Poultry Science
101 (E-Supplement 2)

Poultry Science Association
Latin American Scientific Conference
Abstracts

Presented

October 4-6, 2022
Iguaçu Falls, Paraná, Brazil
### SYMPOSIA AND ORAL PRESENTATIONS

**Tuesday, October 4, 2022**

<table>
<thead>
<tr>
<th>Abstract Section</th>
<th>Abstract No.</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Competition: Metabolism and Nutrition, General Nutrition</td>
<td>1-14</td>
<td>3</td>
</tr>
<tr>
<td>Student Competition: Metabolism and Nutrition, Amino Acids</td>
<td>15-18</td>
<td>10</td>
</tr>
<tr>
<td>Student Competition: Animal Well-Being and Behavior</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Student Competition: Metabolism and Nutrition, Feed Additives</td>
<td>20-23</td>
<td>14</td>
</tr>
<tr>
<td>Student Competition: Processing and Products</td>
<td>24-25</td>
<td>15</td>
</tr>
<tr>
<td>Animal Well-Being and Behavior</td>
<td>26-28</td>
<td>17</td>
</tr>
<tr>
<td>Processing and Products</td>
<td>29-33</td>
<td>20</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Feed Additives I</td>
<td>34-43</td>
<td>23</td>
</tr>
<tr>
<td>Student Competition: Metabolism and Nutrition, Vitamins and Minerals</td>
<td>44-52</td>
<td>27</td>
</tr>
<tr>
<td>Student Competition: Extension and Instruction</td>
<td>53</td>
<td>33</td>
</tr>
<tr>
<td>Extension and Instruction</td>
<td>54-55</td>
<td>34</td>
</tr>
<tr>
<td>Student Competition: Physiology and Reproduction</td>
<td>56-57</td>
<td>36</td>
</tr>
<tr>
<td>Physiology and Reproduction</td>
<td>58</td>
<td>38</td>
</tr>
</tbody>
</table>

**Wednesday, October 5, 2022**

<table>
<thead>
<tr>
<th>Abstract Section</th>
<th>Abstract No.</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Competition: Microbiology and Food Safety</td>
<td>61-65</td>
<td>40</td>
</tr>
<tr>
<td>Student Competition: Immunology, Health and Disease</td>
<td>66-68</td>
<td>43</td>
</tr>
<tr>
<td>Student Competition: Management and Production</td>
<td>69</td>
<td>45</td>
</tr>
<tr>
<td>Management and Production</td>
<td>70-79</td>
<td>46</td>
</tr>
<tr>
<td>Immunology, Health and Disease</td>
<td>80-93</td>
<td>50</td>
</tr>
<tr>
<td>Microbiology and Food Safety</td>
<td>94-103</td>
<td>58</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Amino Acids</td>
<td>104-112</td>
<td>62</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Enzymes</td>
<td>113-127</td>
<td>68</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Feed Additives II</td>
<td>128-135</td>
<td>75</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Feed Additives III</td>
<td>136-149</td>
<td>79</td>
</tr>
</tbody>
</table>

**Thursday, October 6, 2022**

<table>
<thead>
<tr>
<th>Abstract Section</th>
<th>Abstract No.</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolism and Nutrition, General Nutrition</td>
<td>150-168</td>
<td>87</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Feed Additives IV</td>
<td>169-181</td>
<td>95</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Vitamins and Minerals</td>
<td>182-197</td>
<td>103</td>
</tr>
<tr>
<td>Metabolism and Nutrition, Feed Additives V</td>
<td>198</td>
<td>110</td>
</tr>
</tbody>
</table>

### SYMPSOSIUM PRESENTATIONS

<table>
<thead>
<tr>
<th>Title</th>
<th>Abstract</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Approach to Salmonella Control: Perspectives and Opportunities</td>
<td>206S-207S</td>
<td>115</td>
</tr>
<tr>
<td>One Health and Antibiotic-free Poultry Production: Actual Global Challenges</td>
<td>208S-213S</td>
<td>116</td>
</tr>
<tr>
<td>Proteins: From Feedstuffs to Meat</td>
<td>214S-218S</td>
<td>118</td>
</tr>
<tr>
<td>Sustainability in Poultry Production: How Does Nutrition Affect the Animal Performance and Environment?</td>
<td>219S-223S</td>
<td>120</td>
</tr>
<tr>
<td>Feeding Strategies to Improve the Gut Health and Performance of Poultry</td>
<td>224S-229S</td>
<td>121</td>
</tr>
<tr>
<td>The Positive Balance Between Agents that Impact the Optimized Functionality of the Entire Intestinal Process</td>
<td>230S-234S</td>
<td>122</td>
</tr>
<tr>
<td>Precision Intestinal Nutrition: A New Definition for Protease and Xylanase</td>
<td>235S-237S</td>
<td>124</td>
</tr>
<tr>
<td>Soybean and corn: Technical and sustainable Relevance to Latin America and Global Poultry Industry</td>
<td>238S-244S</td>
<td>125</td>
</tr>
</tbody>
</table>
1 Broiler performance and economic evaluation of feeding programs varying energy and protein in times of inflation. Julmar C. Feijo¹, Sergio L. Vieira¹, Douglas D. Maria², Pablo L. Santos³, Raquel M. Horn¹, Bernardo B. Xavier¹, Walter E. Altevogt¹, Giovane B. Tormes¹, Mariane P. Della³, ¹Zootecnia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, ²Zootecnia, Universidade Federal do Rio Grande do Sul, Viamão, Rio Grande do Sul, Brazil, ³Vibra Agroindustrial SA, Montenegro, Brazil.

The objective of the present study was to evaluate performance and economic impacts of Cobb 500 male broilers fed corn-soy feeds in programs with varying AME (High, Moderate, and Low) and three amino acid (AA) densities (High, Moderate, and Low). Moderate levels of AME consisted in 3.00, 3.08, 3.14, 3.16 and 3.18 Mcal/kg formulated in the pre-starter, starter, grower 1, grower 2 and withdrawal phases, respectively. Compared to those, lower and higher AME was 50 kcal/kg above or below moderate levels for the respective phase. AA moderate density were: 1.33, 1.24, 1.13, 1.04 and 0.96 % dig. Lysine formulated in the pre-starter, starter, grower 1, grower 2 and withdrawal phases, respectively. Compared to those, low and moderate AA densities were 5% higher or lower in each phase. A total of 1,800 chicks were randomly distributed in 9 treatments and 8 replications with 25 birds each. Growth performance was adjusted through regressions adjusted to 2,950 g final body weight. Statistical analysis used the GLM procedure of SAS and means were separated by Tukey when significant (P ≤ 0.05). Overall, there was no interaction for AME and AA contents in the feeding programs. The High levels of AME and AA presented the highest body weight (BWG) and lowest feed conversion (FCR). The same occurred for birds fed the High AA densities (P < 0.05). Broilers fed High AA presented highest breast meat yields (P < 0.05) when compared to those fed Low AA density, however, there was no difference for AME levels (P > 0.05). AME and AA did not influence carcass yield, abdominal fat, things, drumsticks or wings (P > 0.05). Broilers fed high AME level and high density of AA presented lower values for FCR per kg of breast produced and FCR per kg of carcass (P < 0.05). Costs of feeding, cost per kg body weight, carcass and breast meat were higher when broilers were fed high AME levels and high AA densities. Data from the present study suggest that performance presented better performance when broilers were fed High AME and High AA; however because these diets are more expensive, the adjusted cost at 2950 g was more competitive for the Low AME ($ 2.15) and Low AA ($ 2.17).

Keywords: amino acid, metabolizable energy, broiler, performance, poultry

*Underlined author is the presenting author.

2 Effect of feeding program, starter diet physical form and breeder age on performance and intestinal development of broilers. Jamile Oliveira¹, Rodrigo F. Jacob², Tabata T. Sabuch³, Javer A. Vieira Filho², Claudio M. Franco², Karina F. Duarte², Priscila R. Oliveira², Sebastião A. Borges², ¹Zootecnia, Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, ²Nutrição, Vaccinar Nutrição Animal, Pinhais, Paraná, Brazil.

The experiment was carried out to determine the effects of the feeding program, broiler breeders age and diet physical form on broiler’s performance and intestinal histomorphometry. A total of 4128 one-day-old Cobb 500 male chicks were used. The experimental design was completely randomized in a 2 x 4 factorial design (2 broiler breeders ages x 4 feeding programs), totaling eight treatments (T1: breeders at 29 week, mash diet; T2: breeders at 58 week, mash diet; T3: breeders at 29 week, pelleted diet up to seven days; T4: breeders at 58 week, pelleted diet up to seven days; T5: breeders at 29 week, pelleted diet up to 11 days; T6: breeders at 58 week, pelleted diet up to 11 days; T7: breeders at 29 week, pelleted diet up to 15 days; T8: breeders at 58 week, pelleted diet up to 15 days). All treatments had 12 replicates of 43 birds each. Feed intake (FI), weight gain (WG) and mortality were recorded throughout the experiment and histomorphometry parameters were evaluated at 15 and 21 days of age. For the histomorphometry study, 1 bird per replicate was sacrificed and fragments of approximately 5 cm in length were obtained from the jejunum, duodenum and ileum. Parameters were measured by light microscopy, using the computerized image analyzer system (ImagePro-Plus - 5.2 – Cybernetic Medium Version). The data were analyzed with ANOVA using the software R (R Core Team, 2019) in a factorial model in which the factors and respective interactions between them were included in the models. A probability of p < 0.05 was considered statistically significant and the Tukey test was used to identify differences between means at the significance level p < 0.05. According to the statistical analysis of the data, there was no significant interaction between the factors on the evaluated variables (P<0.15). However, results demonstrated that the performance was affected (p<0.05) by breeder age and Broilers at 58 week had higher FI and WG. No difference (p > 0.05) was observed between the feeding program for FI and WG from 1 to 21 days. On the other hand, the results indicated better feed conversion ratio (p<0.05) when pelleted diets were provided as compared with the mash diets. In addition, the results demonstrated that the histomorphometry parameters, in the duodenum, were not affected by feeding program nor breeder age (P>0.05). Birds that received pelleted diets had villus width increased in jejunum (P<0.05) at 21 days when compared to the mash diet. The breeder age affected ileum villus height.
ratio and birds from 58 weeks breeders showed better results (P<0.05). In conclusion, birds from 58 weeks breeders have greater performance and the pellet diets promote better performance and higher jejunal villus width.

Keywords: broiler, pelleted diet, breeder age, performance, intestinal histomorphometry

3 Incubation performance and chick quality of quail breeders supplemented with canthaxanthin and 25-hydroxycholecalciferol. Lucas P. Bonagurio1, Claudia C. Martins1, Carlos A. Lozano-Poveda1, Alice E. Murakami1, Tatiana C. Santos2. 1Nutritional Products, DSM, Sao Paulo, Sao Paulo, Brazil, 2Animal Science, State University of Maringa, Maringa, Parana, Brazil.

Preview studies in poultry, have reported that a dietary combination of canthaxanthin (Cx), an antioxidant carotenoid, and 25-hydroxycholecalciferol (25OHD3) a vitamin D metabolite, improves reproductive performance and chick quality. This study assessed the effects of combined supplementation of Cx and 25OHD3 on incubation performance, fertility, and chick quality in European quail breeders in two different ages (32 and 38 wk). A total of 240 quails (n = 240) were reared from (26 to 42 wk) and distributed in 5 treatments of 8 replicates with 46 birds per cage (4 females + 2 males): a basal diet containing 50 µg of vitamin D3 as Treatment 1 (T1); T1+3 mg per kg Cx + 34.5 µg 25OHD3 (1,520 IU); T1+6 mg per kg Cx + 69 µg 25OHD3 (2,760 IU); T1+9 mg per kg Cx + 103.5 µg 25-OH-D3 (4,140 IU); and T1+12 mg per kg Cx + 138 µg 25-OH-D3 (5,520 IU). At 32 and 38 weeks of age, eggs (n = 40 per experimental diet) were analyzed for incubation performance: total hatchability (TH), hatchability of fertile eggs (HOF), fertility, and embryo mortality (initial+middle, and final+pipped). The quality of newly hatched chicks (n = 40 per experimental diet) was analyzed by the chick weight, length, and Pasgar© score (10-point scale that measures reflex, navel closure, legs, beak, and belly characteristics). Statistical analyses were performed using SAS V9.0 at P ≤ 0.05. Incubation performance was analyzed using the PROC GENMOD with a BINOMIAL distribution, and chick quality using PROC GLM. Eggs from breeders aged 32 weeks showed higher TH (P = 0.024), HOF (P = 0.026), and lower initial+middle embryonic mortality (P = 0.021), whereas 38-week-old breeders generated chicks with a greater length at the hatch (P < 0.001), and lower final+pipped embryonic mortality (P = 0.021). In both age groups, Cx+25OHD3 levels had a quadratic effect on fertility (P < 0.001), TH (P < 0.001), and HOF (P < 0.001). Cx+25OHD3 level had a quadratic positive effect on 1-day-old chick length (P = 0.002) and Pasgar© score (P < 0.001). Moreover, the supplementation of quail breeder diets with 6 ppm Cx + 69 µg 25-OH-D3 reduces embryonic mortality and enhances TH and HOF, fertility, and chick quality, especially in older quail breeders.

Keywords: chick quality, fertility, hatchability, mortality, Pasgar© score

4 Performance of laying hens reared in a free-range system with different feeding programs. Isabella d. Dias1, Filipe A. Moreno1, Geovani Costa Senger2, Ana C. Britto Dori2, Marley Conceição dos Santos2, Fabiano Dahlke3, Everton L. Krabbe4, Alex Maiorka2. 1Veterinary Science, Federal University of Paraná, Curitiba, Paraná, Brazil, 2Animal Science, Federal University of Paraná, Curitiba, Paraná, Brazil, 3Animal Science, Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil, 4Embrapa – Suínos e Aves, Concórdia, Santa Catarina, Brazil.

The objective of this study was to evaluate the production performance of a commercial laying hens’ strain, Embrapa 051, in free-range husbandry submitted to different feeding programs during the growing period. A total of 860 birds were housed from 6 to 61 weeks of age and distributed in a completely randomized design with 4 treatments and 5 replications of 43 birds. Treatments varied according to the amount of feed provided during the growing phase: T93= 93%, T100= 100%, T107= 107% and T120= 120% of the consumption recommended by the breeder guideline of Hy-Line Brown. Later, during the production phase, the feed supply was identical to all birds, following the recommendation of Embrapa 051 guideline. The variables analyzed during the growing phase were body weight (g) at 6, 9, 11, 13 and 17 weeks, and feed conversion between 6-17 weeks; In the production phase, body weight (g), egg weight (g), egg weight per dozen of egg (kg/dz) at 25, 31, 37, 44, 50, 56 and 61 weeks were determined. Data were submitted to analysis of variance (P<0.05), and when significant, orthogonal contrasts were used to evaluate the linear and quadratic effect of increasing feed supply. From the 9th week of age, at all ages evaluated, there was a linear (P=0.001) increase in the weight of birds as feed supply was increased; pullets from T120 had a 10% higher weight compared to recommended feeding (T100), whereas birds with feed restriction (T93) were 5% lighter than T100. The birds that received the least amount of feed (T93%) had the best feed conversion (quadratic, P=0.05). The heavier pullets at 17 weeks remained so during the production phase until 50 weeks of age (P=0.031). There was no difference (P=0.05) in egg weight and feed conversion per dozen of egg between treatments. In conclusion, feed supply greater than recommended amounts during growing phase for free-range layers can lead to heavier pullets, without affecting feed conversion and egg weight.

Keywords: Embrapa 051, pullet weight, poultry nutrition

5 Egg production of laying hens reared in a free-range system with different feeding programs. Leticia M. dos Santos2, Marley Conceição dos Santos2, Jean C. Natel1, Leandro Nagae Kuritza2, Isabella d. Dias1, Everton L. Krabbe3, Chayane da Rocha1, Alex Maiorka2. 1Zootecnia,
The aim of this study was to evaluate the productivity of the commercial laying hens’ strain, Embrapa 051, in a free-range husbandry submitted to different feeding programs during the growing period. A total of 860 laying hens were housed from 6 to 61 weeks of age and distributed in a completely randomized design with 4 treatments and 5 replications of 43 birds. Treatments varied according to the amount of feed provided during the growing phase: T1 = 93%, T2 = 100%, T3 = 107% and T4 = 120% of the consumption recommended by the breeder guideline (Hy-Line Brown). During the production phase, the feed supply was identical to all birds, following the recommendation of the Embrapa 051 guideline. The variable analyzed was egg production rate (%) in weeks 20-32 (1st week), 33-44 (2nd week), 45-56 (3rd week), 57-61 (4th week) and total period (20-61 weeks). Data were submitted to analysis of variance (P<0.05), and when significant, orthogonal contrasts were used to evaluate the linear and quadratic effect of increasing feed supply. The birds that had the highest feed supply (T4) produced the highest amount of eggs, up to 32 weeks of age (linear, P<0.001). In the 4th week, egg production had a quadratic effect (P= 0.01), with the best supply recommended by the strain manual (T2). In the total period of production, the laying hens that produced more eggs were those that received the highest supply (linear, P<0.05). In conclusion, feed supply greater than recommended amounts during growing phase for free-range layers can lead to higher egg production in the total period.

Keywords: Embrapa 051, egg production, poultry nutrition

6 Determination of nitrogen-corrected apparent metabolizable energy and standardized ileal amino acid digestibility of high protein DDG for broilers. Kelly M. Dias¹, Carlos H. Oliveira², Romário D. Bernardes¹, Arele A. Calderano², Ideraldo L. Lima¹, Luiz F. Albino¹. ¹Animal Science, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, ²Animal Science, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, ³IL Lima Consultoria em Nutrição Animal, Vila Velha, Brazil.

The objective of this study was to determine nitrogen-corrected apparent metabolizable energy (AMEₙ) and standardized amino acid digestibility (SIAAD) of a high protein distillers dried grains (HP-DDG) produced using the fiber separation technology before the starch fermentation. All the procedures adopted in the study were previously approved by the Ethics Committee of Federal University of Viçosa. 120 Cobb500™ male broilers were randomly distributed into 2 treatments with 10 replicates with 6 birds each. Birds were housed in metabolic cages during the period of 16 to 36 days old, where food and water were given ad libitum. The metabolism trial was performed from 16 to 26 days old, with the following treatments: 1) basal diet (BD) attending the nutritional requirements; and 2) 70% BD + 30% of HP-DDG. In the first 5 days of trial, birds were adapted to experimental diets. For the following 5 days, excreta were collected twice a day. Feed and excreta samples were weighted at the beginning and end of the period. The AMEₙ was calculated using the equations proposed by Matterson et al. (1965). The digestibility trial was performed from 27 to 32 days old, with the following treatments: 1) a N-free control diet (NFD) to measure basal endogenous AA losses; and 2) 70% NFD + 30% HP-DDG replacing starch in NFD. Both experimental diets contained 1% acid insoluble ash as an indigestible marker. During the period of 5 days, birds were adapted to experimental diets. At the end of the 5-day period, birds were euthanized to collect ileal digesta, identified as the section of intestine between Meckel’s diverticulum and the ileocecal junction. Digesta was removed by compressing one end of removed segment and moving along its length. The equations proposed by Ravindran et al. (2014) were used to determine SIAAD through determination of standardized digestibility coefficients. The HP-DDG used in this study had a calculated AMEₙ of 3,334.30 kcal/kg in dry matter basis. The determined coefficient of digestibility and SIAAD were, respectively, 80.33% and 1.09 for Lys, 85.95% and 1.44 for Met + Cys, 75.58% and 1.24 for Thr, 89.58% and 1.66 for Arg, 84.91% and 1.08 for His, 86.37% and 1.35 for Ile, 90.64% and 4.56 for Leu, 85.76% and 1.80 for Val, and 88.67% and 1.90 for Phe.

Keywords: metabolizable energy, amino acid digestibility, HP-DDG, broiler

7 Modelling of the environmental temperature effect on the energy expenditure in poultry. Rony R. Lizana¹, Rosiane d. Camargos², Rauly L. Silva¹, Bruno B. Leme³, Marcos Macari³, Nilva K. Sakomura³. ¹The School of Agricultural and Veterinary Studies, Sao Paulo State University, Jaboticabal, Brazil, ²Zootecnia, UNESP, Jaboticabal, Brazil.

A systematic review was conducted to describe the changes in metabolic rate and energy intake along a wide environmental temperature (Tₑ) variation and establish the low critical temperature (LCT) for poultry. A pool of 11 studies was considered, including 932 registries of metabolic measurements in growth and adult poultry birds, submitted to different Tₑ (from 9 to 40°C). Was collected the metabolizable energy intake (MEi) and heat production measured by indirect calorimetry under feeding (HP) and fasting (FHP). The THP:MEi ratio was calculated to establish the fraction of energy intake to turn heat depending on the temperatures, considered as thermogenesis/thermoregulation cost. The data were weighted according to the n of each study by mixed model analyses (Tₑ random factor and study and age fixed factor). The FHP was fit to a segmented model FHP=FHP₁*[Tₑ-Tₑ₀)/(Tₑ₀-LCT)] for Tₑ<LCT and FHP=FHP₂ for Tₑ≥LCT.
The body temperature ($T_b$) was averaged from the dataset (41.5°C) and assumed as normothermia, and FHP was estimated as the basal energy expenditure in thermoneutrality. The LCT estimated was fit to the model $T_{max}/Age^k$ to predict the LCT by age where $T_{max}$ is the LCT for 0-d old and k is the daily decreasing rate. The data of HP were fit to linear regression $HP=a_1+b_1*T_a$ for determining the reduction rate of heat loss ($b_1$) along $T_a$. Besides, to determine the fraction of energy intake turned heat depending on the $T_a$ was fit a segmented model HP:ME=$(a_1-T_a*[(a_2-H_b)/LTC])$ if $T_a<$LCT and HP:ME=$(a_2-T_a*[(a_2-H_b)/LTC])$; where the inflexion point was defined as LCT, and $H_b$ was estimated as the rate at temperatures higher LCT. The models were fit to reduce the root of the sum square of error. All models fitted significatively ($P<0.001$) with lower error. The FHP was between 477 to 488 and from 269 to 342 kJ/kg$^{0.75}$/d, for young and adult birds, respectively. On the other hand, the LCT fit to the non-linear model ($P<0.001$, Root SSE=8.747) obtain the LCT decrease at 0.097°C per day and LCT for hatch birds at 34.21°C. The $H_b$ was close for all studies around 0.67, increasing when $T_a<$LCT and decreasing to $T_a$≥LCT. The decreasing rate of HP for $T_a$ increasing was from 17.3 to 21.0 and 4.3 to 8.9 for young and adult birds, respectively. The environmental temperature releases a significant effect on basal energy expenditure principally in young birds, and the fraction of energy intake that is expended as heat at low critical temperature is similar between ages.

**Keywords:** heat production, Energy metabolism, Fasting heat production, Indirect calorimetry, Temperature

8 Assessment of live performance responsiveness of Cobb 500 male broilers to a varying digestible lysine levels and dietary energy for a 1-18d grower period. Mathieu F. Costa, Kenneth B. Nelson, Savannah C. Wells, Michael T. Kidd, Poultry Science Department, University of Arkansas, Fayetteville, Arkansas, United States.

This research was conducted to investigate potential interactions between four different levels of digestible lysine and two levels of metabolized energy (ME) on live performance of 1–18d old Cobb 500 male broilers (2 x 4 factorial design). Lysine is an essential amino acid that is known in poultry for increase the growth, decrease abdominal fat pad, and enhance the feed conversion ratio (FCR). The energy system used to formulate diets in poultry based on ME, which its equation can be described as the total amount of energy in the feed minus gases and feces. A total of seven hundred and sixty-eight d-old broilers (Cobb 500 fast feather) were vent sexed and males were randomly allocated in one tunnel ventilated-solid side wall poultry house. Lighting and temperature regimes followed the primary breeder’s recommendation, and feed and water were provided ad libitum. The poultry house had sixty-four pens (0.91 x 1.22 m) with twelve birds. The eight dietary treatments (8 replications each) consisted of: 1) 1.18% Lys, 2,900 kcal/kg ME; 2) 1.26% Lys, 2,900 kcal/kg ME; 3) 1.34% Lys, 2,900 kcal/kg ME; 4) 1.42% Lys, 2,900 kcal/kg ME; 5) 1.18% Lys, 3,000 kcal/kg ME; 6) 1.26% Lys, 3,000 kcal/kg ME; 7) 1.34% Lys, 3,000 kcal/kg ME; 8) 1.42% Lys, 3,000 kcal/kg ME. No lysine x ME interactions ($P<0.05$) occurred on 1 to 18 d live performance. Further, increasing dietary lysine above 1.18% digestible did not improve any live performance parameter. However, chicks fed increased ME had reduced ($P<0.05$) feed intake and FCR corrected for mortality. As primary breeders improve broiler performance annually, more research needs to assess dietary responsiveness of modern broilers to lysine and energy.

**Keywords:** broilers, lysine, metabolizable energy

9 Energy partitioning and maintenance requirements correction by physical activity in lean-type roosters. Audasley T. Santos Fialho1, Rony R. Lizana1, Bruno B. Leme1, Rosiane d. Camargos1, Rauly L. Silva1, Luis Filipe V. Freitas2, Marcos Macari1, Nilva K. Sakomura1, 1Animal Science, São Paulo State University, Jaboticabal, Brazil, 2Animal Science, São Paulo State University, Jaboticabal, Brazil.

The objective was to determine the fraction of energy used for maintenance, heat increment, and physical activity from the metabolizable energy intake, and correct the maintenance requirement by the physical activity. 18 Hy Line Brown roosters of 54-weeks-old with similar body weight (2.916±0.15 kg) were randomly allocated in open-circuit respirometry chambers to metabolic trial and gas exchange measurements (Oxygen consumption - VO2 and CO2 production - VCO2). The physical activity (PA) was measured using a triaxial accelerometer (mV/s). The heat production (HP) was measured weekly. Each week consisted of three days of adaptation, one day of measurements of HP when fed, and one of measuring the fasting heat production (FHP). The HP was calculated using the Brouwer equation (1965). The FHP was estimated through a broken-line model to obtain the plateau of HP twelve hours after the feed was withdrawn. The energy partition was based on the measurements of metabolizable energy intake (MEi), HP, and PA. The heat production due to physical activity (HPA) was obtained by linear regression analyses HP=$a+b*PA$, where $b$ represents the energy cost per unit of PA. The retained energy (ER) was obtained as ER=ME-HP, and heat increment (HI) was the difference between the total HP and the FHP. These values were used to describe the partitioning in maintenance (FHP), HI, ER, and HPA. All birds had the same feed intake (0.13±0.017 kg/b) with a close variation of MEi between the birds (720=85 kJ/kg$^{0.75}$/d). The total HP during the feeding period was 628±125 kJ/kg$^{0.75}$/d. The calculation of HI, ER, and net energy (ER+ FHP) for birds fed with the corn-SBM-wheat diet were 275, 59 and 445 kJ/kg$^{0.75}$/d, respectively. That result corresponds to a diet with 65% of energy efficiency of utilization. The coefficient of determination between PA and HP was
R²=91.28, and the caloric equivalence per unit of PA was b=109±11.3 kJ/mV. The plateau FHP was 386±6.78 kJ/kg0.75/d, and the average PA was 0.296±0.153 mV/s that correspond to 116 kJ/kg0.75/d for HPA. In conclusion, the energy partitioning described as the fractions of the MEI between maintenance, RE and HPA were 53.61, 8.24, and 16.09%, respectively. According to our results, the maintenance energy requirement (MEM) corrected by the PA can be express as \( \text{MEM} = k * a * \text{BW}^{0.75} \), where \( k \) is the correction factor, is described as 1.16*386*BW0.75.

**Keywords:** energy metabolism, heat production, energy expenditure

10 Energy utilization of laying hens fed with different diets varying the chemical composition. Rauly L. Silva1, Rony R. Lizana1, Bruno B. Leme1, Audasley T. Santos Fialho2, Larissa P. Maria3, Bárbara Marçal1, Beatriz S. Colucci1, Nilva K. Sakomura 1, 1Animal Science, Unesp, Jaboticabal, São Paulo, Brazil, 2Animal Science, São Paulo State University, Jaboticabal, Brazil, 3Ciências Agrárias, Unesp- Jaboticabal, Jaboticabal, Brazil.

This study aimed to describe the energy utilization of laying hens fed with diets varying in chemical composition and metabolizable energy (ME). 288 Hy-line W80 laying hens from 25 to 40-wk-old were used in the metabolic trail. The hens were allocated in open-circuit respirometric chambers in groups of six birds and assigned one of the dietary treatments with four replicates. The following protocol was used: diet adaptation (5d), chamber adaptation (2d), and measurements under feed conditions (3d). 12 diets were formulated varying the ME content (2470 to 3053 kcal/kg) and chemical composition (11.5 to 19.3% crude protein; 2.99 to 8.25% ether extract). Diet formulation was made using traditional and non-traditional ingredients. During the metabolic trail were measured the gas exchange parameters (O₂ consumption: VO₂ and CO₂ production: VCO₂), body weight, feed intake, and egg mass. Energy balance and component partitioning were calculated for each diet from the heat production (HP) by the Bronwer equation, metabolizable energy intake (MEI=FI*ME) and the retained energy in the egg (REₓ=EM*Gross energy in egg). Total retention of energy (REₓ) was calculated as the difference between MEI and HP, and the energy retained in the body (RExB) was obtained by subtracting the REₓ from the REₓ. The energy retention as protein (ERp) was performed through the nitrogen balance trail. The ERp was estimated by multiplying the nitrogen retained by the constants of 6.25 and 5.6 (kcal/kg of protein). Energy retained as fat (ERf) was obtained as the difference of REp and ERp. Statistical analyses were performed through linear and multiple regression between the MEI and energy retained components, using the Minitab Statistical Software (v.19). Three models were fit as: model 1: \( \text{REp} = -100.4 + 0.860 * \text{MEI} \); model 2: \( \text{MEI} = 116.7 + 1.579 * \text{REp} + 0.898 * \text{REp} \); and model 3: \( \text{MEI} = 116.7 + 1.130 * \text{REp} + 1.166 * \text{REp} \). The fit for all models were significative (P<0.005). The coefficient of determination was 0.717; 0.780; 0.771 for models 1, 2 and 3 respectively. Model 1 indicates that MEEm is equal to 116.65 kcal/kg0.75d and the efficiency of ME utilization as retained faction was 0.86. Model 2 shown that the efficiency of utilization for protein was 0.63 and for fat was 1.11. Model 3 describes that the energy utilization on the body and egg was 0.88 and 0.85, respectively. In conclusion, the energy can be partitioned for body and egg, as well as tissue components, where the energy use for egg was higher than 1 suggesting that the hens used feed energy and energy endogenous sources for egg production. On the other hand, the utilization as fat and protein on the whole (body and egg) was close for laying hens during the production phases.

**Keywords:** retained energy, indirect calorimetry, energy metabolism, energy prediction, laying hens

11 Use of different mathematical models to determine optimal metabolizable energy levels in broiler diets for optimum feed conversion ratio for growth and final phases. Filipe A. Moreno1, Geovani Costa Senger2, Vivian I. Vieira2, Ana C. Britto Doi1, Isabella d. Dias3, Francielle de Oliveira Marx1, Chayane da Rocha1, Alex Maiorka1, 1Universidade Federal do Paraná, Curitiba, PR, Brazil, 2Departamento de Zootecnia, Universidade Federal do Paraná, Curitiba, Brazil, 3Veterinary Science, Federal University of Paraná, Curitiba, Paraná, Brazil.

The formulation of diets that adequately meet energy requirements in the different phases of broiler production is of utter importance. The objective of this study was to determine the optimal level of metabolizable energy (ME) for of broiler chickens in various production phases through the use of different mathematical models. A total of 900 broilers were distributed in a completely randomized design from growth (21 to 35 days) and final (36 to 42 days) phases, with 5 treatments and 9 replicates of 20 birds each. Experimental diets were based on corn and soybean meal and formulated to meet the nutritional requirements of broilers, except for ME requirements. Dietary treatments consisted on 5 pelleted/crushed diets supplemented with increasing levels of ME: 2,850 (T1); 2,950 (T2); 3,050 (T3); 3,150 (T4); and 3,250 (T5) kcal/kg, divided into growth and final phases. Performance data were obtained, being used for this study the feed conversion ratio (FCR). The ideal ME level for best FCR was determined with the use of quadratic polynomial (QP), broken-line and linear response plateau (LRP) models. The ideal dietary ME levels differed between mathematical models. Evaluating the adjustment of the data, similar results were obtained for the evaluation parameters R² and RSS between the mathematical models, differing only in the AIC parameter, presenting the lowest values for the QP and LRP regressions in the growth phase and the LRP model in the final phase. In this period, the optimal levels estimated by the QP, Bronken-line and LRP models for FCR were 2,814; 2,963 and 3,224 kcal/kg, respectively.
**Keywords:** mathematic model, metabolizable energy, linear response plateau, optimal level

12 Performance and carcass yield of broilers fed different levels of metabolizable energy from 21 to 42 days of age. Geovani C. Senger, Filipe A. Moreno, Lucas S. Bassi, Leandro Nagae Kurita, Vivian I. Vieira, Francielle de Oliveira Marx, Simone G. de Oliveira, Chayane da Rocha, Universidade Federal do Paraná, Curitiba, PR, Brazil.

The objective of this study was to evaluate the effect of metabolizable energy (ME) levels on performance and carcass yield of broilers. A total of 900 broilers were distributed in a completely randomized design with 5 treatments and 9 replicates of 20 birds each, from 21 to 42 days of age. The treatments consisted on 5 pelleted/crushed corn-soybean-based diets with increasing levels of ME: 1) 2,850; 2) 2,950; 3) 3,050; 4) 3,150; and 5) 3,250 kcal/kg. The data were subjected to simple linear (L) and quadratic polynomial regression analyses considering P<0.05. Analyzed variables included: feed intake (FI), body weight gain (BWG), feed conversion (FCR), total energy intake (TEI), energy efficiency for weight gain (EEWG), carcass yield, parts yields, and abdominal fat. In the evaluated period, FI and FCR decreased linearly with increasing ME levels (P<0.05), whereas the BWG was not affected (P>0.05). A quadratic effect showed that TEI decreased in treatments with 2,950 and 3,050 kcal/kg but increased when feeding diets with 3,150 and 3,250 kcal/kg. The EEWG reduced nearly with higher levels of ME (P<0.05). There was no effect of different dietary ME levels on carcass and parts yields (P>0.05). In conclusion, higher ME levels reduce feed conversion and modulate feed intake of finishing broilers.

**Keywords:** broiler, energy efficiency, metabolizable energy, poultry nutrition

13 Determination of physic activity effects and energy expenditure in broilers breeders during the egg production. Camila K. Cheneri1, Rony R. Lizzana1, Raully L. Silva1, Guilherme F. Teofilo2, Marcos Macari1, Nilva K. Sakomura1, 1Departament of Animal Science, São Paulo State University, Jaboticabal, São Paulo, Brazil, Jaboticabal, SP, Brazil. 2Department of Animal Science, São Paulo State University, Jaboticabal, São Paulo, Brazil, Jaboticabal, Brazil.

The physical activity represents an important fraction of the energy demand for displacement and locomotion of the birds. That energy expended should be considered in the energy supply accounts. The objective was to determine the effects of physic activity on the total heat production in broiler breeders during a recommended protocol of photoperiod. Six Cobb 500 broiler breeders with 57-wks-old were selected according to similar body weight (P>0.05). In conclusion, higher ME levels were no effect of different dietary ME levels on carcass and finishing broilers.

**Keywords:** metabolizable energy, poultry nutrition

14 Impact of dietary inclusion of distillers dried grains on broiler chicken gut health. Tania L. Kohler1, Ricardo V. Nunes1, Cleison d. Souza1, Cristine Kaufmann1, Nilton Rohloff Junior1, Bárbara Amanda Bebber1, Edevaldo A. Ianchinski1, Daiane Crespão1, Cristiane R. Duarte2, Cinhia Eyng1, 1Unioeste, Toledo, PR, Brazil, 2UNEMAT, Tangará da Serra, Brazil.

The distillers dried grains, a co-product obtained from the production of ethanol from corn, have been used by the poultry industry. However, the fiber level may induce negative effects on broilers gut health. Therefore, the current study was conducted to investigate the impact of feeding corn high protein distillers dried grains (DDG-HP) on jejunal morphometric and histological parameters in broiler chickens. A total of 280 one-day-old broilers were
allocated to 1 of 5 dietary treatments with 8 replicates (7 birds/each) in a completely randomized design. The diets were formulated to contain 5 inclusion levels of 0, 3, 6, 9, and 12% DDG-HP in diets. The trial lasted 28 days, and at the end, sample from jejunum of one bird/replicate was collected. Morphometric variables analyzed included: villus height, crypt depth, their ratio and the absorption surface. The histological analysis were evaluated by the I See Inside methodology (ISI®). Data were submitted to analysis of variance and the effect of DDG-HP levels for morphometric analysis was determined by polynomial regression. The ISI scores were verified by non-parametric analysis of variance, by the Kruskal-Wallis test, and the mean were compared by Dunn test. The dietary inclusion of HP-DDG did not affect (P>0.05) jejunum morphometric indexes. However, regarding the ISI score it were observed that broilers fed diets containing DDG-HP presented (P<.0001) an increase on lamina propria thickness, presence of inflammatory cell infiltration in the epithelium and lamina propria and a higher goblet cells proliferation. No difference (P>0.05) was observed in epithelium thickness, enterocytes proliferation, and congestion between the inclusion levels of DDG-HP. The analysis did not reveal the presence of Eimeria oocysts in all treatments. The inclusion of DDG-HP levels in diets for broilers did not change the jejunum morphometry, but the histological alterations suggest immune response demand with a negatively influence on bird’s gut health.

**Keywords:** com coproduct, ethanol, fiber, histological lesions, health index
The objective of this research was to assess the effects of isoleucine (Ile) supplementation, through different ratios of standardized ileal digestibility isoleucine:lysine (SID Ile:Lys) in diets with reductions in protein content on performance of broilers from 01 to 21 days old. All procedures adopted in this research were previously approved by the Ethics Committee. A total of 1,320 one-day-old chicks with initial body weights of 37.25 ± 2.0 g were distributed in a completely randomized design into 6 treatments, with 10 replicates with 22 birds each. A control diet was formulated with crude protein (CP) = 23.22% and SID Ile:Lys = 67% to meet all nutritional requirements, and a low-protein diet was formulated with CP reduction (CP = 20.44%, SID Ile:Lys = 56%) to meet the nutritional requirements, except for Ile. Five levels of L-isoleucine (0, 0.6, 1.17, 1.76, and 2.34 g/kg) were added to the low-protein diet, meeting the SID Ile:Lys ratios of 56, 61, 66, 71, and 76%. All birds and feed were individually weighed at 01 and 21 d to determine the average daily feed intake (ADFI), body weight gain (BWG), and feed conversion ratio (FCR). Data were analyzed by one-way ANOVA and Dunnett's test (P≤0.05) was used to individually compare each treatment with low-protein diets to the control group. Additionally, linear and quadratic regressions were performed to model the variables assessed and the ratios of SID Ile:Lys. In case of quadratic responses, the optimal SID Ile:Lys ratio was calculated by taking the first derivative of the quadratic equation and then estimating the ratio using 95% of the maximum responses. The control treatment was not considered in the regression analysis. The SID Ile:Lys ratios in low-protein diets did not affect the ADFI of broiler chickens (P = 0.584). The BWG quadratically increased (P = 0.003) and the FCR quadratically decreased (P = 0.001) as the SID Ile:Lys ratio increased from 56 to 76% in low-protein diets, in which the optimum SID Ile:Lys ratio estimated was 65.99 and 65.77%, respectively. By comparing the ratios of SID Ile:Lys in low-protein diets to the control group, the birds fed diets with protein reduction, regardless of the SID Ile:Lys ratio, showed lower BWG than the birds fed the control diet (P≤0.05), whereas only the ones fed diets with 66 and 71% showed similar FCR than control group (P>0.05). In conclusion, the recommended ratio of SID Ile: Lys in diets reduced in protein content for growth performance is around 66% for broiler chickens from 01 to 21 days old.

**Keywords:** isoleucine, lysine, low-protein diets, performance, broiler

Owing to the versatility of Arg in birds metabolism and the growing interest to reduce crude protein (CP) in diets, we carried out an experiment to assess the effects of Arg supplementation through different ratios of standardized ileal digestible (SID) Arg:Lys on performance, skin quality and creatine content of broiler chickens fed low-protein diets from 01 to 21 days old. All procedures adopted in this research were previously approved by the Ethics Committee. A total of 1,540 one-day-old chicks (initial body weight of 37.25 ± 2.4 g) were distributed in a completely randomized design into 7 treatments, with 10 replicates with 22 birds each. A control diet was formulated with CP = 23.11% and SID Arg:Lys = 107% to meet all nutritional requirements, and a low-protein diet was formulated with CP reduction (CP = 21.38%, SID Arg:Lys = 94%) to meet the nutritional requirements, except for Arg. Six levels of L-arginine (0, 0.70, 1.40, 2.10, 2.80, and 3.50 g/kg) were added to the low-protein diet, meeting the SID Arg:Lys ratios of 94, 100, 106, 112, 118, and 124%. Feed and water were provided ad libitum throughout the experimental period. Chickens and feed were individually weighed at days 1 and 21 for evaluation of the average daily feed intake (ADFI), body weight gain (BWG), and feed conversion ratio (FCR). At 21 d, three birds per replicate were slaughtered to collect samples of muscle Pectoralis profundus, and skin to determine the creatine level in muscle (CrM) and skin thickness (ST). Data were analyzed by one-way ANOVA and Dunnett's test (P≤0.05) was used to individually compare each treatment with low-protein diets to the control group. Additionally, linear and quadratic regressions were performed to model the variables assessed and the ratios of SID Arg:Lys. The control treatment was not considered in the regression analysis. The SID Arg:Lys ratios in low-protein diets did not affect the ADFI of broiler chickens (P = 0.394). The increasing ratios of SID Arg:Lys in low-protein diets linearly increased the BWG, CrM and ST (P<0.001), whereas it linearly decreased the FCR (P=0.038) of birds. When each treatment with low-protein
diet was contrasted to control group, the SID Arg:Lys ratios of 94, 100 and 106% showed lower BWG (P<0.05), whereas only the SID Arg:Lys ratio of 94% showed worse FCR (P≤0.05). In addition, the SID Arg:Lys ratio of 124% showed higher CrM than control group (P≤0.05), and the SID Arg:Lys ratios of 112, 118 and 124% showed thicker ST than control group (P≤0.05). In conclusion, the recommended SID Arg:Lys ratio in diets reduced in protein content is 124%, since it improves the performance, creatine level in muscle and skin thickness of broiler chickens from 01 to 21 days old.

**Keywords:** arginine, low-protein, performance, skin quality, creatine level


In this study, we hypothesized that the optimal Methionine + Cysteine: Lysine (Met + Cys: Lys) ratio in broiler diets is altered in immunologically challenged animals. All procedures adopted in this research were previously approved by the Ethics Committee. To estimate the ideal Digestible (dig) Met + Cys: dig Lys ratio for broilers submitted or not to LPS (E. coli) inflammatory challenge, we distributed 384 thirteen-days-old chickens in a 4 x 2 (four relations x with or without challenge) factorial completely randomized design, with eight replicates per treatment and six chickens per experimental unit. The unchallenged birds received application of saline solution (SS). The experimental diets were formulated to attend the nutritional recommendations except for the levels of digestible Met + Cys, which varied according to the treatments. To obtain the experimental diets, a ration with a ratio of 0.69 dig Met + Cys: dig Lys was initially prepared and, later, a diet with a ratio of 0.84. These rations were mixed in the appropriate proportions to obtain diets with ratios of 0.74 and 0.79. All experimental diets had an essential nitrogen:total nitrogen ratio lower than 0.50, as recommended by Maia et al. (2021). We evaluated at 21 days of age: broilers’ performance (weight gain (WG), feed intake (FI), and feed conversion ratio (FCR)); mRNA content in jejunum of nuclear factor kappa-B (NF-κb), glutathione peroxidase (GPX), superoxide dismutase (SOD), glutathione synthetase (GSS), methionine adenosyltransferase 2 (MAT2) and cystathionine β-synthase (CBS); relative weiths of liver and spleen; and DEXA estimated fat mass (%) and lean mass (%). Data were analyzed using the GLM procedure of SAS 9.4. The differences were considered significant at an alpha level of 0.05. A linear regression model would be used to evaluate the effects of the dig Met + Cys: dig Lys ratio on the evaluated parameters. There was no interaction (P > 0.05) between the inflammatory challenge and the increase of the dig Met + Cys: dig Lys ratio for: WG, FI, FCR, relative weight of liver and spleen, and mRNA content of NF-Kb, GPX, SOD, GSS, MAT2 and CBS. The different ratios had no significant effect (P > 0.05) on the same data observed. However, there were significant differences (P < 0.05) between challenged and unchallenged animals. Chickens received intraperitoneal application of LPS, had all lower performance parameters, liver and spleen heavier and lower expression of GSS than those received SS. With regard to DEXA estimated fat mass and lean mass, no significant differences (P > 0.05) were observed. So, we can affirm that the lowest dig Met + Cys: dig Lys ratio was sufficient to maintain the parameters evaluated.

**Keywords:** methionine, cysteine, lysine, poultry, LPS

18 Determination of the optimum digestible methionine plus cystine to lysine ratio for male broiler chickens from 28 to 42 days of age. Gustavo A. de Aguiar, Gabriel Viana, Jorge C. Muniz, Lucimauro da Fonseca, Filipe A. Monteiro, Gabriel Braga, Andreas Lemme, Juliano Dorigam, Victor D. Naranjo, Melissa Hannas, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, Natural Resources Institute Finland, Jokioinen, Finland, Evonik Operations GmbH, Hanau, Germany.

A study was conducted to estimate the requirement of digestible methionine + cystine to digestible lysine ratio (dig. Met+Cys:Lys) for broilers chickens from 28 to 42 days of age. A total of 840 Cobb 500 male chicks with 28-days-old (initial body weight of 1.537 ± 0.009 kg) were divided in a completely randomized design into 6 treatments with 7 replicates and 20 birds per experimental unit. Dietary treatments were composed by 6 increasing levels of dig. Met+Cys:Lys ratios (54, 58, 63, 68, 75 and 83%) achieved with the inclusion of DL-Met to a corn/soybean-meal based diet. Diets were formulated to meet the recommendations of Rostagno et al. (2017), except for the dig. Met + Cys and dig. Lys levels. The dig. Lys was set at 94% of the recommendation to avoid the excess of this amino acid. Whereas the other amino acids were supplemented 10% above the recommendation to avoid any limitation of bird’s performance. Broilers and diets were weighted at 28 and 42 days to determine final body weight (FBW), average daily weight gain (ADWG) and feed conversion ratio (FCR). Data were analyzed as one-way ANOVA using SAS® software and the ideal ratios were estimated using quadratic polynomial (QP), linear broken-line (LBL), quadratic broken-line (QBL) and exponential asymptotic (EA) models, where performance traits were regressed against dig. Met+Cys:Lys ratios. The 95% asymptotic percentage response was used to estimate the requirement for EA model. The model which better fitted data was considered that with the smaller Akaike Information Criterion (AIC) value. For FBW and ADWG the dig. Met+Cys:Lys requirement using QP and EA models were 77 and 74% and 77 and 75%, respectively. Data from these
2 variables did not fit (P > 0.05) to the LBL (FBW P = 0.06 and ADWG P = 0.07) and QBL (FBW P = 0.06 and ADWG P = 0.07) models. For FCR, the dig. Met+Cys:Lys ratio requirement using QP, LBL, QBL and EA models were 78, 61, 75 and 77%, respectively. For all variables evaluated, data fitted better to EA model. Based on these results, the optimum dig. Met+Cys:Lys ratio requirement for male broiler chickens from 28 to 42 days of age is 74% for FBW, 75% for ADWG and 77% for FCR.

**Keywords:** sulfur amino acids, statistical model, ideal protein, dose-response, productive performance
19 The use of simulating nature in broiler chicken rearing and its effect on some behavioral and physiological traits. Maha Hassn, Salwan M. Abdulateef, Animal Production, University of Anbar, Ramadi, Iraq.

Rearing broilers under the influence of the industrial factor led to diversity and multiplicity of types of rearing, which affected the welfare of broilers and which led to a decrease in production in quantity and quality. The aim of this study was to investigate the effect of different types of broiler rearing by simulating nature and revealing which is better in increasing welfare and knowing its effect on behavioral and physiological traits. 240 birds are divided into six groups: the first is control (in the house, normal rearing), the second is rearing outside the house, the third inside the house using the free-range system, the fourth in the house with perches, and the fifth is rearing outside the house with perches, the sixth inside the house uses the free-range system with perches, each treatment (40 birds for each treatment) were divided into four replicates, each replicate with 10 birds. In order to apply the natural simulation, the sand floor was used in the free-range treatments (third and sixth treatments). The lighting and health programs and the recommendation provided by Rose's guide were followed and with regard, and the nutrition was ad libitum for all treatments. The following traits were measured blood cellular traits included PCV, hemoglobin concentration, the total number of WBC, RBC, in H/L ratio, as well as biochemical blood traits glucose and total protein uric acid and cholesterol and the measured concentration of the hormone corticosterone in blood, as for the behavioral traits, they included motor activity, chick movement, feeding behavior, and dust bath. The statistical analysis by using complete random design (CRD). Data were analyzed using a general linear model (SAS, 2012). Means were compared according to Duncan's polynomial using different significance levels to determine significant differences between treatment means (D. B. Duncan, 1955). Significant improvement (P<0.05) in blood cellular traits of PCV, the total number of WBC, RBC, hemoglobin concentration, glucose, and total protein, Significantly decreased (P<0.05) in H/L ratio, the concentration of uric acid and cholesterol in third and sixth treatments. Significant improvement (P<0.05) in the behavioral traits of motor activity, chick movement, feeding behavior, and dust bath in the third and sixth treatments. Significantly decreased (P<0.05) in hormone corticosterone in blood for third, fifth, and sixth treatments. The use of the natural simulation system in raising chickens led to an increase in the level of their welfare and thus an increase in some behavioral and physiological traits, which led to an increase in production.

Keywords: simulating nature, broiler chicken, rearing, behavioral traits, physiological traits
20 Black wattle (Acacia mearnsii) tannins in broilers diet: Impacts on gut health and nutrient digestibility. Amanda M. Bravo¹, Carlos Miranda¹, Ednaldo Guariento², Felipe Dilelis¹, Túlio Reis¹, Cristina Lima¹, ¹Universidade Federal Rural do Rio de Janeiro (UFRRJ), Rio de Janeiro, Brazil, ²Fundação Centro Universitário da Zona Oeste do Rio de Janeiro, Rio de Janeiro, Brazil.

The black wattle extract (BWE) is rich in condensed tannins (CT) that have anti-inflammatory, antioxidant and antimicrobial action. The objective of this study was to investigate the effects of including BWE in broilers diets on intestinal health and nutrient digestibility. A total of 240 8-day-old Cobb 500 broilers were distributed in a randomized complete block design with 5 treatments (0, 300, 500, 700 and 900 g/t of BWE). Each treatment was replicated 8 times, with 6 birds per replicate. The birds were distributed in 40 metabolism cages and on the day of accommodation they were challenged with Eimeria (10 times the label-recommended individual dose of a commercial coccidiosis vaccine). The birds received the experimental diets from 8 to 22 days of age, feed ad libitum, without any anticoccidials drug or antibiotic as growth promoter. The period of total excreta collection was in the last 3 days. At 22 days of age, one bird per replicate was euthanized for ileum collection and subsequent histological analysis. The data were analyzed using the statistical program SISVAR, submitted to regression analysis and mean compared by Tukey test. Dry matter digestibility was higher (P < 0.05) in animals that received 300 g/t of BWE when compared to animals that did not receive the extract. Birds that received 300, 500 and 700 g/t of BWE showed higher crude protein digestibility (P < 0.05). The ash retention showed a quadratic response (P < 0.05), with a higher retention estimated at 40.72% with the inclusion of 464 g/ton of BWE. Apparent metabolizable energy and apparent metabolizable energy corrected for the nitrogen balance of diets were not influenced by the inclusion of BWE (P > 0.05). The “I See Inside®” gut health score was not influenced by the level of BWE in the diet. The ileum of birds that received 300 g/t of BWE had a lower score of inflammatory cell infiltration in the epithelium (P< 0.05). Lower goblet cell proliferation was observed (P < 0.05) in birds that received 500 g/t of BWE. Greater presence of oocyst was verified in birds that received 900 g/t of BWE. Lamina propria thickness, epithelial thickness, enteroctyes proliferation, Inflammatory cell infiltration in the lamina propria and congestion were not influenced by the inclusion of BWE in broilers diet. Dietary supplementation of broilers 8 to 22 d of age with up to 500 g/t of BWE improve nutrient digestibility and intestinal health parameters.

Keywords: antibiotic free, condensed tannins, metabolizable energy, phytopgenic, proanthocyanidins

21 Effect of peanut skins as a feed additive for turkey toms. Ashley A. Gernat¹, ², Fernanda Santos², Jesse L. Grimes¹, ¹Prestage Department of Poultry Science, North Carolina State University, Raleigh, North Carolina, United States, ²Department of Food, Bioprocessing and Nutrition Sciences, North Carolina State University, Raleigh, North Carolina, United States.

The poultry industry seeks alternatives to feed-based, growth-promoting antibiotics. Peanut skins, a rarely used feed component, contain compounds that might be useful to address common foodborne pathogen infections and improve intestinal health of the bird. The objective of this study was to test the effect of strain and dietary peanut skins on performance of commercial Large White male turkeys. Turkeys (1056) were reared to 19 weeks in a curtain-sided house, which contained 48 pens (22 birds/pen, 8.4 m²/pen) with pine shavings bedding. The design was a 2x6 factorial arrangement of treatments with 2 dietary treatments and 6 strains (A – E). Peanut skins (PS) diets contained 5% PS for the 6 feed phases. The control (C) and PS diets were formulated to be iso-nutritious except for the possible bioactive compounds present in the PS. Data collection included production parameters: individual body weights (BW) at placement, 4, 7, 10, 13, 16, and 19 weeks of age, and feed consumption/pen. Feed conversion ratio (FCR) was calculated by pen (including BW of culls and mortality). One bird/pen was processed for meat yield at 19 weeks. Data were statistically analyzed using the least squares method in JMP 15. Significant differences were determined using Tukey’s HSD where a p-value of p≤0.05 was considered significant. There were no diet x strain interactions on 19-week parameters. At 19 weeks, there was a significant difference in BW gain due to strain where strain F birds had higher gain (p<0.01) in comparison to strains A and B. Strain F had higher feed consumption (p=0.0001) in comparison to other strains. Strain also affected processed leg weights, where strain C (2.3kg), E (2.2kg) and F (2.2kg) had heavier legs than strains A(2.0kg), B(2.0 kg),D(2.0 kg), respectively p<0.05). At 19 weeks, birds consuming the C diet were heavier (21.4 kg) than those consuming the PS diet (20.9 kg, p<0.05). FCR and total breast weight were also significantly affected by diet, where birds fed C diet had a lower FCR and heavier breasts than those fed PS diet (2.15 and 6.1 vs. 2.21 and 5.7 kg, respectively, p<0.05). Peanut skins fed at 5% throughout the rearing period had some unwanted effects, however, they might not be significant economically. Additionally, their influence on intestinal microbiome and foodborne pathogens needs to be studied. Further research to determine other effects of PS are needed. Strains of Large White turkeys can vary in performance; however, their response to 5% dietary PS was consistent.

Keywords: peanut skins, turkey toms, feed additive
22 Growth performance and fecal microbiome of broiler chickens fed diets supplemented with a commercial direct-fed microbial. Yuri Dalmore1, Otoniel F. Souza1, Jessica Agilar1, Fabrizio Matte2, Bruno Vecchi2, Jeffrey Hall3, Sherry Layton4, Catarina Stefanello1, 1Animal Sciences, University of Santa Maria, Santa Maria, RS, Brazil, 2Vetanco do Brasil Imp. e Exp. LTDA, Chapecó, Brazil, 3Vetanco SA, Buenos Aires, Argentina, 4Vetanco USA, Saint Paul, Minnesota, United States.

Direct-fed microbials (DFM) have been added to broiler diets in order to promote the proliferation of beneficial intestinal bacterial populations, which may lead to gains in performance efficiency. The objective of the present study was to evaluate a commercial direct-fed microbial (DFM) from Bacillus subtilis on the performance of broiler chickens under experimental intestinal challenge conditions. Further, the fecal microbiome was evaluated by 16S DNA sequencing. A total of 750 Cobb 500 one-d-old male chicks were distributed to 5 treatments with 6 replicates of 25 birds each in a completely randomized design. Treatments were as follow: Control group (non-challenged with no additives); negative control (NC) supplemented with DFM at 0.2 kg/ton (Zymospore®, Vetanco S.A.); NC + DFM at 0.3 kg/ton; NC + DFM at 0.4 kg/ton of feed, and AGP (positive control supplemented with 0.025 kg/ton of flavomycin). Except those on the non-challenged Control group, all birds were challenged with Eimeria spp. on day 14 and with Clostridium perfringens on day 19. Body weight gain (BWG), feed intake and feed conversion ratio (FCR) were evaluated until 42 days. Fecal samples from the three different treatments (Control, NC + 0.2 kg of DFM/ton, and NC + 0.4 kg of DFM/ton) at two different sampling points (days 5 and 25) were taken. Performance data were submitted to analysis of variance using the PROC GLM of SAS, means were compared by the Tukey test (P < 0.05). For microbiome, Betadisper function was tested and pairwise adonis function was performed on the treatments with multiple test correction using Benjamini-Hochberg formula. Broilers under intestinal challenge and fed DFM and AGP groups had similar performance results compared to the non-challenged Control group. The NC + 0.4 kg/ton DFM had greater growth efficiency compared to NC and NC + 0.2 kg/ton DFM, with the treatment explaining 57.78% of the variance between groups. The microbiota of NC and NC + 0.2 kg/ton DFM were dominated by the Order Lactobacillales, with Lactobacillus and Enterococcus contributing >80% of the total amplicon sequence variants detected. On day 25, the diversity of the NC + 0.4 kg/ton DFM microbiota was underscored by the increased proportions of additional taxa as compared to NC and NC + 0.2 kg/ton DFM. This greater diversity comes as the expense of Lactobacillus and Enterococcus genera, which make up a significantly smaller proportion of the microbiota in the NC + 0.4 kg/ton DFM. In conclusion, the direct-fed microbials from Bacillus subtilis increased the bacterial diversity on microbiota establishing a more favorable bacterial profile, which may be related to an improved broiler performance.

Keywords: broiler, dysbiosis, microbiota, performance, probiotic

23 Effect of propolis supplementation on growth and intestinal integrity in broiler chickens. Camila Daza León, Diana Alvarez Mira, Gloria C. Ramirez-Nieto, Arlen P. Gómez, Liliana Betancourt, Universidad Nacional de Colombia, Bogotá, Colombia.

The regulation and posterior prohibition of antibiotics as growth promoters have encouraged the search for effective nutritional interventions to modulate intestinal functionality, which actively participates in the general condition of birds, favoring an optimal use of nutrients and increasing resistance to diseases. Propolis is a mixture of plant resin and beeswax to which multiple properties have been associated due to its diverse composition. Despite the known effects of propolis, there is still limited information on its use as an additive in broiler diets in terms of its impact on indicators of intestinal integrity. To evaluate the effect of propolis supplementation in broiler diets, 450 broilers were assigned to five treatments: a control group, a group with antibiotic use and three levels of propolis addition. Starting at day 21, raw soybeans were included in the diet as a challenge. At 21 and 42 days of age, physiological and productive parameters were measured, in addition to intestinal morphometry studies and relative quantification by qPCR of the expression of genes associated with epithelial integrity. The results showed that the expression of the genes had distinctive behaviors through time, being higher in the treatments than in the control groups. A significant correlation was observed between ZO-1 expression with ISI in ileum compared to jejunum. OCL expression was associated with the length and area of villi in ileum. Although there were no statistically significant differences in the weight gain of the birds, it was observed that numerically the treatments had the highest weights and there was a significant correlation between the expression of OCLDN-3 with the weight of the birds. Based on the results obtained, propolis is proposed as a beneficial additive in the poultry diet, since its inclusion can influence productive performance, physiological parameters and the expression of genes associated with intestinal integrity.

Keywords: broiler, intestinal health, tight junction, propolis, performance
24 Broilers’ growth performance was affected differently by soybean meal particle sizes and feed form. Marley Conceição dos Santos1, Leopoldo Malcorra de Almeida2, Francielle de Oliveira Marx1, Leandro Nagae Kuritza2, Lucas S. Bassi1, Chayane da Rocha1, Everton L. Krabbe3, Simone G. de Oliveira1, 1Animal Science, Universidade Federal do Paraná, Curitiba, Paraná, Brazil, 2Veterinary Science, Universidade Federal do Paraná, Curitiba, Paraná, Brazil, 3Suínos e Aves, EMBRAPA, Concórdia, Santa Catarina, Brazil.

This study aimed to evaluate different soybean meal particle sizes (SBM) in mash or pelleted (Pe) diets on broilers’ growth performance. A total of 1,440 male one-day-old broilers were distributed in a 2 x 4 completely randomized factorial arrangement, which consisted of two physical forms (mash or pellet) and four SBM (625, 775, 1053, 1406 μm), totaling eight dietary treatments with nine replicates of 20 birds each. The birds received feed and water ad libitum. Birds were fed starter diets from 1 to 21 days (SBM inclusion of 37.08%) and grower diets from 22 to 35 days of age (SBM inclusion of 34.95%). The Pe consisted of the mash diets submitted to pelleting, but the starter Pe diet was crumbled after cooling. Broilers were weighed at housing and at 35 days of age to calculate average weight gain (AWG). Daily feed provisions were recorded to calculate average feed intake (AFI) and feed conversion ratio (FCR) was calculated as the ratio between AFI and AWG. Data were submitted to analysis of variance, and when significant interactions (P<0.05) were observed, the deployment means were compared by Tukey’s test at 5% of probability. In the effect of quantitative parameters, orthogonal contrasts adjusted for unequal spacing between treatments were constructed to evaluate the linear and quadratic effect (P<0.05) of increased SBM on animal performance. There was a significant interaction between feed form and SBM for AFI and AWG. There was a quadratic effect with increasing SBM in the Pe for AFI. When broilers were fed Pe with coarser SBM, 1053 and 1406 μm, AFI increased by 2.8% and 7.2% in contrast with broilers fed mash diets (3020 and 3133 vs. 2937 and 2910g). Also, a quadratic improvement of AWG was observed in broilers fed Pe with coarser SBM, 1053 and 1406 μm) could promote better growth performance.

25 Metabolizable energy from plant-based alternative ingredients for broiler chicken. Ana Beatriz S. Oliveira1, 2, Eduardo S. Lima1, Flavio A. Santos1, Camila Melo2, Amanda T. Franco1, Glauzia N. Komatsu1, José Fernando M. Menten1, 1Animal Nutrition, Ingredion, Mogi Guaçu, São Paulo, Brazil, 2Animal Science, Unesp, Botucatu, São Paulo, Brazil, 3Animal Science, USP, Piracicaba, São Paulo, Brazil.

The use of alternative ingredients in chicken feed can reduce the cost of production. For its proper use in the formulation of diets, it is necessary to characterize their composition and metabolizable energy values. The aim of this study was to determine the nitrogen-corrected apparent metabolizable energy (AMEn) of Corn gluten meal (CGM), Corn gluten feed (CGF), Whole germ high fat (WG), Defatted germ (DG) and Pea protein concentrate (PPC). Male Ross AP95 chicks were raised on a basal diet until 21 days. At this age 220 chickens were transferred to battery cages for a metabolism trial to determine AMEn. The cages have wired-mesh floors, trough feeders and drinkers, and a lower tray for excreta collection. The trial consisted of a five-day adaptation period, followed by four days of collection, using the method of total excreta collection (Sakomura and Rostagno, 2016). Five test diets and a reference diet were used, with four birds per cage and six replicates, in a completely randomized design. The test diets consisted of replacing 30% of the reference diet with the CGM, CGF, DG and PPC and 10% with WG. Feed intake and the amount of excreta produced were recorded during the collection period. Excreta were collected twice a day. The collected excreta were frozen at -18°C. Then, the excreta were thawed, homogenized and pre-dried; the oven-dried samples were weighed and ground for determination of dry matter (DM), nitrogen (N) and gross energy (GE). The same determinations were made on feeds and ingredients. The EMAn and energy metabolizability coefficient (EMC) of ingredients were calculated. Dry matter values were 93, 89, 97, 91 and 93%, GE values 5.445, 4.143, 7.152, 4.502 and 5.255 kcal/g and crude protein (CP) 64, 22, 11, 20 and 74% in CGM, CGF, WG, DG and PPC, respectively, on DM basis. CGM and PPC are classified as protein ingredients, CGF, WG and DG are energy ingredients. WG is a differentiated ingredient, containing 46% of ether extract; this concentration of fat is naturally encapsulated. The EMAn and EMC values determined in the metabolism assay were 4.463, 2.276, 3.794, 2.300 and 4.480 kcal/g DM basis and 76.4, 48.9, 51.6, 46.6 and 79.3% for CGM, CGF, WG, DG and PPC, respectively. Brazilian poultry and swine tables (Rostagno et al., 2017) report other alternative energy ingredients with 16, 15 and 21% CP, 3.833, 3.922 and 3.974 kcal/g GE and 48%, 46% and 46% EMC, for defatted rice.
wheat bran and CGF, respectively. Protein ingredients (cottonseed meal, CGM and soy concentrate) contain 43, 60 and 73% CP, 4.346, 4.977 and 4.977 kcal/g GE and 46%, 74 and 77% EMC, respectively. The AMEn values of alternative ingredients reported here, can be used safely in the formulation of diets for broilers.

**Keywords:** poultry, metabolizable energy, pulses, com co-products, nutrition
Animal Well-Being and Behavior

26 Female preferences for unfamiliar males: the consequences of previous pairing with either high or low aggressive males. Gabriel A. Orso1, 2, Stefania Pellegrini1, Raul H. Marin1, 2, Diego A. Guzman1, 2, 1Instituto de Investigaciones Biológicas y Tecnológicas (IIByT; UNC-CONICET), Córdoba, Argentina, 2Instituto de Ciencia y Tecnología de los Alimentos (ICTA), Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Córdoba, Argentina.

Aggressive behaviors and their potential consequences on social interactions have strong economic and welfare relevance. Here we address whether pairing a female with either a high or low aggressive male has consequences on their subsequent interactions with unknown males. At age 4 wk, birds were housed in male-female pairs. Aggressive behaviors were registered when birds were 11-12 wk old. Females were classified as either frequently (FP) or infrequently (UFP) pecked according to their rank position based on the number of pecks received from their male partners. At age 16 wk, 12 interactions between two males were evaluated in a novel environment in the presence of either a FP or a UFP unknown female audience (behind a wire mesh partition). Males either actively attacked or avoided attacks (high vs. low aggressive performance). Immediately after, female preferences for either male and sex-related interactions were assessed in a novel environment. Testing boxes were divided into two lateral and a central compartment; each male was restricted to a lateral compartment by a physical barrier device, while the female was able to freely ambulate between compartments.

Data were analyzed using Generalized Linear Mixed Models. During the first 10 min of trial, FP females spent more time in proximity to the less aggressive male while UFP females showed the opposite behavior (P=0.047). FP females also continued spending more time in proximity to the less aggressive male during the 8 h test, while UFP females spent a similar time near either male (P=0.004 and 0.1, respectively). FP females received more grabs and mounts from the high aggressive males than their UFP counterparts (P<0.03). The experiment was repeated but with birds that were isolated for 2 wk after cohabitation. Female preferences and their sex-related interactions were then recorded during 6 h as described above. Initially, both FP and UFP females visited more often the males that previously showed a lower aggressive performance (P=0.01). However, they spent similar time near either male along the whole trial (P=0.1). Interestingly, FP females continued receiving more mounts than their UFP counterparts (P=0.02). Results suggest that in a short-term, female preference for a more or a less aggressive male is highly influenced by their social experience with former male partners (i.e., aggressions received). In the middle term, after isolation, prior aggressive related influences on female preferences seem to be diluted or at least masked by other motivational factors (i.e., social reinstatement needs or increased sexual arousal). Nevertheless, consequences during the sexual interactions are still evident.

Keywords: aggression, social experience, female preferences, sex-behavior, Japanese quail

27 Insights on the temporal resolution of quail behaviors. Lucas Barberi2, 1, Catalina Simian3, 4, Raul H. Marin3, 4, Jackelyn M. Kembro3, 4, 1Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Instituto de Física Enrique Gaviola (IFEG), Córdoba, Argentina, 2Universidad Nacional de Córdoba, Facultad de Matemática, Astronomía Física y Computación, Córdoba, Argentina, 3Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Instituto de Investigaciones Biológicas y Tecnológicas (IIByT), Córdoba, Argentina, 4Universidad Nacional de Córdoba, Facultad de Ciencias Exactas, Físicas y Naturales, Instituto de Ciencia y Tecnología de los Alimentos (ICTA), Córdoba, Argentina.

Quail have high metabolic rates and hence, may have an enhanced temporal resolution of perception, where fast movements could be perceived by conspecific as social cues. Thus, high-resolution time scales (<1s) could hold biologically relevant information, especially within social interactions. However, relatively little focus has been placed on temporal organization of different behaviors, especially in regard to the faster time scales. This study aimed to gain insight into the temporal dynamics of behavior by rethinking the definition of behavioral events. In this context, we also explore the effect of the sampling interval used on the distribution of events. Two data-sets of adult quail social groups were explored. First, the locomotor behavior of birds within 12 stable social groups (2 females: 1 male) was recorded at two sampling intervals 0.1 and 1s using IdTracker@ during 1h. Second, in order to favor high-speed social interactions an unfamiliar male was introduced into the home box of two females (6 groups). High-resolution (frame-by-frame; 66ms) data was recorded during 10min using customized software in MATLAB®. We assessed Probability Density Functions (PDF) of the duration of behavioral events (i.e. continuous time performing a given behavior), providing statistical information regarding how likely to occur is an event of a given duration. In the first data-set, assessment of the impact of sampling interval (0.1s vs. 1s) shows a relatively higher proportion of longer durations of mobility events is observed for the lower resolution (1s). Hence, the duration of active behaviors can be highly overestimated if the resolution of sampling is insufficient. On the contrary, with behaviors that reflect inter-event periods, such as immobility, the PDF of large events are not affected. In the second data-set, for most behaviors recorded, the most frequent event durations lasted <300 ms, indicating that
quail can transition between different behaviors at fast speeds. Notoriously, grabs and mounts can even last only 1 frame (~70ms). Hence, social cues included in short pauses or fast transitions between different types of social behavior may go unrecognized when videos are analyzed at insufficient resolution. Lastly, we show that immobility type behaviors do not present normal distributions of event durations but rather show a power law (i.e. linearity on a double logarithmic plot), apparent at high-resolution (~70ms–10000ms). In all, our results highlight the importance of moving away from anthropocentric ways of measuring behavior and redefining events statistically based on the temporal scale pertinent to the species under study and avoiding assumptions of normality in PDF.

**Keywords:** behavioral events, high resolution data, temporal dynamics, social behavior, Japanese quail


Lighting is a critical environmental factor in incubation and growout conditions that can influence performance and well-being of broiler chickens post-hatch. The objectives of this study were to evaluate the performance and welfare of broilers incubated under 12 h of white light and 12 h of blue light (12L:12Lb) or continuous light (24L:0D) and subjected to either one or two photophases per 24 h period during growout. A total of 844 Ross 308 eggs were set in two incubators where Incubator 1 utilized a 24L:0D photoperiod, and Incubator 2 utilized a 12L:12Lb photoperiod. Upon hatch, chicks were allocated to one of 10 rooms (50 chicks/room) at the ONCE Research Facility – 5 rooms utilized a 16L:8D photoperiod (1P), and 5 rooms utilized a 8L:4D:8L:4D photoperiod (2P). All rooms were equipped with NatureDynamics Dome lights using a mixture of red, green, and blue wavelengths during brood, grow, and finish phases. Weights and FCR were monitored throughout the 42 d trial. Behavior and stress measures were conducted during the final week of growout to evaluate bird welfare. Behavior measures included inversion, emergence (EMERG), isolation, and tonic immobility tests. Stress measures included heterophil-to-lymphocyte ratios (H:L) and serum lactate concentration (LAC). Data was analyzed using GLMs by incubation condition, growout condition, and incubation x growout condition. Significant differences were considered at p < 0.05, and Fishers LSD test was used for post hoc mean separation. The 12L:12Lb birds were heavier than the 24L:0D birds on all weigh days (p < 0.05). The 12L:12Lb/1P birds weighed more than 12L:0D/1P, 12L:12Lb/2P, and 24L:0D/2P birds at d7 (0.200 kg vs. 0.183, 0.183, 0.183 kg; p = 0.003), d15 (0.610 kg vs. 0.585, 0.586, 0.545kg; p = 0.001), and d25 (1.534 kg vs. 1.448, 1.415, 1.395 kg; p = 0.049). The 12L:12Lb birds had higher H:L compared to 24L:0D birds (1.199 vs. 0.741, p < 0.001). Birds reared under 2P had elevated LAC compared to 1P birds (5.727 vs. 4.893 mmol/L, p = 0.001). The 24L:0D/2P birds had a longer EMERG time compared to 12L:12Lb/2P (171.756 vs. 68.7 s; p = 0.001) while 12L:12Lb/1P and 24L:0D/1P were intermediates. The results indicate 12L:12Lb during incubation and 1P during growout may improve growth during the first 25 d of growout. The 12L:12Lb treatment can be beneficial for post-hatch bird growth. The stress measure results indicate elevated stress in both 12L:12Lb birds and in birds reared under 2P; however, no interactions between incubation and growout lighting conditions were observed. These results may indicate the physiological consequences of incubation and growout lighting conditions do not present in the same manner; however, future investigation is required.

**Keywords:** lighting, broiler, performance, welfare, behavior
Processing and Products

29 Photodynamic inactivation of microorganisms in chilled chicken breast coated with curcumin biofilm. Laura A. Pinto1, 3, Adriane F. Frizzo1, Ranulfo C. da Silva Júnior2, Beatriz T. Onishi2, Lays P. Mello2, Carlos E. Benito3, Felipe E. de Souza3, Jovanir I. Fernandes1, 3, 1Programa de Pós graduação em Ciência Animal, Universidade Federal do Paraná, Palotina, Paraná, Brazil, 2Chemistry Department, State University of Maringá, Maringá, Brazil, 3Poultry Experimentation Laboratory, Federal University of Paraná, Palotina, PR, Brazil.

The development of bioactive coatings for meat has aroused interest in the scientific community. Known for forming a protective barrier, these coatings can be a carrier vehicle for food protection compounds. Photodynamic inactivation of microorganisms (aPDT) is a technique used to eliminate microorganisms from surfaces, based on the interaction of a photosensitizing compound, light, and molecular oxygen that generate reactive oxygen species with bactericidal and bacteriostatic action. There are no reports in the literature on the selectivity and resistance of microorganisms to aPDT, which places it as an alternative with great potential to reduce microorganisms in food. This work assessed the aPDT (Salmonella Typhimurium) as an alternative to prolong shelf life of chilled chicken meat. Chicken meat (Pectoralis major without skin, bone, and fat) was obtained from a local market in the city of Palotina, Brazil. Curcumin (CUR) was characterized by high performance liquid chromatography and biofilms prepared following Pinto et al. (2019). Chicken breasts were experimentally contaminated with Salmonella Typhimurium (ATCC 14028, 10^8 CFU/mL, in 25g of meat), randomly distributed in the following treatments: CON (uncoated breast); STD (sodium alginate coated breast); BCR (breast coated with sodium alginate + CUR), packaged and stored in conditions simulating the Brazilian market (tray and shrink film, 2°C, warm white LED light 1200 lux, λ: 450 to 800 nm, 12 hours/day). The antimicrobial potential of the films was evaluated in triplicate on days 1, 3, 5, and 7 of storage and the morphological changes under the microorganisms were evaluated by scanning electron microscopy (SEM). The statistical analysis of data was performed by the analysis of variance and the Tukey test (p> 0.05) with IBM SPSS (v.22.0). CUR presented the three curcuminoids described in the literature: curcumin, demethoxycurcumin, and bisdemethoxycurcumin. The BCR biofilm associated with aPDT resulted in a greater (p < 0.05) inhibitory effect during storage and therefore can be used as an alternative to reduce microorganisms in chicken meat.

Keywords: curcumin, chicken meat, scanning electron microscopy, antimicrobial photodynamic therapy, Salmonella

30 Effect of storage time on the quality of eggs from three ages of commercial laying hens. Elias Salvador, Sandra Bonifacio, Universidad Nacional “San Luis Gonzaga”, Chincha, Peru.

The optimal quality of the egg for human consumption depends on many factors such as the age and genetic line of the hen, as well as the storage conditions, but mainly the storage time. Although there are studies such as these factors influence quality. In modern genetic lines it is important to reevaluate and generate information to be adapted to marketing conditions and ensure that the consumer has access to fresh, high-quality eggs. In this line, a study was designed to test the hypothesis that as the age of the laying hens increases, the internal quality of the egg is reduced under storage conditions, so the objective was to determine the effect of the age of the laying hen laying and storage time on egg quality characteristics. 180 laying hen eggs of 45, 65 and 130 weeks of age of the Dekalb genetic line raised under cage conditions were evaluated. The eggs were analyzed at 0, 3, 6, 9, 12 and 15 days of storage under ambient temperature and relative humidity (20.30 ±1.5 °C and 45.7 ±3.5%). A Complete Random Design was used, with a bifactorial arrangement, with 18 treatment combinations and 10 repetitions each. Data were subjected to statistical analysis of variance (two-way ANOVA) and Tukey’s comparison of means test, following the SAS GLM procedure. Haugh unit characteristics, yolk index, albumen and yolk weight (g/100 g of egg), thickness and resistance to shell breakage, and physicochemical properties such as yolk and egg albumen pH were measured. The results indicated that as the storage days progressed, the pH of yolk and albumen increased significantly (P<0.05), no effect of age on the pH of yolk and albumen was found. Shell thickness and crack resistance were not affected by storage days; however, they were significantly lower for eggs obtained from older hens (130 weeks). Significant interaction of storage days and age was found for Haugh unit, yolk index, yolk weight and albumen. The Haugh unit, yolk index and albumen weight decreased significantly with increasing days of storage and age of laying hens, while yolk weight increased with increasing days of storage and age of laying hens. The significant variations of these characteristics depend on the days of storage as a function of age. It is concluded that the days of storage and age have a negative influence on the characteristics of the Haugh unit, yolk index, yolk weight and albumen, and that younger hens maintain better egg quality under storage.
Keywords: egg, quality, storage, age, hens

31 Comparison of metabolites profile based on 1H-NMR spectroscopy in wooden breast muscles. Carla Daniela Suguimoto Leite¹,², Andressa Kuhlen Silva², Renata R. Gomes¹, Laura Alves Duarte¹, Vitória de Oliveira¹, Sanara Sandy da Silva Cabral¹, Luciano Morais Lião³, José Henrique Stringhini¹, ¹Escola de Veterinária e Zootecnia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ²Centro de Pesquisa em Alimentos, Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ³Instituto de Química, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.

Nuclear magnetic resonance (NMR) has been used to assess muscle abnormalities to identify possible changes in metabolism resulting from degeneration and regeneration processes in muscle fibers. The objective of this experiment was to evaluate the impact of Wooden Breast (WB) severity on metabolic composition of chicken breasts. Thirty breast samples (Pectoralis major) were collected from male Cobb 500® broilers slaughtered at 41 days of age, in the experimental avian facilities of Universidade Federal de Goiás (UFG). At the time of slaughter, each breast was visually scored in a five-point scale for WB: 0= normal, without the presence of the lesion; 1= mild, induration, in the caudal or cranial region, 2= moderate, two regions with a hardened appearance, 3= severe, integral induration of the chest, with the presence of yellowish exudate, 4= extreme severe, totally hardened aspect, with presence of hemorrhages and yellowish fluid. The samples were vacuum packed and frozen. The ¹H-NMR spectroscopy analysis was performed using Topspin 3.1 software, and the DSS 47 signal was used for quantification and calibration of the spectrum. (δ 0.00). Data were analyzed using the GLM procedure of SAS software, and means were compared by Tukey test. Among the free amino acids, histidine-containing dipeptides and others main metabolites in broilers Pectoralis major muscles found and quantified, Niacinamide, AMP, Carnosine, Hypoxanthine, Fumarate, IMP, Glucose, Ribose, Acetylcarnitine, Carnitine, Methionine, Valine, Isoleucine, N-Methylhyantoin and Alanine had no significant effect on WB scores. As the severity increased, it was observed a reduction (p< 0.05) in the production of Lactate, Anserine, Creatine, except for Acetate, which showed an increase, compared to normal breasts. Creatine participates in the energy metabolism, and its reduction between scores (140.74, 130.92, 124.26, 120.4, 117.91 mg/100g of meat, respectively), corroborates to the impact of these injuries on muscle metabolism. Anserine is an important dipeptide with antioxidant capacity, it also reduced with increasing severity (p< 0.05), which could be explained by the greater need to inhibit muscle oxidation in the presence of degenerations. The NMR analysis could provide important information about meat metabolism of muscles affected by WB and composition alteration in accordance with the lesion severity.

Keywords: broiler, metabolism, myopathies, Pectoralis major

32 Causes of broiler carcass condemnation in slaughterhouses in the state of Goiás, Brazil. Emanoel Tome Regis Ramos¹, Carla Daniela Suguimoto Leite¹, Cintia Silva Minhafra e Rezende², ¹Escola de Veterinária e Zootecnia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ²Centro de Pesquisa em Alimentos, Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ³Agrodefesa, Goiânia, Goiás, Brazil.

The evaluation of slaughterhouse condemnation of broiler chickens allows to understand the main losses in industry yield, with total or partial carcass discard, and to seek improvements in industrial processes and production systems. This study aimed to identify the main causes of total and partial condemnations in batches of broiler chickens slaughtered in Goiás state, Brazil. Data were collected, by State Inspection Service, in ten slaughterhouses (five in Central region of the state de Goiás, and five in the Southern region) during the period between 2012 to 2018. The retrospect data was analyzed to compare the main causes in these regions by descriptive evaluation (percentage) and frequency (chi-square test). A total of 96 million of birds were evaluated in slaughterhouses located in Central region and 64 million in the South. The three main causes of total condemnation, in Central region, were cachexia (27.87%), disgusting appearance (23.49%), ascitic syndrome (10.46%). Similarly, in the Southern region, the three main causes were the same, but in other classification: cachexia (33.19%), ascitic syndrome (32.03%) and disgusting aspect (10.14%). The main causes of partial condemnation were different between the regions. In the Central regions, the causes were contusion and fracture (63.58%), followed by cellulitis (11.73%) and dermatosis (7.02%). While, in the Southern region there was greater condemnation for ascitic syndrome (29.62%), bruise and fracture (28.04%) and contamination (24.12%). In the Goiás state, it is possible to find a diversity of slaughterhouse companies, carrying in differences in management, feed and diets, genetics, and technological adoption in the productions systems. Also, in the industry, a variety in equipment, slaughtering capacity, and especially the human resources involved in all slaughter processes could influence the main condemnation causes. An expressive occurrence of contusion and fracture may be investigated if they result of problems in pre-slaughter management or in slaughterhouse process. Based on these data, improvements in processes can be listed that aim to optimize slaughter operations and minimize losses in industry yield.

Keywords: ascitic syndrome, bruise, cellulitis, contamination, inspection

33 Dietary replacement of soybean with different levels of Hermetia illucens meal during grower and finisher phases in broilers: effects on live performances
The search for sustainable protein sources to serve as alternatives to soybean meal which is currently used in poultry feeding is deserving the attentions more than ever before. In this context, the present study aims at assessing the impact of the replacement of the commercial soybean-based diet with an *Hermetia illucens* meal (IM) during both the grower and finisher diets on both the growth and production performances of broiler chickens as well as on the main quality traits (pH, color, water holding capacity and oxidative status of lipids and proteins) of breast meat. A total of 1,000 1-day-old Ross 308 male chicks was divided into three experimental groups of 7 replicates fed with the commercial corn-wheat-soybean diet (CON) or the same basal diet with a 9 and 18% replacement of the protein source with an *Hermetia illucens* meal (9IM and 18IM, respectively) during both the grower and finisher phases. Data were analyzed through One-way ANOVA by considering the level of the dietary replacement of soybean meal with IM (i.e., 0, 9, 18%) as main effect. When significant, means were subsequently separated by Tukey-HSD test ($p<0.05$). Overall, replacing the conventional protein source with IM dramatically affected the production performances of broilers. In detail, if compared with CON, the experimental groups 9IM and 18IM exhibited significantly ($p<0.001$) lower body weights, with 18IM showing the lowest values (3,205 vs. 3,001 and 2,441 g, respectively). Concurrently, an 18% inclusion of *Hermetia illucens* meal resulted in a significantly worsened feed conversion ratio if compared with that observed in CON (1.939 vs. 1.610 kg/kg; $p<0.001$). As for breast meat quality, the dietary replacement of the protein source with *Hermetia illucens* meal only marginally affected tested quality traits. Indeed, if compared with CON, 9IM and 18IM exhibited remarkably lower ($p<0.05$) ultimate pH values (5.79 vs. 5.64 and 5.64, respectively) that was not associated to an impaired ability of the meat to hold its constituting water, as depicted by the absence of significant differences concerning drip and cooking losses among the groups ($p>0.05$). In addition, no differences were found concerning the oxidation level of both the protein and the lipid fraction. In conclusion, the findings achieved in the present study evidenced that from the perspective of meat quality the dietary replacement of the commercial corn-wheat-soybean diet with an *Hermetia illucens* meal may represent a possible strategy to improve the sustainability of the feed without negative implication on meat quality traits, however high level of inclusion is severely limited by the impairment of the production performances.

**Keywords:** *Hermetia illucens* meal, soybean replacement, broiler chickens, production performances, meat quality
34 Effects of a proprietary blend of Quillaja and Yucca on egg and eggshell quality of laying breeder hens. Ottoniel F. Souza1, Sandra Bonaspetti2, Guilherme L. Godoy3, Geovana Muller1, Luiza Crumenauer1, Catarina Stefanello1, 1Animal Sciences, University of Santa Maria, Santa Maria, RS, Brazil, 2Phibro Animal Health Corporation, Campinas, SP, Brazil.

This experiment was conducted to evaluate the effects of an additive containing polyphenols and saponins of a proprietary blend from Quillaja saponaria and Yucca schidigera (QY) biomass on egg and eggshell quality of laying breeder hens. A total of 44 Red Rhodes Island and 40 White Plymouth Rock breeder hens at 27 weeks of age were allocated in individual cages using a completely randomized block design with 21 replicates. Each treatment was composed by 11 Red Rhodes Island and 10 White Plymouth Rock hens. After a 28-d period of adaptation, hens were fed 4 experimental diets in 5 periods of 28 days each, from 30 to 49 weeks of age. Experimental diets were a Control diet (formulated with corn, soybean meal and wheat bran without additives); Control supplemented with virginiamycin at 16.5 ppm (Control + virginiamycin); Control supplemented with the QY additive at 250 g/ton (Control + QY), and Control supplemented with virginiamycin + 250 g/ton QY (Control + virginiamycin + QY). In the last 4 days of each experimental period, all eggs were collected to evaluate: egg weight, specific egg weight, percentage of albumen, yolk and shell, as well as yolk index, Haugh unit, shell thickness and shell strength. The yolk color measurement was conducted using a colorimeter to objectively measure CIE L*a*b* values of yolk (L* - lightness, a* - redness and b* - yellowness) in each 28 d-period. The cuticle coverage was also assessed for all eggs L*a*b* color space at four points measured before and after staining of the cuticle. Then, the eggshell color difference, which represents the cuticle coverage or quality, was expressed as a single numerical value (ΔL*ab). Data were submitted to one-way ANOVA using the GLM procedure of SAS Institute. Means were compared by the Tukey test (P < 0.05). No effect between the hens’ strain was observed, which was previously blocked in the experimental design. Treatments did not affect egg weight, yolk index and yolk color, and Haugh unit as well as on shell thickness, and percentage of albumen and yolk (P > 0.05). However, in the overall period from 30 to 49 weeks of age, hens fed Control + QY or Control + virginiamycin + QY produced eggs with improved egg specific weight, shell strength and shell percentage compared to hens fed the Control (P < 0.05). The additive containing polyphenols and saponins from Quillaja and Yucca biomass resulted in increased cuticle quality in the overall period when compared to the Control diet (P < 0.05). In conclusion, diets supplemented with the Quillaja and Yucca additive resulted in increased eggshell quality, with improved cuticle quality for laying breeder hens from 30 to 49 weeks of age.

Keywords: breeder hen, cuticle staining, egg quality, polyphenol, saponin

35 Productive performance and internal and external egg quality of Japanese Quail (Coturnix coturnix) fed with inulin on normal and low-calcium diets. Alejandra Coronado, Carlos Vilchez-Perales, Otto A. Zen, Lima, Universidad Nacional Agraria La Molina, Lima, Lima, Peru.

The objective of the present study was to evaluate the effect of the inclusion of inulin to diets with normal and low calcium levels on performance, shell quality and internal egg quality of quail hens. 64 10 wk-old quail hens were used randomly distributed into four groups with four animals each. Each group received, during six weeks, one of the following treatments: T1, basal diet with normal calcium levels (3.16%) without inulin; T2, basal diet with normal calcium levels (3.16%) with inulin (0.5%); T3, low calcium basal diet (2.37%) without inulin, and T4, low calcium basal diet (2.37%) with inulin (0.5%). Feed, in the form of flour, and water were offered ad libitum. Feed intake, feed conversion and daily percentage of laying and mortality were recorded weekly. On the last day of the experiment, eggs were collected for each treatment to evaluate the internal and external quality of the eggs. Data were analyzed under a completely randomized design (DCA) with a 2 x 2 factorial arrangement, the factors being the two levels of calcium (2.37 and 3.16%) and the two levels of inulin (0.0 and 0.5%), and for comparison of means Tukey test was used. Results showed that the performance was no significant different (P>0.05) between low calcium treatment with inulin and treatment with normal level calcium (T4 vs T1) and inulin and calcium level had an effect on feed intake. In external egg quality, inulin had an influence on the egg shape index, being higher with a value of 0.5% inulin. In relation to egg internal quality, yolk diameter were lower with level of 2.37% of calcium. In conclusion, inclusion of 0.5% inulin to diets with normal calcium levels produces production parameters similar to diets with low calcium and inulin levels.

Keywords: inulin, calcium, laying quail, shell quality, egg

36 Three different intestinal health additives enhance eggshell quality and yolk color in laying hens from 45 to 65 weeks of age. Matheus R. Lima1, Fernando G. Perazzo Costa2, Matheus Resende3, Naiara S. Fagundes3, David Jacob3, Wanderley Quinteiro3, 1Animal Sciences, UFERSA, Mossôô, Rio Grande do Norte, Brazil, 2Animal Sciences, UFPB, Areia, Brazil, 3Adisseo, São Paulo, Brazil.
A study was conducted to evaluate intestinal health additives’ effects on the egg quality of laying hens during the laying period (45 to 65 weeks of age). A total of 320 Hy-Line W80 birds were randomly distributed in 4 trial groups, with 10 replicates of 8 birds each. The trial groups were: T1 - Control with no additives; T2 - 0.015% Phytogenic; T3 - 0.035% Sodium Butyrate (Precision Delivery Coated Butyrate - PDCB); and T4 - 0.050% Probiotic (Bacillus subtilis 29784 – 2x10^8 UFC/g of probiotics). Performance, internal and external egg quality, as well as the percentage of dirty, cracked, broken, and defective eggs were evaluated. The data were submitted to variance analysis and the means were compared to Control treatment by using Dunnett’s test at 5%. Feed intake, feed conversion ratio, and egg production, weight, and mass data were similar among the treatments evaluated (P>0.05). However, a significant effect on egg quality parameters (P<0.05) was observed. Phytogenic, PDCB, and Bacillus subtilis 29784 improved egg yolk pigmentation (P<0.001) and eggshell thickness (P=0.0006) in comparison to the Control diet. Moreover, PDCB and Bacillus subtilis 29784 improved the relative eggshell weight (P=0.0037) and specific gravity (P=0.0006) in comparison to Control. As for non-marketable eggs, a significant reduction in cracked (P=0.0006), broken (P<0.001), and defective eggs (P=0.0090) was observed when using phytogenic, PDCB, and Bacillus subtilis 29784 in comparison to the Control group. Furthermore, PDCB statistically decreased the percentage of dirty eggs (P=0.0324) when compared to Control. Finally, each additive has a different function and activity in bird nutrition. However, all these additives have shown an improvement in external egg quality, by increasing eggshell quality and yolk color. In conclusion, the use of phytogenic, PDCB or Bacillus subtilis 29784 improved the egg quality of W80 laying hens.

Keywords: egg quality, marketable eggs, effective egg production

37 Effect of feeding different levels of inulin on egg quality and productive parameters in laying hens. Katherine Quispe Cangalaya, Carlos Vilchez-Perales, Otto A. Zea, Lima, Universidad Nacional Agraria La Molina, Lima, Lima, Peru.

The objective of this study was to evaluate the effect of different levels of inulin on the external and internal quality of eggs and production parameters of 75-week-old laying hens. 300 Lohmann Brown laying hens randomly distributed in 3 treatments with 4 repetitions and 25 animals per repetition were used. T1, control treatment; T2 basal diet with 0.25% inulin; T3, basal diet with 0.50% inulin. Diets were formulated according to the recommendations of the Lohmann Brown line. Food was supplied in powder form and water ad libitum. Feed intake, feed conversion, laying percentage and egg mass were evaluated daily, egg samples were taken at the end of the last 3 weeks, with a total of 3 measurements to evaluate the external and internal quality of the eggs. Data were analyzed under a completely randomized design (DCA) in the Statistical Analysis System program (SAS, 1999) and Tukey’s test for differences between means. Laying percentage showed significant differences, being T3 higher in relation to T1 and T2; no significant differences were observed in other productive parameters, but a positive influence of inulin levels on feed conversion and egg mass was observed. Regarding the external quality, eggs weight showed significant differences, being T2 superior to T1 and T3, and T3 to T1. In specific gravity T3 was higher than T1 and T2. Regarding egg quality internal, albumen height was higher in T2 followed by T3 and T1; bud height was higher in T2 and T3 than in T1. Significant differences were also shown in Haugh Units and egg surface area (ASDH), with T2 being higher followed by T3 and T1 in both cases. It is concluded that the inclusion of inulin at 0.25% and 0.50% in diets improves the percentage of laying and positively influences feed conversion and egg mass, as well as the external and internal quality of eggs from laying hens.

Keywords: laying hens, inulin, levels, egg quality, performance

38 Inclusion of lignocellulose in the diets of laying hens. Brunna G. Leite, Cristiane S. Araújo, Lucio F. Araújo, Carlos Alexandre Grangelli, Fabricia d. Roque, Giovana M. Longhini, Mario Henrique S. Lopes, Isabela E. Silva, Airton Rafael F. Prezotto, Animal Science and Production, School of Veterinary Medicine and Animal Science of University of Sao Paulo, Pirassununga, Sao Paulo, Brazil, 2Department of Animal Science, Faculty of Animal Science and Food Engineering, Pirassununga, Sao Paulo, Brazil.

The inclusion of fibrous diets in bird nutrition has been highlighted in recent years, due to the positive effects found on intestine health, nutrient digestibility, and performance. The aim of this study was to investigate the effects of lignocellulose inclusion on the live performance, egg quality, and intestinal morphometry in laying hens from 24 to 40 weeks of age. A total of 312 Lohmann® White laying hens were distributed according to a randomized experimental design in 3 treatments (0%, 1% or 2% lignocellulose) with 13 replicates of 8 hens each. Performance and egg quality were evaluated during 4 periods of 28 days. At the end of the trial period, 13 laying hens per treatment were randomly euthanized to the analysis of intestinal morphometry. Regression analyses were performed using orthogonal polynomials as a function of lignocellulose levels (0; 1 or 2 % of feed). Statistical significance was determined at P<0.05. The productive performance variables of laying hens were not influenced (P > 0.05) by the treatments. Regarding egg quality, yolk color showed a quadratic effect with lignocellulose levels in the diet (P = 0.0679). The intestinal morphometry showed a quadratic effect for gizzard weight (P = 0.0011) and intestine length (P < 0.0001). In conclusion, these results
showed that the inclusion of lignocellulose in the feed of laying hens improved yolk color, gizzard weight and the intestine length.

**Keywords:** egg quality, fiber, intestinal morphometry, laying hens, performance

### 39 Productive performance of commercial layers supplemented with the probiotic bacillus amyloliquefaciens.

**Natsiele F. Oliveira,** Deibity Cordeiro, Imar Fernandes Filho, Laura Duarte, Thaisiane Lorenzo, Fernanda Toledo, Lucas Castro, Marcos B. Cafe, José Henrique Stringhini, Zootecnia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.

The objective was to evaluate the productive performance of laying hens fed diets containing a probiotic based on Bacillus amyloliquefaciens. An experiment was carried out in the poultry sector of EVZ/UFG with 320 commercial laying hens of the Hy-Line W-80 strain from 54 to 72 weeks of age, totaling four productive periods of 28 days, with the first two weeks of adaptation. A completely randomized experimental design was used in a 2x2 factorial scheme, with and without the commercial performance-enhancing antibiotic Bacitracin Zinc and with and without the commercial probiotic based on Bacillus amyloliquefaciens, totaling four treatments, with ten replications of 8 birds per experimental unit. At the end of each period of 28 days, the productive performance of laying hens was evaluated. To evaluate the performance, the zootechnical indices were considered: feed intake (g/bird/day), viability (%), egg production (%), average egg weight (kg), egg mass (kg), feed conversion (Kg:Kg) and feed conversion (Kg:DZ). Data were submitted to ANOVA, using the R project software. Means were compared using the Skott-Knott test at 5% probability. Based on the results obtained in the performance variables of laying hens in the total period of production, it was observed that there were no significant differences (p<0.05%) in the simple factor and in the interaction of the association between the antibiotic and probiotic factors, indicating that the probiotic presented similar results to the other treatments, therefore, it can be used to replace the performance-enhancing antibiotic, in order to avoid the residual effect.

**Keywords:** probiotic, Bacillus amyloliquefaciens, laying poultry, nutrition, additives

### 40 Promoting the intestinal health of pullets with protected organic acids and essential oils.

**Marcia d. Vieira**, Mariana L. Moraes, Thais B. Stefanello, Francisco Bertolini, Guilherme M. Silva, Joao M. Tavares, Carlos Y. Nakamatsu, Elizabeth Santin, C. Cruz-Polycarpo, C. Cruz-Polycarpo, 1Technical Support, Jefo Nutrition Inc, Saint-Hyacinthe, Quebec, Canada, 2Safeeds, Toledo, Brazil, 3Grupo Mantiqueira, Primavera do Leste, Brazil, 4Applied Scientific Curiosity, Jefo Nutrition Inc, Saint-Hyacinthe, Quebec, Canada.

The objective of this study was to evaluate protected organic acids and essential oils P(OA+EO) for pullets in field conditions. A total of 208,000 2-weeks-old pullets were assigned to receive 1 of 2 treatments: T1, control diet; T2, P(OA+EO) at 300 g/t (fumaric, sorbic, citric and malic acids + thymol, eugenol and vanillin microencapsulated - Jefo Nutrition Inc. Canada). P(OA+EO) was supplemented from 2 to 18 weeks and the trial lasted 21 weeks. At weeks 6, 12 and 21, 12 pullets/treatment were used for blood sampling and necropsy for ISI – I See Inside analysis. To evaluate intestinal health, birds were orally inoculated with fluorescein-isothiocyanate labelled dextran (FITC-d) and blood samples were collected after 1.5 h. A completely randomized design was used consisting of 2 treatments (12 replicates of 1 hen/replicate). Data were subjected to one-way ANOVA and the T-test was used for parametric data and Kruskal-Wallis for non-parametric data (XLSTAT software). Pullets on P(OA+EO) presented the best (P<0.05) overall health ISI score at weeks 6 and 12. At week 6, this result was due to the lowest score for (P<0.05) muscle hemorrhage. At week 12, the best total ISI was due to the lowest scores for femoral head necrosis (P<0.05), and airsacculitis (P<0.01). Pullets on P(OA+EO) had the best (P<0.05) macro-intestinal ISI scores at weeks 6 and 21. This result may be attributed to the lowest cell debris and reddish on mucosa in the duodenum (P<0.05), jejunum (P<0.05) and ileum (P<0.05) at week 6. At week 21, pullets on P(OA+EO) had the lowest morphologic alteration on serosa and mucosa layers in the jejunum (P<0.05) and the lowest cell debris and reddish on mucosa in the jejunum (P<0.05). Pullets on P(OA+EO) had the best histologic intestinal health ISI score at week 6 (P=0.09), 12 and 21 (P<0.05). At week 6, this result was due to the lowest scores observed for lamina propria thickness (P<0.05). At week 12, this result was due to the lowest scores observed for lamina propria thickness (P<0.01), lamina propria inflammatory infiltration (P<0.01) and congestion (P<0.01). At week 21, this result was due to the lowest scores for lamina propria thickness (P<0.01), enterocytes proliferation (P<0.05), epithelial plasma cell infiltration (P<0.01), lamina propria inflammatory infiltration (P<0.01), goblet cells (P<0.05), and presence of Eimeria oocysts (P<0.01). Pullets on P(OA+EO) had the lowest (P<0.001) levels of FITC-d recovered in the blood in all ages evaluated, which is related to reduced leaky gut. In conclusion, the blend of protected organic acids and essential oils evaluated can be used to improve intestinal and overall health in pullets under commercial conditions.

**Keywords:** essential oil, intestinal health, intestinal permeability, pullet, organic acid

### 41 Hematological analysis of laying hens supplemented with prebiotics.

**Elis O. Figueroa Castillo**, Barbara F. da Silva Barbosa, Monique d. Lima, Gabrieli A. Lima, Bruna Trevizan, Veronica L. Santos, Valquiria C. Cruz-Polycarpo, Gustavo d. Polycarpo, 1Animal Science and Technology, FCAT - UNESP, Dracena, SP,
The use of prebiotics could replace growth promoters, being dietary compounds that were not digested by the host when consumed, but could help beneficial bacteria, as well as fructooligosaccharides (FOS) which are fructose-rich polymers, galactooligosaccharides (GOS) that are obtained of the cell wall of yeasts, being the most studied prebiotics. The aim of this research was to evaluate the effects of prebiotic FOS (fructooligosaccharides and Saccharomyces cerevisiae yeast) e GOS (galactooligosaccharides and dry yeast Saccharomyces cerevisiae), isolated or associated for laying hens it was analyzed about hematological variables (hematocrit, hemoglobin and Wintrobe indices, number of erythrocytes, total and differential counts of defense cells). A total of 96 Hy-line laying hens were randomly distributed in a 4x3 factorial design (6 replicates/4 birds), reared for a period of 84 days (three cycles of 28 days). The first factor was the basal ration (RB) based on corn and soybean meal; RB with inclusion of FOS; RB with inclusion of the GOS; RB with inclusion of FOS + GOS and the second factor was the 3 production cycles. Data analyzes were performed using the SAS University Edition with a 5% significance criterion. Residual normality analyzes were performed using the Shapiro-Wilk Test (PROC UNIVARIATE). Obeying the premises, the data were subjected to analysis of variance, where the matrix with the best variance-covariance structure was chosen with the AIC criterion by the PROC MIXED, and when there was a significant effect, the means were compared by the Tukey test with 5% significance. There was no use of prebiotics and production cycles in the effect study interaction variables and the number of production in the diet with control only. The use of biotic birds in the diet causes changes in variations in hematological variables 1 and 2, due to a higher count of erythrocytes, total leukocytes, lymphocytes, basophils and thrombocytes. In addition, the same results with an increase in heterophils estimating that the birds showed under stress.

**Keywords:** erythrocytes, hens, fructooligosaccharides, galactooligosaccharides

42 Effect of propolis consumption in laying hens on production parameters, egg quality and intestinal integrity genes. Loren Carvajal1, 3, Camila Daza León2, Arlen P. Gómez2, Liliana Betancourt2, Diana Alvarez Mira2, Gloria C. Ramirez-Nieto2, Andres Sanchez3, Jose Vargas3, 1Facultad de medicina Veterinaria y Zootecnia, Universidad nacional de Colombia, Bogota, Colombia, 2Universidad Nacional de Colombia, Bogotá, Colombia, 3Compañía Campo Colombia SAS, Bogotá, Cundinamarca, Colombia.

Propolis is a product made and extracted from bee hives, which has been widely studied for its therapeutic properties and high biological effect. It can be classified as a nutraceutical product. The objective of this study was to characterize propolis from two areas center of Colombia by determination of compound profile by chromatography and ethnobotany and to evaluate its effect on inclusion in diets for laying hens with doses of 300, 600 and 900 ppm, determining the effect on zootechnical parameters, egg quality and intestinal integrity. Propolis samples were taken from of La Mesa and Anolaima (Cundinamarca, Colombia) and their compound profile was determined by means of gas chromatography coupled to mass spectrophotometry. Subsequently, a pool of propolis from areas was prepared and included in diets for laying hens, with a random design with a total of 240 birds of the Hy-Line Brown line from week 24 to 32 week of age. Five treatments with six replicates each with eight birds were established: a control group without additives, a group with an antibiotic growth promoter and three groups with three doses of propolis. Physiological and productive parameters were measured and relative quantification studies were performed by qPCR on the expression of genes associated with intestinal integrity. Descriptive statistical analyzes and analysis of variance were performed, and when significant differences were present, Duncan’s test was used to compare the mean of the experimental treatments (P<0.05). In the characterization of propolis from, compounds mainly terpenoids and phenols were highlighted. In the bioassay for the inclusion of propolis in diets for laying hens, no significant differences were found between the supplemented treatments and the control in the productive variables. Regarding egg quality, there were differences in the yolk index and the breaking force of the shell (P<0.05) for the treatments supplemented with the highest doses of propolis (600 and 900ppm) compared to the control. The results showed that the expression of genes associated with intestinal integrity had different dinamics in the sections evaluated. it was shown that with treatment 3 there was a higher expression of all genes compared to the control group. In the ileum, treatment 5 showed the highest expression of CLDN-3, OCL and, MUC-2. The evaluated propolis contain botanical resources from native plants of the genus Myrtaceae in whose compound profile terpenes stand out. Propolis supplementation was expressed in egg quality, breaking strength. Propolis can be an additive that improves the response of these genes and therefore intestinal integrity and health.

**Keywords:** propolis, antioxidant activity, flavonoids, productive variables, intestinal integrity

43 Effect of dietary supplementation of spray-dried plasma for broiler breeder and their effects on the growth of the progeny. Carlos Alexandre Granghelli1, Luis Rangel2, Joy Campbell3, Javier Polo4, Joe Crenshaw3, Giovana M. Longhini5, Isabela E. Silva1, Mario Henrique S. Lopes5, Cristiane S. Araujo1, Lucio F. Araujo5, 1Animal Science, University of Sao Paulo, Pirassununga, Sao Paulo, Brazil, 2APC LLC, Sao Paulo, Brazil, 3APC LLC, Ankeny, Iowa, United States, 4Animal Science and Production, University of Sao Paulo, Pirassununga, Sao Paulo, Brazil.
School of Veterinary Medicine and Animal Science of University of Sao Paulo, Pirassununga, Sao Paulo, Brazil.

A total of 216 Cobb 500® broiler breeder hens were randomly distributed across two treatments (a diet supplemented with 0 or 1% spray-dried plasma) from 26 to 65 weeks of age. At 45 weeks of age, broiler breeder hens were inseminated with fresh semen, and eggs were incubated using standard procedures. One progeny study was performed, with 480 hatched birds, allocated in a completely randomized 2 x 2 factorial design (maternal diet: with or without inclusion of 1% plasma x progeny diet: with or without the inclusion of 2% plasma from 1 to 7 days of age) with 10 replications of 12 birds. After 7 days of age, all birds received the same diet until 42 days. Progenies were challenged with coccidiosis vaccine using 15 times the dose recommended by the manufacturer (0.03 ml x 15) by gavage at 7 days of age. Furthermore, heat stress was also included in the progeny study model so that from 7 to 21 days, room temperature was kept at 30°C above the normal temperature for this specific age, and 35°C was applied from 10:00 am to 16:00 pm from day 22 to 42 of age. Performance characteristics (feed intake, body weight, body weight gain, and feed conversion) and carcass characteristics (carcass, breast, leg, wing, and abdominal fat yield) were evaluated. Data were analyzed according to ANOVA from the statistical program SAS. At 42 days post-hatch, progeny from breeders fed 1% plasma, and fed plasma from 1 to 7 days, showed higher feed intake, body weight, and body weight gain than progeny from other treatments. There were no statistical differences in carcass characteristics. These results suggest that feeding spray-dried plasma in the broilers diet has some beneficial effects on broiler chickens under caloric stress conditions. Further studies are needed to evaluate this product in other sanitary environments, different from those used in the present study, which may increase the positive responses.

Keywords: broilers, carcass composition, health challenge, performance, spray-dried plasma
Student Competition: Metabolism and Nutrition, Vitamins and Minerals

44 Supplementation of amino acid complexes on performance of broiler breeder hens and their offspring. Douglas D. Maria¹, Sergio L. Vieira¹, Julmar C. Feijo¹, Alba K. Fireman², Raquel M. Horn¹, Pablo L. Santos¹, Walter E. Altevogt¹, Giovane B. Tommasi¹, Yuri J. Olabarriaga¹, ¹Zootecnia, Universidade Federal do Rio Grande do Sul, Viamão, Rio Grande do Sul, Brazil, ²Zinpro corporation, Piracicaba, São Paulo, Brazil.

Microminerals are essential for competitive chicken development and act in a fundamental way for poultry. The objective of this trial was to evaluate the effects of partial replacement of inorganic trace minerals (ITM) by amino acid complexed minerals (AACM) in the feed of broiler breeder hens and also on the offspring’s performance parameters. A total of 640 22-week-old broiler breeder hens and 64 roosters were placed, in a completely randomized design with four treatments randomly assigned to the 32 pens (2.0 x 2.5 m), totaling 8 replicates per treatment, with 20 birds per replicate. The treatments were: T1 - Control - containing only ITM sources at industry levels: Zn, Mn, Cu, Fe and Se 100, 100, 10, 50 and 0.30 ppm, respectively. T2 - Partial replacement of the Control by the AACM forms: Zn, Mn, Cu, Fe and Se at 60, 60, 3, 50 and 0.15 ppm of ITM and 40, 40, 7, 0 and 0.15 ppm of AACM, respectively. T3 - Partial replacement of Control by AACM forms: same composition as T2, but with Fe at 10 ppm ITM and 40 ppm AACM. T4 - On top supplementation by the forms of AACM: Zn, Mn, Cu, Fe and Se at 100, 100, 10, 50 and 0.30 ppm of ITM and 40, 40, 7, 40 and 0.15 ppm of AACM, respectively. Egg production was measured from 26 to 65 wk of age in 10 periods of 28 d each. Eggs were collected during 3 consecutive days at 35, 45, 55 and 65 wk throughout the study for eggshell breaking strength and thickness, thirty-six eggs per treatment each time. At the end of each period, the eggs were incubated; hatchability and chick quality were evaluated at hatch day. At 66 weeks of age, eggs were incubated to obtain 800 1-day-old male chicks (200 birds per treatment, 10 replicates, 20 birds per replicate) for field progeny testing, at 7, 21 and 35 days were measured body weight gain (BWG), feed conversion ratio (FCR) and feed intake (FI). All data from the breeders were analyzed using the PROC MIXED whereas offspring data were analyzed using PROC GLM using SAS 9.4 software. When significant, means were compared using Tukey test (P < 0.05). Total egg production and settable eggs were not affected by treatments (P > 0.05). Eggshell breaking strength and thickness increased significantly in eggs from birds fed on top supplementation compared to eggshell from the control group (P < 0.05). The offspring partially supplemented with Zn, Mn, Cu, Se and Fe AACM obtained greater BWG at 7 d (P < 0.05) and consequently a lower FCR from 1 to 35 d when compared to the control treatment supplemented with ITM (P < 0.05). The AACM supplementation promoted greater offspring BWG at 7 d and cumulative FCR of 1 at 35 d.

Keywords: amino acid complex, offspring, broiler breeder, responses, minerals

45 Broiler meat production as affected by dietary supplemental hydroxy-selenomethionine. Walter E. Altevogt¹, Sergio L. Vieira¹, Julmar C. Feijo¹, Douglas D. Maria², Pablo L. Santos¹, Vinicius d. Teixeira³, ¹Zootecnia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, ²Zootecnia, Universidade Federal do Rio Grande do Sul, Viamão, Rio Grande do Sul, Brazil, ³Zootecnia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, ⁴Evonik Brasil, São Paulo, Brazil.

Selenium (Se) is an essential mineral for biochemical processes in the animal organism and is generally deficient in corn and soy-based diets for broilers. Hydroxy-selenomethionine (OH-SeMet) is a commercial organic source that has not been fully evaluated as a single supplemental source of Se. The objective of the present study was to evaluate the increasing dietary Se supplementation from OHSeMet on broiler growth performance, meat yields, wooden breast (WB) and glutathione peroxidase responses in tissues. A total of 1,500 Cobb vs. Cobb 500 slow feathering one-day-old male chicks were allocated to five treatments (0.0, 0.15, 0.30, 0.45 and 0.60 mg/kg of Se supplemented from OH-SeMet) with 12 replicates of 25 broilers each in a 3-phase feeding program from d 1 to 42. Supplemental Se levels were chosen to provide an adequate dose-response adjustment and were based on known deficient and excessive feed levels for broilers. The non-supplemented starter, grower, and finisher diets had analyzed 0.03, 0.03, and 0.02 mg/kg Se, respectively. At 35 and 42 d of age, five broilers per pen were processed for meat evaluation and scored for WB. Samples from blood, liver, jejunum, and ileum as well as breast meat samples were taken at 42 d for evaluation of glutathione peroxidase (GSH-Px) activity and lipid oxidation (TBARS), whereas breast meat was also analyzed for cooking loss (CL) and water-holding capacity (WHC). Statistical analysis was conducted using the quadratic polynomial regression model. Increasing Se from OH-SeMet led to quadratic increases (P < 0.05) in BWG from d 1 to 42, with optimal concentration at 0.47 mg/kg Se as well as optimized estimations for FCR at 0.42 mg/kg Se. Dietary Se that maximized carcass and breast meat yields at 42 d were 0.41 and 0.48 mg/kg Se, respectively (P < 0.05). Dietary Se that maximized GSH-Px activity in erythrocytes was at 0.27 mg/kg (P < 0.05). No effects of Se were observed on WB scores at 35 and 42 d of age, CL and WHC as well as on TBARS in intestine, liver and breast muscle samples (P > 0.05). Supplementation of Se from OH-SeMet in corn-soy feeds improved broiler performance, carcass and breast yields. Average Se that optimized BWG was 0.48 mg/kg, whereas 0.46 mg/kg was needed for carcass and 0.40 mg/kg for breast yield.
mg/kg for breast yield. These are total Se contents acceptable in the European Union and frequently below commercially used contents in countries that do not have a limit on minerals in feeds.

**Keywords:** selenium, mineral, broiler, performance, requirement

46 Manganese requirements of broiler breeder hens. Raquel M. Horn¹, Sergio L. Vieira¹, Douglas D. Maria², Pablo L. Santos³, Julmar C. Feijo³, Thiago L. Noetzold³, Yuri J. Olabarriaga¹, Walter E. Altevogt¹, Giovane B. Tornes³, ¹Department of Animal Science, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, ²Zootecnia, Universidade Federal do Rio Grande do Sul, Viamão, Rio Grande do Sul, Brazil, ³Zootecnia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, 4universidade federal do rio grande do sul, Porto Alegre, Brazil, 5University of Alberta, Edmonton, Alberta, Canada.

The present research was conducted to assess manganese (Mn) requirements of broiler breeder hens. One hundred and twenty Cobb 500 hens and 30 Cobb broiler breeder male birds, 22 wk of age, the hens were individually allocated in cages. After fed a Mn-deficient diet from 31 to 35 wk (22.2 ppm), hens were randomly placed in treatments having 6 increments of 30-ppm Mn. All trace minerals were from laboratory grade sources being Mn from Mn sulfate. Treatments were fed for 4 periods of 28 d. Eggs were daily collected, all hatchable eggs laid in the last week of each period were weighed for the incubation, hatching chicks were weighed and had their length measured. 45 eggs per treatment were collected per period and used to evaluate egg weight, specific gravity, eggshell thickness, eggshell breaking strength, yolk, albumen, and eggshell percentage. In addition, 3 eggs per treatment from each period were used in the analysis of eggshell ultrastructure (thickness of eggshell layers and number of mammillary buttons/mm²). Data were submitted to ANOVA using the PROC MIXED of SAS (2013). The Tukey-Kramer test was used for means comparison with differences being considered significant at P< 0.05. Estimates of maximum responses to total dietary Mn were done using quadratic polynomial (QP) and broken line quadratic (BLQ) models. Requirements of Mn for hen day egg production and settable egg production were 115.8 and 56.6 ppm and 122.1 and 63.6 ppm (P < 0.05), respectively, QP and BLQ models, whereas total eggs and total settable eggs per hen had Mn requirements estimated at 115.7 and 56.6 and 121.8 and 61.7 ppm (P < 0.05), respectively. Number of cracked, defective, and contaminated eggs decreased, whereas hatchability, hatchability of fertile eggs, eggshell percentage, and eggshell palisade layer increased when hens were fed diets having 48.5 to 168.2-ppm Mn (P < 0.05). Maximum responses for egg weight and eggshell percentage were 117.7 and 63.6 ppm as well as 131.6 and 71.0 ppm (P < 0.05), respectively, using QP and BLQ models. Breaking strength and egg specific gravity had Mn requirements estimated at 140.2 and 112.7 ppm as well as 131.3 68.5 ppm (P < 0.05), whereas eggshell palisade layer and eggshell thickness were maximized with 128.8 and 68.8 ppm and 140.2 and 134.2 ppm, respectively, for QP and BLQ models (P < 0.05). Maximum yolk Mn content values were obtained using 118.0 and 118.4 ppm Mn by QP and BLQ models, respectively. The average Mn requirements estimated for QP and BLQ models is 128.4 and 92.3 ppm Mn (18.7 and 13.5 mg/hen/d), respectively, which is much lower than what has been currently recommended in commercial production.

**Keywords:** manganese, micromineral, broiler breeder, production, hatchability

47 Amino acid-complexed trace minerals on broiler breeder hen performance. Yuri J. Olabarriaga¹, Sergio L. Vieira¹, Bernardo B. Xavier¹, Raquel M. Horn², Pablo L. Santos³, Douglas D. Maria⁴, Walter E. Altevogt¹, Caroline F. Nunes¹, Giovane B. Tornes¹, ¹Department of Animal Science, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, ²Department of Animal Science, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, ³Animal Science, UFRGS, Porto Alegre, Rio Grande do Sul, Brazil, ⁴Zootecnia, Universidade Federal do Rio Grande do Sul, Viamão, Rio Grande do Sul, Brazil, ⁵Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

This study was conducted to evaluate the replacement of trace element sources from inorganic minerals (IM) by amino acid complexed minerals (AACM) sources on broiler breeder hens, and their impact in egg and chick production. Zn, Mn, Cu, and Fe sulfate, Na selenite and K iodate were the inorganic sources whereas the organic were supplemented from amino acid complexed sources. Iodine was provided together with Zn in the amino acid form. The experimental design was completely randomized with 7 treatments, 12 replicates. A total 84 broiler breeder hens Cobb 500, 38-week-old were individually caged, 30 Cobb males roosters were maintained in 3 collective floor pens. The hens were fed with following diets: T1- Control IM sources with Zn, Mn, Cu, Fe and Se I at 100, 100, 20, 60, 0.35 and 2 ppm, respectively; T2- same total mineral content as in T1 in a combination of IM and AACM sources (Zn: 60/60, Mn: 60/40, Cu: 13/7, Fe: 40/20, Se: 0.20/0.15, and I: 0/2 ppm); T3- only IM sources content from T2; T4- only AACM sources content from T2; T5- IM sources with Zn, Mn, Cu, and Fe sulfate, Na selenite and K iodate were the inorganic sources whereas the organic were supplemented from amino acid complexed sources. Iodine was provided together with Zn in the amino acid form. The experimental design was completely randomized with 7 treatments, 12 replicates. A total 84 broiler breeder hens Cobb 500, 38-week-old were individually caged, 30 Cobb males roosters were maintained in 3 collective floor pens. The hens were fed with following diets: T1- Control IM sources with Zn, Mn, Cu, Fe and Se I at 100, 100, 20, 60, 0.35 and 2 ppm, respectively; T2- same total mineral content as in T1 in a combination of IM and AACM sources (Zn: 60/40, Mn: 60/40, Cu: 13/7, Fe: 40/20, Se: 0.20/0.15, and I: 0/2 ppm); T3- only IM sources content from T2; T4- only AACM sources content from T2; T5- IM sources with Zn, Mn, Cu, Fe, Se and I at 120, 120, 25, 70, 0.40 and 3 ppm, respectively; T6- Same total mineral content as in T5 in a combination of IM and AACM sources (Zn: 60/60, Mn: 60/60, Cu: 13/2, Fe: 40/30, Se: 0.20/0.20, and I: 0/3 ppm); T7- only AACM mineral source content from T6. Evaluation was done from week 40–51. During the 39 week hens were fed with the same diet without trace minerals supplementation. Eggs were collected 4 times a day, and
then classified as settable, cracked, shell-less or deformed. At the end of each period, the eggs were incubated; hatchability and chick quality were evaluated at hatch day. Analysis of variance was performed using the PROC MIXED model procedure of SAS with effect of diet and period and their interactions using the repeated statement of SAS program. The total and settable egg production per hen to 51 wk was also analyzed using PROC GLM. There was significant effect occurred for eggshell thickness, which was increased when hens were fed partial and total replacement of AACM (P < 0.05). Contrasts between total replacement with AACM and IM supplemented diets showed an increase in settable eggs when breeders were fed AACM. Higher hatchability of fertile eggs was observed in partial replacements with AACM treatments when compared to IM (P < 0.05). Also, hatching chick had higher length and more chicks with leg score 1 in total replacement of AACM compared to the partial AACM replacement and IM groups (P < 0.05), and IM groups (P < 0.05), respectively. In conclusion, totally or partially replacement with IM by AACM led to improvements in eggshell and chick quality, settable eggs production and hatchling chick weight.

Keywords: hatchability, chick quality, egg quality, incubation, trace minerals

48 Effects of 25-Hydroxycholecalciferol on performance, bone quality and gut health of broilers fed with unbalanced reduced calcium and phosphorus diet during Eimeria challenge. Taina Lopes¹, Hanyi Shi², Dima White², Itallo Araujo¹, Woo K. Kim², ¹Animal Science, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, ²Poultry Science, University of Georgia, Athens, Georgia, United States.

This study evaluated the effects of 25-hydroxycholecalciferol (25-OHD) on performance, bone quality and gut health of broilers fed with a reduced calcium (Ca) and available phosphorus (avP) diet and challenged with Eimeria spp. Cobb 500 male chicks (n = 576) were randomly distributed in a 2 x 2 factorial arrangement (6 replicates/12 birds). The main factors were 25-OHD levels (0 or 3,000 IU/kg of feed), Ca and P levels (0.84% of Ca/0.42% of avP or 0.64% of Ca/0.22 of avP) and challenge or non-challenge with Eimeria spp. At day 14, in the challenge group, each bird received orally 25,000 Eimeria maxima, 25,000 Eimeria tenella, and 125,000 Eimeria acervulina oocysts. Feed intake was determined daily from 0 to 12 d post-infection (dpi). At 6 and 12 dpi, body weight, feed conversion ratio, bone growth rate, and whole body composition by dual energy x-ray absorptiometry were measured. At 6 dpi, intestinal morphology, oocyst shedding, and total tract digestibility were evaluated. At 6 and 9 dpi, bone ash and bone 3-D structural analyses using micro-computed tomography were measured. All statistical procedures were performed using R software v. 4.1.1. The statements of significance were based on P < 0.05. The 25-OHD supplementation counterbalanced the negative effects of Eimeria spp. challenge and dietary mineral reduction. Challenge, regardless of 25-OHD and mineral levels, impaired growth performance, bone ash, bone density, bone growth rate, intestinal morphology, nutrient digestibility (P < 0.001), and bone mineral content (P < 0.05). Regardless of challenge and 25-OHD supplementation, reduced Ca and avP levels decreased fat free bone weight, ash percentage, bone concentration, bone mineral density, bone mineral concentration, and Ca and P digestibility (P < 0.05). Despite of challenge and Ca and avP levels, 25-OHD supplementation improved bone ash, bone concentration, bone mineral content and Ca and P digestibility (P < 0.05). Thus, the Eimeria challenge had a negative effect on growth performance, bone quality, intestinal morphology and mineral digestibility. The dietary 3,000 IU of 25-OHD supplementation improved mineral absorption and bone mineral deposition in coccidiosis challenged broilers fed reduced levels of Ca and P.

Keywords: Vitamin D, Eimeria, bone quality, mineral reduction, gut health


Four trials were conducted to determine mineral requirements for broiler breeder hens. In all trials, 120 Cobb 500 females were allocated in individual wire cages, while Cobb breeder males were kept in separate cages for semen collection. Study 1 consisted in 6 treatments with increasing levels (3.0 ppm) of Cu, after hens receiving 4 wk deficient Cu diet. Study 2, hens were received a deficient Fe diet for 11wk, to induce a partial body Fe depletion, and then hens were fed increasing levels (25.0 ppm) of Fe, totaling 6 treatments. Study 3, hens were fed a basal diet deficient in Mn for 4 wk, after they were fed increasing levels (30.0 ppm) of Mn, totaling 6 treatments. Study 4, hens received a basal diet with Zn depletion for 7 wk. Then, they were fed diets with increasing levels (30.0 ppm) of Zn, totaling 6 treatments. Egg production, settable eggs, eggs weight and egg mineral content were evaluated. Estimation of requirements of the minerals evaluated were done using exponential asymptotic (EA), broken line quadratic (BLQ) and quadratic polynomial (QP) models. In study 1, requirement for total eggs per hen were obtained with 13.1 ppm of Cu, using QP. Egg production and total settable eggs requirement per hen using EA, BLQ and QP were 6.2, 7.3, and 12.9 ppm; 8.1, 9.0, and 13.4 ppm, respectively. Maximum responses for egg weight and yolk Cu content were 14.9 and 12.7 ppm; 15.0 and 16.3; and 7.3 and 7.8 Cu, respectively, for EA, BLQ and QP models. In study 2, the response of Fe requirement for total hatching eggs and egg yolk Fe content were 96.8, 97.1 ppm (QP) and 76.4 and 89.3 ppm, respectively.
ppm (BLQ). Optimization with the EA model was obtained for total hatching eggs and egg yolk at 97.9 and 111.0 ppm of Fe, respectively. In study 3, requirement of egg production and settable egg production using QP and BLQ were 115.8 and 56.6 ppm and 122.1 and 63.6 ppm, respectively. Total eggs and total settable eggs per hen had Mn requirements estimated at 115.7 and 56.6 and 121.8 and 61.7 ppm, using QP and BLQ, respectively. Maximum response for egg weight using QP and BLQ were 117.7 and 131.6, respectively. Maximum values for yolk Mn content were 118.0 and 118.4 ppm of Mn by QP and BLQ, respectively. In study 4, requirements obtained for Zn for hen d egg production and settable egg production were 62.8 and 52.8 and 67.7 and 62.1 ppm, respectively, using BLQ and EA models. Total eggs and total settable eggs produced per hen had Zn requirements estimated for BLQ and EA at 75.7 and 64.7 and 56.5 and 41.5 ppm, respectively. Maximum response for Zn in yolk were 64.5 and 59.6 ppm, using BLQ and EA models, respectively. The average response for Cu, Fe, Mn and Zn were 12.0, 93.0 91.0 and 85.0 ppm, respectively.

Keywords: trace minerals, breeder, egg production, egg content, hatching eggs

50 Use of enzymatic blend for total or partial replacement of conventional phosphorus sources in commercial laying hens diet. Caroline Scheletz1, Javer A. Vieira Filho2, Karina F. Duarte2, Rodrigo F. Jacob2, Tabyta S. Sabchuk2, Claudio M. Franco2, Priscila R. Oliveira2, Sebastião A. Borges2 1Universidade Federal do Paraná, Curitiba, Brazil, 2Vaccinar Nutrição Animal, Pinhais, Brazil, 3Vaccinar Nutrição Animal, Curitiba, Brazil.

An experiment was carried out to evaluate the impact of an enzymatic blend in the total or partial replacement of phosphorus sources (meat meal) in the diet on performance and egg quality of commercial layers. Three hundred Lohmann LSL layers with 32 weeks of age were housed in metallic cages at a commercial aviary and completely randomized distributed in three treatments with ten replicates with ten birds each (T1: meat meal diet; T2: meat meal diet total replaced by enzymatic blend; T3: meat meal diet partial replaced by enzymatic blend). Diets were isoproteic, isenergetic and isophosphoric, formulated according strain recommended levels. The enzymatic blend (Biophosforo, Vaccinar Nutrição Animal) in order to improve the use of ingredients and, mainly, increase the availability of phosphorus for laying hens. Biophosforo composition: citric acid: 12.43 g/kg; phosphoric acid: 24.43 g/kg; formic acid: 44.83 g/kg; pantothenic acid: 115.00 mg/kg; cellulase: 4.5 U/g; phytase: 1100.0 FTU/g; phosphatidylcholine: 317.33 mg/kg; phosphorus: 114.3 g/kg; glucanase: 6250.0 U/g; protease: 750.0 U/g; niacin: 1400.0 mg/kg; vitamin B6: 110.0 mg/kg; vitamin E: 25.0 IU/kg; xylanase: 140.0 U/g. The experiment was divided into four periods with daily evaluations of the following parameters: laying rate (%/layer/day); feed intake (gr/layer/day); egg production per housed layer; broken egg shell (%) and weekly: shell strength (kg/cm), shell thickness (mm) and egg weight (gr) parameters were evaluated. All variables were normal according to the Kolmogorov Smirnov test. The variances homogeneity was evaluated by the Hartley F-maximum test. Data were submitted to variance analysis (ANOVA) at 5.0% probability. There was no difference (p>0.05) between treatments on performance or egg quality. Results support the possibility of total or partial phosphorus sources replacement (meat meal) by the enzymatic blend without compromising performance and egg quality of commercial laying hens during the production period.

Keywords: layer, enzymes, performance, egg quality, phosphorus

51 Effect of hydroxy-selenomethionine on broiler breeders performance. 

Bruno B. Lemel1, Thaisa Pereira de França1, Luis Filipe V. Freitas1, Guilherme F. Teofilo2, Bernardo R. Nogueira1, Garros Fontinhas Netto3, José Henrique Barbi3, Nilva K. Sakomura1, 1Animal Science, São Paulo State University, Jaboticabal, Brazil, 2Department of Animal Science, São Paulo State University, Jaboticabal, São Paulo, Brazil, Jaboticabal, Brazil, 3Adisseo, São Paulo, Brazil.

Selenium (Se) is an essential micronutrient for birds, then the deficiency of this nutrient can affect broiler breeders production and reproduction. The quality of chicks depends on the composition of the egg. Selenium as an antioxidant in animal metabolism could improve the embryos development and hatchability. The aim of this study was to evaluate the egg production and hatchability of eggs of broiler breeders, fed with organic or inorganic Se, in the second production cycle. A total of 600 broiler breeders (Cobb 500) in the second production cycle, and 60 roosters were fed diets supplemented by: 0 ppm of Se or 0.3 ppm hydroxy-selenomethionine or 0.3 ppm sodium selenite with 10 repetitions of 20 broiler breeders and 2 roosters each. The trial lasted 12 weeks, divided into three cycles of 28 days each. Egg production was counted daily. At week 12, 1050 eggs were collected for 8 consecutive days and stored in a climate room (19°C and 60% RH). The eggs were distributed in a hatching machine (CASP) in 10 replicates of 35 eggs according to dietary treatments. During 18 days of incubation, it was controlled the temperature of 99.5 °F in the dry bulb and 85 °F in the wet bulb, a ventilation of 1.1 m3/s, and the eggs were turned every hour. At 18 days, the eggs were transferred to the hatcher and kept at temperature of 98.9 °F in the dry bulb and 86.5 °F in the wet bulb, and ventilation of 0.5 m3/s. At 21 d, hatched chicks and fertility were measured. Hatchability was calculated considering the number of hatched chicks by the number of fertilized eggs. Differences were tested by means of one-way ANOVA, followed by Duncan post hoc test (p <0.05). Significant difference (p<0.05) in egg production was observed only in the third cycle. The egg production of birds fed 0.3 ppm
hydroxy-selenomethionine was significantly higher (57.91%) than those without selenium supplementation (52.86%). However, the diet with 0.3 ppm sodium selenite (54.70%), the difference observed presented a P value of 0.1522. No difference was observed between source for fertility. The hatchability of eggs from broiler breeders supplemented with hydroxy-selenomethionine (91.32%) was significantly higher than sodium selenite and no supplemented (87.06 and 85.20%, respectively). In conclusion, hydroxy-selenomethionine showed to positively influence egg production and in particular hatchability in eggs of broiler breeders.

**Keywords:** egg production, hatchability

---

52 Effects of dietary organic selenium supplementation in broilers diets and its effects on growth performance, carcass and parts yields, blood and hormonal parameters, and breast meat quality.


Selenium (Se) is an integral constituent of selenoproteins that participate in various physiological processes. The antioxidant action of this mineral has positive effects on meat quality, also representing an alternative to reduce or prevent myopathies. Therefore, the objective of this study was to evaluate the effects of organic Se supplementation on growth performance, carcass, parts and liver yields, blood and hormonal parameters, and meat quality of broilers. One-d-old chicks (n = 1,000; Cobb 500) were assigned to 10 replicate pens (20 birds per pen) and fed 1 of 5 dietary treatments (0, 0.15, 0.23, 0.47, and 1.3 mg Se per kg of feed), and were reared from the period of d 1 to 42. Growth performance was determined on d 21 and 42. At d 41, one broiler per pen was randomly selected and fasted for 6 h prior to blood collection. Plasma samples were analyzed for uric acid (UA), alanine aminotransferase (ALT), aspartate aminotransferase (AST), albumin (ALB), cholesterol (CHO), creatinine (CRE), gamma-glutamyltransferase (GGT), glucose (GLU), lactate dehydrogenase (LDH), total protein (TP), triglycerides (TRI) and creatine phosphokinase (CPK) using commercial kits with a high-performance automatic spectrophotometer. Corticosterone (COR) and thyroxine (T4) hormones were quantified with a monochromator-based microplate reader. At d 42, four animals per pen were selected and euthanized to determine carcass and parts yield and to evaluate Wooden Breast (WB) and White Stripes (WS) myopathies. For meat quality analysis, breast muscle samples were used to determine cooking loss (CL), shear force (SF), and water holding capacity (WHC). Thiobarbituric acid reactive substances (TBARS) analysis was performed for lipid peroxidation after 10, 30, and 60 d of storage at -20 °C. Data was analyzed as a 1-way ANOVA using SAS PROC GLM with orthogonal polynomials and a regression analysis was performed when a linear or quadratic effect with a 95% confidence interval was observed. No differences were observed for growth performance for the period from d 1 to 21, while from d 1 to 42 d, for feed intake (P = 0.0376) and weight gain (P = 0.0062), treatments with 0.15, 0.23 and 0.47 mg Se per kg were different in comparison to the control group. Regarding carcass, parts and liver yields, a decreasing linear effect was observed for liver (P = 0.0290), with no effects on the other variables. For blood metabolites and hormonal parameters, a quadratic effect was observed for CRE (P = 0.0171) and ALB (P = 0.0356). No differences were observed for meat quality. Based on the results of this experiment, we conclude that organic Se supplementation improves weight gain, no affecting meat quality.

**Keywords:** antioxidant, broilers, organic selenium, white striping, wooden breast
Indigenous chickens (IC) (*Gallus Domesticus*) have been an essential component of rural agriculture in most low-income countries. In Sub-Saharan Africa, rural communities have achieved socio-economic benefits from IC regarding household incomes, socio-cultural and food and nutritional security. However, market-related barriers have significantly hindered the sustainable development of the IC sector. In 2021, we surveyed 358 households in Eastern, Central and Southern livelihood zones to gather demographic and socio-economic data to assess the motivations for producing IC and evaluate market-related limitations among small-scale farmers (SSF). The data, analysed by mixed methods, revealed that over 80% of the households were male-headed, and 78% of heads were over 35 years old. Over 76% of the farms were established after 1991, with 60%-80% of farmers owning ten hectares or less of agricultural land whose tenure was unsecured. Further, agriculture was the main occupation for over 83% of the households, and nearly 99% of households produced IC, with an average of 45-49 birds per family across the three livelihood zones. Almost 38%-54% of the farmers sold ten chickens and 44%-51% consumed ten chickens or less yearly. Most market-related challenges were exacerbated by distances from the potential market, as more than 77% of farmers lived 11-21 kilometres from the town centre. Other barriers included unfavourable pricing mechanisms, 41% sold hens at Zambian Kwacha 62 per bird based on visual price assessment, unstable seasonal supply, lack of government policies supporting the IC sector, and a slow growth rate for IC resulting in 60%-73% of farmers selling their chickens 6-12 months from hatching. Farmers' motivations for keeping IC for socio-economic gains were consistent in the three livelihood zones. Over 89% of the farmers sold chickens to solve any urgent family problem including funerals, marriages and other socio-cultural demands. However, deliberate policies are required to promote equal participation of men and women in agriculture, secure land ownership, support women and youth-owned agri-businesses, and improve infrastructure and access to market facilities (Klingholz 2020; Lay et al. 2021). These interventions would enhance the IC sector's development, sustainability, and improved rural livelihoods in Zambia.

**Keywords:** rural community, socio-economic, indigenous chicken sector, food and nutritional security, livelihood
Daily production of egg components of laying hens in a semi-extensive system. João Pedro d. Cordido, Karoll Andrea A. Torres-Cordido, Juan Carlos P. Quintero, Samuel D. Rocha, Laboratório de Zootecnia, Centro de Ciências e Tecnologias Agropecuárias, Universidade Estadual do Norte Fluminense Darcy Ribeiro, Campos dos Goytacazes, RJ, Brazil, Centro de Ciências e Tecnologias Agropecuárias, Universidade Estadual do Norte Fluminense Darcy Ribeiro, Campos dos Goytacazes, RJ, Brazil, Ecoavi, São João da Barra, RJ, Brazil. The use of production records is being implemented in small and medium-sized poultry farms served by the extension project in aviculture of the Animal Science Laboratory (LZO) of UENF. The systematic collection of data will be valuable for the structuring of the poultry production chain, which is emerging in the northern region of Rio de Janeiro. The objective of this work was to analyze the daily production of egg components per bird of laying hens raised in a semi-extensive system. Data were collected on a poultry farm located in the district of Carvão in the municipality of Campos dos Goytacazes, RJ, served by the extension project. The producer was instructed to correctly fill in the daily production records. The data corresponded to a batch of 150 laying hens of the Novogen Brown Line, fed with corn and soybean meal-based feed, formulated according to the nutritional needs recommended in the TBAS (Rostagno et al., 2017) and managed following the guideline of the lineage. The birds were housed at 14 weeks of age, with a density of 4.5 birds m² in the shed and 1 bird m² in the open area (two paddocks with rotation management). An increasing light program was programmed until reaching 16 hours of light per day. Egg production started at 18 weeks. The producer made the daily record of egg production, feed intake, and mortality. He sent monthly, for 12 months, a sample of 30 eggs for physical analysis in the LZO. The individual weights of eggs, yolk and shell were recorded, and the albumen weight was calculated by difference. The daily production of egg, yolk, albumen, and shell per bird was calculated. Data were fitted to Gaussian models. The productive peak of each variable was determined by setting the first derivative of the model to zero. As a result, it was observed that the production peaks of egg, yolk, albumen, and shell were at 147, 191, 123 and 91 days, respectively, with 58.61, 15.44, 37.68 and 5.72 g/bird/day, respectively. The egg production peak expected for the strain is at 140 days. The data modeling results also showed that daily egg production from peak to end of cycle varied little, but daily production per bird, of total mass and of each component, dropped dramatically. The relative proportions of the components varied throughout the cycle, and a reduction in the proportion of shell was demonstrated. This type of data analysis can help producers to understand the variation in egg quality throughout the bird's life and to make decisions related to the classification and marketing in natura or in the industrialization of the components. Acknowledgment: Mr. Luiz Fernando Gomes da Silva, Sitio Brejo Grande, PROEX/UENF.

Keywords: Novogen Brown, family fanning, production records

Virginia Tech Research Education Programs: Models for increasing STEM participation in middle- and low-income countries. Ed Smith, School of Animal and Poultry Sciences, Virginia Tech, Blacksburg, Virginia, United States.

Middle- and low-income countries, including Brazil and other Latin American nations, confront similar challenges faced by the United States of America and other high-income countries: engaging, recruiting, and training students from low income and minority backgrounds in STEM and related fields. We describe USA government-funded training programs, and their statistics, and suggest they can be used to train URMs and low-income the next generation of aspiring poultry scientists in Latin America. The traditional approach of a pyramid in which only top-performing students eventually succeed in pursuing STEM careers will not help reduce the paucity of URM PhD trainees in the agricultural sciences. In 2003 and 2007, through competitive funding from the National Institutes of Health, Virginia Tech established the Post-baccalaureate Research Education Program (PREP) and the Initiative to Maximize Student Development (IMSD), respectively. Our training programs are based on the hypothesis that a cohort approach to graduate education have better outcomes than the professor-driven tradition of the land grant system or one-student-at-a-time. A total of 219 trainees have participated in these research education programs. The institutions of origin have been national and The US Territories and Puerto Rico. The trainees have pursued research training in diverse disciplines including genomics/genetics. The training plan has included innovative approaches such as an Ombudsperson for graduate education, retrospectives by scientists as Scientific Journeys” on YouTube, peer and near-peer mentoring, and a committed engagement with alumni for their lived experiences and to continue impacting their careers. Additionally, required courses include “Effective Grant Writing” and Scientific Writing. The courses help us to not only provide additional training in “soft skills,” but to stay in regular contact with trainees in the early months of the PhD. Together, these efforts have resulted in 88 PhDs, 3 MDs, 30 MS and 1 DPharm. Trainees are pursuing diverse careers including 13 in tenure-track academic positions, one of whom was recently tenured. Our recent matriculation rate continues to be above 75%. Beyond research skills, our trainees acquire networking, mentoring, and communication (written and oral) skills that have
contributed to their successes. Our creativity as scientists, I will argue, has made these successes more likely in a department not generally considered biomedical or behavioral. We are confident that this research education model, involving leadership by dedicated scientists and institutional commitment, can be effective in recruiting and training URMs in low- and middle-income countries.

**Keywords:** research education, low-income, minorities, STEM
Biochemical variables are commonly measured in the blood serum and plasma of broiler chickens. However, the impact of light intensity during rearing, fasting and storage times as well as which blood fraction is most appropriate for the metabolites being evaluated are not well understood. Thus, the objective of this completely randomized design experiment with 2 x 7 x 5 x 2 factorial treatment structure was to evaluate the effect of 2 light intensities, 7 fasting and 5 storage times on calcium (Ca) and phosphorus (P), and alkaline phosphatase activity (ALP) in 2 blood fractions (serum vs. plasma) of broilers. Male Cobb 500 (n = 140) were grown to 42 d-of-age and a BW of 3.1 ± 0.7 kg. Then, birds were redistributed into 7 replicate pens (10 birds per pen) per light intensity (5 and 20 lux) and grown to 45-d-of-age. Broilers were fasted for 1 h and then allowed to consume feed for 30 min prior to the initial blood collection (0 h). Blood was then collected from 1 of the 7 replicate pens from each environment (5 and 20 lux) via ulnar venipuncture using vacuum tubes with and without anticoagulant (5 mg NaF + 4 mg EDTA-K3) at 2-h-intervals during the 12 h fasting period (0, 2, 4, 6, 8, 10 and 12 h). Serum and plasma fractions were collected following centrifugation and analyzed after 0, 15, 30, 60, and 120 d of storage in microtubes at -20 °C. Analysis was done using a spectrophotometry biochemical autoanalyzer (Flexor EL 200) with specific kits (Elitech) calibrated with ELICAL standards. Data were analyzed as a 1-way ANOVA by main effect using the GLM procedure of SAS with mean separation at P ≤ 0.05. Broilers reared with 5 lux had greater plasma ALP (P = 0.0002) and Ca (P < 0.0001) compared with those reared from d 42 to 45 at 20 lux. In the serum fraction, Ca decreased (P < 0.0001) and ALP increased (P = 0.0006) linearly as fasting time increased. Plasma ALP increased linearly as storage time increased (P = 0.0204). A quadratic storage time effect was observed for Ca (P < 0.0001) and P (P < 0.0001) concentrations in both fractions. These data indicate that samples can be stored at -20 °C for up to 120 d prior to P analysis, while the use of EDTA as an anticoagulant for subsequent measurement of plasma Ca is not recommended. Overall, this work highlights the importance of considering various factors that can influence the ability to accurately determine circulating concentrations of Ca, P, and ALP in broiler chickens.

**Keywords:** blood metabolites, storage, fasting, light intensity, broiler chickens

In order to achieve the Good Quality Laboratory Practices, with low cost and agility, it is important to determine a standard protocol and Standard Operating Procedure that assess the morphological adaptations of poultry extra and intraembryonic tissues. In the experimentation and innovation of production techniques, embryonic tissues have been widely used. However, it is not clear which techniques allow for comparative analysis between experimental groups that describe embryonic development. The embryonic membranes play an important role in fertilization, embryogenesis, vasculogenesis, nutrition, gas exchange, molecular synthesis, immunity and embryo protection. Investigating these processes provides knowledge about reproductive viability, formation of musculoskeletal tissues, metabolic and digestive maturation, nutritional capacity, growth and tumor development. In addition, studying the germ layers, embryogenesis and organogenesis, provides information on genetic, pharmacological, environmental and nutritional aspects of animals. Then, Cobb fertilized eggs were used, collected at different times of embryonic development. The extra and intraembryonic tissue samples were collected and fixed in formaldehyde solution for further processing and mesoscopic and microscopic analysis. For the mesoscopic analyses, samples were photographed in a stereomicroscope for direct evaluation of the angiogenesis processes. For microscopic analyses, the samples were submitted to processing for embedding in paraffin, microtomy and analyzed for their morphological characteristics. Thus, histological slides were performed by routine stain methods and quantification of lymphocytes, glycogen, glycoproteins, glycolipids, mucins, sulphated acidic polysaccharides, condrotin, aggrean, cartilages, goblet cells, sulphated/carboxylated acid mucopolysaccharides, glycoproteins, hyaluronic acid, muscle cells, collagen I/III and elastin. All slides were measurement by ImageJ and performed to statistical analysis. The evaluation strategies and description of the modifications or adaptations resulting from experimental proposals associated with technological innovation in management and nutrition were standardized, seeking to optimize chicken production. Additionally, the possibility of using these biomaterials in pharmaceutical
and biomedical experimentation in carrying out in vivo, in vitro, ex vivo and in ovo studies. The establishment of a standard protocol that allows evaluating the impact of different experimental tests on the development of different embryonic tissues, provides information that helps to define the degree of success of innovative techniques proposed for the advancement of poultry production.

**Keywords:** histology, development, chicken egg, chicken embryo, germ layers
58 Influence of light intensity, blood fraction, fasting and storage time on liver enzyme activity of broilers. Thiago S. Andrade1, Cluber Polese1, Nilton Rohloff Junior1, Cleison d. Souza1, Maisa B. de Carvalho1, Mariane Cristina Mohr de Souza1, Maressa Fernanda Cardoso Pereira1, Mayara M. Camara1, Lidiane I. Datsch1, Bárbara Amanda Bebber1, Mario Roberto Uhlein Júnior1, Heloísa Sartor1, Gabrieli Toniazzo1, Felipe Potenza Campos1, Ana P. Costa1, Tânia Luiza Kohler1, Charles W. Starkey2, Cinthia Eyng1, Ricardo V. Nunes1, 1Department of Poultry Science, Western Paraná State University – UNIOESTE, Marechal Cândido Rondon, Paraná, Brazil, 2Department of Poultry Science, Auburn University, Auburn, Alabama, United States.

The objective of this study was to evaluate the effect of light intensity, fasting and storage time at -20 °C and blood fractions (serum vs plasma) on activity of aspartate aminotransferase (AST), alanine aminotransferase (ALT) and gamma glutamyltransferase (GGT), to broilers. Male Cobb 500 (n=140) were grown, to 45 d of age with an average weight of 3123±654g. From 42 to 45 days of age the birds were distributed in a completely randomized design, separated in two environments of light intensity 5 and 20 lux m-2. The birds were on a 1 hour fast and then were fed for 30 minutes post fast. After ingestion of feed, the first blood is collected postprandial or time zero, and then blood was harvested at 2 hour intervals during 12 hours of fasting. Blood was collected from 10 birds from each environment (5 and 20 lux2), via brachial puncture of the ulnar vein using vacuum tubes with and without anticoagulant (sodium fluoride 5mg + EDTA-K3 4mg). After blood was harvested it remained in horizontal position for 15 minutes at room temperature and was centrifuged at 1050 G for 10 m. Plasma and serum fractions were separated and stored in microtubes at -20 °C, and were analyzed at 0, 15, 30, 60 and 120 days of storage. Analysis was done using a spectrophotometry biochemical autoanalyzer (Flexor EL 200) with specific kits (Elitech), calibrated with standard ELICAL. Results were analyzed in 2 x 7 x 5 x 2 factorial design, using the GLM procedure of SAS. There was an interaction for blood fraction vs fasting time for ALT and GGT activity, and there was an interaction for blood fraction vs storage time for ALT activity. No effect of light intensity was observed. In the serum fraction, ALT had maximum activity 10.02 U L-1 with 3 h and 46 min (P < 0.0001), (- 0.034*H + 0.251 + 9.550, R² = 0.53, H = hours). Plasma GGT activity decreased linearly (P < 0.0001), (- 1.600*H² + 49.672, R² = 0.77), as the fasting time increased. Maximum serum ALT activity 9.82 U L-1 was obtained with 32 days of storage (P = 0.0086), (- 0.00026*D² + 0.017*D + 9.554, R² = 0.89, D = days). Minimum plasma ALT activity 5.59 U L-1 was obtained with 93 days of storage (P < 0.0001), (0.00054*D² - 0.101*D + 10.234). Serum AST and GGT data, as well as plasma AST and ALT data, did not adjust for regression analysis for fasting time, also serum and plasma AST and GGT did not adjust for regression analysis for storage time. Maximum of 4 h of fasting and 32 days of storage at -20°C is recommended for serum ALT analysis. For plasma ALT analysis maximum 93 days of storage is recommended.

Keywords: biochemistry, light intensity, metabolites, gluconeogenesis, fasting


The improvement in the ratio of linoleic acid (LA) and alpha-linolenic acid (LNA) in the diet of breeders increases eicosapentaenoic and docosahexaenoic acids in the metabolism, with beneficial effects on reproduction and production in general. These fatty acids are more susceptible to oxidative processes and the association with antioxidant substances is necessary. Thus, this study evaluated the effects of LA:LNA ratios combined with vitamin E (vitE) supplementation on incubation performance and chick quality in Japanese quail breeders. 480 15-week-old quails were used, distributed in DIC and 2 x 3 factorial scheme with two ratios of LA:LNA (13.75:1 and 9.29:1) and three levels of vitE (25, 200, 250 mg), with 10 repetitions with 2 males and 5 females. The sources used were soybean oil (LA), flaxseed oil (LNA) and alpha-tocopherol (vitE), in basal feed with 25 mg/kg of the vitamin premix and for the other vitE levels 175-mg vitE was added to obtain 200 mg and 225 mg vitE for 250 mg. Eggs from 4-5 consecutive days were incubated in an automatic incubator and hatchability, fertility and mortality were determined. Chick quality was analyzed in 50 birds/treatment and weight, length, and Pasgar© score were evaluated. Statistical analyses were performed using SAS V9.0 at P ≤ 0.05. Incubation performance was analyzed using the PROC GENMOD with a BINOMIAL distribution, and LOGIT function (Y = expβ/1 + expβ), and chick quality using PROC GLM. For the hatchability of fertile eggs, a difference was observed between the LA:LNA ratios (p = 0.005), with higher hatchability (97.17%) for the 9.29:1 ratio compared to the 13.75:1 ratio (93.99%) and effects on the vitE levels (p = 0.019), with higher means at the 200 (97.02%) and 250 mg (96.53%) levels. There was an interaction effect (p = 0.0467) between LA:LNA ratios and vitE levels for fertility, with better fertility at the 9.29:1 ratio and vitE 25 mg (99.15%), followed by the 13.75:1 ratio and vitE 250 mg (98.27%), demonstrating that for the 13.75:1 ratio a higher level of vitE is required compared to the 9.29:1 ratio. LA:LANA
ratio (p = 0.003) and vitE levels (p = 0.014) influenced total chick mortality. When the LA:LNA ratio was reduced and vitE levels increased, mortality decreased. In chick quality, there was significant interaction between LA:LNA ratio and vitE levels (p = 0.012), with heavier chicks (8.06 g) in the 9.29:1 ratio and vitE 250 mg, while those in the 13.75:1 ratio and in vitE 250 mg treatment chicks weighed 7.5 g. In conclusion, the use of linseed oil to obtain a lower LA:LNA ratio is indicated and should be associated with vitE 250 mg to produce better hatchery rates by improving hatchability, fertility and producing better day-old chicks.

**Keywords:** fertility, hatchability, mortality, Pasgar© score, chick

**60 Effect of a mycotoxin deactivator on the growth, reproductive performance, immunity, egg quality, oxidation and intestinal status of broiler breeders and their offspring broilers.** Damien Preveraud1, Shiping Bai2, Bin Song2, Wanderley Quineteiro3, Yuping Zhang4, Tim Ma4, 1Mycotoxin Management, Adisseo France SAS, Antony, France, 2Animal Nutrition Institute, Sichuan Agricultural University, Chengdu, China, 3Adisseo Brasil, Sao Paulo, Brazil, 4Adisseo Life Science, Shanghai, China.

This study aimed to investigate whether the mycotoxin deactivator can counteract the negative effect of dietary naturally moldy corn on broiler breeders and their offspring chicks. A total of 480 Cobb breeders were allotted into 30 replicates and each replicate contained 2 cages with 8 birds per cage. The 30 replicates were randomly assigned to 6 experimental treatments (n=5) according to the laying-rate during 2 weeks prior to the formal experiment in a completely randomized design. The 6 treatments included a commercial diet (Control), the naturally moldy corn (MC) substituting for 50% corn in the control diet (LM), the LM diet supplemented with 2 kg mycotoxin deactivator (MD) per ton (LML), the naturally moldy corn substituting for 100% corn in the control diet (HM), and the HM diet supplemented with 2 (HML) or 2.5 kg mycotoxin deactivator per ton (HMH). All diets were in mash form. This trial lasted 4 weeks from the age of 50 to 53 weeks. Production parameters (live body weight, total number of eggs including settable eggs, egg weight, and feed consumption) were recorded weekly. Reproduction parameters were measured on 3 successive days. Two birds were randomly selected from each replicate and blood, jejunal and liver tissues were collected. The PROC GLM procedure of SAS (SAS Inst. Inc, USA) was used to analyze the data and the Tukey test was used for multiple population comparisons among different treatments means. Values of P<0.05 were considered statistically significant. Live body weight was not influence by the treatments. Mycotoxins in the diet impaired the laying (egg production and feed efficiency, P<0.05) and reproductive performances (hatchability and embryonic mortality; P<0.05) but MD can restore them to their initial level. Egg quality (shell thickness, Haugh unit, yolk color) were somehow affected by the challenge but the MD aimed to significantly increase these technological parameters. Some redox (SOD) and immune (IgA, lysozyme, pro-inflammatory cytokines) markers in blood were also negatively modulated by the dietary mycotoxins but the mycotoxin solutions was enable to promote them even higher to the non-challenged control. Finally, liver cells were distended with fat in mycotoxin groups. The size of the vacuoles were larger in the HM group than in the LM group as well. MD addition decreased the fat deposition in the hepatocytes and restore an healthy status of the liver. In conclusion, the MD addition could improve the antioxidative function and intestinal immunity of breeders, resulting in the increases of the production performance and reproduction performance and the MD addition in maternal diets could also increase the growth performance and immunity of offspring chicks.

**Keywords:** breeder, chicken, mycotoxin, performance, health
Monitoring of multidrug-resistant *Escherichia coli* in poultry farms in southern Brazil. Victor D. Cruz, Renata K. Takayama Kobayashi, Gerson Nakazato, Fabrizio Mattei, Carolin Prigošič, Maísa F. Menck-Costa, Humberto Schiffer Cury, Luiz E. Takano, Alceu Kazuo, Beatriz D. Cruz, Microbiology, Universidade Estadual de Londrina, Londrina, Paraná, Brazil; 2Vetanco Brasil, Chapecó, Santa Catarina, Brazil; 3UENP, Bandeirantes, Paraná, Brazil.

The purpose of this study was to monitor *Escherichia coli* isolated in chicken litter, cloacal swab and beetles found in the poultry litter, regarding their resistance to antimicrobials used in poultry breeding and to observe if there was a connection between their use and the antimicrobial resistance found in these strains. Brazil has no integrated surveillance programs, and a lack of data regarding the use of antimicrobials. The samples were collected from 28 broiler farms in southern Brazil, in all farms a questionnaire was applied that had questions about the use of antimicrobials, among other things. In each farm, ten cloacal swabs were collected, poultry litter and around 50 beetles. *E. coli* bacteria were identified through biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performed on agar with 17 antimicrobials following biochemical tests and then a Disk Diffusion Susceptibility test was performs...
application led to the development of a less diverse cecal microbial core composition compared to control and spray strategies, indicating some disruption in GIT microbial development could be occurring. Ultimately, to the best of our knowledge, this is the first demonstration of a local microbiota response to a spray-inoculated vaccine to Campylobacter antigen in chickens.

Keywords: Campylobacter, spray vaccine, microbiome, 16S rRNA gene sequencing

63 Effects of phage therapy on Salmonella of feed withdrawal and non-feed withdrawal broilers during in vitro cecal incubation. Jessica A. Brown, Dana Dittoe, James Corban, Srivatsan Raman, Steven Ricke, Meat Science and Animal Biologies Discovery (MSABD), Department of Animal and Dairy Sciences, University of Wisconsin - Madison, Madison, Wisconsin, United States, Department of Biochemistry, University of Wisconsin - Madison, Madison, Wisconsin, United States, Madison, Wisconsin, United States.

Feed withdrawal immediately prior to harvest (8 to 12 h) is a common practice in the poultry industry to reduce the incidence of carcass contamination during evisceration. However, feed withdrawal practices have been shown to impact the microbial ecology of the gastrointestinal tract and alter the virulence and transfer of foodborne pathogens such as Salmonella. Therefore, the objective of the study was to determine the efficacy of phage therapy to reduce Salmonella Enteritidis within an in vitro cecal model on birds that have undergone feed withdrawal for 8 h. One day post-hatch, a total of 20 Ross 708 male broilers were obtained from a local hatchery in Wisconsin and placed in a floor pen. Birds were supplied water and a commercial corn-soybean diet ad libitum. At 63 d of age, broilers were subjected to either a no feed withdrawal (NFW) period or an 8 h feed withdrawal (FW; N=20, n=10). Broilers were humanely euthanized and cecal contents of NFW and FW birds were collected (n=10), transported to Wisconsin - Madison, Madison, Wisconsin, United States, and placed in a floor pen. Birds were supplied water and a commercial corn-soybean diet ad libitum. At 63 d of age, broilers were subjected to either a no feed withdrawal (NFW) period or an 8 h feed withdrawal (FW; N=20, n=10). Broilers were humanely euthanized and cecal contents of the NFW and FW birds were collected (n=10), transported to an anaerobic chamber, and diluted 1:3000 in an anaerobic dilution solution. Subsequent diluted ceca (20 mL) were aliquoted to the following in vitro treatments: (1) NFW ceca, (2) FW ceca, (3) NFW ceca + Salmonella, (4) FW ceca + Salmonella, (5) NFW ceca + Salmonella + Phage, (6) FW ceca + Salmonella + Phage. Where applicable, in vitro treatments were inoculated with an overnight culture (16-18h) of a nalidixic acid resistant strain of S. Enteritidis at 1x10^6 CFU/mL and 1x106 pfu/mL enterobacteria phage P22 (MOI 0.1). Cultures were incubated anaerobically at 37°C and sampled at 0 and 6 h for Salmonella enumeration via dot plating (10 mL) on XLT-4. Salmonella data were Log_{10} transformed and analyzed using a three-way ANOVA with means being separated using Tukey’s HSD. Significance was determined at P≤0.05. There was an interaction between feed withdrawal treatment, in vitro treatment, and incubation time on the load of Salmonella (P<0.05). The Salmonella levels of the in vitro treatments Salmonella (4) and Salmonella + Phage (6) of FW birds (5.90 and 5.35 Log_{10} CFU/mL, respectively) were significantly different than all other treatments (>7 Log_{10} CFU/mL). In addition, there was no difference in Salmonella load between the in vitro treatments of Salmonella (3) and Salmonella + Phage (5) of FW birds (7.15 and 7.39 Log_{10}CFU/mL, respectively). These results demonstrate the Salmonella reduction potential of phage therapy when used as a pre-harvest intervention in combination with a feed withdrawal step.

Keywords: Salmonella, phage, intervention, cecal microbiota, broilers

64 Modulation of broilers intestinal microbiota with Probiotic and Prebiotic supply.

Maisa F. Menck-Costa, Ana A. Baptista, Larissa Justino, Victor D. Cruz, Marielen d. Souza, Matheus S. Sanches, Thiago H. Endo, Leonardo P. Medeiros, Vanessa M. Kaneko, Fabrizio Matti, Gerson Nakazato, Renata K. Takayama Kobayashi, Department of Preventive Veterinary Medicine, State University of Londrina, Londrina, Paraná, Brazil, Microbiology, Universidade Estadual de Londrina, Londrina, Paraná, Brazil, Vetanco Brasil, Chapecó, Brazil.

Probiotics have the ability to colonize the gastrointestinal tract, competitive exclusion and immunomodulation, tend to keep the intestinal ecosystem balanced and have antimicrobial activity. Prebiotics selectively stimulate the growth and/or metabolism of microorganisms and may reduce the growth of pathogens. Due to their mechanisms, they may present synergistic activity when associated. The aim of the study was to evaluate the activity of a probiotic, a prebiotic and their association in intestinal Enterobacteriaceae population of broilers. One-day-old broilers (n=96) were housed in experimental cages. The animals received water and food ad libitum and heating according to physiological requirements (CEUA/UEL 093/2021). They were divided into four groups, with 24 birds per treatment. G1: negative control birds; G2: birds that received probiotic (3rd, 11th and 17th days of age, 0.6g/100mL, orally); G3: birds that received prebiotic-bacteriostatic additive + probiotic and G4: birds that received prebiotic-bacteriostatic additive (1st to 23rd days of age, 1.5 grams/1Kg of feed). Autopsies were performed on the 15th and 23rd days of age, 12 birds/day per treatment, with collection of intestines. The intestines were macerated, subjected to serial dilution, and seeded by spread plate on Violet Red Bile Glucose Agar (Sigma-Aldrich) and incubated at 37 degrees Celsius for 20 hours. Data were compared using ANOVA, followed by T-test (p<0.05). At the first autopsy, the means observed per treatment were G1: 4.58; G2: 2.61; G3: 3.89 and G4: 1.92. The probiotic and prebiotic groups showed a decrease in Enterobacteriaceae population, with a statistical difference between the means of the groups compared to the control. However, they did not show synergistic activity.
when associated. At the autopsy on 23rd days of age, the means observed per treatment were G1: 5.38; G2: 5.05; G3: 5.82; G4: 5.96, with no statistical difference observed in Enterobacteriaceae population between treatments and control. It is concluded that probiotic and prebiotic were able to reduce Enterobacteriaceae population in intestine of broilers up to 15 days of age.

**Keywords:** prebiotics, probiotics, intestinal health, Enterobacteriaceae population

65 Antimicrobial resistance in Escherichia coli and Salmonella spp. isolated from poultry samples in Colombia from 2007 up to 2021. Luis N. Oicatá, Diana Alvarez Mira, Arlen P. Gómez, Universidad Nacional de Colombia, Bogotá D.C., Cundinamarca, Colombia.

Antimicrobial resistance is considered one of the greatest threats to global public health, causing more deaths by 2050 than possibly caused by cancer. The objective of this study was to determine the antimicrobial susceptibility, resistance patterns, resistance related to productive practices, multidrug-resistant (MDR), and pan-resistance to antimicrobials from *E. coli* (n=357) and *Salmonella* spp. (n=31) isolates from mainly sick birds, in different regions of Colombia and from different production systems, referred to the Avian Pathology Laboratory of the Universidad Nacional de Colombia during the last 15 years (2007-2021). The antimicrobial susceptibility test used was disc diffusion. Isolates with resistance to two or more classes of antibiotics were considered multidrug-resistant (MDR). Descriptive statistics were used to analyze resistance data, hypothesis test by Difference of Proportions followed by Chi-squared test were used to evaluate differences in the proportions in the years, and the risk factors associated with MDR were analyzed using Odds Ratio. The highest resistances for *E. coli* were found in Tetracycline (87%), Ampicillin (86%), Doxycycline (83%), Amoxicillin (73%), and Streptomycin (62%), finding 52.10% (186/357) of MDR, 13.45% (48/357) of pan-resistance and patterns with an average resistance to 4.5 antibiotics. In *Salmonella* spp. antibiotics with significant resistance were Amoxicillin (81%), Streptomycin (75%), Tetracycline (71%), Doxycycline (57%), and Florfenicol (52%), finding 32.25% (10/31) of MDR, 6.45% (2/31) of pan-resistance, and patterns with an average resistance to 4.3 antibiotics. Altogether, significant increases in pan-resistance were found for the year 2021 (63.6%, P=0.003). The total of isolates for 2021 also presented MDR with significant increases in the years 2013 and 2020 (17%, P = 0.0375 / 30% P = 0.0202). Likewise, the report of previous antibiotic use increased in 4 of the 15 years, finding that previous use of antibiotics has OR: 2.01 P = 0.0018 of being MDR that has no previous use. These data demonstrate the significant increase in MDR and reiterate the need to continue monitoring the dynamics of resistance and insist on good management practices in antimicrobials use.

**Keywords:** antibiotics, birds, drug resistance, Enterobacteriaceae, multidrug resistance
The study was conducted to evaluate the effect of different feed withdrawal periods from 0 to 12 hours before slaughter. Broilers at 28 days of age, were contaminated or not with aflatoxin (AFL). Fasting and aflatoxin may affect liver color and can consequently organ condemnation in the slaughterhouse. A total of 240, one-d-old female Cobb 500 broiler chickens, were fed a pre-starter basal diet, with corn and soybean meal (1 – 7 days), subsequently, the birds received the control diet without contamination (CON) or a diet containing 1 ppm AFL (AFL) of 8 – 28 days. Birds were placed in a completely randoized design in a 2 x 3 factorial arrangement of AFL (CON or AFL) x feed withdrawal periods (0, 6 or 12 hours). On day 28, all broilers were weighed and euthanized for necropsy following three different feed withdrawal time periods (0, 6 ou 12 hours). The experimental data were submitted to a two-way analysis of variance. Mean differences (P ≤ 0.05) were compared by Tukey's multiple interval test. Body weight gain, liver weight and liver fat content decreased as the feed withdrawal period increased. In contrast, FCR and gallbladder weight increased (P ≤ 0.05). AFL-fed birds reduced body weight and liver fat proportion and there was an increase in FCR, liver and gallbladder weight (P ≤ 0.05). Livers from broilers fed without feed withdrawal showed greater luminosity (L*) and yellowing (b*) than livers from broilers fed 6 or 12 hours of feed (P ≤ 0.05). The L* and redness (a*) values of livers from broilers fed the CON diet were lower than those of chickens fed AFL (P ≤ 0.05). In conclusion, the pre-slaughter starvation period food deficiency and the ingestion of contaminated food with AFL had an influence on liver and gallbladder weights, color and liver lipid content. However, these effects were antagonistic, as there was a reduction in organ weights as feed withdrawal was extended but increased when birds were fed AFL diets. The apparent differences in the brightness and yellowing of the liver of broiler chickens are due to the consumption of AFL present in diet, which can cause difficulty in viewing and separating the livers of uncontaminated broilers in the slaughterhouse.

Keywords: aflatoxin, feed withdrawal, liver, slaughterhouse, broilers

Dietary aflatoxins and pre-slaughter fasting time affect broiler liver morphology. Pablo L. Santos1, Sergio L. Vieira1, Raquel M. Horn1, Douglas D. Maria1, Julmar C. Feijo1, Yuri J. Olabarriaga2, Caroline F. Nunes3, Walter E. Altevogt2, Bernardo B. Xavier1, 1Animal Science, UFRGS, Porto Alegre, Rio Grande do Sul, Brazil, 2Zootecnia, Universidade Federal do Rio Grande do Sul, Viamão, Rio Grande do Sul, Brazil.

Assessment of serological response to Infectious Bursal Disease virus (IBDV) is essential for monitoring vaccinated flocks. However, it is important to understand the peculiarities of seroconversion induced by different strains for correct results interpretation. This study aimed to evaluate the seroconversion induced by different strains of IBDV in broiler flocks vaccinated with two different vaccination programs. Six commercial broiler flocks were randomly chosen from three different regions of Brazil: south, southeast and northeast. Two flocks per region (same company and origin), one vaccinated with a live vaccine MB strain (MB-1) and the other vaccinated with an Immune complex vaccine (Icx) W2512 strain, both vaccinated in ovo at the hatchery. Five samples per flock of Bursa of Fabricius were collected at 18 and 32 days old using FTA cards for identification and genotyping of the IBDV by RT-PCR followed by Restriction Fragment Length Polymorphism. To serology, twenty blood samples were collected at 24 and 42 days old and submitted to ELISA using a commercial kit (IDEXX Laboratories, Inc.). Mean antibody titers at 24 and 42 days old were statistically analyzed using Jamovi Software by One Way ANOVA followed by nonparametric Kruskal-Wallis test and Dwass-Steel-Critchlow-Fligner pairwise comparison and compared according to the viral strain detected through RT-PCR analysis. At 18 days old, in the flocks vaccinated with MB-1, vaccine strain was detected in 67% of the samples and in 33% no viral strain was detected, while in the flocks vaccinated with Icx vaccine, no viral strain was detected in 67% of the samples and in 33% were detected field strain of Genogroup 4. At 32 days old, the recovery rate of vaccine strain to MB-1 group was 100%, while to Icx group, the vaccine strain was detected in 67% and in 33% were detected field strain of Genogroup 4. At 24 days old, in the flocks infected by field strain had significantly (P<0.001) higher antibody titers (Mean=2408) than MB-1 vaccine strain (Mean=1282) and no viral strain (Mean=78). At 42 days old, no difference antibody titers was observed in flocks infected by field strain (Mean=3996) and MB-1 vaccine strain (Mean=2934), but flocks infected by the Icx W2512 vaccine strain had significantly lower antibody titers (Mean=1678) than flocks infected by field strain (P=0.005) and MB-1 vaccine strain (P=0.001). Flocks infected by field strain of Genogroup 4 showed higher seroconversion than the other groups at 24 days, maybe due to early infection by this strain. These results confirm the importance of serological monitoring in flocks at different ages and to know about viral strains circulating in the flocks.

Keywords: Gumboro, MB-1, MB strain, Immune complex vaccine, W2512

Student Competition: Immunology, Health and Disease

66 Difference in seroconversion of Brazilian commercial broiler flocks induced by three different strains of Infectious Bursal Disease virus. José E. Dias1,2, Rafael M. Martello2, Eric d. Culhari2, Igor H. Vellano2, Eva L. Hunka2, 1Health and Sustainable Production of Poultry and Swine, Santa Catarina Federal Institute - IFC, Concordia, SC, Brazil, 2Phibro Animal Health, Campinas, SP, Brazil.

67 Difference in seroconversion of Brazilian commercial broiler flocks induced by three different strains of Infectious Bursal Disease virus. José E. Dias1,2, Rafael M. Martello2, Eric d. Culhari2, Igor H. Vellano2, Eva L. Hunka2, 1Health and Sustainable Production of Poultry and Swine, Santa Catarina Federal Institute - IFC, Concordia, SC, Brazil, 2Phibro Animal Health, Campinas, SP, Brazil.

The aim was to compare the consequences in the body composition, regarding the deposition of protein and lipids, on broilers challenged by *Eimeria maxima*. A total of 480 14-days-old male Cobb500 chicks were randomly distributed in two treatments (Unchallenged (UN) and Challenged (CH)) with six replicates of 40 birds each, allocated in floor pens until 42 days old. To induce the challenge, on the first day of the trial the birds in the CH group received 1 ml of *Eimeria maxima* inoculum (7x10^3 oocysts/ml) by gavage. At d 14, 10 birds with a weight similar to those allocated in the pens were used as reference birds to calculate body protein and lipid contents (g/kg). Broilers were euthanized, and the whole carcass was evaluated for dry matter, protein, and lipid contents. On days 28, 35, and 42, the feed intake and the body weight of birds were measured. On the same days, eight birds per treatment (12 birds at 28 days of age) were selected for body composition measurement, following the same procedures used for the reference birds. The protein and fat depositions (g/kg^0.75/day) were calculated by difference for each phase evaluated (14-28d, 29-35d, and 36-42d). The relative protein intake (g/kg^0.75/day) was calculated by multiplying the protein content in the diet by the daily feed intake of the birds and dividing it by metabolic weight for each phase. One-way ANOVA was used to analyze the data, and treatment means were compared by F test at 5% probability. The CH birds reduced the daily FI (P<0.05) at the phases 14-28d (-10.7%) and 29-35d (-9.31%). The same group demonstrate the lowest BW at the end of each phase (P<0.05); however, for the last period (36-42d) the daily FI and the BW at d 42 were not different between groups. The relative protein intake differed only in the last period (39-42d) with the CH birds having a higher intake (+8.10%). For body composition, the water content did not differ between treatments for all periods evaluated. Broilers in the CH group had a higher body protein content (g/kg) at 42 days (P<0.05) and a lower body lipid content (g/kg) at 28 days old (P<0.05). On the other hand, the protein deposition (g/kg^0.75/day) was lower for the CH group in the first and second phases (-42%, -27%, respectively), while the fat deposition (g/kg^0.75/day) was lower for CH group for the first phase evaluated (-32%), increasing significantly in the second phase (+120%) compared to broilers in the UN group. Broilers challenged with *Eimeria maxima* demonstrate a reduced growth during the first 21 days post-infection due to a reduction in body protein and lipid deposition and a compensatory lipid deposition was observed on challenged broilers after 21 days post-infection.

**Keywords:** coccidiosis, disease, fat, feed intake, protein
The importance of regrouping laying hens during the growing period in the productive aspects raised in a free-range system. Ana C. Britto Doi, Isabella d. Dias, Marley Conceição dos Santos, Augusto J. Coronado, Priscila Arrigucci Bernardes, Alex Maiorka, Chayane da Rocha, Fabiano Dahlke, Veterinary Science, Federal University of Paraná, Curitiba, Paraná, Brazil, Zootecnia, Universidade Federal do Paraná, Curitiba, Paraná, Brazil, Zootecnia, UFSC, Palhoça, SC, Brazil, Zootecnia e Desenvolvimento Rural, Universidade Federal de Santa Catarina, Santa Catarina, Brazil.

The objective of this study was to evaluate how the body weight and homogeneity of laying hens during the growing period can affect their development and productive performance. A total of 300 one-day-old Hy Line Brown® layers were reared up to 49 weeks of age. At housing, the birds were individually weighed (33.5 ± 3.36g) and classified according to weight categories: Light Hens (LH; 23 to 29 g; n= 75), Medium Weight Hens (MWH; 30 to 36 g; n = 150) and Heavy Hens (HH; 37 to 44 g; n = 75). The animals were then individually weighed weekly, and at the 8th week of age they were regrouped according to their new weights, as follows: LH (< 600 g; n = 75), MWH (651 to 690 g; n = 150) and HH (> 690 g; n = 75). The weekly recording of body weight was used to verify the effect of grouping at housing and regrouping at 8th weeks on productive performance. Through these equations, growth curves were determined until the pullets were transferred to the production phase (at 17 weeks), when hens with the highest weekly production were allocated to class 1 and the lowest production to class 2. During the growing period, body weights were adjusted to a simple linear regression model. This model was applied to each weight category (in housing and at 8 weeks) obtaining prediction equations. The performance data obtained were used for the exploratory analysis of the principal components (PCA), verifying if the regrouping of birds at 8 weeks of age was related to egg production. Regrouping of the birds at the 8th week of age led to an increase of body weight in all categories (P<0.01 – comparison by the t test of the angular coefficients). A reduced difference in body weight between MWH and LH was also detected, making the birds of these groups more homogeneous when transferred to production. Through the PCA analysis, it was observed that the average weekly weights in the growing period influenced the egg production from the beginning of laying until 49 weeks. In conclusion, the regrouping of pullets according to their weight category during the growing period produces more uniform and heavier pullets at the transfer age. Heavier pullets become hens with higher egg production per week up to 49 weeks of age.

Keywords: category, body weight, free range, layer, uniformity
Management and Production

70 Water efficiency in broiler production – Update on a USDA comprehensive project in sustainability. Walter G. Bottje, Poultry Science, University of Arkansas, Fayetteville, Arkansas, United States.

Overarching goals of a comprehensive USDA Sustainability Agriculture Systems (SAS) project we received in 2019 are to improve the system wide efficiency of nutrient and water use in broiler production through a) a better understanding and manipulation of the host physiology and microbial influence on water and nutrient efficiency, b) implementation of novel algal-based technology, and c) effecting educational-behavioral changes through enhanced education and extension programs. Some highlights of this project are: 1) Use of a sprinkling system has been shown to reduce water use for cooling by over 50% during summer time flocks. This management system was shown to reduce physiological stress response to heat stress at the bird level. 2) Broiler breeding stock have been divergently selected for high water conversion ratio (WCR) and low WCR (determined as water intake divided by body weight gain). Progeny from these lines will be tested for heat tolerance and drinking behavior. 4) Several studies have been devoted to understanding fundamental mechanisms and methodology associated with prevention of leaky gut. 5) Studies have also been conducted to investigate microalga feeding of broilers as well as engineering algae to produce enzymes (e.g. phytase). 6) Educational opportunities include a global online class, student internships, and establishing a minor in sustainability. To date the project has involved or supported 30 faculty and 7 institutions and over 40 students (graduate and undergraduate) and post-docs. Project supported by USDA NRI SAS grant #2019-69012-29905.

Keywords: drinking water, hardness, nitrates, sodium chloride, sulfates


The way the birds are selected for slaughter can interfere in the carcass and cuts yield, as well as it can interfere in the quality of the data obtained, which also modifies the final answer of the surveys. The objective of this study was to evaluate a way of selecting the birds for slaughter, based on average weights or randomly, on the carcass and cuts yield. For this purpose, 236 broilers were randomly collected and 236 were based on average weight, from a study that evaluated the effect of including the extract of bocaiuva in the diet of broiler chickens, containing 7 treatments and 60 experimental units (EU), with 24 birds per EU. At 42 days of age, each EU was weighed to obtain the average weight and selection of 4 birds with the weight varying 2.5% more and less in the average of the EU. Four birds were selected at random per EU. These birds, after fasting, were sacrificed by electronarcosis, bled, plucked, and eviscerated, so that the hot carcass could be weighed. These were cooled in water with ice to obtain the cold carcass, both carcasses, hot and cold, used to determine the carcass yield. The cold carcass was then divided into 4 commercial cuts, breast fillet, tenderloins, legs and wings, which were entered to insert the cut yield. To collect the data, they were evaluated the normality evaluation, with tests of data transformation, 2-way ANOVA, evaluation of the experimental power and presence or not of outliers. How birds were selected did not affect carcass characteristics (P> 0.05), both with and without the presence of outliers. The dispersion values, such as standard deviation and coefficients of variation, were low for all evaluated characteristics. The transformation is not

71 Review of chemical and physical results of well water for chicken consumption during the years 2018 to 2021, in Lima, Peru. Analucia E. Carrillo, Microbiology, Alfa Biol S.A.C., Lima, Lima, Peru.

Water is the most important nutrient in poultry feeding, as well as the most consumed, representing 58 to 65% of body weight in adult birds and up to 80% in 1-day-old chickens. (Penz, 2011). Therefore, the focus of water sanitation programs must be effective and profitable, since this provides better health for birds, improving their productivity and reducing medication costs (Watkins, 2017). Likewise, not only consumption is important to provide good nutrition in birds, but also to evaluate the balance in the components that determine their chemical and physical quality, such as: hardness, sodium chloride, sulfates, nitrates and their respective pH. These variables have accepted limits in the water intended for consumption by domestic birds. The indices are directly related to the quality of the same, in such a way that, if we find any important variation, it could have bad repercussions on the health of the birds or on the water systems, pipes and facilities. Variations have been found during some months of the year, such as: May, April, September, October and November. Being these months where the different changes of seasons in Peru take place. Highlighting the spring and winter seasons. Finally, in order to perform the interpretation of the results of each of the 5 variables mentioned, the table of permissible parameters rescued from the publication "Management of drinking water in poultry farming" was used as a reference. Susan Watkins MS, Ph. D22 January 2020. Water Quality Standard for Domestic Poultry.

Keywords: drinking water, hardness, nitrates, sodium chloride, sulfates
necessary, since the normal dissipation data, despite the cold carcass yield without removing the outlier, could be transformed by the equation $1 / x^2$, for a better presentation of the data. The selection of birds at random is shown to be effective to produce data determined in determining the source of carcass and cuts, mainly after the removal of discrepant data.

**Keywords:** outliers, randomization, sample, statistics, variation

73 **Choice of sample size for carcass yield and cuts of broilers.** Nilton Rohloff Junior, Ricardo V. Nunes, Cintinha Eyng, Giovana Perin, Cleison d. Souza, Vaneila D. Savaris, Clauer Polesi, Gabriela G. Sangalli, Karine I. Tenório, Tania L. Kohler, Emanuelle C. Santos, Jomara Broch, western Paraná state university, Marechal Cândido Rondon, PR, Brazil.

The purpose of this study to estimate the minimum number of repetitions that could guarantee adequate statistical power to detect significant differences with several differences between means for carcass and cut yield characteristics in broiler chickens. At 42 days of age, 480 poultry were selected, individually weighed, and fasted for subsequent slaughter. The birds were stunned by electronarcosis, followed by bleeding, plucking, evisceration, and removal of the feet and neck. The still hot carcasses were weighed, cooled in ice water, and weighed again to obtain hot and cold carcass yields. The cold carcass was carved into boneless and skinless breast, tenderloins, legs, and wings, which were individually weighed to obtain cut yields. The data obtained were subjected to normality analysis and subsequent descriptive statistics, as well as one-way ANOVA, in both cases to obtain mean, standard deviation, and coefficient of variation (CV) values. With this information and the help of the EPGP.xls program, the numbers of repetitions needed to obtain significant differences between means for different magnitudes were estimated. The CV was found to be stable; the highest CV was found for tenderloin (11, 34%) and the lowest for hot carcass yield (2, 35%). Differences between the CV and standard deviation meant that the number of repetitions needed to obtain a difference between means was different for each variable. Fewer repetitions were needed for hot and cold carcass yields than for cut yields to detect differences between means. The low data variation allows smaller differences to be found between means with fewer repetitions. Experimental designs based on power tests to estimate the number of repetitions needed should be used more often.

**Keywords:** experimental power, statistics, repetition, sample, slaughter

74 **Monitoring of greenhouse gases from broiler litter compost by laser photoacoustic.** Fernanda G. Linhares¹, Marcelo S. Stel¹, Marcelo G. da Silva¹, Karoll Andrea A. Torres-Cordido², Leonardo Mota¹, Caio d. Inácio³, ¹Laboratório de Ciências Físicas, Centro de Ciência e Tecnologia, Universidade Estadual do Norte Fluminense Darcy Ribeiro, Campos dos Goytacazes, RJ, Brazil, ²Laboratório de Zootecnia, Centro de Ciências e Tecnologias Agropecuárias, Universidade Estadual do Norte Fluminense Darcy Ribeiro, Campos dos Goytacazes, RJ, Brazil, ³Solos, Embrapa, Rio de Janeiro, RJ, Brazil.

In 2021, the Brazilian Animal Protein Association (ABPA) launched a program to encourage sustainable practices in the Brazilian poultry and swine production chains, and thus meet the United Nations Sustainable Development Goals (SDGs). The guidelines include the implementation of actions to reduce greenhouse gas (GHG) emissions. Carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) are GHGs emitted by the degradation of organic matter (OM) from broiler litter. The objective of this research was to measure the GHG emission during poultry litter composting using coconut fiber (CF) and wood shavings (WS) substrate. Cobb broilers were reared following the strain manual at a density of 10 birds m⁻², in two open sheds. The floor in each shed was coated with a type of substrate, CF or WS, and after 42 d of the broilers rearing, samples were collected from the broiler litter for composting. An aerobic bioreactor was used and CH₄ and N₂O were monitored by a photoacoustic sensor of high sensitivity and selectivity using quantum cascade laser (QCL) as a radiation source. Infrared and electrochemical sensors were also used to monitor CO₂ and O₂ present in the aerobic process of OM decomposition. The temperature was continuously measured to monitor the evolution of the compost, defining the phases: mesophilic and thermophilic. The maximum temperatures were 58.4°C in the CF sample and 52.7°C in the WS sample. CH₄ emissions ranged from 4.88 to 9.80 ppm in the CF sample and from 2.87 to 7.13 ppm in the WS sample. As for the N₂O gas, they ranged from 2.20 to 6.26 ppm in the CF sample and from 1.50 to 5.31 ppm in the WS sample. CO₂ ranged from 0 to 19.8% in both cases. In both samples, the results suggest higher N₂O emissions in low O₂ availability, which could be caused by nitrification due to high nitrogen availability. The composting of litter for the production of fertilizer alleviates the problem related to the waste disposal, but produces gases that cause global warming. The photoacoustic technique used was sensitive and selective to identify the gases under study. The composting processes reached thermophilic phases (40-60°C), allowing the decomposition of OM. Although decomposing of coconut husk fiber is a sustainable alternative as it is a large residue from the production of coconut water, the results presented in this work point to GHG emissions apparently similar to those of wood shavings. Acknowledgment: CAPES, CNPq, and FAPERJ.

**Keywords:** coconut husk fibers, methane, nitrous oxide, sustainable development goals

75 **Use of virginiamycin during successive flock rotations: Productive and microbiological**
Antimicrobial growth promoters (AGP) have played a decisive role in poultry industry and most management practices were developed and evaluated in a context where antimicrobials were extensively used. Therefore, reductions in antimicrobial use will require not only the inclusion of AGP alternatives but also evaluation of the impact on common practices including litter management. The reuse of litter material is a common practice conducted in order to reduce productive cost and environmental impact. However, reused litter can affect bird’s productive efficiency and may contribute to pathogens transmission. The objective of this study was to evaluate the impact of virginiamycin use on broilers productive efficiency and litter microbiological quality. For this purpose, 1 broiler shed was divided in half, and birds were fed with commercial diets supplemented with or without virginiamycin for 1 year including 5 consecutive flocks’ rotation. In each productive cycle litter samples were collected on days 0 (before bird’s arrival), 21 and 42. Additionally on day 21 necropsies were performed and cecal samples were collected. Microbial evaluation was performed trough CFU counts of the following bacteriologic indicators (mesophilic, anaerobic, acid lactic, enterococci and coliforms). Body weight (BW) and mortality rate (MR) were recorded weekly, and feed intake (FI), feed conversion (FC) and productive efficiency Factor (EPEF) were determined at the end of each cycle. Virginiamycin treated birds showed higher BW during the first 4 cycles (2920 g vs. 2790), but this effect was not observed in the last cycle (2970 g vs. 3010). Relative BW gains (AGP vs control) decrease after the 2nd cycle, and changes in productive efficiency were evident from the 3rd cycle (319 vs. 329). Litter from virginiamycin treated birds showed reduced bacterial counts during the first 2 cycles (11.12 vs 13.14 UFC log/ml, p<0.01), but after the 3rd bacterial load increase with statistically significant differences observed at cycle 4th (7.62 vs 6.25 UFC log/ml, p<0.01). No differences were observed in bacteriological determinations from cecal samples. The results from the present study suggest that beneficial effects of virginiamycin (and eventually others AGPs) are temporal and these limitations can be related with changes in the response of bacterial communities present within farms environment, including litter materials.

**Keywords:** litter, Virginiamycin, broiler
Data collected by commercial broiler production companies may contain valuable information that could be used to predict future events and drive decisions, improving the production indexes of a poultry farm. However, the proper use of such information may not be straightforward, and new techniques are essential in this area. The application of Machine Learning (ML) Algorithms gained attention in the poultry industry because of their properties to analyze and withdraw useful information from practical data that can be used as predictive modeling and decision-making tool. This study aims to present an ML methodology developed at North Carolina State University and its application as a decision-making tool using data obtained from broiler production companies. The ML methodology was built using FeatureWiz, H2O AutoML, and AutoKeras. The FeatureWiz library is used to identify variables of interest, while H2O and AutoKeras are ML libraries capable of producing prediction models. The study and models were constructed using a database containing information from 7,188 flocks, 661 feed formulations, and 274 broiler houses. To evaluate the outcome obtained, cross-validation was performed using 5% of the complete dataset, separated before the model training process, and used only on the final model to compare observed and predicted values, minimizing bias. The Root Mean Square Error (RMSE) validation metric was used to penalize significant errors. The feed conversion ratio (FCR) was chosen as the response variable to demonstrate how the algorithm presented can identify influential variables. The algorithm indicates that the outside weather was the most significant factor influencing the FCR, suggesting that improvements in this factor may positively affect FCR. Further results also indicate that the model could predict real feed intake (RFI) with low error (RMSE = 0.0629) compared to an estimative calculated based on a factorial model to predict lysine intake recently published in the literature. This work demonstrates that data commonly collected by poultry production companies can be combined with machine learning algorithms and methodologies for modeling and decision-making tools. The information generated in this presentation indicates that the methodology applied helped identify limiting factors and predict the real feed intake in the production farms evaluated.

Keywords: poultry production, modeling, machine learning, decision-making tools, data organization

78 Evaluating the draft US-EPA emissions models for laying hen and broiler facilities. Yijie Xiong1, Guoming Li2, Brett C. Ramirez1, Richard S. Gates1, 2, 1Agricultural and Biosystems Engineering, Iowa State University, Ames, Iowa, United States, 2Agricultural and Biosystems Engineering, Egg Industry Center, Ames, Iowa, United States, 3Animal Science Department, University of Nebraska-Lincoln, Lincoln, Nebraska, United States.

In August 2021, the US Environmental Protection Agency (EPA) published draft models to estimate annual NH3, H2S, PM10, PM2.5, and TSP emissions from egg-layer houses (high-rise and manure belt) and manure storage, and broiler housing typical of the US poultry sector before about 2010. The draft models use inputs of daily mean ambient temperature and relative humidity, as well as house bird inventory; broiler models also use an estimate of live bird weight. A separate model is used for each criteria pollutant (ammonia, hydrogen sulfide, particulates), and predict the daily building emission. Model outputs must further processed to estimate annual or flock total emissions. These models were developed from refined datasets generated by the National Air Emissions Monitoring Study, conducted over a decade ago. These models, if adopted, will have a substantial impact on the US egg industry. The objectives of this study were to evaluate model robustness and assess modeled annual emissions for twelve locations throughout the USA associated with egg or broiler production under differing climate scenarios. A sensitivity analysis demonstrated that the EPA draft models may distort emission factors for lower and higher inventories than those used to develop the models. With inventory held constant, the marginal influence of ambient temperature and relative humidity on daily emissions varied from relatively small amounts that are likely beneath any detection threshold to measure and within the model’s prediction uncertainty; however, in some cases, marginal influences were surprisingly large and were not supported in the literature. For the twelve selected locations representing differing climates, substantial differences in emission factors for both laying hen and broiler facilities were found for inventories outside the range in the database, and also in annual emissions estimates at inventories used to develop the EPA models. We conclude that the draft EPA emission models cannot be used to the degree of precision that is suggested in the report. Several recommendations are suggested regarding these draft models and will be reported at the meeting.

Keywords: air quality, emissions model, ammonia, hydrogen sulfide, particulate matter

79 Life cycle assessment project for the Brazilian egg industry. Fabiane F. Maciel1, Richard S. Gates2, Ilda d. Tínóco1, Nathan Pelletier3, Maro A Ibarburu-Blanc2, 1Agricultural engineering, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, 2Agricultural and Biosystems Engineering, Animal Science, Egg Industry, Iowa State University, Ames, Iowa, United States, 3Biology, Faculty of Management, University of British Columbia, Okanagan, British Columbia, Canada.

According to estimates by the Food and Agriculture Organization, the global population is expected to grow to 9.7 billion by 2050. The challenge is not limited to
providing more food for a growing population, but also considering social and environmental issues. Brazil is among the ten largest egg producers in the world. Domestic consumption of Brazilian eggs is 99.59%, with the remainder exported to more than 22 countries and with an expectation of growth in the foreign market. The agricultural sector undergoes constant economic, technological, social, environmental, and marketing changes, which occur simultaneously under different conditions and at high speed. Life Cycle Assessment (LCA) is an environmental tool initially applied to industry in 1960 in Europe; in recent years, the LCA, together with the Life Cycle Inventory (LCI) has been used in the agricultural sector in response to the growing demand for information about production and its supply chain. LCA's informational approach facilitates the identification of opportunities for improvement and efficiency in the use of resources, including emission reduction objectives, improving the understanding of the types of impacts generated in the different stages of the supply chain and providing better results for decision makers. An LCA provides an objective basis for sustainable interventions, analyzing the main variables of the supply chain. On a global scale, researchers address LCA as a constructive and quantitative technique, and there is great interest in implementing LCA for the egg production sector. As this is an intensive production system with increasing demand, studies are needed that clearly and accurately indicate the current egg production-related impact on the environment, as every production process generates depletion of natural resources, flows of materials, energy expenditure, and increase in emissions along the production chain. However, the methodology to be implemented relies on a partnership with a large Brazilian egg company, which is in progress. There is a clear need to use data collection tools, such as appropriate software to assess the impacts generated in this chain. Progress to date will be detailed and the next steps in the analysis will be discussed.

**Keywords:** eggs, production, sustainable, LCA, LCI
80 Induction of lesions in the trachea of broiler chickens vaccinated for infectious bronchitis with serotypes Massachusetts and BR in broiler chickens.

Geise L. Linzmeier, Boehringer Ingelheim, Cascavel, Brazil.

Abstract not available.

Keywords: Massachusetts, Bronquite infeciosa

81 Selection of Bacillus subtilis isolates through in vitro and in vivo models for use as probiotics for poultry.

abriela R. Silva1, Vasco A. Azevedo2, Thais F. Reis1, Paula F. Braga1, Ícaro M. Costa1, Maria Cecília Soares1, André Schlemper1, Belchihina B. Fonseca1, 1Universidade Federal de Uberlândia, Uberlândia, MG, Brazil; 1Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.

Bacillus subtilis (BS) has been used as an excellent probiotic; however, some BS strains seem to be opportunistic pathogens or do not present inhibitory effects in the pathogenic bacterium, so the characterization of BS strains for use in poultry is mandatory. This study aimed to select non-pathogenic strains of BS which have beneficial effects on the bird and can inhibit Salmonella spp and Campylobacter jejuni (CJ). We tested nine (9) strains of BS isolated from several sources (named from A to I) in vitro by the tests of mucin degradation activity, haemolytic activity, apoptosis and necrosis in fibroblast from chicken. A negative control (NC), positive control (PC) and a commercial strain of BS (CBS) were used as control. We evaluated apoptosis and necrosis using DAP, Yo Pro-01 (YP) and propide iodate (PI) by fluorescence analysis. After the in vitro test, we tested the remaining seven (7) strains (strains from A to G) in chicken embryo (CE) as an in vivo model. CE was inoculated with 3log CFU/CE of each strain via allantoic fluid at the 10th day post incubation (DPI). At the 17th DPI we checked CE mortality, gross lesions, CE weight and whether BS strains were still viable. Blood was collected from the allantoic vessel to perform cytokine analysis (IL-4, IL-10 and IL-6) by ELISA and quantify total protein, albumin and reactive C protein by turbidimetry. Each group consisted of eight (8) CE and we used ANOVA for statistical analysis. After the results in CE, we tested the inhibition capacity of selected SB strains on different strains of Salmonella Heidelberg (SH), S. Typhimurium (ST), S. Enteritidis (SE), S. Minnesota (SM), S. Infantis (SI), Salmonella var. monophasic (SVM) and CJ. From in vitro test (mucin degradation activity, haemolytic activity, apoptosis and necrosis), two (2) strains (H and I) were removed once they showed hemolysis activity, mucin degradation and high apoptosis and necrosis. From in vivo model test in CE, we removed four (4) strains (A, B, D, F) once they led to more significant mortality in CE or high albumin/ protein relation, showing CE dehydration. All strains of BS were viable in CE at the 17th DPI. CE inoculated with strain G had greater weight compared to CBS. The analysis of cytokine showed that strains E and G presented immunomodulatory effects. From the tests in CE, we selected the strains C, E, and G. The strains E and G presented better results than CBS in inhibition of one (1) strain of SH, three (3) strains of ST, two (2) strains of SI and two (2) strains of CJ. This work selected strains E and G of BS because they had beneficial effects on birds in vitro and in vivo and inhibited Salmonella spp and CJ.

Keywords: immunomodulation, Salmonella, Campylobacter jejuni, chicken embryos, chicken embryo

82 Zootechnical performance in broilers fed with two different Nicarbazin-potentiated ionophores up to 28 days in the presence of a field coccidia challenge.

Patricia T. Rocha2, Luis Gomez1, Ken Bafundo1, Douglas Haese2, 1Global Marketing and Technical Services, Phibro, Teaneck, New Jersey, United States; 2Poultry Technical Services, Phibro, Campinas, SP, Brazil, 3Technical Department, Centro de Tecnologia Animal, Paraju, ES, Brazil.

The purpose of this study was to compare the efficacy of two nicarbazin-potentiated ionophores that belong to different ionophore classes with a contemporary challenge of coccidia. These products are ubiquitous in many markets around the world and have become a cornerstone of the toolbox for coccidia control being used in the first phase of broilers life. In Brazil, the use of in-feed anticoccidials is the main tool applied for coccidiosis control and in recent years, it was possible to observe a practice to increase the anticoccidial doses approved. A hypothesis for the need of increased doses can be related to anticoccidial efficacy, suggesting that some coccidia strains become less sensitive for some anticoccidials. Two different nicarbazin-potentiated ionophores in two different doses were evaluated up to 28 days in comparison to an Infected Untreated Control (IUC). Nicarbazin with a glycosidic ionophore – Semduramicin: Nic+Sem 600 g/ton (Nicarbazin 48 ppm + Semduramicin 18 ppm) and Nic+Sem 800 g/ton (Nicarbazin 64 ppm + Semduramicin 24 ppm), and Nicarbazin with a monovalent ionophore – Narasin: Nic+Nar 625 g/ton (Nicarbazin 50 ppm + Narasin 50 ppm) and Nic+Nar 875 g/ton – (Nicarbazin 70 ppm + Narasin 70 ppm). A challenge with Brazilian field strains of E. acervulina, E. maxima and E. tenella (214,000, 63,000, 7,700 sporulated oocysts/bird, respectively) was gavaged on Cobb 500 male broilers at 18 days. Broilers were kept in floor pens, in randomized complete block design for 5 treatments and 10 replicates. Thirty birds per pen were distributed for a total of 1,500 birds. Weight gain (WG) at 28 days was statistically improved (P<0.05) in treatments with Nic+Sem 600 and Nic+Sem 800 in comparison to IUC and Nic+Nar treatments. Feed Conversion Rate (FCR) at 28...
days was statistically improved (P<0.05) with Nic+Sem 600, Nic+Sem 800 and Nic+Nar 625. IUC and Nic+Nar 875 were statistically equal (P<0.05) with the worst FCR. There was no difference in WG and FCR comparing the treatments with the same potentiated ionophore in their different doses. Specifically, for the Nic+Nar 875 treatment there is a possibility that the doses of nicarbazin (70 ppm) is closest to the doses that impair zootechnical results. Considering the coccidia challenge used in this study and taking into account that monovalent ionophores are frequently used in Brazil without any resting period, the differences in WG and FCR between the two nicarbazin-potentiated ionophores tested can be explained by this overexposure of coccidia strains to monovalent ionophores.

**Keywords:** coccidiosis, Nicarbazin, Semduramicin, Narasin, broilers

### 83 Application of nanopore sequencing in commercial broiler farms for rapid characterization of gut microbiome and antibiotic resistance genes. Maia Segura-Wang1, Sergi Raurich1, Suzana Ilic1, Brit Blokker2, Bertrand Grenier1, 1DSM Animal Nutrition and Health, Tulln an der Donau, Austria, 2DSM Animal Nutrition and Health, Kaiseraugst, Switzerland.

Increasing evidence shows that the chicken gut microbiome plays an important role in the modulation of metabolic functions and correlates with significant economic parameters such as feed efficiency and health. Recent advances in sequencing technologies allow surveying the genomes of entire microbial communities to explore their taxonomic and functional diversity. Furthermore, the emergence and spread of antibiotic resistance genes (ARGs) highlights the need to monitor and characterize these genes in poultry farms. The objective of this project was to develop a fast and robust workflow for the characterization of the gut microbiome by using Oxford Nanopore portable sequencing devices either directly on-site at the farms or in the lab. Through the optimization of multiple steps, from sample collection to generation of results, we developed a standardized protocol that enables the detection and relative quantification of microbial species and ARGs. We report here the meta-analysis of over 1000 samples collected from ceca content of broilers (22-26 days old) from 15 commercial farms in different countries. DNA extraction was performed with the QIAamp PowerFecal Pro DNA Kit (Qiagen), and sequencing libraries using the Ligation Sequencing Kit (Oxford Nanopore). Sequencing data was processed with in-house bioinformatics analysis pipelines. Samples from individual farms had an average processing time of 5 days from collection to result delivery. Taxonomic profiling identified several species directly related to observed veterinary conditions or potential concerns, including *E. cecorum, E. coli, E. tenella* and *S. enterica, C. jejuni* in addition to a wide range of other taxa (Shannon index from 1.8 to 5.3). Additionally, through long-read sequencing we have generated ARG profiles and have estimates of diversity (Shannon diversity index 2.0 to 4.6), number, abundance, and prevalence of resistance genes of public health importance in different geographical regions. Information about the mobility potential of specific resistance genes is also predicted from the genetic context in which genes occur. Our collection reveals a higher abundance of genes of the MLS, tetracycline and glycopeptide classes, and a higher prevalence of resistance genes in the Enterobacteriaceae family across all datasets. By combining data from multiple sites, we have a great resource for cross-regional comparisons in terms of microbial and ARG abundance and prevalence. This study is a first effort toward building a commercial database of broiler gut microbiomes and ARGs. It has the potential to provide rapid and reliable on-site support to monitor the gut microbiota and derive useful insights related to health and antimicrobial resistance.

**Keywords:** microbiome, antibiotic resistance, nanopore sequencing, metagenomics, commercial database

### 84 Detection of novel infectious bronchitis viruses in broilers and layers in Mexico and their control by using a synergic live vaccine combination. Juan Francisco R. Cámara1, Alberto Estrada1, Néstor González2, Sergio Carrasco2, Juan Pablo González-Alcalá3, Valentin López-Gómez4, Eduardo Cruz-Mercedo5, 1Poultry Business Unit, MSD Salud Animal, Mexico City, Mexico, 2Independent, Tepatitlán, Jalisco, Mexico, 3Agroalimentos San José, Capilla de Guadalupe, Jalisco, Mexico, 4Gigantes Agroindustrias, Tepatitlán, Jalisco, Mexico, 5Avicola Los Viveros, Tepatitlán, Jalisco, Mexico.

Infectious Bronchitis is caused by a gammacoronavirus which is highly contagious and is distributed worldwide causing serious economic burden in broilers and layers. The high capability of this RNA virus to mutate and recombine has caused the emergence of many serotypes, as well as the generation of antigenic variants that make their control very difficult by vaccination. The use of homologous vaccines for controlling these variants may also induce the emergence of novel variants. The concept of Protectotype, briefly, the use of two antigenically different vaccine viruses for controlling variants, has proven successful in many areas of the world, including the Mexican broiler industry. By using Sanger sequencing, we were able to detect five different novel IB strains that are not genetically related to any known IB virus strain, as well as five other variant strains not previously found in the Mexican poultry industry, but previously recorded in the US. By applying the Protectotype combination of two strains a Massachusetts strain that spontaneously agglutinates chicken red blood cells, and another one belonging to the 793-B serotype, we were able to demonstrate that all five novel variant strains, as well as the US variants were not detected anymore in the selected flocks where such viruses were initially found, having found the vaccine viruses instead, and in all cases we...
were able to prove an improvement in the main production parameters in all vaccinated flocks.

**Keywords:** infectious bronchitis, variant strains, layers, broilers, vaccines

**85 Evaluation of three vaccination programs against Clostridium perfringens alpha toxin and its effects on the performance, intestinal lesions and serum antibody titers in broilers.** Daniel J. Huaringa, Otto A. Zea, Teresita S. Huapaya, Liliana Jimenez, Daniel Molina, Miguel Salazar, Carlos Vilchez-Perales, Lima, Universidad Nacional Agraria La Molina, Lima, Lima, Peru. 

The objective of trial was to evaluate vaccination programs against *Clostridium perfringens* (CP) causing the disease known as necrotic enteritis. 300 one-day-old Cobb 500 male chicks, distributed in 4 treatments with 10 repetitions. Each group received, during 28 days, one of the following treatments: T1: no vaccination; T2: vaccination at day 1; T3: vaccination at day 7 and T4, vaccination at days 7 and 17. Birds were vaccinated with CP toxoid type A, which was administered in the drinking water. During the first 14 days a diet high in protein (27%) based on corn, soy and fish flour was fed. Coccidial challenge at day 14 was carried out with *Eimeria acervulina*, *Eimeria maxima*, *Eimeria tenella*, *Eimeria necatrix* and *Eimeria brunetti*. Then, at days 18, 19 and 20 CP toxoid type A was inoculated. Ten birds by treatment were slaughtered to take serology samples to determine antibody titers and intestine samples for *Eimeria spp* lesion score and gut integrity indicators. Productive performance was analyzed under DCA and media comparison with the Tukey test, and for intestinal integrity and antibody titers a Kruskal-Wallis as non-parametric method was used. The results showed that the productive performance was not influenced (p>0.05) by the treatments; however, a tendency was shown in body weight in T3 compared to T1 (p=0.08). In relation to lesion score at day 21, T4 had lower score lesion by *Eimeria acervulina* and *Eimeria maxima* that T1. In gut integrity indicators at day 21, cell desquamation in T2 was lower than in T4 and for mucus excess, T1 was worst. On the hand, at day 25, T2 had more mucus excess than T3 and T4. No statistical differences (p>0.05) were found in antibody titers measurement against toxin type A. These results suggest that simple vaccination at day 7 days (T3) or double vaccination at days 7 and 17 (T4) had better results than vaccination at day 1 on gut integrity and lesion scores.

**Keywords:** Clostridium, Eimeria, poultry, vaccine, program

**86 Dynamic of the energy utilization of broiler chicks under health challenge.** Rosiane de Camargos, Rony R. Lizana, Marcos Macari, Luis Filipe V. Freitas, Miguel Z. Costa, Kênia C. Bicego, Nilva K. Sakomura, School of Agricultural and Veterinarian Sciences, São Paulo State University - UNESP, Jaboticabal, São Paulo, Brazil. 

The reduction of voluntary feed intake as a result of the advance of a disease is a problem that worsens, even more, the adequate development of broiler chicks, triking complexed the comprehension of energy utilization destined for essential metabolic functions and bird response to the infection. Therefore, the objective was to explore the dynamic of daily energy metabolism and physiological response in growing chicks under health challenges. Ninety-six 13-d-old male Cobb 500 broiler chicks were randomly distributed in three treatments with four replication each (eight birds/replicate): non-challenge birds with *ad libitum* fed (AL), challenge group (C), and non-challenged birds with pair-feeding to the C treatment (PF). The birds of the C treatment were inoculated (by oral gavage) with 1 ml of *E. maxima* (8x10³ oocysts/ml) at 14-d-old, and with *C. perfringens* (2.5x10⁶ CFUs) at 18, 19, and 20-d-old. The birds of the AL and PF treatments were inoculated with 1 ml of saline solution. The chicks were allocated in the open-circuit respirometric chambers. At 13-d-old the birds were acclimatized and from 14 to 22-d-old, were measure the daily gas exchange (oxygen consumption – VO₂, and carbon dioxide production – VCO₂). The heat production (HP) was calculated using the Brouwer equation and the respiratory quotient (RQ) was obtained as the VCO₂/VO₂ ratio. HP and RQ were collected for each hour during the experimental period. Core body temperature (Tb) was recorded each hour through Ibutton implanted in the visceral cavity of one bird per chamber. HP and Tb variations to each hour were evaluated to describe the circadian rhythm affected by the feeding of birds depending on the availability of feed (contrasted with the PF) and (or) by the infectious effect (contrasted with the C). Daily MEi and HP were submitted to two-way ANOVA (treatment and age as a longitudinal factor) and the Tukey test to mean comparison. Circadian variation was described for Tb and HP and RQ were collected for each hour during the experimental period. Core body temperature (Tb) was recorded each hour through Ibutton implanted in the visceral cavity of one bird per chamber. HP and Tb variations to each hour were evaluated to describe the circadian rhythm affected by the feeding of birds depending on the availability of feed (contrasted with the PF) and (or) by the infectious effect (contrasted with the C). Daily MEi and HP were submitted to two-way ANOVA (treatment and age as a longitudinal factor) and the Tukey test to mean comparison. Circadian variation was described for Tb and HP throughout Pearson correlation and linear regression for each treatment. Regarding MEi, treatment*age interaction was shown (p<0.01), where at 19-d-old the birds of the C group presented a reduction of MEi. On the other hand, the RQ was similar between C and PF, and both were lower than AL (p<0.05). Tb and HP presented strong-significant (p<0.01) correlation of 0.360, 0.609, 0.695 for AL, PF, and C, respectively. Also, was shown an increase of 45.83 kJ/kg⁰.⁷⁵⁷/d of HP to regulate one degree Celsius of the Tb compared with the AL birds. In conclusion, the health challenge with *E. maxima* and *C. perfringens* affect negatively the energy intake and produce disturbances in the circadian variation, requiring more energy to varied in the body temperature.

**Keywords:** Clostridium perfringens, *Eimeria maxima*, energy metabolism, growing birds, health challenge

**87 Case Report: Angioinvasive Pulmonary Aspergillosis in an Adult Captive Green Java Peafowl**
Kidneys were pale, yellow and atrophied. Microscopically, the lung nodules were typical but fungus hyphae or conidia could not be detected in any tissue. Systemic spread of the fungus to the liver causing hepatitis was also noticed. Kidneys were pale, yellow and atrophied but fungus hyphae or conidia could not be detected in kidneys. Microscopically, the lung nodules were typical granulomas consisting of Aspergillus spp. hyphae and necrosis in the centre surrounded by inflammatory cells mainly heterophils and macrophages and rare multinucleated giant cells. From the literature search, it appears to be the first report of angioinvasive mycotic pneumonia in Green Java peafowl.

**Keywords:** Mycotic pneumonia, Green Java Peafowl, Pulmonary Aspergillosis

### 88 Test of anticoccidial sensitivity in turkeys.

**Thaciane L. Amaral, Lisa Bielke, Kate McGovern, Philip Yeboah, Demilade Ibiwoye, Department of Animal Sciences, The Ohio State University, Wooster, Ohio, United States; 2Veterinary Medicine, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.**

Avian coccidiosis causes billions of dollars of damage to the poultry industry annually. Control and prevention depend on anticoccidials and vaccines, which due to the mutation of *Eimeria* strains, are losing their effectiveness. The Anticoccidial Sensitivity Test (TACS) was conducted to provide data for four farms about the sensitivity of *Eimeria* present in the herd to anticoccidials, indicating the most effective drug to control oocysts. It also aims to provide information to a drug panel to serve as a long-term resistance monitoring system. The treatments chosen for the test were inoculated control, amprolium, lasalocid, diclazuril, monensin, clopidol, and zoalene. 612 Aviagen commercial turkeys were received and housed from 1 to 23 days of age. A completely randomized design was used in the cage farms (BKBE and DDF) and non-randomized on the floor farms (New Brooder and Circle R) with 7 treatments and 4 pens per treatment, with 4 birds each, comprising 112 experimental units and 448 birds. BKBE and DDF were housed in 5 batteries, containing 4 floors with 3 cages. On day 1, turkeys were housed in three-floor stalls with feeders, drinkers, and heating lamps for two weeks with non-medicated feed. Medication started when the turkeys were transferred from the stalls to the floor and cages at 14 days post-hatch. On day 16, 100 sporulated oocysts/bird, from the provided farm sample, were inoculated by oral gavage. Feces were collected on days 21, 22, and 23 for microscopic analysis counting oocysts per gram of feces (OPG). On day 23 the birds were euthanized. The number of oocysts excreted by the control group was compared to other treatments and the values inserted in the classification intervals: Sensitive (-100% to -80%), Reduced sensitivity (-79% to -30%), Resistant (-29% to >0%). Results obtained were that oocysts from DDF farm had *Eimeria* strains sensitive to all drugs, except for zoalene, which showed a reduced sensitivity (-74%). New Brooder’s oocysts showed sensitivity to all drugs except lasalocid, which is resistant (33.14%), and zoalene, which showed reduced sensitivity (-51.71%). Circle R presented the least satisfactory results, where only diclazuril and clopidol were sensitive (-100%). Oocysts from BKBE were sensitive to all treatments except lasalocid, which showed reduced sensitivity (-71.25%). Based on these results, the sequence of drugs from the best efficacy to the worst were diclazuril, clopidol, amprolium, monensin, zoalene, and lasalocid. *Eimeria* drug resistance is observed due to the repeated use of anticoccidials that induce strain selection on the farms.

**Keywords:** turkeys, Eimeria, resistance, anticoccidial, Coccirosis

### 89 Algal polysaccharides improve gut barrier function.

**Maria Garcia, Franciele Giacobbo, Mustapha Berri, Pi Nyvall-Collen, Olmix Group, Brehan, France; 2Animal Health, INRAE, Nouzilly, France.**

Recent research has highlighted the potential of in-feed marine macroalgal polysaccharides to strengthen animal’s gut barrier function. The cell wall of marine algae is mainly composed of water soluble sulfated polysaccharides that present diverse biological activities. Previous research has shown, in-vitro, that a red algal extract from *Solieria chordalis* upregulates the gene expression of tight junction proteins and mucin proteins which determine intestinal integrity (Intestinal Biotech Development, 2017). The present work evaluated, in-vitro, the capacity of this red algal extract to reinforce the epithelium barrier in the presence of pathogenic bacterial strains. The ability of the red algal extract from *Solieria chordalis* to reinforce the epithelium barrier function was evaluated in a research project in collaboration with INRAE (2019, unpublished data) using several epithelial cell lines. Firstly, an intestinal cell line (IPEC-1) was cultured in the cell-culture medium alone (negative control), incubated with *E. coli* K88 1305 (1,35x10 8 CFU/mL) (positive control) or incubated with *E. coli* K88 1305 and the red algal extract (test). The trans-epithelial electrical resistance (TEER) of the cell monolayer was measured. Secondly, an avian hepatocyte cell line (LHM) was pre-treated with cell-culture medium only (control) or the red algal extract at three different concentrations (tests). After 24 hours, the cell-culture medium was removed, and cells were inoculated with *E. coli* O78K80 (4,13x10 8 CFU/mL). The percentage of adhesion of bacteria to the cells was obtained by dividing the number of bacteria that adhered to the cells by the total number of cells.
number of bacteria brought into contact with the cells (inoculate). The IPEC-1 cell line incubated with the red algal extract (test) showed an improved gut integrity as observed by a higher trans-epithelial electrical resistance (TEER) when compared to the positive control in the first ten hours of infection with E. coli K88 1305. Moreover, the red algal extract reduced the percentage of adhesion of E. coli O78K80 at the three concentrations tested compared to the negative control, thus highlighting the capacity of this red algal extract to inhibit bacterial adhesion to the epithelial cells. The studies proved the capacity of this red algal extract to support in-vitro epithelial barrier function by preventing bacteria from adhering and colonizing target tissues. The in-feed combination of this red algal extract with an immunomodulating green algal extract further showed optimized health parameters and performance of birds raised in commercial conditions.

**Keywords:** gut barrier, E. coli K88, seaweed, polysaccharides

---

90  Model generation using machine learning for the detection of *Eimeria Maxima* in broilers. Thomas Frost1, C. A. Phillips2, K. Freeman2, L. Laprade2, Aaron Cowieson3, 1DSM Nutritional Products, Parsippany, New Jersey, United States, 2DSM Biotechnology Group, Lexington, Massachusetts, United States, 3DSM Nutritional Products, Kaiseraugst, Switzerland.

*Eimeria maxima* infections are associated with poorer growth rate, body weight gain, and feed conversion ratio. While gross *E. maxima* lesions may not be evident during veterinarian necropsy, microscopic *E. maxima* (mMX) oocysts are present in intestinal scrapings and are a serious challenge to broiler performance. It was hypothesized that the concepts of machine learning could be applied to specific blood biomarkers in broilers to create a model to predict the early onset of an *E. maxima* infection. Using blood parameters, the concepts of machine learning were utilized to generate algorithms to create a model for the detection of mMX prevalence. The model herein was designed to serve as an early indicator for an increased detection of mMX in field conditions. In addition, this model allows for the opportunity to evaluate individual and groups of blood parameters that are involved in classifying mMX. In essence, this allows for a deeper analysis of why certain blood features within this model are being used to classify birds with mMX. Carotenoids were discovered as a top ranking feature the model uses to determine if mMX is present for the individual bird. Taking it a step further, the model has been validated in multiple field conditions at different locations. This validation is accomplished by comparing the model’s predicted prevalence of mMX with the actual prevalence detected by veterinarians in the field. To date, 74% of the samplings from this database were within a 25% difference of model-predicted to veterinarian-observed mMX prevalence.

**Keywords:** modeling, machine learning, E. maxima, blood biomarkers, algorithms

91 Deletion of *mgtC* gene does not affect pathogenicity of *Salmonella Gallinarum* biovar Gallinarum in a chicken infection model. Lucas B. Rodrigues Alves1, 2, Mauro Saraiva1, 2, Oliveiro C. Freitas Neto1, 3, Bruna Nestlehner de Lima1, Daniel Farias Marinho F. Monte1, John E. Olsen2, Angelo Berchieri Junior1, 1Pathology, Theriogenology, and One Health, Unesp, Jaboticabal, São Paulo, Brazil, 2Department of Veterinary and Animal Sciences, Section for Clinical Veterinary Microbiology, University of Copenhagen, Copenhagen, Denmark, 3Medicina Veterinária Preventiva, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

*Salmonella Gallinarum* biovar Gallinarum (*S. Gallinarum*) causes an acute systemic infection in susceptible chicken that leads to high mortality and considerable losses to poultry industry. The *mgtC* gene has been shown to be important for intramacrophage survival and pathogenicity of typhoid-like Salmonellosis in mammalians. Thus, we aimed to elucidate the requirement of *mgtC* gene for *S. Gallinarum* systemic infection in susceptible chickens. *S. Gallinarum* str. 287/91 (SG), isolated from a fowl typhoid outbreak in Brazil, provided the genetic background for the construction of a mutant strain lacking the *mgtC* gene (SG ΔmgtC) through Lambda-red technique. One hundred commercial brown egg-layer day-old chicks were randomly distributed within two groups and after 21 days were orally challenged with 1 mL (10^9 CFU/mL) of SG ΔmgtC or SG. Thirty birds of each group were observed over 21 days to record mortality and clinical signs twice a day. Whereas other 20 birds of each group were euthanized (5 birds/group) at 2, 5, 7 and 10 days post-infection (dpi) and samples of liver and spleen were harvested to bacterial counts. Mortality rates were submitted to Chi-square test with Yates correction, whereas survival curves were analysed using Gehan-Breslow-Wilcoxon test. Bacterial counts in organs were analysed by means of two-way ANOVA followed by Sidak's correction for multiple comparisons. Birds of both groups showed apathy, ruffled feathers, somnolence, and greenish-yellow diarrhoea. Nevertheless, the severity of the disease was more acute in birds infected with the wild-type strain. At 5 dpi, 20/28 birds in SG ΔmgtC Group and 26/28 birds in SG Group were showing clinical signs. At the end (21 dpi), two birds inoculated with SG ΔmgtC were not showing clinical signs, while the remaining bird infected from SG-Group was recovering from the fowl typhoid. SG ΔmgtC and SG provoked 25 and 29 deaths (P > 0.05), respectively. Nevertheless, the deletion of *mgtC* gene lead to late mortality (P = 0.01). The peak of bird mortality inoculated with SG occurred between the 6 and 7 dpi. In contrast, birds challenged with SG ΔmgtC succumbed between 7 and 9 dpi. Despite early mortality observed from SG Group, no significant differences (P > 0.05) in bacterial load in liver...
and spleen of birds infected with both strains, but a clear trend of SG ΔmgtC load to reach the peak required more time in comparison to the SG in both organs. The mgtC gene is not required for bacterial pathogenicity and systemic infection of S. Gallinarum, but its absence delayed deaths in susceptible birds experimentally infected.

**Keywords:** Fowl typhoid, intramacrophage, Salmonellosis, systemic infections, virulence genes

92 Evaluation of the ISI macroscopic score as a benchmark for broiler performance in commercial farms in Brazil. Bruna L. Belote1, Igor Soares1, Otto Figueiro1, Cleverson Souza2, Fernando A. Silva2, Elizabeth Santin1, 1ISI Institute, Londrina, Parana, Brazil, 2Universidade do Oeste Paulista, Presidente Prudente, Brazil. A continuous and detailed sanitary monitory is a key tool to understand what might be affecting the broilers' performance in the field. Therefore, we have developed the ISI app, through which we turn the bird's overall health into numbers in real time. The service is based on the scoring of certain alterations in the respiratory and locomotor systems, and in the gastrointestinal tract of the necropsied birds. Each parameter is scored from 0 to 3, according to the extension and intensity of the alteration. The surveyed scores (S) are multiplied by the parameter impact factor (IF), which varies from 1 to 3 according to the impact of that alteration on the tissue physiology. The final ISI score is assessed by the formula ISI = \( \sum (IF*S) \), which refers to the sum of all parameters. The present study aimed to evaluate the relation between all lesions evaluated in the ISI method with production performance data. For that was used the ISI macro data, initial and slaughter weight, feed conversion ratio (FCR), daily weight gain (DWG), viability, mortality %, production factor (IEP), sanitary break, density, age at slaughter, at 30 months in the same epidemiological units in commercial farms in Brazil using the ISI SYS mobile app. Were evaluated 48 barns over 30 months (November 14th 2019 – January 3rd 2022), totaling 521 flocks slaughtered and 2608 birds (5 birds per flock) were necropsied for macroscopic evaluation of the ISI method from 20 to 30 days of age. The data were clustered by k-means method, which aims to partition the points into k groups such that the sum of squares from points to the assigned cluster centers is minimized. In this way, were divided the flocks into 3 clusters groups, the first group (183 flocks), second group (154 flocks) and third group (224 flocks). All the flocks in the first cluster showed better ISI total results compared to second group. The average of the first group showed a better (P<0.05) result than the second group in ISI total (14 vs 22.9), FCR (1.647 vs 1.684), DWG (0.069 vs 0.067), Mortality % (4.4 vs 5.6), IEP (399 vs 379) and Slaughter age (44 vs 45 d), respectively. The third group present the same significant result (P<0.05) compared to first group for ISI total score (13 vs 14) and lowest (P<0.05) average of sanitary break (9.2 vs 12.4), respectively. However, there was no significant difference in the other factors evaluated between the third with other groups. As conclusion, the results showed a relation between the lowest score found in the sum of all the ISI lesions with the best performance values. These values are suggestive for benchmarking the ISI method to evaluate performance in the field and ISI SYS as a potential health monitoring tool in the field.

**Keywords:** ISI SYS, necropsy, big data, field, monitory

93 Effect of a probiotic solution on intestinal health of broiler chickens challenged with salmonella and mycotoxins. Damien Preveraud1, Max Ingberman2, Breno C. Beirão2, Wanderley Quinteiro3, 1Health by Nutrition, Adisseo France SAS, Antony, France, 2Imunova Análises Biológicas, Curitiba, Brazil, 3Adisseo Brasil, São Paulo, Brazil. The test comprises evaluating the immune parameter modulation by a commercial probiotic solution, Bacillus Subtilis DSM 29784 (Bs29784) in a mycotoxin-Salmonellosis experimental challenge. For this experiment, an amount of 506 one-day-old Ross broilers were acquired from a commercial hatchery. The animals were segregated, randomly, in eleven different experimental groups of 46 broilers each. On the first experimental day, the animals of the determined groups started to receive the mycotoxins challenge (fumonisin, deoxyribonucleol and T-2 toxin) by the feed. On the fourth experimental day, each animal of the determined groups, were challenged with 1x10⁸ CFU of Salmonella Heidelberg by oral delivery, in a single dose of 100 µL. Then, intestinal permeability was evaluated at d7 and d14 by oral administration of FITC-Dextran, a non-absorbable fluorescent marker in plasma. Salmonella spp. counts by Most Probable Number (MPN) and microbiota S16 sequencing was determined from d4 to d28 in ceca content. Histomorphology was assessed from jejunum and cecum tissues. In cecal tonsil, the cytokines gene expression was also measured and liver samples were also collected for lipoperoxidation and histopathology evaluation. Statistical analysis were performed by two-way ANOVA with Tukey’s post-hoc test (P < 0.05). At 4d, Bs29784 showed a decrease of plasma FITC-d and a reinforcement of the gut barrier. At d14, the Salmonella spp prevalence in ceca decreased with the supplementation of Bs29784. The probiotic also aimed to promote the anti-inflammatory response with a greater IL10 expression. LPO as a sensitive indicator of the redox balance, was also positively shifted by Bs29784. Villus height increased with the supplementation of Bs29784. Finally, beneficial bacteria such as butyrate producers firmicutes were also promoted in the Bs29784 group. Bs29784 demonstrated a positive effect on liver histological integrity, and in a mycotoxin and Salmonellosis challenge, they demonstrated a positive antioxidant effect. It seems to protect the intestinal layer in a mycotoxin-Salmonellosis challenge, reducing the
bacterial counts and promoting the good microbiota’s diversity.

**Keywords:** broiler, salmonella, mycotoxin, gut barrier, microbiota
Microbiology and Food Safety

94 Genome features and comparative analysis of *Salmonella enterica* subsp. *enterica* serovar Schwarzengrund isolated from both human and poultry. Valdine P. Benevides¹, ², Mauro Saraiva¹, ², Isabella Cardeal Campos¹, Lucas B. Rodrigues Alves¹, ², John E. Olsen², Angelo Berchieri Junior¹, ¹Pathology, Theriogenology, and One Health, Unesp, Jaboticabal, São Paulo, Brazil, ²Department of Veterinary and Animal Sciences, Section for Clinical Veterinary Microbiology, University of Copenhagen, Copenhagen, Denmark.

*Salmonella* Schwarzengrund, can cause salmonellosis in humans and colonize other animal species. In recent years, an increase in multidrug-resistant *S. Schwarzengrund* from food products and humans has been reported. The antimicrobial genes and virulence factors are often encoded on plasmids, which can facilitate their rapid transfer among pathogens. In this context, the aim was to do a comparative genomics study of *S. Schwarzengrund* isolated from poultry and humans gathered in public databases reference. We compare sequences of *S. Schwarzengrund* genomes from humans (n = 38) and poultry (n = 50). The prediction of antimicrobial resistance (AMR) determinants was carried out using the server of the Center for Genomic Epidemiology (CGE), while plasmid profiles and *Salmonella* Pathogenicity Islands (SPIs) were investigated using PlasmidFinder and SPIFinder, respectively. IncFIC (FII) (80%) and IncFIB (78%) were the most frequent plasmids, indicating that there was little plasmid variability in isolates from poultry. Unlike *S. Schwarzengrund* isolated from humans, which differs in a high diversity of plasmids. The aac(6’)-Iaa gene, that confers resistance to Aminoglycoside was detected in 100% of isolates from both hosts. 80% of the poultry isolates carried the sitABCD gene which encodes resistance to the peroxide group. Diversity of antimicrobial resistance genes was observed among the *S. Schwarzengrund* isolated from humans, in which 18% were resistant to three or more antibiotics. The most prevalent β-lactam resistance genes of *S. Schwarzengrund* isolated from humans were *blaTEM*-1B (11% = 4/38), *blaCTX-M-2*, *blaTEM*-106, *blaTEM*-220, *blaTEM*-126, *blaTEM*-135 (3% = 1 /38). *S. Schwarzengrund* from poultry showed only the mutation in the ParC (T57S). However, in *S. Schwarzengrund* sequences from humans, the *gyrA* gene were also detected. SPIs 1-3, 5, and 9 were detected in 100% of the isolates studied and C63PI was present in high percentages. Only 10.5% and 76.3% of *S. Schwarzengrund* sequences from humans harbored SPI-8 and SPI-4, respectively, and 89.5% carried SPI-13 and SPI-14. The latter was observed in 100% of the sequences from poultry, as well. The genomes of *S. Schwarzengrund* were divergent in both plasmids and resistance determinants present in relation to the isolated source. The monitoring of AMR genetic profile and characterization of mobile genetic elements, such as plasmids of *S. Schwarzengrund*, is important to strategies for the use of antimicrobials, in the correct way, especially in food animal production.

**Keywords:** mobile genetic elements, multidrug resistance, One-Health, poultry, Salmonellosis

95 Quantification of *Campylobacter* spp in turkey meat refrigerated using real-time PCR, automated technique for most-probable-number (MPN) and traditional plate counting methodology. Carlos Fuhr, Tainá Simonetti, Guiomar P. Bergmann, Vladimir P. Nascimento, Liris Kindlein, UFRGS, Porto Alegre, Brazil.

Animal products are potential causes of Foodborne Diseases, and *Campylobacter* spp. is one of the most relevant pathogens in public health. In Brazil, this agent has been studied in broiler meat, but there is few research associated with turkey meat. Based on this, the present study describes a pilot project that quantifies *Campylobacter* spp in turkey meat refrigerated using three methodologies: isolation method and plate count (standard method), real-time PCR and automated technique for most-probable-number (MPN). For the development of the assays, the specific protocol of each procedure was followed and all samples started from the same principle and dilution medium. The plate counting method consisted of inoculating the samples on mCCD agar for identification and counting of typical colonies. Then, they were picked to perform the biochemical tests. For the automated MPN technique, the samples were inserted into the specific reconstituted culture medium and the automated reading and quantification of the microorganism was performed by the equipment. In PCR, an aliquot of the samples was used for DNA extraction and amplification and for quantification. The result is performed automatically by comparing the sample growth curve with the kit’s standard curve. To calculate the sample size, the results of 28 samples analyzed by the three methodologies were initially submitted. The Agresti-Coull method was used with the objective of estimating the confidence interval and the proportion of 25% of contaminated samples, reaching the number of 287. Afterwards, another 10% was added for possible losses, totaling 319 samples. To assess the level of agreement between the methods, the proportion test was used for two dependent groups. Both methods (PCR and MPN) when compared to the standard method showed an agreement of 87.5%. The results to date demonstrate a low level of contamination of the turkey meat cuts. These data will be useful for the assessment of public health risks of turkey meat refrigerated consumption and a source of information for companies. They will also serve as a basis for alternative methods to be used as auxiliary tools that will speed up and facilitate the processes with safety and reliability.
96 Effect of a diet containing a sanguinarine-based phytobiotic on Salmonella Heidelberg infection in broiler chicks. Victória V. Alves¹, Raissa A. Silva², Leticia C. Arantes¹, Mailson d. Texeira¹, Ricardo B. Lucena², Celso J. Oliveira³, Oliveira C. Freitas Neto¹, ¹Medicina Veterinária Preventiva, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, ²Ciências Veterinárias, Universidade Federal da Paraíba, Areia, Paraíba, Brazil, ³zootecnia, Universidade Federal da Paraíba, Areia, Paraíba, Brazil.

Salmonella Heidelberg (SH) spreads in broiler flocks and can reach the poultry meat, posing a health risk to the consumers. Recently, there has been an increase in the frequency of isolation of multidrug-resistant strains of SH in broiler flocks reared in Brazil. Therefore, non-antibiotics strategies to control this pathogen at the farm level are welcome. The present study aimed at evaluating the effects of a diet containing Sangrovit (Phytobiotics Fut-terzusatzstoffe GmbH, Germany), a sanguinarine-based phytobiotic (SAN), on the infection by SH in broiler chicks. For this, one-day-old chicks were divided in three groups (A, B and C). Birds of group A were fed with a diet containing 100 g of SAN per ton and birds of groups B and C received the same feed but without SAN. At 2 days of age, birds of groups A and B were orally challenged with 5 x 10⁶ CFU of a SH strain. Birds of group C were kept as uninfected control. Cecal colonization and invasion of liver and spleen by SH were comparatively assessed at 3, 7 and 14 days post-infection (dpi), as well as the histopathological changes in these organs and the histomorphometric parameters on the ileum. The means (log¹⁰) of SH counts and means obtained by the histomorphometric analyses were submitted to analysis of variance and compared by Tukey’s test. Birds of group A (SAN) presented lower amounts of SH in cecal contents than birds of group B at 7 and 14 dpi (P<0.05). Means of SH counts in liver and spleen were similar between birds of the two groups (P>0.05). In general, birds of groups A and B (challenged with SH) showed similar macroscopic alterations such as hepatomegaly and splenomegaly, but alterations were more intense in birds of group B. The microscopic changes observed in the liver included congestion of hepatocytes, infiltrate of heterophils in sinusoid capillaries, areas of necrosis and mononuclear cell infiltration. In the cecum, heterophilic infiltrate and thickening of the lamina propria could be observed. In the ileum, the most common alterations were congestion and thickening of the lamina propria and atrophy of the villi and crypts. It was noted that the microscopic changes were less intense in birds of group A compared to group B. In the present study, higher means of height and villus area were observed in birds of the uninfected control group (C) and in those fed with the diet containing SAN (A). The highest villus:crypt ratio were observed in the uninfected control birds followed by those of group A. The results indicate that sanguinarine helped the birds to reduce caecal colonization by SH and to improve their intestinal health.

Keywords: paratyphoid infection, non-antibiotics, gut health, control, phytobiotic

97 Bacteriophages as a promising sustainable solution to control Salmonella bacteria in poultry on the example of BAFASAL preparation. Justyna Andrysiak, Ewelina Wojcik, RnD, Proteon Pharmaceuticals, Łódź, Poland.

Extensive application of antibiotics in animal production creates environmental and human safety concerns due to the rise of antibiotic resistance. This growing trend forces scientific community to urgent search for other solutions to protect animals against bacterial pathogens. Bacteriophages are promising alternative that can support the reduction of the unnecessary use of antibiotics. Here, we present BAFASAL®, a feed additive which is a mixture of carefully selected and patented bacteriophages, that helps to control Salmonella in poultry farms. The aim of this study was to investigate the efficacy of BAFASAL® in the prevention of Salmonella Enteritidis colonization and its influence on performance of breeders and egg quality. In the study 336 healthy 22-weeks old Ross 308 breeders were randomly allocated to 24 pens, at 12 breeding hens and 2 rosters per pen. Birds were distributed into 4 groups (6 replicates per each group): T1 – negative control, T2 – positive control: Salmonella infection, T3 – Salmonella infection, BAFASAL® (2x10⁶ PFU/bird 3 weeks on EOD/3 weeks off), T4 – Salmonella infection, BAFASAL®(1.33x10⁶ PFU/bird 3 weeks on EOD/3 weeks off). During the 90 days study Salmonella presence was monitored and mortality, body weight, feed intake, water intake, feed conversion, laying rate, egg mass, fertility, hatchability, chick viability were evaluated. For statistical analyses 1-way ANOVA followed by Tukey post hoc was used (Statistica version 13.1). The results observed were as follows. At day 90, number of Salmonella in faeces of birds from T3 was reduced by more than 4.3 Log (0.79 vs. 5.13; P<0.01), while for birds from T4 it was more than 3.4 Log (1.68 vs. 5.13; P>0.05) in comparison to the group T2 not obtaining BAFASAL®. BAFASAL® significantly reduced the mortality of Salmonella-infected birds, showing the mortality rate in the range of 1.39-4.17% what was like those observed for T1 (0%) and statistically lower than for T2 (19.44%). Weight gain, feed and water intake were within the breeder performance objectives of Ross 308 for all tested groups. Birds from group T2 had significantly lower egg laying rate than birds from groups T1, T3-T4, but egg composition was not influenced by infection. Fertility and hatchability of eggs from treated groups were higher.
than those of T2. What is more, BAFASAL® was proved to be effective in reducing the rate of Salmonella vertical transfer to eggs. This data suggest that the BAFASAL® feed additive has proven to be very efficient in prevention and reduction of Salmonella occurrence in gastrointestinal tract of breeders and may be successfully applied to prevent Salmonella infections in poultry breeders.

Keywords: bacteriophages, Salmonella, poultry, breeders, antibiotic's alternative

98 Inactivation of Pseudomonas aeruginosa virulence factors by activated calcium montmorillonite.

Dongping Wang1, Sara Johnston1, San Ching1, Bidemi Fashina2, Youjun Deng2, 1Amlan International, Vernon Hills, Illinois, United States, 2Texas A&M University, College station, Texas, United States.

Infection with the opportunistic pathogen Pseudomonas aeruginosa is associated with diarrhea, respiratory signs, and death, causing economic loss in the poultry industry. The characteristic pigment of P. aeruginosa, pyocyanin and pyoverdine, are key virulence factors for iron acquisition, biofilm formation and successful host colonization. Thermally processed calcium montmorillonite clay (“Test Article”) has been shown to bind diverse groups of microbial derived toxins, including alpha and NetB toxins from Clostridium perfringens; TcdA and TcdB from C. difficile; PirA and PirB from Vibrio parahaemolyticus; and Shiga toxin 2 and heat labile toxin and LPS endotoxin from E. coli. In a series of experiments, we explored the ability of this mineral to interfere with the two pigments as well as P. aeruginosa virulence gene expression. A number of tests including adsorption isotherm, toxicity assay and gene expression analysis were performed in this study. Results demonstrated that the Test Article exhibited high binding capability for both pigments. Toxicity testing showed V. parahaemolyticus growth was completely arrested by pyocyanin, but growth inhibition was abrogated by the addition of montmorillonite. The presence of montmorillonite in the lysogeny broth media did not affect bacterial growth, yet markedly reduced the abundance of P. aeruginosa pigmentation. Transcriptome analysis revealed 57 gene transcripts had significant changes due to the Test Article treatment. The products of these genes are key players in the virulence regulatory network and function in quorum sensing, iron scavenging, cytotoxicity, antibiotic resistance, biofilm formation and immune evasion. Overall, mineral treatment resulted in a transcriptome profile skewed toward virulence regulatory network inhibition. In summary, the Test Article neutralizes key virulence factors, transcriptionally suppress virulence gene expression, and has clear potential for poultry disease control.

Keywords: Pseudomonas aeruginosa, montmorillonite, pigment, quorum sensing, gene expression

99 Accumulation of fumonisins in broiler tissues with or without feeding algae-clay based technology.

Maria A. Rodriguez¹, Franciele Giacobbo¹, Didier Tardieu², Maria Matard-Mann¹, Philippe Guerre³, ¹Olmix Group, Brehan, France, ²Pharmacy-Toxicology, Ecole Nationale Vétérinaire de Toulouse, Toulouse, France.

Mycotoxins are secondary metabolites produced by molds on cereals and feedstuffs, with harmful effects on the animals. Fumonisins (FB), produced by Fusarium molds, are the most prevalent mycotoxins in Latin America and represent a significant threat for animal performance. It was long considered that FB don’t accumulate in animals as they have a low oral absorption and a rapid plasma elimination. Nevertheless, recent studies demonstrated that the hepatic half-elimination of fumonisin B1 (FB1) was up to several days. Based on these findings, the aim of this study was to evaluate fumonisin deposit in broiler tissues. Twenty-one-day old broilers were slaughtered after being fed a diet with 20 mg FB/kg for 4 or 9 days prior to slaughtering at 21 days, with or without an algae-clay based technology (Olmix, France). The exposure to fumonisins alone showed no sign of toxicity on broilers performance at this level of FB in feed, but increased concentrations of sphiogamine (Sa) and sphingosine (So) over time were measured in the liver. An accumulation of FB1 was measured in the liver, with concentrations of 20.3 and 32.1 ng FB1/g observed respectively after 4 and 9 days of exposure. The same pattern was observed with fumonisin B2 (FB2), with hepatic levels of 0.79 ng/g after 4 days and 1.38 ng/g after 9 days of exposure. Even if FB1 levels were very low in breast muscles, an accumulation could also be observed after 4 and 9 days of exposure with concentrations of respectively 0.036 and 0.072 ng FB1/g. When feeding the algae-clay based technology to the broilers, a reduction of FB1 deposit in the liver and muscles was measured. After 9 days of exposure, a significant reduction of around 40 and 50% was observed, whereas a non-significant effect was observed after 4 days exposure. Broilers fed the algae-clay based technology also showed a decrease in Sa and So levels in the liver compared to the non-supplemented broilers. Further studies are needed to confirm this fumonisin accumulation over longer time of exposure and different animal age. Meanwhile, the algae-clay technology shows promising results to prevent such deposit.

Keywords: fumonisin, mycotoxin, liver, clay, algae

100 Salmonella Typhimurium infection with a knockout of ttrA and pduA genes interferes with the abundance and diversity of the ceacal broiler microbiota. Mauro Saraiva¹,², Mattia Pirolo², Lucas B. Rodrigues Alves¹,², Daniel Farias Marinho F. Monte¹, Valdine P. Benevides¹,², John E. Olsen², Angelo Berchieri Junior¹, ¹Pathology, Theriogenology, and One Health, Unesp, Jaboticabal, São Paulo, Brazil, ²Department of Veterinary and Animal Sciences, Section for Clinical Veterinary Microbiology, University of Copenhagen, Copenhagen, Denmark.
Salmonella Typhimurium can overcome the competition from the microbiota and anaerobic environment, causing gut inflammation and being transmitted to humans by means of contaminated food consumption. The trrA and pduA genes play a central role in infection and dissemination by enhancing the period of bacterial excretion amidst faeces and therefore successfully enabling the infection of new hosts. Thus, we aimed to evaluate the importance of trrA and pduA genes for the relationship between S. Typhimurium and the gut microbiota of broilers. S. Typhimurium str. F98 (STM) provided the genetic background for the construction of a mutant strain lacking both the trrA and pduA genes (STM ΔtrrApduA) through Lambda-red technique. Broilers were acquired from a commercial company and randomly distributed into three groups: Two groups with birds challenged with 1 mL (10^6 CFU/mL) of STM ΔtrrApduA or STM at the first day old and a control group with non-infected chicks (NInf). Birds received sterilized water and balanced feed ad libitum. Five birds from each group were euthanized at 3 days post-infection (dpi) and caecum was harvested. The caecal DNA was extracted and then subjected to library preparation (Illumina 16S rRNA) and sequencing (Illumina MiSeq). Statistics for both Alpha and Beta diversity indices were performed by paired Kruskall-Wallis test and PERMANOVA (P < 0.05), respectively. Differential abundance analysis to identify OTUs differences between groups was performed by means of LDA Effect Size. The abundance analysis to identify OTUs differences between treatment groups. Lachnospiraceae, broilers evidenced microbial shifts in the most abundant taxa between the treatment groups. Ruminococcaceae, Ruminococcaceae and Enterobacteriaceae comprised the main taxa at Family level. STM ΔtrrApduA group led to a reduction of Enterobacteriaceae abundance and an increase in the Lachnospiraceae load in comparison with both STM and NInf groups. Ruminococcaceae abundance was reduced in STM ΔtrrApduA group in comparison with STM one. In terms of alpha diversity, the STM group showed the highest values for Shannon’s diversity index, while the STM ΔtrrApduA group had the highest values for the Chao1 index, however, no statistical differences were observed (P > 0.05). According to the beta diversity analysis, STM ΔtrrApduA group was the most dissimilar to STM one. Less dissimilarity was observed between STM and NInf groups. The absence of both trrA and pduA genes impacts on both compositional structure and dissimilarity (beta diversity) of caecal microbiota in broilers experimentally infected with S. Typhimurium.

**Keywords:** 16S rRNA, alpha diversity, caecal microbiota, beta diversity, paratyphoid disease

**101 Persistence of Lactobacillus spp. in poultry litter nebulized with FloraMax-B11®**, Larissa Justino1,2, Ana C. Benteo1, Marilen d. Souza1, Maísa F. Menck-Costa1, Vanessa M. Kaneko1, Claudia E. Cicerò1, Sidnêi Trocato de Freitas Júnior1, Alexandre Oba2, Fabrizio Matti3, Ana A. Baptista1,1Department of Preventive Veterinary Medicine, State University of Londrina, Londrina, Paraná, Brazil, 2Department of Zootechny, State University of Londrina, Londrina, Paraná, Brazil, 3Vetanco, Chapecó, Santa Catarina, Brazil.

The goal of this study was to evaluate the persistence of a poll of strains of Lactobacillus spp. in aviary bed. For that, plastic trays containing new shavings plus 25% of previously decontaminated poultry litter were prepared and one sample was sample was subjected to bacterial recuperation in order to indicate the negativity of Lactobacillus spp. in poultry litter prior to treatments. Two treatments were performed: T1: Nebulized bed with 10 mL of FloraMax-B11® (2.4 grams diluted in 200 mL of PBS) and T2: Nebulized bed with 10 mL of FloraMax-B11® incubated in MRS broth 37 degrees Celsius for 24h (9.55 Log CFU/mL). For each treatment, three replications were performed. Bacterial quantifications were carried out at 0, 24, 48, 72, 96 and 168 hours, with the aid of a boots swabs in MRS broth, followed by a serial dilution and a spread plate technique in Lactobacillus Selective Agar, that was subsequently incubated at 37 degrees Celsius for 48 hours. For statistical analysis, simple linear regression was used using the PRISM GraphPad® software. At time 0 hours the means of Log CFU/ were 4.33 and 7.32 at T1 and T2, respectively, at 24h and 48h in T2 treatment we observed 6.56 and 6.35 Log CFU/mL and at T1 4.08 and 3.84 Log CFU/mL, respectively. At T72h, we observed a decrease in Log in treatments T1 (3.26 Log CFU/mL) and T2 (5.70 Log CFU/mL), however, at T96h, only in T1 a decrease was observed to 2.72 Log CFU/mL, while T2 obtained a Log CFU/mL of 5.73. At 168 hours, a decrease was observed in both treatments, T1 and T2 with Log CFU/mL of 2.45 and 4.79 respectively. In our study, no difference was observed between treatments at all analyzed points (p >0.05). Indicated that the FloraMax-B11® product can be used in both forms of preparation and remains viable in poultry litter up to seven days after nebulization.

**Keywords:** FloraMax-B11®, Lactobacillus spp., poultry litter, aviiculture, poultry

**102 Oral vaccination in broilers as a strategy to control Salmonella spp.** Marielen d. Souza1, Alceu Kazuo2, Carlos A. DalleMole2, Luiz E. Takano2, Larissa Justino1, Maísa F. Menck-Costa1, Vanessa M. Kaneko1, Sherry Layton3, Ana A. Baptista1,1Department of Preventive Veterinary Medicine, State University of Londrina, Londrina, Paraná, Brazil, 2Vetanco do Brasil importação e exportação, Chapecó, Santa Catarina, Brazil, 3Vetanco, Saint Paul, Minnesota, United States.

Poultry meat and products are a primary source of non-typhoidal salmonellosis in humans. While most Salmonella species do not cause disease in chickens, vaccination is often utilized to reduce or eliminate Salmonella from the animal for food safety concerns. In this study we evaluated
the effect of an oral subunit vaccine (Biotech Vac® Salmonella) on non-typhoidal Salmonella spp. elimination in naturally infected broilers. Four poultry farms, for a total amount of 176,500 birds, with a high historical occurrence of Salmonella spp. contamination were selected. For three consecutive productive cycles, chicks were orally vaccinated via the drinking water on the 3rd and 17th day of life, at a dosage of 0.2 ml/bird. To quantify Salmonella spp., nine birds per barn were harvested on the 40th day of life and the ceca from three birds was pooled (3 pools, 3 birds each) and Salmonella was quantified by Most Probable Number per gram of ceca (MPN/g) according to ISO 6579-1 2017. Kruskal -Wallis test (α ≤ 5%) followed by Dunn's multiple comparisons test indicated that there was a reduction in cecal Salmonella spp throughout the cycles. MPN/g in cycles 2 and 3 was significantly lower when compared to cycle 1 (p = 0.231), cycle 01 – 1.012a (± 1.309) MPN/g, cycle 02 - 0.1655ab (± 0.2855) MPN/g and cycle 3 – 0.12b (0.1549) MPN/g. These results indicate that the application of this subunit oral vaccine can be used as part of a farm-level strategy to reduce the amount of Salmonella contamination in broilers.

**Keywords:** food safety, Salmonella spp., vaccine, chicken, zoonosis

**103 Supplementation of a yeast fermentate product on broiler carcass microbiota gollowing rvisceration and chilling steps.** Lindsey A. Wythe¹, Dana Dittoe¹, Abe Schaeffer², Steven Ricke³, ¹Animal Science, University of Wisconsin, Madison, Wisconsin, United States, ²Harvest Fuels, Walhalla, North Dakota, United States.

Yeast fermentate (YF) products have been shown to improve bird growth and performance, however, little research has been conducted on potential effects on final carcass microbiota. The objective of this study was to evaluate the effects of supplementing a YF product, ProBiotein® (PB), in a standardized broiler diet on carcass microbial composition. Male Ross x Ross 308 broilers (N = 400, n = 50, r = 4) were placed using a randomized complete block design and raised in floor pens until d 46. Birds were provided a corn-soybean meal diet ad libitum supplemented with PB and sand balanced to 0.75% of the diet. The treatment inclusion levels were: 0.00% PB + 0.75% sand (0.0PB); 0.20% PB + 0.55% sand (0.2PB); 0.50% PB + 0.2% sand (0.5PB); and 0.75% PB + 0.0% sand (0.75PB). Following evisceration, carcasses were chilled in separate immersion tanks per treatment (1.5 h). From each treatment, 10 carcasses (N = 40) were randomly selected from respective chilling tanks and rinsed in 400 mL of buffered peptone water for 60 s. Genomic DNA from 40 mL aliquots of each rinse was extracted and the V4 region of the 16S rRNA gene was sequenced on an Illumina MiSeq. Sequencing data were analyzed in QIIME2-2020.2. The main effect of treatment and pairwise differences on α and β diversity were determined using Kruskal-Wallis and ANOSIM with significance determined at P < 0.05 and Q < 0.05. Significantly different taxonomical relative abundances were determined using ANCOM. Rinsates from birds fed 0.0PB were different in Pioulou’s Evenness from rinsates from 0.5PB birds (P < 0.01, Q < 0.01). For Faith’s phylogenetic diversity, rinsates from birds fed 0.0PB were different from rinsates of those fed 0.5PB and 0.75PB (P < 0.05, Q < 0.05). For β diversity, Weighted and Unweighted UniFrac results showed similar findings: 0.0PB rinsates were different from those of birds fed 0.5PB and 0.75PB; rinsates from 0.2PB birds were different from those fed 0.5PB, but not those fed 0.0PB or 0.75PB; and rinsates of 0.2PB birds were different from that of 0.5PB (P<0.05, Q=0.05). ANCOM results at the phyla level revealed Campilobacterota and Desulfobacterota as significantly different in relative abundances (W = 20, 20, respectively), but at the genera level only a previously uncultured member of the Desulfovionaceae family was significantly different in relative abundance (W = 309). These results reveal that feed amendments may have a significant effect on the microbial ecology of final carcass microbiota. Further research into the effects of feed amendments and processing parameters on final carcasses may help the poultry industry better combat spoilage and food safety implications.

**Keywords:** yeast fermentate, microbiome, processing, 16S sequencing, Rinsate
Metabolism and Nutrition, Amino Acids

104 Methionine and cysteine ideal levels for growing and finishing broiler chickens. Marley Conceição dos Santos1, Leandro Nagae Kuritza2, Geovani Costa Senger1, Ana C. Britto Doi1, Chayane da Rocha1, Leticia Moreira dos Santos2, Francielle de Oliveira Marx1, Simone G. de Oliveira1, 1Animal Science, Universidade Federal do Paraná, Curitiba, Paraná, Brazil, 2Veterinary Science, Universidade Federal do Paraná, Curitiba, Brazil.

The objective of this study was to determine the ideal level of digestible methionine + cysteine (Met+Cys) for broilers considering their response in performance, carcass yield and abdominal fat. A total of 1,296 male broilers were distributed in a completely randomized design with 6 treatments and 9 replicates of 24 birds each, housed in 2.06 m2 experimental pens (11.6 broilers/m2). From 1 to 21 days old, all birds received a basal diet. Starting at 21 days the experimental diets were fed, which consisted on a basal diet (with no inclusion of synthetic methionine) and 5 diets supplemented with increasing levels of DL-methionine, which supplied: 0.770, 0.829, 0.889, 0.948, 1.007 and 1.067% Met+Cys respectively, on the growth phase (21 to 35); and 0.692, 0.741, 0.790, 0.838, 0.887 and 0.936% Met+Cys respectively, on the final phase (36 to 42 d). Feed intake (FI), body weight gain, feed conversion ratio, methionine intake, efficiency of methionine utilization, carcass yield, breast yield and abdominal fat percentage were recorded. The data were analyzed by linear and quadratic analysis of regression. During growth phase, FI was not affected by the increasing levels of Met+Cys, but it was linearly reduced during the final period (P<0.05). In both phases Met+Cys had a quadratic effect on performance parameters, carcass and breast yield, and abdominal fat (P<0.05), that had increased in greater levels (between 1.007 and 1.067%). Regression analyses showed that in the growth phase the ideal Met+Cys level is 1.067% and in the final phase is between 0.887 and 0.936% for performance parameters. For carcass and breast yield and abdominal fat the ideal Met+Cys level is 0.948% in growth phase, and 0.838% in final phase (considered the weighted average of the growth (66.66%) and finishing (33.34%) periods).

Keywords: poultry nutrition, sulfur, amino acids, carcass composition, protein

105 Evaluation of sulfur amino acid levels in relation to diet digestible lysine on the performance of Ross broilers from 1 to 24 days. Maisa B. de Carvalho1, Ricardo V. Nunes2, Cleison d. Souza1, André S. de Avila2, Edevaldo A. Ianchinski1, Marcelo A. Silva1, Cristina Kaufmann1, Felipe P. Campos1, Hélida Sartor2, Maressa Fernanda Cardoso Pereira1, Eduarda L. Stork2, 1Universidade Tecnológica Federal do Paraná, Dois Vizinhos, Paraná, Brazil, 2Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.

A study was conducted to estimate the requirement of digestible methionine + cysteine to digestible lysine ratio (dig. Met+Cys:Lys dig.) for male broilers from 14 to 28 days of age. For this purpose, a total of 840 Cobb 500 male chicks with 14-days-old (initial body weight of 0.430 ± 0.005 kg) were divided in a completely randomized design into 6 treatments with 7 replicates and 20 birds per experimental unit. Dietary
treatments were composed by 6 increasing levels of dig. Met + Cys:Lys ratios (54, 58, 62, 67, 75 and 83%) achieved with the inclusion of DL-Met to a corn/soybean-meal based diet. Diets were formulated to meet the recommendations of Rostagno et al. (2017), except for the dig. Met + Cys and dig. Lys. The dig. Lys was set at 94% of the recommendation to avoid excess of this amino acid. Whereas the other amino acids were supplemented 10% above the recommendations to avoid any limitation of bird’s performance. Broilers and diets were weighed at 14 and 28 days to determine final body weight (FBW), average daily weight gain (ADWG) and feed conversion ratio (FCR).

Data were analyzed as one-way ANOVA using SAS® software and the ideal ratios were estimated using quadratic polynomial (QP), linear broken-line (LBL), quadratic broken-line (QBL) and exponential asymptotic (EA) models, where performance parameters were regressed against dig. Met+Cys:Lys ratios. The 95% asymptotic percentage response was used to estimate the requirement for EA model. The model which better fitted data was considered that with the smaller Akaike Information Criterion (AIC) value. For FBW and ADWG, the dig. Met+Cys:Lys requirements using the QP, LBL, QBL and EA models were 76, 69, 75, 77% and 76, 67, 75, 77%, respectively. For FCR, the dig. Met+Cys:Lys ratio requirement using the QP, LBL, QBL and EA models were 78, 66, 75 and 81%, respectively. Data fitted better to QP model, except for FCR which fitted better to EA model. Based on these results, the optimum dig. Met+Cys:Lys ratio for FBW and ADWG of male broiler chickens from 14 to 28 days of age is 76% and 81% for FCR.

Keywords: dose-response, ideal protein, sulfur amino acids, productive performance, poultry


Validation of the replacement ratio or in other words, the relative bioavailability (RBA) of methionine sources, is a critical factor for cost effective formulation of broiler diets. Several dose-response trials with subsequent multi-exponential regression analysis have demonstrated that the RBA of DL-Met hydroxy analogue free-acid (MHA-FA) is close to 65% compared to DL-Met. This RBA value can be continuously validated under different broiler production conditions. Therefore, a broiler commercial trial was conducted to determine the effect of replacing 100 parts of MHA-FA with 65 parts of DL-Met on growth performance of mixed sex broilers from 1 to 45 days of age reared under Brazilian production conditions. A total of 217,000 one-day old Cobb 500 mixed-sex broilers were allocated to 9 tunnel broiler houses with similar rearing conditions according to integrators practice but with capacities ranging from 21,000 to 29,000 broilers per house. Stocking densities across houses varied between 10 to 12 broilers/m². Broilers were fed according to the integrator commercial 4-phase feeding program with starter (24% CP and 3,020 kcal/kg AMEn), grower 1 (21%CP and 3,100 kcal/kg AMEn), grower 2 (18% CP and 3,130 kcal/kg AMEn) and finisher (18% CP and 3,150 kcal/kg AMEn) diets. Each feeding phase comprised 2 dietary treatments including 1) MHA-FA100: control diet with MHA-FA formulated with the integrator RBA value of 82% and 2) DL-Met65: similar to diet 1 but with DL-Met at 65 parts of the MHA-FA levels. The MHA-FA inclusion levels were: 0.44, 0.34, 0.27 and 0.27% and for DL-Met were: 0.29, 0.22, 0.18 and 0.18% for each feeding phase, respectively. The MHA-FA100 diet was offered to 5 broiler houses (total = 128,000 broilers) and the DL-Met65 diet to 4 broiler houses (89,000 broilers). Each broiler house was considered the experimental unit. Growth performance data was calculated from the total birds harvested and total feed consumed per broiler house. Data were analyzed with Minitab using the 2-sided t-test with a significance of 0.05. Total mortality across houses ranged from 4 to 6% with an average of 5.0% for the MHA-FA100 and 5.1% for DL-Met65 (P = 0.36). Overall, broilers fed the MHA-FA100 diets and DL-Met65 diets had similar ADG (60.99 vs. 61.38 g/d; P = 0.35), FCR (1.78 vs. 1.76 g/g; P = 0.68) and adjusted FCR to 2.9 kg BW (1.83 vs. 1.83 g/g; P = 0.52). Similarly, the production efficiency factor was not affected (P =0.33) by treatments with an average of 325 for MHA-FA100 and 331 for DL-Met65. These results demonstrate that 100 parts of MHA-FA can be replaced with 65 parts of DL-Met without affecting growth performance of mixed sex broilers under large commercial conditions.

Keywords: bioefficacy, broiler, DL-methionine, amino acids, methionine

108 The effects of arginine:lysine ratios on performance, skin quality and creatine levels of broiler chickens fed low-protein diets from 22 to 44 days old. Carlos H. Oliveira, Kelly M. Dias, Romário D. Bernardes, Jisoo Tak, Chorong Park, Ramalho Rodrigues, Arelle A. Calderano, Luiz F. Albino, Animal Science, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, Animal Science, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, CJ Bio, Jung-gu, Seoul, Korea (the Republic of), CJ Brazil, São Paulo, São Paulo, Brazil.

The aim of this study was to elucidate the effects of arginine supplementation in low-protein diets through different standardized ileal digestible (SID) Arg:Lys ratios on performance, skin quality and creatine levels of broiler chickens from 22 to 44 days old. All procedures adopted in this research were previously approved by the Ethics Committee. A total of 1,540 22-days-old chickens with
initial body weights of 958.62 ± 61.8 g were distributed in a completely randomized design into 7 treatments, with 10 replicates with 22 birds each. A control diet was formulated with CP = 20.77% and SID Arg:Lys = 107% to meet all nutritional requirements, and a low-protein diet was formulated with CP reduction (CP = 19.04%, SID Arg:Lys = 94%) to meet the nutritional requirements, except for Arg. Six levels of L-arginine (0, 0.60, 1.20, 1.80, 2.40, and 3.10 g/kg) were added to the low-protein diet, meeting the SID Arg:Lys ratios of 94, 100, 106, 112, 118, and 124%. Chickens and feed were weighed at days 22 and 44 for evaluation of the average daily feed intake (ADFI), body weight gain (BWG), and feed conversion ratio (FCR). At 44 d, three birds per replicate were slaughtered to collect samples of muscle Pectoralis profundus, blood, and skin to determine the creatine level in muscle (CrM) and serum (CrS), and skin thickness (ST). Data were analyzed by one-way ANOVA and Dunnett's test (P≤0.05) was used to individually compare each treatment with low-protein diets to the control group. Additionally, linear and quadratic regressions were performed to model the variables assessed and the ratios of SID Arg:Lys. The control treatment was not considered in the regression analysis. The SID Arg:Lys ratios in low-protein diets did not affect the ADFI of broiler chickens (P = 0.702). The increasing ratios of SID Arg:Lys in low-protein diets linearly increased the BWG, CrS and ST (P<0.001), and quadratically increased the CrM (P = 0.001), whereas it linearly decreased the FCR (P<0.001) of broiler chickens. When each treatment with low-protein diet was contrasted to control group, the SID Arg:Lys ratios of 94 and 100% showed lower BWG (P≤0.05), whereas the SID Arg:Lys ratio of 94, 100 and 106% showed worse FCR (P≤0.05). In addition, only the chickens fed diets meeting SID Arg:Lys ratios of 112 and 118% showed higher CrM than the chickens from the control group (P≤0.05). Birds fed diets with SID Arg:Lys ratios of 118 and 124% showed thicker ST than control (P≤0.05). Although the creatine level in muscle showed a quadratic effect, the majority of variables assessed linearly increased as the ratios of SID Arg:Lys increased, therefore the recommended ratio of SID Arg:Lys is 124% for broiler chickens from 22 to 44 days old.

**Keywords:** arginine, low-protein, performance, skin quality, creatine level

109 The effects of isoleucine:lysine ratios on growth performance of broiler chickens fed low-protein diets from 22 to 44 days old, Romário D. Bernardes1, Kelly M. Dias1, Carlos H. Oliveira2, Jisoo Tak3, Ramalho Rodrigueiro4, Arelle A. Calderano3, Luiz F. Albino1, 1Animal Science, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, 2Animal Science, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, 3CJ Bio, Jung-gu, Seoul, Korea (the Republic of), 4CJ Brazil, São Paulo, São Paulo, Brazil.

Due to the growing interest in reduce crude protein (CP) in diets for broiler chickens, and the important role that isoleucine plays in birds metabolism, this study aimed to assess the effects of isoleucine supplementation through different standardized ileal digestibility isoleucine:lysine (SID Ile:Lys) ratios on performance of broilers fed low-protein diets from 22 to 44 days old. All procedures adopted in this research were previously approved by the Ethics Committee. A total of 1,320 22-days-old chickens with initial body weights of 955.89 ± 8.32g were distributed in a completely randomized design into 6 treatments, with 10 replicates with 22 birds each. A control diet was formulated with CP = 20.95% and SID Ile:Lys = 68% to meet all nutritional requirements, and a low-protein diet was formulated with CP reduction (CP = 18.50%, SID Ile:Lys = 56%) to meet the nutritional requirements, except for Ile. Five levels of L-isoleucine (0, 0.5, 1.02, 1.52, and 2.01 g/kg) were added to the low-protein diet, meeting the SID Ile:Lys ratios of 56, 61, 66, 71, and 76%. All birds and feed were individually weighed at 22 and 44 d to determine the average daily feed intake (ADFI), body weight gain (BWG), and feed conversion ratio (FCR). Data were analyzed by one-way ANOVA and Dunnett's test (P≤0.05) was used to individually compare each treatment with low-protein diets to the control group. Additionally, linear and quadratic regressions were performed to model the variables assessed and the ratios of SID Ile:Lys. In case of quadratic responses, the optimal SID Ile:Lys ratio was calculated by taking the first derivative of the quadratic equation and then estimating the ratio using 95% of the maximum responses. The control treatment was not considered in the regression analysis. The SID Ile:Lys ratios in low-protein diets did not affect the ADFI of broiler chickens (P = 0.144). The BWG quadratically increased (P = 0.005) and the FCR quadratically decreased (P = 0.006) as the SID Ile:Lys ratio increased from 56 to 76% in low-protein diets, in which the optimum SID Ile:Lys ratio estimated was 65.35 and 64.78%, respectively. All treatments in which birds fed with low-protein diets, regardless the SID Ile:Lys ratio, showed worse BWG and FCR than the ones from control group (P≤0.05). In conclusion, the recommended ratio of SID Ile: Lys in diets reduced in protein content for growth performance is around 65% for broiler chickens from 22 to 44 days old.

**Keywords:** isoleucine, lysine, low-protein diets, performance, broiler

110 Evaluation of the effect of decreasing crude protein (CP) levels with supplementation of synthetic amino acids (AAs) upon the performance in broilers. Danie Goncalves Bruno, Juliana Vieira Marques de Souza Pereira Batista, Silva Caio Cesar Besson, Alvaro Medina Dubois, Penz Jr Antonio Mario, Cargill Alimentos LTDA, Campinas, São Paulo, Brazil.

Increasing raw material costs is impacting feed cost for poultry producers, shrinking their profit margin. In this
scenario, the decrease in CP levels and soybean inclusion can lead to significant reduction in feed cost and N excretion. The objective of the of the present study was to evaluate the effect of decreasing CP levels with supplementation of synthetic AAs, in diets formulated with either current recommended levels (CL) or reduced levels (RL), consisting of the same digestible lysine requirement of CL but with an average decrease of 2% in the ratio of digestible-AAs to lys ratio and in average 0.4 perc. point less CP) upon the performance and abdominal fat % in broilers fed corn-soy based diets. For this study, 1,520 male Cobb 500 broilers were allocated to floor pens with 19 broilers per pen (80 pens in total), distributed in 10 treatments, in a randomized block design with a factorial of 2 levels of protein (L) x 5 synthetic amino acids (AA) distribution of treatments. From 1 to 21 days of age, broilers were fed either CL or RL diets. From 22 days to 41 days old, synthetic AAs were added to both control CL and RL diets, to meet the requirement of these amino acids and then decrease CP in the following order: Ile; Ile+Val; Ile+Val+Trp and Ile+Val+Trp+Arg. Control diet had only synthetic Lys, Met and Thr. The reduction of CP with the addition of each AA was in relation to control, 0.4; 0.8; 1.0 and 2.0 perc. points. Diets were fed as mash. The variables evaluated were: feed intake (FI), body weight (BW) and feed conversion ratio (FCR) from 1 to 21 and 1 to 41 days and % of abdominal fat pad (from 2 birds per pen at 42 days of age). ANOVA was used to evaluate the effects of each factor and their interaction and means were compared by Tukey Test, with significance assumed if P<0.05. From 1 to 21 days no differences were detected. From 22 to 41 days of age it was not observed interaction between factors (p>0.05), nor differences between CL and RL for any of the evaluated variables, in any of the amino acids added diets. In relation to the synthetic AA level supplementation, no effects upon FI and BW were observed. FCR of birds fed the lowest dietary CP level, in CL and RL diets (with synthetic Lys, Met, Thr, Ile, Val, Trp and Arg) was worse than control birds, whereas birds in other treatments had intermediate results (p=0.014). A tendency of significance (p=0.058) was observed for % of abdominal fat, with birds fed the lowest CP (CL and RL diets) level having numerically the highest percentage fat. In conclusion, decreasing crude protein up to 1.0 percentage point in relation to the current diets (CL and RL diets) did not impact the performance, provided that synthetic Ile, Val and Trp were fed.

Keywords: crude protein, synthetic amino acids, isoleucine, performance, soybean meal

111 Response of laying hens to repletion and depletion in dietary balanced protein. Ingryd P. Nobrega1, Matheus Reis2, Leticia C. Bittencourt2, Nilva K. Sakomura3, 1DSM Animal Nutrition & Health, Mainirne, São Paulo, Brazil, 2DSM, Sao paulo sp, Brazil, 3Animal Scientist, São Paulo State University, Jaboticabal, Brazil.

The growing period of a laying hen is the most critical time of a hen’s life and the mistakes made during this period are difficult to rectify. In this context, we hypothesize that balanced protein levels (BP) affect pullet formation, leading to a shift in the long-term laying cycle and the repletion in dietary BP may recover the responses of laying hens; thus, the aim of the present research is to evaluate the impact of depletion and repletion of dietary BP on performance and egg components in laying hens submitted to low and high dietary protein during the rearing period. At the beginning of the rearing period (eight w-old), four-hundred pullets were equally distributed and received one of two experimental feeds: 1- Low BP (L); and 2- High BP (H). For the laying period (19 to 102 w-old), four feeding programs were designed based on the same treatments for rearing phases (LL, HH, LH, HL), where subsequent letters indicate the feed received during the rearing and laying period, respectively. Standardized ideal digestible lysine (SID-Lys) proposed by the breeding company (Lohmann Tierzucht GmbH, Cuxhaven, Germany), was used as a reference to produce the two levels of BP. The responses evaluated were daily feed intake (g/day), egg production (%), egg weight (g), egg mass (g), and egg components (weight of yolk, albumen, and dry eggshell). The data were evaluated as a two-factor repeated measure to determine the effects of dietary treatments over time, using a mixed model. Orthogonal contrasts were elaborated to investigate the effects of repletion (LL vs LH) and depletion (HH vs HL) of dietary balanced protein. On average, The FI was not affected (P>0.05) by the dietary BP. On the other hand, the repletion of dietary balanced protein improved (LL vs LH, P<0.05) egg production (3.7 %), egg weight (3.0 g), egg mass (4.9 g), and feed conversion (0.16 g/g). A depletion of dietary balanced protein reduced (HH vs HL, P<0.05) egg weight (-3.5 g) and egg mass (-4.5 g) and increased feed conversion (0.18 g/g) of laying hens. Laying hens consuming the LH and HH feed produced eggs with heavier yolk in comparison with hens consuming the LL or HL feeds (around 6% difference). The results indicate that the feed given in the rearing phase has a limited influence on the yolk production. The differences observed for albumen and eggshell weights suggest a similar behavior. The results presented herein demonstrate the adverse effects of reducing the balanced protein in the growing phase were minimized by repleting the dietary balanced protein in the laying period. On the other hand, the depletion of balanced protein in the layer phase reduced the performance of hens.

Keywords: amino acids, egg components, egg production, ideal protein, laying hens

112 Crude protein reduction and balanced amino acid profile keeps egg performance in two different production systems. Márcio Pilecco1, Alexandre P. Rosa1, Alana B. Serraglio2, Andreas Lemme2, Carlos de la Cruz2, Nei A. Barbosa3, 1Animal Science, Federal University of Santa Maria, Santa Maria, RS, Brazil, 2Nutrition & Care, Evonik Operations GmbH,
The aim of the current study is to evaluate the effects of low crude protein diets supplemented with L-isoleucine on the performance, egg quality for layers with 85-to-100-week-old housed under different production systems. In total, 768 Isa Brown laying hens were distributed into two experiments: Experiment 1 - Cage-free system (576 hens); and Experiment 2 - Conventional cages (192 hens), based on the density recommended for each system. Both experiments were performed through similar methodologies, except for the production system. Hens were randomly distributed in three dietary treatments: control (160 g/kg of CP), low crude protein (LCP; 135 g/kg of CP) and low crude protein + L-isoleucine (LCP + ILE; 135 g/kg of CP). The performance and egg quality parameters of the models were evaluated. Analysis of variance and the least square method were performed based on Mixed procedure; means were compared through Tukey-test (P<0.05). Hens subjected to the LCP + ILE treatment in experiment 1 have shown lower body weight than, and intermediate feed intake in comparison to, animals subjected to other treatments (P<0.05). Experiment 2 did not show difference in body weight between hens treated with LCP and LCP + ILE; however, hens treated with LCP +ILE recorded higher feed intake than the ones in the LCP group. Egg quality (percentage and amount of albumen and eggshell) has increased in animals treated with diets balanced with L-isoleucine (P<0.05), in both production systems. A balanced diet with all amino acids available, including ILE allowed meeting amino acid requirements resulting from decreased crude protein levels observed in old laying hens in both production systems, maintaining laying hens’ performance and egg quality.

Keywords: amino acids, crude protein, egg production, egg quality, L-Isoleucine
113 Impact of feeding black pepper (Piper nigrum L) and xylanase on hepatic antioxidants of broiler chickens. Vasil Pirgozliev1, Kristina Kljak2, Isobel Whiting1, Stepenh Mansbridge1, Stephen Rose1, Judith Rollinger3, Atanas Atanasov3,4, Arthur Jozwik3,1Harper Adams University, Newport, Shropshire, United Kingdom, 2Faculty of Agriculture, University of Zagreb, Zagreb, Croatia, 3Department of Pharmaceutical Sciences, Division of Pharmacognosy, University of Vienna, Vienna, Austria, 4Institute of Genetics and Animal Biotechnology of the Polish Academy of Sciences, Jastrzebiec, Poland.

Black pepper (Piper nigrum L) (BP) has been shown to improve overall antioxidant and health status of animals. Exogenous xylanase (XYL) is routinely used in monogastric animal nutrition to improve performance. However, information on the interaction between BP and XYL is limited. The aim of this study was to determine hepatic antioxidant status of broilers fed diets containing BP and XYL alone or in combination. The experiment was conducted at the National Institute of Poultry Husbandry and approved by the Harper Adams University (HAU) Research Ethics Committee. A wheat-soy-based basal feed containing 650 g/kg wheat and 220 g/kg soybean meal as main ingredients (12.67 MJ/kg AME and 206 g/kg CP) was prepared. The basal feed was then split into four batches; one batch was fed as is; second batch was supplemented with Aspergillus oryzae commercial preparation of endo-1,4-beta XYL at 200 FXU/kg (Ronozyme WX, DSM, Switzerland); third batch was supplemented with 10g/kg diet of milled BP (determined 4.2% piperine); the fourth batch was supplemented with both, XYL and BP, at the same level as in the previous two batches. Xylanase and BP in each diet were added on the top of the basal feed. Sixty-four male Ross 308 chicks were used in the study. At 7 d age the birds were allocated to 32 pens, 2 birds in a pen, following randomisation. Standard rearing conditions for broilers were used (Aviagen Ltd., Edinburgh, UK). Each diet was fed to 8 pens from 7 d old to 21 d of age. During the last day of the study, one bird from each pen was culled and the liver was collected, freeze dried, milled and used for analysis of total carotenoids (TC), vitamin E (vit E) and coenzyme Q_{10} (Q_{10}). Data were analysed by two-way ANOVA following 2 x 2 factorial arrangement (Genstat 19th edition). Feeding XYL increased the concentration of hepatic TC and Q_{10} (P < 0.05) but BP did not have an impact (P > 0.05) on those variables. There were BP by XYL interactions (P < 0.05) on hepatic vit E concentration, as feeding both BP and XYL, led to an increase in hepatic vit E, compared to BP alone. Supplementing XYL to poultry diets can be used to improve growth performance and overall health of poultry. Research to optimise inclusion rates of BP is warranted to provide more information to poultry nutritionists.

Keywords: black pepper, xylanase, broilers, hepatic antioxidants

114 Combination of a novel bacterial phytase with endogenous phosphatases for myo-inositol release evaluated in vitro. Diogo F. Rosso1, Jacqueline C. de Souza1, Morten B. Tovborg1, Leticia C. Bittencourt2, Vitor Fascina2,1Novozymes Latin America, Araucária, Paraná, Brazil, 2DSM Produtos Nutricionais Brasil, São Paulo, Brazil, 3Novozymes A/S, Kgs. Lyngby, Denmark.

Myo-inositol hexakisphosphate (InsP_6) and its salt (phytate) are natural sources of phosphorous in plant seeds. In this form, however, phytate is considered an anti-nutritional factor (ANF) due to the limited availability for monogastric animals. Phytases cleave the phytate molecule into phosphate and inositol phosphate with different phosphorylated states (InsP_1-5). Inositol phosphate with few phosphates is substrate for intestinal phosphatases where the final reaction products are myo-inositol and phosphate. Endogenous phosphatases and possible intestinal microbial phytases are insufficient in degrading phytate. Substantial degradation of phytate during gastric conditions is required to reduce anti-nutritional effects of the intact molecule. The main objective of this work was to demonstrate the synergistic effect of a novel bacterial phytase (HiPhorius™, DSM Nutritional Products, encoded by a 6-phytase gene from Citrobacter braakii) and endogenous phosphatases for myo-inositol release in an in-vitro set-up. The experiment simulated conditions from broiler gastro-intestinal tract, including gizzard (pH 3, 30 minutes) and intestines (pH 6, 240 min). Endogenous protease pepsin (3000 U/g diet) and bacterial phytase (2000 FYT/kg diet) were added in gizzard phase, while alkaline phosphatase (10 U/ml) added in intestinal phase. Control treatment without phytase or phosphatases was included. Aliquots were collected every 15 minutes and myo-inositol was quantified using a spectrophotometric assay (Myo-Inositol Assay Kit, Megazyme). Percentage of myo-inositol release was calculated based on initial phytate concentration and results analyzed using Tukey-Kramer HSD. The experiment demonstrated that the alkaline phosphatase did not result in a statistically significant (p<0.05) increase in myo-inositol release compared to control treatment. The inclusion of bacterial phytase, contrary, led to a significant increase in myo-inositol (13.1%) after 150 min compared to the control (3.65%) and alkaline phosphatase (5.33%) treatments, an increase also observed throughout the remainder of the hydrolysis reaction. The combination of phytase and alkaline phosphatase, however, led to larger phytate degradation with consequent higher myo-inositol release. The synergistic effect was noted at 60 min reaction, with a myo-inositol release of 27.3%, representing an increase of approximately 520%. After completion of the enzymatic reaction, 79.2% of myo-inositol was released, evidencing...
the synergistic effect between enzymes. The results demonstrate that the novel bacterial phytase degrades phytate while acting in synergy with endogenous phosphatases during the digestion, thus maximizing the release of myo-inositol.

**Keywords:** phytase, endogenous, myo-inositol, synergy, digestibility


The experiment was carried out to evaluate influence of different levels of microbial serine sfericase endopeptidase expressed in *Bacillus Licheniformis* on laying hen diet on performance and egg quality. A total of three hundred eighty-four ISA Brown with 40 weeks of age were placed in 48 cages in a completely randomized design with 3 treatments, 8 replicates with 16 hens each one in a period of 4 cycles of 28d. The treatments were different levels of protease inclusion 0, 18,000, and 30,000 NFP/kg of feed. For all treatments were provided mash diets based on corn, soybean, meat, and bone meal and wheat and water ad libitum (nutritional levels of the strain as a reference).

Number of eggs produced was registered daily and all eggs produced were weighed, and after, the egg mass was calculated. The response variables evaluated were daily feed intake (g/day), egg production (%), egg mass (g), feed conversion ratio (g/g) and egg quality (Haugh unity, yolk color, shell strength (kgf) and shell thickness (mm)). The data was analyzed as One-Way ANOVA with a Tukey test to evaluate the differences between dietary protease inclusion levels, using a generalized linear model. The increase from 0 to 30,000 NFP/kg of protease inclusion in the laying feed did not affect the feed intake and feed conversion rates (P>0.05), however, improved 1.8% of egg production and 1.23 g egg mass compared to 0 and 30,000 NFP/kg of protease levels. Furthermore, hens consuming feed contended 18,000 and 30,000 NFP/kg of protease produced better internal quality eggs, compare to hens feeding without protease (P<0.05). The average Haugh unit was 88.40 (group with enzyme) vs. 87.59 (group without enzyme). Overall, the inclusion of protease on layer diet enhances egg production and egg mass in addition to improving the internal egg quality. In conclusion, level of 30,000 NFP/kg of feed protease on laying hens diet improve egg production and egg internal quality.

**Keywords:** amino acids, anti-nutritional factors, enzymes, intestinal health

### 117 Protease supplementation in diets for broilers containing extruded full-fat soybean and its effects on performance and intestinal morphometry. Warley J. Alves1, Pedro R. Arnaut2, Carolaine Renata Ferreira2, Lucímauro da Fonseca2, Jorge C. Muniz2, Melissa Hannas2, Thiago P. Ribeiro2, Andreia Massuquetto1, Daniel P. Monteiro1, 1Animal Nutrition, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, 2Animal Nutrition, Tectron, Toledo, Brazil.

The objective was to evaluate the supplementation of protease in diets for broilers containing extruded whole soybean and its effects over the absolute weight and relative weight of pancreas and liver, activity of antioxidant enzymes, glutathione peroxidase (GPx) and superoxide dismutase (SOD) in blood plasma and trypsin activity in jejunal digesta of broilers at 21 and 42-d. In total, 1560 one-day old Cobb 500 male chicks were used over a 42-d production period. A completely randomized design with six treatments and 13 replicates of 20 birds each was adopted. The treatments were: Diets containing extruded full-fat soybean (EFFS) at three different processing levels (under-processed (U-EFFS), standard (S-EFFS), and over processed (O-EFFS)) each one with (125 g/t; 20,000 U/g) and without protease. The protease used was composed by acid and alkaline protease blend from *Aspergillus niger* and *Bacillus subtilis* respectively (Tecmax Pro®). The effect of 3 EFFS processing levels, enzyme supplementation and their interactions were analyzed using MIXED procedure of SAS with Tukeys range test to separate means. Differences were significant when P<0.05. Broilers fed a diet with U-EFFS had the higher absolute and relative weight of the pancreas at 21 and 42 days, liver at 42 days, and SOD activity at 21 and 42 days (P<0.05). The diets supplemented with protease improved the liver weight and GPx activity at 42-d, and trypsin activity at 21 and 42-d (P<0.05). Therefore, under these experimental conditions, it can be noted that the extruded full-fat soybean in under-processed conditions influenced absolute and relative weight of pancreas and liver at 42-d, and the protease supplementation reduced the effects of the antinutritional factors in the pancreas and liver. Besides that, the benefits of protease may be related to reduced plasma oxidation.

**Keywords:** amino acids, anti-nutritional factors, enzymes, intestinal health
three different processing levels (under-processed (U-EFFS), standard (S-EFFS), and over-processed (O-EFFS)) each one with (125g/t; 20,000U/g) and without protease. The protease used was composed by acid and alkaline protease blend from Aspergillus niger and Bacillus subtilis respectively (Tecmax Pro®). Feed intake (FI), body weight (BW), daily weight gain (DWG) and feed efficiency (FE) were analyzed from 1 to 21, 1 to 42 and 22-42 days. At 21 and 42-d, villus height (VH), depth of the crypts (DC), relation villus/crypts (duodenum, jejunum and ileum) and intestinal area were also analyzed. The effect of 3 EFFS processing levels, enzyme supplementation and their interactions were analyzed using MIXED procedure of SAS with Tukeys range test to separate means. Differences were significant when P<0.05. Chickens fed the O-EFFS diet had higher BW at 21 and 42 days, DWG from 1 to 21 and 1 to 42 days, and better FE from 1 to 42 days. The supplementation of protease promoted higher FE as a trend (P=0.092) from 22 to 42 days. Broilers fed a diet with U-EFFS had the lower VH and DC of the small intestine. The protease influenced the health and intestinal integrity of chickens by increasing VH and DC. The VH is related to the surface area, hence the absorption of nutrients. The DC is related to the speed of tissue and villus turnover. The relationship between VH and DC indicates the digestive and absorption capacity of the nutrients of the small intestine. Therefore, under these experimental conditions, it can be concluded that the O-EFFS influenced positively the performance and U-EFFS promoted a impaired in intestinal health, and, the protease supplementation was efficient in mitigating the antinutritional effect of on these parameters.

Keywords: amino acids, enzymes, intestinal health, soybean processing

118 In vitro analysis of protein hydrolysis boost by novel sfericase protease when added in combination with endogenous enzymes. Jacqueline C. de Souza1, Diogo F. Rosso1, Laerke T. Haahr2, José O. Sorbara3, Murtala U. Faruk3, 1Novozymes Latin America, Araucária, Paraná, Brazil, 2Novozymes A/S, Kgs. Lyngby, Denmark, 3DSM Nutritional Products, Kaiseraugst, Switzerland.

Although broilers secrete their proteases, such as the acid protease pepsin and pancreatic proteases, digestion of proteins can be limited by some factors, such as the presence of trypsin inhibitors or complex proteins, leading to lower extent of protein hydrolysis. To overcome such limitations, exogenous proteases are employed due to their improved ability to cleave almost any peptide linkage within protein chains and therefore leading to more extensive hydrolysis. The main objective of this work was to demonstrate how an exogenous protease, a novel subtilisin sfericase protease, improves protein degradation in synergy with endogenous proteases using an in vitro set-up. In this study we evaluated three different approaches to compare the action of endogenous enzymes and the synergy effect by adding the exogenous sfericase protease on top. The first test consisted in incubating (4 hours at 40 °C and pH 6.5) different substrates in two conditions: using trypsin or the combination of trypsin + sfericase protease. Samples were collected after each step at 60, 90, 120 and 240 min, and supernatants submitted to further analysis. The extent of protein degradation was evaluated using a spectrophotometric assay; results were submitted to One-way ANOVA. The increments in protein hydrolysis were observed for all the substrates analyzed: 10% with meat and bone meal, 5% with soybean meal and 8% with rapeseed meal. The second test evaluated the efficacy of both trypsin and sfericase protease in degrading relevant antinutritional factors found in vegetable substrates, using proteomics techniques. Trypsin alone was not able to degrade any of the inhibitors, but the combination of endogenous and exogenous enzymes was effective in reducing the amount of inhibitors in solution. The third test was the evaluation of the peptides size profile with mass spectrometric methods. Soybean meal samples were incubated (3 hours at 37°C) with pancreatin alone and with the combination of sfericase protease and pancreatin. In the intestines, there are transporters which can absorb single amino acids, but also di and tripeptides, therefore the resulting peptide profile can impact absorption and, consequently, protein digestibility. The results shown that the addition of sfericase protease boosts the amount of di and tripeptides compared to the control treatment only containing pancreatin, and this is one of the hypotheses supporting the explanation of improved in vivo performance of broilers using this exogenous protease.

Keywords: protease, exogenous, hydrolysis, proteomics, digestibility

119 Growth performance and carcass yield of broilers fed a multi-carbohydrase complex associated with high levels of phytase. Guilherme L. Godoy1, Valeria Biselo1, Jessica A. Alencar2, Adriana Toscan2, Guilherme Vasconcellos2, Naiara S. Fagundes2, Catarina Stefanello1, 1Animal Sciences, University of Santa Maria, Santa Maria, RS, Brazil, 2Adisseo Latin America, São Paulo, Brazil.

Exogenous enzymes have been used in poultry diets in order to improve nutrient and energy digestibility, resulting in enhanced broiler performance. In this study, the objective was to evaluate the effect of a multi-carbohydrase complex associated with high levels of phytase (MCPC; Rovabio® Advance Phy, Adisseo) on growth performance and carcass yield of broiler chickens until day 43. A total of 1,200 Cobb 500 one-d-old male chicks were distributed to 4 treatments with 10 replicates of 30 birds each in a completely randomized design. Dietary treatments consisted of a positive control (PC) formulated with AME and nutrients as commercially used by the Brazilian integrators without enzyme supplementation. A negative control (NC) having reductions in formulated AME (-5%), digestible amino acids (dig. AAs, -5%), Ca (-0.16%), Av. P (-0.17%), and Na (-0.03%) also without enzyme supplementation. To compose the other two treatments, PC
and NC groups were supplemented with 100 mg/kg of multi-carbohydrase and phytase (1,000 FTU) complex. Body weight gain (BWG), feed intake, and feed conversion ratio (FCR) were evaluated weekly until 43 days. On day 43, five broilers per pen were processed for carcass and commercial cuts evaluation. Data was submitted to the analysis of variance using the PROC GLM of SAS, means were compared by the Tukey test (P<0.05). In all evaluated periods, the reduction of AME and nutrients in the NC diet led to decreases on BWG and increases on FCR of broilers (P<0.001) when compared to the PC diet, being the differences at 9.7 and 6.7%, respectively. Growth performance was improved in all studied periods (P<0.001) when MCPC was added to NC diets; evaluating the overall period, BWG and FCR were improved by 8.3% and 4.0%, respectively, compared to non-supplemented NC, and had similar results to the PC group (P>0.05). Broilers from the PC + MCPC group presented improved FCR (P<0.001) compared to the PC diet, from 1 to 21 d (3.1%) and in the overall period (3.6%). Carcass and commercial cuts weights were also improved (P<0.001) when broilers were fed PC, PC + MCPC, and NC + MCPC diets compared to the NC diet. These results suggest that the multi-carbohydrase complex associated with high levels of phytase was efficient to release enough nutrients from raw materials used in corn-soy diets and it could recover the lower performance provided by the nutritional reduction offered in negative control diets. In addition, the enzyme product presented the ability to improve FCR in diets with regular nutritional levels. In conclusion, corn-soy diets supplemented with Rovabio® Advance Phy improved FCR, BWG and carcass weight of broilers and it can be used as a tool to reduce costs in feed formulation.

**Keywords:** broiler, carbohydrase, carcass, performance, phytase

### 120 A comparison of the efficacy of a novel phytase as compared to other commercially available phytases for broiler.

Vitoria E. Silva¹, Andre Favero¹, Liris Kindlein², Sergio Vieira², Levy D. Teixeira³, Vitor Fascina³, ¹Santa Lívia Experimental Farm, Garibaldi, Brazil, ²Federal University of Rio Grande do Sul, Porto Alegre, Brazil, ³DSM Nutritional Products, Sao Paulo, Brazil.

An experiment was conducted to evaluate the efficacy of commercially available phytases such as the novel phytase Hiphorius (DSM Nutritional Products was encoded by a 6-phytase gene from *Citobacter braakii*) efficacy in comparison with a former phytase from the same manufacturer (RONOZYME HiPhos) and a commercially available phytase (Phytase A). A total of 2,000 one-day-old male Cobb x Cobb 500 broilers were allocated into 80 floor pens (1.50 x 1.50 m) with 25 birds each. Experimental pens contained 4 nipple drinkers and one 18 kg tubular feeder, feed and water were provided *ad libitum*. Birds were vaccinated for Marek’s disease at the hatchery and individually weighed at placement. General health status, weight, mortality, and estimated cause of death were observed throughout the study. Treatments were distributed in a completely randomized block design with 7 treatments and 11 replicates. The experimental treatments were a positive control (PC, 0.48% Av.P, 0.96% Ca); a negative control 1 (NC1, 0.40% Av.P, 0.80% Ca); a negative control 2 (NC2, 0.32% Av.P, 0.65% Ca); a negative 3 (NC3, 0.23% Av.P, 0.65% Ca); NC3 + HiPhos 2,000 FTY/kg; NC3 + HiPhorius 1,000 FTY/kg; NC3 + Fitase A 1,000 FTY/kg. Data were subjected to statistical analysis tested for the normality of variance with probability accepted when lower than 5%. Additionally, linear and quadratic regression models were performed for each variable against the dietary calcium (Ca) and Available Phosphorus (Av.P) contents. Corn-soy diets were formulated following Brazilian industry routine use. Birds were fed a common diet up to 7 days and experimental diets (having 1% Celite as indigestible marker) from 8 to 28 days. Feed ingredients were scanned for proximal analyses using NIRS prior to feed formulation. At 28 d, body weight gain was significantly lower for NC3 compared to PC and NC1 (P<0.05; 1.47 vs 1.53/1.55, kg) with feed conversion ratio significantly increased for the NC2 and NC3 compared to PC and NC1 (P<0.05; 1.51/1.52 vs 1.44/1.45). No differences were observed in the performance of birds fed the NC3 diet plus phytase supplementation regardless of the products evaluated. At 28 days, 1,000 FTU/kg of Phytase A, 2,000 FTY/kg of RONOZYME HiPhos and 1,000 FTY/kg of HiPhorius released 0.18; 0.19 and 0.21% of Av. P respectively based on FCR linear regression (P<0.0001; R² 0.55). No differences (P>0.05) were observed on the mortality or culled birds. Based on performance data and phosphorus release linear regression, a novel phytase evaluated provides higher phosphorus release with lower inclusion dose in broilers diets.

**Keywords:** phytase, phosphorus release, broiler, performance, poultry

### 121 Nutritional challenges for a new protease in corn and soybean meal-based diets for broilers.

José L. Schneiders², Elisa P. Françoís³, Gisele N. Rosseti³, Andressa Carvalho², Bernardo R. Nogueira², Antonio G. Bertechini², ¹Technical, Kemin, Jundiaí, São Paulo, Brazil, ²UFLA, LAVRAS, Minas Gerais, Brazil, ³Nutrition, Agri Stats, Chapecó, Santa Catarina, Brazil.

An experiment was carried out to evaluate the effects of dietary supplementation of a new protease with nutritional reduction of protein and amino acids for broilers raised from 1 to 42 days old. The protease is a new kind of product working during all intestinal tract, with action in acid, neutral and alkaline pH. The guarantees level of this protease is 8,000 units/g of product. Were used a total of 2,250 day old chicks male Cobb-500, in a completely randomized design with 9 treatments, and 10 replications each. The treatments were: 1.Positive control (PC); 2. PC + 200 g/ton of protease (on top); 3. Negative control 1 (NC1)
- 4% of CP and amino acids; 4. NC1 + 100 g/ton of protease; 5. NC1 + 200/ton of protease; 6. NC1 + 300 g/ton of protease; 7. NC2 (NC2) – 8% of CP and amino acids; 8. NC2 + 100g/ton of protease; 9. NC2 + 200 g/ton of protease; 10. NC2 + 300 g/ton of protease. Diets based on corn and soybean meal were used for the initial, growth and final stages. Nutritional reductions harmed the performance of the birds. The use of protease over PC diet and nutritional reductions of 4% with 200 g/ton of protease and 8% with 300 g/ton resulted in similar performance. As protease levels increased, there was a linear improvement in bird weight gain, regardless of nutritional reductions. For feed conversion the best indexes were observed in the CPs and with the use of the enzyme. Results from 1 to 21 days and 1 to 42 days were similar. It is concluded that the new protease is effective in improving the performance of broilers, especially in nutritional challenges conditions of protein and amino acids.

**Keywords:** protease, broiler performance, nutritional challenges

#### 122 Enzymatic associations in diets of broiler chickens on energy utilization and ileal digestibility of nutrients. Gabriele L. Freitag Tischer, Bárbara Colcetta, Cinthia Eynig, Nilton Rohloff Junior, Cristine Kaufmann, Gabrieli Toniasso, Thiago P. Ribeiro, Ricardo V. Nunes, Western Paraná State University, Marechal Cândido Rondon, PR, Brazil, Animal Nutrition, Tectron, Toledo, Brazil.

This study evaluated the combination of doses of amylase and xylanase in diets for broilers chickens on ileal digestibility of energy and nutrients. A total of 1,120 male broiler chickens were distributed in a completely randomized design with a factorial scheme 2 x 3 + 2 (2 levels of amylase (100; 200 g t⁻¹) x 3 levels of xylanase (0; 100; 200 g t⁻¹) + positive control (PC - meeting the nutritional requirements) and negative control (PC diet with a reduction of 100 kcal and 6% of crude protein and nutritional reduction provided a worst CDGE compare all treatments in relation to PC and NC. The test were performed. Dunnett's test was performed to analysis of variance. When significant for amylase level, feeding of experimental diets for 7 d. Data were submitted digesta were collected from the terminal ileum following the ileal digestibility of gross energy (CDGE), crude protein (CDCP) and dry matter (CDDM), as well as the values of digestible energy (DE), digestible crude protein (CPdig), and digestible dry matter (DMdig). At 42 days of age, the digestion of birds causing unwanted reactions, such as increased feed passage rate, diarrhea, and energy expenditure. These reactions may impair productivity and increase the occurrence of dirty eggs in laying hens. This study was developed to evaluate the effect of a β-mannanase (Hemicell™ HT, Elanco Animal Health) supplementation on the performance of laying hens and cleanliness of produced eggs. Hyline W36 laying hens (60 cages with 4 animals each) housed in commercial aviaries were evaluated. Control animals were fed the farm's conventional diet. A second treatment received the control feed with the inclusion of β-mannanase (300 g/t). The birds had free access to water and food. The experiment started at 36 weeks of age and data collection was carried out at 40, 44, and 48 weeks. Performance and cleanliness were measured with eggs collected in the last 3 days of each period. Eggs were classified as clean when no dirt was found; small dirt classification was used for eggs that presented spots up to 1 cm²; and large-dirt classification was used to define those with spots greater than 1 cm². Means were compared by ANOVA and considered different at 5% of significance. The egg-laying rate increase (P<0.05) with β-mannanase at

**Keywords:** amylase, digestible energy, digestible protein, xylanase

#### 123 β-mannanase as an alternative to increasing the layer hen's productivity. Camila Lopes Carvalho, Ines Andretta, Gabriela Miotto Galli, Nathalia de Oliveira Telesca Camargo, Marcos Kipper, Animal Science, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, Elanco Animal Health, São Paulo, Brazil, Ghent University, Merelbeke, Belgium.

β-mannans present in feed can activate the immune system of birds causing unwanted reactions, such as increased feed passage rate, diarrhea, and energy expenditure. These reactions may impair productivity and increase the occurrence of dirty eggs in laying hens. This study was developed to evaluate the effect of a β-mannanase (Hemicell™ HT, Elanco Animal Health) supplementation on the performance of laying hens and cleanliness of produced eggs. Hyline W36 laying hens (60 cages with 4 animals each) housed in commercial aviaries were evaluated. Control animals were fed the farm's conventional diet. A second treatment received the control feed with the inclusion of β-mannanase (300 g/t). The birds had free access to water and feed. The experiment started at 36 weeks of age and data collection was carried out at 40, 44, and 48 weeks. Performance and cleanliness were measured with eggs collected in the last 3 days of each period. Eggs were classified as clean when no dirt was found; small-dirt classification was used for eggs that presented spots up to 1 cm²; and large-dirt classification was used to define those with spots greater than 1 cm². Means were compared by ANOVA and considered different at 5% of significance. The egg-laying rate increase (P<0.05) with β-mannanase at

---

*Poult. Sci. 102 (E-Supplement #2)*
the week 40 (85.3 vs 93.7%), week 44 (73.3 vs 96.7%), and on average (84.9 vs 94.33%). At week 48, egg-laying rate (91.0 vs 92.6%) was not affected (P > 0.05) by the treatment. Egg weight increased (P < 0.05) with β-mannanase at week 44 (61.3 vs 63.1%), 48 (64.1 vs 65.2%), and on average (62.5 vs 63.6g). At the week 40, egg weight (62.0 vs 62.3%) was not affected (P > 0.05) by the treatment. The CV of egg weight reduced (P < 0.05) with β-mannanase at week 44 (7.2 vs 5.6%), 48 (7.1 vs 5.4%), and on average (6.7 vs 5.6%). At week 40, the CV of egg weight (5.9 vs 5.9%) was not affected (P > 0.05) by the treatment. Using β-mannanase increased (P < 0.05) the cleanliness of eggs in all periods evaluated. At week 40, the β-mannanase increased clean eggs (82.2 vs 93.5%) and reduced eggs with small (14.3 vs 5.9%) and large dirt (3.6 vs 0.6%). The same was observed at the week 44, when the β-mannanase increased clean eggs (72.6 vs 93.8%) and reduce eggs with small (21.5 vs 4.8%) and large dirt (5.9 vs 1.5%). Finally, at 48 weeks, the β-mannanase still increased the frequency of clean eggs (85.4 vs 93.8%) and reduced eggs with small (10.0 vs 3.8%) and large-dirt (4.6 vs 2.5%). Using β-mannanase increases productivity by improving laying rate, egg weight, and uniformity, while increasing the frequency of clean eggs.

**Keywords:** additives, eggs, enzymes, feeding, poultry

124 β-mannanase supplementation as an environmentally friendly feed strategy to mitigate the environmental impacts of broiler feeding programs. 

**Authors:** Eliepe M. W. Hickmann1-3, Ines Andretta1, Marie-Pierre Létourneau-Montminy3, Aline Remus3, Gabriela Miotto Galli1, Marcos Kipper2, 1Animal Science, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, 2Elanco Animal Health, São Paulo, Brazil, 3Département des Sciences Animales, Université Laval, Quebec, Quebec, Canada, 4Sherbrooke Research and Development Center, Agriculture and Agri-Food Canada, Sherbrooke, Quebec, Canada.

Feeding is an important environmental impact source associated with broiler production systems. Thus, improving feeding practices that mitigate the environmental footprint of broiler production is desirable. The present study was therefore undertaken to assess the environmental impacts of using β-mannanase (Hemicell™ HT, Elanco Animal Health) in broiler feeding programs. Environmental impacts were evaluated according to life-cycle assessment standards using four interrelated steps: goal and scope definition, life cycle inventory analysis, life cycle impact assessment, and interpretation of results. The functional unit considered was 1 kg of feed produced at a feed mill gate located in Concórdia, Santa Catarina, Brazil; simulated through a cradle-to-feed mill gate scope. The major stages considered in the model were the production of feed ingredients from plant sources, the production of other feed ingredients, drying, processing, storage, and transportation. The simulation considered a scenario in which only grain from the Southern region was used to produce feeds: (i) based on the nutritional requirements of broilers; formulated without the enzyme or (ii) diets supplemented with β-mannanase; formulated with lower energy levels (reduction of 45 kcal of metabolizable energy/kg of feed). Inputs and outputs were defined for each stage of the life cycle through the SimaPro software (v. 8.0.3.14). The impact of climate change was estimated with the CML-IA baseline method. Only descriptive statistics were assessed due to the nature of the project. Producing feeds (1 kg at feed mill gate) in Southern Brazil using grain cultivated in the same region led to the emissions of 816 to 910 g of CO2-eq (climate change potential impact) and 4.62 to 4.97 g of PO4-eq (eutrophication potential impact), depending on the broiler growth phase being assessed. A formulation procedure that considered the energy saved by β-mannanase mitigated the impact of climate change by 5.0 to 5.6% and eutrophication by 1.1%. Due to their high environmental impacts, feeding practices may be considered as a prime target when developing mitigation strategies for the broiler production chain. In this context, the use of exogenous enzymes such as β-mannanase can be considered as an eco-friendly feed strategy for improving the environmental sustainability of broiler production.

**Keywords:** climate change, enzyme, eutrophication, life cycle assessment, modelling

125 Protease supplementation in diets with reduced crude protein for broilers. Lidiane I. Datsch1, Guilherme L. Silva Tesser1, André S. de Avila2, Edevaldo A. Ianchinski1, Cristina Kaufmann2, Luiza M. Stork3, Thiago P. Ribeiro3, Daniel P. Monteiro3, Cinthia Eyng1, Ricardo V. Nunes1, 1Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, 2Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, 3Tectron, Toledo, Brazil.

The availability of nutrients in diets for broilers is reduced due to the lack of digestive enzymes and the presence of anti-nutritional factors. These compounds are present in the ingredients and negatively affect animal performance. The use of exogenous enzymes improves the digestibility of nutrients and, consequently, impacting productive efficiency reduction costs. Therefore, the objective of this study was to evaluate the protease supplementation in broiler diets and its effects on growth performance, carcass yield, abdominal fat, liver and pancreas yields. One-d-old male chicks (n = 800; Ross 308) were assigned to a completely randomized design composed by five treatments and eight replicates of 20 birds per pen from the period of d 1 to 35. Treatments were: control diet (CD), standard nutritional levels; negative control (NC1), reduction of 3% crude protein (CP), digestible amino acids and 25 kcal of metabolizable energy (ME); negative control 2 (NC2), reduction of 6% CP, digestible amino acids and 50 kcal of ME; (NC1 + 125), NC1 + 125 g/ton of protease; (NC2 + 250), NC2 + 250 g/ton of protease. The commercial protease used was Tecmax Pro®, composed of acid and
alkaline protease from Aspergillus niger and Bacillus subtilis, respectively. At d 35, feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) were determined, and 2 broilers per pen were randomly selected and euthanized to determine carcass and abdominal fat and organs yield. Data was analyzed using ANOVA procedure and means were separated using Student Newman Keuls (SNK). Subsequently, a contrast analysis was performed considering (P≤0.05). Curiously, CD presented the lowest FI (P=0.0010), WG (P=0.0001), and highest FCR (P=0.0032), while animals that received NC2 presented higher WG (P= 0.0567). The FCR of these animals also were lower (1.570 vs. 1.549) with the use of the protease, although with no statistical difference (P = 0.2178).

Proteases may reduce amino acids and energy requirement, improve dietary protein digestibility and hydrolyze protein-based anti-nutrients. Some evidences in the literature can indicate that proteases may improve the performance of birds receiving or not diets with low CP and amino acids. In conclusion, protease supplementation in diets with reduction of 6% CP and digestible amino acids increased WG of broilers at 35 days of age.

**Keywords:** digestible amino acids, metabolizable energy, performance, exogenous enzymes

126 Inclusion of newly harvested corn (NHC) and enzyme supplementation in the diet of broilers: Impact on cecal gut microbiota diversity, composition and function. Juan M. Díaz-Carrasco1, Gaston Royero2, Cintia Y. Suarez2, Jesica S. Bucci1, Leandro M. Redondo1, Natalia A. Casanova1, Johana E. Dominguez1, Mariano E. Fernandez-Miyakawa1, 1Instituto de Patobiología, INTA, Hurlingham, Buenos Aires, Argentina. 2Frigorífico de Aves Soychú S.A., Buenos Aires, Argentina.

Corn is the cereal grain of choice for poultry feeds in many regions of the world. As corn production is seasonal, corn grains need to be stored throughout the year to provide sufficient supplies for feed industries. Newly harvested corn (NHC) is used by animal and feed producers to reduce feed cost or because it is the only available supply. NHC has a high concentration of non-soluble polysaccharides (NSP) such as xylans and cellulose, limiting feed digestibility. NSP also interacts with the intestinal epithelium producing changes in mucus homeostasis and gut microbiota. Therefore, NHC may affect not only productivity but eventually gut microbiota and health. A group of 1-d old Male Arbor Acres broilers were obtained from a commercial hatchery and allocated into 48 floor pens with new rice husk under controlled conditions. The number of animals placed was 1,680 in 4 treatments (35 birds/pen; 12 pens/treatment). Animals and pens were randomly assigned according to a one-way ANOVA randomized complete block with four dietary treatments. (X1) stored corn + Xylanase; (X2) NHC + Xilanase; (M1) stored corn + Multienzyme mix; (M2) NHC + Multienzyme mix. On day 21, necropsies were performed and cecal contents were collected from 2 birds per pen. Cecal contents were pooled in 3 replicates per treatment, each pool representing 3 pens. DNA was extracted from each pool and 16S rRNA gene V3-V4 amplicons were sequenced on the Illumina MiSeq platform. Bioinformatics and statistical analysis of gut microbiota profiles was conducted using QIME2, PICRUSt2 STAMP software. Birds fed diet X1 showed significantly higher bacterial richness and phylogenetic diversity than those fed NHC diet X2. Significant clustering by treatment was observed in the beta diversity PCoA plots, mainly driven by X2 samples. There were no differences between treatments M1 and M2. At the composition level, a significant increase in the phylum Firmicutes was observed in treatment X2. At deeper taxonomical levels, these changes were driven by a significant decrease in members of Bacteroidetes (Barnesiella viscericola, Odoribacter) and Proteobacteria (Helicobacter pullorum, Campylobacter, Cobetia); and an increase in Lactobacillus and members of the order Clostridiales (Faecalibacterium prausnitzii, Ruminococcus, Lachnospiraceae). At the functional level, microbiota in treatment X2 showed higher capacity of carbohydrate catabolism and synthesis of peptidoglycan. In treatment X1, an increase in the synthesis of vitamins, cofactors and LPS was observed. Our results show that both the age of the corn and the type of digestive enzymes supplemented in the diet have a significant impact on the composition and function of broiler's gut microbiota.

**Keywords:** broilers, gut microbiota, newly harvested corn, enzymes

127 Intestinal permeability of broilers at 40 days of age fed diets with reduced energy levels and inclusion of β-mannanase. Alison Batista V. Gouveia1, Lorryane M. Paulo1, Allan G. Dias1, João Marcos M. Batista1, Marcos Kipper2, José H. Stringhini1, 1Zootecnia, Universidade Federal de Goiás, Goiânia, Brazil. 2Eldano Saúde Animal, São Paulo, São Paulo, Brazil.

Diets for broilers have significant amounts of β-mannans, and these polysaccharides implies in an unnecessary immune response, bringing negative impacts to health and performance. The β-mannanase enzyme breaks down β-mannans, improving intestinal integrity, providing more energy and nutrients, promoting better productive performance. To evaluate the effects of dietetic metabolizable energy (ME) reduction and inclusion of β-mannanase on intestinal permeability of broilers at 40 days of age. A total of 1680 Cobb 500-day-old chicks were allotted in a completely randomized design in a factorial arrangement 3x2, consisting in a combination of 3 ME reduction levels (control, -45 and -90 kcal/kg) and diets with or without β-mannanase with 8 replicates of 35 birds each. At 40 days of age, one bird per replicate were selected and fasted for 2 hours. After this, 0.2 mL of FITC-dextran were administered orally by gavage. After 2.5 hours, the blood was collected, and the marker was determined. The
interaction of EM reduction levels and β-mannanase inclusion was not statistically significant (p=0.812) (0.168; 0.168; 0.142; 0.233; 0.249; 0.217 μg/mL). No significant effect was observed (p=0.061) on intestinal permeability because of EM reduction in diets (0.200; 0.208; 0.179 μg/mL). But the inclusion of the enzyme β-mannanase reduced (p=<0.001) the FITC blood levels indicating low intestinal permeability for the marker (0.159 μg/mL with β-mannanase and 0.233 μg/mL without β-mannanase). It is possible to conclude that the supplementation of β-mannanase improve the intestinal health with the lower permeability of FITC-dextran. This is an important indicator of integrity of intestinal mucosa.

Keywords: -mannan, enzyme, intestinal health, poultry
The aim was to investigate the impact of dietary Bacillus coagulans DSM 32016 supplementation on performance and gut health of broilers infected with Clostridium perfringens. 720 1-d old broilers (Arbor Acres plus) were randomly allocated to 6 treatments as follow: Negative Control (NC), NC1, NC2, Positive Control (PC), PC1 and PC2. PC groups were challenged orally with Clostridium perfringens (4 x 10^8 CFU/ml) at day 14. NC1 and PC1 were supplemented via feed with Bacillus coagulans DSM 32016 at 1.0 x 10^8 CFU/kg feed in Starter and Grower phases, and 0.5 x 10^8 in Finisher phase. NC2 and PC2 were supplemented via feed with Bacillus coagulans DSM 32016 at 1.0 x 10^8 CFU/kg feed in all three phases. Each treatment consisted of 6 replicates and the trial duration was 35 days. Broilers were fed standard corn-soybean meal based 3-phase diets offered ad libitum. Bacillus coagulans DSM 32016 was produced by Biochem Zusatzstoffe Handels- und Produktionsges. mbH, Germany. Body weight (BW) and feed intake were measured weekly. Intestinal and caecal Clostridium perfringens counts were quantified based on colony forming units. Lesion scoring of the small intestine was based on the six-point system. At the end of trial, duodenum and jejunum samples were taken to measure villus height and crypts depth. Statistics were based on ANOVA using SAS software general linear model procedure (Bacillus coagulans DSM 32016 treatment). Mean values were assessed for significance using Duncan's multiple range test with significance set at p≤0.05. PC birds showed a reduced final BW, BW-gain, FCR, and increased mortality compared to NC, indicating a successful pathogen challenge. In comparison to PC, birds in PC1 and PC2 showed enhanced performance parameters (i.e., final BW, BW-gain, FCR) and a numerically reduced mortality rate. Furthermore, intestinal lesions and gut histomorphology parameters (i.e., lesion scores, villi height, crypt depth, villi:crypt ratio) were improved in birds of PC1 and PC2 compared to PC. Intestinal and caecal counts of Clostridium perfringens were numerically reduced in PC1 and PC2 compared to PC. The collective data demonstrate that Bacillus coagulans DSM 32016 supplementation led to a significantly increased broiler performance, reduced intestinal lesions, and stimulated epithelial growth. Therefore, this probiotic strain can counteract negative affect of Clostridium perfringens infections in broiler.

Keywords: probiotics, Bacillus coagulans, necrotic enteritis, clostridium perfringens, broiler chickens

Probiotics are live microorganisms which, when administered in adequate amounts, confer health benefits to the host. The use in animal diets increased due to higher demand for reduction of antibiotic as growth promoters. The gut microbiome benefits the host by modulating the development and function of the digestive and immune system. In return, the host provides a permissive habitat and nutrients for bacterial colonization and growth. The objective of this research was to evaluate the effects of a multi strain probiotic (Lactobacillus reuteri; Enterococcus faecium; Bifidobacterium animalis; Lactobacillus salivarius and Pediococcus acidilactici) in broiler diets on gut microbiota of broilers raised in commercial farms, located in Sao Paulo, Brazil. Four barns were selected for the trial, two receiving the control diet (corn and soybean meal mash diets) and two received the addition of probiotic on top of the diet (from 1 to 21 days of age). A total of 30 birds per treatment were randomly selected at 22d to collect cecal content, and blood samples for exploratory microbiome analysis, evaluate profile of antibiotic resistance genes, and inflammatory proteins. Data was analyzed by ANOVA using the GLM procedure at 5 % probability, and each bird was considered an experimental unit. The results showed that probiotic diet supplementation modified the intestinal microbiota and reduced the level of antibiotic resistance genes. The birds fed with the probiotic presented higher diversity of gut microbiota (P<0.025), which may be related to better functioning of gut, and higher bird productivity. Proteobacteria includes a wide variety of pathogenic bacteria, such as the ones causing foodborne illnesses, Escherichia, Salmonella, Vibrio, Shigella, Campylobacter, Legionella. Overall, the abundance of those bacteria was lower (P<0.016) in the probiotic treated group (driven by a strong reduction of E. coli abundance). On the other hand, the population of Alistipes (P<0.05) and Bacteroides (P<0.014) were enriched in the probiotic group. These microorganisms are producers of short chain fatty acids, with emerging evidence of their role in protecting the gut, and in chicken growth promotion. The number of antibiotic resistance genes, in the broilers fed with probiotic was overall lower compared with the control group. For inflammatory proteins (α1-Acid Glycoprotein and Ceruloplasmine) no significant difference was observed between treatments. In conclusion, the application of probiotic in broiler diets did modulate the microbiota profiling, and stability, also reduced pathogen abundance and the level of antimicrobial resistance, increasing the chances for better productivity.
In broiler production, it is important to maximize carcass yield, carcass cuts (breast, thigh + drumstick) and reduce the fat content in the carcass. In general, excessive fat deposition is an unfavorable trait because it is considered to be wasted dietary energy, which also reduces carcass yield and affects consumer acceptance. The objective of this study was to investigate the effect of a dietary β-1,3-glucan from algae (Euglena gracilis), probiotic (Bacillus subtilis PB6) and organic chromium (chromium propionate) on broiler carcass, breast, thigh + drumstick and abdominal fat. A total of 1,728 1-day-old Cobb 500 male chicks with an average initial BW of 48.0g were housed to 8 treatments. Each treatment was further divided into 6 replicates of 36 birds each. The chicks were randomly divided into the following groups: T1: Control diet without additives; T2: Control diet with antibiotic growth promoters (enramycin); T3: Control diet with 0.01% β-1,3-glucan; T4: Control diet with 0.05% of organic chromium; T5: Control diet with 0.05% probiotic; T6: Control diet with 0.01% β-glucan + 0.05% probiotic; T7: Control diet with 0.01% β-glucan + 0.05% organic chromium; T8: Control diet with 0.01% β-glucan + 0.05% probiotic + 0.05% organic chromium. At 42 days of age, 6 birds per treatment were slaughtered and carcass yield, cuts and abdominal fat were determined. The determination of carcass yield used the relative weight of the eviscerated carcass without head, neck and weight in relation to live weight. In relation to the yield of the cuts, the relationship between the weight of the cuts (breast, thigh + drumstick and abdominal fat) and the weight of the carcass was calculated. Orthogonal polynomial contrasts were used at 5% probability. The treatment with β-glucan + probiotic + organic chromium resulted in higher carcass yield when compared with T2 (control diet with antibiotic growth promoters). No differences were observed between treatments for breast yield (p>0.05). Higher results for thigh + drumstick yield were observed for the treatment with β-glucan + probiotic + organic chromium when compared to the T5, control diet with 0.05% probiotic (p<0.05). For abdominal fat the treatments: T4 (organic chromium); T5 (probiotic); T6 (β-glucan + probiotic); T7 (β-glucan + chromium) and T8 (β-glucan + probiotic + chromium) had lower abdominal fat content when compared to the T1 (control treatment (without additives)). It can be concluded that the use of β-glucan + probiotic + organic chromium in broilers feed reduces the abdominal fat content and increases carcass yield.
Keywords: additives, Bacillus subtilis, intestinal health, intestinal permeability

132 Probiotics effects on intestinal components of broilers challenged with Clostridium perfringens. Bruna Pereira Siqueira1, José Henrique Stringhini2, Wagner Azis Garcia de Araújo3, Carla Daniela Suguimoto Leite2, Eduardo Garrido1, Hérica da Silva Messias4, Síntia Pereira Siqueira5, João Lucas Araújo Castro1, Patrik Diogo de Soza3, Bruno Lacerda Denucci1, 1Zootecnia, Universidade Federal de Goiás, Goiânia, Brazil, 2Escola de Veterinária e Zootecnia, Universidade Federal de Goiás, Goiânia, Brazil, 3Zootecnia, Instituto Federal do Norte de Minas Gerais, Salinas, Brazil. The objective of this work was to evaluate the impact of different probiotics supplementation in diets of broilers challenged with inoculation of Clostridium perfringens intestinal components. 1,200 male and female Cobb 1 d old chicks were used during 42 days of trial. Broilers were distributed according to a randomized block experimental design among 8 dietary treatments with ten replicates of 15 birds each. The dietary treatments were: 1. standard feed without any probiotics without challenge; 2. standard feed without any probiotics and challenged with Clostridium perfringens incubation; 3. Standard feed with the addition of 400g/ton probiotic #1 (B. Licheniformis); 4. standard feed with the addition of 400g/ton probiotic #2 (B. Coagulans); 5. standard feed with the addition of 400g/ton probiotic #3 (B. licheniformis DSM 17236); 6. standard feed with the addition of 400g/ton probiotic #4 (B. subtilis DSMZ 17299); 7. standard feed with the addition of 400g/ton probiotic #5 (B. coagulans DSM 32016); 8. standard feed with the addition of 400g/ton probiotic #6 (B. licheniformis DSM 33806). All the treatments with probiotic addition, it was applied entire trial period and challenged with Clostridium perfringens inoculation. All the chicks (except control treatment) were challenged in the 14h d after hatching by water containing cells of Clostridium perfringens for 2 h. On day 42, three birds per replicate were slaughtered and collected duodenum, ileum, jejenum, that were weighed and recorded the length (mm). Then they were evaluated for necrotic enteritis lesions, based on a seven-point scale (0 = normal to 6= Diffuse necrosis). The effects of diet treatments, blocks and initial weight were tested for the normal distribution, and the analysis of variance was performed using the general linear model (GLM). The effects of diet treatments, blocks and initial weight were tested according to a general linear procedure analysis of variance (GLM procedure of SAS). No differences were found in the values heart, liver, spleen, proventriculus, gizzard, duodenum weight and length, jejenum weight and length, ileum weight and length, right cecum weight and length, left cecum weight and length, colon weight and length, rectum weight and length of the birds (p> 0.05). For necrotic enteritis lesions in duodenum, jejenum and ileum, the scores were higher for treatment 2 (challenged and no supplementation), and lower for control treatment (p< 0.05). Among the probiotics, all the treatment obtained close results, and reducing injuries compared to treatment 2. The probiotic supplementation does not change the intestine length but improve gut mucosa for bacteria injury. Keywords: additives, necrotic enteritis, probiotic, poultry

133 Effect of the progressive replacement of the growth promoter antibiotic by probiotic on productive parameters, intestinal and bone morphometry in broilers. Jim Alvarez, Carlos Vilchez-Perales, Otto A. Zea, Lima, Universidad Nacional Agraria La Molina, Lima, Peru. The study evaluated the effect of progressive replacement of growth promoting antibiotic by probiotic on the productive response, intestinal and bone morphometry in broilers from 1 to 21 days of age. For this study, 200 male BB chickens of the Cobb 500 Line were used, distributed in four treatments with 10 repetitions and five animals per repetition. Each group received one of the following treatments: T1, basal diet with BMD (500 ppm) from 1 to 21 days; T2, basal diet with BMD (500 ppm) for 1-4 weeks and Enterococcus faecium (17.5 ppm) for 15-21 days; T3, basal diet with BMD (500 ppm) for 1-7 days and Enterococcus faecium (17.5 ppm) for 8-21 days; T4, basal diet with Enterococcus faecium (17.5 ppm) from 1 to 21 days. Diets were formulated according to Cobb 500 line recommendations. Feed, in the form of flour, and water were offered ad libitum. Live weight, daily weight gain, feed intake, feed conversion and mortality were recorded weekly. At 21 days, two animals per experimental unit were sacrificed to collect histological samples from the jejunum and tibial region. Data were analyzed under a Completely Randomized Design using the ANOVA and Tukey test for comparison of means. Results showed that body weight and daily gain weight were favorable (p<0.05) for the birds that received T1 compared to T2, without being different from T3 and T4. In gut morphometry T4 had a greater height and villus area (p<0.05) compared to T1, T2 and T3, while in crypt depth T1 was lower than the other treatments. In bone morphometry no difference was reported (p>0.05) between the treatments for variables, while in bone mineralization a greater (p<0.05) resistance to rupture was observed in T4 in relation to T1, T2 and T3. It is concluded that progressive replacement of antibiotic by probiotic did not present statistical differences between treatments and treatments exclusively with antibiotic or probiotic had an influence on gut morphometry and tibia breaking strength. Keywords: probiotic, Enterococcus faecium, reemplace, antibiotic, poultry

Poult. Sci. 102 (E-Supplement #2) 78
Bruno Lacerda Dennuci, 1Escola de Veterinária e Zootecnia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil; 2Zootecnia, Instituto Federal Norte de Minas Gerais, Teofilooto, Minas Gerais, Brazil; 3Zootecnia, Instituto Federal do Norte de Minas Gerais, Salinas, Brazil.

This work aimed to evaluate the impact of different probiotics supplementation in diets of broilers challenged with Clostridium perfringens inoculation on carcass components. 1,200 Cobb males and females broiler were distributed in a randomized block experimental design, in eight treatments with 10 replications and 15 birds each [CDSL1] [bps2]. The dietary treatments were: 1. standard feed without any probiotics without challenge; 2. standard feed without any probiotics and challenged with Clostridium perfringens inoculation; 3. standard feed with the addition of 400g/ton probiotic #1 (B. Licheniformis); 4. standard feed with the addition of 400g/ton probiotic #2 (B. Coagulans); 5. standard feed with the addition of 400g/ton probiotic #3 (B. licheniformis DSM 17236); 6. standard feed with the addition of 400g/ton probiotic #4 (B. subtilis DSMZ 17299); 7. standard feed with the addition of 400g/ton probiotic #5 (B. coagulans DSM 32016); 8. standard feed with the addition of 400g/ton probiotic #6 (B. licheniformis DSM 33806). All the treatments with probiotic addition, it was applied entire trial period and challenged with Clostridium perfringens inoculation. All the chicks (except control treatment) were challenged in the 14th d after hatching by water containing cells of Clostridium perfringens for 2 h. On day 42, three birds per replicate were slaughtered and measured carcass weighed before and after evisceration and all components. The effects of diet treatments, blocks and initial weight were tested according to a general linear procedure analysis of variance (GLM procedure of SAS). Broilers challenged, and not supplemented with probiotics, showed lower carcass + viscera, empty carcass and legs than the other birds (P<.05). No differences were found in the values breast, breast fillet and wings (P>.05).

Keywords: additives, poultry, microorganisms, nutrition

135 Effect of antibiotic growth promoter, probiotics, and β-glucan on microbiome diversity of broiler chickens under commercial conditions. Elisa P. Francois, Josilene Correa Rocha, Marcos B. Cafe, Nadja S. Leandro, Gisele Neri, Elisa P. Francois, 1Escola de Veterinária e Zootecnia, UFG, Goiânia, Goiás, Brazil; 2Technical, Kemin South America, Sao Paulo, Sao Paulo, Brazil.

The balance between the various bacteria that inhabit the TGI or microbiome of birds is known as gut health. The intestinal microbiome has been recognized as an important factor in the maintenance of energy homeostasis, host immunity and for the best performance of the organism. Microbiome dysbiosis leads to huge losses in poultry production worldwide. The objective of this study was to investigate the effect of a dietary β-1,3-glucan from algae (Euglena gracillis), probiotic (Bacillus subtilis PB6), and an antibiotic growth promoter (enramycin) on the microbiota of broilers. A total of 864 1-day-old male Cobb 500 chicks with a mean initial weight of 48g were distributed in 4 treatments. Each treatment was divided into 6 replicates of 36 birds each. The chicks were randomly divided as follows: T1: Control diet without additives; T2: Control diet with antibiotic growth promoters (enramycin); T3: Control diet with 0.01% β-1,3-glucan; T4: Control diet with 0.05% probiotic. The experimental facilities were inside a commercial barn. DNA from cecum samples of birds slaughtered at 42d was extracted using a commercial kit and a segment of approximately 460 bases the 16S rRNA ribosomal gene was amplified using the universal primers described by the methodology. The readings obtained from the sequencer were analyzed using the QIIME2 platform. The statistical comparison between the groups in the alpha microbiome diversity analysis was performed using Wilcoxon's non-parametric test accepting statistically significant results lower than 0.05 (p<0.05). Statistical analyzes for beta microbiome diversity were performed using perMANOVA present in the QIIME2 pipeline, using a number of 10,000 permutations. Statistical analyzes were performed in the R program. Regarding alpha diversity, no statistically significant microbiome modulation was observed for the applied alpha diversity tests (Shannon, Evenness Piolou, Simpson's Index, Fisher, N observed OTUs and Chao). In terms of beta diversity, it was estimated by the parameters Bray-Curtis, Jaccard, UniFrac and Weighted Unifrac. The groups did not show differences regarding the dissimilarity of taxa present in the samples, considering both the presence/absence of taxa (Bray-Curtis) and the phylogenetic relationship between taxa (Weighted Unifrac). In conclusion, the microbiome in this study was not affected by the different treatments regarding its composition, considering the presence or absence of specific taxonomic groups, or the abundance of taxa by the beta diversity distances. More studies in this field are necessary to understand the relationship of these additives in the measurements performed.

Keywords: feed additive, -1,3-glucan, bacillus subtiliss, AGP, microbiome
An experiment was conducted to evaluate the effects of an additive containing polyphenols and saponins of a proprietary blend from *Quillaja saponaria* and *Yucca schidigera* (QY) biomass on growth performance and carcass yield of broilers as well as on nutrient digestibility, blood biochemistry, and intestinal measurements. A total of 800 Cobb 500 male chicks were fed 4 dietary treatments, with 8 replicates and 25 birds each from day 1 to 43, using a completely randomized design. Birds were fed a non-supplemented control diet (Control); Control supplemented with a commercial additive from QY (250 g/ton) from d 1 to 42; Control + QY (250 g/ton) from d 28 to 42, and Control + QY (250 g/ton) from d 35 to 42. Performance was evaluated weekly and carcass yield was performed on d 42. On d 43, ileal digestible energy (IDE) and digestibility of dry matter (DM), nitrogen and energy were determined, whereas samples of jejunum were collected for morphometric. Blood was collected on d 43 to determine albumin, glucose, total cholesterol, and triglycerides serum concentration. The intestinal permeability was evaluated on d 43 using systemic fluorescein isothiocyanate-dextran (FITC-d) as marker. Data were subjected to one-way ANOVA using the GLM procedure of SAS and when significant means were compared by Tukey test (*P* < 0.05). There were no effects of dietary treatments on BW gain, feed intake, carcass yield, and blood biochemistry parameters; however, from d 1 to 42, birds fed QY during the overall period had lower feed conversion ratio compared to the Control. Intestinal permeability was reduced with QY, whereas higher IDE, ileal digestibility of DM, nitrogen and energy as well as higher villus height and lower crypt depth were observed when broilers were fed QY from d 28 to 42. In conclusion, the quillaja and yucca biomass additive improved nutrient digestibility, jejunal morphometric, and intestinal permeability of broilers, and these effects were associated with the improved feed conversion ratio. The additive demonstrated satisfactory results on nutrient digestibility and villus height when supplemented in grower and finisher corn-soy diets for broilers.

**Keywords:** broiler, digestibility, intestinal morphometric, polyphenol, saponin

**137 Combination of microencapsulated propionic acid and phytochemicals improves the productive performance of broilers.** Caroline Facchi1, Lediane T. Miotto1, Beatriz P. Fernandes1, Daiane S. Ribeiro1, Ítalo Ferreira1, José Valter D. Mello1, Tiago G. Petrolli2, Thiago E. Perez, 1Research and Development, BTA Aditivos, Vargeão, Santa Catarina, Brazil, 2Zootecnia, UNOESC, Xanxerê, Santa Catarina, Brazil, 3Zootecnia, UDESC, Lages, Santa Catarina, Brazil.

Phytochemicals and organic acids comprise a promising group of molecules that have the potential to replace conventionally used molecules (ZHAI et al., 2018) as growth-promoting antibiotics (AGP). Intensive research seeks to present economic alternatives to replace AGP in the production of broilers, based on this, an additive program was developed, using microencapsulated molecules and free molecules, so that they can have the appropriate physiological action in the animal's organism. The additives used were supplied to the animals throughout the experimental period, divided into two stages to better meet the needs of each phase. Additive “I” was used in the pre-initial and initial phase (up to 21 days), and additive “II” with supply starting from day 22 to 42 days of the broilers. The animals were housed in a completely randomized design, consisting of five treatments with eight replications and fourteen animals per box. The treatments used in the experiment were: T1 – NC, Negative control 0 mg/kg; T2 – PC, Positive control 4 ppm/ton (avilamycin); T3 – Additive, 500 g/ton; T4 – Additive, 1000 g/ton; T5 – Additive, 1500 g/ton. The zootechnical performance of the chickens submitted to the treatments were measured, the weighing occurred at 7, 21 and 42 days. The animals treated with the additive “I” showed greater weight gain at 21 days when compared to NC (*P* = 0.009) and greater individual weight (*P* < 0.001). At 42 days, the chickens that received the additive “II” obtained greater weight gain (*P* = 0.001), when compared to the NC. There was no influence of the addition of the additive on feed intake (*P* = 0.405) and feed conversion (*P* = 0.842). Treatments fed with PC diet and additive “II”, had a higher productive efficiency index (PEI) when compared to birds fed the NC diet (*P* = 0.001). The variables feed intake and feed conversion did not differ between the evaluated groups (*P* > 0.05). There was a reduction in the levels of serum triglycerides in birds fed with 1000g/Ton and 1500g/Ton of the additive blend II. The additive program evaluated improves the weight gain and body weight of the birds, enhances the productive efficiency index of the flocks and reduces the level of serum triglycerides of the birds, without compromising other biochemical parameters nor the weight development of birds’ organs. Being a potential substitute for performance-enhancing antimicrobials in poultry production.

**Keywords:** animal health, antimicrobial, digestibility, production

**138 Microencapsulated blends of botanicals are effective feed supplements to control necrotic enteritis**

Poult. Sci. 102 (E-Supplement #2) 80
caused by Clostridium perfringens in broiler chickens. Benedetta Tugnoli1, Andrea Piva2, Philip Maynard3, Ester Grilli2,1, Vetagro S.P.A., Reggio Emilia, Italy, 2DIMEVET, University of Bologna, Ozzano Emilia (BO), Italy, 3Vetagro Inc, Chicago, Illinois, United States.

Necrotic enteritis (NE) is one of the most common diseases in poultry production worldwide, leading to sub-optimal performance and considerable economic losses. Botanicals are progressively gaining importance as feed additives for their biological properties among which antibacterial and anti-coccidial. The aim of this study was to reproduce a NE challenge model caused by Eimeria coccidia and Clostridium perfringens (CP) in broilers and evaluate the effects of microencapsulated blends of botanicals in comparison with conventional drug treatments. A total of 2,500 day-old chicks (Cobb500) were vaccinated for coccidiosis with Coccivac®-B52, divided in pens (50 birds/pen) and assigned to 5 groups (10 pens/group): CTR group, fed a control diet; Amp group, fed a diet with 100 ppm of Amprolium; BMD group, fed a diet with 55 ppm of bacitracin; TRT1, fed a diet supplemented with 400 g/MT of prototype 1; TRT2, fed a diet supplemented with Prototype 1 at 400 g/MT and Prototype 2 at 500 g/MT. Prototype 1 and Prototype 2 are a two microencapsulated blends of botanicals manufactured by Vetagro. All the animals were challenged first with cocci through an oral inoculation with Eimeria maxima (5,000 oocysts) at day 14, then with CP (alpha toxin and netB toxin positive, 10^8 CFU) orally administered for 3 days (d19, 20, and 21). The study lasted 42 days with small intestine lesions scored at d21 from 3 birds/pen, fecal oocysts counted at d28 and growth performance recorded throughout the study. Data were analyzed with ANOVA and differences considered significant at P<0.05. No differences in growth performance were observed before the challenge. From d14 to d28, immediately after the challenge, all the treated groups showed improved growth with higher weight gains and lower feed conversion ratio values compared to CTR group (P<0.01). In the overall period (0-42 days), the group TRT2 had the highest weight gain although only numerically (P=0.17), while FCR values were significantly reduced in particular by TRT2 and BMD (1.68 both) followed by TRT1 and AMP (1.73 both) compared to CTR group (1.84). All the treatments reduced overall mortality and mortality due to NE compared to CTR (P<0.0001). Compared to CTR, small intestine lesions score was reduced particularly by AMP and TRT2, while E. maxima counts were significantly lower only in TRT2 group (P<0.01). In conclusion, the microencapsulated blends of botanicals used in this study have the potential to contain loss of performance and lesions associated with NE challenge in broiler chickens to the same extent of conventional drugs.

**Keywords:** microencapsulation, botanicals, necrotic enteritis, C. perfringens, broilers

139 Impact of Isoquinoline Alkaloids and Essential Oils addition in broiler feed in intestinal histological parameters. Kelvin P. Silva2, Núbia d. Oliveira2, Elisangela T. Santos2, Arthur S. Massei1, Dimitri M. Freitas1, Cleverson d. Souza1, 1Phytobiotics Brasil, Cambé, Paraná, Brazil, 2Pluma Agroviacola, Dois Vizinhos, Paraná, Brazil.

The objective of this study was to evaluate the effects of Isoquinoline Alkaloids (IQ) + essential oils (EO) on broilers’ histological intestinal inflammatory parameters compared to a conventional additive program. In a scenario where restrictions and prohibitions on the use of antibiotics are being adopted around the world and the growing demand for animal protein raises the inherent challenges of production, alternative tools, such as phytotherapeutic additives, end up being given great prominence. Studies with the extract of Macleaya cordata composed of IQ have shown positive effects on the performance and on intestinal health of broilers, which compare with the effects of antibiotics. The results demonstrate that IQ decrease intestinal permeability through the control of intestinal inflammation. A total of 400 broilers aged from 1 to 28d were housed in pens (1,2m x 1,5m) in the experimental farm from Pluma Agroviacola. The experiment followed a randomized design, with 10 replicates of 20 birds for each of the 2 treatments: T1 - Control diet with Enramycin 10 ppm; and T2 – Control diet with IQ (Sangrovit® ED 100g/ton) + Blend of EO (carvacrol e cinnamaldehyde 100g/ton). On day 28, 10 birds of each treatment were euthanized by cervical dislocation and samples of ileum were collected for histological analysis. The I See Inside (ISI) methodology was used and it is based on a numeric score of alteration. The parameters evaluated were: Lamina Propria Thickness, Epithelial Thickness, Proliferation of Enterocytes, Inflammatory Cell Infiltration on Epithelium, Inflammatory Cell Infiltration in the Lamina Propria, Increase of Goblet Cells, Congestion and Presence of Oocysts. Data were analyzed by the Shapiro-Wilk normality test. The non-parametric data were submitted to the Kruskal-Wallis test (P<0.05). There was a statistical difference (P<0.05) between the means of the treatments in most parameters evaluated, except for Congestion and Presence of Oocysts (P>0.05). The Total ISI Score was statistically (P<0.05) lower for the T2 group (T1=6.41 and T2=3.24), the T2 group had statistically (P<0.05) lower scores than T1 group for Lamina Propria Thickness (1.2 and 2.22, respectively), Epithelial Thickness (0.28 and 0.49, respectively), Proliferation of Enterocytes (0.23 and 0.36, respectively), Inflammatory Cell Infiltration on Epithelium (0.21 and 0.38, respectively), Inflammatory Cell Infiltration in the Lamina Propria (0.86 and 2.22, respectively) and Increase of Goblet Cells (0.44 and 0.74, respectively). Therefore, we conclude that IQ + EO control intestinal inflammation and improve broilers’ intestinal health.

**Keywords:** isoquinoline alkaloids, AGP, intestinal inflammation, gut health, gut immunity
140 Supplementation of organic acids and essential oils microencapsulated on technological properties and quality of fresh and frozen meat of broiler. Caio Tellini¹, ² ³, Laura Gubert¹, Pedro Yamamoto², Ana C. Ferreira², Lucas K. Alves², André N. Pinto², Beatriz T. Onishi², Jovania I. Fernandes¹, ², ¹Animal Science Post-Graduate Program, Federal University of Paraná- Sector Palotina, Palotina, Paraná, Brazil, ²Poultry Experimentation Laboratory, Federal University of Paraná – Sector Palotina, Palotina, Paraná, Brazil, ³Safeeds Animal Nutrition, Cascavel, Paraná, Brazil.

The objective was to evaluate the effect of a blend of organic acids (OA) and essential oils (EO) on the quality of fresh and frozen broiler meat. 2016 broiler chicks were used, distributed in a randomized design, with six treatments, eight replications and 42 birds per experimental unit. The treatments consisted of: T1 - basal diet (negative control); T2 - basal diet plus 15% zinc bacitracin (positive control); T3 - basal diet plus 15g/t of blend; T4 - basal diet plus 300g/t of blend; T5 - basal diet plus 450g/t of blend; and T6 - basal diet plus 600g/t of blend. The blend of microencapsulated OA and EO consisted of a combination of calcium formate, citric acid, fumaric acid, orange essential oil (Citrus sinenses), thymol, and carvacrol. At 42 days of age, 24 breast/treatment was divided into two parts to analyze the technological properties and quality of fresh and frozen meat (60 days). The Tukey test was applied to compare means using the SAS statistical program. The meat pH 24h, water loss by pressure, dripping, water loss by cooking, and the shear force of fresh or frozen meat were not altered (p>0.05) by the experimental diets. At 60 days of freezing, the inclusion of 300g/t of the blend had a significant effect (p<0.05) indicating less weight loss by defrosting (% of breast compared to the negative control. Fresh meat from birds supplemented with the positive control diet showed higher (p<0.05) values of a* (red color), while diets supplemented with levels of the blend resulted in coloration with lower values (p<0.05) of a* (green color). The color of frozen meat from birds of the positive control showed higher values (p<0.05) of b* (yellow color) than the other treatments. Supplementation with microencapsulated OA and EO blends resulted in less water loss by defrosting and altered the color of broiler breast meat. The improvement in these features can contribute to an increase in the meat shelf life and to the consumer’s purchase decision.

Keywords: shelf life, citrus sinenses, weight loss by defrosting, water loss

141 Assessment of the Redox System of the intestinal mucosa of broilers supplemented with a microencapsulated blend of organic acids and essential oils. Caio Tellini², ³, Eduarda P. Simões¹, Isadora P. Pallaro², Larissa Priscilla D. Melo¹, Laura Gubert¹, Luíza R. Stefanello¹, Laura A. Pinto², ³, Jovania I. Fernandes², ³, ¹Animal Science Post-Graduate Program, Federal University of Paraná- Sector Palotina, Palotina, Paraná, Brazil, ²Poultry Experimentation Laboratory, Federal University of Paraná – Sector Palotina, Palotina, Paraná, Brazil, ³Safeeds Animal Nutrition, Cascavel, Paraná, Brazil.

The objective was to assess the antioxidant effect of a microencapsulated blend of organic acids (OA) and essential oils (EO) on the redox system. 2016 broiler chicks were distributed in a randomized design, with six treatments, eight replications and 42 birds per experimental unit. The treatments consisted of: T1 - negative control; T2 - positive control (15% zinc bacitracin); T3 - 150g/t of OA and EO blend; T4 - 300g/t of OA and EO blend; T5 - 450g/t of OA and EO blend; and T6 - 600g/t of OA and EO blend. The blend of microencapsulated OA and EO consisted of a combination of calcium formate, citric acid, fumaric acid, orange essential oil (Citrus sinenses), thymol, and carvacrol. At 42 days, samples were collected from the mucosa of the jejunum to evaluate the effect of activities of the enzymes superoxide dismutase (SOD), catalase (CAT), glutathione transferase (GST), glutathione (GSH) and lipid peroxidation (LPO). The contrast test and the polynomial regression were used by SAS. The regression analysis showed no significant effect of levels of the blend of OA and EO on the antioxidant systems. In the contrast test, there was lower activity of GST and CAT enzymes in the jejunum mucosa of birds that received diets supplemented with 300g/t of blend compared to the control diets, indicating less need for the action of the endogenous antioxidant systems, due to the capacity of bioactive compounds in essential oils to protect cells against the effects of free radicals. There was no significant difference (p>0.05) of OA and EO blend on the activity of the other antioxidant systems (GSH, LPO, and SOD). Improved redox status in the gut microenvironment reduces oxidative stress associated to inflammation and metabolic costs to maintain gut health and ensure a productive performance. The inclusion of 300g/ton of microencapsulated OA and EO additive blend resulted in antioxidant protection of the intestinal mucosa of broilers.

Keywords: catalase, oxidative stress, bioactive compounds, gut health

142 Effect of a precision biotic in broiler chickens under a necrotic enteritis challenge. Cristiano Bortoluzzi¹, Fan Fei¹, Frank Xu¹, Brett Lumpkins², Bruna Belote³, José O. Sorbara¹, Jack Geremia¹, ¹DSM, College Station, Texas, United States, ²Soynish Poultry Feed and Research, Inc., Athens, Georgia, United States, ³I See Inside, Inc, Curitiba, Brazil.

The objective of the present study was to evaluate the effect of a precision biotic (PB; Symphiomé™, DSM Nutritional Products) on the growth performance, lesion scores, mortality, and cecal metabolome of broiler chickens under a necrotic enteritis (NE) challenge model. One-day-old broiler chicks were placed in a completely randomized block design with 3 treatments, 8 replicates/treatment, and...
25 birds/replicate. The treatments consisted of a non-challenged control group (CON), challenged group (CHA), and challenged supplemented 900 ppm of PB. All the birds were vaccinated against coccidiosis at the hatchery (Coccivac-B52). Additionally, all the birds were submitted to a challenge consisting of 5,000 oocysts of Eimeria maxima given via feed on d14, and Clostridium perfringens strain #6 via feed on d19, 20, and 21. On d21, 2 birds/pen were euthanized and scored for NE lesions, cecal content was collected for metabolomic analysis, jejunal samples were collected for histopathology analysis, and growth performance was evaluated on days 14, 21, 35 and 42. The data were submitted to one-way ANOVA (P≤0.05), and LSMeans Tukey was used to separate the means in case of significance. Non-parametric data were analyzed by Kruskal-Wallis test and the means separated by Dunn’s Test using JMP 15. On day 21, it was observed that the challenge impaired body weight (BW; P = 0.0008), and feed conversion ratio (FCR; P < 0.0001), but the supplementation of PB improved both parameters similar to the control group. On day 42, the supplementation of PB improved BW by 10% (P < 0.0001), and the FCR by 8.4% (P < 0.0001) when compared to the challenged group. The supplementation of PB reduced NE associated mortality (5.5 vs 0.5%; P = 0.002) which was similar to the control group and reduced the lesions characteristic of NE (P < 0.0001). Metabolomic and histopathology analyses are being conducted and will be presented at the conference. This data suggests that the supplementation of PB is a beneficial strategy to mitigate the negative effect of NE and support the integrity of the intestinal lining in broiler chickens.

**Keywords:** broiler, precision biotic, microbiome

143 **Evaluation of a blend of organic acids and essential oils microencapsulated on the performance and carcass yield or broilers.** Caio Tellini1, 2, Lucas P. Glaeser1, lays Priscilla d. Melo1, Eduarda P. Simões1, Lucas K. Alvares2, 1, Pedro Yamamoto1, James d. Barbosa1, Jovani I. Fernandes2, 1, 1Poultry Experimentation Laboratory, Federal University of Paraná – Sector Palotina, Palotina, Paraná, Brazil, 2Animal Science Post-Graduate Program, Federal University of Paraná- Sector Palotina, Palotina, Paraná, Brazil, 3Safeeds Animal Nutrition, Cascavel, Paraná, Brazil.

Oxidation of lipid components in muscle tissues is the major cause of quality deterioration and short shelf life after slaughter. This study assessed the antioxidant effect of a blend of organic acids (OA) and essential oils (EO) on the fresh and frozen broiler meat. 2016 broiler chicks were distributed in a completely randomized design, with six treatments, eight replications, and 42 birds per experimental unit. The treatments consisted of: T1 - basal diet (negative control); T2 - basal diet plus 15% zinc bacitracin (positive control); T3 - basal diet plus 150g/t of blend; T4 - basal diet plus 300g/t of blend; T5 - basal diet plus 450g/t of blend; and T6 - basal diet plus 600g/t of blend. The blend of microencapsulated OA and EO consisted of a combination of calcium formate, citric acid, fumaric acid, orange essential oil (Citrus sinenses), thymol, and carvacrol. Using the Tukey test was applied to compare means using the SAS statistical program. Birds supplemented with zinc bacitracin in the diet had higher live weight in relation to only the negative control diet and the diet supplemented with the highest blend level (600g/ton). The other diets supplemented with the blend showed intermediate and similar results for live weight and feed intake at 42 days. The higher inclusion level of the blend resulted in lower (p<0.05) feed intake. Feed conversion was not affected by the diets. Carcass yield (40 birds per treatment) differed (p<0.05) only among diets containing 300 g/t and 450 g/t. The highest yield was observed with the inclusion of 450 g/t. The other diets did not affect (p>0.05) carcass yield. The diets with zinc bacitracin and 600 g/t blend resulted in the highest breast yield in relation to the diet without additive. The highest (p<0.05) carcass and wing weights were observed with diets supplemented with zinc bacitracin and 450g/t of blend. The evaluation of productive parameters showed better results at the dosage of 300 g/t, while for carcass yield parameters the dosage of 450 g/t resulted in higher rates.

**Keywords:** bioactive compounds, productive parameters, phytotherapeutics, breast yield

144 **Antioxidant effect of microencapsulated blend of organic and essential oils on fresh and frozen broiler meat.** Caio Tellini1, 2, Luciana R. Stefanello3, Lucas K. Alvares1, Cassiano B. Pasa1, Anderson H. Reuter3, Isadora P. Pallaoro3, Carlos E. Benito3, Jovani I. Fernandes1, 3, 1Animal Science Post-Graduate Program, Federal University of Paraná- Sector Palotina, Palotina, Paraná, Brazil, 2Safeeds Animal Nutrition, Cascavel, Paraná, Brazil, 3Poultry Experimentation Laboratory, Federal University of Paraná – Sector Palotina, Palotina, Paraná, Brazil.

Oxidation of lipid components in muscle tissues is the major cause of quality deterioration and short shelf life after slaughter. This study assessed the antioxidant effect of a blend of organic acids (OA) and essential oils (EO) on the fresh and frozen broiler meat. 2016 broiler chicks were distributed in a completely randomized design, with six treatments, eight replications, and 42 birds per experimental unit. The treatments consisted of: T1 - basal diet (negative control); T2 - basal diet plus 15% zinc bacitracin (positive control); T3 - basal diet plus 150g/t of blend; T4 - basal diet plus 300g/t of blend; T5 - basal diet plus 450g/t of blend; and T6 - basal diet plus 600g/t of blend. At 42 days of age, 16 birds per treatment were slaughtered and the Pectorales major was collected and subdivided into samples to evaluate the total antioxidant activity by capturing the free radical DPPH and quantification of Malondialdehyde (MDA) at the initial time (24 h) and after 60, 90, and 120 days of freezing. The statistical analysis was performed using IBM SPSS software (SPSS Inc., Chicago, USA, V.
There was a quadratic effect (p<0.05) of the blend inclusion levels on the antioxidant activity evaluated by DPPH. The inclusion of 450 g/t of blend increased the antioxidant activity of the meat in relation to the negative control (1 and 60 days). The inclusion of 600g/t of the blend resulted in greater oxidative in the frozen broiler meat compared to the PC. At 120 days of freezing, the blend in the diets reduced MDA content in breast of birds in relation of PC diet. On day 1, there was a decreasing linear effect (p<0.019) for MDA content. At 60 days, the PC and the treatment with 300g/t showed lower oxidation rates in relation to the treatment with 450 g/t, suggesting a pro-oxidant effect of this dosage. Supplementation with microencapsulated OA and EO improved the oxidative stability evaluated by MDA concentration and antioxidant activity of broiler meat.

**Keywords:** chicken breast, oxidative stability, DPPH, TBARS, phytotherapic additives

145 Intestinal quality of broilers challenged by Eimeria and Clostridium perfringers and fed with phytotherapics to replace the growth promoting antibiotic. Gabrieli Toniazza1, Gabriel N. Comin1, Nilton Rohloff Junior2, Cleison d. Souza2, Tania L. Kohler1, Lidiane I. Datsch1, Felippe P. Campos1, Mario Roberto Uhlein Júnior1, Cinthia Eyng1, Ricardo V. Nunes1, Evandro Campestrini2, Andre Marca2, 1Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, PR, Brazil, 2COPACOL, cooperativa agroindustrial Consolata, Marechal Candido Rondon, Brazil.

The present study aimed to evaluate the intestinal quality through permeability and the intestinal health index of broilers challenged and fed with different natural additives derived from herbal extracts. A total of 600 one-day-old male broiler chicks of the Cobb strain were used, distributed in a completely randomized design, with 5 treatments, 6 replications and 20 birds per experimental unit (EU). The treatments consisted of a negative control (NC - without antibiotic growth promoter); positive control (PC, avilamycin 20%, inclusion of 50 g/ton); NC supplemented with 100 g/ton of product based on plant extracts from the papaveracea family (*Macleaya cordata*); NC supplemented with 1000 g/ton of product based on tannic acid, sodium lignosulfonate and cellulose; and NC supplemented with 1000 g/ton of product based on prebiotic, mixture of yeast, amino acids and aluminosilicate. The use of 1000g/ton of the additive based on prebiotic, mixture of yeasts, amino acids and aluminosilicate in the improvement of intestinal health when the antibiotic growth promoter is an auxiliary of broiler hens.

**Keywords:** phytotherapy, intestinal permeability, herbal extract

146 Use of essential oils to replace performance enhancers for broilers challenged with Eimeria and Clostridium perfringers. Gabriel N. Comin1, Cinthia Eyng1, Nilton Rohloff Junior1, Gabrieli Toniazza1, Cleison d. Souza1, Ana Paula G. Cruz Costa1, Thiago S. Andrade1, Mayara M. Tesch Câmara1, Heloisa Sartor1, Ricardo V. Nunes1, Evandro Campestrini2, Andre Marca2, 1Department of Poultry Science, Western Paraná State University – UNIOESTE, Marechal Cândido Rondon, Paraná, Brazil, 2Cooperativa Agroindustrial Consolata – COPACOL, PR, Brazil, Toledo, Brazil.

With the restrictions that have been imposed in recent years on the use of antibiotics as performances modulators (APM), the use of essential oils can be considered an alternative, as they have microbial, immunomodulatory, antioxidant and food preservation properties, favoring the health and productivity of animals. Therefore, the objective of this work was to evaluate the redox potential of superoxide dismutase (SOD), performance, carcass yield and cuts of chickens challenged with *Eimeria* and *Clostridium perfringers* fed diets containing products based on essential oils (EO) to replace the antibiotic growth enhancer. A total of 720 one-day-old male Cobb chicks were used, distributed in a completely randomized design, with six treatments, six replications and 20 birds per experimental unit (EU). The treatments were composed of negative control (NC) without the inclusion of APM; positive control (PC) with 50 g/ton of 20% avilamycin; NC + 100 g/ton product A (cinamaldehyde, carvacrol and thymol); NC + 1000 g/ton product B (*Anacardium occidentale* and *Ricinus communis* oil); NC + 150 g/ton product C (*Eucalyptus*, carvacrol, cinamaldehyde and paprika oleoresin); NC + 300 g/ton collected from the jejunum for ISI, in which propria thickness, epithelial thickness, the enterocyte evaluation lamina, inflammatory infiltration in the epithelium, inflammatory infiltration in the lamina propria, goblets, congestion and presence of oocysts. Data were selected for a one-way analysis of variance and effect (P<0.05) as means of transmission were given to the 5% SNK test. The NC birds showed lower intestinal permeability compared to the other treatments (P=0.486). For the ISI analysis, there was a difference for the total score at 14 (P=0.0001) and 28 (P=0.0279) days of age. Being that at 14 days, CN birds had the highest total ISI score, and was observed at 28 days of age for birds receiving similar plants of the papaveracea family (*Macleaya cordata*). The lowest score was observed at 28 days for birds that received a prebiotic base, yeast mixture, amino acids and aluminosilicate. The use of 1000g/ton of the additive based on prebiotic, mixture of yeasts, amino acids and aluminosilicate in the improvement of intestinal health when the antibiotic growth promoter is an auxiliary of broiler hens.
microencapsulated product D (organic acids, essential oils in vegetable fat, Curcuma zanthorrhiza, tannins, vitamin and zinc). The inclusion of the products replaced the inert material of the NC. To challenge the birds, 3 inoculations were performed by gavage in all birds, being inoculated at 4-d-age, 20 times the dose of the vaccine for coccidiosis (0.6 ml Bird⁻¹ of Biococcivet R⁶) and at 7 and 10 d-of-age. 5 × 10⁷ CFU Bird⁻¹ of Clostridium perfringens inoculum of a field strain related to cases of necrotic enteritis was inoculated. At 18 days, blood was collected from one bird per EU to assess SOD activity. The birds and feed were weighed at 21 and 42 days to assess feed intake (FI), weight gain (WG) and feed conversion ratio (FCR). At 42 days, two birds per EU were slaughtered to determine carcass and cuts yield, liver weight and abdominal fat. The results were analyzed using the GLM procedure in SAS. At 21 days there was a difference (P<0.05) for WG and FCR, in which the birds that received product A showed a reduction in WG compared to the group that received the PC diet (738 vs. 783) and a worsening in FCR compared to birds that received diets PC and product D (1.395 vs. 1.348 and 1.348). There was no effect (P>0.05) between treatments for SOD activity, performance, carcass yield and poultry cuts at 42 days. It can be concluded that the use of products B, C and D can replace the use of APM in broilers challenged with Eimeria spp. and Clostridium perfringens without impairing performance, SOD and carcass yield.

Keywords: phytotherapics, feed conversion, essential oil blends in two physical forms with or without ionophore.

Priscila d. Moraes¹ ², Paula G. Pires², Caroline V. Poltronieri¹ ², Heloisa L. Silva¹, ¹Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil, ²Advanced Poultry Gut Science, Porto Alegre, Brazil.

The aim of this study was to evaluate the commercial mixture of cashew nut shell liquid and castor oil (CNSL-oil) in two physical forms and compare them with the association of virginiamycin with salinomycin (SAL) in broilers challenged with coccidiosis. A total of 1760 one-day-old male broilers (Cobb 500) were distributed in a completely randomized design with 8 treatments with 10 replicates of 22 birds each. Treatments were: control (without additive), OFS_0.75 (functional oil spray mixture 0.75kg/t), OFP_1.0 (functional oil powder mixture 1.0 kg/t), OFP_1.5 (functional oil spray mixture 1.5kg/t), SAL (salinomycin 66 ppm), SAL_VIR (virginiamycin 16 ppm and salinomycin 66 ppm), SAL+OFS_0.5 (salinomycin 66 ppm plus functional oil spray mix 0.5 kg/t), and SAL+OFP_1.0 (salinomycin 66 ppm plus functional oil powder blend 1.0 kg/t). All birds were gavaged with 1 ml of water containing sporulated oocysts of E. tenella (5x10⁶), E. acervulina (2.5x10⁶), and E. maxima (2.0x10⁵) at 14 days of age. Performance parameters, including live weight (LW), weight gain (BWG) and feed conversion ratios (FCR), were evaluated at 14, 28 and 42 days of age. The intestinal health index was evaluated by the “I See Inside” (ISI) methodology at 21 and 28 days of age. Seven days after infection (21 days of age), treatments without SAL yielded lower BWG, FI, and LW. Therefore, at 21 days of age, treatments with only functional oils, regardless of dosage and physical form, did not differ from the control (P<0.05). Also, BWG was higher for the SAL_VIR and lower for the control (P<0.05), and treatments supplemented with SAL were not different from the OFP_1.5 treatment at 28 days of age (14 days post-challenge). At 42 days, broilers from the control and OFS_0.75 yielded the lowest LW, being lighter than the SAL_VIR and SAL_OFP_1.0 treatments, the latter treatments being the heaviest and not different from each other. The OFP_1.5 treatment, in turn, was heavier than the control (P<0.05). The birds in the negative control group showed the worse feed conversion (P<0.05). For the ISI, and at 21 days, the control, Sal_OFS_0.5 and Sal_OFP_1.0 treatments yielded higher indexes than the OFS_0.75 and OFP_1.5 treatments (P<0.05), and the indexes for other treatments were intermediate. Summarizing, the use of functional oils improved the intestinal health. The physical form of the CNSL+castor oil blend did not influence the performance of the animals, and the dosage of CNSL+castor oil, and its association with salinomycin influenced the LW, BWG, and FCR at 42 days, with positive results for the treatments Sal_OFS_0.5 and Sal_OFP_1.

Keywords: additives, coccidiosis, functional oils, poultry, salinomycin


The objective of this study was to evaluate the effects of dietary levels of an oil extracted from bocaiuva (Acrocomia aculeata) pulp (BO) on the performance and meat quality of broilers. A total of 1,176 broilers were randomly allotted to seven dietary treatments, with five levels of inclusion of BO - 100; 200; 300; 400 and 500 ppm and two controls (negative control - NC, without antibiotic addition and positive control - PC, with antibiotic addition), seven replicates with 24 birds each. Broiler weight gain, feed intake and feed conversion were evaluated at 42 days. At d 42, two birds from each replicate were randomly selected and the breast and thigh meat were collected to meat quality analysis. On breast meat were performed the analysis of shear force, water-holding capacity, cooking weight loss, pH and colour. The content of thiobarbituric acid reactive substances (TBARS) in the muscle was determined immediately after the slaughter and after 20 days of storage under -20°C. Data were submitted to analysis of variance,
excluding the control diets. The effect of BO levels was determined by polynomial regression. TBARS data were analyzed considering a factorial scheme, including the effects of treatments (different levels of BO), storage time and the interaction between them. The comparison between the diets containing BO, regardless of inclusion level, and the PC and NC, was performed using F test for contrasts. The levels of inclusion of BO did not influence (P>0.05) the performance. For the contrasts it was observed that birds that received the oil had worse (P<0.05) feed conversion when compared to PC. Regarding meat quality, it was only observed interference of BO levels on lightness (L*) values with a positive linear effect (P<0.05) at 15 minutes postmortem. Variation was evidenced for TBARS value only for storage time with the highest value of lipid oxidation being observed after 20 days of meat storage. The results showed that inclusion of 100 to 500 ppm of BO in broiler chicken diets did not improve performance and meat quality, being not possible to observe the antioxidant effect of the oil.

Keywords: Acrocomia aculeata, antioxidant, meat color, TBARS

Supplementation of condensed tannin in diets for broiler chickens. Felipe Dalolio¹, Anderson Malmmann¹, Bruna Poletti¹, Sérgio Vieira², André Fávero², Diogo Taschetto², ¹Tanac S/A, Montenegro, Rio Grande do Sul, Brazil, ²Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, ³Granja Santa Lívia, Farroupilha, Brazil.

The use of antibiotic growth promoters in the poultry industry becomes increasingly restricted. This is because of the risk of developing bacterial resistance. Thus, there is a growing demand for the use of additives in diets that do not cause bacterial resistance and do not leave residues in products of animal origin. The inclusion of phytogenic has become common in antibiotic-free diets due to their antimicrobial properties, improved digestibility and intestinal health. Thus, the supplementation of condensed tannins in the diets can be a promising alternative given their anti-bacterial, anti-fungal and antioxidant properties, which can provide satisfactory performance. The objective of the present study was to evaluate the black wattle condensed tannin supplementation on performance, ileal digestibility and intestinal integrity of broilers from 1 to 42 days of age. A total of 660 1-day-old male Cobb 500 broilers were distributed in a completely randomized design with three treatments (basal diet without additives, basal diet with enramycin 125 (1-35d) and 63 g/ton (36-42d), and basal diet with tannin black wattle in 500 g/ton for 1-42d), ten repetitions and 22 birds per replicate. Feed intake, weight gain, feed conversion ratio, ileal digestibility at 42 days of age (dry matter, crude protein and energy) and Fit-C as a measure of intestinal permeability were measured. Data were analyzed through analysis of variance and Tukey test at 5%, using SAS (2002). For performance, it was observed that there was no effect (P>0.05) on feed intake. However, it was observed that tannin supplementation and enramycin inclusion provided greater weight gain and better feed conversion compared to the treatment without the use of additives (P<0.05). For ileal digestibility and intestinal permeability parameters, no effect was observed between treatments (P>0.05). It is concluded that the supplementation of black wattle condensed tannin in diets for broilers can be used as an alternative to the inclusion of antibiotic growth promoters.

Keywords: tannin
The effect of different storage times, validation and development of prediction equations of hen egg quality. Daniel J. Huaringa1, Carlos Vilchez-Perales2, Teresita S. Huapaya2, Otto A. Zea2, Ihonatan Inca2, Rubén Céspedes2, 1Nutrición, Integración Avícola Oro, Quito, Pichincha, Ecuador; 2Nutrición, Universidad Nacional Agraria La Molina, Lima, Lima, Peru.

The present study investigated the storage time on the egg quality of laying hens, and aimed to validate and develop prediction equations that allow determining the external and internal quality parameters of eggs stored up to fourteen days. 720 eggs from Hy-Line Brown hens in the second production phase were worked. The hens were fed a corn-soybean diet, with a daily consumption of 120 grams and water ad libitum. The eggs were divided into three groups of 240 and stored to later measure their internal and external characteristics. Measurements were made at one, seven and fourteen days of storage. The variables egg weight (EW), egg length (EL), egg diameter (ED), shell weight (SW), yolk height (YH), yolk weight (YW), albumen diameter (AD), albumen height (AH), albumen weight (AW), shell thickness (ST), egg surface area (ESA) and egg shape index (ESI) were used. Statistical analysis indicates significant differences (p<0.05) in most of the egg characteristics at different storage times. With the data collected, four prediction equations taken from a previous trial can be validated: yolk height (YW = 2.908 + 0.261ED; R2 = 46.50), yolk weight (YW = 3.358 + 0.214EW; R2 = 20.25), area egg surface (ESA = 6.254 + 1.387EW; R2 = 99.40) and egg shape index (ESI = 0.79 + 0.0307ED - 0.02423EL; R2 = 98.80); the validation was carried out with an error level of less than 12%. Six prediction equations were developed using the linear regression model for the variables albumen diameter (AD = 39.136 + 0.797EL; R2 = 1.13), albumen diameter (AD = 35.509 + 0.650EL; R2 = 2.24), albumen height (AH = 12.017 - 0.076ED; R2 = 31.44), albumen weight (AW = -2.918 + 0.683EW; R2 = 83.34), shell weight (SW = -0.315 + 0.099EW; R2 = 56.93), and shell thickness (ST = 0.215 + 0.039SW; R2 = 30.05) and shell thickness (ST = 0.215 + 0.039SW; R2 = 30.05).

Keywords: linear regression, correlation, egg quality, layers hens, validation

Assessments of productive performance of laying breeder hens fed a proprietary blend of Quillaja and Yucca. Otoniel F. Souza1, Sandra Bonaspetti1, Renius Mello3, Kelly N. Castro1, Jessica A. Alencar1, Gabriel Bernardi1, Catarina Stefanello1, 1Animal Sciences, University of Santa Maria, Santa Maria, RS, Brazil; 2Phibro Animal Health Corporation, Campinas, SP, Brazil; 3Tecnologia e Ciência dos Alimentos, University of Santa Maria, Santa Maria, RS, Brazil.

This experiment was conducted to evaluate productive performance of laying breeder hens fed diets supplemented with an additive containing polyphenols and saponins of a proprietary blend from Quillaja saponaria and Yucca schidigera (QY) biomass. A total of 44 Red Rhodes Island and 40 White Plymouth Rock breeder hens at 27 weeks of age were allocated in individual cages using a completely randomized block design with 21 replicates. Each treatment was composed by 11 Red Rhodes Island and 10 White Plymouth Rock hens. After a 28-d period of adaptation, hens were fed 4 experimental feeds in 5 periods of 28 days each, from 30 to 49 weeks of age. Experimental feeds were a Control diet (formulated with corn, soybean meal and wheat bran without additives); Control supplemented with virginiamycin at 16.5 ppm (Control + virginiamycin); Control supplemented with the QY additive at 250 g/t (Control + QY), and Control supplemented with virginiamycin + 250 g/t QY (Control + virginiamycin + QY). Productive parameters were evaluated per period and in the overall period as: egg production, egg mass, egg weight, egg loss and dirty eggs as well as feed intake and feed conversion ratio. Data were submitted to one-way analysis of variance using the GLM procedure of SAS Institute and significance was accepted at P < 0.05. Means were compared by Tukey test. No effect between the hens’ strain was observed, which was previously blocked in the experimental design. Treatments did not affect daily feed intake, egg production and egg mass (P > 0.05); however, hens fed Control + QY had lower (P < 0.05) egg loss and dirty eggs from 30 to 49 wk. From 46 to 49 wk, hens fed Control + QY had improved feed conversion ratio than hens fed the Control (P < 0.05). In conclusion, diets supplemented with the Quillaja and Yucca additive resulted in decreased percentage of egg loss and dirty eggs, maintaining the productive performance for laying breeder hens from 30 to 49 weeks of age.

Keywords: breeder hen, egg loss, egg production, polyphenol, saponin

Influence of light intensity, blood fraction, fasting and storage time on energy pathway metabolites in broilers. Thiago S. Andrade1, Clauber Polese1, Maisa B. de Carvalho1, Nilton Rohloff Junior1, Mariane Cristina Mohr de Souza1, Maressa Fernanda Cardoso Pereira1, Mayara M. Camara1, Lidiane I. Datsch1, Bárbara Amanda Bebber1, Mario Roberto Uhlein Júnior1, Gabrieli Tonizzio1, Felipe Potenza Campos1, Cleison d. Souza1, Ana P. Costa1, Tânia Luiza Kohler1, Heloisa Sartor1, Lucas Wachholz1, Jessica D. Starkey2, Cinthia Eyn2, Ricardo V. Nunes1, 1Department of Poultry Science, Western Paraná State University – UNIOESTE, Marechal Cândido Rondon, PR, Brazil; 2Department of Poultry Science, Auburn University, Auburn, Alabama, United States.

Poult. Sci. 102 (E-Supplement #2) 87
The objective of this study was to evaluate the effect of light intensity, fasting and storage time -20 oC and blood fractions (serum vs plasma) on concentrations of glucose, cholesterol and triglycerides, of broilers. Male Cobb 500 (n=140) were grown, to 45 d of age with an average weight of 3123±654g. From 42 to 45 days of age the birds were distributed in a completely randomized design, separated in two environments of light intensity 5 and 20 lux m-2. The birds were on a 1 hour fast and then were fed for 30 minutes post fast. After ingestion of feed, the first blood is called postprandial or time zero, and then blood was harvested at 2 hour intervals during 12 hours of fasting. Blood was collected from 10 birds from each environment (5 and 20 lux-2), via brachial puncture of the ulnar vein using vacuum tubes with and without anticoagulant (sodium fluoride 5mg + EDTA-K3 4mg). After blood was harvested it remained in horizontal position for 15 minutes at room temperature and was centrifuged at 1050 G for 10 m. Plasma and serum fractions were separated and stored in microtubes at -20 oC, and were analyzed at 0, 15, 30, 60 and 120 days of storage. Analysis was done using a spectrophotometry biochemical autoanalyzer (Flexor EL 200) with specific kits (Elitech). Results were analyzed in 2 x 7 x 5 x 2 factorial design, using the GLM procedure of SAS. No effect of light intensity was observed. In the serum fraction, glucose concentration decreased linearly (P < 0.0001), (- 1.147*H + 245.30, R2 = 0.64, H = hours), as the fasting time increased, while colesterol increased linearly (P < 0.0063), (0.390*H + 135.50, R2 = 0.53), triglycerides had maximum concentration 30.25 mg dL-1 with 4 h of fasting (P < 0.0001), (- 0.052*H2 + 0.406*H + 29.456, R2 = 0.81). The plasma cholesterol concentration increased linearly (P < 0.0001), (1.248*H +115.693, R2 = 0.55), while glucose and triglycerides had maximum concentration 224.65 and 35.91 mg dL-1, with 8 h 13 min, and 8 h 18 min, (P < 0.0001), (0.116*H2 - 1.912*H + 232.515, R2 = 0.72), (- 0.404*H2 - 6.706*H + 63.709, R2 = 0.74), of fasting, respectively. For the storage time serum glucose had a maximum concentration of 223 mg dL-1 with 95 days at -20 oC of storage, while triglycerides increased linearly (P = 0.0062), (0.040*D + 42.200, R2 = 0.27, D = days) Plasma glucose had a maximum concentration of 230 mg dL-1 (P = 0.0017), (0.0012*D2 + 0.174*D + 223.921) with 72 days of storage. Fasting of 4 h is recommended to measure serum triglycerides concentration, while for plasma glucose and triglycerides, a maximum of 8 hours of fasting and the use of serum for the analysis of glucose, cholesterol and triglycerides, avoiding freezing is recommended.

**Key words:** biochemistry, light intensity, metabolites, gluconeogenes, fasting

**153 Ileal digesta viscosity of broilers fed corn-based diets of varying particle sizes supplemented with graded levels of multienzyme.** Damilola U. Kareem1, 2, Lawrence T. Egbeye1, Adedoyin T. Amos2, Olubukola P. Idowu3, 4, Akinyemi I. Akinlade2, Nilka V. Sakomura1, Olusegun M. Idowu2, Lucas P. Bonaguro1, 1Department of Animal Science, São Paulo State University (UNESP), Jaboticabal, São Paulo, Brazil, 2Department of Animal Nutrition, Federal University of Agriculture Abeokuta, Abeokuta, Ogun, Nigeria, 3Department of Animal Production and Health, Federal University of Agriculture Abeokuta, Abeokuta, Ogun State, Nigeria, 4Agricultural Media Resources and Extension Centre, Federal University of Agriculture Abeokuta, Abeokuta, Ogun, Nigeria.

Poultry diets containing enzymes, especially those of cereals origin, and rich in non-starch polysaccharides (NSPs) such as rye, wheat, and barley had been reported to reduce digesta viscosity. Birds fed fine mash diets have higher digesta viscosity than those on medium or coarse wheat diets and studies have reported the effects of enzyme supplementation on ileal digesta viscosity of broilers fed wheat-based diets of varying particle sizes. This study aims to evaluate the ileal digesta viscosity of broilers fed corn-based diets of varying particle sizes supplemented with multienzyme. Three sieves (3, 4, and 5 mm) were fabricated to obtain diets of different particle sizes supplemented with multienzyme at three levels (0, 1, and 2 g/kg). A total of 450 one-day-old Cobb500 mixed-sex broiler chicks were randomly allotted to nine dietary treatments with five replicates of ten birds each. At 42-day-old, four birds per replicate whose weights were closest to the average weight were slaughtered and dissected to expose the celomic cavity to sample the intestinal content. The digesta content was collected on the third distal section of the ileum. Data obtained from this experiment were subjected to Analysis of Variance (ANOVA) in a 3x3 factorial experimental arrangement using the GLM procedure in SAS 9.1.3 software statistical package (SAS, 2002). Means were compared by Tukey HSD test at a 5% level of significance. Multienzyme and its interaction with particle size had no significant (p>0.05) effect on the ileal viscosity, while the particle sizes significantly (p<0.05) affected the ileal viscosity, with the ileal content of birds fed 3 mm particle sizes being the most viscous (1.24 PaS). Using a polynomial contrast, ileal viscosity was observed to linearly decrease with an increase in particle size. The viscosity of ileal digesta of the birds fed with 3mm feed particles is 4% higher than those fed with 4 mm and 5 mm feed particles. The significant effect recorded is in line with some reports that stated that higher digesta viscosity occurs with birds fed fine mash diets compared to that fed medium or coarse diets. An increase in particle size of corn-based diets can therefore be concluded to lead to a reduction in viscosity of the ileal digesta.

**Key words:** ileal digesta viscosity, particle size, broiler, multienzyme, corn-based diets

**154 The use of water holding capacity to estimate maximum feed intake for laying hens.** Larissa P. Maria, Matheus Reis, Bárbara Marçal, Raully L. Silva, Bruno B. Leme, Nilva K. Sakomura, Ciências Agrárias-Ciência Povoa, São Paulo, Brazil, 1Department of Animal Production and Health, Federal University of Agriculture Abeokuta, Abeokuta, Ogun, Nigeria.
The laying hens are assumed to eat for the first limiting component in the feed, consuming their needs and regulating feed intake at the same time. However, the intestine’s physical capacity may prevent the hen to consume a sufficient amount of the given feed, which may have negative consequences for the laying hen. The objective of this study was to produce a feasible solution to estimate the maximum feed intake (FImax) of laying hens consuming any given feed. The water holding capacity (WHC) of the feed was used as the trait related to feed bulkiness. Six treatments were randomly assigned to 84 wire-laying cages of one laying hen per cage (83 weeks old, Hy-Line W80), totaling 14 replicates per treatment, performing a completed randomized design. A basal feed (BD) was formulated to meet or exceed breeding company recommendations and treatments consisted of six dilution levels (vermiculite was the diluent) in the basal feed (0, 5, 10, 15, 20, and 30%). Feed intake was collected once a week for 10, 15, 20, and 30%). Feed intake was diluted, up to a dilution that elicited a reduction in feed intake. The adaptation to bulky feeds with age was rejected (P>0.05) and data were averaged before further procedures. There was a proportionality between feed intake and body weight, then a scaled feed intake (SFI, g of feed/kg of body weight) was calculated. The second-degree polynomial equation was used to estimate the maximum SFI in function of the WHC and the equation adjusted is SFI\textsubscript{max} (g/kg) = 239 + 50.62*WHC – 3.5626*WHC\textsuperscript{2}. For simplicity, the reciprocal of WHC was adjusted in function of the SFI\textsubscript{max} measurement. The intake increased as the feed was diluted, up to a dilution that elicited a reduction in feed intake. The adaptation to bulky feeds with age was rejected (P=0.05) and data were averaged before further procedures. There was a proportionality between feed intake and body weight, then a scaled feed intake (SFI, g of feed/kg of body weight) was calculated. The second-degree polynomial equation was used to estimate the maximum SFI in function of the WHC and the equation adjusted is SFI\textsubscript{max} (g/kg) = 239 + 50.62*WHC – 3.5626*WHC\textsuperscript{2}. For simplicity, the reciprocal of WHC was adjusted in function of the SFI\textsubscript{max} and for each 0.1 unit of 1/WHC, the SFI\textsubscript{max} changes 37.6 g. According to this relation, in this study, the maximum SFI of the BD with 0 or 30% dilutions is easily estimated as 86 and 68 g/kg, respectively. A simple solution to estimate maximum scaled feed intake for laying hens is given in this work, and for that, the water holding capacity of the feed needs to be measured.

Keywords: voluntary consumption, dilution, vermiculite

155 Evaluation of a mycotoxin enzymatic inactivator based on Saccharomyces cerevisiae lysate as a feed additive for broilers previously contaminated by deoxynivalenol and fumonisin. Marcel M. Boiago1, João Vitor Strapazzon1, Paulo Oliveira1, Fabrizio Matte2, Lenita M. Stefani1, Eduardo M. Glória3, Animal Science, UDESC, Chapecó, Santa Catarina, Brazil, Poultry Technical Consultant, Vetanco of Brazil Ltda, Chapecó, Santa Catarina, Brazil, Department of Agribusiness, Food and Nutrition, University of São Paulo, Pirassununga, São Paulo, Brazil.

The objective of this study was to evaluate whether the addition of a commercial product made of Saccharomyces cerevisiae lysate (Detoxa® Plus, Vetanco of Brazil Ltda) would be able to minimize the negative effects on performance and health of broilers fed diets contaminated with deoxynivalenol (DON) and fumonisin (FB1). A total of 630 one day old male Cobb broiler chickens were distributed in a completely randomized design with six treatments with seven replicates of 15 birds each, divided as follows: NC – Negative control diet (without mycotoxin); PC – positive control (diet contaminated with 3 ppm of DON and 30 ppm of FB1); PC+D500 (contaminated diet + Detoxa® Plus 500 mg/kg); PC+D750 (contaminated diet + Detoxa® Plus 750 mg/kg); PC+D1000 (contaminated diet + Detoxa® Plus 1000 mg/kg); NC+D1000 (negative control diet + Detoxa® Plus 1000 mg/kg). Animal performance was measured in the periods of 1 to 21, 1 to 35 and 1 to 42 days of age. Blood samples were collected at 42 days of age for analysis of oxidative stress indicators, as well as liver and intestinal samples of five birds per treatment for the measurement of oxidative stress markers and villus length. Means were submitted to analysis of variance (ANOVA) and in cases of significant differences the Tukey test (5%) was used. Birds that received contaminated diets had lower mean weight gain (WG) when compared to NC and NC+D1000 (P<0.01) at 21 days; however, at 35 and 42 days only birds from the group NC+D1000 showed higher WG compared to the other treatments. The best feed conversion (FC) was observed, in all rearing periods in birds of groups NC and NC+D1000 (P=0.01), while the worst occurred in groups PC and PC+D500 when compared to NC and NC+D1000 (P<0.01) up to 35 days and PC, PC+D500 and PC+D750 at 42 days. The group CP+D1000 showed FC similar to the NC and NC+D1000 groups in all studied periods. There was an increase in ROS in the liver of PC birds when compared to the other groups (P<0.0001), while for TBARS an increase in PC was also observed in relation to the NC, PC+D750, PC+D1000 and NC+D1000 (P=0.0016). Birds in the NC+D1000 and PC+D1000 groups had the largest intestinal villus length when compared to the other treatments, however, the PC+D750, PC+D500 and PC groups had the largest villus in relation to the NC group (P<0.0001). It is concluded that the consumption of mycotoxins impaired the performance of broilers and increased the oxidative stress of these birds. However, the addition of 1000 mg/kg of Detoxa® Plus minimized the negative effects observed in FC and also in the oxidative stress caused by DON and FB1, in addition to providing larger villus length.

Keywords: feed conversion, oxidative stress, reactive oxygen species, villus length, yeast

156 Feed cost analysis of 1.4 kg broiler griller chickens fed diets with different metabolizable energy
and digestsible lysine. Caroline F. Nunes¹, Bernardo B. Xavier², Sergio L. Vieira³, Yuri J. Olabarriaga³. ¹UFRGS, Porto Alegre, Brazil, ²Animal Science, UFRGS, Porto Alegre, Rio Grande do Sul, Brazil, ³Department of Animal Science, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.

The present study aimed to evaluate the profitability of the performance of 2016 broiler chicks Cobb x Cobb 500 allocated for 25 d in 72 pens on a completely randomized design. The experiment consisted of 9 treatments, 8 replications, in a 3 x 3 factorial design having 3 apparent metabolizable energy (AME) levels: high, moderate and low, and 3 protein levels (high, moderate and low) using ideal protein (IP) concept. Four diets were formulated: pre-starter (AME of 3,025, 2,995 and 2,965 kcal/kg; 1.36, 1.31 and 1.26% of digestible lysine), starter (AME of 3,100, 3,065 and 3,030 kcal/kg; 1.27, 1.22 and 1.17% of digestible lysine), grower (AME of 3,180, 3,150 and 3,120 kcal/kg; 1.18, 1.13 and 1.08% of digestible lysine) and finisher (AME of 3,200, 3,175 and 3,150 kcal/kg; 1.08, 1.03 and 0.98% of digestible lysine). Birds were weighed weekly to determine body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR). Dead birds were weighed to correct FCR. On days 21st, 23rd and 25th, birds were weighed to determine when they reached 1,400g. Feed costs were done using market prices of protein, pig meal, and digestible lysine. Birds were randomly divided into five treatment groups with the inclusion of compost in the feed with a percentage of 0, 2.5, 5, 7.5, and 10 in each group. Blood samples were collected from wing vein of all the birds on day 42 which were analyzed for hematology, lipid profile, total protein, albumin, serum glucose level, and oxidative stress biomarkers. One way analysis of variance was used to compare the mean values of results among different treatment groups. The results were non-significant among different treatment groups when compared with the control group with 0% compost supplementation which shows no adverse effects of compost in layers birds feed. So, it was concluded that the composted bird’s litter can be used as a safe and cost-effective feed ingredient in the layer bird’s food with a cost reduction.

Keywords: poultry litter, Compost, layer, microbiome, bio health markers

158 Energy partitioning in broiler breeders under net energy system. Guilherme F. Teofilo¹, Freddy Alexander H. Morillo¹, Damilola U. Kareem¹,², Luis Filipe V. Freitas¹, Rosiane d. Camargos¹, Camila K. Cheneri¹, Miguel Z. Costa¹, Bruno B. Leme¹, Nilva K. Sakomura¹, ¹Department of Animal Science, São Paulo State University, Jaboricabal, São Paulo, Brazil, Jaboricabal, Brazil, ²Department of Animal Nutrition, Federal University of Agriculture Abeokuta, Nigeria, Abeokuta, Nigeria.

Waste of poultry farms, which includes litter and dead birds, is being used as a fertilizer in agriculture fields and as a source of food for the cattle and poultry. Presence of nitrates and other harmful constituents in the non-processed birds’ litter is a risk to consumers health leading to serious ailments like cancer, respiratory tract disorders and various fetal anomalies. According to the scientific literature, removal of these toxic substances can be achieved by composting the litter. Present study was designed to confirm the nutritional efficacy of the composted poultry litter in a clinical trial of layer birds. Compost was prepared from the litter and dead birds and its nutritional value was evaluated by proximate and mineral analysis. Three hundred, day old layer birds were randomly divided into five treatment groups with the inclusion of compost in the feed with a percentage of 0, 2.5, 5, 7.5, and 10 in each group. Blood samples were collected from wing vein of all the birds on day 42 which were analyzed for hematology, lipid profile, total protein, albumin, serum glucose level, and oxidative stress biomarkers. One way analysis of variance was used to compare the mean values of results among different treatment groups. The results were non-significant among different treatment groups when compared with the control group with 0% compost supplementation which shows no adverse effects of compost in layers birds feed. So, it was concluded that the composted bird’s litter can be used as a safe and cost-effective feed ingredient in the layer bird’s food with a cost reduction.

Keywords: poultry litter, Compost, layer, microbiome, bio health markers

157 Use of Poultry Compost as a Feed Ingredient in Layer birds. Haseeb Anwar¹, Athar Mahmud², Imtiaz Mustafa³. ¹Department of Physiology, Government College University Faisalabad, Pakistan, Faisalabad, Pakistan, ²Department of Poultry Production, University of Veterinary and Animal Science, Lahore, Pakistan., Lahore, Punjab, Pakistan, ³Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore, Punjab, Pakistan.

This study aimed to describe the dynamics of energy metabolism in broiler breeders during the laying period. A total of 300 broiler breeder hens were reared and fed according to Cobb-500 guidelines, then 50 hens (27 to 63-wk-old) were selected according to the target body weight (BW) recommended in the guidelines. Each bird was individually housed in a respirometry chamber and fed based on guidelines, where the O2 consumption (vO2) and CO2 production(vCO2) were measured. The total heat production (THP) in the fed state and the fasting heat production (FHP) was calculated by the Brouwer equation. The respiratory quotient (RQ) was calculated as vCO2/vO2.
Feed intake (FI), excreta, and egg mass (EM) were recorded daily. Samples of diet, excreta, and egg were chemically analyzed for dry matter, nitrogen, and gross energy contents. Parameter measurements were taken every 4 weeks. The metabolizable energy intake (MEi) was partitioned as follows:

$$\text{MEi} = \text{FHP} + \text{HI} + \text{REef} + \text{REep} + \text{REbf} + \text{REbp};$$

where HI is the heat increment (HI = THP - FHP); the retained energy (RE) in the egg as protein (REep) was calculated by multiplying the protein content by its caloric coefficient (23.43 kJ/g); the RE in the egg as fat (REef) was obtained by subtracting the REep from gross energy in egg; the RE in the body as protein (REbp) was calculated by subtracting the nitrogen retained in the egg from nitrogen balance (NB), transformed to protein and multiplying by 23.43 kJ/g; and RE in the body as fat (REbf) was calculated as REbf = MEi - (FHP + HI + REef + REep + REbf).

These results were expressed as kJ/kg^{0.75}d and subjected to ANOVA and Tukey's test using the PROC GLM of SAS 9.4. The BW increases as the birds age (p<0.01). The EM was not different throughout the weeks (p>0.05), showing the highest numerical values at the peak production (31 and 35 wks). The FI and consequently the MEi were statistically different across ages (p<0.001), showing their higher values at the peak. No differences were found for FHP (p=0.072) and HI (p=0.0651). Also, the THP differed between the ages (p<0.05), showing an increase up to 47 wks followed by a decline till the end of the study. The REep and REef showed no differences between ages (p>0.05). REbp increased linearly (p=0.0011) as the birds aged. The higher amount of MEi in the production peak resulted in increased REbf (p<0.0001). The RQ in the fed state was within the range of 0.97-1.03 while it was 0.75-0.82 in the fasted state. This study showed that in broiler breeders under positive energy balance, the MEi is mainly used to support constant energy demand functions of maintenance and egg production while the remaining energy is deposited in body tissues in a large quantity as fat protein.

Keywords: energy balance, nitrogen balance, retained energy, indirect calorimetry, fasting heat production

159 Relationships among intestinal morphometry, tibia morphology and live body weight in 21-day-old broilers. Otto A. Zea1, Daniel J. Huaringa2, Cristian Ucudulma Morales1, Carlos Vilchez-Perales1, 1Lima, Universidad Nacional Agraria La Molina, Lima, Lima, Peru, 2Nutrición, Integración Avícola Oro, Quito, Pichincha, Ecuador, 1Olmix Group, Lima, Peru.

A study was conducted to determine the relationships among the jejunal morphology measurements, tibia bone morphology measurements, and live body weight (LBW). For this purpose, 80 21-day-old male Cobb500 broilers were used. The jejunal morphometry measurements were: villus height (VH), villus width (VW), villus area (VA) and crypt depth (CD). The tibia morphology measurements were: tibia weight (TW), tibia length (TL), tibia width (TWh), tibia-breaking strength (TBS), and ash content (AC). Relationships were established using Pearson correlations using the SAS statistical package. The results showed that LBW is positively associated with TW (r=0.64), TWh (r=0.52) and TL (r=0.41). The LBW is associated with CD (r=0.23) and it were also found that CD is associated with TW (r=0.36) and TL (r=0.40). A low and positive relationship was also found between VA and TWH (r=0.26). No significant relationships were found between VH, VW and VA (jejunal morphology measurements) with TW, TL and TWH (tibia morphology measurements). Both AC and TBS did not show significant relationships with the tibia morphology measurements; however, a positive relationship was found between TBS and LBW (r=0.47). It can be concluded that some intestinal morphology measurements (i.e. CD) can be used to relate intestinal health with tibia morphology.

Keywords: relationship, intestinal morphometry, bone morphometry, crypt depth, broilers
and ileum. The use of DDGS in the diet of broilers reduced the digestibility of nutrients in the diet and altered the morphology of the intestinal mucosa. The decision to include corn DDGS in broiler diets should be cautious and based not only on costs, but also on the chemical composition and occurrence of mycotoxins, since the quality of this co-product directly affects the absorption capacity of the intestinal mucosa of the birds as well as the growth of broilers.

Keywords: villus:crypt ratio, absorption area, intestinal quality, co-product, SCFA

161 Corn distillers dried grains on the productive performance and carcass yield of chicken broilers. Daiane Horn³, Felipe E. de Souza⁵, Beatriz T. Onishi⁵, Cassiano B. Pasa⁴, Larissa Priscilla D. Melo⁵, Lucas P. Glaeser², André N. Pinto², Jovanir I. Fernandes¹,², ¹Animal Science Post-Graduate Program, Federal University of Paraná–Sector Palotina, Palotina, Paraná, Brazil, ²Poultry Experimentation Laboratory, Federal University of Paraná – Sector Palotina, Palotina, Paraná, Brazil.

This study assessed the inclusion of distillers dried grains with solubles (DDGS) in diets on the productive performance and carcass yield of broilers. A total of 1,008 broiler chicks, male Ross AP 95 strain, were distributed in a completely randomized design with four levels of corn DDGS inclusion (0, 10, 20, and 30%), six replications with 42 birds per experimental unit. To evaluate their productive performance, the birds and the feed leftovers were weighed weekly and at 43 days. 48 birds per treatment were slaughtered for carcass yield and commercial cuts. The results obtained were analyzed with the polynomial regression using the SAS statistical program. In the initial phase, the inclusion of DDGS resulted in a decreasing linear effect on the weight gain of the birds and an increasing effect on feed conversion, without affecting feed intake. Considering the total phase from day 1 to 42, a quadratic effect of DDGS levels on weight gain and feed conversion was observed. To obtain the greatest weight gain, the addition of 1.10% of DDGS is recommended, while for best feed conversion, a maximum inclusion of 6.08% of DDGS is ideal. In carcass yield and commercial cuts, there was a decreasing linear effect of DDGS levels on carcass yield and quadratic effect on breast, thighs, and wings yield. According to the regression equations, the inclusion of 16% of DDGS resulted in the highest breast yield, while the inclusion of 18% and 7.46% resulted in the lowest thigh and wing yields, respectively. Abdominal fat deposition was not affected by the inclusion of the co-product. The results of the study indicate that the inclusion of corn DDGS depends on the chemical composition of the co-product and on complementary analyses, such as mycotoxins, since negative effects on productive performance and carcass yield were observed. According to the co-product purchase condition, it is recommended to use only it at levels below 10% and only in growth and slaughter diets.

Keywords: breast yield, feed conversion, co-product, mycotoxins

162 Effect of energy levels in broiler diets on caecal microbiota at 28 days of age. Cristine Kaufmann¹, Cinthia Eyng¹, Edevaldo A. Ianchinski², Nilton Rohloff Junior¹, Bárbara Colcutta¹, Felipe Potenza Campos¹, Maressa Fernanda Cardoso Pereira¹, Taciana Bruxel², Ricardo V. Nunes¹, ¹Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, ²Universidade Tecnológica Federal do Paraná, Dois Vizinhos, Brazil. ¹Cargill Alimentos SA, Marechal Cândido Rondon, Brazil.

The aim of present study was to determine the effect of energy levels on caecal microbiota of broiler chickens at 28 days of age. A total of 648 one-day-old male broiler chicks were randomly assigned to 3 treatments composed by 3 levels of energy (high, intermediate and low), with 9 replicate of 24 birds each one. Considering the highest level of energy (1 to 7 days: 3050 kcal kg⁻¹; 8 to 21 days: 3225 kcal kg⁻¹; and 22 to 28 days: 3280 kcal kg⁻¹) two other levels were established (intermediate and low) with reduction of 40 and 80 kcal kg⁻¹ for the period from 1 to 7 days, and 80 and 160 kcal kg⁻¹ for the remain phases, respectively. After 28 days of life, caecal content from one bird/replicate was analyzed for bacterial composition using 16S rDNA sequencing, qPCR and QIIME ² β (Quantitative Insights Into Microbial Ecology 2) bioinformatics pipeline. Alpha-diversity was measured by Shannon’s diversity index and Chao1 (richness). For statistical analysis, the differences were assessed using Kruskal-Wallis test followed by Dunn’s test for multiple comparison test. Statistical significance was accepted at p<0.05. On the phylum level, the analysis revealed no interference of energetic levels. The predominant phylum in all treatments was Firmicutes (81.68%), followed by Bacteroidetes (15.78%), and Proteobacteria (1.75%). The Streptococcaceae family was more prevalent on broilers fed diets containing low and intermediated energy level, comparing to the group that received the highest level (p=0.034) (0.45% vs 3.69%/3.84%), respectively. The lowest level of energy reduced caecal bacterial diversity indexes of observed-species, chao1 (p=0.058) and Shannon (0.072). In conclusion, our results demonstrate that the energy level of the diets may change de substrate available to the caecal microbiota of broilers at 28 days of age, causing a reduction of their richness.

Keywords: caecal bacteria, chao1, energy density, Shannon index

163 Egg quality of laying hens reared in a free-range system with different feeding programs. Filipe A. Moreno², Isabella d. Dias², Gabriela d. Pilon², Leandro Nagae Kuritza¹, Marley Conceição dos Santos², Everton L. Krabbe¹, Alex Maiorka¹, Chayane da Rocha¹, ¹Universidade Federal do Paraná, Curitiba, PR, Brazil.

Poult. Sci. 102 (E-Supplement #2) 92
The objective of this study was to evaluate the egg quality of a commercial laying hen strain, Embrapa 051, in a free-range husbandry submitted to different feeding programs during the growing period. A total of 860 birds were housed from 6 to 61 weeks of age and distributed in a completely randomized design with 4 treatments and 5 replications of 43 birds. Treatments varied according to the amount of feed provided during the growing phase: T93=93%, T100=100%, T107=107% and T120=120% of the consumption recommended by the breeder guideline of Hy-Line Brown. Later, during the production phase, the feed supply was identical to all birds, following the recommendation of Embrapa 051 guideline. The variables egg quality analyzed were internal quality (Haugh unit, yolk color and albumen percentage) and external quality (shell strength and shell thickness) at 25, 31, 37, 44, 50, 56 and 61 weeks of age. Data were submitted to analysis of variance (P<0.05), and when significant, orthogonal contrasts were used to evaluate the linear and quadratic effect of increasing feed supply. In general, there was no significant difference in any of the egg quality parameters in the analyzed periods. Therefore, it was possible to conclude that the quality of the eggs can be maintained even by the lower feed supply (T93) during the growing phase, making it a more advantageous strategy for the industry.

**Keywords:** Embrapa 51, laying hen nutrition, feed supply

164  Modeling the body weight growth of turkeys.  
Matheus Reis1, 2, Nilva K. Sakomura2, Peter Ferket1, 1Animal Science, NC State University, Raleigh, North Carolina, United States, 2Animal Science, UNESP, Jaboticabal, Sao Paulo, Brazil.

The objective of this study was to adjust non-linear mathematical functions to the body weight (BW) of turkeys and investigate whether males and females share the same parameter estimates. The functions were adjusted using a database obtained from a commercial performance objective of Nikolas Select breed (Aviagen) of turkeys for males and females. The database has 22 observations of BW from males and females composed by 3 levels of energy (high, intermediate and low), with 9 replicate of 24 birds each one. Considering the extra sum of square principle. The parameter estimates obtained with the Gompertz function for males were 35.4, 0.199, and 0.018, and for females were 21.6, 0.137, and 0.019, respectively for BWf, BW0, and b. For the Richards model, the parameters BWf, BW0, n, and c estimated for males were 43.9, 0.018, -0.305, and 0.011, while for females were 23.9, 0.074, -0.158, and 0.015. Using the Lopes function the parameters BWf, BW0, n, and k estimated for males were 49.4, 0.052, 151.7, and 2.16, and for females were 30.1, 0.164, 137.5, and 2.21. Richards and Lopes had the lowest RSS and no difference was observed between the two models (P>0.05), independent of the sex evaluated. For males, the Gompertz function was different (P<0.05) from other models, and a single b value could be used (P<0.05), independent of sex. The BW predicted from the Gompertz function, for males, produced estimates for MEi around 20% higher during the first five weeks of age (107 kcal/bird at 21 days of age), while the energy predictions using the BW from Richards and Lopes were similar. In conclusion, Richards and Lopes functions had the best fit to the observed data and the Gompertz overestimated body weight at the beginning of turkeys' life. An example about the consequences of such overestimation was demonstrated herein.

**Keywords:** growth model, non-linear function, Gompertz, Richards, Lopez

165  Dietary energy effect on broiler performance and digestive enzyme activities.  
Luiza M. Storck1, Cristine Kaufmann2, Cinthia Eyng1; Cristiane R. Duarte2, Maisa B. de Carvalho2, Tânia Luiza Kohler4, Cleison d. Souza1, Taciana Bruxel2, Ricardo V. Nunes1, 1Universidade Estadual do Oeste do Parânam, Marechal Cândido Rondon, PR, Brazil, 2Universidade Estadual do Oeste do Parânam, Marechal Cândido Rondon, Parânam, Brazil, 3Universidade Estadual do Mato Grosso, Tangará da Serra, Brazil, 4UTFPR, Marechal Cândido Rondon, Parânam, Brazil, 5Cargill Alimentos SA, Toledo, Brazil.

The effect of energy levels on performance and intestinal and pancreatic enzymes activities were studied in broiler chickens at 28 days of age. A total of 648 one-day-old male broiler chicks were randomly assigned to 3 treatments composed by 3 levels of energy (high, intermediate and low), with 9 replicate of 24 birds each one. Considering the highest level of energy (1 to 7 days: 3050 kcal kg⁻¹; 8 to 21 days: 3225 kcal kg⁻¹; and 22 to 28 days: 3280 kcal kg⁻¹) two other levels were established (intermediate and low) with reduction of 40 and 80 kcal kg⁻¹ for the period from 1 to 7 days, and 80 and 160 kcal kg⁻¹ for the remain phases, respectively. The average feed intake (AFI), body weight
gain (BWG), and feed conversion ratio (FCR) were calculated from days 1 to 28. Sucrose and maltase activities on jejunum mucosa and lipase, amylase, trypsin, and chymotrypsin activities on pancreas were determined from 1 bird/replicate, randomly selected, at 28 days. The data were analyzed as a one-way ANOVA using PROC GLM with Tukey test for multiple comparison. Results were considered significant at a level of 0.05. The highest AFI (P=0.001) and the worst FCR (P=0.001) were observed in the group fed diet containing the low level of energy. No effect was observed for BWG. The intestinal and pancreatic enzymes activities were not affected by the energy levels of the diets. The results demonstrate that the fast-growing birds respond to a higher level of dietary energy, showing better performance, with no interference on endogenous enzymes activities.

**Keywords:** energy levels, growth performance, intestine enzymes, pancreatic enzymes


Fluorescein isothiocyanate-dextran (FITC-d) is a molecule that has been used as an indicator of intestinal permeability in poultry research. The purpose of this study was evaluate the gut permeability in birds fed diets containing high-protein distillers dried grains (DDG-HP) and the fluorescence stability of FITC-d on serum of broiler chickens during storage. A total of 280 day-old chicks were randomly distributed into five treatments (levels of dietary inclusion of DDG-HP – 0; 3; 6; 9; and 12%) with 8 replicates of 7 birds each. On day 28, one bird/replicate were orally gavaged with FITC-d (8.32 mg/kg). The serum was collected from blood drawn 1-h postgavage and then diluted (1:5) in sterile 0.9% saline solution. FITC-d was measured at an excitation wavelength of 485 nm and an emission wavelength of 528 nm immediately after the blood collection (day 1) and after two (day 2) and three (day 3) days of storage at -20°C. Serum fluorescent concentrations were determined using a standard curve and sera of chickens not given FITC-d. The effects of DDG-HP inclusion and storage time, as well as the interaction between these factors, were verified by analysis of variance. The effect of DDG-HP levels was determined by polynomial regression. Analysis of variance showed no interaction (P>0.05) between the factors. Independently of the storage time, FITC-d absorption was significantly enhanced (P<0.0001) in chickens fed diets containing 9 and 12% of DDG-HP compared to those that did not receive the ingredient. There was an interference of storage time on serum FITC-d levels, with a higher value (P<0.0001) observed at day 3 (47.37 ng/mL vs 26.65 ng/mL and 30.35 ng/mL for day 1 and day 2, respectively). The results indicate that dietary inclusion of 9% and 12% of DDG-HP induce gut leakage in broiler chickens. Up two days of storage the FITC-d serum level is not altered.

**Keywords:** FITC-d, gut health, leaky gut, storage time


The current study evaluated the effect of energy levels on ceca short-chain fatty acids (SCFA) production of broiler chickens at 28 days of age. A total of 648 one-day-old male broiler chicks were randomly assigned to 3 treatments composed by 5 levels of energy (high, intermediate and low), with 9 replicate of 24 birds each. Considering the highest level of energy (1 to 7 days: 3050 kcal kg⁻¹; 8 to 21 days: 3225 kcal kg⁻¹; and 22 to 28 days: 3280 kcal kg⁻¹) two other levels were established (intermediate and low) with reduction of 40 and 80 kcal kg⁻¹ for the period from 1 to 7 days, and 80 and 160 kcal kg⁻¹ for the remain phases, respectively. At 28 days of age, one bird/replicate was randomly selected, euthanized and the cecal content was collected to determine the SCFA profile (acetic, propanoic, butyric, isobutyric, valeric and isovaleric acid) by gas chromatography. The data were analyzed as a one-way ANOVA using PROC GLM with Tukey test for multiple comparison. Results were considered significant at a level of 0.05. The energy levels only interfered in the production (P=0.005) of acetic acid, being observed a higher concentration in the ceca content on groups fed diets containing high (36.94 mmol kg⁻¹) and intermediate (35.00 mmol kg⁻¹) levels compared to the low energy level (24.17 mmol kg⁻¹). Regarding isobutyric, valeric and isovaleric acid, their concentration in the cecal contents were below the limit of quantification. In conclusion, the energy level of the diet can influence the substrate availability in the cecum, modifying the production of acetic acid for broilers at 28 days of age.

**Keywords:** acetic acid, broiler, butyric acid, cecum, energy levels

### 168 Influence of a new source of fiber on the performance of broiler chickens. Andressa Carvalho, Bernardo R. Nogueira, Antonio Bertechini, Felipe S. Dalolio, UFLA, Lavras, Brazil.

The use of high nutrient density diets for broilers results in low levels of crude fiber, less than 4%. Thus, the digestibility and absorption of nutrients may be compromised due to changes in the viscosity and flow of the digesta. Such alterations can influence the action of endogenous enzymes on substrates present in the digestive process. Thus, the present study aimed to evaluate the

---

**Poult. Sci. 102 (E-Supplement #2)**
inclusion of a new fiber with special characteristics and with low levels of lignin produced by the extrusion process on the performance of modern broiler chickens. All experimental procedures with production animals were submitted by the ethical committee. A total of 1440 male Cobb 500® male broiler chicks, one day old, distributed in a completely randomized design, in six treatments (0, 2, 4, 6, 8 and 10% fiber), with eight replications, with 30 birds per replicate, totaling 48 experimental units. Birds and leftover feeds were weighed throughout the experimental period to calculate average body weight, average weight gain, average feed intake, feed conversion ratio and mortality. The results were submitted to ANOVA and the Tukey test at a 5% probability level to compare the control treatment with the other experimental treatments. Pre-starter, starter, growth and finish diets (0-14, 15-28, 29-35 and 36-42 days, respectively) were formulated based on corn and soybean meal. Considering the entire experimental phase (0 to 42 days of age), it was found that the on top use of up to 10% of fiber did not influence feed intake (P>0.05). However, there was an effect (P<0.05) of fiber inclusion on weight gain and feed conversion ratio of broilers. For weight gain, it was observed that the inclusion of up to 4% of fiber promoted similar weight gain (P>0.05) in relation to the positive control treatment. From this inclusion level, there was a significant reduction (P<0.05) in weight gain by the broilers. Regarding feed conversion ratio, it was observed that the inclusion of up to 4% resulted in data similar to the positive control. Therefore, the use of fiber in the diets of broilers proved to be viable to be used with benefits in the performance and nutritional characteristics of the birds. The use of up to 4% of fiber in the diet does not affect the performance of broilers, with results similar to the use of corn and soybean meal-based feed, and up to this level can be used to obtain the benefits of the use of dietary fiber for broilers.

**Keywords:** fiber, broiler, performance
The objective was to evaluate the existence of the effect of the use of liquid acidifiers on the performance, microbiological and serum biochemical parameters in broilers. A total of 320 animals of the COBB strain were used, distributed on the first day of age, in a completely randomized design, consisting of three treatments and eight replications, with 12 animals in each replication. The blend used was composed of phosphoric (60 - 80%), tartaric (5 - 10%) and citric (5 - 10%) acids (Acitrat®, Engenutri, Chapecó, Brazil), supplied via drinking water, through nipple drinkers. The treatments were: Control, 60 ml/1000L and 150 ml/1000L, which resulted in a final drinking water pH of 5.54, 3.17 and 2.72, respectively. For the supply of acidifiers, the protocol was established in a non-continuous form, being supplied from 19 to 22 days, from 26 to 28 and from 33 to 42 days of the experimental period. Performance data was collected from 1 to 21 days (weight, feed intake and feed conversion) and from 1 to 42 days of age of the broilers (weight, feed intake, feed conversion and productive efficiency index). The analysis of total mesophilic counts occurred at 42 days, through the collection of crop (whole) and large intestine (jejunum) fragments and sent to the laboratory where they were subjected to PCA culture medium (Plate Count Agar). Serum biochemical parameters were also analyzed at 42 days, and total protein, albumin, globulin, cholesterol and uric acid levels were evaluated. The experimental results were submitted to the Shapiro-Wilk normality test, and then, when considered normal, submitted to linear and quadratic regression analysis, at 0.05 probability, using the R statistical software. There was no influence of the addition of acidifiers on final weight, feed intake and feed conversion. There was a linear reduction in the microbial count of the crop and intestine content in the chickens that received the acidifiers (60 and 150 ml/1000). Quadratic effect was found in total serum proteins, globulin, cholesterol and uric acid analysis (p=0.001), with no difference in albumin levels. It is concluded that acidifiers can be used via drinking water for broilers, reducing the microbial load of the crop of the intestine, without compromising the performance and health of the birds.

Keywords: citric acid, microbiology, nutrition, phosphoric acid, tartaric acid

169 Liquid acidifiers via drinking water for broilers: Performance, total mesophyll count and serum biochemistry. Heloisa Pagnussatt1, Gustavo Zaccaron1, Alicia Dal Santo1, Felipe Leite1, Fernanda Danieli Antoniazi Valentini1, Milena Perotto Marin1, Alan Miranda Prestes1, Lilian Kolling Girardini1, Fernando de Castro Tavernari2, Tiago G. Petrolli1, 1Animal Sciences, West Santa Catarina University, Xaxim, SC, Brazil, 2Embrapa, Concórdia, Brazil.

170 Validation of the use of guanidinoacetic acid (AGA) as an energy source for broilers. Fernanda Danieli Antoniazi Valentini1, Felipe Leite1, Heloisa Pagnussatt2, Alicia Dal Santo1, Gustavo Zaccaron1, Milena Perotto Marin1, Gabriel Rossato1, Ricardo de Andrade César3, Marlene Schmidt3, Arele A. Calderano2, Tiago G. Petrolli1, 1Unese, Xanxerê, Brazil, 2UFV, Vicsa, Brazil, 3Nutriquest, Campinas, Brazil, 4Animal Sciences, West Santa Catarina University, Xaxim, SC, Brazil.

Energy sources, especially soybean oil, strongly impacts production costs and currently there are few alternative sources for reducing production costs. The inclusion of AGA in broiler feed as a precursor of creatine can constitute an alternative to replace energy content. The objective was to evaluate if there are effects of the addition of guanidinoacetic acid in broiler diets with different levels of metabolizable energy, to verify if there is an influence on performance, carcass, organ and serum biochemical parameters. The research was carried out in the poultry sector of UNOESC Xanxerê, using 480 male COBB birds, in a completely randomized design, consisting of three treatments, eight replications and 20 animals each. The guanidinoacetic acid (Creamino®, Nutriquest, Campinas, Brazil) was added in the experimental diet in the amount of 600g/Ton, established to contribute with 75kcal/kg of metabolizable energy. The treatments were: Positive controle (metabolizable energy requirement according to Rostagno et al., 2017); negative control (reduction of 75kcal/kg of metabolizable energy) and negative control + AGA. The treatments took into account diets formulated to evaluate if there are effects of the addition of guanidinoacetic acid in broiler diets with different levels of metabolizable energy, to verify if there is an influence on performance, carcass, organ and serum biochemical parameters. The research was carried out in the poultry sector of UNOESC Xanxerê, using 480 male COBB birds, in a completely randomized design, consisting of three treatments, eight replications and 20 animals each. The guanidinoacetic acid (Creamino®, Nutriquest, Campinas, Brazil) was added in the experimental diet in the amount of 600g/Ton, established to contribute with 75kcal/kg of metabolizable energy. The treatments were: Positive controle (metabolizable energy requirement according to Rostagno et al., 2017); negative control (reduction of 75kcal/kg of metabolizable energy) and negative control + AGA. The treatments took into account diets formulated with the inclusion of ingredients of animal origin (meat and bone meal) in their composition. The chickens were weighed at 21 and 42 days, to determine weight gain, feed intake and feed gain ratio. At 42 days of age, to evaluate carcass yield, cuts (wing, thigh, thigh and back, breast and abdominal fat) and organs (heart, liver, proventriculus, gizzard, small intestine, spleen and abdominal fat), one bird per experimental unit was euthanised. The experimental results were submitted to the Shapiro-Wilk normality test and analysis of variance, with means compared by the Tukey test at 0.05 of significance. There was a reduction (P<0.001) in the feed:gain ratio of birds fed positive control and negative control + AGA diets when compared to the negative control group. In 1-42 day, positive control and negative control groups + AGA birds showed greater weight gain, weight and feed intake (P<0.001) compared to the birds fed negative control diets. Birds belonging to the positive control had lower organ weight compared to birds from the negative control (P=0.037). Broilers received negative control + AGA feed had higher levels of glucose (P=0.001), lower levels of cholesterol (P=0.013), triglycerides (P=0.005), total protein (P=0.001) and of creatinine (P=0.056) in serum blood. The addition of guanidinoacetic acid can act as an energy source for...
broilers, ensuring the maintenance of zootechnical performance and no compromising organ, carcass and serum parameters of birds.

Keywords: carcass quality, creatine, feed conversion, metabolizable energy, nutrition

171 Effect of feed energy reduction with use of emulsifier additive on the performance and ileal digestibility of the nutrients and energy in broilers. Rafael Neme1, Ellen Fukayama1, Silvano Bunzen2, Fernando Toledano2, 1Research and Development, BITA, Ribeirão Preto, São Paulo, Brazil, 2Research and Development, Feedis, Salto, São Paulo, Brazil.

The objective of this study was evaluate the effects of an emulsifier additive and energy reduction in the broiler performance - live weight (LW), feed intake (FI), feed gain (FG) and ileal digestibility coefficient (DC) of the nutrients (Dry Matter - DCDM, Fat - DCF, Crude Protein – DCCP and Gross Energy – DCGE). The studied period was 42 days, and 1,140 chicks were distributed in a completely randomized design with 3 treatments, 10 replicates of 38 birds. At 21 days, 8 birds of each replicate were slaughtered to collect ileal content. As a tracer, Celite® product (acid insoluble ash) was added to the diets (1.0% inclusion) and analyzed in the intestinal content and diets to enable the calculation of ileal DC. All diets were based on corn, soybean meal and soybean oil, attending the requirements of the birds in the phases: 1-21 (3.050 kcal ME/kg), 21-35 (3.150 kcal ME/kg) and 35-42 days (3.200 kcal ME/kg).

The diets were iso-nutritive, except for metabolizable energy (ME). The treatments T1: Positive Control (PC) with adequate energy levels mentioned above, T2: PC + Emulsifier and T3: Negative Control (PC - 75 kcal ME/kg + Emulsifier). The data were submitted to a variance analysis by the software SAS Studio (2022). The means were compared through the Tukey Test to 5%. At 42 days, there was no difference (p>0.05) for LW and FI between the treatments, showing for these parameters a positive effect of the emulsifier even with the reduction of 75 kcal ME/kg. For FG, the inclusion of the emulsifier (T2) showed no significant effect in relation to the (T1), despite numerically showing the best result of the study (1.517 vs 1.523), respectively. For this same parameter (FG), both positive controls T1 and T2 differed significantly from the T3, being this treatment 3.48% above T1 (1.576 vs 1.523), respectively (p<0.001). Regarding the FG variable, despite the small difference detected between T3 and the other controls, it is important to analyze the impact of reducing the energy cost of this diet (less 75 kcal ME/kg) in each agroindustry scenario, since the birds had the same final LW and FI. All studied digestibility coefficients were improved with the inclusion of the emulsifier. When comparing the treatments T1 vs T3, the following results were obtained respectively: DCDM: 69.93% vs 73.82% (p<0.0122), DCF: 86.91% vs 91.95% (p<0.0039), DCCP: 78.10% vs 81.43% (p<0.0282) and DCGE: 69.59% vs 73.93% (p<0.0228). In conclusion, it was possible to notice in this study the positive impact of the use of emulsifier on the digestibility of dry matter, fat, crude protein, gross energy, live weight and feed intake of the birds at 42 days of age, even with a less energetic diet.

Keywords: broiler, performance, ileal digestibility, energy reduction, emulsifier

172 In vitro binding capacity of a mycotoxin adsorbent towards alpha-toxin and NetB produced by Clostridium Perfringens. Jolien van Soest1, Brecht Bruneel2, Arno van der Aa2, Tessa Gryp3, Liesbeth Vande Ginste1, 1Central Technical Management, Orffa Additives, Breda, Netherlands, 2Orffa Additives BV, Breda, Netherlands, 3Poulpharm, Izegem, Belgium.

Alpha-toxin and NetB toxin are virulence factors or exotoxins produced by Clostridium perfringens, which can cause Necrotic Enteritis (NE) in poultry. The aim of this study was to investigate binding activity of a mycotoxin binder (Excential Toxin Plus, Orffa Additives BV), consisting of three binding agents; two clay-based and one yeast-derived component, with alpha-toxin and NetB exotoxins. Binding of alpha-toxin was determined via enzyme-linked immunosorbent assay (ELISA). Starting from a C. Perfringens culture (10^9 CFU/mL) a dilution series was prepared and transferred in a 96 well plate. To each well, mycotoxin binder was added to obtain a final concentration of 0.5%. The plates were incubated for 90 min at 37°C, continuous shaking. Supernatant was collected after centrifugation to determine alpha-toxin concentration using ELISA Bio-X-kit (via optical density measurements).

The controls were BHI (culture medium of C. perfringens), phosphate buffered saline (PBS, solvent of Excential Toxin Plus solution) and ELISA kit controls. Binding of NetB was determined via a hemolytic assay. Mycotoxin binder was dissolved in PBS, of which 60 μL was added to a V-shaped bottom 96 well plate. In addition, 60 μL recombinant NetB (rNetB) toxin with 80 μg/mL or 60 μL sterile PBS were added. The plate was incubated for 30 min at 37°C, with continuous shaking and centrifuged 1 min at 1000g at room temperature. To a flat-bottomed 96 well plate, 100 μL of 1% chicken red blood cells (RBCs), 100 μL of lysed chicken RBC, 100 μL supernatant of pre-incubated material, and/or 100 μL PBS were added to the wells. The plate was incubated 60 min at 37°C and shaken at 200 rpm. After 1 min centrifugation at 1000g at room temperature, 180 μL supernatant was transferred to a flat-bottomed 96 well plate to measure optical density (OD) at 492 nm and 560 nm. rNetB toxin activity was measured by the increase in absorbance due to release of hemoglobin from RBCs. For binding of alpha-toxin, the study shows that when C. Perfringens concentration decreased, binding activity of the mycotoxin binder to alpha-toxin increased to 10.3%, 54.2%, 62.8%, 66.0% and 70.3% for C. perfringens concentrations of 10^-9, 10^-8, 10^-7 and 10^-6 CFU/mL, respectively.

For binding rNetB toxin, in vitro hemolytic assay showed...
that Excential Toxin Plus was able to inhibit rNetB toxin activity with 46.0% and 46.3% at a wavelength of 492 nm and 560 nm, respectively. In conclusion, in vitro results show that the mycotoxin binder is able to adsorb alpha-toxin and NetB toxin produced by C. Perfringens and this to a high extend in mild and severe C. Perfringens concentrations. These results indicate a protective effect in development of C. perfringens-associated NE.

**Keywords:** C. perfringens, necrotic enteritis, alpha-toxin, NetB toxin, binding

### 173 Yeast cell wall improves immune modulation response in aflatoxin challenge broilers.

Melina A. Bonato1, Breno C. Beirão2, Max Ingberman3, Fernando A. Souza1, 1R&D, ICC Brazil, São Paulo, São Paulo, Brazil, 2Department of Basic Pathology, Universidade Federal do Paraná, Curitiba, Paraná, Brazil, 3Imunova Análises Clínicas, Curitiba, Paraná, Brazil.

There are many problems with mycotoxins in poultry production, mainly about their capacity to depressed production and performance, damage the spleen and kidney structure, increasing susceptibility to opportunistic infections. The objective of this study was to evaluate the effect of yeast cell wall (source of β-glucans and MOS) to modulate the immune responses in aflatoxin-challenged broilers. It was used 152 one-day-old chicks randomly distributed in 4 treatments: NC (negative control, basal diet without contamination), AFB (positive control, basal diet with 2.5 ppm of aflatoxin in diet administration), YCW (basal diet with 0.5 kg/MT from Saccharomyces cerevisiae’s wall - ImmunoWall®) and YCW+AFB (YCW diet with 2.5 ppm contamination of aflatoxin). The experimental period was 35 days with the diets and on the 14 day was administrated the Newcastle vaccine. The liquid chromatography method coupled to sequential mass spectrometry (LC-MS/MS) was performed to verify the presence and level of aflatoxin contamination in the ingredients used. On days 1 and 14, blood samples were collected with anticoagulant for ELISA antibodies against Newcastle Disease (NDV) to determine maternal titer (10 birds/treat). ELISA for antibodies against NDV was assessed in blood samples at days 28 and 35 (8 birds/treat). The blood collection samples with anticoagulant for determination of cell profile by flow cytometry, the phagocytic capacity of peripheral blood lymphocytes, and the assessment of intestinal permeability (using Dextran-FITC, 3-5 kD) were performed at days 7, 28, and 35 (8 birds/treat). The data from each analysis were submitted to the D’Agostino-Pearson omnibus K2 normality test. However, the data that failed this test were submitted to non-parametric analyses, Kruskal-Wallis test (GraphPad Software). The challenge with aflatoxin was verified and resulted in 2.24±0.28 ppm in the challenged groups. The Aflatoxin challenge promoted the depletion of cytotoxic T lymphocytes on day 14. The YCW+AFB promoted an increase (P<0.05) in diverse populations of immune cells, including total lymphocytes, T and B lymphocytes, in addition to phagocytic macrophages and heterophils (at day 28). Even in the absence of aflatoxin challenge, animals treated with YCW showed higher production of NDV antibodies (P<0.05) at day 35. No differences between the treatments were found in the intestinal permeability. The YCW supplementation in broilers challenged with 2.5 ppm of aflatoxin showed an immune modulation effect; and, in non-challenged birds, it was observed an impact in higher production of antibodies probably thought trained immunity mechanism (cytotoxic T lymphocytes).

**Keywords:** yeast cell wall, immunomodulation, immunonutrition, mycotoxins, linphocytes

### 174 Effect of two mycotoxin adsorbents on performance, hepatic and renal parameters broilers fed with natural contamination.

Daniel J. Huaringa1, Rodolfo Riboty Lara2, 1Nutrición, Integración Avícola Oro, Quito, Pichincha, Ecuador, 2Nutrición, Universidad Nacional Agraria La Molina, Lima, Peru.

Two similar experiments were carried out consecutively to evaluate the effects of mycotoxin adsorbents based on deactivating additives (MA1) and mannan oligosaccharides (MA2) on growth performance, weight of liver, spleen, gizzard and proventriculus, and serum enzymes of chicks fed mycotoxin naturally contaminated diets. A total of 420 one-day-old Cobb 500 chicks were distributed in three treatments with 6 repetitions (Exp.1) and 8 repetitions (Exp.2) respectively. A three-phase meal diet was fed to all chicks and raised under similar conditions. Chicks were assigned to one of three groups for 42 days: 1) Negative control (NC, without mycotoxin adsorbent), 2) NC+MA1 and 3) NC+MA2. Concentration of six mycotoxins in corn, soybean meal, wheat bran, beer bran, corn powder from the end of the silo and complete feed were measured by Elisa (Neoegen Veratox®). On average, high levels of ZEA (446 ppb), FUM (9279 ppb) and DON (954 ppb) were found in the corn powder from the end of silo. Medium and high levels of FUM (1600 – 3300 ppb) and DON (500 - 1250 ppb) were found in three diets. Only weight gain at 14 days (p<0.06) and feed conversion at 21 days (p<0.05) were better in treatment NC+MA2 than CN and CN+MA1 treatments. No other difference in performance was found in the experiment. The ratio of proventriculus: gizzard weight was higher for CN+MA1 with respect to CN+MA2 (p<0.08). Lowest values of creatinine and uric acid were from the CN treatment (p<0.03). ALT, AST and ALP did not show differences between treatments (P=0.1). In the present trial, CN had the lowest body weight and highest feed conversion rate. FUM, DON and ZEN pose the greatest mycotoxin threats to poultry health and productivity and feeding poultry with feed natural contamination is possible to try different commercial adsorbents.

**Keywords:** mycotoxins, hepatic, renal, adsorbents, broiler
The objective of this trial was to assess relative bioavailability of two hydroxycholecalciferol sources (25-
hydroxy vitamin D₃ or 25-OH-D₃) compared to vitamin D₃ by evaluating broiler performance and bone
characteristics. The trial included 1,560 male Cobb-500 chickens and had 13 treatments in a completely randomized
factorial design, with eight replicates; four levels (200, 500, 1,000, 2,000 IU/kg) of vitamin D₃ and 3 types; two 25-
hydroxy D₃ sources (A* and B), one regular vitamin D₃ source (C) and control group NC (no vitamin D₃). All
diets had 10% reduction in phosphorus and 15% in calcium in relation to recommendations as nutritional challenge.

Statistical analysis was performed using General Linear Procedures of SAS® software. Weight gain was highest for
group A (2.622, 2.379, 2.896 and 2.951 kg) compared to B (2.511, 2.711, 2.972 and 2.869 kg) and C (2.411, 2.730,
2.706 and 2.758 kg) for 200, 500, 1,000, 2,000 IU/kg, respectively (P<0.001). FCR was shown to be best for group
A in the first 21 days of age (1.403, 1.334, 1.307 and 1.315) compared to B (1.376, 1.377, 1.346 and 1.385) and C
(1.607, 1.439, 1.352 and 1.369) and for 200, 500, 1,000, 2,000 IU/kg, respectively (P<0.001). Bone measurements
showed higher tibial calcium levels (21.13, 21.28) for A, compared to B (19.93, 20.21) and C (19.89, 20.06) at 1,000
and 2,000 IU/kg, respectively (P<0.05). For 200 IU/kg, a greater spongy bone (SB) (225.99 µm) was shown for B
(19.93, 20.21) and C (19.89, 20.06) at 1,000 and 2,000 IU/kg, respectively (P<0.001). For 200 IU/kg, a greater spongy bone (SB) (225.99 µm) was shown for B (P<0.05), relative to A (186.27 µm) and C (154.71 µm). Larger areas of SB were obtained for C (198.34, 202.99 µm) compared to A (186.27 µm) and C (154.71 µm). For 200 IU/kg, a greater spongy bone (SB) (225.99 µm) was shown for B (19.93, 20.21) and C (19.89, 20.06) at 1,000 and 2,000 IU/kg, respectively (P<0.001). Bone measurements showed higher tibial calcium levels (21.13, 21.28) for A, compared to B (19.93, 20.21) and C (19.89, 20.06) at 1,000 and 2,000 IU/kg, respectively (P<0.05). For 200 IU/kg, a greater spongy bone (SB) (225.99 µm) was shown for B (P<0.05), relative to A (186.27 µm) and C (154.71 µm). Larger areas of SB were obtained for C (198.34, 202.99 µm) and less for A (191.42, 163.55 µm) for 1,000 and 2,000 IU/kg (p<0.05). A linear increase (p<0.05) in calcium and phosphorus digestibility was found for all sources with increased vitamin supplementation. Regression coefficients were consistently higher with use of A and B compared to C. Morphological intestinal characteristics are influenced by levels and sources of vitamin D₃ in the diet. For blood calcium concentration, A showed highest bioavailability (p<0.05) and both sources 25-hydroxy vitamin D have higher bioavailability (123 and 115 at day 21 and 121 and 107 at day 40 for A and B respectively) compared to C (100). Bioavailability considering calcium analysis in tibias showed that 25-hydroxy vitamins were higher, (111 and 100 at day 21 and 175 and 125 at day 40 for A and B respectively) compared to C (100). Results based on analysis of tibia, serum and calcium digestibility confirm the sequence of increasing values for bio-efficacy with C followed by B and A. In conclusion, vitamin D₃ in 25-
hydroxy form allows for higher calcium digestibility, composition of compact bone and relative bioavailability,
with best results for A.
tocopherol dosages for broilers raised in a tropical zone. The use of both strategies is the best recommendation.

**Keywords:** antioxidant, heat stress, hydroxy-selenomethionine, tocopherol, selenium

**177 Effects of organic acids supplementation in broilers diets.** Lidiane I. Datsch\textsuperscript{2}, Guilherme L. Silva Tesser\textsuperscript{1}, Nilton Rohloff Junior\textsuperscript{2}, Eduarda L. Storck\textsuperscript{2}, Clauber Polese\textsuperscript{2}, Tania L. Kohler\textsuperscript{2}, Bárbara Colletta\textsuperscript{2}, Thiago P. Ribeiro\textsuperscript{1}, Daniel P. Monteiro\textsuperscript{1}, Cinthia Eung\textsuperscript{2}, Ricardo V. Nunes\textsuperscript{2}, \textsuperscript{1}Tectron, Toledo, Pa, Brazil, \textsuperscript{2}Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.

An experiment was conducted to evaluate the effects of organic acid supplementations in broilers diets on performance, carcass, parts, liver and abdominal fat yields. The blend of organic acids was composed of benzoic, citric and fumaric acid (Acidmax\textsuperscript{®}). A total of 480 one-day-old, Ross 308 strain, male chicks were reared from d 1 to 42 and were assigned to a completely randomized design composed by 3 treatments with 8 replicates of 20 birds per pen. The treatments consisted of a basal diet with the addition of different concentration (0, 1,000 and 2,000 g ton\textsuperscript{-1}) of Acidmax\textsuperscript{®}. Data was analyzed using ANOVA procedure and means were separated using Student-Newman-Keuls (SNK). Subsequently, contrast analysis was performed considering (P<0.05). At d 42, feed intake (FI), weight gain (WG), and feed conversion ratio (FCR) were determined, and 4 broilers per pen were randomly selected to determine carcass, parts, abdominal fat and liver yields. Overall, the administration of organic acids blend (1,000 and 2,000 g ton\textsuperscript{-1}) improved WG (P=0.0001), FCR (P=0.0001) and reduced abdominal fat (P=0.0069). Carcass, parts and liver yields were similar among the treatments when compared to the treatment without inclusion of organic acids. Animals receiving treatments with 2,000 g ton\textsuperscript{-1} improved breast weight (P=0.0389). There are several potential modes of action that may explain the beneficial effects of organic acids. The reduction of feed pH and digestive tract, that inhibit low pH sensitive pathogenic organisms proliferation or increasing lactobacillus colonization, promoting direct antimicrobial. In addition, it is possible that the action of several acids together present synergy with each other, potentiating the effects on pathogenic microorganisms. In conclusion, results suggest that the administration of Acidmax\textsuperscript{®} can be an important component of poultry production programs with high capacity to improve the performance of broilers.

**Keywords:** organic acids, benzoic acid, citric acid, fumaric acid

**178 Effect of guanidinoacetic acid (GAA) supplementation on growth performance of male broilers from 1 to 35 days old.** Renata R. Gomes\textsuperscript{1}, Laura Alves Duarte\textsuperscript{1}, Fernanda Alves Duarte\textsuperscript{1}, Ingrid Carneiro de Oliveira Falcão\textsuperscript{1}, Carla Daniela Suguimoto Leite\textsuperscript{1}, Marianne Jesus Silva Patriarca\textsuperscript{1}, Thaciane L. Amaral\textsuperscript{1}, Adriana Santana do Carmo\textsuperscript{1}, Patrícia Tomazini Medeiros\textsuperscript{2}, José Henrique Stringhini\textsuperscript{1}, \textsuperscript{1}Universidade Federal de Goiás, Goiânia, Brazil, \textsuperscript{2}Evonik Operations GmbH, Goiânia, Brazil.

Guanidinoacetic acid (GAA) is the natural metabolic precursor of creatine which improves cellular energy metabolism of broilers. Several trials with on top supplementation of GAA at 600g/MT, have shown consistent improvements on FCR and carcass traits. However, data using the nutritional matrix of GAA under Brazilian conditions are more limited. Therefore, a experiment was conducted to determine the effects of GAA (GuanAMINO\textsuperscript{®}, Evonik Operations GmbH) supplementation with either nutritional matrix or on top strategies on growth performance of broilers. A total of 720 Cobb 500\textsuperscript{®}-day-old male chicks were distributed in a completely randomized design with 3 treatments, 8 replicates of 30 chicks per pen (experimental unit) from 1 to 35 days old. The dietrytreatments were corn-SBM based and included: 1) basal diet without GAA (basal), 2) basal diet with 0.06% GAA using nutritional matrix (GAA – matrix), and 3) basal diet with 0.06% GAA on top (GAA – on top). The GAA nutritional matrix included 83,000 kcal/kg of AMEn and 77% SID Arg at 600 g/MT.Diets were formulated to meet or exceed the nutrient recommendations proposed by the Brazilian tables (2017). Birds were weighed weekly, and body weight, weight gain, feed intake and feed conversion were determined. Performance data were analyzed for each phase, considering the overall periods from 1 to 7, 1 to 21 and 1 to 35 days old. Statistical analyses were performed using the GLM procedure of SAS\textsuperscript{®} and when any statistical difference was observed at 5% of significance, means were compared by Tukey test. Final body weight and body weight gain were not affected (P > 0.05) by dietary treatments during any of the periods. Feed intake was similar (P > 0.05) among treatments from 1 to 7 and 1 to 35 days. From 1 to 21 days, broilers fed the GAA-on top diet had the lowest feed intake (P = 0.01) compared to broilers fed the basal and GAA-matrix diets. Feed conversion was improved (P = 0.04) in broilers fed the GAA-on top diet compared to broilers fed the basal and GAA-matrix diets. Feed conversion was improved (P = 0.04) in broilers fed the GAA-on top diet compared to broilers fed the basal and GAA-matrix diets from 1 to 7, 1 to 35 days and 1 to 21 days. For 1 to 35 days, broilers fed the GAA-on top diet had the lowest (P = 0.03) FCR compared to the basal diet, followed by broilers fed the GAA-matrix diet. During all feeding phases, FCR was similar between broilers fed the basal and the GAA-matrix diets. In conclusion, GAA supplementation from 1 to 35 days improves FCR of broilers when used on top while the nutritional matrix approach effectively maintains a similar broiler performance allowing considerable reductions in feed costs.

**Keywords:** creatine, guanidinoacetic acid, energy, feed conversion, nutritional strategy

**179 Performance, redox potential and carcass yield and cuts of challenged broilers fed alternative antibiotic
The objective of this work was to evaluate the performance, redox potential of superoxide dismutase (SOD) and carcass yield and cuts of challenged chickens that received diets with different food additives in place of the antibiotic. Six hundred one-day-old male Cobb chicks were used, distributed in a completely randomized design, containing five treatments with six replications and 20 birds per experimental unit (EU). The treatments consisted of negative control (NC - without growth promoter - antibiotic); positive control treatment (avilamycin 20%, inclusion of 50 g/ton); NC supplemented with 100 g/ton of product based on plant extracts from the papaveracea family; NC supplemented with 1000 g/ton of product based on tannic acid, sodium lignosulfonate and cellulose; and NC supplemented with 100 g/ton of product based on plant extracts from the papaveracea family in inclusion of 50 g/ton); NC supplemented with 1000 g/ton of product based on tannic acid, sodium lignosulfonate and cellulose; and NC supplemented with 1000 g/ton of product based on plant extracts from the papaveracea family in inclusion of 50 g/ton).

In recent years, the poultry industry has encountered challenges such as the emergence of myopathies that mainly affect the breast muscles of broilers, as affected meats have reduced protein content, higher fat content, increased connective tissue and a reduction in general consumer acceptance. An experiment was conducted to evaluate the centesimal composition and incidence of myopathies on the breast meat from broilers at 42d of age, fed diets supplemented with guanidinoacetic acid (GAA) containing levels of arginine (Arg) and glycine (Gly). A total of 2800 one-day-old male broiler chicks, distributed in a central composite design rotated with two factors, and double experimental mesh. Each experimental mesh, represented by the on top inclusion of 0.6 g kg⁻¹ of GAA or not in the diet, presented four factorial and axial points, and one central point. The four factorial points came from the combination of two Arg levels (96.4 and 117.6%) with two Gly levels (132.5 and 161.5%). The estimated axial coordinates were 92 and 122% for Arg and 126.5 and 167.5% for Gly. The central point of each experimental mesh was represented by 107 Arg and 147% Gly, totaling 18 treatments. Each factorial and axial point had four repetitions and the two central points had 24 repetitions each, all with 25 birds per pen. The data were submitted to variance analysis, considering the isolated effects and the triple interaction between the factors studied, Arg, Gly levels and GAA classes. Regression analysis was used to evaluate the isolated effects to estimate Arg and Gly levels. The means between GAA classes were compared using the F test. The significance level adopted in all hypothesis tests was alpha ≤ 0.05. No difference (P>0.05) was found for triple interaction on content of protein, humidity, fat, and collagen of the breast meat of from broilers chickens. GAA supplementation affected (P=0.015) the occurrence of mild score in chickens, in which birds that received GAA supplementation had a higher proportion of this score in relation to who did not receive. Also, for the sum of the moderate+severe scores, an effect (P=0.039) of GAA supplementation was observed, the birds that received the diet with GAA presented a lower proportion of the sum of these scores. There was an effect of GAA supplementation on the proportions of occurrence of normal (P=0.001) and severe scores (P=0.001), where birds that received GAA in the diet showed an increase in the proportion of occurrence of the normal score and a reduction in the occurrence of the severe score in relation to animals that did not receive. In...
conclusion, dietary GAA supplementation reduces the incidence of myopathies, without affecting the centesimal composition.

**Keywords:** wooden breast, white striping, muscular dystrophy, amino acids, creatine

181 Metabolomic profile of the pectoralis major muscle in broilers supplemented with chondroitin sulfate and manganese. Julian A. Muñoz¹, Taiane S. Martins², Pollyana M. Garbossa², Lenise F. Mueller⁴, Mirele D. Poleti¹, Daniel R. Cardoso⁵, Priscila M. Dalle-Piagge³, Cristiane S. Araujo², Angélica S. Pereira², ¹Department of Animal Science, Faculty of Animal Science and Food Engineering, University of Sao Paulo, Pirassununga, Sao Paulo, Brazil, ²Animal Nutrition and Production, School of Veterinary Medicine and Animal Science, University of Sao Paulo, Pirassununga, Sao Paulo, Brazil, ³Sao Carlos Institute of Chemistry, University of Sao Paulo, Sao Carlos, Sao Paulo, Brazil.

Nutrition has been one of the strategies used in the poultry industry to mitigate the occurrence and severity of breast abnormalities. Metabolomic analyses are conducted to identify biomarkers capable of discriminating myopathies from unaffected breasts. In this context, we aimed to evaluate, through proton nuclear magnetic resonance (¹H-NMR) spectroscopy, the metabolic differences of the pectoralis major muscle of broilers supplemented or not with chondroitin sulfate (CS) and manganese (Mn) and their incidence with white striping myopathy. A total of 1152 Cobb male chicks were housed for 47 days. In the slaughter process, one breast was collected per experimental unit to assess the presence of white striping myopathy. Five grams of sample were removed for further metabolomic analysis using the contrasting groups model. Eight breast samples from the diet of 0.12% CS and 80 mg/kg Mn were used as contrasting treatments to determine the differences in the metabolic profile of eight samples from the control treatment of 0.00% CS with 0 mg/kg Mn by ¹H-NMR spectroscopy. Metabolomics data were analyzed using MetaboAnalyst 5.0 with the aid of multivariate statistical analysis. It was observed that regardless of CS or Mn levels added to the diets, breasts were classified as having moderate white striping myopathy. According to the ¹H-NMR data, the pectoral muscle of birds showed a metabolism towards the glycolytic pathways, with the presence of high concentrations of lactate, carnosine, creatine, and alanine. The analysis in the first two components explained 52.4% of the data variance, and the model is valid according to the results of the cross-validation test. Increases in β-alanine and adenosine triphosphate (ATP) concentrations were observed in the control treatment (VIP >1). Likewise, contrast treatment showed high concentrations of taurine and alanine (VIP >1). The differentially expressed metabolic pathways according to the important metabolites were pantotenate and Coenzyme-A biosynthesis, primary bile acid biosynthesis, pyrimidine, propanoate, purine, taurine, and hypotaurine metabolism (Raw P<0.1). Therefore, broiler breasts demonstrated high metabolic work, increased oxidative stress, and hypoxia derived from white striping myopathy. However, supplementation of broilers with CS and Mn possibly contributed to the reduction of breast muscle stress, interacting with the extracellular matrix remodeling and the cellular defense enzymatic system. Effects associated with activating metabolites related to mitochondrial protection and cell repair, decreasing muscle protein degradation associated with myopathy.

**Keywords:** glycosaminoglycans, NMR spectroscopy, minerals, poultry, white striping
Metabolism and Nutrition, Vitamins and Minerals

182 Determination of the standardized ileal digestible calcium requirement of fast-growing broilers from day 15 to 31 post-hatch. Carrie L. Walk¹, Pauline Jenn², Anaelle Tschambser², Aaron Cowieson³, Raffaella Aureli², ¹DSM Nutritional Products, Kaiseraugst, Switzerland, ²DSM Nutritional Products, Research Center for Animal Nutrition and Health, Village-Neuf, France.

An experiment was conducted to determine the standardized ileal digestible (SID) Ca requirement of fast-growing broilers from d 15 to 31 post-hatch. Ross 308 male broilers (n = 432) were obtained at d of hatch and allocated to 72 battery cages with 6 birds/cage. From hatch to d 31, 12 randomly allocated cages were fed a nutrient adequate (reference) diet. The reference diet was formulated to contain 0.90 and 0.87% total Ca from hatch to d 14 and d 15 to 31, respectively. The remaining 60 cages were fed a nutrient adequate diet, formulated to contain 0.54% SID Ca (0.89% total Ca) from hatch to d 14. On d 15, five diets, formulated to contain 0.58, 0.48, 0.38, 0.28 or 0.18% SID Ca, were randomly assigned to the remaining 60 cages with 12 replicates/cage. Available P (avP) was maintained at 0.45 and 0.40% in all diets from hatch to d 14 and d 15 to 31, respectively. The SID Ca diets contained 2,000 FYT/kg of phytase with an avP contribution of 0.185%. Data were analyzed using JMP. Means were separated using orthogonal contrasts. The SID Ca requirement was estimated using quadratic models and 95% of the maximum response. The reference diet was compared with the SID Ca diets using the Dunnett’s test. From hatch to d 14 or d 15 to 31, there was no impact of diet on BW gain or feed intake. Mortality corrected feed conversion ratio (mFCR) was improved (P < 0.05) in birds fed the SID Ca diets compared with birds fed the reference diet from hatch to d 14 and lowest in birds fed 0.38% SID Ca (quadratic, P < 0.05) from d 15 to 31. There was no impact of diet on tibia ash percent. Tibia ash weight, P or Ca linearly (P < 0.05) decreased as the SID Ca concentration in the diet decreased and these parameters were lower than the reference diet in birds fed 0.28 or 0.18% SID Ca. Apparent ileal digestibility (AID) of P and P retention were greater (P < 0.05) in birds fed the SID Ca diets compared with birds fed the reference diet. The AID of P increased (linear, P < 0.05) and the retention of P decreased (quadratic, P < 0.05) as the SID Ca concentration in the diet decreased. The AID and retention of Ca increased (quadratic, P < 0.05) as the SID Ca concentration in the diet decreased from 0.38 to 0.18%. Finally, blood Ca quadratically (P < 0.05) decreased as the SID Ca content in the diet decreased to 0.18%. In conclusion, the SID Ca requirement of fast-growing broilers from d 15 to 31 post-hatch was estimated at 0.466% when using quadratic models (95% of max) of mFCR, AID of Ca, retained P, and blood Ca. This corresponds to a SID Ca to avP ratio of 1.17 or an SID Ca to digestible P ratio of 1.33. These results agree with previous work suggesting the SID Ca requirement of broilers from d 11 to 24 was between 0.42 and 0.50%.

Keywords: digestible calcium, digestible phosphorus, phytase, requirements

183 Golden mussel meal with different particle size and their effect on performance and gene expression in broiler. Ana Paula G. Cruz Costa¹, Cristine Kaufmann¹, Nilton Rohloff Junior¹, Daniela B. Jablonski¹, Guilherme L. Silva Tesser¹, Clauer Polesè¹, Felipe Potenza Campos¹, Tania L. Kohler¹, Jomara Broch¹, Thiago S. Andreade³, Anna Cristina S. Dalmaso², Fernanda Tanamati², Robie Allan Bombardelli², Cinthia Eyng¹, Ricardo V. Nunes¹, ¹Western Paraná State University, Marechal Candido Rondon, Paraná, Brazil, ²Western Paraná State University, Toledo, PR, Brazil, ³Department of Poultry Science, Western Paraná State University – UNIOESTE, Marechal Candido Rondon, Paraná, Brazil.

The objective of this study was to evaluate the effects of different particle sizes of golden mussel meal (GMM) in total replacement of limestone, as a mineral source, in broiler diets at 1 to 21 and 21 to 42 days old on performance and intestinal transporters gene expression. 1,100 male Cobb 500 broilers were distributed in a completely randomized experimental design, with five treatments, 10 replicates, and 22 birds per experimental unit (EU). The study was conducted at the Poultry Research Center of Western Paraná State University − Marechal Candido Rondon, Paraná, Brazil. The golden mussels were collected from Itaipu Hydroelectric Power Plant Lake (Porto Mendes, Paraná). The treatments were constituted by a control diet using limestone (381 µm) and GMM in different particle size (302, 380, 451 and 549 µm). The performance were measured at 21 and 42 days to determine the feed intake (FI), weight gain (WG) and feed conversion ratio (FCR), with the mortality corrected by feed intake and conversion. For evaluate the transporters gene expression of calbindin-D28k (1,25(OH)2D3 - induced Ca binding protein), cell receptors sensitive to Ca (CaSR), Ca and Na carriers (NCX1) and Ca Plasma Membrane (PMCa), jejunal samples from 1 birds per EU (n= 50) at 21 and 42 days were collected and stored in RNA Later solution (Invitrogen®). The RNA was extracted using a commercial kit QIAzol (Qiagen®) and the integrity was evaluated using a solution of 1% agarose gel, stained with SYBR Safe DNA Gel Stain (Invitrogen®) and visualized on a UV (ultraviolet light) transilluminator. PCR analyzes were performed in duplicate in a Rotor Gene, with the β-actinin gene as an endogenous control, and the primers were designed using the Primer3 program. The performance data were analyzed by ANOVA using the PROC GLM procedure of SAS student version, submitted to ANOVA and Dunnett’s test and polynomial regression, both at 5% significance level. For gene expression analysis, as the results did not present a
normal distribution, the Kruskal-Wallis test at 5% significance level, a non-parametric test, was used as a statistical alternative. The calcium replacement by GMM, regardless the particle size, did not affect the performance (P>0.05) and intestinal transportes gene expression (P>0.05) on broiler at 21 and 42 days old. The GMM in different particle size made Ca available in a similar way, supplying their metabolic needs and becoming a possibility of alternative mineral source use in broilers nutrition.

**Keywords:** alternative ingredient, calcium, intestinal transportes, Limnopema fortunei, RNA extraction

### 184 Effect of different metabolites of vitamin D dietary supplementation on growth performance, mTOR gene expression and 25OHD3 serum status of broilers.

Claudia C. Martins1, Felipe S. Dalolio1, Ingryd P. Nobrega1, Leticia C. Bittencourt1, Carlos A. Lozano-Poveda2, 1DSM Nutritional Products, São Paulo, Brazil, 2DSM Nutritional Products, Tocancipa, Colombia.

The objective of this study was to evaluate the supplementation of different dietary vitamin D sources on growth performance, feed efficiency, mTOR gene expression and 25OHD3 blood status of broiler chickens. A total of 900 one day male broilers were distributed in a completely randomized design, with 3 treatments, 12 replicates of 25 birds each. The treatments were: T1 = 4000 IU vitamin D3/kg of feed; T2 = 2000 IU vitamin D3/kg of feed + 69 mg of 25OHD3/kg of feed; and T3 = 2000 IU/kg of D3 + 100mg of 1,25OHD3/kg of feed, that were supplemented from 1 to 39 days. Broilers were fed with a basal diet (mash form) based on corn-soybean meal formulated to meet breed nutritional recommendations. Feed intake (FI), body weight gain (BWG), and feed conversion ratio (FCR) were calculated weekly. At 7, 21 and 35 days, 2 birds per replicate were randomly selected to collect blood samples by wing puncture to analyze 25OHD3 status using a Dried Blood Spot test and liquid chromatography-tandem mass spectrometry (LC-MS/MS). At 35d, 8 birds per treatment were euthanized to collect the cranial portion of breast to evaluate mTOR gene expression. Data was analyzed as One-Way ANOVA with a Tukey test to evaluate the differences between treatments using a generalized linear model; effects were considered significant at P<0.05. The 25OHD3 supplementation had a significantly lower FCR (P=0.03, g:g) but increased in birds placed in DH (15.6 g vs 14.9 g) when compared to non-supplemented birds (P<0.05). An interaction was observed between the two factors for all analyzed variables (P<0.05). Broiler age at the day of sampling was considered as a covariate but had no effect (P>0.05). In comparison to non-supplemented birds, broilers fed dietary 25OHD3 had a significantly greater bone L (P=0.001) regardless of house type, DH (D= 52.2 Vs 56.9), OH (D=48.2 Vs 56.5), which suggests an increased bone density. Bone weight was slightly reduced in broilers supplemented with 25OHD3 and raised in OH (13.2 Vs 14.8 g) but increased in birds placed in DH (15.6 g vs 14.9 g) when compared to non-supplemented birds (P<0.05). Greater BBS was observed for broilers fed 25OHD3 supplemented diets and reared in OH compared to other treatments (P=0.002). Broilers reared in OH had greater 25OHD3 blood levels regardless of dietary supplementation. In comparison to non-supplemented birds, dietary 25OHD3 increased blood levels of 25OHD3 regardless of house type, DH (33 vs 43.5 ng/mL); OH (43.2 and 46.9 ng/mL; P=0.031). In conclusion, 25OHD3 supplementation increased 25OHD3 blood levels of broiler chickens which positively influenced bone quality by increasing bone density and breaking strength.
Keywords: broiler, bone development, broiler house, 25OHD3, bone breaking resistance

186 Effect of 25-OH-D3 supplementation and different dietary levels of available phosphorus on growth performance, bone characteristics, ileal digestibility, and vitamin D status of broilers. Lucas S. Bassi1, Filipe A. Moreno1, Marley Conceição dos Santos1, Carlos A. Lozano-Poveda2, Claudia C. Martins3, Alex Maiorka1, 1Federal University of Paraná, Curitiba, Paraná, Brazil, 2DSM Nutritional Products, Bogotá, Colombia, 3DSM Nutritional Products, São Paulo, Brazil.

The objective of this study was to evaluate the supplementation of 25-OH-D3 and different dietary levels of available phosphorus (Av. P) on growth performance, bone characteristics, ileal digestibility, and vitamin D3 status of broilers. A total of 560 broilers were reared from 1 to 21 days in battery cages and distributed in a completely randomized design with a 4 x 2 factorial arrangement: 4 dietary levels of Av. P (0.45, 0.42, 0.39, and 0.36%) and with or without the inclusion of 69 μg of 25-OH-D3/kg feed, totaling 8 treatments and 7 replicates of 10 broilers. Diets were corn-soybean based, mash, and were all supplied with 1,500 units of phytase/kg and a vitamin premix containing cholecalciferol (4,000 IU). Feed intake (FI), body weight gain (BWG), and feed conversion ratio (FCR) were calculated weekly. At 21 days, 5 broilers per replicate were randomly selected and euthanized to collect ileal digesta; 2 broilers had both tibiae bones collected for ash, Ca, and P content, and bone breaking strength (BBS) determination, and blood samples collected for analysis of serum concentration of 25-OH-D3. Data were analyzed as a two-way analysis of variance and when significant (P<0.05), the effect of Av. P was submitted to linear and quadratic analysis of regression. No interactions were observed between treatments for performance, digestibility, or bone variables (P>0.05). Reducing dietary Av. P levels led to a quadratic effect on FI (P<0.05), as broilers fed medium Av. P levels (0.39 and 0.42%) had the highest FI (1,125 and 1,149 g, respectively), but BWG and FCR were not affected by Av. P. Supplementing 25-OH-D3 significantly increased (P<0.05) broiler performance by resulting in greater FI (1,146 vs 1,107 g) and BWG (872 vs 826 g), and lower FCR (1,313 vs 1,340). Reducing Av. P levels linearly increased Ca and P digestibility (up to 59.98 and 72.6%, respectively; P<0.05), but, inversely, increasing the levels led to higher P deposition in the tibiae (P<0.05; up to 8.64%); the 25-OH-D3 supplementation greatly increased (P<0.05) Ca and P digestibility (56.6 vs. 53.9% and 72.1 vs. 68.4%, respectively) and bone ash content (48.55 vs 47.62%). An interaction showed that broilers fed 25-OH-D3 with higher levels of Av. P (above 0.39%) had greater 25-OH-D3 serum concentration (up to 77.6 ng/mL) compared to other treatments with lower Av.P levels or no dietary supplementation. It was concluded that dietary 25-OH-D3 enhanced broiler performance, Ca and P digestibility, bone ash content, and 25-OH-D3 blood level of 21-day-old broilers regardless of dietary Av. P levels; additionally, higher Av. P levels reduced Ca and P digestibility but increased P deposition in the bone.

Keywords: broiler, bone mineralization, 25-OH-D3 metabolite, phosphorus, Vitamin D

187 Evaluation of different feed vitamin levels on growth performance and meat quality of broilers. Marta I. Gracia1, Carlos Millán1, Guillermo Cano1, Francois Nell2, Jose-Maria Hernandez2, Adsos A. Passos3, 1Inmasde Agroalimentaria, Madrid, Spain, 2DSM Nutritional Products, Kaiseraugst, Switzerland, 3DSM Nutritional Products, Sao Paulo, Brazil.

As for any other nutrient, vitamin levels in feed should be regularly reviewed once the requirements may change due to genetic improvements of animal breeds. The objective of this study was to evaluate the impact of two different vitamin levels on growth performance and meat quality of broilers. A total of 936 one-day-old male Ross 308 broilers were allocated according to a completely randomized design with 2 treatments, 18 replicates of 26 birds each. Treatments were vitamin levels commonly used by the industry in Spain (T1) and Optimum Vitamin Nutrition (OVN, 2022 broiler guidelines) (T2). Diets were based on corn, wheat, barley, and soybean meal with three phase mash feeds (1-14 days; 15-28 days; 29-42 days) to meet the nutrient requirement of the genetics. Body weight, weight gain, feed intake, and feed efficiency were evaluated at 1, 28 and 42d while mortality was evaluated daily. At 28d, 36 broilers per treatment were randomized selected to measure vitamin E content in blood and tibia bone strength. Breast meat MDA-malondialdehyde was also evaluated in those birds at 0, 3 and 6d after meat defrosting. Data were analyzed by ANOVA using the GLM procedure at 5 % probability. The mortality at 42d was lower (0.4 vs. 2.4%; P<0.05) in the broilers fed T2 when compared to T1. Breaking strength (195 vs. 167 N; P<0.05) and diameter of tibia (6.3 vs. 5.8 mm; P<0.05) was improved in broilers receiving T2. Broilers fed T2 had superior vitamin E content in the blood (14.2 vs. 18.1; P<0.05). At 28d, broilers treated with T2 had higher body weight (1069 vs. 969 g; P<0.05), average daily gain (36.0 vs. 32.3 g; P<0.05), and feed intake (61.1 vs. 55.7 g; P<0.05) than T1. At 42d, the average daily feed intake was higher (84.4 vs. 81.2 g; P<0.05) in the broilers fed T2 when compared to T1. Breast meat MDA did not differ at 0d after defrosting, but it was higher for T1 on 3d (0.417 vs 0.300; P<0.05) and 6d (0.629 vs 0.388; P<0.05). The results indicated the importance of reviewing broilers vitamin levels. Birds that received vitamin levels according to a novel OVN 2022 broiler guidelines improved zootechnical performance, vitamin E blood status, bone strength, and oxidative stability of meat.

Keywords: vitamin, nutrition, broiler, performance, shelflife
Supplementation of 25-OH-D3 and different levels of calcium and phosphorus in broiler diets on growth performance, bone characteristics, ileal digestibility, and mineral and vitamin D status. Lucas S. Bassi¹, Isabella d. Dias¹, Geovani Costa Senger¹, Carlos A. Lozano-Poveda², Claudia C. Martins³, Alex Maiorka¹,
¹Federal University of Paraná, Curitiba, Brazil, ²DSM Nutritional Products, Bogotá, Colombia, ³DSM Nutritional Products, São Paulo, Brazil.

The effect of inclusion of 25-OH-D3 in broiler diets formulated with different levels of Ca and P on growth performance, bone mineralization, ileal nutrient digestibility, and Ca, P, and vitamin D status was evaluated. A total of 560 broilers were reared from 1 to 21 days in battery cages and distributed in a completely randomized design with a 4 x 2 factorial arrangement: 4 levels of total Ca + available P (0.6+0.3, 0.7+0.35, 0.8+0.4, 0.9+0.45) kept at a constant 2:1 ratio, and with or without the inclusion of 69 µg/kg feed of 25-OH-D3, totaling 8 treatments and 7 replicates of 10 birds. Diets were based on corn+soybean and offered in mash form; all diets contained 1,500 units of phytase/kg and a vitamin premix containing vitamin D3 (4,000 IU). Feed intake (FI), body weight gain (BWG), and feed conversion ratio (FCR) were calculated. At 21 days, 5 birds per replicate were randomly selected for collection of blood samples by wing puncture, used in Ca, P, and vitamin D status evaluation. The same birds were then euthanized to collect both tibiae bones, assessed for ash, Ca, and P content, and bone breaking strength (BBS), and ileal digesta for digestibility calculations. Data were analyzed as a two-way analysis of variance and when significant, the effect of Ca+P levels was submitted to regression analysis. No interactions were found between treatments for any of the variables. Increasing Ca+P levels linearly increased BWG up to 927.7 g and reduced FCR down to 1.270 (P<0.05). Supplementing 25-OH-D3 reduced FCR (1.326 vs 1.283; P<0.05). Increasing Ca+P levels linearly reduced (P<0.05) with higher mineral levels, leading to greater bone ash (52.5 vs. 51.1%; P=0.008), bone Ca (20.4 vs. 19.6%; P<0.001), bone P (9.3 vs. 8.8%; P=0.01), and BBS (204.4 vs. 189.04 N; P=0.01). It was concluded that even though higher levels of Ca+P reduced Ca and P digestibility, it improved performance and bone mineralization. The dietary supplementation of 25-OH-D3 reduced FCR and increased the digestibility, absorption, and bone deposition of Ca and P, along with higher 25-OH-D3 blood levels, regardless of Ca+P levels.

Keywords: 25-OH-D3 metabolite, broiler, bone mineralization, calcium, phosphorus

Inorganic selenium content and speciation in selenium yeasts. Mohammed Amine Hachemi¹, Denise Cardoso¹, Garros Fontinhas Netto², Wanderley Quinteiro², Mickael Briens¹, ¹Adisseo, Antony, France, ²Adisseo, São Paulo, Brazil.

Selenium (Se) is an essential trace mineral for animal nutrition largely due to its key roles in the antioxidant system, metabolism, and inflammatory modulation. Selenium is typically supplemented into livestock premixes via sodium selenite or sodium selenate (these are known to have low bio-efficacy) or in organic forms via selenium yeasts (SY) or pure, chemically synthesized hydroxy-selenomethionine (OH-SeMet; these are known to have a higher bio-efficacy). SY products are well known to contain different Se species and, based on previous analytical methods, were only shown to contain mainly selenomethionine (SeMet), selenocysteine (SeCys), residual selenate (SeIV) and selenite (Se VI); other organic and inorganic Se forms can be characterized but are rarely quantified. Recently, however, Vaccina et al. (2021) developed a new analytical method to quantify elemental Se (Se0), an inorganic Se species. This method provides better insight and an update on the proportion of inorganic Se in SY products. The objective of the study was to quantify the Se0 in SY products and assess the proportion of inorganic Se in those products. To accomplish this, the Se composition of 13 fresh commercial samples of SY products, from different suppliers and batches from the same supplier (CNCM I-3060, CNCM I-3399, NCYC R397, NCYC R645, NCYC R646), were assayed for total Se, inorganic Se species (SeIV, SeVI and Se0), and organic Se species (SeMet and SeCys). The samples were analyzed in duplicate. Results in terms of total Se were in line with expected Se concentrations for all 13 SY samples. The concentration of Se0 (mg/kg ± uncertainty) and proportion (%) of Se present as Se0 were SY1: 206 ± 2 (9%), SY2: 116 ± 1 (6%), SY3: 156 ± 2 (8%), SY4: 73 ± 9 (4%), SY5: 247 ± 6 (13%), SY6: 664 ± 46 (52%), SY7: 641 ± 67 (30%), SY8: 196 ± 2 (9%), SY9: 255 ± 6 (9%), SY10: 345 ± 6 (11%), SY11: 177 ± 30 (8%), SY12: 377 ± 4 (18%), SY13: 139 ± 3 (7%). The quantification of Se0 in SY products, in addition to SeIV and SeVI, indicated an average proportion of inorganic Se of 14.2%, with a range of 4% to 52% for the 13 SY products. The proportion of Se as SeMet ranged between 19% to 72%, with an average of 55.8%, confirming that the variability in SeMet content for SY products is high. The SeCys content was also variable with an average of 3.8%. The Se0 quantified in SY is hypothetically from the variable and lower bio-efficacy compared to pure organic form of Se (SeMet).
Keywords: selenium yeasts, elemental selenium, inorganic selenium, selenomethionine, speciation

190 Using plant-based 1,25(OH)2D3-glycosides to reduce the incidence of lameness in broiler chickens. Adnan Alrubaye*,1, Douglas Rhodes2, Kathrin* Buehler3, Katia Pedrosa3, Marine* Dewez4, Javier Gonzalez2, 1Center of Excellence for Poultry Science, University of Arkansas, Fayetteville (AR), Fayetteville, Arkansas, United States, 2Center of Excellence for Poultry Science, University of Arkansas, Fayetteville (AR), Fayetteville, Arkansas, United States, 3Herbonis Animal Health, Augst, Switzerland, 4Nuproxa Switzerland, Eto, Switzerland.

Lameness in broiler chickens causes major financial losses and is considered the main animal welfare issue affecting the poultry industry. Lamenesses can be separated into functional and bacterial lameness. The latter is facilitated by translocation of potentially pathogenic bacteria across the respiratory and intestinal epithelia. This translocation leads to bacterial chondronecrosis with osteomyelitis (BCO), especially in proximal femoral and tibial heads. BCO can be reduced by increasing gut integrity and by supporting calcium metabolism to ensure optimal bone structure. Therefore, a herbal source of the metabolically active form of vitamin D (1,25 dihydroxycholecalciferol-glycosides [G-1,25(OH)2D3]) and phytogenic antioxidants were tested in a broiler lameness challenge model. A total of 1560 day-old male Cobb500 were divided in 6 experimental groups with 4 replicates T2: negative control; T3: 10 µg G-1,25(OH)2D3/kg; T4: 1 µg G-1,25(OH)2D3/kg; T5: 1 µg G-1,25(OH)2D3/kg plus 500 mg/kg of a polyherbal gut health product; T6: 1 µg G-1,25(OH)2D3/kg plus 750 mg/kg of a polyherbal antioxidative and anti-inflammatory product; T7: 1 µg G-1,25(OH)2D3/kg plus 500 mg/kg thyme oil. All polyherbal antioxidative and anti-inflammatory product; T6: 1 µg G-1,25(OH)2D3/kg plus 500 mg/kg thyme oil. All polyherbal antioxidative and anti-inflammatory product; T6: 1 µg G-1,25(OH)2D3/kg plus 750 mg/kg of a polyherbal gut health product; T6: 1 µg G-1,25(OH)2D3/kg plus 750 mg/kg of a polyherbal antioxidative and anti-inflammatory product; T7: 1 µg G-1,25(OH)2D3/kg plus 500 mg/kg thyme oil. All experimental groups were on standard litter flooring and the infection source (IS; T1) was 2 pens on suspended wire flooring. All animals were fed the experimental diet on top of a corn/soy-based basal diet. Nutritional composition of the basal diet was according to breeder standards. Experimental diets were fed during the whole trial period of 60 days as a 2-phase program. For statistical analysis, T3 to T7 were compared to T2. Incidence of lameness was recorded daily. Birds diagnosed as lame (defined as reluctance to stand) were sacrificed and tibial and femoral lesions in both legs were assessed. Results were analysed with GLM (Rx64 2.2.4). Lameness was first observed at around d30. Cumulative lameness at d60 in IS and T2 was 91.3 and 83.4 %, respectively, but did not differ between the two groups (p=0.64). Cumulative lameness in the supplemented diets was much lower; average of 44.6 ± 4.0 % (p < 0.001). Within the supplemented treatments, cumulative lameness in T3 and T5 was higher, with T7 showing the lowest incidence (38.9 %). The reduction in cumulative lameness at d60 from T2 to T3 was 83% and from T2 to T7 54%. In conclusion, the herbal source of G-1,25(OH)2D3 with or without the addition of phytogenic antioxidants not only reduced the incidence of bacterial lameness in broilers but also its severity. No additional effects by the antioxidant feed ingredients were observed. Further trials need to be conducted to examine the underlying cause of the reduced occurrence of BCO.

Keywords: solanum glaucophyllum, gut barrier, chondronecrosis, osteomyelitis, bone

191 Amino acid complexed minerals, partially replacing inorganic sources in layer diets from starter phase, improve bone quality and mineral deposition in adult phases. Heraldo B. Oliveira1, Carlos B. Rabello1, Marcos J. Santos1, Mercia R. Barros2, Maria do Camo M. Ludke1, Waleesa R. Medeiros-Ventura1, Andrea G. Faria1, Camila G. Pereira1, Rogerio V. Silva Junior1, Fabiano S. Costa2, Alba K. Fireman1, 1Animal Science, Federal Rural University of Pernambuco, Olinda, Brazil, 2Medicina Veterinaria, Universidade Federal Rural de Pernambuco, Recife, Brazil, 3Zinpro Corporation, Campinas/SP, Brazil.

Inorganic minerals (IM) have lower absorption capability, though they are the most used trace mineral sources in laying hen diets. Conversely, amino acid complexed minerals (AACM) are known for having greater intestinal permeability in birds. This study was conducted to evaluate tibial mineral composition and bone characteristics of laying hens fed IM and AACM. From day one to 30-weeks-of-age (growing phase, GP), two groups of Lohmann Brown-Lite chicks were fed one of two diets: 1) IM, 70 ppm Zn + 70 ppm Mn + 8 ppm Cu as ZnO, MnO, and CuSO4, respectively; or 2) AACM-ZMC, 40 ppm Zn + 40 ppm Mn + 2.75 ppm Cu, from IM sources, and 30 ppm Zn + 30 ppm Mn + 5.25 ppm Cu, from AACM sources. From 30 to 50 weeks of age (production phase, PP), 800 laying hens originating from two initial treatment groups were evaluated in a completely randomized design in a 2×4 factorial arrangement, with 10 replicates of 10 birds per treatment. The 2 initial GP groups were divided into four: IM, AACM-ZMC, AACM-ZMCF (AACM-ZMC + 10 ppm Fe as FeSO4 + 40 ppm Fe as Fe-AACM), and AACM-Fe (IM + 10 ppm Fe as FeSO4 + 40 ppm Fe as AACM-Fe). One bird per replicate was euthanized in the 50th week, and tibias were collected for mineral composition and bone characteristic analysis. Bone densitometry was evaluated using transverse images of five tibias per treatment. Data were subjected to ANOVA and Tukey’s test was performed (P < 0.05). Tibia weight tended to improve in hens fed AACM-ZMC during GP (P = 0.06). Seedor index, a measurement of bone density, was higher in the tibias of birds fed AACM-ZMC through GP, and in those fed AACM-ZMCF during PP (P = 0.05). Greatest bone resistance was observed in tibias of hens fed IM diets (P < 0.05), and lowest in those fed AACM-Fe diets during PP, although greater Ca levels were observed in tibias of hens fed AACM-Fe diets during PP. Tibia Cu and P levels were reduced (P < 0.05) by feeding hens AACM-ZMC diets.
during GP, however, their Ca:P was increased (P < 0.05). The interaction between GP and PP diets showed that birds fed AACM-diets earlier had the greatest Ca:P and lowest Cu content of the tibia. Bone densitometry was improved in hens fed AACM-ZMCFe throughout PP (P = 0.01). These data support the partial replacement of IM with AACM in pullets to improve bone quality of hens in growth and production phases.

**Keywords:** bone densitometry, mineral complexes, trace minerals

**192 Effect of partial replacement of inorganic trace mineral sources with amino acid complexed minerals in laying hen diets from starter phase until 50 weeks of age on the serum biochemical profile and mineral deposition in liver and egg yolk.** Heraldo B. Oliveira¹, Carlos B. Rabello¹, Marcos J. Santos¹, Maria R. Barros², Maria do Camo M. Ludke¹, Waleska R. Medeiros-Ventura¹, Andrea G. Faria¹, Camila G. Pereira¹, Rogerio V. Silva Junior¹, Almir F. Silva¹, Alba K. Fireman³, ¹Animal Science, Federal Rural University of Pernambuco, Olinda, Brazil, ²Medicina Veterinaria, Universidade Federal Rural de Pernambuco, Recife_PE, Brazil, ³Zinpro Corporation, Campinas SP, Brazil.

Inorganic mineral sources (IM) are known for being less absorbed and utilized by animals. Organic trace minerals have been implemented in diets to improve mineral utilization and animal performance. From day 1 to 30 weeks of age (WOA) (GP), two groups of 400 Lohmann Brown-Lite chicks were fed either IM or amino acid complexed minerals (AACM), partially replacing the IM, as follows; IM: 70 ppm Zn + 70 ppm Mn + 8 ppm Cu as ZnO, MnO, and CuSO4, respectively; or ZMC-AACM: 40 ppm Zn + 40 ppm Mn + 2.75 ppm Cu (IM) and 30 ppm Zn + 30 ppm Mn + 5.25 ppm Cu (AACM). From 30 to 50 WOA (PP), 800 laying hens originating from the two initial treatment groups were evaluated in a completely randomized 2 × 4 factorial arrangement, with 10 replicates per treatment and 10 birds per replicate. Each of the two initial diet groups in GP were divided into four, IM; AACM-ZMC; AACM-ZMCFe (AACM-ZMC and 10 ppm Fe as FeSO4 + 40 ppm Fe as Fe-AACM); and AACM-Fe (IM and 10 ppm Fe as FeSO4 + 40 ppm Fe as AACM-Fe). The objectives of this study were to evaluate the serum biochemical profile, liver and egg yolk mineral composition of laying hens fed different sources of trace minerals at 50 WOA. Data were subjected to MANOVA and Tukey’s test was performed (P < 0.05). Birds fed AACM-ZMC diets during GP, presented greater levels of alanine aminotransferase and thyroxine (P < 0.05) and thyroxine (P < 0.05). Hens fed AACM-ZMC diets in GP and PP had reduced P in the liver, while greater levels of P were observed for those hens fed with IM group (P < 0.01). Calcium levels in the liver were observed to be greater in IM and AACM-ZMC, and lower in AACM-Fe diets (P < 0.01). Birds fed AACM diets in GP and kept in the AACM-ZMC diet in PP presented greater levels of Mn in the liver, but birds fed AACM diets during GP and fed AACM-Fe diets during PP had reduced the Mn content in the liver (P < 0.05). Feeding hens IM diets in PP resulted in higher Cu liver levels (P=0.02) than in hens fed AACM. An interaction was observed between GP and PP diets for P levels in the yolk, where hens fed AACM during GP and AACM-Fe diets during PP had higher yolk P levels. In conclusion, AACM diets in hens’ fed early and continue to be supplemented in PP is an adequate strategy to increase Mn deposition in egg yolk, which also promotes higher serum levels of alanine aminotransferase and thyroxine. Laying hens fed with AACM diets result in different levels of mineral deposition in the liver.

**Keywords:** bone density, complex minerals, trace minerals

**193 Effect of continuous use of 1,25 dihydroxycholecalciferol-glycosides in broiler breeders on the weight of their progeny.** Barbara Amanda Bebber¹, Nilton Rohloff Junior¹, Thiago S. Andrade², Cleison d. Souza¹, Tania L. Kohler¹, Bruna Griss¹, Heloisa Sartor¹, Raquel P. Schoffen¹, Ricardo V. Nunes¹, Marlene Schmidt¹, Kathrin* Buehler⁴, ¹Western Paraná State University, Marechal Cândido Rondon, PR, Brazil, ²Department of Poultry Science, Western Paraná State University – UNIOESTE, Marechal Cândido Rondon, Parana, Brazil, ³NutriQuest, São Paulo, SP, Brazil, ⁴Herbonis Zurich, Switzerland, Herbonis, Zurich, Switzerland.

The aim of this study was to evaluate the effect of continuous supplementation of 1,25 dihydroxycholecalciferol glycosides (G-1,25 (OH)2 D3) in the diets of broiler breeders on their progeny weight. For this, 4,224 broiler chicks were used, hatched from broiler breeders of 3 different ages: 30, 46 and 62 weeks. The of G-1,25 (OH)2 D3 was added at 1 µg/kg feed to the diet from 24 weeks of age, until the end of the laying period. The breeders (Ross 308 AT) were distributed in three farms, located in Southwest - Paraná – Brazil. Eggs were collected daily and placed in single-stage incubators. After hatch, the chicks were sexed and the males were evaluated in a progeny test. A completely randomized design was used in a plot repeated over time, the treatments being the inclusion or not of G-1,25 (OH)2 D3 in the diet of the broiler breeders and the plots repeated at the time were the age of the breeders (30, 46 and 62 weeks). At 30 weeks of age there were 24 replicates and at the other ages 32 replicates, each with 24 birds. The birds were distributed at each age so that all the experimental units had a similar initial average weight. Initial mean broilers chick weight data were subjected to the normality test and then subjected to two-way ANOVA at 5% significance. If statistical differences were found (P=0.0001), breeder supplementation was compared by F test, and the age of the breeders was compared by Tukey test. There was an effect of diet and age as well as an interaction (P=0.0144). The older the breeders, the greater the chick weight at placement. Supplementation...
of breeders with 1 µg/kg feed of G-1,25 (OH)₂ D₃ glycoside produced heavier chicks at 1 day of age when compared to broiler breeder that were not supplemented. It can be concluded that the use of G-1,25 (OH)₂ D₃ in broiler breeders from 24 to 65 weeks of age provides a broiler chick with higher birth weight from 30 to 62 weeks of production age.

**Keywords:** vitamin supplementation, broiler breeder nutrition, chicks hatch weight, poultry nutrition, Vitamin D

**194 Effect of supplementing broiler breeders and their progeny with 1,25 dihydroxycholecalciferol glycosides on broiler performance.** Barbara Amanda Bebber¹, Nilton Rohloff-Junior¹, Thiago S. Andrade², Maisa B. de Carvalho³, Cristine Kaufmann¹, Edevaldo A. Ianchinski¹, Lidiane I. Datsch¹, Maressa Fernanda Cardoso Pereira¹, Ricardo V. Nunes⁴, Jonivan Luiz Paloschi⁴, Javier Gonzalez⁵, ¹Western Paraná State University - UNIOESTE, Marechal Cândido Rondon, PR, Brazil, Toledo, Brazil, ²Department of Poultry Science, Western Paraná State University – UNIOESTE, Marechal Cândido Rondon, Paraná, Brazil, ³Animal Science, UTFPR/Unioste, Marechal Candido Rondon, Paraná, Brazil, ⁴Nuprox Switzerland Ltd, Etoy, Switzerland.

The objective of this trial was to evaluate the impact of supplementing 1,25 dihydroxycholecalciferol glycosides (G-1,25 (OH)₂ D₃) in the diet of broiler breeders and their progeny on broiler performance. A total of 1,152 one-day-old male, broiler chicks, Ross 308 AP were distributed in a completely randomized design in a 2 x 3 factorial design. One of the factors was broiler chicks hatched from breeders receiving or not a supplementation with G-1,25 (OH)₂ D₃ (0 and 1 µg/kg feed) and the other factor were 3 inclusion levels of G-1,25 (OH)₂ D₃ (0, 0.5 and 1.1 µg/kg feed), in the broilers hatched from the breeders. There were 8 replicates per treatment with 24 birds each. The supplementation of G-1,25 (OH)₂ D₃ in the diets of the progenies was up to 21 d of age. From 22 to 42 d all birds received the same diet. The average feed intake (FI), weight gain (WG), feed conversion ratio (FCR), viability and productive efficiency index (IEP) were calculated at 1, 21 and 42 d of age. Data were submitted to the normality test and then to a two-way ANOVA at 5% significance. Main effects were analyzed using F test for the broiler breeders and Tukey test for the progeny. No interaction (P>0.05) was observed for any of the variables evaluated. The inclusion of 1 µg/kg feed of G-1,25 (OH)₂ D₃ in the breeder diet improved the weight gain and FCR of the progeny at 42 d (P=0.0652 and 0.0082, respectively). In addition, the chicks supplemented with 1 µg/kg feed showed a higher WG (P=0.0671) and better IEP (P=0.032) at 42 d. The inclusion of G-1,25 (OH)₂ D₃ in the broiler diets improved FCR (P=0.0526) and viability (P=0.0531) at 42 d, independant of breeder diet. Birds that received 0.5 µg/kg feed of G-1,25 (OH)₂ D₃ had the lowest CMR (P=0.0243) at 42 d. In conclusion, the supplementation of G-1,25 (OH)₂ D₃ to broiler breeders improved the performance of their progeny and the addition of G-1,25 (OH)₂ D₃ 1 µg/kg feed in the diet of broilers from 1 to 21 days of age improved overall FCR and survival.

**Keywords:** Vitamin D3 supplementation, broilers chick nutrition, broiler breeder nutrition, productive performance, vitamins and minerals

**195 Effect of dietary calcium and phosphorus recommendation and limestone solubility on performance, bone mineralization, litter quality and paw quality.** Clara R. Angel¹, Kyle M. Venter¹,², Thabisa Soko¹, Peter W. Plumstead¹, ²Chemunique PTY Ltd, Lanseria, Gauteng, South Africa, ³Department of Animal and Avian Sciences, University of Maryland, College Park, Maryland, United States, ²Neuro Livestock Research, Lanseria, Gauteng, South Africa.

Limestone (LS) solubility has been shown to alter Ca and P digestibility, in doing so altering dietary requirements for these nutrients. The study objectives were to assess effects of different Ca and P recommendations (Rec) on broilers production parameters when diets were formulated using LS with different solubility. The 2x3 factorial design included 2 LS solubilities (fast and medium) determined as per Kim et al. (2019); and three Ca and P Rec: University of Maryland (UMD), Ross 308 breed Rec 2019 (BR), and a Dutch nutrition group (NL) 2019 recommendations. As hatched Cobb 500 chicks were placed, in 72-floor pens, 50 broilers/pen and 12 replicates per treatment. BW and FI were determined at 7, 10, 14, 21, 28 and 32 d and FCR calculated. Water intake was determined daily, and litter dry matter determined at 32d. Foot pad and hock scoring was conducted on day 32 using a 4-point and 3-point system, respectively. Data were analysed in JMP 15.0 (SAS Inst. Inc., Cary, NC, 2016) by two-way ANOVA with block as a random effect and means separated with Tukey HSD at P<0.05. Foot and paw scoring were analysed using a Pearson Chi square test. Defatted tibia ash was determined at 10 and 32-d from 5 broilers/pen. Feed cost/kg broiler was calculated using feed ingredient prices in South Africa, December 2021. The UMD and BR had similar 32d wt (2033 and 2039g) but both greater than NL (1980g) (P<0.05). FCR at 32d for UMD was lower (P<0.05) than BR, and NL (1.33, 1.35, and 1.36, respectively). Medium soluble LS improved (P<0.05) 32-d BW (2028 vs. 2006g) but had no impact on FCR. An interaction (P<0.05) was observed on 10 and 32d tibia ash wt. Fast soluble LS reduced (P<0.05) tibia ash wt in birds fed UMD Rec at 10d but had no effect on tibia ash wt when fed NL or BR Recs. The tibia ash wt for the NL Rec with a fast soluble LS was reduced (P<0.05) than the BR and UMD spec with both LS. At 32-d, fast soluble LS reduced (P<0.05) tibia ash in birds fed the NL Recs, but not UMD or BR Recs. Total P consumed (g) per kg harvested where both NL and the UMD spec with a medium LS were lower (P<0.001) compared to birds fed NL Rec. Both the BR treatments with different LS
profiles had a higher (P<0.05) P consumed (g) per kg harvested. There, was an effect of treatment on footpad and hock scoring with the best footpad score being observed for the NL Rec with a medium soluble LS. There was an effect (P<0.05) of Rec on litter DM, with NL obtained the highest litter DM (54.8%) compared to BR (50.72%). The lowest (P<0.05) feed cost/kg broiler for the UMD Recs, followed by BR and NL (P<0.05), with no effect of LS. These results suggest Ca and P Recs and LS used in commercial broiler diets can impact broiler production.

**Keywords:** calcium, phosphorus, limestone, broiler

196 Effect of amino acids-mineral complexed supplementation with or without the inclusion of phytase on performance, egg quality and blood profile of laying hens. Waleska R. Medeiros-Ventura², Carlos B. Rabello¹, Marcos J. Santos², Mercia R. Barros³, Heraldo B. Oliveira², Maria do Camo M. Ludke², Helena E. Manso¹, Apolonio G. Ribeiro¹, Dayane A. Silva¹, Alba K. Fireman⁴, ¹Zootecnia, Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil, ²Animal Science, Federal Rural University of Pernambuco, Olinda, Brazil, ³Universidade Federal Rural de Pernambuco, Recife, Brazil, ⁴Zinpro Corporation, Campinas SP, Brazil.

A study was carried out to evaluate the effect of sources and levels of trace minerals complexed with amino acids (AACM), with or without the enzyme phytase (EZ), on the production performance, egg quality, and blood profile of laying hens. A total of 320 birds were used in a completely randomized design in a factorial arrangement (2×3+2) with eight replications per experimental unit (EU). The 1st factor was enzyme supplementation (EZ) and the 2nd was the AACM inclusion levels (100, 70, and 40%) plus two control treatments, namely, IM (inorganic minerals) with and without EZ. On the last three days of each period, it was collected three eggs per EU to be analyzed. In the last week was collected blood samples of one bird per EU. On the 89th week, one bird per EU was euthanized to evaluate the chicken’s organs. Data were subjected to ANOVA, after that Dunnett and Tukey’s test was performed (P < 0.05). Higher percentage of egg output and egg mass were observed for laying hens fed AACM-100 diet than those fed LGCM-70 and LGCM-40 diets. The lowest percentage was observed for those fed IM-EZ diet, while the IM and IM-EZ groups had a worse egg mass and FCR (kg kg⁻¹). Phytase increased egg weight, while LGCM diet improved shell thickness. Layer fed IM and IM-EZ supplemented diets had reduced shell thickness compared to those fed LGCM-100 diet, while the IM-EZ group showed the lowest eggshell resistance. Phytase supplementation reduced the pancreas’ weight. LGCM supplementation influenced the blood profile and hormonal concentration, while phytase supplementation reduced alkaline phosphatase activity. LGCM supplementation improved laying hens’ performance and shell quality, while phytase increased egg weight and decreased pancreatic and AF activity.

**Keywords:** egg production, enzyme, shell resistance

197 Minerals complexed to lysin and glutamic acid, with or without the inclusion of phytase on performance, egg quality, and blood profile of laying hens. Waleska R. Medeiros-Ventura², Carlos B. Rabello¹, Marcos J. Santos², Maria do Camo M. Ludke¹, Mercia R. Barros¹, Rogerio V. Silva Junior¹, Heraldo B. Oliveira¹, Helena E. Manso¹, Alba K. Fireman², ¹Zootecnia, Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil, ²Animal Science, Federal Rural University of Pernambuco, Olinda, Brazil.

The objective of this study was to evaluate the effect of sources and levels of microminerals complexed with lysine and glutamic acid (LGCM), with or without phytase enzyme (EZ) in relation to the productive performance, quality of eggs, and blood profile. A total of 320 laying hens were used, distributed in a completely randomized design in a factorial scheme (2x3+2) with eight replications per experimental unit (EU). The 1st factor was diets LGCM supplemented with or without EZ, the 2nd was three levels of LGCM inclusion (100, 70, and 40%) and plus two control treatments, inorganic minerals (IM) with and without EZ. In the last three days of each period, it was collected three eggs per EU to be analyzed. In the last week was collected blood samples of one bird per EU. On the 89th week, one bird per EU was euthanized to evaluate the chicken’s organs. Data were subjected to ANOVA, after that Dunnett and Tukey’s test was performed (P < 0.05). Higher percentage of egg output and egg mass were observed for laying hens fed LGCM-100 diet than those fed LGCM-70 and LGCM-40 diets. The lowest percentage was observed for those fed IM-EZ diet, while the IM and IM-EZ groups had a worse egg mass and FCR (kg kg⁻¹). Phytase increased egg weight, while LGCM diet improved shell thickness. Layer fed IM and IM-EZ supplemented diets had reduced shell thickness compared to those fed LGCM-100 diet, while the IM-EZ group showed the lowest eggshell resistance. Phytase supplementation reduced the pancreas’ weight. LGCM supplementation influenced the blood profile and hormonal concentration, while phytase supplementation reduced alkaline phosphatase activity. LGCM supplementation improved laying hens’ performance and shell quality, while phytase increased egg weight and decreased pancreatic and AF activity.

**Keywords:** egg production, enzyme, shell resistance
198 Effect of a blend of food additives on the intestinal health an enteric challenge model. Fabricio Imperatori^1, Ana C. Ferreira^1, James d. Barbosa^1, Eduarda P. Simões^1, Luiza R. Stefanello^1, Laura Guberti^1, Bianca d. Lara^1, Jovani I. Fernandes^2, 1, 3, 1Poultry Experimentation Laboratory, Federal University of Paraná – Sector Palotina, Palotina, Paraná, Brazil, 2Animal Science Post-Graduate Program, Federal University of Paraná- Sector Palotina, Palotina, Paraná, Brazil, 3Programa de Pós graduação em Zootecnia, Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.

This study assessed the effects of a blend of additives on intestinal health in experimentally challenged broilers. A total of 3280 Ross® male broilers were distributed in a 5x2 factorial scheme with ten treatments and eight replicates of 41 birds per box with the following experimental treatments: negative control (NC) without antibiotic growth promoters (AGP); positive control (PC) with AGP; PC + 1.0 kg of additive blend/ton of feed; NC + 0.5 kg and NC + 1.5 kg of additive blend/ton of feed x challenged or not. The blend of additives used comprised encapsulated sodium butyrate, hydrolyzed yeast, and zinc proteinate. At 14 days of age, birds in the challenged group were orally gavaged directly into the crop a coccidiosis vaccine (20 times the dose recommended by the manufacturer) and two days later with Escherichia coli (ATCC® 8739™) 10⁹ CFU/bird. The data were analyzed by Anova and Tukey. The challenged birds showed worse (p<0.05) productive performance at all ages evaluated, regardless of the diets used. The birds supplemented with the PC diet + 1.0kg/ton of the blend showed better weight gain at 42 days of age and better feed conversion with the NC diet + 1.5kg/ton of the blend in relation to a NC diet. There was no effect (p>0.05) of diets or enteric challenge on the yield of carcass, breasts, and legs. The birds fed diets PC, PC + 1.0kg of additive blend/ton of feed and diet NC + 1.5kg of additive blend/ton of feed had lower relative weight of abdominal fat in compared to birds supplemented with NC + 0.5kg diet. The supplemented diets with AGP or additives blend resulted in lower relative weight of abdominal fat and presented better feed conversion. This is an important indication of the best use of the diet, reflecting in better feed conversion, as well as better carcass quality with better production costs. Supplementation with a blend of additives can be a viable alternative to improve the performance and the use of diet.

Keywords: blends, Escherichia coli, weight gain, sodium butyrate, additives


This study investigated the use of a blend of additives on the performance and carcass yield of broilers submitted to an enteric challenge model. A total of 3280 male broilers were distributed in a 5x2 factorial scheme with ten treatments and eight replicates of 41 birds per box with the following experimental treatments: negative control (NC) without antibiotic growth promoters (AGP); positive control (PC) with AGP; PC + 1.0 kg of additive blend/ton of feed; NC + 0.5 kg and NC + 1.5 kg of additive blend/ton of feed x challenged or not. The blend of additives used comprised encapsulated sodium butyrate, hydrolyzed yeast, and zinc proteinate. At 14 days of age, birds in the challenged group were orally gavaged directly into the crop a coccidiosis vaccine (20 times the dose recommended by the manufacturer) and two days later with Escherichia coli (ATCC® 8739™) 10⁹ CFU/bird. The data were analyzed by Anova and Tukey. The challenged birds showed worse (p<0.05) productive performance at all ages evaluated, regardless of the diets used. The birds supplemented with the PC diet + 1.0kg/ton of the blend showed better weight gain at 42 days of age and better feed conversion with the NC diet + 1.5kg/ton of the blend in relation to a NC diet. There was no effect (p>0.05) of diets or enteric challenge on the yield of carcass, breasts, and legs. The birds fed diets PC, PC + 1.0kg of additive blend/ton of feed and diet NC + 1.5kg of additive blend/ton of feed had lower relative weight of abdominal fat in compared to birds supplemented with NC + 0.5kg diet. The supplemented diets with AGP or additives blend resulted in lower relative weight of abdominal fat and presented better feed conversion. This is an important indication of the best use of the diet, reflecting in better feed conversion, as well as better carcass quality with better production costs. Supplementation with a blend of additives can be a viable alternative to improve the performance and the use of diet.

Keywords: blends, Escherichia coli, weight gain, sodium butyrate, additives
Adenosine-5-monophosphate (AMP) and guanosine-5-monophosphate (GMP) are purine nucleotides, related to RNA, which can be used as additives in the broilers diet. Studies report these nucleotides can promote improvements in animal performance, gut health and immunity. Thus, the study aimed to evaluate AMP and GMP supplementation as an energy source in performance, biochemical profile, immune system, yield and carcass quality of broilers in the growth phase. 896 male Cobb-Vantress® broilers were used and the experimental design was completely randomized, in a factorial arrangement \((2 \times 3) + 1 + 1\) (AMP and GMP 3 supplementation levels, + positive control (PC), + negative control (NC)), totaling 8 treatments, with the PC a conventional diet; NC with 100 kcal reduction from the conventional diet, and 3 levels of inclusion for AMP and GMP (0.07%, 0.14% and 0.21%) supplemented in NC diets, 7 replicates with 16 birds per experimental unit. The birds were challenged with Newcastle disease (NC) vaccine and the data obtained were analyzed and submitted to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of the SAS Institute software, at a significance level of 5%. There was no interaction effect for weight gain, feed intake and feed conversion, Elisa for NC, carcass yield and meat quality \((P>0.05)\). There was an interaction effect of triglycerides \((P<0.05)\), where it can be observed that treatments with GMP supplementation had higher serum of triglycerides levels than treatments with AMP, with the exception of the 0.21% level \((P<0.05)\). There was an increasing effect of levels \((P<0.05)\) for AMP and the higher the AMP supplementation, the higher the IgY titers. Thus, AMP supplementation at 0.21% in broiler diets is effective in the humoral immune system and high triglycerides levels, without compromising animal performance, carcass and cuts yield in diets that show reduced energy up to 100 kcal.

**Keywords:** meat quality, nucleotides, nutrition, poultry

### 201 Inosine-5-monophosphate (IMP) in a diet of broilers in the initial phase challenged with *Eimeria* spp.

Alceu K. Hirata\(^1\), Paulo C. Pozza\(^1\), Marcia I. Sakamoto\(^1\), Pedro A. Ezidio\(^2\), Ana Eliza B. Silva\(^1\), Alice E. Murakami\(^1\),
\(^1\)Zootecnia, Universidade Estadual de Maringá, Maringá, Paraná, Brazil, \(^2\)PPZ/UEM - Programa de Pós-Graduação em Zootecnia, Universidade Estadual de Maringá, Maringá, PR, Brazil.

Inosine-5-monophosphate (IMP) is a purine nucleotide extracted from yeasts that participates in the de novo synthesis of living organisms to make new nucleotides available for cellular metabolism. Studies show that diets containing nucleotides have positive effects on development, improving performance and intestinal health, as nucleotides promote increased immunoglobulin A (IgA) production in chicks. Thus, the aim of the study was to evaluate IMP nucleotide supplementation in the diet of broilers from 1 to 21 days challenged with *Eimeria* spp. 1000 male broilers were used in a completely randomized design, in a 5 x 2 factorial scheme (IMP x challenged or not) with 10 treatments and 5 replications of 20 birds per experimental unit. A control diet and four IMP levels (0.12, 0.17, 0.24 and 0.32%) were used for the non-challenged group and for the challenged group. The challenge of the birds was carried out with an *Eimeria* spp. oocyst vaccine. Among the analyzeds performed are weight gain (WG), feed intake (FI) and feed conversion (FC) for bird performance, oocyst count per gram (OPG) for detection and oocyst count of *Eimeria* spp. on days 5, 7, 8, 11, 14 and 18-days post infection and Elisa for IgA detection. The data obtained were analyzed using the GLM procedure of the SAS software. There was interaction \((P<0.05)\) between IMP levels and the vaccine challenge for WG and FC at 21 days for broilers. For the WG, the IMP in the diet challenged birds with 0.24% and 0.32% showed statistically similar results when compared to unchallenged birds. For FC, supplementation with IMP (unchallenged and challenged) showed better FC when compared to unchallenged birds without IMP supplementation. There was interaction \((P<0.05)\) between IMP levels and vaccine challenge on post-infection days (PID) 5, 7 and 8 for OPG. It can be observed that the birds challenged at PID 5, 7 and 8 had a higher number of oocysts and with or without the sanitary challenge, and the higher the levels of IMP supplementation in the diet of broilers, the lower the OPG values on the days 5, 7 and 8, with supplementation levels of 0.17%, 0.24% and 0.32%, respectively. There was an isolated effect for IgA, where the higher the IMP in the diet, the greater the amount of IgA. IMP supplementation in broiler diets positively influenced the performance of challenged birds from 0.24% to WG and 0.12% to FC and oocyst reduction from 0.12% of supplementation, improving the system immune system regardless of challenge.

**Keywords:** *Eimeria* spp, nucleotides, nutrition, poultry, immunoglobulin

### 202 Blend of short and medium-chain fatty acids on growth performance of broilers challenged with *Clostridium perfringens*

Liris Kindlein\(^1\), Sergio L. Vieira\(^2\), Andre Favero\(^2\), Vitoria E. Silva\(^4\), Ross Wolfenden\(^3\), Patricia Aristimunha\(^4\), Flavio A. Longo\(^2\), \(^1\)Medicina veterinária preventiva, UFRGS, Porto Alegre, Brazil, \(^2\)Santa Lívia Farm, Farroupilha, RS, Brazil, \(^3\)Eastman USA, Kingsport, Tennessee, United States, \(^4\)Animal Science, UFRGS, Porto Alegre, Brazil.

The objective was to evaluate a formulation (S&MCFA) containing calcium formate, calcium lactate, citric acid and a unique combination of medium-chain fatty acids as a potential option to replace antibiotic growth promoters (AGP) in a necrotic enteritis’ challenge model in broilers. A total of 1,584 one-day-old male Cobb x Cobb 500 slow-feathering broiler chicks were allocated in 72 floor pens (1.5 x 1.5 m), placed on six times reused pine shavings as bedding. Treatments were distributed in a completely...
randomized design with 6 treatments of 12 replicates of 22 chickens each. The experimental treatments were NC: negative control (AGP free), PC: Positive control (avilamycin – 10ppm); NC + S&MCFA at 1kg/MT; NC + S&MCFA at 2kg/MT; NC + S&MCFA at 3kg/MT and NC + S&MCFA at 4kg/MT. All broilers were vaccinated for coccidiosis at placement using 2x of the label dose, the broilers were also orally inoculated with a pathogenic strain of *Clostridium perfringens* type A on days 11, 12, and 13 after placement using the concentration of $10^8$ CFU/mL/bird. Data were analyzed using one-way ANOVA and means were separated using Tukey’s test (p<0.05) in SAS 9.0 (2009). A contrast analysis (NC vs. S&MCFA) was also conducted. No significantly differences (p>0.05) were observed on cumulative body weight gain on over the entire period (1-42 days). A significantly better feed conversion was observed in the treatments with S&MCFA by contrasts analysis compared to the negative control (p<0.05) in the period from 1 to 42 days of age. Also, all treatments with S&MCFA showed a significantly improved Productivity Index over the negative control (p<0.05) in the period from 1 to 42 days. For the villus: crypt ratio at 35 days, the birds fed S&MCFA showed better result than negative control (p<0.05) and the ileal digestibility for dry matter and energy were higher (p<0.05) to the birds fed with 2 kg/MT of S&MCFA when compared to NC, proving the benefit of the medium-chain fatty acids combined with short-chain fatty acids on supporting the birds under this model of challenge. In conclusion, the level of 1 kg/MT of S&MCFA was enough to promote improved performance in a diet with no AGP. However, no additional benefits were observed with the increase of the levels from 1 to 4 kg/MT. Broilers fed with 1 kg/MT of S&MCFA had improved performance compared to NC and when it was observed the villus height and villus: crypt ratio presented similar results to the PC diets (with AGP). These results show an interesting action of the association of short and medium-chain fatty acids on gut health and can be considered an effective alternative to AGP under these conditions.

**Keywords:** fatty acids, performance, clostridium perfringens

### 203 Understanding the effect of different treatments on broiler chicken microbiota exposed to Eimeria challenge for an improved management of intestinal inflammations using the ISI tool. Mariana Q. Nascimento1, Marcos Antônio Nascimento2, Adriana N. Figueiredo1, Ana Beatriz S. Oliveira2, Liliana L. Oetting1, Ibiara C. Paz2, 1Technical, Aleris Animal Nutrition, Jundiaí, Sao Paulo, Brazil, 2Animal Science, Universidade Estadual de Sao Paulo Julio de Mesquita Filho, Botucatu, Brazil.

The microbiota gut modulation appears to be the key to preventing and alleviating the microbial dysbiosis established by the Eimeria challenge. This study evaluated the potential of postbiotics (fermented compounds produced by yeast) combinations on intestinal inflammation and caecal microbiota of broilers exposed to Eimeria challenge. 1575 one-d-old male chicks were assigned to 5 treatments with 7 replicates (45 chicks/treatment) for 41 days. Dietary treatments were: T1 - negative control (NC), T2 - positive control (PC – enramycin average of 7.5g of active principle/ton); T3 – NC + probiotic (yeast cell wall), T4 – NC + prebiotic + postbiotics, T5 – NC + prebiotic + postbiotics + probiotic (*Bacillus subtilis*). In all treatments the total inclusion of additives resulted in 500 g/ton. At d4, chicks from all treatments were orally inoculated with Bio-coccivet, (20x immunization dose, Biovet S/A). At d28, swab samples were collected (n=6/treatment) to understand the dynamic of gut microbiota. At d15 and d29, 6 birds/treatment were euthanized to collect the ileum for histological analysis according to the I See Inside (ISI) methodology and the score were analyzed by One-way ANOVA (Tukey test, p<0.05). Microbiota was characterized by 16S sequencing on MiSeq Illumina and the data analyzed by an artificial intelligent platform. Gut microbiota analysis showed a linear increase in relative taxonomic abundance between treatments 4 and 5 (combination with postbiotics). However, the other treatments showed a linear decrease in the diversity among them. In both periods, chickens supplemented with the postbiotics combination showed the best ISI Factor, which is closely related to low rates of inflammation. T5 presented the best results of ISI factor at both ages, 1.80 at 15d (P-value. 0.001) and 1.37 at 29d (P-value. 0.01), and NC (3.95 at 15d and 1.51 at 29d) and PC (3.97 at 15d and 1.57 at 29d) the worst values, possibly indicating that the intestinal tissue was more harmed after the challenge. These two treatments showed the presence of specie *Bacteroides dorei*, which is associated with damage to the brush edge and leads to a reduction in the surface area available for nutrient absorption. On the other hand, specie *Butyricicoccus pullicaecorum*, a biomarker related to decreased intestinal lesions, was identified only in T5 group (p-value 0.035). Eimeria infection shifts microbiota, indicating a relationship between intestinal inflammation and modulation by additives that resulted in a better response to the challenge. Thus, the postbiotic combinations were shown to be significant in the maintenance of the gut, modifying and restoring the intestinal microbiota, without drug resistance.

**Keywords:** saccharomyces cerevisiae, intestinal inflammation, postbiotic, microbiota, chickens

### 204 Yeast-based prebiotic improves intestinal microbiota and serotonin production of broiler chickens exposed to Eimeria challenge. Mariana Q. Nascimento1, Marcos Antônio Nascimento2, Ana Beatriz S. Oliveira2, Adriana N. Figueiredo1, João Pedro Fiuza2, Lais C. Garcia2, Ibiara C. Paz2, 1Technical, Aleris Animal Nutrition, Jundiaí, Sao Paulo, Brazil, 2Animal Science, Universidade Estadual Paulista "Julio de Mesquita Filho", Botucatu, Sao Paulo, Brazil.

The microbiota gut modulation appears to be the key to preventing and alleviating the microbial dysbiosis established by the Eimeria challenge. This study evaluated the potential of postbiotics (fermented compounds produced by yeast) combinations on intestinal inflammation and caecal microbiota of broilers exposed to Eimeria challenge. 1575 one-d-old male chicks were assigned to 5 treatments with 7 replicates (45 chicks/treatment) for 41 days. Dietary treatments were: T1 - negative control (NC), T2 - positive control (PC – enramycin average of 7.5g of active principle/ton); T3 – NC + probiotic (yeast cell wall), T4 – NC + prebiotic + postbiotics, T5 – NC + prebiotic + postbiotics + probiotic (*Bacillus subtilis*). In all treatments the total inclusion of additives resulted in 500 g/ton. At d4, chicks from all treatments were orally inoculated with Bio-coccivet, (20x immunization dose, Biovet S/A). At d28, swab samples were collected (n=6/treatment) to understand the dynamic of gut microbiota. At d15 and d29, 6 birds/treatment were euthanized to collect the ileum for histological analysis according to the I See Inside (ISI) methodology and the score were analyzed by One-way ANOVA (Tukey test, p<0.05). Microbiota was characterized by 16S sequencing on MiSeq Illumina and the data analyzed by an artificial intelligent platform. Gut microbiota analysis showed a linear increase in relative taxonomic abundance between treatments 4 and 5 (combination with postbiotics). However, the other treatments showed a linear decrease in the diversity among them. In both periods, chickens supplemented with the postbiotics combination showed the best ISI Factor, which is closely related to low rates of inflammation. T5 presented the best results of ISI factor at both ages, 1.80 at 15d (P-value. 0.001) and 1.37 at 29d (P-value. 0.01), and NC (3.95 at 15d and 1.51 at 29d) and PC (3.97 at 15d and 1.57 at 29d) the worst values, possibly indicating that the intestinal tissue was more harmed after the challenge. These two treatments showed the presence of specie *Bacteroides dorei*, which is associated with damage to the brush edge and leads to a reduction in the surface area available for nutrient absorption. On the other hand, specie *Butyricicoccus pullicaecorum*, a biomarker related to decreased intestinal lesions, was identified only in T5 group (p-value 0.035). Eimeria infection shifts microbiota, indicating a relationship between intestinal inflammation and modulation by additives that resulted in a better response to the challenge. Thus, the postbiotic combinations were shown to be significant in the maintenance of the gut, modifying and restoring the intestinal microbiota, without drug resistance.

**Keywords:** saccharomyces cerevisiae, intestinal inflammation, postbiotic, microbiota, chickens
The correlation between welfare and serotonin production is recognized in the literature as 90% of serotonin is produced in the intestine, which might improve the intestinal quality of chickens, favoring the birds’ well-being. The aim of this study was to determine the serotonin production and the intestinal quality of chickens supplemented with yeast-based prebiotics and exposed to Eimeria challenge. 1890 one-d-old male chicks were assigned to 6 treatments with 7 replicates (45 chicks/cage) for 41 days. Dietary treatments were: T1 - negative control (NC), T2 - positive control (PC – enramycin average of 7.5g of active principle/ton), T3 - NC + Prebiotic (yeast cell wall), T4 - NC + prebiotic + free nucleotides, T5 - NC + prebiotic + probiotic + postbiotic (250g/ton), T6 - NC + prebiotic + probiotic + postbiotic (500g/ton). The control diet (antibiotic-free) was a corn-soybean diet formulated to meet the nutrient requirements of chickens according to the Brazilian tables. Feed and water were available ad libitum. At d4, chicks from all treatments were orally inoculated with Bio-coccivet, (20x immunization dose, Biovet S/A). At d28, swab samples were collected (n=6/treatment) to understand the dynamic of gut microbiota. At d20 and d40, blood samples were collected (n=7/treatment) to a non-invasive evaluation of serotonin dosage. Serotonin data were analyzed by One-way ANOVA and Tukey test (p<0.05). Microbiota was characterized by 16S sequencing on MiSeq Illumina, and data were analyzed by the artificial intelligent platform. Regarding the gut microbiota, a linear increase in relative taxonomic abundance was observed between treatments. The genus Turicibacter, a biomarker for host serotonin production, was identified only in T6 group (p-value 0.0271). Its abundance in T6 was 1.78% and for host serotonin production, was identified only in T6 between treatments. The genus Turicibacter, a biomarker increase in relative taxonomic abundance was observed on MiSeq Illumina, and data were analyzed by the artificial intelligent platform. The effective of antiocccidials was evaluated by analyzes of weight gain (WG), feed conversion (FC) and mean lesion scores. Feces containing E. maxima oocysts were collected in five units and sent to the laboratory for preparation of the challenge inoculum. The test used 240 birds (1-day-old chicks in suspended cages), with the following experimental design: 24 birds per treatment and 10 treatments (T1- negative control, T2- positive control, T3- lasalocide, T4- nicarbazin+ salinomycin, T5-decoquinate, T6- nicarbazine+senduramycin, T7-monensin, T8- salinomycin, T9- narasin+nicarbazine, T10- nicarbazine). At 12 days and until the end of the experiment, the birds received their feed medicated with different anticoccidials. At 14 days, birds from T02 to T10 received the inoculum of E. maxima with about 300,000 oocysts (1 mL/bird). At 20 days, the birds were weighed, as well as the leftover feed, for feed conversion calculation purposes. After that, they were sacrificed, and the lesion score was evaluated at necropsy. The mean lesions scores showed a significant difference between the treatments T1 (negative control), T2 (positive control) and other treatments and among treatments T3, T4, T5, T6, T7, T8, T9 and T10 did not significant difference was found (Kruskal-Wallis test). In the parameters WG, treatments T3, T4, T5, T6, T7, T8 and T10 were statistically equal between each other and different from treatments T1 and T2. The treatments T3 and T7 were the best results in these parameters because they were statistically different from T9 and T2. Treatments T4, T5 and T7 showed the best results in the FC parameter as they showed no difference in significant (Tukey test) with the negative control group (T1) and were different T2 (positive control). Through these results, we have an indication of agents that can compose future programs in this company, with the objective of achieving better zootechnical indicators and, consequently, financial return.

**Keywords:** saccharomyces cerevisiae, welfare, microbiota, chickens, postbiotic

205 Anticoccidial sensitivity test for *Eimeria maxima* in a broiler company in southeast Brazil. Josias R. Vogt1, Eduardo Muniz1, Dircelio N. Junior1, Gleidson Salles1, Antonio L. Neto1, Giovanna Esteves2, Renata N. Reis3, Zoetis, Campinas, Sao Paulo, Brazil, 1CAPEV, Amparo, Sao Paulo, Brazil, 2UDESC, Lages, Brazil.

Coccidiosis is a recurring problem faced by companies producing broilers. Exhaustive use of certain anticoccidial agents without conscious rotation of product classes has led to resistance. The objective of this study was to evaluate the response of the main control molecules to coccidiosis, in a broiler company in the Southeast of Brazil. The tool used was the AST – Anticoccidial sensitivity test, a scientific method to support the differentiation of these molecules by field-isolated *Eimerias*. The effectiveness of anticoccidials was evaluated by analyzes of weight gain (WG), feed conversion (FC) and mean lesion scores. Feces containing *E. maxima* oocysts were collected in five units and sent to the laboratory for preparation of the challenge inoculum. The test used 240 birds (1-day-old chicks in suspended cages), with the following experimental design: 24 birds per treatment and 10 treatments (T1- negative control, T2- positive control, T3- lasalocide, T4- nicarbazin+ salinomycin, T5-decoquinate, T6- nicarbazine+senduramycin, T7-monensin, T8- salinomycin, T9- narasin+nicarbazine, T10- nicarbazine). At 12 days and until the end of the experiment, the birds received their feed medicated with different anticoccidials. At 14 days, birds from T02 to T10 received the inoculum of *E. maxima* with about 300,000 oocysts (1 mL/bird). At 20 days, the birds were weighed, as well as the leftover feed, for feed conversion calculation purposes. After that, they were sacrificed, and the lesion score was evaluated at necropsy. The mean lesions scores showed a significant difference between the treatments T1 (negative control), T2 (positive control) and other treatments and among treatments T3, T4, T5, T6, T7, T8, T9 and T10 did not significant difference was found (Kruskal-Wallis test). In the parameters WG, treatments T3, T4, T5, T6, T7, T8 and T10 were statistically equal between each other and different from treatments T1 and T2. The treatments T3 and T7 were the best results in these parameters because they were statistically different from T9 and T2. Treatments T4, T5 and T7 showed the best results in the FC parameter as they showed no difference in significant (Tukey test) with the negative control group (T1) and were different T2 (positive control). Through these results, we have an indication of agents that can compose future programs in this company, with the objective of achieving better zootechnical indicators and, consequently, financial return.

**Keywords:** coccidiosis, AST, weight gain, feed conversion, lesion scores
Symposium: Total Approach to Salmonella Control: Perspectives and Opportunities

206S The importance of “solutions” synergy for Salmonella control in the poultry chain. Sherry Layton, University of Arkansas, Fayetteville, Arkansas, United States.

Advancements in the area of biotechnology have increased our innovative potential and allow us to use these technologies to design advanced control strategies for Salmonella spp. It is important for us to remember there is no “magic” one control strategy for Salmonella. These control strategies should incorporate several approaches throughout the chain. It is also equally as important to ensure that these control strategies are synergistic and work together.

Keywords: biotechnology, Salmonella

207S Salmonella: Control in the field for success in the slaughterhouse. Roberto M. Filho, São Salvador Alimentos, Itaberaí, GO, Brazil.

The subject will be approached emphasizing the pillars of poultry production that are under the responsibility of Agro-Industries. The importance of balance between handling, biosecurity, environment and nutrition will be addressed. The success for salmonella control is dependent on concepts and procedures established by the field, before chickens arrive at the slaughterhouse.

Keywords: environment, biosecurity, handling, nutrition, salmonella
Symposium:
One Health and Antibiotic-free Poultry Production: Actual Global Challenges

208S One Health: Concept and relevance in food safety. Control of zoonoses, antibiotic resistance and impact on public health. João Palermo-Neto, School of Veterinary Medicine, University of São Paulo, São Paulo, SP, Brazil.

The “one health” is an integrated approach that considers human health, animal health and the environment. The knowledge on guidelines of prudent use of antimicrobials in livestock together with strong surveillance system actions for zoonotic diseases prevention and control, including those transmitted by resistant bacteria, might contribute to reduce antimicrobial-drug resistance spread and its impact on public health.

Keywords: antimicrobial-drug resistance, drugs, diseases, poultry

209S Brazilian public policies for the prevention and control of antimicrobial resistance in animal production. Diego Menezes de Brito, DIFE/CGPV, MAPA, Brasilia, Brazil.

The topics that will be addressed are antimicrobial resistance and unique health, global context, national context, PAN-BR Agro, the 5 strategic objectives and their actions during the 1st 5-year cycle (2018-2022), surveillance and monitoring of antimicrobial resistance in agriculture, institutional commitments and international cooperation, context in the world organization for animal health, challenges, opportunities, expectations, and MAPA positioning.

Keywords: unique health, animal health, Brazilian government

210S Antibiotic use impact in poultry immune system and food safety. Doug Korver, University of Alberta, Edmonton, Alberta, Canada.

Antibiotic growth promoting (AGP) antibiotics have been successfully used to increase growth, productivity, and efficiency of broiler chickens. The global trend, however, is to reduce and eventually remove these products from use, largely over concerns related to antimicrobial resistance in human pathogens. There are several likely mechanisms of AGP action, but most important seems to be the direct and indirect reduction of inflammation in the gut, which reduces the whole-body cost of diverting nutrients away from growth, and towards the inflammatory response. The removal of AGP has resulted in significant costs to the industry, and efforts are underway to identify alternative strategies to replace the function of AGP. The metabolic costs of inflammation in broiler chickens will be discussed, as well as some examples of alternative strategies that have shown some success under research and commercial conditions. Successful replacement of AGP will likely involve the use of multiple alternate products, each with different modes of action.

Keywords: Antibiotic growth promotor, cost of inflammation, antibiotic alternatives, antimicrobial resistance

211S Immunonutrition applied to poultry production supporting the AGP reduction. Breno C. Beirão, Paraná Federal University (UFPR), Curitiba, Brazil.

Optimal performance of immune cells requires a combination of nutrients and of other feed substances that are different from those required for muscle cell growth. Intestinal neurons and enterocytes will also signal to immune cells during “challenge”, and this has rarely been assessed during feed formulation. Here we will discuss several nutrients and other feed components that can influence on cells within the intestine which can alter the function of mucosal immunity.

Keywords: immunonutrients, gut health, gut-brain axis

212S Brazilian poultry industry experience: immunonutrition practical application. Ricardo Rauber, Vetinova, Curitiba, Brazil.

The concept of modulating the responses of the animal’s organism to build better response to diseases and health challenges is not new. However, the approach we apply for this modulation is new when talking about immunonutrition and the use of certain strategies to achieve this objective. Replacing Antibiotics as Growth Promoters (AGP) in poultry production can be as challenging as dealing with clinical, endemic diseases and the poultry industry is getting more and more support from the academy, suppliers, and internal talents to do it with limited to no losses in the process. This knowledge generated with the experience of professional in the field is being applied in several companies in Latin America and other parts of the world and involve the use of commercial products as part of the strategies but also relies on the commitment of the producers in applying the standards on biosecurity and management stablished by those professionals.

Keywords: health challenges, AGP, biosecurity, gut health

213S Practical application of feed additives as immunonutrients. Melina A. Bonato, R&D, ICC Brazil, Jaboticabal, São Paulo, Brazil.

According to the established concept of immunonutrition, there some substances that are not absorbed like nutrients but are able...
to modify the immune system response, directly or indirectly, such as prebiotics, probiotics, phytogenics, organic acids, and others. β-glucans are among the most studied immunonutrients and the benefits in the animals can be measured through the quantification of antigen-presenting cells circulating in the blood, helper T (CD4) and cytotoxic T (CD8) lymphocytes, immunoglobulins, vaccine titers and others. Thus, effects on the maintenance of intestinal permeability may also be observed, since there is a close relation between the microbiota, the intestinal permeability, and the immune system.

**Keywords:** immunomodulation, β-glucans, gut health
Symposium: 
Proteins: From Feedstuffs to Meat


Many parameters are affecting the quality of the nutrients of the raw materials used for formulating animal feed. Cultivars, soil management, weather conditions, technological and chemical processes are examples influencing the quality and digestibility of those nutrients. Feed formulation often take only one value from tables to optimize the nutritional value of the feed and the nutritionist has to adjust its safety margin. This leads to an insecurity in feed composition and a waste of nutrients and money. In this presentation, the focus will be on the evaluation of variability and quality parameters of the protein from raw materials and the impact on digestibility and performance.

Keywords: digestible amino acids, near infrared reflectance spectroscopy, safety margin, anti-nutritional factors, feed efficiency


Dietary formulation for broilers in terms of feed grade amino acid ingredient availability now includes the first four most limiting amino acids. The former is in reference to diets where valine is fourth limiting that are primarily based on vegetable protein sources. However, both arginine and isoleucine can be fourth limiting pending dietary ingredient makeup, and their feed grade forms are available in practice in limited amounts. In diets based on corn and soybean meal, the increased use of feed grade amino acids results in diets with increased corn, and as a result increased leucine. This presentation will focus on the branched-chain amino acids and practical interactions, in addition to assessment of the histidine needs in broilers. The use of alternative ingredients in broiler diets (e.g., trait improved soybean meal and algae) will be discussed, in addition to the use of the net energy system in broiler diets with lowered protein.

Keywords: algae, broiler, net energy, valine, isoleucine


Protein utilization by broiler chickens depends on digestion, absorption, and synthesis of body components in rates that optimize economical response. The chickens, as well as the turkeys, are omnivorous animals that have limited gut fermentation. In the nature they are fed from seeds, worms, and insects, for which they are well equipped by having gizzards providing adequate feed texture as well a wide range of endogenously secreted proteases. Commercially grown chickens are mostly fed cereals (corn, wheat), soybean meal (eventually canola and sunflower). All other feed ingredients have a minor role in integrated systems that are in place to raise birds for meat. Animal by-products are excellent sources of feed protein as well as Ca and P, but, for one side they can only have a limited use as a proportion of the whole feed due to market availability, but also cannot be used as feed ingredients for animals raised for human consumption due to rules in various countries. Major limitations arise from the use of the vegetable feed ingredients described above. Their amino acid balance requires inclusion of synthetic amino acids. A main concern relates to the digestibility of insoluble and soluble types of fiber present. These limit the energy value obtained by birds but also induce anaerobic environments potentially leading to limitation in protein digestion. Extensive research is presently conducted with exogenous enzymes with positive perspectives that reduce the limitation in feed protein digestion that include proteases, but also carbohydrases that degrade soluble fiber that reduce the overall bird capacity to digest protein.

Keywords: gut health, protein digestibility, microbiota, dysbiosis

217S Undigested proteins, one of the important factors of gut health. Richard Ducatelle, Ghent University, Merelbeke, Belgium.

In healthy birds, ideally all feed proteins should be digested and absorbed in the duodenum and jejunum. Proteins from the host, including secreted enzymes and desquamated cells, reach the lower intestinal tract and are fermented by a specific subfraction of the microbiota, causing no harm. Excess and undigestible feed protein, however, is one of the most important triggers of dysbiosis and inflammation in the intestinal tract. In this presentation, the focus will be on the harmful effects of undigestible protein on the microbiota and how to remediate these issues.

Keywords: gut health, protein digestibility, microbiota, dysbiosis

218S New insights on breast abnormalities in broilers: possible underlying mechanisms. Francesca Soglia, University of Bologna, Cesena, Italy.

Selection for fast-growing and high-breast-yield hybrids has considerably increased the pressure on breast muscle development, leading to the appearance of growth-related abnormalities (i.e., white striping, wooden breast and spaghetti meat) affecting the pectoral muscles of heavy and fast-growing birds. Occurrence of these defects negatively affect both visual aspect and quality properties of raw and
processed meat, causing relevant economic losses for the poultry industry. In the past few years, several studies have been carried out to investigate the biological mechanisms and involved in their occurrence and understand their eventual genetic basis. In addition, attempts have been made in the fields of animal nutrition and early animal management to reduce the incidence levels of these defects. This lecture is therefore intended to examine the possible causative mechanisms and methods for mitigating one the most important quality issues affecting chicken breast meat.

**Keywords:** breast muscle abnormalities, mechanisms, white striping, wooden breast, spaghetti meat
Symposium:
Sustainability in Poultry Production: How Does Nutrition Affect the Animal Performance and Environment?

219S Interaction between physiology, digestion and digestibility. José Henrique Stringhini, Universidade Federal de Goias, Goiânia, GO, Brazil.

In this presentation, the theme, Interaction between physiology, digestion and digestibility in poultry will be correlated using personal experience and experiments conducted in our and other universities and research centers. Sometimes, it is hard to explain the theme because we need special conditions to summarize and conclude about nutrition and other aspects of poultry production and health. The idea is analyzing some scientific results and point some aspects that could collaborate with the studies in digestibility.

Keywords: digestibility, intestinal integrity, metabolism, nutrition, poultry

220S Gut health as a scientific methodology and practical tool for modern poultry. Antonio G. Bertechini, Animal Science, Federal University of Lavras, Lavras, Brazil.

Studies over time have always focused exclusively on the productive performance of birds. At the same time, they indicate great variability of results and nutritional indications influencing aspects related to the welfare and productivity of broilers and commercial layers. Understanding the entire process, with indicators that can have an impact on the health and well-being of birds, is essential to harmonize the entire system. The health of the digestive tract of birds directly affects all events in the broiler meat and egg production system. Problems such as foot pad dermatitis, ascites, skin condition, mycotoxin effects, intestinal microbiological challenges, microbiota, immune system competence, epithelial barriers, among others, in addition to influencing performance, have strong effects on the well-being and health of birds. Knowing measures that can understand and harmonize the physiological and nutritional aspects of birds can improve the entire production system of modern industrial poultry.

Keywords: gut health, immune system, microbiome, productivity, well-being

221S Impact of proteases on nutrient digestibility and performance. Horacio S. Rostagno, Federal University of Viçosa, Viçosa, MG, Brazil.

The objective of the addition of enzymes to broiler diets is to minimize nutrients excretion and simultaneously maximizing retention without affecting animal performance. Experiments have shown that the utilization of protease improves the metabolizable energy and the amino acids digestibility of full fat soybean, soybean meal and corn/soybean meal diets. Diets formulated with corn/soybean meal/alternative feedstuffs plus phytase and protease resulted in increased amino acids digestibility and performance. Thus, it is recommended the supplementation of enzymes to poultry diets, in order to optimize nutrient utilization.

Keywords: alternative feedstuffs, amino acids, broilers, digestibility, protease

222S Anti-nutritional factors in poultry feed ingredients. Andreia Massuquetto, Tectron, Toledo, Parana, Brazil.

The main challenges nowadays in poultry production are to reduce feeding cost, improve products quality and decrease the impact of production on environment. Given the current scenario of high commodity prices, the use of unconventional ingredients is an alternative to meet the demand for animal feed and reduce costs. However, the presence of anti-nutritional factors in these ingredients may interfere with the feed intake, availability, or metabolism of nutrients in the animal, worsening performance and increasing the excretion of undigested components into the environment. Therefore, companies must be committed to developing solutions that promote efficient nutrient utilization to sustainably enhance productivity.

Keywords: alternative ingredients, nutrients digestibility, performance, soybean, sustainability

223S What are the ways to poultry production adaptation to the new demands of society? Lucio F. Araujo, Animal Science, University of Sao Paulo, Pirassununga, Sao Paulo, Brazil.

Consumers play an important role in choosing the products that will be part of their diet. It is not enough to offer a quality final product at a low cost. It is necessary to think about animal welfare and preserve the environment for future generations.

Keywords: antibiotic free production, sustainability, welfare
Symposium: Feeding Strategies to Improve the Gut Health and Performance of Poultry

224S Critical points in the quality control of raw materials and new solutions and its impact on poultry health and performance. Everton L. Krabbe, Embrapa, Concórdia, SC, Brazil.

Abstract not available.

Keywords: raw materials

225S Influence of feed particle size and feed structure on intestinal health and poultry performance. Wilmer Pacheco, Auburn University, Auburn, Alabama, United States.

Abstract not available.

Keywords: particle size, intestinal health, performance


Abstract not available.

Keywords: fiber

227S Achieving a precise amino acid nutrition to improve poultry health, welfare and performance. Juliano Dorigam, Evonik, Hanau, Darmstadt, Denmark.

Abstract not available.

Keywords: poultry health, welfare, performance

228S Optimizing feed additives in poultry using microbiome analyses. Steven Ricke, University of Wisconsin, Madison, Wisconsin, United States.

Abstract not available.

Keywords: feed additives, microbiome analyses

229S Practical application of feeding strategies to improve the overall health and performance of broilers. Eduardo Butolo, Integral, Eusebio, Brazil.

Abstract not available.

Keywords: health, performance, broilers
**Symposium:**

**The Positive Balance Between Agents that Impact the Optimized Functionality of the Entire Intestinal Process**

**230S** A new look to the gut health concept, approach, and management. Hugo Romero Sanchez, Novus International, Saint Charles, Missouri, United States.

The increase in antimicrobial resistance has led to the banning of Antibiotic Growth Promoters (AGP) in the poultry industry, bringing about a proliferation of products to replace AGP, in the mitigation of subclinical enteric diseases, such as organic acids (short and middle chain fatty acids), essential oils, probiotics, and different commercial products with several combinations. Additionally, the number of peer review publications has increased exponentially as the number of products appear into the market. This increment in products and research, brings new opportunities but also creates big challenges to the poultry nutritionist who should maintain lower feed cost at high performance with a sustainable solution. On the other hand, numerous methodologies have been developed to demonstrate pertinence and efficacy of these products, with different mode of actions and economic variables like return of investment. Methods include challenges using different instigators to exacerbate the gut inflammation, including dietary composition and different microbiological challenges (coccidia & Cl. perfringes). Despite the extensive data under controlled conditions, the variability in the commercial farms affect the response of the feed additives, leading to questions about the mode of action or the efficacy of the feed additive under specific conditions. A basic solution should be to choose feed additives that add nutrients while improving gut function and maintaining microbiota balance. The first concept to maintain gut function should be related to feed formulation (including enzymes to reduce undigestible and antinutritional compounds), adequate feed particle size to improve gut function and the use of trace minerals to decrease pathogen population. However, in any given solution, environmental sustainability and profit should be prioritized.

**Keywords:** gut function, feed additive, enteritis, minerals, sustainability

**231S** Intestinal integrity - Reorganizing concepts and their practical applications in broilers. Antônio Froilano, Froilano Consultoria Ltda, Descalvado, SP, Brazil.

Abstract not available.

**Keywords:** weight gain, microbiota, intestinal health, high absorption

**232S** Dynamic of immunology and barriers response – Updates on concepts. Luis F. Caron, Federal University of Paraná, Curitiba, Brazil.

Gut microbiota has multiple interactive effects on host immunity, nutrition, and health. The balance of host-microbiome impacts live performance, welfare, food safety, and the environment inside and outside the poultry houses. For several decades, controlling the gut microbiome of poultry and livestock has been a research objective. Despite the accumulated knowledge, there is much to learn about the microbiome to develop consistent methodologies to modulate it. Most research projects have focused on gut bacteria, but little is known about enteric fungi and virome, their interactions, and their functions. This presentation will discuss maternal nutrition, egg disinfection, early management, host nutrition, feed and water additives, and the house environment on the gut microbiome. There is evidence that microorganisms can colonize poultry guts in the hen’s reproductive tract during egg formation. These confirmed facts give more relevance to maternal microflora, nutrition, and welfare on the gut health of the next generation. In the past two decades, microbiology shifted from traditional culture-dependent techniques to advanced metagenomic approaches with culture-independent methodologies. Despite these advances, some scientists still use culture-based methodologies for more straightforward interpretation. But, we should consider the misleading results that these techniques can cause when trying to understand these incredibly diverse and dynamic anaerobic microbial communities. Gut microbiome succession, richness, diversity, stability, resilience, and metabolism are traits that should be studied to understand the multiple effects of any intervention to modulate microbial flora. Molecular biology methods and bioinformatics have evolved to quantify each one of these factors. Many new microbial taxa and genes have been discovered using metagenomics. However, the microbiome dynamism, its diversity, and the variable gut microenvironments make it challenging to understand the multiple changes that may occur with each intervention. The most up-to-date methodologies to study the microbiome and its limitations will be discussed during this presentation. The advances in modulating poultry gut microbiome and the potential flaws will be highlighted. Mechanisms of action for several feed additives considered microbial modulators will be described and the unknowns listed. The gut microbiome will remain an exciting area of research for years since different kinds
of unknowns arise in every project. The interrelationships among gut microbiota and host are complex and poorly elucidated. The author expects to stimulate holistic research development considering all these multiple factors.

**Keywords:** microbiome, gut health, food safety, environment, methods

234S Searching and understanding the microbiota metabolites. Anderson Cunha, Universidade Federal de São Carlos, São Carlos, Brazil.

Microbiota is defined as the assemblage of microorganisms such as bacteria, fungi, protists, and viruses that live together in a specific environment. The interactions among these microorganisms and their hosts are of paramount importance since the proteins, enzymes, and metabolites expressed by the microbiota could interfere directly with the host metabolism. Several methods have been used to understand this relationship, identifying who are those microorganisms, their function, and how and what changes they could produce in the hosts. Undoubtedly, metabarcoding analyses emerged as a high-throughput and low-cost option for characterizing the structure and composition of the communities of these microorganisms. Using high throughput sequencing of a region of the 16S and/or 18S rRNA (ribosomal RNA), this technique allows the genetic analysis and quantification of several microorganisms from pooled samples of various sources. For broilers, this technique has been used for the study of microorganism communities associated with changes and supplementation in diet, feed efficiency, during treatment against infection, and even the relationship with geographic localization. Several studies showed that the composition of the microbiota is strongly linked to chicken health and productivity and that metabolites produced by both the microbiota and the host can influence intestinal health. Furthermore, this technique allows the analysis of microorganism composition using feces, which could help in monitoring the farm without the need of handling animals. Understand all the aspects related to changes in the broiler’s microbiota could increment the knowledge and help in the assertiveness of the different methodologies that aim to improve the quality of health and productivity in these animals. All aspects related to the concept of this technique and several results obtained in studies conducted by our group in association with Novus International Inc., will be addressed in this lecture.

**Keywords:** microbiota, productivity, metabarcoding analyses
**Symposium:**

**Precision Intestinal Nutrition: A New Definition for Protease and Xylanase**

235S *Variation on ingredient quality and substrate concentrations: Opportunities for protease and xylanase.* C. Roselina Angel, University of Maryland, College Park, Maryland, United States.

Choosing the right enzyme or combination of enzymes and their concentration depends primarily in the concentration and location within the ingredient these substrates are. Ingredients vary considerably in the concentration and specific chemical structure of substrates for which we have enzymes for. Substrates also can be bound together in ways that are best addresses with more than one enzyme acting in synergy. This presentation will focus on substrates, their location within the seed and their interactions with each other for which we currently have commercial enzymes and the variability of these key substrates within key ingredients, as well as exploring single or interactive efficacy of enzymes towards these substrates.

**Keywords:** Feed enzymes, ingredient nutrient variability, substrate concentration and location, interaction between substrates

236S *Precision intestinal nutrition and meat quality: A new application for enzymes.* Elizabeth Santin, 1 I See Inside Institute, Curitiba, SP, Brazil, 2 Jefo Nutrition, Saint-Hyacinthe, Quebec, Canada.

The chronic low-grade inflammation at the intestinal have been presented a recurrent find in broilers production and is related to negatively affect animal performance and contribute to reduce meat quality. Some technologies that can act preventing this process as proteases and xylanases, their proposal mechanism of action and some results will be discussed.

**Keywords:** intestinal health, enzymes, low-grade-inflammation, meat quality

237S *The use of enzymes as a tool to meet the demands of modern consumers.* Everton L. Krabbe, Embrapa, Concórdia, Brazil.

Poultry industry has been facing different challenges worldwide. Diseases, raw material shortage and consequent feed cost increase, antimicrobial removal from the feed, climate changes and so on. Beside all those aspects, sustainability has come to our agenda very strongly. Enzymes are extraordinary tools to support feed industry to deal with all those critical points. Join us during the LA PSA for a nice discussion.

**Keywords:** feed, food security, sustainability, customers demand
238S The environmental footprints of Grain production in different regions of the world and is any of them more sustainable than others? Carlos Saviani, DSM Nutritional Products, Pratteln, Switzerland.

The grains produced in Latin America have, by the greater part, been negatively impacted on the sustainability aspects especially because of the high risk of deforestation that many countries in the region carry. Many retailers, investors, processors, government officials and NGOs alike are discouraging the use of grains and their core-products from the region because of those issues, reflected also in a high carbon footprint due to land use change (the so called LUC). This has created a big burden and also possible higher costs to the poultry industry. So in this presentation we will review these issues, understand their impacts and implications for the poultry industry and explore possible solutions.

Keywords: Poultry, sustainability, deforestation, land use change, GHG emissions

239S Optimizing the nutritional value of soybean meal for poultry. Aaron Cowieson1,2, DSM Nutritional Products, Kirkwall, United Kingdom,2Purdue University, West Lafayette, Indiana, United States.

The nutritional value of soybean meal for poultry varies and this variation is both chemical and mechanical in origin. For example, residual trypsin inhibitors, phytic acid and raffinose series oligosaccharides are a nutritional headwind for poultry and disrupt protein and energy digestibility, especially at a net level. Particle size and soybean processing conditions also create variance in bulk density and nutrient bioavailability. This talk will consider the most dominant factors that contribute to the nutritional value of soybean meal and provide examples where the use of exogenous feed enzymes can be used to mitigate these effects.

Keywords: soybean, enzymes, nutrition, digestion, anti-nutrients

240S Variation of starch digestibility between animals. Sebastian Kaczmarek, University of Poznan, Poznan, Poland.

Starch is the primary source of energy in diets for broiler chickens, and its rate of degradation in the gastrointestinal tract has a significant impact on energy availability for the bird. Broilers are notorious for their efficiency in digesting starch, as ileal digestibility coefficients observed throughout the literature are commonly above 0.95. Nutrient utilization is also affected by individual animal heterogeneity, as traits like enzyme production and AME may have between-bird variation. The purpose of the study was to investigate the variance of starch digestibility coefficients in broilers fed maize based-diets with or without exogenous amylase on an individual bird basis.

Keywords: amylase, broiler, individual variation, starch

241S Starch digestibility and intestinal dynamics during four growth phases in broiler chickens. Layi Adeola, Purdue University, West Lafayette, Indiana, United States.

Among the nutrients in poultry diets, starch is the most quantitatively significant energy-yielding source. Although digestibility of starch is relatively high, some proportion of the dietary starch may escape digestion in the small intestine and maturity of the digestive system of younger birds may affect digestion. The capacity to digest starch changes as the intestinal tract matures with age and pancreatic amylase production. Therefore, interaction between bird age and exogenous amylase supplementation is imperative, as this may be relevant in targeted opportunity for the most effective dietary supplementation. The talk will present studies conducted to evaluate the growth performance, nutrient digestibility, intestinal health, and endogenous enzyme secretion responses to dietary α-amylase supplementation during four growth phases of broiler chickens fed corn-soybean meal–based diets.

Keywords: amylase, broiler, digestibility, enzyme, starch

242S Corn utilization differences from area of production and processing treatments. Sergio L. Vieira, Universidade Federal do Rio Grande Do Sul, Porto Alegre, RS, Brazil.

Original from the Americas, corn is presently the most important feed ingredient produced worldwide. It is by far the main energy source in commercial feeds for animals. Production estimation from the world’s last year crop averages 1.2 billion tons. Few areas in the world, however, respond to most of the corn production. Environment and genetics vary from corn produced in these areas, which affect its composition. Even though significant differences exist in terms of composition, however, these are almost never considered when formulating feeds. Main differences in composition are related to protein and starch contents, which may impact digestibility and overall utilization of corn, more importantly by chickens and other non-ruminant animals. For instance, changes in composition from corn produced in the Brazilian cerrado are consistent when compared to that produced in the South of the country. These differences raise opportunities related to the use of
exogenous enzymes, which then may create added value to corn.

**Keywords:** crop quality, weather, biome

**243S Predicting FCR based on corn quality and NSP content?** Carrie L. Walk, DSM Nutritional Products, UK, Heanor, United Kingdom.

Differences in corn quality, due to genetics, environment, and harvest and processing conditions can result in large variation in the nutrient content of corn. This includes starch, protein, non-starch polysaccharide (NSP), and apparent metabolizable energy (AME) and can impact broiler feed conversion ratio (FCR). The objective of this work was to determine corn quality factors that influence broiler FCR using a meta-analysis and then quantifying the impact of these factors on FCR. The estimated differences in FCR were approximately 12 points (1.57 vs. 1.45) and these results highlight the significant impact corn quality has on production efficiency and relationships between protein solubility, NSP, and starch content in corn.

**Keywords:** broiler, corn, protein solubility, starch digestibility

**244S Amino acid digestibility in corn and SBM – Where to put armour plates?** Reza Abdollahi, Massey University, Wellington, New Zealand.

A large volume of published data exists on the ileal digestible amino acid (AA) content of feed ingredients, including corn and soybean meal, for broiler chickens. These evaluations have been accomplished using mash diets. Commercially, however, broiler chickens are fed pelleted diets and the applicability of data generated using mash diets to pelleted diets can be questioned. Our research shown that the feed form has a substantial impact on digestibility estimates of AA, and it should be considered in AA digestibility assays. Moreover, endogenous AA (EAA) value for birds is influenced by bird age, and therefore, application of age-specific values for EAA flow may benefit accurate standardization of amino acid digestibility for corn and soybean meal and improve the precision of feed formulations. Apparent ileal digestibility (AID) of AA in corn and soybean meal (SBM) is undervalued when individually assessed compared with their contribution in a corn/SBM mixture but that this discrepancy is rectified when standardized ileal digestibility (SID) values are used. Furthermore, when feed enzymes are applied under AID-based systems of formulation, it may be that effects are difficult to interpret because of lack of precision in the feed formulation. A recent study demonstrated additivity of AA digestibility effects of exogenous enzymes under AID and SID systems and suggests the use of exogenous enzymes may improve the additivity of AID and SID AA values for use in complex diets.

**Keywords:** poultry, amino acid digestibility, endogenous amino acid flow, enzymes, feed form
Symposium:
Current Challenges in the Poultry Industry – Health and Nutrition

245S Health challenges for the poultry production in Latin America - an update. Aristóteles M. Vergara, Consultant, Mainz, Germany.

Abstract not available.

Keywords: health challenges, Latin America


Abstract not available.

Keywords: necrotic enteritis, broiler production

247S Experience with coccidiosis vaccination in ABF/NAE broilers. Juan Francisco R. Cambre, Poultry Business Unit, MSD Salud Animal, Mexico City, Mexico.

Abstract not available.

Keywords: coccidiosis vaccination

248S Early nutrition and immune in broilers. Luis F. Caron, UFPR, Curitiba, Brazil.

Abstract not available.

Keywords: challenges

249S Challenges and opportunities to advance broiler nutrition. Peter Ferket, North Carolina State University, Raleigh, North Carolina, United States.

Abstract not available.

Keywords: challenges, broiler nutrition
Symposium:
End to End Concept

250S Inspection systems through self-controls and main convictions in slaughterhouses. Liris Kindlein, UFRGS, Porto Alegre, Brazil.

Abstract not available.

Keywords: inspection, slaughterhouses

251S Reproductive parameters of hens and roosters: How can we improve? Tiago G. Petrolli, Animal Sciences, West Santa Catarina University, Xaxim, SC, Brazil.

Abstract not available.

Keywords: reproductive parameters

252S Strategies with alternative products that maintain batch health. It's possible? Caroline Facchi, Research and Development, BTA Aditivos, Vargeão, Santa Catarina, Brazil.

Abstract not available.

Keywords: batch health

253S PPLA and liquid dosing: A technical approach to concept and use. Fernando Vieira, BTA Aditivos, Xanxerê, SC, Brazil.

Abstract not available.

Keywords: PPLA
Authors Index

A
Abdollahi, Reza, 244S
Abdulateef, Salwan M., 19
Adeola, Layi, 241S
Agilar, Jessica, 22
Akinlade, Akinyemi I., 153
Albino, Luiz F., 6, 15, 16, 17, 108, 109
Alencar, Jessica A., 119, 151
Alrubaye*, Adnan, 190
Altevogt, Walter E., 1, 44, 45, 46, 47, 66
Alvares, Lucas K., 140, 143, 144, 199
Alvarez, Jim, 133
Alvarez Mira, Diana, 23, 42, 65
Alves, Victória V., 96
Alves, Warley J., 116, 117
Alves Duarte, Fernanda, 178
Alves Duarte, Laura, 31, 178
Amanda Bebber, Bárbara, 14, 58, 152
Amaral, Thaciane L., 88, 178
Amos, Adedoyin T., 153
Andrade, Thiago S., 58, 146, 152, 183, 193, 194
Andretta, Ines, 123, 124
Andrysiak, Justyna, 97
Angel, Clara R., 195, 235S
Anjum, A.D., 87
Antonio Mario, Penz Jr, 110
Anwar, Haseeb, 157
Arantes, Leticia C., 96
Araujo, Cristiane S., 38, 43, 181
Araujo, Itatto, 48
Araújo, Lucio F., 38, 43, 223S
Araújo Castro, João Lucas, 132, 134
Aristimunha, Patricia, 202
Arnaut, Pedro R., 117
Arrigucci Bernardes, Priscila, 69
Atanasov, Atanas, 113
Aureli, Raffaella, 182
Awaad, Mohamed H., 128
Azevedo, Vasco A., 81
Azis Garcia de Araújo, Wagner, 132, 134

B
Bafundo, Ken, 82
Bai, Shiping, 60
Baptista, Ana A., 64, 101, 102
Barberis, Lucas, 27
Barbi, José Henrique, 51
Barbosa, James d., 143, 198
Barbosa, Nei A., 112
Barcellos, Joyce, 106, 116
Barros, Mercia R., 191, 192, 196, 197
Bassi, Lucas S., 12, 24, 185, 186, 188
Batista, João Marcos M., 127
Bebber, Barbara Amanda, 179, 193, 194
Beirão, Breno C., 93, 173, 211S
Belote, Bruna, 142
Belote, Bruna L., 92
Benevides, Valdinepe P., 94, 100
Benito, Carlos E., 29, 144, 199
Benteo, Ana C., 101
Berchieri Junior, Angelo, 91, 94, 100
Bergmann, Guiomar P., 95
Bernardes, Romário, 17
Bernardes, Romário D., 6, 15, 16, 108, 109
Bernardi, Gabriel, 151
Berri, Mustapha, 89
Bertechni, Antonio G., 121, 175, 220S
Bertechni, Antonio, 168
Bertolini, Francisco, 40
Betancourt, Liliana, 23, 42
Bícego, Kênia C., 86
Biêlke, Lisa, 88
Biselo, Valeria, 119
Bittencourt, Leticia C., 111, 114, 115, 129, 184
Blokker, Britt, 83
Bodie, Aaron, 62
Boiago, Marcel M., 155
Bombardelli, Robie Allan, 183
Bonagurio, Lucas P., 3, 153
Bonamigo, Renata, 136
Bonaspetti, Sandra, 34, 136, 151
Bonato, Melina A., 173, 213S
Bonifacio, Sandra, 30
Borges, Samuel O., 17
Borges, Sebastião A., 2, 50
Bortoluzzi, Cristiano, 142
Bottje, Walter G., 70
Braga, Gabriel, 18
Braga, Paula F., 81
Bravo, Amanda M., 20
Briens, Mickael, 189
Britto Doi, Ana C., 4, 11, 69, 104
Broch, Jomara, 73, 183
Brown, Jessica A., 63
Bruneel, Brecht, 172
Bruxel, Taciana, 162, 165, 167
Bucci, Jessica S., 75, 126
Buehler, Kathrin*, 190, 193
Bunzen, Silvano, 171
Butolo, Eduardo, 229S

C
Café, Marcos B., 39, 130, 135
Café, Marcos B., 131
Caio Cesar Besson, Silva, 110
Calderano, Arele A., 6, 15, 16, 17, 108, 109, 170
Camara, Mayara M., 58, 148, 152
Camargos, Rosiane d., 7, 9, 86, 158
Cambre, Juan Francisco R., 84, 247S
Campbell, Joy, 43
Campestrini, Evandro, 145, 146, 179
Campos, Felipe P., 52, 72, 105, 145, 148, 180
Campos, Isabella Cardeal, 94
Cano, Guillermo, 187
Cardoso, Daniel R., 181
Cardoso, Denise, 189
Cardoso, Mateus, 136
Cardoso, Vinicio dos Santos, 59
Careli, Pedro, 106
Carneiro de Oliveira Falcão, Ingrid, 178
Caron, Luis F., 232S, 248S
Carrasco, Sergio, 84
Carrillo, Analucia E., 71
Carvajal, Jairo, 185
Carvajal, Loren, 42
Carvalho, A.C., 175
Carvalho, Andressa, 121, 168
Casanova, Natalia A., 75, 126
Casimiro, Lara H., 166
Castelani, Amanda B., 200
Castelo, Pedro, 107
Castro, Kelly N., 151
Castro, Lucas, 39
Céspedes, Rubén, 150
Cheneri, Camila K., 13, 158
Ching, San, 98
Cicero, Claudineia E., 101
Cirilo, Edinan H., 72, 167, 180
Cirilo, Lucas V., 131
Colcetta, Bárbara, 122, 162, 166, 177
Colucci, Beatriz S., 10
Comin, Gabriel N., 145, 146
Conceição dos Santos, Marley, 4, 5, 24, 69, 104, 163, 186
Corban, James, 63
Cordeiro, Deibity, 39
Cordido, João Pedro d., 54
Coronado, Alejandra, 35
Coronado, Augusto J., 69
Correa Rocha, Josilene, 135
Costa, Ana P., 58, 152
Costa, Fabiano S., 191
Costa, Icaro M., 81
Costa, Miguel Z., 86, 158
Costa, Silvio T., 57
Costa, Matheus F., 8
Costa Senger, Geovani, 4, 11, 104, 188
Cowieson, Aaron, 90, 182, 239S
Crenshaw, Joe, 43
Crespão, Daiane, 14
Cristina Mohr de Souza, Mariane, 58, 152, 179
Crowley, Tamsyn M., 53
D. Starkey, Jessica, 56, 152
da Fonseca, Lucimauro, 18, 106, 116, 117
Dahlke, Fabiano, 4, 69
DalleMole, Carlos A., 102
Dalle-Piagge, Priscila M., 181
Dalmaso, Anna Cristina S., 183
Dalondo, Yuri, 22
Dalolio, Felipe S., 168, 184
Dalolio, Felipe, 149
Dal Santo, Alicia, 169, 170
Danieli Antoniauzzi Valentini, Fernanda, 169, 170
da Rocha, Chayane, 5, 11, 12, 24, 69, 104, 163
da Silva, Marcelo G., 74
da Silva Barbosa, Barbara F., 41
da Silva Júnior, Ranulfo C., 29
da Silva Messias, Hérica, 132, 134
Datsch, Lidiane L., 52, 58, 125, 145, 152, 177, 194
Daza León, Camila, 23, 42
de Aguiar, Gustavo A., 18, 106
de Andrade César, Ricardo, 170
de Avila, André S., 105, 125
de Carvalho, Maisa B., 58, 105, 146, 152, 165, 194
de Castro Tavernari, Fernanda, 169
de la Cruz, Carlos, 112
Della, Mariane P., 1
Deng, Youjun, 98
de Oliveira, Simone G., 12, 24, 104
de Oliveira, Vitória, 31
de Oliveira Marx, Francielle, 11, 12, 24, 104
de Oliveira Telesca Camargo, Nathalia, 123
de Paula, Vinicius Ricardo C., 128
de Souza, Felipe E., 29, 160, 161
de Souza, Jacqueline C., 114, 118
Dewez, Marine*, 190
Dias, Allan G., 127, 131
Dias, Isabella d., 4, 5, 11, 69, 163, 188
Dias, José E., 67
Dias, Kelly M., 6, 15, 16, 108, 109
Dias, Patryck d., 130
Diaz-Carrasco, Juan M., 75, 126
Dilelis, Felipe, 20
Diogo de Soza, Patrik, 132, 134
Dittoe, Dana, 63, 103
Dominguez, Johana E., 75, 126
do Nascimento, Mariana A., 106
Dorigam, Juliano, 18, 106, 107, 227S
dos Santos, Leticia M., 5
Duarte, Cristiano R., 14, 165
Duarte, Karina F., 2, 50

Poult. Sci. 102 (E-Supplement #2)
Matard-Mann, Maria, 99  
Mateos, Gonzalo, **226S**  
Mathias, Christiane, 129  
Matte, Fabrizio, 155  
Matté, Fabrizio, 22, 61, 64, 101  
Maynard, Philip, **138**  
McGovern, Kate, 88  
Medeiros, Leonardo P., 64  
Medeiros-Ventura, Waleska R., 191, 192, 196, 197  
Medina Dubois, Alvaro, 110  
Mello, José Valter D., 137  
Mello, Lays P., 29  
Mello, Renius, 151  
Melo, Camila, 25  
Melo, Larissa Priscilla D., 141, 160, 161  
Melo, Lays Priscilla d., 143, 199  
Menck-Costa, Maísa F., 61, **64**, 101, 102  
Menezes, Raissa Gabriela D., 49  
Menezes de Brito, Diego, **209S**  
Menten, José Fernando M., 25  
Millán, Carlos, 187  
Miottot, Lediane T., 137  
Miottot Galli, Gabriela, 123, 124  
Miranda, Carlos, 20  
Miranda Prestes, Alan, 169  
Molina, Daniel, 85  
Monte, Daniel Farias Marinho F., 91, 100  
Monteiro, Daniel P., 116, 117, 125, 177  
Monteiro, Filipe A., 18  
Moraes, Mariana L., 40  
Moraes, Priscila d., **147**  
Morais Lião, Luciano, 31  
Moreira dos Santos, Leticia, 104  
Moreno, Filipe A., 4, **11**, 12, **163**, 186  
Morillo, Freddy Alexander H., 68, 158  
Moss, Amy F., 53  
Mota, Leonardo, 74  
Mueller, Lenise F., 181  
Muller, Geovana, 34  
Muniz, Eduardo, 205  
Muniz, Jorge C., 18, 116, 117  
Muñoz, Julian A., **181**  
Murakami, Alice E., 3, 200, 201  
Mustafa, Imtiaz, 157  

<table>
<thead>
<tr>
<th>N</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nagae Kuritza, Leandro, 5, 12, 24, 104, 163</td>
<td></td>
</tr>
<tr>
<td>Nakamatsu, Carlos Y., 40</td>
<td></td>
</tr>
<tr>
<td>Nakazato, Gerson, 61, 64</td>
<td></td>
</tr>
<tr>
<td>Naranjo, Victor D., 18, 106, <strong>107</strong></td>
<td></td>
</tr>
<tr>
<td>Nascimento, Marcos Antônio, 203, 204</td>
<td></td>
</tr>
<tr>
<td>Nascimento, Mariana Q., <strong>203, 204</strong></td>
<td></td>
</tr>
<tr>
<td>Nascimento, Vladimir P., 95</td>
<td></td>
</tr>
<tr>
<td>Natel, Jean C., 5</td>
<td></td>
</tr>
<tr>
<td>Nell, Francois, 187</td>
<td></td>
</tr>
<tr>
<td>Nelson, Kenneth B., 8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>O</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oba, Alexandre, 101</td>
<td></td>
</tr>
<tr>
<td>Oetting, Liliana L., 203</td>
<td></td>
</tr>
<tr>
<td>Oicatá, Luís N., <strong>65</strong></td>
<td></td>
</tr>
<tr>
<td>Olabarriaga, Yuri J., 44, 46, <strong>47</strong>, 49, 66, 156</td>
<td></td>
</tr>
<tr>
<td>Oliveira, Ana Beatriz S., <strong>25</strong>, 203, 204</td>
<td></td>
</tr>
<tr>
<td>Oliveira, Carlos H., 6, <strong>15, 16</strong>, 17, 108, 109</td>
<td></td>
</tr>
<tr>
<td>Oliveira, Celso J., 96</td>
<td></td>
</tr>
<tr>
<td>Oliveira, Heraldo B., 191, 192, 196, 197</td>
<td></td>
</tr>
<tr>
<td>Oliveira, Jamile, <strong>2</strong></td>
<td></td>
</tr>
<tr>
<td>Oliveira, Natiele F., <strong>39</strong></td>
<td></td>
</tr>
<tr>
<td>Oliveira, Núbia d., 139</td>
<td></td>
</tr>
<tr>
<td>Oliveira, Paulo, 155</td>
<td></td>
</tr>
<tr>
<td>Oliveira, Priscila R., 2, 50</td>
<td></td>
</tr>
<tr>
<td>Olsen, John E., 91, 94, 100</td>
<td></td>
</tr>
<tr>
<td>Olson, Elena G., <strong>62</strong></td>
<td></td>
</tr>
<tr>
<td>Onishi, Beatriz T., 29, 140, 161</td>
<td></td>
</tr>
<tr>
<td>Orso, Gabriel A., 26</td>
<td></td>
</tr>
<tr>
<td>Oviedo-Rondón, Edgar O., <strong>233S</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacheco, Wilmer, <strong>225S</strong></td>
<td></td>
</tr>
<tr>
<td>Pagnussatt, Heloisa, 169, 170</td>
<td></td>
</tr>
<tr>
<td>Palermo-Neto, João, <strong>208S</strong></td>
<td></td>
</tr>
<tr>
<td>Pałaoro, Isadora P., 141, 144</td>
<td></td>
</tr>
<tr>
<td>Paloschi, Jonivan Luiz, 194</td>
<td></td>
</tr>
<tr>
<td>Park, Chorong, 16, 108</td>
<td></td>
</tr>
<tr>
<td>Pasa, Cassiano B., 144, 161</td>
<td></td>
</tr>
<tr>
<td>Passos, Adsos A., 187</td>
<td></td>
</tr>
<tr>
<td>Paulo, Lorrayne M., 127</td>
<td></td>
</tr>
<tr>
<td>Pavlak, Maira S., 72</td>
<td></td>
</tr>
<tr>
<td>Paz, Ibiara C., 203, 204</td>
<td></td>
</tr>
<tr>
<td>Pedrosa, Katia, <strong>190</strong></td>
<td></td>
</tr>
<tr>
<td>Pellegrini, Stefania, 26</td>
<td></td>
</tr>
<tr>
<td>Pelletier, Nathan, 79</td>
<td></td>
</tr>
<tr>
<td>Perazzo Costa, Fernando G., 36, 176</td>
<td></td>
</tr>
<tr>
<td>Pereira, Angélica S., 181</td>
<td></td>
</tr>
<tr>
<td>Pereira, Camila G., 191, 192</td>
<td></td>
</tr>
<tr>
<td>Pereira de França, Thaisa, 51</td>
<td></td>
</tr>
<tr>
<td>Pereira Siqueira, Bruna, <strong>132, 134</strong></td>
<td></td>
</tr>
</tbody>
</table>
Pereira Siqueira, Sinthia, 132, 134
Perez Fabregat, Thiago E., 137
Perin, Giovana, 72, 73, 148
Perotto Marin, Milena, 169, 170
Petracci, Massimiliano, 33
Petroli, Tiago G., 137, 169, 170, 251S
Phillips, C. A., 90
Pilecco, Márcio, 112
Pilon, Gabriela d., 163
Pinto, André N., 140, 160, 161
Pinto, Laura A., 29, 141
Piotrowski, Débora, 166
Pires, Paula G., 147
Pirgozliev, Vasil, 113
Pirolo, Mattia, 100
Piva, Andrea, 138
Plumstead, Peter W., 195
Polese, Clauber, 56, 58, 152, 167, 183
Polesi, Clauber, 52, 73
Poleti, Mirele D., 181
Poletti, Bruna, 149
Polo, Javier, 43
Poltronieri, Caroline V., 147
Polycarpo, Gustavo d., 41
Potenza Campos, Felipe, 58, 152, 162, 183
Pozza, Paulo C., 201
Preveraud, Damien, 60, 93
Prezoto, Airton Raphael F., 38
Prigol, Carolini, 61

Q
Quinteiro, Wanderley, 36, 60, 93, 189
Quintero, Juan Carlos P., 54
Quispe Cangalaya, Katherine, 37

R
Rabello, Carlos B., 191, 192, 196, 197
Raman, Srivatsan, 63
Ramirez, Brett C., 78
Ramirez-Nieto, Gloria C., 23, 42
Rangel, Luis, 43
Rauber, Ricardo, 212S
Raurich, Sergi, 83, 129
Redondo, Leandro M., 75, 126
Reis, Matheus, 68, 111, 154, 164
Reis, Matheus d., 185
Reis, Renata N., 205
Reis, Thais F., 81
Reis, Túlio, 20
Remus, Aline, 124
Renata Ferreira, Carolaine, 117
Resende, Matheus, 36
Reuter, Anderson H., 144
Rhodes, Douglas, 190
Ribeiro, Apolonio G., 196
Ribeiro, Daiane S., 137
Ribeiro, Thiago P., 116, 117, 122, 125, 177
Riboty Lara, Rodolfo, 174
Ricke, Steven, 62, 63, 103, 228S
Roberto Uhlein Júnior, Mario, 58, 145, 152
Rocha, Maria Isabel U., 57
Rocha, Patricia T., 82
Rocha, Samuel d., 54
Rodrigues, Weslley Rogério, 59
Rodrigues Alves, Lucas B., 91, 94, 100
Rodriguez, Maria A., 99
Rohloff Junior, Nilton, 14, 52, 56, 72, 73, 122, 145, 146, 148, 152, 162, 177, 179, 180, 183, 193, 194
Rollinger, Judith, 113
Romero Sanchez, Hugo, 230S
Roque, Fabricia d., 38
Rosa, Alexandre P., 57, 112
Rosário Silva, Brenna Cristine, 59
Rose, Stephen, 113
Rossato, Gabriel, 170
Rosseti, Gisele N., 121
Rosso, Diogo F., 114, 118
Rostagno, Horacio S., 221S
Royero, Gaston, 75, 126
Rubinelli, Peter, 62
Rudio Furlani, Nathana, 116

S
Sa, Luciano, 129
Sachuk, Tabyta T., 2, 50
Sakamoto, Márcia I., 201
Sakomura, Nilva K., 7, 9, 10, 13, 51, 68, 86, 111, 153, 154, 158, 164
Salazar, Miguel, 85
Salgado, Hallef Rieger, 17
Salles, Gleidson, 205
Salvador, Elias, 30
Sanches, Matheus S., 64
Sanchez, Andres, 42
Sandy da Silva Cabral, Sanara, 31
Sangalli, Gabriela G., 73
Santana do Carmo, Adriana, 178
Santin, Elizabeth, 40, 92, 236S
Santos, Elisangela T., 139
Santos, Emanuelle C., 73, 180
Santos, Fernanda, 21
Santos, Flavio A., 25
Santos, Igor S., 131
Santos, Marcos J., 191, 192, 196, 197
Santos, Nathanael C., 52, 72
Santos, Pablo L., 1, 44, 45, 46, 47, 66
Santos, Raphael R., 130
Santos, Tatiana C., 3, 59, 200
Santos, Veronica L., 41
Santos Fialho, Audasley T., 9, 10
Saraiva, Mauro, 91, 94, 100
Sartor, Heloisa, 58, 105, 146, 152, 193
Savari, Vaneila D., 73, 180
Savani, Carlos, 238S
Schaeffer, Abe, 103
Scheletz, Caroline, 50
Schiffer Cury, Humberto, 61
Schlagheck, Alexandra, 128
Schlemper, André, 81
Schneiders, José L., 121
Schoffen, Raquel P., 193
Segura-Wang, Maia, 83, 129
Senger, Geovani C., 12
Serraglio, Alana B., 112
Shi, Hanyi, 48
Silva, Almir F., 192
Silva, Ana Eliza B., 201
Silva, Dayane A., 96
Silva, Fernando A., 92
Silva, Gabriela R., 81
Silva, Guilherme M., 40
Silva, Heloisa L., 147
Silva, Isabela E., 38, 43
Silva, Kelvin P., 139
Silva, Leticia ALine L., 59
Silva, Marcelo A., 105
Silva, Raissa A., 96
Silva, Rauly L., 7, 9, 10, 13, 68, 154
Silva, Vitoria E., 120, 202
Silva Junior, Rogerio V., 191, 192, 197
Silva Minafra e Rezende, Cintia, 32
Silva Tesser, Guilherme L., 56, 72, 125, 167, 177, 183
Silva Tesser, Guilherme L., 52
Simian, Catalina, 27
Simões, Eduardo P., 141, 143, 160, 198
Simonetti, Tainá, 95
Sirri, Federico, 33
Smith, Ed, 55
Soares, Igor, 92
Soares, Maria Cecília, 81
Socas, Laura, 75
Soglia, Francesca, 33, 218S
Song, Bin, 60
Sorbara, José O., 118, 142
Souza, Agnaldo B., 130
Souza, Cleison d., 14, 56, 58, 73, 105, 145, 146, 148, 152, 165, 166, 179, 180, 193
Souza, Cleverson d., 139, 180
Souza, Cleverson, 92
Souza, Fernando A., 173
Souza, Marielen d., 64, 101, 102
Souza, Otoniel F., 22, 34, 151
Starkey, Charles W., 56, 58
Stefanello, Catarina, 22, 34, 119, 136, 151
Stefanello, Luíza R., 141, 144, 198
Stefanello, Thais B., 40
Stefani, Lenita M., 155
Stephan, Aaron, 28
Stel, Marcelo S., 74
Storck, Eduarda L., 177
Storck, Eduarda L., 105, 166, 167
Storck, Luiza M., 125, 165, 166
Strapazzon, João Vitor, 155
Stringhini, José H., 127
Stringhini, José Henrique, 31, 39, 132, 134, 178, 219S
Suarez, Cintia Y., 75, 126
Suguimoto Leite, Carla Daniela, 31, 32, 132, 134, 178

T
Tak, Jisoo, 108, 109
Takano, Luiz E., 61, 102
Takayama Kobayashi, Renata K., 61, 64
Tanamati, Fernanda, 183
Tardieu, Didier, 99
Taschetto, Diogo, 149
Tavares, Joao M., 40
Teixeira, Levy d., 115, 120
Teixeira, Vinicius d., 45
Tellez-Isaias, Guillermo, 62
Tellini, Caio, 140, 141, 143, 144
Tenório, Karine L., 73, 148, 180
Teofilo, Guilherme F., 13, 51, 158
Tesch Câmara, Mayara M., 146
Texeira, Mailson d., 96
Theiry, Pascal, 214S
Tieberg, Jack, 28
Timo, Fernando, 75
Tinôco, Ilda d., 79
Toledano, Fernanda, 171
Toledo, Fernanda, 39
Tomazini Medeiros, Patrícia, 107, 178
Tome Regis Ramos, Emanoel, 32
Toniazzo, Gabrieli, 58, 122, 145, 146, 152, 179
Tormes, Giovane B., 1, 44, 46, 47
Torres-Cordido, Karoll Andrea A., 54, 74
Toscan, Adriana, 119
Tovborg, Morten B., 114
Trevizan, Bruna, 41
Trocato de Freitas Júnior, Sidnei, 101
Tschambser, Anuelle, 182
Tugnoli, Benedetta, 138

U
Uculmana Morales, Cristian, 159

V
Vande Ginste, Liesbeth, 172
Van der Aa, Arno, 172, 175
Van Soest, Jolien, 172, 175
Vasconcellos, Guilherme, 119
Vecchi, Bruno, 22
Veiga, Marcelo L., 57
Vellano, Igor H., 67
Venter, Kyle M., 195
Vergara, Aristóteles M., 245S
Viana, Gabriel, 18, 106
Vieira, Fernando, 253S
Vieira, Marcia d., 40
Vieira, Sergio L., 1, 44, 45, 46, 47, 49, 66, 156, 202, 216S, 242S
Vieira, Sergio, 120
Vieira, Sérgio, 149
Vieira, Vivian L., 11, 12
Vieira, Isabela M., 57
Vieira Filho, Javer A., 2, 50
Vieira Marques de Souza Pereira Batista, Juliana, 110
Vilchez-Perales, Carlos, 35, 37, 85, 133, 150, 159
Vogt, Josias R., 205

W
Wachholz, Lucas, 56, 72, 152, 180
Walk, Carrie L., 182, 243S
Wang, Dongping, 98

Vargas, Jose, 42
Wells, Savannah C., 8
White, Dima, 48
Whiting, Isobel, 113
Wojcik, Ewelina, 97
Wolfenden, Ross, 202
Wythe, Lindsey A., 103

X
Xavier, Bernardo B., 1, 47, 49, 66, 156
Xiong, Yijie, 78
Xu, Frank, 142

Y
Yamamoto, Pedro, 140, 143, 160, 199
Yeboah, Philip, 88

Z
Zaccaron, Gustavo, 169, 170
Zampiga, Marco, 33
Zea, Otto A., 35, 37, 85, 133, 150, 159
Zhang, Yuping, 60
Keyword Index

1 1,25OHD3 184
16S rRNA 100
16S rRNA gene sequencing 62
16S sequencing 103

2 25OHD3 184, 185
25-OH-D3 metabolite 186, 188

A Absorption area 160
acetic acid 167
Acrocomia aculeata 148
additives 123, 130, 131, 134, 147, 39
Additives 198, 199
additives 132
adsorbents 174
Aflatoxin 66
age 30
Aggression 26
AGP 135, 139, 212S
air quality 78
algae 99
Algae 215S
algorithms 90
Alpha diversity 100
alpha-toxin 172
alternative feedstuffs 221S
alternative ingredients 183
alternative ingredients 222S
alternative products 179
amino acid 1
amino acid complex 44
amino acid digestibility 244S, 6
Amino acids 111
amino acids 107, 112, 116, 117, 221S
Amino acids 180
Amino Acids 104
ammonia 78
amylase 122, 241S
Amylase 240S
animal health 137, 209S
Antibiogram 61
antibiotic 130, 133
antibiotic alternatives 210S
antibiotic free 20
antibiotic free production 223S
Antibiotic growth promoter 210S
antibiotic resistance 83
Antibiotics 65
antibiotic’s alternative 97
Anticoccidial 88
antimicrobial 137
antimicrobial-drug resistance 208S
Antimicrobial Photodynamic Therapy 29
antimicrobial resistance 210S
anti-nutrients 239S
antinutritional factors 116, 214S
antioxidant 148, 52
Antioxidant 176
antioxidant activity 42
arginine 108, 16
ascitic syndrome 32
AST 205
automated technique for most-probable-number 95
aviculture 101

B Bacillus amyloliquefaciens 39
Bacillus coagulans 128
Bacillus subtilis 131
bacillus subtilis 135
Bacteriophages 97
batch health 252S
Behavior 28
Behavioral events 27
Behavioral Traits 19
Beta diversity 100
BIG DATA 92
binding 172
bioactive compounds 141
Bioactive compounds 143
bioavailability 175
biochemistry 152, 58
bioefficacy 107
bio health markers 157
biome 242S
biosecurity 212S
Biosecurity 207S
Biotechnology 206S
Birds 65
Birds Intestine 232S
black pepper 113
Blends 199
blood biomarkers 90
blood metabolites 56
Body weight 69
bone 190
bone breaking resistance 185
bone characteristics 175
Bone densitometry 191
Bone density 192
bone development 185
Bone mineralization 186, 188
bone morphometry 159
bone quality 48
botanicals 138
Brazilian government 209S
breast muscle abnormalities 218S
breast yield 161
Breast yield 143
breeder 60
Breeder 49
breeder age 2
breeder hen 151, 34
breeders 97
Broiler 12, 168, 186, 187, 188, 195, 2, 240S, 28
broiler breeder 44
Broiler breeder 46
broiler breeder nutrition 193, 194
Broiler Chicken 19, 24
broiler chickens 33, 56
Broiler chickens 128
broiler house 185
broiler nutrition 249S
broiler performance 121
broiler production 246S
broilers 113, 126, 138, 159, 175, 221S, 229S, 52, 63, 70
Broilers 43, 66, 8, 82, 84
broilers chick nutrition 194
Bronquite infecciosa 80
bruise 32
butyric acid 167
Butyric acid 198
C C. perfringens 138, 172
Caecal microbiota 100
calcium 183, 35
Calcium 188, 195
Campylobacter 62
Campylobacter jejuni 81
Campylobacter spp. 95
carbohydrase 119
carcass 119
Carcass composition 43
Carcass Compositon 104
Carcass quality 170
carcass yield 130
catalase 141
Category 69
cecal bacteria 162
<table>
<thead>
<tr>
<th>Term</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cecal microbiota</td>
<td>63</td>
</tr>
<tr>
<td>Cecum</td>
<td>167</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>32</td>
</tr>
<tr>
<td>Challenges</td>
<td>248S, 249S</td>
</tr>
<tr>
<td>Chambers of respirometry</td>
<td>13</td>
</tr>
<tr>
<td>Chaol</td>
<td>162</td>
</tr>
<tr>
<td>Chick</td>
<td>59</td>
</tr>
<tr>
<td>Chicken</td>
<td>102, 60</td>
</tr>
<tr>
<td>Chicken egg</td>
<td>57</td>
</tr>
<tr>
<td>Chicken embryos</td>
<td>81</td>
</tr>
<tr>
<td>Chicken meat</td>
<td>29</td>
</tr>
<tr>
<td>Chickens</td>
<td>203, 204</td>
</tr>
<tr>
<td>Chick quality</td>
<td>3, 47</td>
</tr>
<tr>
<td>Chicks hatch weight</td>
<td>193</td>
</tr>
<tr>
<td>Chondronecrosis</td>
<td>190</td>
</tr>
<tr>
<td>Citric acid</td>
<td>177</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>169</td>
</tr>
<tr>
<td>Citrus sinenses</td>
<td>140</td>
</tr>
<tr>
<td>Clay</td>
<td>99</td>
</tr>
<tr>
<td>Climate change</td>
<td>124</td>
</tr>
<tr>
<td>Clostridium</td>
<td>85</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>202</td>
</tr>
<tr>
<td>Clostridium perfringens 128, 86</td>
<td>85</td>
</tr>
<tr>
<td>Coccidiosis 147, 205, 68</td>
<td>82</td>
</tr>
<tr>
<td>Coccidiosis vaccination</td>
<td>247S</td>
</tr>
<tr>
<td>Coccidiosis</td>
<td>88</td>
</tr>
<tr>
<td>Coconut husk fibers</td>
<td>74</td>
</tr>
<tr>
<td>Commercial database</td>
<td>83</td>
</tr>
<tr>
<td>Complex minerals</td>
<td>192</td>
</tr>
<tr>
<td>Compost</td>
<td>157</td>
</tr>
<tr>
<td>Condensed tannins</td>
<td>20</td>
</tr>
<tr>
<td>Contamination</td>
<td>32</td>
</tr>
<tr>
<td>Control</td>
<td>96</td>
</tr>
<tr>
<td>Co-product</td>
<td>161</td>
</tr>
<tr>
<td>Co-product 160</td>
<td>153</td>
</tr>
<tr>
<td>Corn 243S</td>
<td>14</td>
</tr>
<tr>
<td>Corn-based diets</td>
<td>153</td>
</tr>
<tr>
<td>Corn coproduct</td>
<td>14</td>
</tr>
<tr>
<td>Corn Co-products</td>
<td>25</td>
</tr>
<tr>
<td>Correlation</td>
<td>150</td>
</tr>
<tr>
<td>Cost of inflammation</td>
<td>210S</td>
</tr>
<tr>
<td>Creatine</td>
<td>178</td>
</tr>
<tr>
<td>Creatine 170, 180</td>
<td></td>
</tr>
<tr>
<td>Creatine level 108, 16</td>
<td></td>
</tr>
<tr>
<td>Crop quality</td>
<td>242S</td>
</tr>
<tr>
<td>Crude protein 110, 112</td>
<td></td>
</tr>
<tr>
<td>Crypt depth</td>
<td>159</td>
</tr>
<tr>
<td>Curcumin</td>
<td>29</td>
</tr>
<tr>
<td>Customers demand</td>
<td>237S</td>
</tr>
<tr>
<td>Cuticle staining</td>
<td>34</td>
</tr>
<tr>
<td>Cysteine</td>
<td>17</td>
</tr>
</tbody>
</table>

**D**

Data Organization 76, 77

**E**

E. coli K88 89
E. maxima 90
Economy 156
Effective egg production 36
egg 30, 35
egg components 111
Egg content 49
egg loss 151
egg production 111, 112, 151, 196, 197, 5
Egg production 49, 51
egg quality 112, 150, 34, 36, 37, 50
Egg quality 38, 47
eggs 123
EGGS 79
Eimeria 48, 85, 88
Eimeria maxima 86
Eimeria spp 201
Eimeria spp. 198
Elemental selenium 189
Embrapa 051 4
EMBRAPA 051 5
Emissions model 78
Empraba 51 163
Emulsifier 171
Endogenous amino acid flow 244S
Energy 156
Energy balance 158
Energy density 162

**F**

Family Farming 54
Fasting 152, 56, 58
Fasting heat production 158, 7
Fat 68
Fatty acids 202
Feed 237S
Feed additive 135, 21, 230S
Feed additives 228S
Feed conversion 155, 161, 178, 205
Feed conversion 146, 170
Feed efficiency 214S
Feed enzymes 235S
Feed form 244S
Feeding 123
Feed intake 68
Feed supply 163
Feed withdrawal 66
Female preferences 26
Fertility 3
Fiber 14, 226S
Fiber 168, 38
FIELD 92
FITC-d 166
Flavonoids 42
FloraMax-B11® 101
Food and nutritional security 53
Food safety 102, 233S
Food security 237S

**Energy efficiency** 12
Energy expenditure 9
Energy levels 165, 167
Energy metabolism 10
Energy metabolism 7, 86, 9
Energy prediction 10
Energy reduction 171
Enteritis 230S
Enterobacteriaceae 65
Enterobacteriaceae 64
Enterococcus faecium 133
Environment 233S
Environment 207S
Enzyme 124, 127, 196, 197, 216S, 241S
Enzymes 116, 117, 123, 126, 236S, 239S, 244S, 50
Erythrocytes 41
Escherichia coli 199, 61
Essential oil 40
Essential oil 146
Ethanol 14
eutrophication 124
Exogenous 114, 118
Exogenous enzymes 125
Experimental power 73
Fowl typhoid 91
Free range 69
fructooligosaccharides 41
fumaric acid 177
Fumonisin 99
functional oils 147

G
galactooligosaccharides 41
gene expression 98
germ layers 57
GHG emissions 238S
gluconeogenesis 152, 58
glycosaminoglycans 181
Gompertz 164
Green Java Peafowl 87
Griller 156
Growing birds 86
growth model 164
growth performance 165
guanidinoacetic acid 178
Gumboro 67
gut barrier 190, 89, 93
gut-brain axis 211S
gut function 230S
gut health 139, 141, 166, 211S, 212S, 213S, 233S, 48, 96
Gut health 217S, 220S
gut immunity 139
gut microbiota 126, 129

Bacillus subtilis 130
benzoic acid 177
Chicken breast 144
Fertility 59
hardness 71
lysine 109, 15
Metabolizable energy 170
Rearing 19

H
Handling 207S
hatchability 3
Hatchability 46, 47, 51, 59
Hatching eggs 49
health 229S, 60
Health challenge 43, 86
health challenges 212S
health index 14
heath challenges 245S
Heat production 13, 7, 9
Heat stress 176
hens 30
Hens 41
hepatic 174
hepatic antioxidants 113
herbal extract 145
Hermetia illucens meal 33
high absorption 231S
High resolution data 27
histological lesions 14
histology 57
HP-DDG 6
hydrogen sulfide 78
Hydrolysis 118
hydroxycholecalciferol 175
Hydroxy-selenomethionine 176

I
ideal protein 106, 111, 18
ileal digesta viscosity 153
ileal digestibility 171
Immune complex vaccine 67
immune system 220S
Immunoglobulin 201
immunomodulation 213S, 81
Immunomodulation 173
immunonutrients 211S
Immunonutrition 173
Incubation 47
Indigenous chicken sector 53
indirect calorimetry 10, 13
Indirect calorimetry 158, 7
Individual variation 240S
Infectious bronchitis 84
ingredient nutrient variability 235S
inorganic selenium 189
inspection 250S, 32
interaction between substrates 235S
intervention 63
Intestinal cell proliferative capacity 198
intestinal health 116, 117, 127, 129, 131, 225S, 231S, 236S, 40
Intestinal health 198, 64
intestinal health 23
intestinal histomorphometry 2
intestinal inflammation 139, 203
intestinal integrity 219S, 42
intestinal morphometric 136
intestinal morphometry 159
Intestinal morphometry 38
intestinal permeability 131, 145, 40
Intestinal quality 160
intestinal transportes 183
intestine enzymes 165
Intramacrophage 91
inulin 35, 37
ISI SYS 92
isoleucine 109, 15, 215S

J
Japanese quail 26, 27

L
Lactobacillus spp. 101
land use change 238S
Latin America 245S
layer 115, 157
Layer 50, 69
Layers 84
layers hens 150
Laying hen nutrition 163
laying hens 111, 37
Laying hens 10, 38
laying poultry 39
laying quail 35
LCA 79
LCI 79
leaky gut 166
lesion scores 205
levels 37
life cycle assessment 124
Lighting 28
light intensity 56
light intensity 152, 58
Limestone 195
Limnopea fortunaei 183
linear regression 150
Linear response plateau 11
Lymphocytes 173
L-Isoleucine 112
Litter 75
Livelihood 53
Liver 66, 99
Lopez 164
low-grade-inflammation 236S
Low-income 55
low-protein 108, 16
low-protein diets 109, 15
LPS 17
Lysine 17, 8

M
machine learning 90
Machine Learning 76, 77
Manganese 46
marketable eggs 36
Mash 24
Massachusetts 80
Mathematic model 11
MB-1 67
MB strain 67
meat color 148
meat quality 236S, 33
Meat quality 200
mechanisms 218S
metabarcoding analyses 234S
metabolism 105, 219S, 31
metabolites 152, 58
metabolites D3 184
metabolizable energy 1, 125, 13, 20, 6
Metabolizable energy 11, 12, 25, 8
metagenomics 83
Methane 74
methionine 107, 17
methionine+cystine 105
methods 233S
Microbiology 169
microbiome 135, 142, 157, 220S, 62, 83
Microbiome 103, 233S
microbiome analyses 228S
microbiota 217S, 22, 231S, 93
Microbiota 203, 204
microbiota, 234S
Microencapsulation 138
Micromineral 46
mineral 45
mineral complexes 191
mineral reduction 48
minerals 181, 230S, 44
Minorities 55
Mobile genetic elements 94
modeling 90
Modeling 76, 77
modelling 124
Monitoring 61
MONITORY 92
mono-component 115
montmorillonite 98
mortality 3
Mortality 59
mTOR 184
Multidrug resistance 94
Multidrug Resistance 65
Multienzyme 153
Muscular dystrophy 180
Mycotic pneumonia 87
mycotoxin 60, 93
Mycotoxin 99
mycotoxins 161, 174
Mycotoxins 173
Myo-inositol 114
myopathies 31

N
nanopore sequencing 83
Narasin 82
Near Infrared Reflectance Spectroscopy 214S
NECROPSY 92
necrotic enteritis 132, 138, 172, 246S
Necrotic Enteritis 128
NetB toxin 172
net energy 215S
newly harvested corn 126
Nicarbazin 82
nitrates 71
Nitrogen balance 158
Nitrous oxide 74
NMR spectroscopy 181
non-antibiotics 96
non-linear function 164
Novogen Brown 54
Nucleotides 200, 201
nutrients digestibility 222S
nutrition 105, 129, 130, 134, 219S, 239S, 39
Nutrition 169, 187, 200, 201, 207S, 25
Nutrition. 170
nutritional challenges 121
nutritional requirements 105
nutritional strategy 178

O
offspring 44
One Health 61
One-health 94
Optimal level 11
organic acid 40
organic acids 177
organic selenium 52
osteoarthritis 190
outliers 72
oxidative stability 144
oxidative stress 141, 155

P
pancreatic enzymes 165
Paratyphoid disease 100
Paratyphoid infection 96
particle size 225S
Particle size 153
particulate matter 78
pasgar© score 3
Pasgar© score 59
Peanut skins 21
Pectoralis major 31
Pellet 24

pelleted diet 2
performance 125
Performance 168, 187, 28, 38, 43
phage 63
Phosphoric Acid 169
phosphorus 50
Phosphorus 186, 188, 195
phosphorus release 120
Physiological Traits 19
phytase 119, 120, 182
Phytase 114
phytobiotic 96
phytogenic 20
phytogenic additives 144
Phytogenic additives 143
Phytotherapics 146
phytotherapy 145
pigment 98
polyphenol 136, 151, 34
polysaccharides 89
Postbiotic 203, 204
poultry 1, 101, 106, 120, 123, 127, 132, 133, 134, 147, 181, 208S, 219S, 85, 97
Poultry 17, 200, 201, 238S, 244S, 25, 61, 94
poultry health 227S
poultry litter 101
Poultry litter 157
poultry nutrition 4, 5
Poultry nutrition 12
Poultry Nutrition 104, 193, 24
Poultry Production 76, 77
Poultry science 156
PPLA 253S
Prebiotics 64
precision biotic 142
proanthocyanidins 20
probiotic 132, 133, 22, 39
Probiotics 128, 64
Processing 103
production 137
Production 46
PRODUCTION 79
production performances 33
Production records 54
Productive parameters 143
productive performance 106, 18, 194
productive variables 42
productivity 220S
productivity, 234S
program 85
propolis 23
Propolis 42
protease 115, 221S
Protease 118, 121
protein 216S, 68
Protein 104, 156
protein digestibility 217S
protein solubility 243S
Proteomics 118
Pseudomonas aeruginosa 98
public health 95
pullet 40
pullet weight 4
Pulmonary Aspergillosis 87
Pulses 25
Q
quality 30
quorum sensing 98
R
randomization 72
raw materials 224S
reactive oxygen species 155
real time PCR 95
reemplace 133
regulate inflammatory 232S
relationship 159
renal 174
repetition 73
reproductive parameters 251S
requirement 45
requirements 182
Research Education 55
Resistance 88
responses 44
Retained energy 158
retained energy 10
Richards 164
Rinsate 103
RNA extraction 183
Rural community 53
S
Saccharomyces cerevisiae 203, 204
safety margin 214S
salinomycin 147
salmonella 93
Salmonella 206S, 207S, 29, 63, 81, 97
Salmonella spp. 102
Salmonellosis 91, 94
sample 72, 73
saponin 136, 151, 34
Scanning electron microscopy 29
SCFA 160
seaweed 89
selenium 45
Selenium 176
Selenium yeasts 189
selenomethionine 189
Semduramicin 82
Sex-behavior 26
Shannon index 162
shelf life 140
shelf life 187
shell quality 35
shell resistance 196, 197
Simulating Nature 19
skin quality 108, 16
slaughter 73
Slaughterhouse 66
slaughterhouses 250S
Social behavior 27
Social experience 26
Socio-economic 53
Sodium butyrate 199
sodium chloride 71
Solanum glaucophyllum 190
soybean 222S, 239S
soybean meal 110
soybean processing 117
soybean replacement 33
spaghetti meat 218S
speciation 189
Spray-dried plasma 43
spray vaccine 62
starch 241S
Starch 240S
starch digestibility 243S
statistical model 18
statistics 72, 73
STEM 55
storage 30, 56
storage time 166
substrate concentration and location 235S
sulfates 71
Sulfur 104
sulfur amino acids 106, 18
sustainability 222S, 223S, 230S, 237S, 238S, 70
SUSTAINABLE 79
Sustainable Development Goals 74
Synergy 114
synthetic amino acids 110
Systemic infections 91
T
tannin 149
Tartaric Acid 169
TBARS 144, 148
Temperature 7
Temporal dynamics 27
Thermal Processing 24
tight junction 23
Tocopherol 176
Trace minerals 191, 192, 47, 49
triaxial accelerometer 13
turkey 216S
turkey meat 95
Turkeys 88
Turkey toms 21
U
Uniformity 69
Unique health 209S
V
vaccine 102, 85
Vaccines 84
validation 150
valine 215S
Variant strains 84
variation 72
Vermiculite 154
Villus:crypt ratio 160
villus length 155
Virginia mycin 75
Virulence genes 91
Vitamin 187
vitamin D 48
Vitamin D 175, 186, 193
Vitamin D3 supplementation 194
Vitamins and Minerals 194
Vitamin Supplement 193
Voluntary consumption 154
W
W2512 67
water efficiency 70
water loss 140
weather 242S
weight gain 179, 205
Weight gain 199, 231S
weight loss by defrosting 140
welfare 223S, 227S
Welfare 204, 28
well-being 220S
white striping 181, 218S
White striping 180
White Stripping 52
wooden breast 218S
Wooden breast 180
Wooden Breast 52
X
xylanase 113, 122

Y
yeast 155

Z
zoonosis 102

Yeast cell wall 173
Yeast Fermentate 103

β
β-1,3-glucan 135
β-glucans 213S
β-mannan 127