\% of digestible amino acids (dig. AA), 0.11\% available P (Av.P) and 0.10\% of Ca} \); and a dietary treatment that included a multi-carbohydrase containing 1250 VU xylanase, 860 VU \( \beta \)-glucanase and 6-phytase 1000 FTU/kg added to NC (NC + MCPC). For the digestibility trial, 42 male broilers were fed NC or NC + MCPC from 14 to 21 d and placed in metabolic cages with 7 replicates of 3 birds per cage. After 3 d of adaptation, total excreta was collected during 5 d. Feed contained ferric oxide as marker. For the performance trial, 1,368 male broilers were fed one of the 3 diets, in 12 replicates of 38 birds per pen. Broilers were adapted to diets from 1 to 21 d of age, and performance was evaluated from 22 to 42 d. Both trials were carried out in a completely randomized design and data analyzed using the 2-samples t-test. The multi-enzyme complex added to the NC diet increased the metabolizability of DM \( P < 0.001 \), CP \( P = 0.006 \) and energy \( P = 0.002 \) by 2.3%, 12.8%, and 1.9%, respectively. The nutritional reduction in NC impaired feed conversion (FC) of birds compared with FC from 1.745 to 1.811 \( P = 0.015 \). Body weight gain (BWG) of birds fed the NC diet was reduced from 2,116 g to 2,033 g, when compared with birds from the PC treatment \( P = 0.007 \). The addition of the multi-enzyme complex to the NC diet recovered FC to 1.746 \( P = 0.038 \) and BWG to 2,084 g \( P = 0.057 \), achieving the same performance of birds fed the PC diet \( P = 0.662 \) and \( P = 0.770 \). In conclusion, the multi-enzyme complex improved broiler performance due to an overall improvement on nutrients utilization (Feedase effect), as shown by the digestibility results. Dietary reductions in AME, dig. AA, Av.P and Ca negatively affected broiler performance during the experimental period (22–42 d), and the addition of the multi-enzyme complex recovered those losses. The use of the multi-enzyme complex in broiler fed sorghum and soybean meal based diets can be considered an important strategy to reduces the excretion of nitrogen (g) in the poultry litter for birds that consumed diets containing corn type 1 with addition of the enzymatic complex obtained lower pH value in relation to the birds that consumed a diet containing corn type 3 with addition of the enzymatic complex \( P < 0.05 \). It was observed that there was a poultry litter lower temperature \( (^\circ \text{C}) \) for treatments in which birds consumed type 1 maize \( P < 0.05 \). In relation to the inclusion of the enzymatic complex, the birds that consumed the enzymatic complex showed poultry litter lower temperature \( P < 0.05 \). It was observed that there was a lower excretion of nitrogen (g) in the poultry litter for the birds that consumed diets containing corn type 1 with addition of the enzymatic complex \( P < 0.05 \). Lower ammonia (ppm) values were observed in poultry litter for birds that consumed diets containing type 1 corn with enzyme complex addition \( P < 0.05 \). As conclusion, it can be affirmed that the quality of the poultry litter of the birds that consumed diet containing corn type 1 with addition of the enzymatic complex was better than the other treatments in the period of 42 d.

**Acknowledgements:** I thank FAPEG for the financial support through the scholarship and the nutron for giving to the enzyme for research.

**Key Words:** ammonia, nitrogen, \( \text{pH} \), temperature and humidity.


The advancement of new technologies enabled new product launches on the market that included in the ration lead to better feed efficiency and performance in broilers. The objective of this work was to evaluate the effect of the addition of an enzymatic complex (Axtra - Xylanase, Amylase and Protease) in diets formulated with corn type 1 and 3, on performance of poutry from 1 to 21 d age. The experiment was conducted in the Experimental Aviary of the Federal University of Goiás - GO, in the period of April 2017. The experiment was approved in the animal ethics committee of UFG under protocol no. 009/17 where 600 male poutry of the Cobb 500 strain were housed. The experiment was composed of 4 experimental diets: T1 - corn type 1, without enzyme addition; T2 - Type 1 corn, with enzyme addition; T3 - Type 3 corn, without enzyme addition; T4 - Type 3 corn, with added enzyme. The final weight, feed intake,
feed conversion and poultry mortality were evaluated. The inclusion of the complex enzyme was 100 g per ton, respecting the manufacturer’s recommendations. Type 1 corn consists of regular, regular grain dry corn with a maximum moisture content of 14% with a maximum tolerance of 1% of foreign matter and impurities; 6% of damaged grains, with a maximum of 1% of moldy and burned grains, and type 3 corn consisting of regular dry grain corn with a maximum moisture content equal to 14% with tolerance - a maximum of 2% of foreign matter and impurities; 15% of damaged grains, with a maximum of 3% of moldy and burned grains. The experimental design was completely randomized, distributed in a factorial scheme (2x2), with addition of the enzymatic complex or not and 2 types of corn (type 1 and 3), consisting of 4 treatments, with 6 replicates of 25 poultry. Poultry were housed in individual floor boxes with a new bed. It was observed that there was a higher final weight and lower feed conversion for the poultry that consumed type 1 corn ($P < 0.05$). In relation to the inclusion of the enzyme, poultry that consumed the enzyme presented higher final weight and lower feed conversion ($P < 0.05$). There was no significant difference ($P > 0.05$) for feed intake in relation to corn type and enzyme addition. There were no significant differences ($P > 0.05$) for mortality. As conclusion, it can be affirmed that growth performance of broilers that consumed diets containing corn type 1 with addition of the enzymatic complex was more higher than the other treatments in the period of one to 21 d.

**Acknowledgements:** I thank FAPEG for the financial support through the scholarship and the nutron for giving to the enzyme for research.

**Key Words:** amylase, maize quality, poultry nutrition, protease and xylanase.

### 241 Chicks performance (1 to 7 days) fed diets containing xylanase, protease, and two levels of phytase.


The objective of this study was to evaluate the performance of broilers fed diets with 2 levels of phytase associated with xylanase and protease from one to 7 d of age. The experiment was conducted in the experimental avian research facilities of EVZ/UFG, under a protocol approved by the Commission of Ethics in the Use of Animals nr. CEUA 010/17. A total of 1536 male Ross 308AP (AP95) day-old chicks were allotted in a completely randomized design, in a 2 × 2 × 2 factorial arrangement, corresponding to the interaction of 2 phytase levels (750 FTU and 1500 FTU), xylanase and protease; in a total of 8 treatments and 6 replicates of 32 birds each. The experimental diets were formulated according to Brazilian Tables recommendations, and supplemented with xylanase (60g/ton), protease (500g/ton) and phytase (75, 150g/ton). Broilers and diets were measured weekly until 7 d of age to determine weight gain, final weight, feed intake and feed conversion. The analysis of the data was performed using the variance analysis procedure (ANOVA) and the data were compared by the Scott-Knott test (5%), in the statistical software R. The final weight and weight gain of the chicks did not differ between the experimental diets ($P > 0.05$). Feed intake and feed conversion of the birds showed statistical interaction on the enzymes phytase, xylanase and protease present in the diets ($P < 0.05$). The higher values of feed intake were observed for broilers fed diets with 1500 FTU of phytase containing the protease and also in the diets containing only 750 FTU of phytase. For feed conversion, the chicks fed diets with 750 FTU of phytase containing protease showed better feed conversion. In the present experiment, birds fed 750 FTU of phytase and protease showed better performance, expressed mainly by the feed conversion variable.

### 242 Exogenous protease, mannanase and xylanase supplementation in corn DDGS-based diets: Effects on growth performance, intestinal health and nutrient digestibility in broiler chickens.

M. Hussain, M. A. Mirza, H. Nawaz, G. Ahmed, T. Mahmood, 1 Institute of Animal and Dairy Sciences, University of Agriculture, Faisalabad, Punjab, Pakistan; 2Sadig Feeds (Pvt) Ltd., Rawalpindi, Punjab, Pakistan; 3Department of Biochemistry, University of Agriculture, Faisalabad, Punjab, Pakistan.

A study was conducted to evaluate the effects of exogenous enzymes supplementation in Hi-Pro corn DDGS-based diets on broiler’s growth performance, intestinal health and nutrient digestibility. A total of 200 (n = 200) one-day-old broiler hatchlings were randomly allocated to 4 dietary treatments with 5 replicates of 10 birds each. A basal diet (CON) was formulated (CP: 20%; ME: 2900 kcal/kg) containing 15% dietary crude protein from Hi-Pro corn DDGS. The CON diet was further subdivided into 3 parts. One part was supplemented with exogenous proteases (CON-P), second part was supplemented with enzyme mix of mannanase and xylanase (CON-MX) while third part was supplemented with protease and enzyme mix of mannanase and xylanase (CON-MXP). A digestibility assay was carried out using Celete, a source of acid insoluble of ash (AIA), from d 29 to d 35. On d 35, 4 birds from each replicate were picked randomly and killed by cervical dislocation to collect ileal digesta. Also, duodenum, jejunum and ileum lengths were measured and tissue samples were collected from midpoints of jejunum to note villus height and crypt depths. Feed intake, BWG and FCR were not different among the dietary treatments during the entire production period. Likewise, no difference on carcass characteristics, soft organ weight, intestinal integrity, amino acids digestibility and apparent metabolizable energy was observed by the dietary treatments. However, high nitrogen retention ($P < 0.05$) was noted in birds fed the CON-MXP diet compared with the CON diet. In conclusion, supplementation of exogenous protease and enzyme mix (mannanase and xylanase) had no effect on growth performance, intestinal integrity and nutrient availability of broiler chickens fed Hi-Pro DDGS-based diets.

**Key Words:** broiler, exogenous enzyme, Hi Pro DDGS, intestinal integrity.

### 243 Effect of an exogenous protease on ileal nutrient digestibility and peptide populations in the GI tract.

L. P. Barnard, A. Belalcazar, S. Y. Bak, and R. Ravindran, 1 Danisco Animal Nutrition, DuPont Industrial Biosciences, Marlborough, United Kingdom; 2DuPont Nutrition and Health, Denmark; 3Massey University, Palmerston North, New Zealand.

The aim was to investigate the effect of an exogenous subtilisin protease enzyme on the ileal digestibility of dry matter (DM), nitrogen (N) and gross energy (GE). There were 2 treatments; 1. A control diet (NC), 2. A control diet supplemented with 2,000U/kg subtilisin protease (PRO; from Danisco Animal Nutrition, DuPont Industrial Biosciences). Each treatment was replicated 8 times with 8 birds/ replicate; test diets were fed from d0-21. Treatment feeds were based on corn and soybean meal and were formulated to be isonitrogenous (21% CP). All feeds contained 750FTU/kg of phytase and TiO$_2$ was used as an inert marker. Feed,
in mash form, and water was available ad libitum for the duration of the study. At study termination, birds were euthanized and contents of the lower ileum were collected by gentle flushing with distilled water. Digesta and diets were analysed for N, DM GE, and an inert marker to calculate digestibility. Digesta samples were also analysed using proteomic techniques to assess the different types of peptides that remained undigested in the GI tract. Data were analysed using JMP 12.0 and significance was considered at \( P < 0.05 \). Protease significantly increased ileal digestibility of GE (+3.2%) and DM (+3.8%; \( P < 0.05 \)) and showed a tendency to increase ileal N digestibility (+1.8%; \( P = 0.06 \)). Principle component analysis of the proteomes showed a clear separation between the populations of peptides found in the control diets vs. the protein treated diets indicating the ability of the protease to impact specific protein fractions of the diet. This work showed that exogenous subtilisin protease can increase ileal N, GE and DM digestibility of corn and soybean meal diets. The improvements in energy digestibility were greater than the effects coming from protease alone, this suggests an extra-proteinaceous effect of protease.

**Key Words:** broiler, protease, peptide, proteomics, digestibility

### 244 A mono-component microbial protease affects net energy and jejunal gene expression in broiler chickens fed corn/wheat-based diets that contain phytase and xylanase

L. F. Romero¹*, M. Toghyani², S. Wu², S. Kheravii², A. J. Cowieson¹, and M. Choct², ¹DSM Animal Nutrition and Health, Kaiseraugst, Switzerland, ²University of New England, School of Environmental and Rural Science, Armidale, Australia.

This study assessed the effect of a reduction in digestible amino acids and inclusion of an exogenous mono-component protease on amino acid digestibility, net energy (NE), and jejunal gene expression of broiler chickens. A total of 90 male Ross 308 broiler chicks were used in a digestibility and performance bioassay. Four dietary treatments were created by the supplementation, or not, of 2 control diets with a mono-component exogenous protease (Ronozyme ProAct; DSM Nutritional Products) in a 2 × 2 factorial design. On d 24, after 3 h fasting, 32 chicks were allocated to 16 calorimetric chambers, which were used to measure AME and NE by total collection of excreta and gaseous exchange. The control diets were corn/wheat/soybean meal-based and were formulated to be either nutritionally adequate or reduced in protein and amino acids by 3%. Both control diets contained both xylanase and a high concentration of exogenous phytase. Data were analyzed with a 2-way ANOVA and compared by Tukey’s test at 5% significance. Differences were found (\( P < 0.05 \)) for (EEB), (NMC), (EEMC) and (DMMC) (Table 1). Treatments with animal by-products presented the best metabolizability coefficients. An interaction was found (\( P < 0.05 \)) for (EEMC) and (DMMC) (Table 2). Vegetable protein diets presented a better EEB but the best EEMC was observed for animal by-products diets supplementation, with no significant difference (\( P < 0.05 \)) was observed for protease supplementation. The use of animal by-products from 1 to 7 d of age is advantageous independent of the protease addition.

**Key Words:** protease, broiler, net energy, gene expression, amino acids

### Table 1. Metabolic coefficients of dry matter (DMMC), nitrogen (NMC) and ether extract (EEMC) and nitrogen balance (NB) for broilers fed diets supplemented with protease, containing animal meal in the period 4 to 7 days of age. The lower part of the table shows the development of interactions.

<table>
<thead>
<tr>
<th>Variable</th>
<th>NB (g)</th>
<th>EEB (g)</th>
<th>NMC (%)</th>
<th>EEMC (%)</th>
<th>DMMC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>29.349</td>
<td>43.341 (^{a,b})</td>
<td>75.589</td>
<td>86.704</td>
<td>75.589</td>
</tr>
<tr>
<td>T2</td>
<td>27.257</td>
<td>48.665 (^{a})</td>
<td>75.236</td>
<td>89.185</td>
<td>75.236</td>
</tr>
<tr>
<td>T3</td>
<td>28.984</td>
<td>46.131 (^{a})</td>
<td>79.345</td>
<td>90.884</td>
<td>79.345</td>
</tr>
<tr>
<td>T4</td>
<td>27.225</td>
<td>40.491 (^{a})</td>
<td>79.289</td>
<td>90.102</td>
<td>79.289</td>
</tr>
<tr>
<td>Feed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal</td>
<td>28.104</td>
<td>43.311 (^{a})</td>
<td>79.317</td>
<td>90.493 (^{a})</td>
<td>79.317 (^{a})</td>
</tr>
<tr>
<td>Vegetable</td>
<td>28.104</td>
<td>46.003 (^{a})</td>
<td>75.412</td>
<td>87.944</td>
<td>75.412</td>
</tr>
<tr>
<td>Enzymes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No enzyme</td>
<td>29.167</td>
<td>44.736</td>
<td>77.467</td>
<td>88.794</td>
<td>77.567</td>
</tr>
<tr>
<td>With enzyme</td>
<td>27.240</td>
<td>44.578</td>
<td>77.262</td>
<td>89.644</td>
<td>77.262</td>
</tr>
</tbody>
</table>

\( P \)-value

- Feed: 0.8407, 0.0322, 0.003, 0.001, 0.003
- Enzymes: 0.0594, 0.8958, 0.8662, 0.1662, 0.8662
- Interaction: 0.8664, <0.001, 0.9028, 0.0109, 0.9028
- CV (%): 9.83, 7.57, 4.39, 1.90, 2.99

With protease: Y

Without protease: Y

<table>
<thead>
<tr>
<th>Variable</th>
<th>EEB (g)</th>
<th>EEMC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal</td>
<td>40.491 (^{a,b})</td>
<td>46.132 (^{a,a})</td>
</tr>
<tr>
<td>Vegetable</td>
<td>48.666 (^{a,a})</td>
<td>43.341 (^{a,a})</td>
</tr>
</tbody>
</table>

\(^{a,a}\)Means followed by the same superscript (row/column) or lower case (row) letter do not differ by Tukey test (\( P < 0.05 \)).

\( T1 = \) corn and soybean meal, \( T2 = \) corn and soybean meal with protease, \( T3 = \) corn and soybean meal with soybean meal inclusion, feathers and viscera, \( T4 = \) corn and soybean meal with inclusion of meat meal, feathers and viscera, with protease.

**Key Words:** broiler, protease enzyme, metabolizability of nutrients, animal origin flour

### 245 Nutrient metabolizability of fed diets containing animal meals supplemented with protease


In this experiment, we evaluated the effect of diets containing animal by-products supplemented with protease, on nutrient metabolizability. Three hundred twenty day-old Cobb 500 male chicks with 48g were housed in batteries. The broilers were allotted in a 2 × 2 factorial arrangement with our without supplementation of 0.05% of protease (Cybenza), with vegetal or animal meal diets. The metabolism test was performed in the pre-starter phase (4–7 d) by the total excreta collection method. Data were analyzed as ANOVA and compared by Tukey’s test at 5% of significance. Differences were found (\( P < 0.05 \)) for (EEB), (NMC), (EEMC) and (DMMC) (Table 1). Treatments with animal by-products presented the best metabolizability coefficients. An interaction was found (\( P < 0.05 \)) for (EEMC) and (DMMC) (Table 2). Vegetable protein diets presented a better EEB but the best EEMC was observed for animal by-products diets supplementation, with no significant difference (\( P < 0.05 \)) was observed for protease supplementation. The use of animal by-products from 1 to 7 d of age is advantageous independent of the protease addition.

<table>
<thead>
<tr>
<th>Variable</th>
<th>NB (g)</th>
<th>EEB (g)</th>
<th>NMC (%)</th>
<th>EEMC (%)</th>
<th>DMMC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal</td>
<td>90.102 (^{a,a})</td>
<td>90.102 (^{a,a})</td>
<td>90.102 (^{a,a})</td>
<td>90.102 (^{a,a})</td>
<td>90.102 (^{a,a})</td>
</tr>
<tr>
<td>Vegetable</td>
<td>89.185 (^{a,a})</td>
<td>89.185 (^{a,a})</td>
<td>89.185 (^{a,a})</td>
<td>89.185 (^{a,a})</td>
<td>89.185 (^{a,a})</td>
</tr>
</tbody>
</table>

\(^{a,a}\)Means followed by the same lowercase (column) or uppercase (row) letter do not differ by Tukey test (\( P < 0.05 \)).
246 Metabolizable energy and standardized amino acid digestibility of Brazilian soybean meals with protease supplementation in diets for broilers chickens. M. Xavier*1, L. Albino1, H. Rostagno1, B. Kreuz1, R. Silva1, G. Laud1, L. Teixeira2, and R. Sens2, 1Federal University of Viçosa, Viçosa, MG, Brazil, 2DSM Nutritional Products, São Paulo, SP, Brazil.

The aim of this study was to determine the energy values and the standard amino acid digestibility of 9 different Brazilian soybean meals (SBM) for broilers chickens, with or without supplementation of a protease enzyme. Two trials were carried out. In the first experiment, to determine the energy values, a total of 720 male broilers chicks 14-d-old were weighed and randomly allocated to a 9 × 2 complete factorial design, with the factors being the 9 different Brazilian SBM and with or without protease (15,000 PROT/kg of feed, RONOZYM ProAct, DSM Nutritional Products), totalizing 18 treatments, with 6 replicates of 6 birds in each one. Total excreta were collected from 18 to 21 d to determine AME and AMEn. In the second experiment, 720 male broilers 24-d-old were randomly allocated in the same 18 treatments, previously described in the first trial, with 6 replicates of 6 birds in each one. Also, 1% of acid insoluble ash (Celite) was added to the diets as an indigestible marker to determine the amino acid digestibility at the 28 d of age. All birds were euthanized by cervical dislocation to collect the ileal content. Data were submitted to ANOVA, and means were compared by SNK’s test (P < 0.05). Overall, the protease enhanced (P < 0.05) values of AME and AMEn, compared with those without the addition of the enzyme, providing an average of 97 and 85 kcal/kg, which are 4.1 and 3.7% more AME and AMEn, respectively, in the SBM samples evaluated in this study. It indicates a better utilization of crude protein from the SBM, providing a greater amount of amino acids available for protein metabolism. The 9 different SBM sources differ among them in the amino acid digestibility (P < 0.05). The sample number 1 of SBM with or without protease supplementation showed higher Lys, Met, Thr, and Val digestibility when compared with the others SBM. Supplementation with protease led to improvements in the standard amino acid digestibility (P < 0.05). Protease increases most of the limiting amino acids (1.04% Lys, 2.31% Met, 3.60% Thr, and 2.39% Val) when compared with diets without protease. In conclusion, protease supplementation improves AME, AMEn and the standard amino acids digestibility on different SBMs.

Key Words: enzyme, AMEn, vegetal protein, poultry

247 Performance of broilers fed diets containing wheat and supplements with xylanase. J. M. Silva*1, A. Gouveia2, W. Silva2, C. Minafra2, and S. Camargo1, 1Universidade Federal de Goias, Goiânia, Goias, Brazil, 2Instituto Federal Goiano, Rio Verde, Goiaís, Brazil.

The objective of this work was to evaluate the effect of increasing wheat substitution on diets with or without xylanases on the performance of broilers. Among the alternative ingredients to corn in diets, wheat presents as a potential partial substitute without causing damage to the performance of the broilers. The use of xylanases could reduce the negative effect caused by xylans found in wheat. The experiment was conducted in the poultry sector of the IFGoiano - Rio Verde Campus. The project was registered with the Committee on Ethics in Research with Animals, under no. 3845300616. A total of 600 male chicks from 1 to 42 d old of the COBB 500 strain were used. The broilers were distributed in a 5 × 2 factorial (0, 10, 20, 30, 40% wheat with and without the addition of 100g / ton of the xylanase enzyme) all treatments with 6 replicates and 10 of birds each. The rations were given ad libitum. The experimental design was completely randomized and the data analyzed by regression in the statistical program SAEG. The parameters evaluated were body weight, daily weight gain, feed intake, feed conversion, percentage of mortality. There was a significant quadratic effect for feed intake (CR = 1406.2–0.2494), weight gain (GP = 80.3093–0.0026), feed conversion (CA = 1.5494–0.00022) at the levels of inclusion of wheat. The interaction effect of the inclusion of 100g / ton xylanases was observed for the same parameters cited above, for substitutions of up to 20% wheat. It is concluded that the substitution of up to 20% of wheat supplemented with the xylanase enzyme does not affect the performance of the birds.

Acknowledgements: We thank the Federal Institute of Goiano, Rio Verde Campus, for financial support.

Key Words: alternative, animal, antinutritional, enzyme, xylan

248 Broiler performance fed on diets containing xylanase, protease associated with increasing doses of phytase. P. M. Rezende*1, M. Alves da Costa1, J. M. D. S. Martins1, R. M. J. Filho2, T. Tedesco dos Santos1, M. B. Café1, and J. H. Stringhini1, 1Universidade Federal de Goias, Goiania, Goias, Brazil, 2São Salvador Alimentos, Itaberai, Goiás, Brazil, 3ABVista, Marlborough, United Kingdom.

Enzymes in broiler diets can be an excellent tool against anti-nutritional factors to provide greater nutrient release digestibility. Performance of broilers fed diets with 2 phytase levels associated with xylanase and protease was evaluated. The experiment was carried out in the experimental facilities of EVZ/UFG, under protocol approved by the Commission of Ethics in Animal Use nr. 010/17. A total of 1536 male Ross 308AP (AP95) day-old chicks were allotted in a completely randomized design, in a 2x2 factorial arrangement, corresponding to the interaction of phytase levels (750 FTU and 1500 FTU), xylanase and protease; in a total of 8 treatments and 6 replicates of 32 birds each. The experimental diets were formulated according to Brazilian Tables recommendations, and supplemented with xylanase (60g/ton), protease (500g/ton) and phytase (75, 150g/ton). Broilers and diets were measured weekly until 42 d of age to determine weight gain, final weight, feed conversion (corrected by mortality) and feed intake. The data analysis was performed using the ANOVA procedure and the data were compared by the Scott-Knott test (5%), in the statistical software R. The final weight, weight gain and feed intake of the broilers were not affected by treatments (P > 0.05) and an interaction (P < 0.001) was observed on phytase levels, xylanase and protease (Table 1). Broilers fed diets with 750 FTU of phytase with xylanase and 750 FTU with protease presented lower feed conversion. In the present experiment, the diets containing xylanase or protease associated with 750 FTU of phytase promoted improvement in feed conversion.
had greater results. For wings yield, an interaction for xylanase and protease resulted in greater values for both enzymes. Broilers fed 1500 FTU phytase had greater abdominal fat. Broilers without protease in diets presented greater abdominal fat. Carcass and cuts yield can be improved by the combination of protease, xylanase and phytase.

### Table 1. Broiler carcass and parts yield and abdominal fat percentage at 42 days of age

<table>
<thead>
<tr>
<th>Trait</th>
<th>Carcass</th>
<th>Breast</th>
<th>Legs</th>
<th>Wings</th>
<th>AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>750 FTU Phytase</td>
<td>83.71</td>
<td>28.51</td>
<td>29.79</td>
<td>10.12</td>
<td>1.90b</td>
</tr>
<tr>
<td>1500 FTU Phytase</td>
<td>83.33</td>
<td>28.10</td>
<td>30.06</td>
<td>10.07</td>
<td>2.04b</td>
</tr>
<tr>
<td>Xylanase</td>
<td>82.96</td>
<td>28.47</td>
<td>29.72</td>
<td>10.12</td>
<td>1.98</td>
</tr>
<tr>
<td>No Xylanase</td>
<td>84.08</td>
<td>28.15</td>
<td>30.13</td>
<td>10.08</td>
<td>1.95</td>
</tr>
<tr>
<td>Protease</td>
<td>83.91</td>
<td>28.11</td>
<td>29.58</td>
<td>10.11</td>
<td>1.85b</td>
</tr>
<tr>
<td>No Protease</td>
<td>83.13</td>
<td>28.50</td>
<td>30.27</td>
<td>10.09</td>
<td>2.08a</td>
</tr>
</tbody>
</table>

**Probability** for all traits are presented in the following table:

<table>
<thead>
<tr>
<th>Trait</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytase</td>
<td>0.61</td>
</tr>
<tr>
<td>Xylanase</td>
<td>0.14</td>
</tr>
<tr>
<td>Protease</td>
<td>0.30</td>
</tr>
<tr>
<td>Phyt. × Xyl.</td>
<td>0.23</td>
</tr>
<tr>
<td>Phyt. × Prot.</td>
<td>0.16</td>
</tr>
<tr>
<td>Xyl. × Prot.</td>
<td>0.55</td>
</tr>
<tr>
<td>Phyt. × Xyl × Prot.</td>
<td>0.53</td>
</tr>
<tr>
<td>CV (%)</td>
<td>4.39</td>
</tr>
</tbody>
</table>

**Interactions**:

- Xylanase: 1.471^A
- No protease: 1.442^B
- Xylanase: 1.450^B
- No protease: 1.481^A
- Xylanase: 1.468^A
- No protease: 1.478^A
- Xylanase: 1.499^A

### Acknowledgements:

Authors thanks to São Salvador Alimentos, ABVista and Novus International for technical and financial support.

### Key Words:

abdominal fat enzyme, breast yield, poultry meat, thigh and drumsticks.

### 250 Interactive effects of dietary AME content and xylanase supplementation on breast meat yield of broiler chickens at 44 days of age.

**Acknowledgements**: Authors thanks to São Salvador Alimentos, ABVista and Novus International for technical and financial support.

**Key Words**: abdominal fat enzyme, breast yield, poultry meat, thigh and drumsticks.

The aim of this trial was to evaluate the impact of feeding graded levels AME with or without xylanase supplementation on breast meat yield. Two thousand one day-old Cobb500 male chicks, with average initial weight of 41 g, were allocated to 10 treatments in a completely randomized block design, distributed in a factorial design 2 × 5
(supplementation or not with 16,000 BXU/kg of xylanase [Econase XT, AB Vista, Marlborough], and 5 levels of AME, where basal levels for each dietary phase was 2,800, 2,900 and 3,000 kcal/kg, respectively for starter, grower and finisher phases, with graded increase of AME levels by steps of 75, 150, 225 and 300 kcal/kg). Eight replicates of 20 chickens each were tested at each treatment. At 44 d of age, 3 birds per pen where euthanized and the characteristics of the carcasses were measured. The body weight after fasting live weight was evaluated was determined (kg/broiler) using a scale with 1-g accuracy. To obtain the absolute carcass weight (kg/broiler), the broiler was plucked, eviscerated and decapitated. The breast meat yield was determined by carcass weight. The data was submitted to ANOVA using replication as random effect on Mixed models. There was a trend for interaction between AME and xylanase supplementation \( (P = 0.068) \). This interaction happened because xylanase changed the slope of response, or how the dietary AME affected breast meat yield. In general terms the higher the AME the lower the breast meat yield, although without xylanase the slope is flatter \( (\text{BMY, } \% = -0.00166 \ast \text{AME} + 37.258; R^2 = 0.160; P = 0.267) \), while with xylanase slope is more inclined \( (\text{BMY, } \% = -0.00580 \ast \text{AME} + 37.823; R^2 = 0.123; P = 0.002) \). This may have happened because on lower dietary AME levels the breast yield was being limited by energy utilization, and the use of xylanase allowed birds to use energy more efficiently, therefore allowing the muscle accretion in a more efficient way. This was the opposite at higher AME levels, while the intake of AME was excessive and at that stage birds breast meat yield was possibly being limited by lower amino acid intake. In conclusion, breast meat yield of broilers was influenced by both xylanase and dietary AME, and seems that maximization of breast meat yield is dictated by dLys:AME ratio, and therefore it is recommend the adjustment on dLys:AME ratio specially when diets are formulated with high AME content.

Key Words: carcass yield, regression

251  Effects of xylanase and AME on bone characteristics of broilers chickens at 21 and 44 days of age. G. S. Lima1, M. Ramalho de Lima2, F. G. P. Costa1, J. C. Lima Muniz1, D. T. Cavalcante3, T. Tedeschi dos Santos4, G. A. Gomes4, A. Barbosa de Brito4, and M. Bedford4, 1Federal University of Paraiba, Areia, Paraiba, Brazil, 2Federal University of South of Banhia, Itabuna, Bahia, Brazil, 3Federal Rural University of Pernambuco, Garanhuns, Pernambuco, Brazil, 4AB Vista, Marlborough, United Kingdom.

The aim was to evaluate increasing levels of dietary AME and supplementation of xylanase effects on bone traits at 21 and 42 d of age. Two thousand one-day-old Cobb500 male chicks, with average initial weight of 41 g, were allocated to 10 treatments in a completely randomized block design, distributed in a factorial design \( 2 \times 5 \) (supplementation or not with 16,000 BXU/kg of xylanase [Econase XT, AB Vista, Marlborough], and 5 levels of AME, where basal levels for each dietary phase was 2,800, 2,900 and 3,000 kcal/kg, respectively for starter, grower and finisher phases, with graded increase of AME levels by steps of 75, 150, 225 and 300 kcal/kg). Eight replicates of 20 chickens each were tested at each treatment. At 21 and 44 d of age, 3 birds per pen where euthanized and tibias collected for measurement of bone ash (expressed as percentage of dried and defatted bone weight), bone breaking strength (measured using dry bones, kgf) and seedor index. The data was submitted to ANOVA using replication as random effect on Mixed models. The AME levels influenced bone ash content \( (21d, P = 0.004; 44, P < 0.001) \), bone breaking strength \( (21d, P = 0.001; 44d, P = 0.054) \), and in the seedor index \( (44d, P < 0.001) \). Xylanase reduced bone ash content \( (21d, P = 0.005; 44d, P = 0.007) \), and seedor index \( (21d, P = 0.024; 44d, P = 0.063) \). No effect of xylanase was noticed on bone breaking strength \( (21d, P = 0.685; 44d, P = 0.671) \). Xylanase and AME interactions were observed on bone ash \( (44d, P = 0.017) \) and seedor index \( (21d, P = 0.016; 44d, P = 0.014) \). In general, xylanase reduced bone ash and seedor index at 21 and 44 d, although no effects were noticed on bone breaking strength, and these results can be explained because of the better growth of broilers fed with xylanase,therefore probably more minerals can be being used to general metabolism than bone mineralization. Regarding AME levels, the gradual increase on AME (or gradual increase on fat) had a positive effect on bone ash and bone breaking strength, which could be related to fat and hormonal regulation on bone mineralization and/or uptake of fat soluble vitamins (specially Vit D3).

In conclusion, both xylanase and AME impacted bone characteristics of broilers at 21 and 44 d of age.

Key Words: fat, Seedor index, tibia ash, tibia resistance

252  Comparative evaluation of single xylanase and an α-galactosidase-based multicarbohydrase enzyme on the growth performance of broilers fed sorghum-based diets. A. Mañón*,1, S. Llamas-Moya1, R. Adhikari1, N. Higgins1, G. Cortez1, and M. Forat2, 1Kerry Inc., Beloit, WI, USA, 2Instituto Internacional de Investigación Animal, Querétaro, México.

Carbohydrase supplementation in poultry feed improves nutrient digestibility, thus facilitating the use of alternative feed ingredients while reducing the cost of feed. However, improving feed digestibility through exogenous enzyme supplementation requires the inclusion of a variety of different carbohydrate enzymes, each targeting a specific anti-nutritional component in feed. This study evaluated the effect of an α-galactosidase-based multicarbohydrase enzyme system (AlphaGal 280P, Kerry Inc., USA) [AG280P] versus a monocomponent xylanase formulation [XYL] in broilers fed a sorghum-soybean meal based diet. A total of 1,920 male DOC (Ross 708) were assigned to 48 replicated pens with 40 birds per pen. Pens were randomly allocated to one of 4 dietary treatments: 1) Positive Control [PC]; 2) Negative Control [NC], formulated to have 100 Kcal/kg ME less than the PC; 3) NC + AG280P, at 200 g/MT, 4) NC + XYL, at 100 g/MT. Birds were fed ad libitum a 5-phase mash feeding program up to 49 d of age. Feed intake, body weight gain (BWG) and feed conversion ratio (FCR) were measured coinciding with the change of feeding phase. Statistical analyses were performed by one-way ANOVA (SAS 9.2). Tukey HSD test was used for post hoc comparisons, with significant differences considered at \( P < 0.05 \). On d 49, NC birds had lower BWG and poorer FCR compared with birds on the PC, AG280P and XYL treated diets \( (P < 0.01) \). However, while dietary supplementation with AG280P and XYL improved BWG and FCR, relative to the NC group, AG280P further improved the overall BWG and FCR compared with the XYL treated birds \( (P < 0.001) \). Furthermore, birds treated with AG280P exhibited BWG and FCR equivalent to that of the PC treatment \( (P < 0.001) \). Our results indicate that dietary supplementation with an α-galactosidase-based multicarbohydrase enzyme, AlphaGal 280P, improved the performance of broilers fed sorghum diets compared with monocomponent xylanase enzyme.

Key Words: α-galactosidase, carbohydrase, xylanase, sorghum, broiler
253  Effects of pigmentants in feed and different temperatures of scald in slow-growth chickens. S. Verissimo*, S. D. De Assis, N. S. M. Leandro, J. P. Machado, F. B. De Carvalho, and L. L. D. C. Menezes, Federal University of Goiânia, Goiânia, Goiás, Brazil.

The color of the chicken carcass is an important aspect for commercialization, since it defines the acceptance of the consumer. A product with good pigmentation is considered by the consumer as a fresh, healthy and with more flavor. The objective of this study was to verify the effects of the inclusion of pigment (Carophyll red - 250mg / kg of feed) on the diet combined with different scalding temperatures, skin coloration, drumstick and thigh meat of slow growing chickens. 480 slow-growing broilers (Isa-Label) were fed with 2 types of feed (with or without pigments), the birds were fed with pigmentation from 28 to 63 d of age. 240 birds from each group were slaughtered at 2 different scalding temperatures, 54°C and 60°C. The design was entirely randomized, in a factorial scheme, 2x2 (pigmentation x scald temperature), therefore, 4 treatments, with 12 replicates of 20 birds. Coloring of the skin and the drumstick and thigh meat, at different points, through a digital colorimeter. In the evaluation the parameters of L* (luminosity), a* (red) and b* (yellow) were obtained. Data were submitted to ANOVA using the JMP program. There was interaction (P < 0.05) between the factors pigmentation x scald temperature for the parameter a* in the skin of the drumstick and thigh. The low temperature with the non-use of pigment in the diet decreased this parameter. There was an effect (P < 0.05) of the use of pigment in the diet and scalding temperature for parameter b*. The pigment in the diet and the low scalding temperature increased the values of b* of the skin of the drumstick and thigh. There was no effect (P > 0.05) of the parameters L* and b* for meat of the evaluated cuts. The use of pigment in the diet increased (P < 0.05) the parameter of a* in the meat of drumstick and thigh. Birds that consumed ration with the pigment showed more yellowish skin tones than the birds that did not consume. The scalding temperature influenced the color of the skin. The birds submitted to the lower temperature of scalding presented a more yellowish color. The best results for skin pigmentation were in the treatments in which the birds consumed pigment and were submitted to scalding with low temperature.

Key Words: preference, free range, color, meat quality

254  Effect of six phytogenic based prototypes on the performance of broiler chickens reared under thermo-neutral and heat stress conditions. S. E. Ladirat1, D. J. A. Miranda2, J. D. van der Klis3, M. Dalmagro2, and A. A. Belucio2, 1Cargill Animal Nutrition, Velddriel, the Netherlands, 2Cargill Animal Nutrition, Campinas, Brazil, 3Delacon Biotechnik GmbH, Steyregg, Austria.

Heat stress is one of the most important environmental stress factor in poultry production and has known detrimental effects on animal welfare and productivity. Most commonly used nutritional strategies aim at maintaining feed intake, electrolyte and water balance. Other nutritional strategies such as supplementation with phytotheremics are less known although their reported activities as anti-oxidant, immune modulator and feed consumption stimulator seem appropriate to mitigate the negative effects of heat stress. This study examined the effect of 6 phytoigenic-based prototypes (Basic 1, Basic 2, Protect, RED, Rose, MED) and betaine as benchmark on the performance of broiler chickens reared under thermo-neutral and heat stress conditions versus a negative control during 46 d. A total of 3360 male Cobb X Cobb broilers were fed the same diet until 23 d of age before being allocated according to completely randomized design with a 2x8 factorial arrangement, which resulted in 10 replicates of 21 birds per treatment. A cyclic heat stress was applied from d 23 onwards with temperature raising to 33°C from 6:30 a.m. to 5:30 p.m. Body weights and feed consumption were recorded and feed efficiency was calculated on d 0, 23, 29, 36 and 43. Data were analyzed using PROC GLIMMIX mixed model methodology of SAS with treatments being compared by Tukey test (P < 0.05). The high temperature induced a significant reduction in feed intake (−1.5%, P < 0.05) and weight gain (−1.7%, P < 0.05) vs the thermo-neutral control during the overall period. Detrimental effects of heat stress on performance were most severe between 23 and 36 d. From 23 to 29 d, a tendency of interaction between feed additives and temperature (P = 0.0906) was observed for weight gain. Numerically, the heat stressed birds fed betaine had the highest weight gain, followed by the prototypes Basic 1, RED and MED. From 29 to 36 d, the body weight of the birds raised in normal temperature only tended to be higher than the body weight of the heat stressed birds (P = 0.1074). This shows that birds allocated to heat stressed room caught up the performance of birds raised on normal temperature. No differences was observed for feed intake, so the improved weight gain of heat stressed birds was driven by stronger an efficiency. From 36 to 43 d of age and overall, no effects of interaction additives x temperature, nor additives alone was observed (P > 0.05). Numerically, the prototypes Basic 2, RED and MED improved BWG of heat stress birds the most. These results show the positive effect of 2 blends of phytotheremics, Red and MED, on the performance of broilers under heat stress.

Key Words: heat stress, phytotheremics, performance, broiler


Necrotic enteritis (NE) is most often a multifactorial disease involving a dietary or pathogenic challenge to the gastrointestinal tract, and the bacteria, Clostridium perfringens (CP). Short-chain fatty acids have been shown to reduce the deleterious effects of clinical and subclinical NE. Valerins, glyceride esters of valeric acid, may offer a novel mechanism for improving gut health and have shown protective effects in previous NE trials. In this study, 5 treatments were evaluated in a 50-pen NE challenge model using Cobb 500 broilers (50 birds/pen). Chicks were vaccinated on D1 with a commercial coccidiosis vaccine and separated into 5 groups: 1) Negative control, 2) CP-challenge control, 3) Valerins 1 kg/MT, 4) Valerins 1.5 kg/MT, and 5) Valerins variable dose. Groups 2–5 were challenged with E. maxima on D14 by spreading 20 mL of inoculant around each feeder and challenged with CP on D18 and D19 via water. One-way ANOVA was used for statistical analysis and means were separated using Tukey’s HSD test with significance considered P < 0.05. Body weight gain at D35 was 1.65a, 1.57bc, 1.56a, 1.63a, and 1.62ab kg for Groups 1–5, respectively. Feed conversion at D35 was 1.73ab, 1.88a, 1.81ab, 1.81ab, and 1.82a for Groups 1–5, respectively. NE-related mortality percentage was 0.4%a, 15.4%a, 10.2%a, 12.4%a, and 13%a for Groups 1–5, respectively. No differences in lesion scores were seen between groups.

Key Words: organic acids, valerins, Clostridium, gut health
256 Intestinal morphology of broiler fed with green banana meal. E. M. Muro*, I. R. Sartori1, J. A. V. Filho1, T. S. Santos1, L. H. Zanetti1, G. A. M. Pasquali1, R. G. F. Netto1, I. S. Batistioli2, L. S. F. Lopes1, A. C. C. Neto1, J. C. Denadai1, D. S. Souza1, R. G. A. C. Araujo1, L. Granero1, A. C. B. Bolfarini2, 1São Paulo State University (UNESP), School of Veterinary Medicine and Animal Science, Botucatu, São Paulo, Brazil, 2São Paulo State University (UNESP), School of Agriculture, Botucatu, São Paulo, Brazil.

Using regionally adapted plant raw materials is fundamental to improve the supply of feed that can replace commonly used components in animal diets. Some meals, such as green banana meal (GBM), are known to have sugars with prebiotic potential. Therefore, an experiment was conducted to evaluate the intestinal morphology of broiler chickens fed this product up to 42 d of age. A total of 400 Cobb 500 male chickens were allotted in a completely randomized experimental design with 2 treatments [control with antibiotics (avilamycin 20% at 50 ppm inclusion) and 0.2% inclusion of GBM without antibiotics] and 8 replicates of 25 birds each. The data collected were submitted to ANOVA followed by Tukey’s means test at 5% of probability. Although GBM did not promote an increase in duodenal villi compared with control (P < 0.05), it provided lower crypt depth. No difference was observed in the duodenal villus to crypt ratio. In the jejunum, no statistical differences were observed, whereas in the ileal segment, GBM promoted crypt reduction and improved villus to crypt ratio, with no changes in villus height. The lack of positive results in promoting improvement in villi height and, consequently, in the absorption area of intestinal segments of recognized importance in nutrient uptake does not allow us to indicate GBM as a mucosal growth stimulant and substitute for the antibiotic.

Key Words: antibiotic, FOS, functional food, histology, inulin

257 Performance of broilers fed with a ration containing homeopathic product instead of the use of antibiotic growth promoter: F. R. Bueno*,1 V. P. Granjo1, F. B. Marinho1, F. R. Leonel2, and A. Oba1, 1State University of Londrina, Londrina, Paraná, Brazil, 2Colleges of Technology Rio Preto, Rio Preto, São Paulo, Brazil.

The intensive use of antimicrobials can leave residues in animal products, an alternative to this is the use of homeopathic products, its greatest benefit is the absence of pharmacological residues in animal products, low cost, and positive effects on the development of the animal. This research has the objective of evaluating the zootecnic performance of broilers fed with ration with the addition of homeopathic product in substitution to the use of antibiotic growth promoter. The experiment was conducted at the Bird Nutrition Research Unit of the State University of Londrina. The experimental design was a randomized complete block design with 4 treatments, 6 replicates and 26 birds per experimental plot, totaling 624 one-year-old male broilers from the Cobb line. Experimental treatments consisted of: T1 = positive control (zinc bacitracin); T2 = negative control (no use of additives); T3 = T2 + homeopathic product up to 7 d; T4 = T2 + homeopathic product up to 21 d old. The homeopathic product was Aconitum napellus, Arnica montana, Hypericum perforatum, Matricaria. The breeding period was divided into 4 phases: pre-initial (1–7 d) and initial (8–21 d), growth (22–35 d), finishing (36–42 d). Experimental rations were based on corn and soybean meal and met the minimum requirements recommended. The broilers received water and food at will, during the experimental period of 42 d. Feed intake, weight gain, feed conversion ratio, and viability were evaluated. The results were submitted to ANOVA, and compared with 5% of significance by the Tukey test using the statistical program R. The results show that the different treatments used did not present significant differences in feed intake, weight gain, feed conversion ratio, and viability. These results show that in the experimental conditions of this work, the use of the different additives did not differ in relation to the treatment without the use of additives. It was concluded that in the experimental conditions, the use of antibiotic growth promoter or homeopathic product did not provide an improvement in the performance of the broilers.

Key Words: alternative additives, bacitracin zinc, bird, feed conversion ratio, weight gain

258 The effects of essential oils and organic acids (Gallinat+) on the growth performance of commercial Pekin ducks from 0 to 40 days. Z. S. Lowman*1 and M. A. Barrios2, 1Joe Jurgielewicz and Son Ltd., Hamburg, PA, USA, 2Jefo Nutrition Inc., St Hyacinthe, Quebec, Canada.

There has been a drastic increase in demand for the production of all natural livestock and poultry in recent years. This change in consumer preference has resulted in the decreased use of antibiotics; consequently, producers have had to find alternatives to ensure their flocks stay healthy and perform optimally. Gallinat+, a blend of protected essential oils and organic acids, has been demonstrated to ameliorate the negative repercussions of increased pathogen levels in poultry. To date, data on such additives is limited in regards to commercial duck production. To explore the effects of these ingredients on ducks, 2 large-scale trials were conducted. Trial 1 consisted of 14 flocks (~9,800 ducks per flock) of commercial broiler-type ducks (~140,000 ducks total) and trial 2 consisted of 8 flocks (~9,800 ducks per flock). Both trials utilized several farms with paired, side-by-side houses in continuous succession. Treatments were as follows: trial 1: C1) control (no additives) and E1) experimental (Gallinat+ 600g/ton), Trial 2: C2) control (no additives) and E2) experimental (Gallinat+ 300g/ton). Each of the paired flocks were hatched and placed on the same day for all of the 11 comparisons. All data was collected from the final company settlements and analyzed using the one-way ANOVA feature of JMP 13. The Gallinat+ E1 group demonstrated a 4-point improvement in FCR (P ≤ 0.57) as well as improving average overall flock mortality by 0.25% (P ≤ 0.59) compared with C1. Ducks from trial 2 demonstrated similar improvements in FCR (4 points; P ≤ 0.65); furthermore, the E2 group demonstrated a 0.97% (P ≤ 0.39) improvement in mortality compared with C2. This difference in mortality between trial 1 and trial 2 is attributed to a subacute bacterial challenge on this particular farm. The numerical differences in these 2 trials amount to 555 more birds in the Gallinat+ group. This could be of great monetary value on a commercial scale, especially for production systems looking for alternative ingredients. On average, birds from the Gallinat+ group consumed less feed and yet produced a slightly larger duck. This may be due to the improved GI function typically associated with some alternative ingredients used as antibiotic replacements. Based on the findings from this trial, it appears that this blend of essential oils and organic acids elicits similar beneficial responses in commercial Pekin ducks as in published chicken and turkey data.

Key Words: broiler-type duck, FCR, ABF

Using regionally plant raw materials is fundamental to improve the supply of feed that can be one alternative to replace commonly used ingredients in animal diets. Some meals, such as green banana meal (GBM), are known to have sugars with prebiotic potential. Broilers under stress, such as intestinal bacterial challenge, are more likely to show changes in hematological parameters and prebiotics are known for selectively alter the intestinal microbiota, thus promoting alterations in hematological parameters, such as the heterophilic/lymphocyte ratio and differential leukocyte count. A total of 400 Cobb 500 male chickens were allotted in a completely randomized experimental design with 3 treatments [control with antibiotics (avilamycin 20% at 50 ppm inclusion) and 0.2% inclusion of GBM without antibiotics] and 8 replicates of 25 birds each. At 21 and 42 d of age, a bird per experimental unit was randomly selected and had blood collected by puncture of the ulnar vein, a blood smear was made and stained with hematoxylin and eosin. Data collected were submitted to Kruskall-Wallis non-parametric multiple comparison test at 5% of probability. No differences (P > 0.05) were found in the 2 periods analyzed, these results do not allow us to conclude that the prebiotic studied improves the hematological profile of broilers.

Key Words: antibiotic, FOS, functional food, histology, inulin


Pathogenic strains of Clostridium perfringens (CP) are major cause of enteric problems, which may lead to necrotic enteritis (NE) when birds are under coccidiosis infection. Historically, antibiotic growth promoters (AGPs) have been used to control NE. However, concerns over antibiotic resistance led to regional bans to reduce the use of AGPs. Alternatively, direct-fed microbial (DFM) may positively impact the intestinal microbiota to prevent enteric problems. Thus, this study evaluated DFM (Bacillus amyloliquefaciens CECT 5940) alone or in combination with BMD (bacitracin methylene disalicylate) in broilers under enteric pathogen challenge. A total of 1,530 d-old male Cobb500 broilers were assigned to 5 treatments with 9 replicates of 34 birds. The treatments were: positive control (PC, basal diet without additives or challenge); negative control (NC, basal diet without additive and challenged birds); NC + 0.05g/kg AGP (BMD); NC + 1g/kg DFM (1x10^6 cfu/g of feed); and NC + 0.05g/kg AGP + 1g/kg DFM. The challenge consisted of oral gavage with 1 mL of Eimeria maxima (3.8x10^6 oocyst/mL) on d 17 and 3 administrations with 1 mL/bird of CP inoculum (2.5x10^5 cfu/mL) on d 18, 19 and 20. Feed intake (FI), weight gain (WG), feed conversion (FC), uniformity (UN), carcass (CYS) and breast meat yield (BMY) were evaluated on d 42. Data was analyzed by one-way ANOVA and means were compared by SNK test at 5% of probability. The NC groups without additives, had significantly (P < 0.05) lower WG and FI (about 10 and 6% less, respectively) compared with PC. However, PC was significantly (P < 0.05) lower in birds fed DFM, AGP or its combination (1.66, 1.67, and 1.66 g/g, respectively) compared with NC (1.70 g/g). The UN was improved (P < 0.05) in birds fed DFM, AGP or its combination (89.0, 86.3, and 84.9%, respectively) compared with NC (78.9%), which was similar (P > 0.05) to PC (91.7%). The BMY was higher (P < 0.05) in birds fed DFM, AGP or its combination (37.4, 37.2, and 36.7%, respectively) compared with NC (35.4%) and similar to PC (37.5%). Furthermore, CY was higher (P < 0.05) in the groups receiving DFM, AGP or its combination (76.3, 76.4, and 76.8%, respectively) compared with NC (75.4%) and similar to PC (77.0%). These results indicate that DFM was effective as the AGP in promoting performance. In conclusion, B. amyloliquefaciens CECT 5940 may act in combination with AGP or alone to improve overall health and performance of broiler chickens during an enteric pathogen challenge.

Key Words: antibiotic, Bacillus amyloliquefaciens, Clostridium perfringens

261 Effect of probiotic (Paenibacillus spp.) on intestinal histomorphometry and enzymatic activity in broilers. A. G. Veras*1, J. C. R. Alva1, G. Manegis2, D. E. Karcher3, A. E. Da Silva Lemos4, L. Amoroso1, and S. M. B. Artoni1, 1Universidade Estadual Paulista “Júlio de Mesquita Filho”, Faculdade de Ciências Agrárias e Veterinárias/UNESP/FCAV, Jabiocco, SP, Brazil, 2North Carolina State University, Raleigh, NC, USA, 3Universidad Nacional Agraria La Molina, Lima, Peru, 4Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil.

These new methods include the use of exogenous enzymes, probiotics, vegetable extracts to the broiler rations, relining in better control of intestinal pathogens and digestive functions. The objective of this study was to evaluate the effect of levels of Paenibacillus sp on the feeding of broiler (to 49 d of age) on intestinal morphology (mean portion of the duodenum, jejunum and ileum) and the actity enzymatic of the pancreas. A total of 400 male chicks from one to 49 d of age, Ross 308 strain, were distributed in a completely randomized experimental design with 5 treatments and 4 replicates of 20 birds/box. The treatments were: basal diet (BD) without additives used as negative control, with lincomycin used as a positive control and diets with 30, 45 and 60ppm of the probiotic Paenibacillus sp. At 14, 28 and 42 d of age 4 birds from each box were collected for evaluation of the following variables: length, goblet cells, kupffer cells of intestinal regions and the activities of amylase, trypsin and pancreatic chymotrypsin. The statistical model fixed factor, repetitions and measurements. The normality measurement was performed by the Cramer-Von-Mises test and homogeneity of the least squares means for comparison of treatment means with negative and positive controls. The ANOVA and regression results was no significant (P > 0.05) in the treatments for the mean of the villi length in the 3 breeding stages and of the tree levels of the probiotic used on the positive and negative control, respectively. Regarding the number of Kupffer cells, there was an effect (P < 0.05) in the treatments in the different stages of development of the birds, where through the regression analysis a quadratic effect (P < 0.05) was observed on the number of cellus by the levels of probiotic in dies. Amylase showed a linear and quadratic effect (P < 0.05) on probiotic levels in birds at 28 d of age, respectively. The probiotic Paenibacillus sp. did not interfere with the length of intestinal villi. However, there was an increase in the number of kupffer cells, providing a better immune response to the birds, due to the greater phagocytic of the microorganism leading to maintenance of intestinal homeostasis. At 28 d the use of Paenibacillus sp. favored the increase of the amylasic activity in the pancreas, corroborating with the morphometric parameters responses directly reflecting in the metabolism and greater use of carbohydrates of the resulting in better feed conversion during the whole breeding phase.

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Key Words: pancreatic enzyme, intestinal morphometry, probiotic
Improving laying hens' performance by using dietary probiotic. **M. A. F. El-Manylawi*** and A. O. Abbas, Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt.

The present study was conducted to evaluate the laying hens performance by using dietary *Lactobacillus acidophilus* as a probiotic supplementation. One hundred-89 40-wk-old laying hens (Hy-line) were randomly assigned into 3 groups with 3 replicates of 21 birds each (63 laying hens per group) *Lactobacillus Acidophilus* were added to the hen’s diet by 0.00 as control, 0.10 and 0.20% as supplementation for 6 wk. All data were subjected to one-way ANOVA, and the means were compared for significance by Duncan’s multiple-range tests (1955). Results showed that egg yolk and liver cholesterol, plasma lipid profile and hen layer performance were evaluated. The plasma HDL-cholesterol increased by 9.6 and 10.6%, respectively, while, plasma LDL-cholesterol significantly decreased by 10.9 and 16%, respectively, at the levels of 0.10 and 0.20% probiotic in diets compared by control. Moreover, the results showed significantly (P<0.05) reduction in the liver and egg yolk cholesterol concentrations compared with control group, for hens fed diets supplemented with 0.10 and 0.20% probiotic. Feed conversion ratio significantly improved, egg weight and feed intake significantly (P<0.05) increased at the levels of at the level of 0.20%. Also, However, Egg production was not affected during the 6-wk of feeding probiotic 0.10 and 0.20%. In conclusion, using *Lactobacillus acidophilus* as probiotic supplementation reduced plasma, liver, and egg yolk cholesterol. Therefore, it may be a recommended to commercial production of low cholesterol eggs along with positive effects on performance of laying hens.

Acknowledgements: Faculty of Agriculture, Cairo University, Egypt.

Key Words: laying hen, probiotic, *Lactobacillus acidophilus*, cholesterol, performance


The objective of this study was to evaluate the effect of the dietary supplementation of probiotic alone or in combination with AGP on the growth performance and composition of the intestinal microbiota of broiler chickens. One-day-old Cobb slow chickens (1,800) were distributed in a completely randomized design (4 treatments, 9 replicates, 50 birds/rep). The dietary treatments consisted of: control diet, control + probiotic, control + AGP, control + probiotic + AGP. The AGP used herein was Enramicin (125 mg/kg; Enramax - Farmabase Animal Health Ltda), and the probiotic was a *Bacillus subtilis* strain (100 mg/kg; Baymik Grobig, Bayer Animal Health). Productive performance (feed intake, FI; body weight gain, BW gain; feed conversion ratio, FCR) was evaluated weekly. At 42 d of age, 4 birds/treatment were euthanized, the GIT was collected, and the ileal and cecal contents were pooled for microbiota analysis by 16S rRNA sequencing through Illumina MiSeq platform. Performance data were analyzed by ANOVA and the means were compared by Tukey’s test using SAS software. There was no effect of the dietary treatments on the growth performance parameters (P > 0.05), with the exception of the wk 4 (21–28 d) wherein the FCR of birds fed control diet was better when compared with the birds supplemented with probiotic plus AGP. It was observed that the ileal microbiota of birds supplemented with probiotic had higher frequency of the genera *Streptococcus* and *Clostridium* when compared with the other treatments. Additionally, *Lactobacillus aviarus*, *L. helveticus* and *L. salivarius* were the most abundant species in the ileal microbiota; probiotic supplementation increased the frequency of *L. salivarius* compared with the control treatment. The cecal microbiota was dominated by bacteria belonging to the groups *Lactobacillales, Subdoligranum*, *Gemmiger, Streptococcus, Blautia*, and *Bacteroides*, regardless of the diet. The genus *Bacteroides* was more abundant in the microbiota of birds fed the control diet. In the cecum, the most frequent species were: *L. helveticus, L. aviaris,* and *L. salivarius, Subdoligranum variable, Gemmiger formicilis, Blautia glucerasea* and *Streptococcus macedonicus* without significant differences among experimental treatments. Additional studies looking at the effects of different feed additives on the intestinal microbiota should be conducted, especially in disease-induced situations, such as coccidiosis and necrotic enteritis.

Key Words: antibiotic growth promoter, *Bacillus subtilis*, intestinal microbiota, 16S rRNA sequencing


*Bacillus subtilis* DSM 17299 (BS) produces a wide range of digestive enzymes. BS produces enzymes potentially advantageous to digest feed in the gut of broiler chickens. The objective of this study was to evaluate the effect of addition of a BS in standard and energy- and protein/amino acid- reduced diets fed to broilers from d 1 to d 42 of age. A total of 720-d-old Cobb male chicks were distributed in 48 floor pens (15 birds/pen), allocated to 6 dietary treatments (8 rep/treat): T1 (basal diet without probiotics), T2 (~20 MJ/kg −0.3 points CP), T3 (~40 MJ/kg −0.6 points CP), T4 (T1+BS), T5 (T2+BS), T6 (T3+BS). The concentration of BS in starter diet: 1.6E+9 cfu/kg feed; grower diet: 8E+8 cfu/kg feed). All diets had the same CP:AA ratio. Body weight (BW), feed intake, and mortality adjusted FCR were assessed at each feed change. There were no significant improvements in WG in all treatments, but T2 showed the highest WGR (81.04) intermediate to T3 (80.49) and T5 (80.69). There were no significant improvements in WGR in all treatments, but T2 showed the highest WGR (81.04) intermediate to T3 (80.49) and T5 (80.69). There were no significant improvements in WGR in all treatments, but T2 showed the highest WGR (81.04) intermediate to T3 (80.49) and T5 (80.69). Feed conversion ratio significantly improved, egg weight and feed intake significantly (P<0.05) increased at the levels of at the level of 0.20%. Also, However, Egg production was not affected during the 6-wk of feeding probiotic 0.10 and 0.20%. In conclusion, using *Bacillus subtilis* as probiotic supplementation reduced plasma, liver, and egg yolk cholesterol. Therefore, it may be a recommended to commercial production of low cholesterol eggs along with positive effects on performance of laying hens.

Key Words: laying hen, probiotic, *Bacillus subtilis*, cholesterol, performance

The aim of this research was to evaluate a probiotic product as a replacement for antibiotic growth promoters, its impact on the intestinal health of birds, productive parameters and immune response. *Butyricicoccus pullicaecorum* is an anaerobic bacterium member of *Clostridium* cluster IV isolated from the cecal content of broiler chicken with the ability to produce large amounts of butyrate. 2500 1-d-old Ross chicks were housed in pens containing 50 birds each. The chickens were randomly allocated into 5 experimental groups containing 50 chicks each. T1: Positive control with AGP’s from d 1 to 42; Avilamycin 10%; 100 g/t; Halquinol 60%; 100 g/t; and anticoccidial program: Narasin 8%; nicarbazin 8%; 500 g/ton (d 1 - 21) and Salinomycin 12%; 500 g/ton (d 22 - 42). T2: Negative control without AGP’s and anticoccidials. T3: Same as negative control adding to the diet 500 g/ton of a probiotic containing 2 × 1011 cfu/g of *Butyricicoccus pullicaecorum* from d 1 to 7 and 250 g/ton from d 8 to 42. T4: Same as T3 with the anticoccidial program of T1 and, T5: Same as T4 but decreasing 50 kcal/kg of metabolizable energy of feed from d 8 to 42. On d 14, 21, 28, 35 and 42 tissue samples of duodenum, jejunum, ileum and cecum were taken from 10 birds of each group for morphometric evaluation of villus height, crypt depth and inflammatory lesions. On d 1, 21 and 42 blood samples were taken for IV, IBVD, NDV, CAV and ARV of 20 chickens from each group, it was used IDEXX kits for ELISA test following the manufacturer’s instructions. Only CAV showed significant differences for T5 in comparison with the other treatments (*P* < 0.005) The productive parameters were evaluated weekly. Statistical analysis was done with one-way ANOVA, Tukey test and multiple regression analysis. T3 presented significant differences in greater height of the villus in comparison with the control groups (T1 = *P* < 0.005, T2 = *P* < 0.05). Additionally, T3 presented significant differences in greater depth of the crypt with respect to the control groups, T4 and T5 (T1 and T2 = *P* < 0.005, T4 and T5 = *P* < 0.0001). The weight gain was significantly higher in T3 (*P* < 0.005), as well as the significantly lower feed conversion in the same group (*P* < 0.05) compared with controls, but not with groups T4 and T5. No significant differences were found between groups for the immune response. In conclusion, the T3 treatment with probiotic without any chemical, showed better productive parameters and intestinal health compared with the control groups, which suggests that it can be used in the field replacing the use of AGP’S

**Key Words:** *Butyricicoccus pullicaecorum*, antibiotics, anticoccidial, metabolizable energy, amino acid


The aim of the study was to evaluate the different forms of a probiotic administration based on *Buticoccus subtilis* on the performance and on the intestinal and cecal microbiota diversity of broilers from 1 to 21 d of age submitted to a sanitary challenge. 640 Cobb-male broilers were housed in a randomized design, 4 × 2 factorial scheme (4 administration forms: probiotic-free diet (negative control), probiotic in ovo, post-hatch probiotic spray and probiotic in the feed vs 2 poultry litter: new one and deteriorate and moisture litter from previous commercial flocks), obtaining 8 diets, 8 replicates with 10 birds per cage, totaling 64 units. The probiotic had *Buticoccus subtilis* at 109 UFC/g. At 21 d of age, 4 birds/treatment were slaughtered and intestinal and cecum contents were collected to the sequencing of the 16S ribosomal RNA gene through Illumina MiSeq platform. Performance data was analyzed by ANOVA and the means were compared by Tukey’s test using SAS software. Inoculation of probiotic in egg based on *Buticoccus subtilis* and feed supplementation resulted in the best performance at the initial stage one to 21 d (−21 d) age of the broilers in relation to the probiotic-free diet and the application probiotic by spray. Analysis of the microbial showed that the health challenge did not alter the diversity (Shannon index; *P* > 0.05) in the cecum of the birds that received control diet. However, it was observed that the use of probiotic, regardless the application form, altered the diversity of the microbial communities found in the cecum. Birds that were supplemented with probiotic in ovo and were not challenged had higher (Shannon index *P* < 0.05) diversity regarding the challenged group. On the other hand, supplementation with probiotic via spray or in the feed resulted in higher (Shannon index *P* < 0.05) diversity in the challenged versus unchallenged group. Regarding the genus phylogenetic classification in the small intestine, there was higher prevalence of genus belonging to the Lactobacillus order. The genus *Alistipes* and *Bacteroides* of the order Enterobacteriales occurred more frequently in the unchallenged chickens compared with the unchallenged ones. The use of probiotic based on *Buticoccus subtilis* continuously in the diet resulted in a greater balance of the microbiota of the ileum and cecum in relation to the other forms of application. The results indicate that, considering the challenge conditions and the experimental design, the use of probiotics based on *Buticoccus subtilis* spores can contribute to the maintenance of health and favor the performance of broilers.

**Key Words:** *Buticoccus subtilis*, poultry litter, Shannon index, cecum microbiota, Enterobacteriales.

267 Effects of different levels of a novel muramidase on broilers’ performance. L. C. Bittencourt*, V. B. Fascina, A. Back, M. Kluasen, R. Lopez-Ulibarri, E. P. Calvo, DSM Produtos Nutricionais, Sao Paulo, Brazil, Mercobio Laboratorios Ltda, Parana, Brazil, Novoymzes A/S, Bagsvaerd, Denmark, DSM Nutritional Products, Basel, Switzerland, DSM Nutritional Products, Village-Neuf, France.

Peptidoglycans (PGNs) are components forming the bacterial cell wall. The PGNs turnover is a very common pathway for cell wall bacterial recycling. The excessive PGNs in the gut could interact with an optimal gastrointestinal functionality, especially interfering in its capacity for nutrient absorption, and consequently in performance. Muramidases are enzymes, naturally present in animal fluids and can hydrolyze PGNs. The aim of this trial was to assess the effect of a muramidase produced by fermentation (*Muramidase* 007, MUR) on the broilers performance, challenged with *Clostridium perfringens*. A total of 1680-d-old Cobb 500, were distributed in a completely randomized design, 6 treatments, 8 replicates, in a floor-pens with fresh litter for 42d to evaluate the effect of dietary inclusion of MUR on performance and carotenoids absorption capacity. Animals were fed with mash diets based on corn and SBM. All diets included phytase 1000 FYT/kg of feed (RONOZYME HiPhos) and 40 ppm of ApoEster (CAROPHYL yellow 10%). At d 10, 11 and 12, all birds were inoculated by gavage with *C. perfringens* (0.5 mL with 1x10^6 cfu isolated from field). Treatments were: Control (C); C + MUR at 15,000 LSU/kg (MUR 15); C + MUR at 25,000 LSU/kg (MUR 25); C + MUR at 35,000 LSU/kg (MUR 35); C + MUR at 45,000 LSU/kg (MUR 45) and C + Enramycin (ENR). Growth performance parameters
were recorded weekly and, blood samples were collected from 20 birds per treatment at 42d to measure total carotenoids content, as an indicator of nutrient absorption and gut integrity. Data were analyzed by ANOVA, polynomial regression and means were compared by the Duncan test at 5% probability. To estimate dose response, 95% of confidence interval was used. The analysis showed, better feed conversion ratio (FCR) and higher body weight gain (BWG, g) in birds fed with diets including MUR 15 and 45 compared with control at 42d (FCR = 1.48 MUR 15/25 and 1.47 MUR 45 vs 1.56, P > 0.026 and, BWG = 3.108 MUR 15 and 3.104 MUR 45 vs 2.950, P = 0.049). No differences were found between MUR and ENR. The optimal level showed by significant quadratic response for BWG at 35d and 42d was 32,000 LSU/kg. Broilers supplemented with MUR at the highest dose tested, showed higher levels of total carotenoids in blood (mg/L), compared with control (5.56 MUR 45 vs 4.46, P < 0.0001), suggesting a better intestinal integrity and thus a more nutrient absorption capacity. The results shown that the addition of MUR, 32,000 LSU/kg of feed, has resulted in significant improvements in performance and nutrient absorption.

**Key Words:** muramidase, peptidoglycans, gastrointestinal functionality, performance, nutrient absorption

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### 268 Effect of a novel muramidase on broilers performance.

B. F. Iglesias1, M. Hidalgo2, L. C. Bittencourt1, V. B. Fascina2, M. Klausen2, D. Garcez2, E. P. Calvo2, A. M. Cabrera1, and M. V. Charrière1,1 INTA-EEA Pergamino, Pergamino, Buenos Aires, Argentina, 2DSM Nutritional Products, Port Madero, Buenos Aires, Argentina, 3DSM Nutritional Products, São Paulo, SP, Brazil, 4Novozymes A/S, Bagsvaerd, Denmark, 5DSM Nutritional Products, Village-Neuf, France.

Muramidase is an enzyme that hydrolyzes peptidoglycans (PGNs), which are bacterial cell wall components and are released in microbial turnover and bacterial dead. The accumulation of PGNs on the intestinal lumen could impair gastrointestinal functionality and consequently performance. The aim of the study was to evaluate the effect of dietary supplementation with a novel microbial muramidase (Muramidase 007, MUR) on broilers performance, with or without antibiotic growth promoter (AGP).

A total of 1,008 d-old Cobb 500 chicks were distributed in a completely randomized design with 5 treatments: 1 - Control; 2 - Control with ZBC (50 g/MT); 3 - YNU1 (Saccharomyces cerevisiae hydrolyzed yeast, 1 kg/MT up to 7 d/ 0.5 kg/MT from 8 to 42 d, HiLyses - ICC Brazil Company); 4 - YNU2 (5 kg/MT up to 7 d/0.5 kg/MT from 8 to 42 d); 5 - YCW (from Saccharomyces cerevisiae at 0.5 kg/MT, Immunowall ICC Brazil Company), with 14 replicates of 12 birds each. The diets were divided into: pre-initial (1–7 d); initial (8–21 d); growth (22–33 d) and final (34–42 d). The birds were housed in pens with reutilized litter from a commercial farm (2nd time used). The performance parameters (BWG, FI, FCR and ENR) were measured at 7, 21 and 42 d. Immunity and gut integrity parameters were evaluated at 21 d when 8 birds per treatment were selected and slaughtered to collect the ileum. The samples were prepared for histology and immunohistochemistry analyzes and were evaluated macrophages, CD4+, and CD8+ cells count; lamina propria (LP) and epithelial thickness; enterocytes proliferation; epithelial plasma infiltration; mixed inflammatory infiltration of LP; goblet cells; congestion and necrosis. These parameters were qualified by “I See Inside” (ISI) index methodology (Kraieski, 2017). The data were analyzed by GLM produced from SAS and the means compared by Tukey test at 5% of significance. Also, the effects were analyzed by orthogonal contrasts by F test at 5% of significance. There were significant differences (P < 0.05) for immunohistochemistry, where YCW group provided lower number macrophages and CD8+ cells count compared with others treatments. However, the control group showed the higher CD4+ cells count (P < 0.05) relation other ones. Observing the ISI index, no statistical differences were found (P > 0.05). Regarding the performance parameters, the YCW and YNU2 groups improved (P < 0.05) the FCR compared with the control group. The YCW group presented similar results to ZBC (P > 0.05). The supplementation of YNU2 and YCW in the broilers diet improved the FCR at 42 d compared with control group. Also, the YCW supplementation provided the best response of the immune parameters analyzed.

**Key Words:** antibiotic, immunohistochemistry, nutrition, poultry, Saccharomyces cerevisiae

### 269 Effect of yeast cell wall and hydrolyzed yeast as a source of nucleotides on immunity, gut integrity, and performance of broilers.

J. A. Rivera1, L. F. Araújo1, E. Santin2, C. Oliveira2, M. A. Bonato1, and L. L. Borges3, 1Novozymes Latin America Ltda, Araucária, Paraná, Brazil, 2Novozymes North America Inc., Durham, NC, USA, 3Novozymes A/S, Bagsvaerd, Denmark.

The objective of this study was to evaluate the effects of the yeast cell wall (YCW) and hydrolyzed yeast as a source of nucleotides (YNU) compared with zinc bacitracin (ZBC) on the immunity, gut integrity and performance parameters of broilers. A total of 840 male Hubbard chicks (1 d) were distributed in a completely randomized design with 5 treatments: 1 - Control; 2 - Control with ZBC (50 g/MT); 3 - YNU1 (Saccharomyces cerevisiae hydrolyzed yeast, 1 kg/MT up to 7 d/ 0.5 kg/MT from 8 to 42 d, Hilyxes - ICC Brazil Company); 4 - YNU2 (5 kg/MT up to 7 d/0.5 kg/MT from 8 to 42 d); 5 - YCW (from Saccharomyces cerevisiae at 0.5 kg/MT, Immunowall ICC Brazil Company), with 14 replicates of 12 birds each. The diets were divided into: pre-initial (1–7 d); initial (8–21 d); growth (22–33 d) and final (34–42 d). The birds were housed in pens with reutilized litter from a commercial farm (2nd time used). The performance parameters (BWG, FI, FCR and Production factor) were measured at 7, 21 and 42 d. Immunity and gut integrity parameters were evaluated at 21 d when 8 birds per treatment were selected and slaughtered to collect the ileum. The samples were prepared for histology and immunohistochemistry analyzes and were evaluated macrophages, CD4+, and CD8+ cells count; lamina propria (LP) and epithelial thickness; enterocytes proliferation; epithelial plasma infiltration; mixed inflammatory infiltration of LP; goblet cells; congestion and necrosis. These parameters were qualified by “I See Inside” (ISI) index methodology (Kraieski, 2017). The data were analyzed by GLM produced from SAS and the means compared by Tukey test at 5% of significance. Also, the effects were analyzed by orthogonal contrasts by F test at 5% of significance. There were significant differences (P < 0.05) for immunohistochemistry, where YCW group provided lower number macrophages and CD8+ cells count compared with others treatments. However, the control group showed the higher CD4+ cells count (P < 0.05) relation other ones. Observing the ISI index, no statistical differences were found (P > 0.05). Regarding the performance parameters, the YCW and YNU2 groups improved (P < 0.05) the FCR compared with the control group. The YCW group presented similar results to ZBC (P > 0.05). The supplementation of YNU2 and YCW in the broilers diet improved the FCR at 42 d compared with control group. Also, the YCW supplementation provided the best response of the immune parameters analyzed.

**Key Words:** antibiotic, immunohistochemistry, nutrition, poultry, Saccharomyces cerevisiae

This study was designed to measure the response of broilers fed diets containing inactive whole yeast and yeast cell wall supplements in terms of digestibility and enzyme activities. Four hundred eighty-six Ross 308 broilers were fed 9 corn-soybean meal-based diets containing enzymatically hydrolyzed whole yeast (WY) and yeast cell wall (YCW) at 4 levels: (0.5, 1.0, 1.5 and 2.0 g/kg diet), respectively from hatch to 35d. These treatments were compared with a control diet (without yeast supplementation) in a 2 × 4 + 1 factorial design. Each of the 9 treatments was replicated 6 times, with 9 birds per replicate. On 10 and 24d, one bird per replicate was electrically stunned, killed by cervical dislocation. Pancreas and jejunum were collected and used to assess endogenous enzyme activities. At 24d, 2 birds were also electrically stunned, killed (by cervical dislocation). The ileal digesta content was collected to determine ileal digestibility of energy, protein, and starch. Data collected were analyzed using ANOVA of Minitab 17. Differences between means were established using Fisher’s least difference test while differences between treatments were compared using orthogonal probability contrast. Significance was declared at (P < 0.05). There was no significant effect (P > 0.05) of the dietary treatment on the weight of the visceral organs considered except for the weight of the small intestine. At 10 and 24d, there was no significant difference (P > 0.05) between the control and treatments in the jejunal protein content or activities of maltase, sucrase, and aminopeptidase for birds on the control, WY and YCW diets. However, there was a significant increase (P < 0.05) in the pancreatic protein content and enzyme (trypsin and chymotrypsin) activities in birds on the WY and YCW diets compared with birds on the control diet at 10d. This trend continued up to 24d especially at 2.0 g/kg WY or YCW diet supplementation. Except for protein, there was no significant difference (P > 0.05) observed in energy and starch digestibility at 24d. Compared with the control group, birds on the WY and YCW had better (P < 0.05) protein digestibility especially at 2.0 g/kg diet inclusion level. According to results of this study, supplementation of broiler chicken diets with whole yeast or yeast cell wall at 2.0 g/kg diet can improve digestibility and enzyme activities of broiler chicken, which may result in improved growth performance of broiler chickens.

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Key Words: ileal digesta, nutrient digestibility, endogenous enzyme activities.