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**SYMPOSIA AND ORAL SESSIONS**

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**Tuesday, October 4, 2016**  
**SYMPOSIA AND ORAL SESSIONS**

**Student Competition, Metabolism and Nutrition: Vitamins and Minerals**

**1 Iron supplementation of broiler breeder diets: Effects on egg production, eggshell color, blood variables and progeny.** Silvana M. Rauber\*, Sergio Luiz Vieira, Liris Kindlein, Marco A. Ebbing, Barbara M. dos Santos, and Natália C. Serafini, *Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.*

The objective of this study was to evaluate the supplementation of different Fe sources in Cobb 500 broiler breeder diets from 40 to 67 wk. Birds were allocated in a completely randomized design with 3 Fe supplementation levels: 50 ppm of ferrous sulfate (Fe-S), 50 ppm of Fe-S + 40 ppm of iron amino acid complex (Fe-AA), and 40 ppm Fe-AA. Eggs from the 65th week were separated by the degree of shell darkness as pale or dark in a  $3 \times 2$  factorial arrangement and incubated. Hatchability, blood variables and performance of progeny were evaluated. Blood samples were collected at hatching and growth performance was measured from 1 to 35 d and in 3 phases feeding program. Carcass yield was measured at 35 d. Sources of Fe supplementation did not affected hens egg production, egg quality and eggshell color. No interactions between Fe sources and eggshell color were found. Fertility and hatchability were higher when supplementation was done with Fe-AA compared with Fe-S; however, both were similar to the diet with Fe-AA+Fe-S. No effects of eggshell color were observed on these responses. Hemoglobin and hematocrit were not affected by any factors. Body weight gain (BWG) from 1 to 35 d was higher ( $P < 0.05$ ) for the Fe-AA compared with the Fe-AA+Fe-S, which was higher than Fe-S. Chicks originated from dark eggshells had higher BWG and lower feed conversion ratio ( $P < 0.05$ ) compared with pale eggshell color. Breast fillet was the only commercial cut affected by Fe supplementation, where Fe-AA had higher weight than Fe-AA+Fe-S and Fe-S in relative values. Carcass yield and other commercial cuts were not affected by treatments. In conclusion, supplementation of diets for broiler breeders hens with Fe-AA improved breeder fertility and egg hatchability. Performance and breast meat yield of the progeny was improved by the Fe-AA. Dark shell eggs provided chicks with superior growth performance.

**Key Words:** Broiler breeder, iron, eggshell, progeny, blood

**2 Broiler breeder egg characteristics as influenced by different Fe supplemental sources.** Silvana de Castro Caldas\*, Morgana Zortea, Diogo Taschetto, Liris Kindlein, and Sérgio Luiz Vieira, *Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.*

Nutritionists make use of inorganic forms of trace minerals due to its low cost of inclusion in the diet. However, concerns with excess mineral excretion and their use by animals has led to the question of mineral sources that are better utilized by poultry. Micro minerals complexed to amino acids have been used to supplement poultry with the expectation of obtaining performance benefits. The present study aimed to assess levels of Fe with the use of 2 sources of supplementation for parameters of eggs quality. Two hundred and 60 slow-feathering broiler breeder hens were housed in cages electrostatically painted and fed semi purified diets deficient in Fe (27.26 ppm Fe). Supplementation of Fe was done at the levels of Fe 25, 50, 75, 100 and 125 ppm using 2 Fe sources (Fe sulfate and Fe amino acid complex) in 6 periods of 28 d, starting at 47 wk of age. Yolk and albumen height, eggshell color, eggshell thickness

and iron content in yolk. Treatments were distributed in a completely randomized design with factorial arrangement  $2 \times 6 \times 6$  (sources  $\times$  levels  $\times$  periods). The Fe level of 50 ppm improved albumen height and red color (*a*) of eggshell and eggshell thickness were higher with 75 ppm, whereas luminance (*L*), yellow color (*b*) and Fe content in yolks were higher with 125 ppm of Fe. Throughout the study there was an increase of yolk height and luminance of shells whereas there was a decrease in values of albumen height. Interactions between sources and periods were observed in eggshell color for *L* ( $P = 0.0119$ ), *a* ( $P < 0.0001$ ) e *b* ( $P = 0.0128$ ). Regression analyses revealed maximum response for levels of 113.3, 115.5, 132.9, 134.3, 123.4 and 116.0 ppm of Fe in diet for albumen height, eggshell thickness, Fe content in yolk and eggshell color for *L*, *a* and *b* respectively.

**Key Words:** Broiler hens, iron, egg quality, supplementation.

**3 Nano particle size improves relative bioavailability of copper oxide for broiler chickens.** Edenilse Gopinger\*<sup>1</sup>, Eduardo G. Xavier<sup>1</sup>, Ning Lu<sup>2</sup>, Young Dal Jang<sup>2</sup>, Ding Wang<sup>2</sup>, Sunday A. Adedokun<sup>2</sup>, Kun Dong<sup>2</sup>, and Merlin D. Lindemann<sup>2</sup>, <sup>1</sup>*Universidade Federal de Pelotas, Pelotas, RS, Brazil,* <sup>2</sup>*University of Kentucky, Lexington, KY, USA.*

The effect of feeding nano copper oxide (<50 nm) in broiler chicken diets fed at levels below the requirements (8mg/kg) was evaluated. Chicks (n = 150) averaging 57.0g were allotted to 10 treatments at random, from outcome groups of weight following 3 d on a common diet. There were 5 chicks per pen for a total of 3 complete replications. The experiment was conducted for 14 d. Chicks were fed a semi-purified diet based on casein and dextrose (0.9 mg/kg total Cu) containing graded levels of added Cu (0, 0.5, 1.0, 2.0 mg/kg) from feed-grade  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , nano CuO, and feed-grade CuO. Body weight, weight gain, feed consumption, feed:gain, liver weight, and liver Cu were assessed to determine the Cu bioavailability. Birds fed diets containing both sources of Cu were significantly heavier at the end of trial than the ones fed the negative control diet ( $P = 0.017$ ). Additionally, chickens fed diets containing  $\text{CuSO}_4$  and nano CuO were heavier than the ones fed diets containing CuO ( $P < 0.01$ ), and no difference was found among birds fed  $\text{CuSO}_4$  and nano CuO ( $P > 0.05$ ). A similar response was obtained for weight gain (347.9, 346.0, and 313.6 g, respectively) and feed intake (443.1, 455.8, and 369.6 g, respectively). Chicks fed diets containing  $\text{CuSO}_4$  and nano CuO had heavier liver, with a higher Cu content than the ones fed CuO ( $P < 0.01$ ). However, no difference was observed for the birds fed diets with  $\text{CuSO}_4$  and nano CuO in terms of liver weight and liver Cu. Slope-ratio of total liver Cu regressed on supplemental Cu intake indicated Cu bioavailability values (relative to the standard, feed-grade  $\text{CuSO}_4$ , set at 100%) of 78% for nano CuO, and 25% for CuO. The results indicate that nano CuO (<50 nm) presents a higher bioavailability than CuO.

**Acknowledgments:** This work was conducted during a scholarship supported by the International Cooperation Program CAPES at the University of Kentucky. Financed by CAPES–Brazilian Federal Agency for Support and Evaluation of Graduate Education within the Ministry of Education of Brazil.

**Key Words:** bioavailability, nano copper, nano mineral, poultry.

**4 Levels of inorganic and complexed minerals on broilers performance.** Josiane Carla Panisson\*, Andréia Massuquetto, Ricardo Scheffer de Andrade Silva, Emanuele Cristiny Goes, Victor Moro Taveira, and Simone Gisele de Oliveira, *Universidade Federal do Paraná, Curitiba, Parana, Brazil.*

The objective of this experiment was to evaluate inclusion of inorganic (I) and complexed (C) minerals on broilers performance. We used 1540 Cobb 1-d-old male broilers, distributed in a completely randomized design, into 7 treatments (T) and 10 replicates of 22 birds on each. The birds were housed until 41 d and supplied with feed and water

ad libitum. The T varied on the source, I (sulfates for Zn, Mn, Cu, Fe, sodium selenite, and calcium iodide) and amino acid complex, and the inclusion of trace minerals, made by premix (Table 1). The feed was the same for all the T, varied only with the premix. Feed intake (FI), weight gain (WG), and feed conversion ratio (FCR) were from d 1 to 41. Performance were compared by ANOVA ( $P < 0.05$ ), and the means were compared by Tukey test at 5% of probability (Table 1). The FI and WG were not significantly different ( $P > 0.05$ ). Birds fed diets with Zn, Mn, and Cu complexed had trends with better FCR than those fed diets only with I ( $P = 0.061$ ) but equal to the others. The use of mineral complexed in diets of broilers should result reduced excretion of micro-nutrients, based on the assumption that the complexed minerals have more bioavailability than inorganic minerals. Therefore, the use of Zn, Mn, and Cu complexed could improve the FCR of broilers.

**Table 1.** Levels (ppm) of inorganic (I) and amino acid complexes (C) minerals in broilers diets and feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) for the period of 1 to 41 d for broilers fed with different levels of inorganic (I) and amino acid complex (C) minerals

	Zinc		Manganese		Copper		Iron		Selenium	
	I	C	I	C	I	C	I	C	I	C
I	80		80		14		50		0.3	
C Zn		40	80		14		50		0.3	
C Zn Mn		40		40	14		50		0.3	
C Zn Mn Cu		40		40		7	50		0.3	
C Zn Mn Cu Fe		40		40		7		25	0.3	
C Zn Mn Cu Fe Se		40		40		7		25		0.15
C and I	40	40	40	40	7	7	25	25	0.15	0.15
	FI (g)				WG (g)				FCR (g/g)	
I	4,345				2,739				1.586 <sup>a</sup>	
C Zn	4,285				2,715				1.578 <sup>ab</sup>	
C Zn Mn	4,264				2,716				1.570 <sup>ab</sup>	
C Zn Mn Cu	4,310				2,767				1.558 <sup>b</sup>	
C Zn Mn Cu Fe	4,314				2,754				1.567 <sup>ab</sup>	
C Zn Mn Cu Fe Se	4,266				2,736				1.559 <sup>ab</sup>	
C and I	4,230				2,679				1.580 <sup>ab</sup>	
P-value	0.537				0.343				0.061	
SEM	0.0156				0.0103				0.0029	

**Key Words:** feed conversion, feed intake, micronutrients, mineral premix, weight gain

**5 Performance and quality of foot of broilers fed with complexed minerals.** Jean Fagner Durau\*<sup>1</sup>, Vitor Augusto Bernardini Zavelinski<sup>1</sup>, Josiane Carla Panisson<sup>1</sup>, Francielle de Oliveira Marx<sup>1</sup>, Alba Fireman<sup>2</sup>, and Alex Maiorka<sup>1</sup>, <sup>1</sup>University Federal of Parana, Curitiba, Parana, Brazil, <sup>2</sup>Zinpro Corporation, Piracicaba, São Paulo, Brazil.

The aim of this study was to evaluate the inclusion of inorganic (I) and complexed (C) minerals (M) on broiler performance. The study used 1960 one-day-old males in a completely randomized design with 7 treatments (T) of 10 replicates of 28 birds each. The broilers were housed until 42 d in pens with wood shavings litter with a density of 14 birds/m<sup>2</sup>. The T varied on the source, I and amino acid complex, and inclusion of trace M (Table 1). On the last day, 100 pairs of paws per T were analyzed for footpad score lesions (FPSL) with scores from 1 to 4 representing, respectively, no lesions, up to 25, between 25 and 50, and more than 50% of damage. Feed intake, weight gain, and feed conversion ratio (FCR) from 1–41 d were compared by ANOVA and

Tukey test and FPSL by Wilcoxon Mann Whitney test at 5% (Table 1). Performance was not significantly different ( $P > 0.05$ ). The FCR of broilers fed with only C minerals was better than T with an overdos-

age of I ( $P = 0.08$ ). The FPSL of the T with almost half of the needed C minerals was better than that broilers fed with only I. The inclusion of C minerals in broilers feed can improve FCR and quality of paws.

**Table 1.** Levels (ppm) of inorganic (I) and amino acid complexed (C) minerals in broiler diets, and feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) of 1-41 days and foot pad score lesion (FPSL) at 42 days of broilers fed with different levels of inorganic (I) and amino acid complexed (C) minerals.

	Zinc		Manganese		Copper		Iron		Selenium	
	I	C	I	C	I	C	I	C	I	C
C Total Replacement	0	60	0	60	0	10	0	40	0	0.2
Low I	60	0	60	0	10	0	40	0	0.2	0
I Standard (IS)	100	0	100	0	20	0	60	0	0.3	0
High I	140	0	140	0	27	0	80	0	0.4	0
Low I + C	20	40	20	40	3	7	20	20	0.1	0.1
Low I + C On Top	60	40	60	40	13	7	40	20	0.2	0.1
IS + C On Top	100	40	100	40	20	7	60	20	0.3	0.1
T	FI (g)		WG (g)		FCR (g/g) <sup>1</sup>		FPSL			
C Total Replacement	4,611		2,877		1.602 <sup>b</sup>		1.36			
Low I	4,644		2,858		1.625 <sup>ab</sup>		1.51			
I Standard (IS)	4,620		2,831		1.632 <sup>ab</sup>		1.53			
High I	4,551		2,770		1.643 <sup>a</sup>		1.41			
Low I + C	4,638		2,850		1.627 <sup>ab</sup>		1.36			
Low I + C On Top	4,607		2,831		1.627 <sup>ab</sup>		1.23*			
IS + C On Top	4,572		2,825		1.618 <sup>ab</sup>		1.36			
P	0.5391		0.1456		0.0856					
SEM	0.0138		0.0095		0.0033		0.0254			

<sup>1</sup>Compared by Tukey test.

\*Different from IS ( $P < 0.05$ ) by Wilcoxon Mann Whitney test.

**Acknowledgments:** UFPR, Zinpro Corporation

**Key Words:** complexed, foot, inorganic, iron, zinc

## 6 Selenium sources in broiler breeders and the effect on

**subsequent progeny.** P. S. Zorzetto\*<sup>1</sup>, M. Ceccantini<sup>2</sup>, A. Toscan<sup>2</sup>, J. G. Gonçalves<sup>2</sup>, S. M. Silva<sup>1</sup>, and C. S. S. Araújo<sup>1</sup>, <sup>1</sup>University of São Paulo, Pirassununga, SP, Brazil, <sup>2</sup>Adisseo Brazil Nutrição Animal, São Paulo, SP, Brazil.

The nutrition for broiler breeders has an objective to maximize egg production and the quality of subsequent progeny. The nutrients transferred to the eggs are essential for growth and physiological development embryo (Favero, 2013). Selenium is an essential antioxidant nutrient in broiler breeder diets. This trial was conducted using chicks hatched from broiler breeder hens fed different sources of Se (organic selenomethionine vs. inorganic sodium selenite) to determine the effect of the maternal

diet on the performance and carcass yield of the progeny. We used 520 chicks from broiler breeders (AP95 Aviagen) in a completely randomized design in a  $2 \times 2$  factorial (2 sources of Se for broiler breeder diets and 2 sources of Se for broiler diets: sodium selenite and selenomethionine) with 4 treatments and 13 replications of 10 birds each. Performance and carcass yield and cuts were evaluated. No interactions ( $P > 0.05$ ) between broiler diet and the maternal diet were observed for any of the criteria measured. No effect of maternal ( $P > 0.05$ ) diet or broiler diet differences were observed on feed intake, body weight gain, or carcass yield and cuts. However, feed conversion ratio was improved ( $P = 0.017$ ) in broilers from breeders fed selenomethionine. Thus, selenomethionine improved feed conversion ratio because of greater bioavailability, and the isolated effect for broiler breeders showed evidence that nutrients were transferred for subsequent progeny.

**Key Words:** antioxidant, mineral, oxidative stress, selenomethionine, sodium selenite

# Student Competition, Metabolism and Nutrition: Enzymes I

**7 Supplementation of different levels of phytase for laying hens.** F. A. Roque<sup>\*1</sup>, U. R. T. Moraes<sup>2</sup>, N. A. C. R. Garcia<sup>2</sup>, N. Wen<sup>2</sup>, J. C. Gonçalves<sup>2</sup>, and L. F. Araújo<sup>1</sup>, <sup>1</sup>University of São Paulo, Pirassununga, SP, Brazil, <sup>2</sup>Mecassab Animal Nutrition, São Paulo, SP, Brazil.

This trial was conducted to evaluate the effect of phytase supplementation for laying hens on performance and egg quality parameters from 66 to 74 wk of age (4 wk for adaptation and 4 wk for the trial). We used 300 laying hens (Novogen White) in a randomized block experimental design with 5 treatments and 8 replications. The diets formulated were according to Rostagno et al. (2011) in positive control (PC); negative control (NC1) with reduction of 0.12% P and 0.10% Ca; NC1: + 60 g/ton of phytase; NC2: with reduction of 0.16% P and 0.13% Ca +120 g/ton. phytase; NC3: with reduction of 0.18% P and 0.15% Ca +120 g/ton phytase. Diets were based on corn and soybean meal. Evaluation of performance and egg quality parameters started 4 wk after the trial began. It was carried out in one interval of 28 d from 70 to 74 wk of age. The evaluated performance parameters were feed intake (g/bird-day), egg production (% hen-day), egg weight (g), feed conversion (kg of feed intake/dozen), feed conversion (kg of feed intake/egg mass), and egg mass (g). The number of eggs was recorded every day and summarized by 28-d period. After the period, the mean production of 3 consecutive days was used to evaluate egg quality parameters. We evaluated by egg weight (g), albumen height, Haugh units, eggshell thickness (mm), egg breaking strength (kg of force), and eggshell weight (g). Statistic analysis was achieved using variance analysis (ANOVA) followed by the Tukey ( $P < 0.05$ ) test. There was no significant difference for any parameters evaluated. Thus, for laying hens it is possible to reduce P and Ca levels in a diet supplemented with phytase without reducing egg production and egg quality.

**Key Words:** calcium, egg quality, enzyme, phosphorus, recovery of nutrients

**8 Phytase inclusion on high phytate diets affect bone characteristics of broilers.** Gabriela C. Dal Pont<sup>\*</sup>, Lucas N. E. Barrilli, Jean F. Durau, Francielle O. Marx, Leopoldo M. Almeida, and Simone G. Oliveira, *Federal University of Paraná, Curitiba, Paraná, Brazil.*

In diets, most Ca and P are present in the form of phytic acid, which is unavailable to the broilers. A whole bone development is important to keep up with growth rate of actual strains and is intricately involved with these minerals. Therefore, this study aimed to evaluate the effect of phytase inclusion on high phytate diets in inorganic matrix bone. In our experiment 936 Cobb male broiler chicks (1 to 21 d) were distributed in a completely randomized design with 4 treatments and 9 replicates of 26 birds each. Treatments consisted of a positive control (PC; without phytase and with inorganic P supplementation), a negative control (NC; without enzyme, reduction of 0.192% Ca and 0.175% avP), NC+750 FTU/kg, and NC+1500 FTU/kg. All diets contained 7% rice bran to increase phytic P. Nine birds per treatment were killed for the collection of the right tibia. The tibias were weighed, and ashes, Ca, and P were analyzed. All data were subjected to ANOVA, and means were compared by the Tukey's test ( $P < 0.05$ ). Addition of phytase influenced all bone parameters analyzed. Ash content and bone weight were similar with inorganic P supplementation or enzyme utilization. Also, when phytase was used the percentage of Ca was higher than NC and PC equivalent. These results show that phytase action in phytate-mineral complex increasing the availability of minerals and those were used to formation of bone inorganic matrix. In summary, supplementing diets containing 7% rice bran with inorganic P or phytase resulted in similar beneficial effects on bone development.

**Table 1.** Effect of phytase levels on bone weight (BW), ash percentage (% Ash), calcium percentage (% Ca), phosphorus percentage (% P), and proportion calcium phosphorus (% Ca / % P).

Treatment	BW (g)	% Ash	% Ca	% P	% Ca / % P
PC	1.814 <sup>a</sup>	46.86 <sup>a</sup>	16.205 <sup>ab</sup>	9.127 <sup>a</sup>	1.776 <sup>b</sup>
NC	1.482 <sup>b</sup>	43.55 <sup>b</sup>	14.616 <sup>b</sup>	8.422 <sup>b</sup>	1.766 <sup>b</sup>
750 FTU	1.665 <sup>ab</sup>	45.81 <sup>ab</sup>	17.679 <sup>a</sup>	8.722 <sup>ab</sup>	2.044 <sup>a</sup>
1,500 FTU	1.705 <sup>a</sup>	46.97 <sup>a</sup>	17.290 <sup>a</sup>	8.967 <sup>ab</sup>	1.886 <sup>ab</sup>
CV <sup>1</sup>	9.11	4.86	8.43	5.12	7.32
P-value	0.0007	0.0131	0.0003	0.0177	0.006

<sup>ab</sup>Different letters in the same column differ by Tukey test ( $P < 0.05$ ).

<sup>1</sup>CV (%) = coefficient of variation.

**Acknowledgments:** AB Vista

**Key Words:** calcium, enzyme, minerals, phosphorus.

**9 Energy and nutrient utilization of broiler chickens fed corn-soybean meal and corn based diets supplemented with xylanase.** Gabriela de O. Santiago<sup>\*1</sup>, Catarina Stefanello<sup>1</sup>, Sergio L. Vieira<sup>1</sup>, Natália C. Serafini<sup>1</sup>, Heitor V. Rios<sup>1</sup>, and José O. B. Sorbara<sup>2</sup>, <sup>1</sup>UFRGS, Porto Alegre, Rio Grande do Sul, Brazil, <sup>2</sup>DSM Nutritional Products, São Paulo, São Paulo, Brazil.

The objective of this study was to evaluate the effects of different supplementation levels of an exogenous  $\beta$ -xylanase on energy utilization and nutrient digestibility of broiler chickens fed corn-soybean meal diets. A

total of 480 one-day-old male Cobb 500 chicks was distributed using a completely randomized design, with 10 treatments, 8 repetitions, and 6 broilers per experimental unit. Birds were fed a common starter diet to 14 d. From 14 to 25 d, birds were fed 2 experimental basal diets in a  $2 \times 5$  factorial arrangement of a conventional corn/soy-based basal diet (CS) and the basal diet (CN) where 40% was displaced by corn. These diets were supplemented with 0, 50, 100, 150, and 200 mg/kg of a fungal  $\beta$ -xylanase units (FXU/kg). Samples of feed, excreta, and ileal digesta were analyzed for determination of ileal digestible energy (IDE), metabolizable energy, and total-tract retention of protein and lipid. The CS diets had higher ( $P < 0.05$ ) energy utilization and nutrient digestibility when compared with the CN diets. AME<sub>n</sub> and IDE were improved ( $P < 0.05$ ) by 192 and 145 kcal/kg, respectively when diets were supplemented with 100 FXU/kg xylanase. The xylanase added to



the CN diet led to quadratic increases ( $P < 0.05$ ) in IDE ( $Y = -0.014x^2 + 2.570x + 3.155$ ;  $r^2 = 0.60$ ) and in  $AME_n$  ( $Y = -0.016x^2 + 3.982x + 3.155$ ;  $r^2 = 0.68$ ). Crude protein digestibility and  $AME_n$  were linearly increased ( $P < 0.05$ ) when xylanase was added to the CN diet. In conclusion, energy utilization, digestibility of crude protein and dry matter increased with xylanase supplementation in corn-soy-based diets. When xylanase was tested in the CS diet, 92 and 124 FXU/kg maximized the energy release effect; however, the maximum energy response in the CN diet was not achieved until 200 FXU/kg.

**Key Words:** broiler, corn, digestibility, metabolizable energy, xylanase

**10 Performance of broiler breeder hens fed corn-soybean meal diets supplemented with  $\beta$ -mannanase.** Nathalia I. M. Cordeiro\*, Sergio L. Vieira, Andre N. Mayer, Liris Kindlein, Douglas D. Maria, V. R. Quadros, and P. Ibaíro dos Santos *Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.*

A study was conducted to evaluate the effect of dietary  $\beta$ -mannanase (Hemicell HT by Elanco Animal Health) supplementation and energy restriction on broiler breeders' performance from 25 to 65 wk. A total of 672 Cobb 500 hens were randomly assigned to one of four treatments with eight replicates. Experimental units consisted of 21 hens and 2 males each. Corn-soybean meal and soybean hulls based diets

were formulated according to Cobb SF breeder management recommendations. Treatments consisted of three energy levels: 2760, 2715 and 2670 kcal/kg AME and a fourth treatment with 2670 kcal/kg AME supplemented with 400g/t of  $\beta$ -mannanase. Total egg production, body weight, egg weight, and hatchability were analyzed every 28 d, totaling 10 periods. Data were analyzed using the mixed model procedure of SAS and means were compared by Tukey test ( $P < 0.05$ ). All parameters were significantly affected by period as expected. Whereas egg production, egg weight and hatchability were not impaired by dietary energy restriction neither  $\beta$ -mannanase supplementation. However, hens body weight was significantly lower as dietary energy level decreased. Contrasts analyses comparing the diets with 2670 kcal/kg with and without  $\beta$ -mannanase supplementation, the number of chicks hatched per hen was significantly higher for the animals which received the enzyme supplementation, even though the egg production and hatchability were not significantly different. The dietary energy restriction imposed by treatments was not sufficiently broad to impair hens performance, thus the enzyme supplementation effect could not properly be evaluated. New studies are necessary to evaluate dietary energy levels and  $\beta$ -mannanase supplementation effects for broiler breeders.

**Key Words:** egg production, hatchability, enzyme, AME

# Student Competition, Management and Production

**11 Effect of broiler breeder age on progeny performance, bone mineralization, and organ development up to 21 d of age.** Hernan A. Cordova\* and Diego A. Chaves, *Universidad Central del Ecuador, UCE, Quito, Ecuador.*

Broiler breeder age could have a major effect on the development of organs and leg health of their progeny, which could effect on live performance later in life. This experiment was conducted to evaluate the effect of broiler breeder age on performance, bone mineralization, and organ development of the progeny from 0 to 21 d of age. A total of 432 1-d-old male birds from 3 different breeder ages (40-, 60-, and 73-wk-old molted breeders) were randomly allocated to 36 cages with 12 replicates per breeder age. For the 73-wk-old molted breeder treatment, 216 female hens were molted at 55 wk of age. The fasting period for molting was 14 d. Broiler body weight was recorded at hatch, 7, 14, and 21 d of age. Feed conversion ratio, BW gain, and feed intake were calculated at the end of each wk. At 14 d, one bird per cage was euthanized and shank samples were collected to analyze ash content. Breast meat yield, relative organ weights, and villi height were calculated at 21 d. Data were analyzed as completely randomized design using JMP software. No significant effect ( $P > 0.05$ ) of breeder age was detected for BW, feed intake, BW gain, and feed conversion ratio at 14 and 21 d of age. However, significant effects of breeder age were observed on bone ash content ( $P < 0.01$ ). The highest value of ash content was detected in broilers from younger breeders (40 wk old). Whereas the value of ash content obtained in broilers from older breeders (60 and 73 wk old) showed no significant difference between these 2 treatments. Villi height was not affected ( $P > 0.05$ ) by treatments for duodenum and ileum regions. We concluded that female breeder age did not affect live performance parameters of male broilers at 21 d of age. However, bone mineralization in progeny could be affected by breeder age.

**Key Words:** breeder age, progeny, bone mineralization, organ development, molted breeders.

**12 Effect of different feeding schedules on reproductive quality on broiler breeders.** Angélica Londero\*, Alexandre Pires Rosa, Catiane Orso, Janaina Santos de Moura, Karine P. Pontin, Mariane Oliveira Fernandes, Daniele Pozzebon Rosa, and Lourdes Bernadete Padilha Brittes, *Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil.*

The objective of this study was to evaluate different feeding schedules on productive and reproductive performance of broiler breeder. The feeding schedules were: a single feeding at 8:00 am, twice daily feeding (50% at 8:00 am and 50% at 3:00 pm), and single feeding at 3:00 pm. We used 330 females and 45 males (Cobb 500) broiler breeders from 28 to 65 wk of age. The experimental design was completely randomized with 3 treatments of 5 replicates with 22 females and 3 males. Productive parameters were body weight (BW), egg production (EP), and eggs laid on the floor (EF). The reproductive parameters were fertility (F), hatchability of fertile eggs (HF), and hatchability of total eggs (HT). The nonhatched eggs were subjected to embryo diagnostics and classified through a macroscopic visual examination as infertile, embryonic mortality at the first 48 h of incubation (EM1), between 3 and 7 d (EM2), 8 and 14 d (EM3), and 15 d until hatched (EM4). Also total embryonic mortality (TM), pipped (P), contaminated (C), and number (NC) and weight of chicks (WC). At the 65 wk of age, 3 hens per pen were used to evaluate ovary (O) and oviduct weight (OW), number of small white

follicles (SWF), small yellow follicles (SYF), and big yellow follicles (BYF). The data were analyzed by ANOVA when significant at 10% were submitted to Tukey's test. Broiler breeders fed at 3:00 pm had greater BW than others ( $P < 0.0010$ ). Hens fed at 3:00 pm had lower EP in the total period ( $P < 0.0621$ ) and higher EF than hens fed twice at 8:00 am and 3 pm ( $P < 0.0674$ ). The HT was greatest for hens fed 8:00 am ( $P < 0.0042$ ). The F ( $P < 0.0799$ ) and HF ( $P = 0.0152$ ) for hens fed at 8:00 am was higher than for hens fed at 3:00 pm. The EM2 was greater for hens fed at 3:00 pm than others ( $P < 0.0103$ ). Hens fed at 3:00 pm had higher TM ( $P < 0.0068$ ) and lower NC ( $P < 0.0279$ ) than hens fed at 8:00 am. Hens fed at 3:00 pm had the highest ovary weight ( $P < 0.0113$ ). The variables EM1, EM3, EM4, P, C, WC, OW, SWF, SYF, and BYF did not differ for the different feeding schedules. We concluded that hens fed at 3:00 pm had greater increased body weight, resulting in the decline of reproductive parameters.

**Key Words:** egg, body weight, embryonic mortality, hatchability, follicle

**13 Efficiency of ultraviolet light in fertile eggs disinfection.**

José Renato de Oliveira Branco\*, Francisco Ernesto Moreno Bernal, Bruno Stéfano Lima Dallago, and Concepta Margaret McManus Pimentel, *Universidade de Brasília, Brasília, Distrito Federal, Brazil.*

This investigation was divided into 2 experiments. The first part aimed to compare the disinfection efficiency of a 254-nm UV light (UV-C) and a routine protocol with paraformaldehyde. Eggs from mated hens at 36 wk of age were exposed to the following treatments: untreated eggs; 1, 3, 5, 7, 9 min of UV-C light and paraformaldehyde 5 g/m<sup>3</sup>. A prototype to turn the eggs was developed to expose all egg shell to the UV-C lamp placed on the upper part of the laminar flow cabinet used. For each treatment 35 eggs were individually and aseptically placed into sterile plastic bags containing 20 mL of sterile-phosphate buffered solution. After 1 min of gentle hand massage 1 mL of the rinse solution of each bag was diluted on the proportion 1:10 and plated on aerobic plate counts (APC) for further incubation at 37°C during 48 h. Assessment of bacterial growth has detected a negative correlation with UV-C treatment duration and significant reduction of 0.68 log<sub>10</sub> UFC after 5 min of exposition. Paraformaldehyde was significantly more effective than all UV-C treatments except for the 9 min protocol. All data were analyzed with Fisher's exact test ( $P < 0.05$ ) and means evaluated using Tukey method ( $P < 0.05$ ). To study interference of disinfection protocols in the hatchability, 3 incubations with 35 untreated eggs, 35 eggs from paraformaldehyde group and 35 eggs treated with 9 min of UV-C were held. All eggs came from the same flock living 38, 42, and 48 wk at the moment they were collected and set. At first incubation the difference on hatchability of fertile eggs was at maximum 0.70% between all treatments. This difference persisted at second and third incubation between disinfected groups. From the results of these trials it was possible to infer that egg shell disinfection using UV light has growing potential according to the time of exposure. Bacterial reduction similar to paraformaldehyde protocol was detected only after 9 min of UV-C exposition, and hatchability of fertile eggs was not negatively affected by UV-C light when compared with the paraformaldehyde or to the control group.

**Key Words:** eggshell, exposure, paraformaldehyde, treatment, hatchability

**14 Effects of single and multistage incubation systems under commercial conditions on broiler live performance and leg health.** P. H. S. Ferzola\*<sup>1,2</sup>, E. O. Oviedo-Rondón<sup>1</sup>, A. H. Sarsour<sup>1</sup>, and H. A. Córdoba<sup>1</sup>, <sup>1</sup>*Prestage Department of Poultry Science, Raleigh, NC, USA*, <sup>2</sup>*Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil*.

Incubation conditions affect embryo development and consequently growth and development of chicks post-hatch. This experiment was conducted to evaluate the effect of single (SS) and multistage (MS) incubation systems on large broiler live performance and leg health. 240,000 eggs were randomly distributed into 5 setters, one SS Jamesway and 4 MS ChickMaster. In the SS, machine set points were managed to maintain eggshell temperatures close to 37.8°C. In the hatchers temperatures were step down up to 35.6°C. In the other 4 MS setters, machine set points were 37.5°C for 18.5 d of incubation and in the hatchers temperatures were reduced up to 33.6°C at the end of incubation. At hatch, 76,400 chicks were placed in a farm with 4 identical houses (2/treatment). Random samples of chickens were weighed at 14, 28, and 49 d of age, and the whole flock weighed at the processing plant at 60 d of age. A total of 280 chickens per treatment were individually evaluated in each period for footpad dermatitis (FPD) severity and incidence, and leg health issues such as valgus (VL), varus, hock burns, red hocks (RH), twisted legs and crooked toes. Data were analyzed as a completely randomized design with ANOVA. No differences ( $P > 0.05$ ) were observed on BW. At 49 d of age, MS broilers were on average 38 g heavier than SS broilers. No differences ( $P > 0.05$ ) due to incubation conditions were observed on FPD at any of the times evaluated. Valgus incidence was not different at 14 and 49 d of age, but at 28 d of age VL, and RH were higher for SS chickens. The grow out data of the whole flock at 60 d of age clearly indicated that the MS flock had better BW, livability, feed conversion, lower first week mortality (1.44 vs. 1.52%), and half of the farm condemnations (0.11 vs. 0.25%) observed in the SS flock. In conclusion, incubation conditions evaluated in this trial did not cause significant differences on grow out parameters, incidence of FPD, and only a few effects were detected on leg health. Some deleterious effects of SS incubation were observed due mainly to elevated temperatures in hatchers.

**Key Words:** single stage, multistage, live performance, footpad dermatitis, leg health issue

**15 Weight gain estimate of broiler chicks using digital image analysis.** Carlos Gutemberg de Souza Teles Júnior\*<sup>1</sup>, Richard S. Gates<sup>2</sup>, Ilda de Fátima Ferreira Tinôco<sup>1</sup>, Monique de Oliveira Vilela<sup>1</sup>,

Cecília de Fatima Souza<sup>1</sup>, Marcia Gabrielle Lima Candido<sup>1</sup>, Leticia Cibele da Silva Ramos Freitas<sup>1</sup>, Tatiany Carvalho dos Santos<sup>1</sup>, Catia Borges Ferreira<sup>3</sup>, and Keller Sullivan Oliveira Rocha<sup>2</sup>, <sup>1</sup>*Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil*, <sup>2</sup>*University of Illinois, Urbana, IL, USA*, <sup>3</sup>*Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil*.

The aim of this study was to develop an algorithm to determine the broiler's surface body area increase through digital image analysis and estimate their weekly body mass gain, based on the body surface area increase and its age. The animals were subjected to 3 different thermal conditions (thermoneutral condition, moderate cold, and severe cold). The animals' weight gain was recorded weekly in each considered thermal environment. A sample of 120 animals per thermal environment for the weight gain determination was used. The images relating to the animals' activities monitoring were processed and analyzed using the computer program MATLAB 7.9, from which information regarding the broiler body surface area were extracted. The data related to weekly weight gain and increased weekly body surface area of the animals were subjected to nonlinear regression in SigmaPlot software, which was extracted estimation model of weekly gain weight of animals based on generated response surface. The model chosen to represent the variation in weekly broiler weight gain, due to their age and your body surface area increase, was Lorentzian. It was found that weight gain and broiler body surface area increase showed an increasing trend over the creation weeks, independent of the thermal environment to which the animals were created. The model was evaluated based on the significance of the regression and of the regression parameters and of the coefficient of determination ( $R^2$ ), also evaluated the percentage error, by comparing the estimated results by the model and the animals' weight gain data measured in the traditional way. The proposed model for the broiler weight gain estimate was adequate with coefficient of determination  $R^2$  equal to 0.9995. In addition, variance regression analysis and evaluation of the regression parameters were significant with ( $P < 0.05$ ). The proposed model showed a low error percentage on average 0.7% and high correlation  $R = 0.9998$  between the data obtained by the model and the manual weighing.

**Acknowledgments:** To CAPES, CNPq, FAPEMIG, AMBIAGRO - DEA - UFV, PIF PAF ALIMENTOS.

**Key Words:** mathematical modeling, precision animal production, production management, productive performance, thermal environment

## Student Competition, Physiology and Reproduction

**16 Keel bone differences in laying hens housed in enriched colony cages.** Nicholas J. Chargo\*<sup>1</sup>, Cara I. Robison<sup>1</sup>, Michael J. Toscano<sup>3</sup>, Maja M. Makagon<sup>2</sup>, Sydney L. Baker<sup>2</sup>, and Darrin M. Karcher<sup>1</sup>, <sup>1</sup>*Michigan State University, East Lansing, Michigan, USA*, <sup>2</sup>*University of California, Davis, Davis, California, USA*, <sup>3</sup>*University of Bern, Bern, Switzerland*.

Keel bone damage may be painful to birds and affect their production. To better understand the types of keel bone damage during production, we evaluated the integrity of W-36 laying hen keel bones that were housed in enriched colony cages at 116 in<sup>2</sup>. At 4 time points, 120 birds (10 per cage; 3 cages per each of 4 rooms) had keel bones evaluated. Each hen was placed in a motion limiting restraint, scanned using CT (CT), fitted in vests containing tri-axial accelerometers and placed back in their cages for 21 d. After 21 d, the hens were rescanned and placed back in their cages. This process was repeated after 133 d. The CT scans were imported into Mimics software (Materialise NV, Leuven, Belgium); 3D models were made of each keel bone and exported to 3-matic software (Materialise NV, Leuven, Belgium). Each laying hen's keel bone model was superimposed to the initial scan creating 4 bone

pairings representative of each 21 d period, time off trial, and entire duration. Next, the proximal portion of each bone pairing was edited to normalize bone shape according to a strict protocol. Additionally, each pairing was divided into 3 portions: distal aspect (3cm), proximal aspect (2cm), and middle portion (remaining). Whole bone pairing and each bone portion was analyzed using the part comparison tool. Raw data from part comparison was imported into SAS 9.3 and summarized using Proc Means (mean, median, 1%, 90%, variance). Resulting data were analyzed using Proc Mixed with cage, part, time, and part by time in the model. Preliminary results (n = 15) revealed that part ( $P < 0.01$ ) was the only important main effect. Analysis of mean, median, and 90% for the part effect, showed the lsmeans of the distal aspect were greatest compared with other portions of the keel. The distal aspect averaged 1.2mm at the 90th percentile, which was roughly 50% greater than all other parts ( $P < 0.01$ ). Overall, results found the greatest morphological changes occur in the distal aspect of the keel.

**Key Words:** keel, laying hen, enriched colony, computed tomography, bone

## Student Competition, Processing and Products

**17 Causes of turkey condemnations in turkeys slaughtered in different seasons of the year.** Janaina Matte Weiss\*, Morgana Zorteá, Vinicius Sasso Nickel, Guiomar Pedro Bergmann, Saionara Araújo Wagner, Sérgio Luiz Vieira, and Liris Kindlein, *Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.*

This retrospective survey was carried out to determine the various causes of turkey carcass condemnation and their prevalence in slaughterhouses located at Rio Grande do Sul, Brazil at different seasons of the year. To this, survey data were generated by the Federal Inspection Service based on the total and partial condemnations and the total of birds slaughtered in 2015. The descriptive analysis (percentage) and frequency of variables was found by chi - square test. A total of 9 million of turkeys were evaluated and means of partial and total condemnations were estimated being grouped according to the season of the year. The main causes of total condemnations from processed turkeys were: repugnant aspect (29.23 %), colibacilosis (18.62 %) and biliar/fecal contamination (15.86 %) whereas partial condemnation were: aerossaculitis (39.30 %), bruises/ bone fractures (26.49 %) and biliar/fecal contamination (17.05 %). The most cause of condemnation in turkeys, aerossaculitis (36.25%) was also influenced according to the season of the year, with a higher prevalence in the summer (33.25 %) when compared to autumn (26.39 %), spring (20.53 %) and winter (19.81 %). In relation to total condemnations, there was a higher occurrence of colibacilosis in the summer (5.75%) and autumn (4.62%). According to the results obtained it was observed that there is a higher occurrence of aerossaculitis in the summer but in relation to colibacilosis this pathology affects turkeys in the summer and autumn. Optimal management practices on the farm and observation of proper methods during slaughtering are some of the ways that may be used to reduce incidences of condemnations.

**Key Words:** aerossaculitis, colibacilosis, condemnation, turkey.

**18 Egg quality of broiler breeder hens fed different sources and levels of iron.** Vinicius Sasso Nickel\*, Silvana de Castro Caldas, Diogo Taschetto, Tamara Zinn Ferreira, Sérgio Luiz Vieira, and Liris

Kindlein, *Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.*

This study aimed to reassess the nutritional levels of Fe with the use of 2 sources (organic and inorganic) of supplementation for parameters of eggs quality. In this way, 260 broiler breeder hens were fed with semi-purified control diet containing 27.26 ppm of iron (Fe) and about these added 5 levels of Fe 25, 50, 75, 100, 125 ppm from 2 sources, organic (complex Fe-amino acid (Fe-AA)) and inorganic (ferrous sulfate) in 6 periods of 28 d. Were evaluated percentages of yolk, albumen, shell, and specific gravity and egg weight. Treatments were distributed in a completely randomized design with factorial arrangement  $2 \times 6 \times 6$ . Significant differences were found between sources of Fe for egg weight and yolks percentage ( $P < 0.001$ ), with superiority of ferrous sulfate. Birds fed Fe-AA had higher values of percentage of albumen ( $P = 0.02$ ) and specific gravity ( $P = 0.02$ ). Iron level of 50 ppm improved the percentage of yolk and shell while egg weight and albumen were higher with 125 ppm of Fe. Throughout the study there was an increase of egg weight, albumen and shell (%) while there was a decrease in values of yolk (%) and specific gravity. Interactions between sources and periods were observed for yolk, albumen and shell, specific gravity ( $P < 0.0001$ ). Eggs from hens fed 25 and 50 ppm of ferrous sulfate had higher yolk percentage, while hens fed with 125 ppm of Fe-AA laid eggs with a higher albumen percentage and the highest percentage of shell was to eggs of hens fed with 50 and 100 ppm of Fe-AA. Regression analysis revealed maximum response for levels of 181.5; 56.2 and 75.1 ppm of Fe in diet for egg weight, yolk and shell (%), respectively and all variables showed a quadratic response, however for albumen (%) was observed minimum point for the level of 68 ppm of Fe in the diet. The results from the present study showed that the dietary Fe level directly influences the quality of eggs, regardless of the source used. Age of birds also influences the quality of eggs, older birds produce lower quality eggs, although heavier and, for Fe concentration in the yolk can estimate the level of 132.9 ppm of Fe in the diet for most response.

**Key Words:** Broiler hens, eggshell, iron, supplementation.

## Student Competition, Microbiology and Food Safety

### 19 Effects of essential oils on *Salmonella enterica* serovar

**Enteritidis: in vitro and in vivo assays.** Adriana Nogueira Figueiredo\*<sup>1,2</sup>, Renata Maria Teixeira Duarte<sup>2</sup>, Flavio Alves Longo<sup>3</sup>, Adriana Ayres Pedroso<sup>4</sup>, and Marta Cristina Teixeira Duarte<sup>1,2</sup>,  
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An increased demand for products free of antibiotics has forced the animal industry to find alternatives to traditional growth promoters. Thymol and eugenol presence in natural plant extracts are recognized for their antimicrobial properties. We hypothesized that essential oils from *Thymus vulgaris* (thymol) and *Ocimum gratissimum* (eugenol) could exclude *Salmonella* Enteritidis in the intestinal tract of chickens. We compared commercial and experimental produced oils from *T. vulgaris* and *O. gratissimum* in vitro. Experimental oils extracted from fresh leaves presented a less diversified gas chromatography-mass spectrophotometer compounds profile than commercial oils. Pure and essential oils blend (EOB) based on the thymol:eugenol concentration were

prepared and the minimum inhibitory concentration (MIC) determined. The value of 700 µg/mL of the EOB at the proportion 1:3 was efficient to inhibit the growth of strains of *S. Enteritidis*. To evaluate the growth kinetics of *S. Enteritidis* MB089-R (rifamycin resistant, 64 µg/mL), LB broth was inoculated with 0, 70, 350 and 700 µg/mL of EOB and the growth curves determined. Levels of EOB were efficient to decrease the bacterial growth rate and increased the doubling time ( $P < 0.05$ ). Next, microencapsulated EOB (20% oil + 80% maltodextrin) was fed to chicks at different levels (0, 70, 350 and 700 ppm of EOB) on the diets and did not negatively affect performance ( $P > 0.05$ ). Finally, 2d old chicks orally challenged with  $10^6$  cfu of *S. Enteritidis* MB089-R was fed the diets containing the same levels of microencapsulated EOB used in the performance experiment. The cecal *S. Enteritidis* load was determined at 1, 2, 3, 11 and 25 d after challenge using XLT4 agar. It was observed a reduction of the amount of *S. Enteritidis* present in the cecal microbiota of chickens fed diets containing 700 ppm of microencapsulated EOB. The blend of essential oils from *T. vulgaris* and *O. gratissimum* could be effective to control *S. Enteritidis*.

**Key Words:** eugenol, thymol, chicken, microencapsulation, cecal microbiota

## Student Competition, Genetics and Genomics

### 20 Whole genome sequencing to investigate *Salmonella Gallinarum* isolates of recent fowl typhoid outbreaks in South Brazil.

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Fowl typhoid (FT) and pullorosis (PU) are avian diseases caused by *Salmonella Gallinarum* biovars *Gallinarum* and *Pullorum*. In Brazil, a governmental program (PNSA) was effective to control *S. Gallinarum* from 1994 to 2006, but more than 100 cases (mainly of FT) were reported in the last 10 years. Two possibilities were raised to explain FT resurgence: (i) virulence reversion of the live vaccine SG9R and (ii) failure in the farm biosecurity programs. In this study, we applied molecular biology assays (including whole-genome sequencing – WGS) to investigate *S. Gallinarum* strains of recent outbreaks in South Brazil. Eleven *S. Gallinarum* strains were isolated from poultry flocks with FT/PU in South Brazil from 2013 to 2015. *Salmonella* colonies were serotyped and tested to differentiate bvs *Gallinarum* and *Pullorum* by

specific PCR assays targeting *speC* and *glgC* genes. Intergenic sequence ribotyping (ISR) was also performed to observe intra-serotype differences. WGS of one *S. Gallinarum* strain (BR\_RS12) was obtained with Illumina sequencing platform. A phylogenetic tree was generated by single nucleotide polymorphisms (SNPs) analysis. The results demonstrated that 6 isolates were from bv *Gallinarum* and 5 from bv *Pullorum*. ISR region analysis revealed that all bv *Gallinarum* isolates presented 100% of similarity with other reference strains of this biovar (including SG9R). On oppose, bv *Pullorum* isolates presented 2 different nucleotide sequences, divergent from the bv *Gallinarum*. In the phylogeny with the whole genome SNPs, BR\_RS12 clustered in the same branch of one Brazilian field isolate from the 1990s (287/91) while all other *Gallinarum* genomes (including SG9R) clustered in another branch of the tree. These results support the hypothesis that the current field strains are not due to virulence reversion of the SG9R vaccine, but to bacteria maintained in some low-level biosecurity production flocks and backyard chickens.

**Key Words:** *Salmonella*, fowl typhoid, Pullorosis, whole genome, SNP

# Student Competition; Immunology, Health, and Disease

**21 Effect of three strains of *Bacillus subtilis* on immune response and control of *Salmonella* Heidelberg on broilers.** Jessica Wammes\*<sup>1</sup>, Ricardo Hayashi<sup>1</sup>, Aline Silva<sup>1</sup>, Ricardo Gonzalez-Esquerre<sup>2</sup>, Raquel Araujo<sup>2</sup>, and Elizabeth Santin<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná - UFPR, Curitiba, Paraná, Brazil, <sup>2</sup>Novus, Indaiatuba, São Paulo, Brazil.

The potential of feeding a blend of 3 strains of *Bacillus subtilis* (Sporulin; SPR), to control *Salmonella* (SAL) was evaluated in broilers challenged with a strain of *Salmonella* Heidelberg (SH) isolated in Brazil. A total of 288 broilers were allocated to 6 treatments of 4 replicates of 12 birds each. Groups were T1) Non-challenged (NC), T2) NC fed 250 g of SPR/ton, T3) NC fed 500 g of SPR/ton, T4) SH-challenged (SHC) birds with SH, T5) SHC fed 250 g of SPR/ton, T6) SHC fed 500 g of SPR /ton. At 3 d of age, birds in groups T4, T5, and T6, were orally challenged with 10<sup>7</sup> cfu of SH /chick. Liver SAL counts; macrophage, CD4+ and CD8+ cell counts; and histology evaluations at the distal ileum by the ISI method (INPIBR1020150036019) were performed at 7 and 21 d of age on 12 birds per treatment. Data were submitted to ANOVA (ANOVA) and Tukey's test ( $P < 0.05$ ) for the means with a significant difference. Feeding 250 g/ton of SPR improved weight gain and reduced SAL counts in liver at 21 d. Feeding 500 g/ton reduced liver SAL counts at 7 and 21 d, and cecal SAL counts at 21d, significantly suggesting an inhibitory effect of SPR against SH. Feeding 500 g/ton of SPR to challenged birds increased lamina propria and epithelial thickness and proliferation of goblet cell and macrophages in ileal mucosa vs. challenged control birds. In non-challenged birds, SPR 500 g/ton reduced liver macrophages and CD4+ cells vs. non-challenged control birds. In challenged birds, 250 g and 500 g/ton of SPR showed greater macrophage counts in liver parenchyma vs. challenged control group suggesting that control of SH could be associated with increased macrophage presence in liver and an immune modulatory effect of SPR at the highest dose. The treatment with SPR 250 g/ton improved weight gain and reduced the liver SH isolation at 21 d. The treatment with SPR 500 g/ton did not affect the performance but reduced the SH isolation in liver at 7 and 21 d, suggesting an early control of the SH infection.

**Key Words:** Probiotic, gut health, macrophages, CD4+cell, CD8+cell

**22 Molecular characterization of Brazilian antigenic variants of the infectious bursal disease virus.** Aline Fraga\*<sup>1</sup>, André Fonseca<sup>2</sup>, Nilo Ikuta<sup>1,2</sup>, and Vagner Lunge<sup>1,2</sup>, <sup>1</sup>Laboratório de Diagnóstico Molecular ULBRA, Canoas, Rio Grande do Sul, Brazil, <sup>2</sup>Simbios Biotecnologia, Cachoeirinha, Rio Grande do Sul, Brazil.

Infectious bursal disease virus (IBDV) is the causative agent of the highly contagious Gumboro disease. IBDV is a double-stranded RNA (dsRNA) of the family *Birnaviridae*, genus *Avibirnavirus*. It is further divided into 2 serotypes (1 and 2) and 3 main genotype groups: classic viruses (cv), very virulent (vv), and antigenic variants (av) (all of them of the serotype 1). The IBDV classification in genotypes is based on phylogenetic analysis of the hypervariable region (hv) of the *vp2* gene. Genotyping studies have been used to understand the global distribution and virulence of the IBDV strains. The aim of this study was to analyze nucleotide and amino acid sequences to detect molecular signatures of IBDV from Brazil. IBDV *vp2* gene sequences from different years and regions of the world were retrieved from GenBank. The sequence data sets were aligned using MUSCLE and phylogenetic hypotheses

were inferred by maximum likelihood, using MEGA7 program. The phylogenetic analysis showed the presence of all 3 genotypes of IBDV in Brazil (cv, vv and avIBDV). Brazilian cv and vv strains were grouped with the remaining cv and vvIBDVs of the other countries, whereas local avIBDV clustered separately in one specific clade of the phylogenetic tree. In addition, Brazilian avIBDVs were subdivided into 2 well-supported clades or genetic groups (BR-G1 and BR-G2). These samples have high similarity within each group and have been detected since the 1990s, showing the occurrence of these genetic groups over the past 2 decades in Brazilian flocks. The hvVP2 amino acid sequences of Brazilian avIBDV have a unique and conserved molecular signature: 222S, 272T, 289P, 290I and 296F. Further, a comparison of the polymorphic sites of the VP2 Brazilian avIBDVs revealed 2 specific amino acids (275T and 280T) of the BR-G1 genetic group. These results are useful for understand the spread of avIBDV in Brazil.

**Key Words:** infectious bursal disease virus, genotyping, VP2, Brazilian avIBDV, phylogenetics

**23 Clinical and histopathological lesions in broiler immunosuppression disease associated with chicken infectious anemia virus (CIAV).** Lina P. Rodriguez\*, Diana M. Alvarez, and Claudia C. Torres, *Universidad Nacional de Colombia, Cr 45 Cl 30 Bogotá, DC, Colombia.*

The objective of this study was to analyze clinical and pathological parameters of broilers from different breeder flocks with or without reports of high mortality during the first 2 wk of life under experimental conditions (EC) and field conditions (FC). We analyzed 260 broilers from 4 breeder flocks. The chickens were housed under EC at the Universidad Nacional de Colombia for 15 d and on a farm under commercial conditions for 35 d. Samples for total blood cell counts, necropsy, histopathology, and microbiology were taken at 1, 8, 15, 24, and 35 d of age. Additionally, CIAV antibodies were tested by ELISA. Pathological and microbiological parameters were described and blood cell counts were analyzed using one-way ANOVA to see whether there was any significant difference between the breeder flocks and housing conditions. Histopathology indicated a mild hypoplasia of erythroid, myeloid, and lymphoid cells in bone marrow at d 1 and 35 in chickens with high mortality reports. The most common lesions were different grades of lymphoid necrosis and depletion in bursa, spleen, and thymus. Tracheitis, myocarditis, hepatitis, and granulomatous pneumonia lesions were associated with bacterial and other pathogen co-infections (*Escherichia coli*, *Aspergillus* spp.) at 8 d in all animals and 15 to 35 d in chickens under FC. Animals with severe anemia and pancytopenia were identified in all groups in EC and FC during the first 2 wk of life with recovery at normal levels at 24 and 35 d. Significant differences between flocks ( $P < 0.05$ ) were found at 1 and 8 d for hematocrit, at 8 and 15 d for white blood cell counts (mainly lymphocytes), and at 15 d for red blood cell counts. Serological tests indicated a low transfer of maternal antibodies to progeny with fast catabolism evidenced in all groups at 8 d. In all groups evaluated, the clinic pathological findings are compatible with infectious anemia, which presented more severely in animals housed under FC because of bacterial contamination.

**Key Words:** chicken infectious anemia virus, histopathology, hematology, serology, broiler



**24 In silico procedures, based on amino acid sequence and crystallography, to generate an egg yolk antibody for the quantification of avian cytokines (interleukin-10).** Maria K. Arendt<sup>\*1,2</sup>, Jordan M. Sand<sup>3</sup>, Megan A. Mezera<sup>3</sup>, and Mark E. Cook<sup>3</sup>, <sup>1</sup>University of Wisconsin-Madison Department of Comparative Biomedical Sciences, Madison, WI, USA, <sup>2</sup>School of Veterinary Medicine, University of Wisconsin-Madison, Madison, WI, USA, <sup>3</sup>Department of Animal Science, University of Wisconsin-Madison, Madison, WI, USA.

Scientists using poultry species have limited biologic reagents. New tools have become available to develop novel reagents. Our objective was to use in silico tools to develop a useful antibody to detect interleukin 10 (IL-10) in samples. The sequence for chicken IL-10 was sourced from pubmed.gov, protein: CAF18432. Antigenic regions on the protein were identified using BepiPred. Crystallography of the homologous human sequence (human IL-10, 2H24 A) approximated the location of antigenic regions accessible to antibody. An 8 amino acid peptide (vlpramqt) was identified, synthesized (GenScript; Piscataway, NJ), conjugated to a carrier protein (bovine gamma globulin, 1 mg carrier/1 mg peptide) and injected in hens using adjuvant (0.1 mg of the peptide conjugate/injection d 0 and d 7). IgY (d 21) was purified (acidified saline, crude antibody) and antibody was purified using affinity chromatography. Crude and affinity purified anti-IL-10 peptide antibody and a polyclonal rabbit-anti-IL-10 antibody (Bioss, Woburn, MA) was used to develop a sandwich ELISA to quantify IL-10 protein in samples. In experiment 1, crude anti-IL-10 IgY was bound to the plate as the capture antibody, and after sample or pure IL-10 (Kingfisher Biotech, St. Paul MN), rabbit anti-IL-10 (sandwich antibody) followed by goat-anti-rabbit IgG-horseradish peroxidase (HRP) conjugate (detection antibody), then substrate were sequentially added after washing. This ELISA design failed to detect IL-10. In experiment 2, the capture, sandwich, and detection antibody were rabbit anti-IL-10, affinity purified anti-IL-10 peptide IgY, and goat anti-chicken-IgG-HRP conjugate, respectively. This ELISA resulted in high background due to detection antibody binding capture antibody. Experiments 3 and 2 were the same except the detection antibody was rabbit-anti-chicken-IgG HRP. A linear curve was generated between 16- 1,000ng/mL ( $R^2 = 95\%$ ). Intestinal lumen and serum IL-10 could be detected at 0.25 mg protein/mL or a 1:500 dilution, respectively. The approach described provides a method to develop useful reagents.

**Key Words:** IL-10, chicken, ELISA, antibody, detection

**25 Effect of antibiotic growth promote in the mucosa immune response in broilers challenged by *Eimeria* and *Clostridium*.** André L. P. Ribeiro\*, Antonio L. Kraieski, Paula. G. Santin, Ana C. W. Heemann, Juliana C. Azevedo, and Elizabeth Santin, *Universidade Federal do Paraná, Curitiba, Paraná, Brazil.*

Coccidiosis is an important disease caused by *Eimeria* that has economic impacts in poultry production and also is a predisposing agent to necrotic enteritis (NE). The use of antibiotic growth promoter (AGP) is a feed prophylactic additive to control harmful agents to the intestinal tract and provide benefits in nutrient absorption. The goal of this study was to evaluate the effect of AGP in the immunologic response in broilers challenged by *Eimeria* and *Clostridium*. We used 192 male broilers divided into 4 treatments (challenged + AGP fed, challenged + not AGP fed, not challenged + AGP fed, and not challenged + not AGP fed) with 48 birds in each. At 7, 14, 21, and 28 d, 8 birds per treatment were killed and samples of ileum were taken for macrophages (MAC), TCD4+, and TCD8+ counts. At 7 and 14 d, liver and ileum were taken for mRNA expression of IL-10 and IL-12. All data were analyzed by ANOVA followed by Tukey's test. At 7 d there is an interaction for MAC count where in the challenged groups, the AGP showed higher

amount of MAC compared with non-supplemented birds. At this age, birds fed with AGP showed higher ileum CD8 cell and IL-10 mRNA expression compared with non-supplemented. For CD4 the challenged factor reduced this cell in challenged birds. At 14 d, there is no interaction between factors, but the AGP group showed lower amount of MAC, CD4 and higher amount of CD8 compared with non-supplemented one. For challenge factor, at this age, there was a greater number of CD4, CD8 cell, and IL-12 mRNA expression in the ileum of challenged birds compared with non-challenged birds. At 21 d there was an interaction for CD4 cell where AGP was decreased in challenged birds or non-challenged birds. At 28 d there was an interaction between factors where in non-challenged birds, the AGP group had lower MAC, CD4, and CD8 cell counts compared with non-supplemented birds. In challenged birds, the AGP only showed lower CD8 cell in the ileum compared with non-supplemented birds. From these results it was possible to conclude that the use of AGP affected the dynamics of immune cells of broilers challenged or not with *Eimeria* and *Clostridium*.

**Key Words:** immune cell, IL-10, IL-12, lymphocyte

**26 Correlation between histology alteration and performance in broilers vaccinated or challenged with *Eimeria*.** Carolina O. Pinto\*, Antonio L. Kraieski<sup>1</sup>, Bruna L. Belote<sup>1</sup>, André Ribeiro<sup>1</sup>, Georgia Almeida<sup>2</sup>, and Elizabeth Santin<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Curitiba, PR, Brazil, <sup>2</sup>Universidade Tuiuti do Paraná, Curitiba, PR, Brazil.

Coccidiosis is caused by *Eimeria*, which replicates in the intestinal epithelium of birds and causes injuries that impair performance indexes. The purpose of this study was to correlate the intestinal morphology of broilers *Eimeria* vaccinated and challenged with animal performance. This experiment used 176 broilers from 1 to 28 d of age. Birds were divided into 3 treatments: negative control (NC), *Eimeria* vaccinated (EV), and *Eimeria* vaccine at 15× the manufacturer's recommended dose (EC). At 2, 7, 14, 21, and 28 d of age, samples of liver, duodenum, jejunum, and ileum from 5 birds per treatment were gathered for histological analysis applying the I See Inside (ISI) index methodology and at 2 and 7 d of age we quantified hepatic IL-10 and IL-12 mRNA expression. At 2 d, we observed a higher ISI index in livers of birds from the EV and EC groups compared with NC group, and the main histologic lesions observed were vacuolation, proliferation of ducts, infiltrated lymphoid, and pericolangitis. At 7 d, we observed a higher ISI index in the duodenum of birds from EC group compared with other groups ( $P < 0.05$ ), but there was no correlation with performance. At 7 d, the ileum histologic index was correlated with BWG and FCR ( $r = -0.60$  and  $r = 0.63$ , respectively). The mRNA expression of IL-10 was higher in EC group compared with NC and EV groups at 7 d. At 14 d, the EV group presented higher ISI index in jejunum compared with the NC and EC groups ( $P < 0.05$ ). At 21 d, we observed a higher ISI index ( $P < 0.05$ ) in EC and EV groups in jejunum and ileum compared with CN group, and it was correlated with lower BWG ( $r = -0.47$  and  $r = -0.57$ , respectively). In the period from 1 to 21 d, EC group showed lower FI and BWG ( $P < 0.05$ ) compared with CN group. At 28 d, birds from EC group showed higher ISI index in liver compared with CN group ( $P < 0.05$ ), and it was correlated with FI and BWG ( $r = -0.54$  and  $r = -0.48$ , respectively). According to the results it was evidenced that the birds from EV and EC group presented higher histological alterations compared with NC group and it was correlated with worse performance parameters.

**Key Words:** IL-10, IL-12, ISI index, coccidiosis, immunity

**27 Application of a morphometric index for ileum and liver histological alterations and its correlation with broiler performance: *Eimeria* and *Clostridium perfringens* challenge and antibiotic growth promoter supplementation model.** Antonio L. Kraieski\*<sup>1</sup>, Paula G. Santin<sup>1</sup>, Juliana C. Azevedo<sup>1</sup>, Carol O. Pinto<sup>1</sup>, Mariana L. Moraes<sup>2</sup>, and Elizabeth Santin<sup>1</sup>, <sup>1</sup>Federal University of Paraná, Curitiba, Paraná, Brazil, <sup>2</sup>Jefo Nutrition Inc., St-Hyacinthe, Quebec, Canada.

The intestinal mucosa surface is responsible for digestion and absorption and acts as a defense barrier against pathogens present in the intestinal lumen. Mucosa integrity may be impaired in different ways and it could be useful to evaluate these changes. The objective of the present study was to apply a morphometric index for liver and ileum histological alterations and to correlate it with performance in broilers challenged with *Eimeria* and *Clostridium* and supplemented with antibiotic growth promoter (AGP). A total of 192 one-d-old broiler chickens were divided in a 2 × 2 factorial arrangement with 4 treatments (4 replications each): T1, control diet and no challenge; T2, diet with AGP (10 ppm of Enramycin) and no challenge; T3, control diet and challenge; and T4, diet with AGP and challenge. Challenged birds received 10<sup>8</sup> the manufacturer recommendation dose of coccidiosis vaccine at d 1 and 10<sup>8</sup> cfu/mL per bird of *Clostridium perfringens* at 11, 12, and 13 d. At 14, 21, and 28 d, samples of ileum and liver were gathered for histological analysis applying the I See Inside-ISI index methodology, and the performance was calculated. There was no interaction between factors for performance. The challenged birds had lower BWG compared with non-challenged ones ( $P < 0.05$ ) and this was correlated to the liver ISI index from 1 to 14d ( $r = -0.88$ ) and to the ileum from 1 to 21 d ( $r = -0.61$ ), mainly due to infiltration of inflammatory cells. From 1 to 28 d, challenged birds had worse BWG and FCR than non-challenged ones ( $P < 0.05$ ), and the BWG was correlated with higher histological index in liver and ileum ( $r = -0.49$  and  $r = -0.56$ , respectively). AGP-supplemented birds presented better BWG from 1 to 21 d and FCR from 1 to 14 d and 1 to 21 d compared with the non-supplemented ones. The histological index applied in this trial was efficient in quantifying and correlating the alterations with performance data. The challenge applied and the AGP supplementation affected performance and histological parameters.

**Key Words:** histopathology, health index, mucosa integrity, ISI

**28 Serologic profile of broilers affected with wooden breast.** Tamara Zinn Ferreira\*, Letícia da Silveira Gross, Stella de Faria Valle, Sérgio Luiz Vieira, and Liris Kindlein, *Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.*

Wooden breast (WB) is a myopathy that has been increasingly reported by poultry integrations. It is characterized by macroscopically visible alterations of the pectoralis major muscle in comparison to the normal muscle showing hard, bulging, and pale areas. Muscle damage can be investigated by analyzing serum enzymes, such as creatine kinase (CK), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and lactate dehydrogenase (LDH). The aim of this study was to evaluate the serum profile of breast meat affected with WB condition to get more information on the systemic changes associated with this condition. At 42 d, 1 bird per replication ( $n = 72$ ) was slaughtered and macroscopically evaluated according to WB scores, where 0 = normal breast, 1 = mild hardening in the upper, 2 = moderate hardening in the upper and/or lower part of the fillet, 3 = severe hardening, and 4 = severe hardening with hemorrhagic lesions, increased volume, and presence of yellow fluid. There were statistical differences ( $P < 0.05$ ) in the serum levels of ALT, AST, CK, and LDH, with higher levels of these enzymes as WB severity increased. No differences for any enzyme occurred between

scores 3 and 4. When compared with normal breast meat, WB scores 3 and 4 presented levels of enzymes higher, respectively, 9 times for ALT, 2.5 times for AST, 4 times for CK, and 2 times for LDH. Total leukocytes were not different between treatments.

**Key Words:** broiler, enzymatic level, myopathy, wooden breast

**29 Evaluation of enzymatic markers on the occurrence of white striping on broiler breast filets.** Ítalo da Silva\*, Vinícius Sasso Nickel, Nilton Nunes da Silva Junior, Stella de Faria Valle, Sérgio Luiz Vieira, and Liris Kindlein, *Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.*

White striping (WS) is a condition characterized by the presence of white striations in parallel to muscle fibers in the major breast muscle and occasionally also in thighs. With regards to the incidence of this myopathy, breast filets are categorized as normal (NORM – without striations), moderate (MOD – striations less than 1 mm), or severe (SEV – striations  $\geq 1$  mm on the surface of pectoralis major). The aim of this study was to evaluate profile of enzymes usually involved with muscle degradation aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatine kinase (CK), and lactate dehydrogenase (LDH) as well as leukocytes of broilers with breast muscle presenting different degrees of WS. Blood was collected (3 mL) from 42 d old Cobb 500 male broilers ( $n = 72$ ) at the time of slaughter. Results showed statistical differences for ALT ( $P < 0.05$ ) as well as for AST, CK, and LDH ( $P < 0.001$ ); however, no significant difference was observed in leukocytes count. Levels of CK were 2.3 times higher for the SEV (19.45) when compared with NORM (8.39) degrees of WS. Degrees of WS severity demonstrated also to influence ALT, AST, and LDH with higher levels for SEV and MOD when compared with NORM filets (NORM: 0.72, 351, 4.27; MOD: 142, 493, 5.15 and SEV: 2.99, 693, 6.98). These results suggest that WS myopathy causes muscle damage in broilers breast filets once it was observed an increased of serum enzyme levels with the evolution of this myopathy.

**Key Words:** biochemical parameter, broiler, myopathy, white striping

**30 Effect of botanical extracts and essential oils in feed on laying hen performance and *Salmonella*, *Escherichia coli*, and total bacterial counts in feces.** Abdulla Ahmad Tahir\*<sup>1</sup>, Abid Hasnain<sup>1</sup>, Shahid Waheed<sup>1</sup>, Omer Mukhtar Tarar<sup>2</sup>, Zahra Yaqeen<sup>2</sup>, Tehmina Sohail<sup>2</sup>, and Tahira Mohsin Ali<sup>1</sup>, <sup>1</sup>University of Karachi, Karachi, Sindh, Pakistan, <sup>2</sup>Pakistan Council of Scientific and Industrial Research, Karachi, Sindh, Pakistan.

The aim of the present study was to investigate the effect of botanical extracts and essential oils on performance of laying hens and total bacterial counts of *Escherichia coli* and salmonella present in feces. We used 112, 40-wk-old, white Novagin laying hens randomly assigned to 7 groups equally ( $n = 16$ ). Each treatment (group) was replicated 4 times with 4 birds per replicate. Experimental diets were as follows: A: positive control, antibiotic lincomycin 4.4%, 120 mg/kg of feed, antioxidant seldox (BHA, BHT, ethoxyquine, and citric acid) 120 mg/kg of feed, acetic acid 99.5% pure 0.15 mL/kg of feed; B: negative control (NC), no antibiotic, antioxidant, and acetic acid; C: NC + black tea poly phenolic extract 1 mL/kg of feed; D: NC + black cumin seed poly phenolic extract 1 mL/kg of feed; E: NC + fenugreek seed polyphenolic extract 1 mL/kg of feed; F: NC + black cumin seed oil 1 mL/kg of feed; and G: NC + fenugreek seed oil 1 mL/kg of feed. Weekly egg production percentage of treatment A was significantly greater than treatment B ( $P$

<0.05), but treatments A, C, D, E, F, and G had no significant difference between each other ( $P < 0.05$ ). On the other hand, total bacterial count was significantly reduced with increasing age in all treatments except the NC but there was no significant difference between treatments when compared for presence of salmonella and *E. coli* ( $P < 0.05$ ) in feces.

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**Key Words:** laying hen, salmonella, *Escherichia coli*, egg production

# Student Competition, Metabolism and Nutrition: Feed Additives

**31 Can the dietary probiotic recover gut microbiome after of chickens submitted to antibiotic therapy?** Rafaela Pereira<sup>\*1</sup>, José Fernando M. Menten<sup>1</sup>, Adriana A. Pedroso<sup>2</sup>, Cristiano Bortoluzzi<sup>1</sup>, Naiara S. Fagundes<sup>1</sup>, Thiago Gumiere<sup>1</sup>, Diogo P. Costa<sup>1</sup>, Gláucia S. Napyt<sup>1</sup>, Kelen Zavarize<sup>1</sup>, and Fernando D. Andreote<sup>1</sup>, <sup>1</sup>University of São Paulo, Piracicaba, SP, Brazil, <sup>2</sup>University of Georgia, Athens, GA, USA.

The purpose of this study was to verify the ability of a probiotic in the feed to maintain the stability of gut microbiota in chickens after antibiotic therapy. The probiotic *Bacillus subtilis* was supplemented or not in the feed based on corn and soybean meal from 1 to 42 d of age. At 21, 22, and 23 d of age the chickens received or not antibiotic treatment (bacitracin methylene disalicylate + neomycin sulfate) in the drinking water. At 26, 28, and 30 d of age (2, 4, and 6 d after the therapeutic treatment), birds were euthanized and the contents of the ceca of 3 birds/pen were collected and pooled in a total of 3 replicates. The trial was conducted in floor pens (40 birds/pen) in a 2 × 2 × 3 factorial arrangement: with or without probiotic (+P / -P) × with or without antibiotic therapy (+A / -A) × 2, 4, and 6 d after the antibiotic therapy (T). DNA was extracted and the 16S rRNA gene was analyzed by terminal restriction fragment length polymorphism (T-RFLP) through multivariate statistical analyses to study microbial profile and the real time PCR (qPCR) technique was used to quantify the number of 16S rDNA gene copies per gram of cecal content. T-RFLP analysis showed that each treatment modulated individually the microbial profile in the gut. In addition, at 30 d there was higher similarity in the cecal microbiome profile of birds from the 2 treatments that received probiotic (+P-A and +P+A); on the other hand, the bacterial community from treatments that did not receive probiotic (-P-A and -P+A) were more distanced. The qPCR analysis revealed a main effect of days after the antibiotic therapy on the number of copies 16S rRNA gene in cecal contents, with a lower bacterial population at 28 and 30 d in relation to 26 d. These results indicated changes on the microbial profile and lower quantity of microorganisms with the time after the antibiotic therapy that possibly were related to recovering of the microbiota 6 d after the therapeutic treatment promoted by dietary probiotic.

**Key Words:** probiotic, antibiotic therapy, microbiota, broiler chicken, cecum

**32 Use of stable isotopes to assess intestinal quality of broilers supplemented with *Baccharis dracunculifolia* extract.** Everton M. Muro<sup>\*</sup>, Antonio C. Pezzato, Guilherme A. M. Pasquali, Daniella A. Berto, Mônica M. Aoyagi, and Nathália M. G. Causso, *Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista, Botucatu, São Paulo, Brazil.*

Due to growing ban on performance enhancer antibiotics (PEA) it is necessary to search for substitutes to maintain both productivity and animal health. In this context plant extracts appear as a natural and safe alternative. Therefore, this study aimed to evaluate the effects of *Baccharis dracunculifolia*'s extract (BDE) in broiler diets on intestinal health. Two studies in a completely randomized design with 6 treatments were performed: control diet (CD) without inclusion of PEA and BDE; CD + 0.1% BDE; CD + 0.2% BDE; CD + 0.3% BDE; CD + 0.4% BDE and CD+PEA (virginiamycin, 10 ppm). In the first experiment 1,080 male broilers were allotted to 6 replicates per treatment. Histomorphometric measurements of intestine were performed at 21 and 42 d of

age, and the data collected were analyzed by GLM procedure of SAS. In the second experiment we used 720 male broilers to evaluate the carbon turnover of the intestinal mucosa with the same treatments in 2 phases: from 1 to 21 d of age and from 21 to 49 d of age. The mucosa was analyzed by isotope-ratio mass spectrometry, and the weights of birds were recorded, the data were plotted in OriginPro software, and the turnover constant obtained was derived for metabolic and growth rate. At 21 d of age, birds treated with CD + 0.2% BDE showed an increase in duodenal crypt depth ( $P < 0.05$ ) compared with controls, but no stimulation of villi development was observed at 42 d of age. In the second experiment we observed, at 21 d, decreased carbon half-life and increased metabolic rate of the intestinal mucosa for the treatment with CD + 0.2% BDE; the effects disappeared in the second phase of the study, also the growth rate did not differ between treatments. The high metabolic rate and shorter half-life, combined with increased crypt depths in the first period, especially at the 0.2% level, seemed to indicate a possible irritant effect of the extract on the intestinal mucosa, an effect that would cause the need for greater tissue replacement. The inclusion of BDE in any levels studied did not result in improved intestinal health compared with PEA.

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**Key Words:** carbon, metabolic rate, phytogetic additive, plant extract, turnover rate

**33 Age-related energy values of bakery meal determined using the regression method for broiler chickens.** Catarina Stefanello<sup>\*1</sup>, Olayiwola Adeola<sup>2</sup>, Sergio L. Vieira<sup>1</sup>, Cristina T. Simoes<sup>1</sup>, and Heitor V. Rios<sup>1</sup>, <sup>1</sup>Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, <sup>2</sup>Purdue University, West Lafayette, IN, USA.

A study was conducted to determine the ileal digestible energy (IDE), ME, and ME<sub>n</sub> contents of bakery meal using the regression method and to evaluate if the energy values are age-dependent in broiler chickens from 0 to 21 d post hatching. A total of 780 male Ross 708 chicks were fed 3 experimental diets in which bakery meal was incorporated into a corn-soybean meal-based reference diet at 0, 100, or 200 g/kg by replacing the energy-yielding ingredients. A 3 × 3 factorial arrangement of 3 ages (1, 2, or 3 wk) and 3 dietary bakery meal levels was used. Birds were fed the same experimental diets in these 3 evaluated ages. Birds were grouped by weight into 10 replicates per treatment in a randomized complete block design. Data were analyzed using the GLM procedures of SAS Institute. The effects of increasing levels of bakery meal in assay diets were compared using linear and quadratic contrasts. Apparent ileal digestibility and total-tract retention of DM, N, and energy were calculated. Expression of mucin (MUC2), sodium-dependent phosphate transporter (NaPi-IIb), solute carrier family 7 (cationic amino acid transporter, Y<sup>+</sup> system, SLC7A2), glucose (GLUT2), and sodium-glucose linked transporter (SGLT1) genes were measured at each age in the jejunum by real-time PCR. Inclusion of bakery meal to the reference diet resulted in a linear decrease in retention of DM, N, and energy; and a quadratic reduction ( $P < 0.05$ ) in N retention and ME. There was a linear increase in DM, N, and energy as birds' age increased from 1 to 3 wk. There was no effect of dietary bakery meal on jejunal gene expression. Expression of genes encoding MUC2, NaPi-IIb, and SLC7A2 linearly increased ( $P < 0.05$ ) with age. Regression-derived ME<sub>n</sub> of bakery meal linearly increased ( $P < 0.05$ ) as the age of birds increased, with values of 2,710; 2,820, and 2,923 kcal/kg DM for 1, 2, and 3 wk, respectively. Based on these results, utilization of energy and

nitrogen in the basal diet decreased when bakery meal was included and increased with age of broiler chickens.

**Key Words:** age, bakery meal, broiler, gene expression, metabolizable energy

**34 Effect of oil level, enzyme, and emulsifier in diets of broiler chickens.** Levy V. Teixeira<sup>\*1,2</sup>, Cristiano Bortoluzzi<sup>1,4</sup>, Rosana C. Maia<sup>1,3</sup>, Antonio G. Bertechini<sup>1,2</sup>, and Todd J. Applegate<sup>1,4</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, USA, <sup>2</sup>Federal University of Lavras, Lavras, MG, Brazil, <sup>3</sup>Federal University of Viçosa, Viçosa, MG, Brazil, <sup>4</sup>University of Georgia, Athens, GA, USA.

The objective of this study was to evaluate the effects of oil level, enzyme, and emulsifier on performance, nutrient digestibility, and nitrogen-corrected apparent metabolizable energy (AMEn) for broiler chickens. A total of 480 1-d-old male Ross 708 were weighed and randomly assigned to 8 treatments in a factorial arrangement with 2 levels of soybean oil (1.5% and 4.5%), 2 levels of amylase (0 and 80 KNU/kg) and 2 levels of emulsifier glyceryl polyethylene glycol ricinoleato (0 and 350 g/ton) with 10 replicates of 6 birds each. Total excreta were collected from d 5 to 7 and from d 19 to 21 to determine AMEn, apparent retention coefficients of dry matter (ARCDM), crude protein (ARCCP), and fat (ARCF). Feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) were recorded at d 7 and 21. The data were analyzed as a 3-way ANOVA (PROC GLM/SAS), and the means were compared using Tukey's test with  $P < 0.05$  and tended values lower than  $P < 0.1$ . There was no interaction ( $P > 0.05$ ) among oil level, enzyme, and emulsifier. A high level of soybean oil increased ( $P < 0.05$ ) DM, CP, and fat retention and improved the performance in both ages evaluated. The emulsifier improved ( $P < 0.05$ ) fat retention and tended to improve AMEn ( $P = 0.056$ ) and ARCDM ( $P = 0.096$ ) at 21 d. In addition, amylase tended to increase AMEn ( $P = 0.068$ ) and ARCDM ( $P = 0.086$ ) at 21 d of age. From performance results, amylase tended to increase BWG ( $P = 0.063$ ) at the d 7 and BWG ( $P = 0.089$ ) and FCR ( $P = 0.07$ ) at 21 d. Emulsifier tended to increase BWG ( $P = 0.053$ ) at 7 d and FCR ( $P = 0.055$ ) at 21 d. There was no effect of factors on FI. In conclusion, the effects of amylase and emulsifier were not additive; however, both tended to improve the AMEn of the diets and the performance of the birds.

**Key Words:** emulsifier, amylase, nutrient retention, dietary oil, AMEn

**35 Effects of canthaxanthin and 25-hydroxycholecalciferol on broilers meat physical and chemical characteristics.** Douglas V. Bonamigo<sup>\*1</sup>, Alexandre P. Rosa<sup>1</sup>, Daniele P. Rosa<sup>1</sup>, Sandro J. Paixão<sup>1</sup>, Alexandre B. Mariani<sup>1</sup>, Adrian S. Ertmann<sup>1</sup>, Isaac Bittar<sup>2</sup>, and Leticia C. Bittencourt<sup>2</sup>, <sup>1</sup>Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil, <sup>2</sup>DSM Nutritional Products, São Paulo, São Paulo, Brazil.

The purpose of this study was to evaluate the effect of MaxiChick and its active ingredients, canthaxanthin combined with 25-hydroxycholecalciferol (25-OH-D<sub>3</sub>) in broilers feed on the physico-chemical characteristics of the meat. Two experiments were made to evaluate the effects on male and female chicks: 1500 and 1680 male and female one-day old Cobb-500 broilers were used, distributed in a completely randomized design, with 2 treatments of 15 replicates of 50 birds each for male chicks and 56 birds each for female chicks. Male broilers were raised during 42 d and female broilers during 43 d. Treatments were: T1: Control Diet and T2: Control Diet + 0.1% MaxiChick until 21 d

of age. Samples for breast meat physical and chemical characteristics' measurement were harvested at 28 and 43 d of age in female chicks and 42 d of age in male chicks. Three birds with average weight per replicate were selected. Variables measured were: pH, color (L\*, a\* and b\*), water-holding capacity, sheare force and cook loss. Leg color pigmentation levels were evaluated in 6 birds per replicate, at 42 d of age in male chicks and 43 d in female chicks. Data were subjected to ANOVA. Significant results ( $P < 0.05$ ) were observed in yellow color strength (b\*) in breast meat of male broilers supplemented with MaxiChick (7.76 vs. 7.06) and in leg color pigmentation in male broilers evaluated at 42 d of age (4.68 vs. 3.11). In female chicks, significant results ( $P < 0.05$ ) were observed in red color strength (a\*) (3.26 vs. 2.83) and yellow (b\*) (6.48 vs. 5.70) in breast meat of birds evaluated at 28 d of age supplemented with MaxiChick. No differences were observed at the other variables. It is therefore concluded that the addition of MaxiChick to the diet, based on Canthaxanthin and 25-hydroxycholecalciferol (25-OH-D<sub>3</sub>), had a direct influence on color, with differentiated results among sexes. Better pigmentation of meat results in greater acceptance of the product by the consumer market.

**Key Words:** Vitamin D, color, nutrition, pigmentation, meat quality

**36 Effect of supplementation of vitamin E in laying hens diets on egg quality with different storage periods.** Mariane O. Fernandes<sup>\*</sup>, Alexandre P. Rosa, Daniele P. Rosa, Catiane Orso, Angélica Londero, Adrian S. Ertmann, Alexandre B. Mariani, and Janaina S. Moura, Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil.

The objective of this study was to evaluate the effect of inclusion of vitamin E on egg quality of laying hens. We used 128 laying hens Novogen Brown, 40 to 55 wk of age, distributed in a completely randomized design with 2 treatments, 8 replicates of 8 hens each. The treatments were: DC - negative control diet and DVitE - diet with addition of 200 mg/kg of vitamin E (acetate dl- $\alpha$ -tocopherol). The parameters evaluated were: weight of stored eggs (WSE), percentage of yolk, albumen and shell (% Y, %A, and %S), Haugh unit (HU), pH of albumen (pH), yolk color (YC), vitelline membrane resistance (VMR) and lipid oxidation. To determine the quality parameters were selected 3 eggs per replicate for each storage time (0, 14, 21 and 28 d) within a range of 2.5% variation from the average egg weight. To determine VMR was used TA.XT Texture Analyzer 123 and to the lipid oxidation was used TBARS method (reactive substances to the Thiobarbituric Acid on  $\mu$ g of Malondialdehyde/kg of yolk). Data were subject to ANOVA (ANOVA) using the SAS statistical program. Supplementation with vitamin E provided a better %Y and %A for eggs stored for 21 ( $P = 0.0581$  and  $P = 0.0392$ ) and 28 d ( $P = 0.0470$  and  $P = 0.0530$ ). Also WSE ( $P = 0.0711$ ) and pH albumen ( $P = 0.0085$ ) on 14 d of storage had better results. The DvitE showed lowest lipid oxidation ( $P = 0.0268$ ), highest VMR ( $P = 0.0132$ ) and better UH ( $P = 0.0889$ ) in eggs stored on 21 d. No differences were observed between treatments for other variables in different times of storage ( $P > 0.10$ ). The addition of Vitamin E in diets of laying hens is an alternative to improve the internal quality of stored eggs with up to 28 d.

**Key Words:** laying hen, internal egg quality, storage time, lipid oxidation.

**37 Effect of canthaxanthin supplementation on internal egg quality of laying hens and storage at different temperatures.** Daniele P. Rosa<sup>\*1</sup>, Alexandre P. Rosa<sup>1</sup>, Angélica Londero<sup>1</sup>, Catiane Orso<sup>1</sup>, Mariane O. Fernandes<sup>1</sup>, and José F. Miranda<sup>2</sup>, <sup>1</sup>Universidade

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The aim of this study was to evaluate the effects of canthaxanthin (CTX) supplementation on internal egg quality of laying hens, storage at room temperature or refrigerated. We used 2,400 eggs, distributed in randomized design with a 2 × 2 factorial arrangement [supplementation 0 or 6 mg of CTX (CAROPHYLL Red 10%, DSM Nutritional Products)/kg diet; 2 types of storage: room temperature (25°C) or refrigerated (4°C)], with 10 replicates of 60 eggs each. The eggs were stored for 0, 7, 14, 21, and 28 d (d). The parameters analyzed were: egg weight (EW), yolk and albumen percentage (%Y and %A), yolk index (YI), Haugh unit (HU), vitelline membrane resistance (VMR), lipid oxidation (TBARS), and milligrams of total carotenoids per kilogram of yolk (C). To determine internal quality, 3 eggs were selected per repetition according to EW (within an interval for variance of 2.5%). To determine the C we used an iCheck portable photometer, VMR was measured by a TA.XT Texture Analyzer 123, and TBARS measured the amount of thiobarbituric acid-reactive substances. All the data were subjected to ANOVA. Tukey's test was used for significant interaction at the 10% level. Statistical procedures were performed using SAS software. In the interactions study only was observed that storage eggs at 4°C from hens fed with different diets had higher YI to 21 d ( $P = 0.0601$ ) and 28 d ( $P = 0.0738$ ) than eggs stored at 25°C. Hens fed with 6 mg CTX/kg of diet had highest C in all storage periods ( $P < 0.10$ ), VMR at 21 d ( $P = 0.0918$ ), HU at 0 d ( $P = 0.0335$ ) and lowest %A at 14 d ( $P = 0.0564$ ) and 21 d ( $P = 0.0405$ ). However, hens fed with 0 mg/kg CTX had highest YI to 0 d ( $P = 0.0086$ ). Eggs stored at 4°C had highest HU from 7 to 28 d ( $P < 0.10$ ), YI and lowest TBARS at 7 to 14 d ( $P < 0.10$ ). Eggs from hens fed with 6 mg CTX/kg of diet, stored at refrigerated temperature (4°C) had better shelf life.

**Key Words:** corn, carotenoid, refrigerated, yolk index

**38 Lipid profile and susceptibility to peroxidation on semen of roosters supplemented with canthaxanthin.** Catiane Orso\*, Alexandre Rosa, Angélica Londero, Janaina Moura, Adrian Ertmann, Alexandre Mariani, Ana Cougo, Pedro Feltrin, and Ademir Bach, *Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul- Brazil.*

The study evaluated the effect of dietary supplementation of canthaxanthin (CTX) on the oxidation and lipid profile of semen from roosters at different ages. 32 males White Plymouth Rock from 52 to 72 wk of age were distributed in a completely randomized design with 16 replicates. The treatments were males supplemented with 6 mg/kg/feed CTX or without CTX (negative control). Semen samples were collected at 52, 56, 60, 64, 68 and 72 wk of age, by abdominal massage, for analysis of lipids. Lipid oxidation was determined by Thiobarbituric Acid reactive-substances (TBARS) method, quantified by spectrophotometry. The fatty acid composition was determined using gas chromatography. The results were obtained as a percentage of the identified fatty acids. Data were submitted to ANOVA. No difference was observed between treatments for the TBARS ( $P > 0.05$ ) in all weeks analyzed. There was an increase in the proportion of total polyunsaturated fatty acids, with a significant increase in Docosadienoic Acid C22:2 ( $P = 0.0001$ ) and Nervonic acid + acid cervonic (C24:1+C22:6) ( $P = 0.0454$ ) at 52 wk of age. At the 56th week we observed a significant increase of dihomo- $\gamma$ -linolenic acid

C20:3n-6 ( $P = 0.0152$ ). At the 64th week there was an increase of eicosapentaenoic acid (EPA) C20:5n-3 ( $P = 0.0442$ ) and dihomo- $\alpha$ -linolenic acid C20:3n-3 ( $P = 0.0240$ ). At the 68th week there was an increase the proportion of C20:3n-6 ( $P = 0.0163$ ), C20:5n-3 ( $P = 0.0291$ ) and (C24:1 + C22:6) ( $P = 0.0358$ ). At the 72nd week there was considerable increase in the arachidonic acid C20:4n-6 ( $P = 0.0385$ ). The oleic acid, C18:1n-9c, was highest in semen of males feed with CTX ( $P < 0.005$ ) in all age groups. The addition of canthaxanthin did not decrease lipid peroxidation. The increase in the proportion in fatty acids in the sperm phospholipids that resulted from dietary supplementation of the males with the cantaxanthin, may have beneficial consequences for fertility.

**Key Words:** male, oxidation, carotenoid, spermatozoa

**39 Effect of supplementing exogenous protease in poultry by-product-meal based diets on growth, carcass characteristics, and nutrient digestibility in broilers.** Tahir Mahmood\*<sup>1</sup>, Muhammad A. Mirza<sup>1</sup>, Haq Nawaz<sup>1</sup>, Muhammad Shahid<sup>2</sup>, Tariq Mushtaq<sup>3</sup>, and Mubashar Hussain<sup>1</sup>, <sup>1</sup>*Institute of Animal Sciences, University of Agriculture, Faisalabad, Punjab, Pakistan*, <sup>2</sup>*Department of Biochemistry, University of Agriculture, Faisalabad, Punjab, Pakistan*, <sup>3</sup>*Agro-Visions (Pvt) Ltd., Faisalabad, Punjab, Pakistan.*

A 3 × 2 factorial experiment was conducted using 3 levels (0, 3, and 6%) of poultry by-product meal (PBM) and 2 levels of exogenous protease (with and without) in broilers to check the effect on growth, carcass characteristics and nutrient digestibility from d 1 to 35. The data were statistically analyzed in 3 × 2 factorial design by generalized linear method of ANOVA using MINITAB. Significant means were separated by Tukey's test. The birds (n = 240) were randomly divided into 24 replicates (10 birds/replicate) and fed equi-caloric and equi-nitrogenous (ME 2850; CP 20) diets *ad libitum* throughout the experiment. The exogenous enzyme was supplemented at 200 g/ton of feed. Enzyme supplementation increased feed intake and body weight gain ( $P < 0.01$ ) but feed: gain remained unaffected ( $P > 0.05$ ) from d 1 to 21. Increasing level of PBM decreased feed intake ( $P < 0.05$ ). However, body weight gain and feed: gain was improved ( $P < 0.05$ ) at 3% PBM level from d 1 to 21. A strong interaction effect ( $P < 0.01$ ) of enzyme and PBM on feed intake was noted during d 1 to 21. No interaction was recorded for body weight gain and feed: gain. Percent carcass yield ( $P < 0.01$ ) was improved by the addition of enzyme. Percent breast meat yield was depressed ( $P < 0.001$ ) with addition of PBM in the diet. No main effect or interaction effect was noted for all other carcass characteristics. The AME ( $P < 0.001$ ), nitrogen retention ( $P < 0.01$ ), AME<sub>n</sub> ( $P < 0.001$ ), and apparent digestibility coefficient for nitrogen ( $P < 0.01$ ), all were improved by the supplementation of protease; however, the reverse was noticed for birds fed diets containing only PBM. In conclusion, improved performance and nutrient digestibility were recorded in birds fed diets containing 3% PBM with protease supplementation

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**Key Words:** poultry by-product meal, broiler, exogenous protease, nutrient digestibility

# Student Competition, Metabolism and Nutrition: Nutrition

**40 Can feeding amount influence internal quality of commercial egg?** Juliana Forgiarini<sup>\*1</sup>, Everton L. Krabbe<sup>2</sup>, Suelen N. Silva<sup>1</sup>, Cristiele L. Contreira<sup>1</sup>, Débora A. Alves<sup>1</sup>, Valdir S. Avila<sup>2</sup>, Márcio G. Satkamp<sup>2</sup>, and Victor F. B. Roll<sup>1</sup>, <sup>1</sup>University Federal of Pelotas, Pelotas, RS, Brazil, <sup>2</sup>Embrapa Swine and Poultry, Concórdia, SC, Brazil.

Several countries have already changed their production systems, choosing cage-free structures. Such modifications affect bird maintenance requirements. It is also assumed that different breeds will respond in different ways to the new production trend. Embrapa 051 (E051) is a national dual purpose genetic line, and there is a lack of information when raised in new rearing systems. The study was performed with the objective to evaluate the internal quality of eggs produced by E051 layers under different feeding programs. In this experiment, 600 layers, 36 to 40 wk old, were housed in 15 floor pens with wood shaving and access to external paddocks. The feed was delivered early the morning and in the afternoon; greens (*Pennisetum purpureum* Schum. cv. Mott) were provided (30 g/bird per day). Each pen corresponded to an experimental unit containing 40 birds. The 3 treatments with 5 replicates each consisted of different feed amount: T1, 106 g feed/bird per day; T2, 114 g/bird per day; and T3, 122 g/bird per day. The nutritional profile was extracted from the Commercial Line Management Guide, with AME content of 2,750 kcal/kg, CP = 16.0%, Ca = 3.74%, aP = 0.33% and 0.72% digestible Lys following the ideal protein profile. The evaluated parameters were percentage of yolk (Yolk%), albumen percentage (Alb%), Haugh units (HU), yolk index and yolk color (YolkFan). The data were submitted to variance analysis and means were compared through Tukey Test. No significant difference ( $P > 0.05$ ) for HU, index, and color of yolk were observed. However, Yolk% ( $P = 0.0124$ ) and Alb% ( $P = 0.0205$ ) differed for treatments, with the highest Yolk% for T3 when compared with T2 and T1. The Alb% was the highest for T2, significantly different from T3 and not statically different from T1. Based on the data collected from eggs produced by 40-wk-old layers, it was concluded that the E051 breed need a greater nutritional intake, thus improving the internal quality of their eggs.

**Key Words:** Haugh unit, feeding program, laying hen, cage free

**41 Assessment of feeding programs for Embrapa 051 layers.** Cristiele L. Contreira<sup>\*2</sup>, Victor F. B. Roll<sup>2</sup>, Juliana Forgiarini<sup>2</sup>, Suelen N. Silva<sup>2</sup>, Débora A. Alves<sup>2</sup>, Diego Surek<sup>1</sup>, Everton L. Krabbe<sup>1</sup>, and Valdir S. de Avila<sup>1</sup>, <sup>1</sup>Embrapa Swine and Poultry, <sup>2</sup>Department of Animal Science, University Federal of Pelotas (UFPel).

Embrapa 051 (E051) is a national dual-purpose genetic line, a brown eggshell layer, with an average body weight of 2.2 kg at 40 wk of age. This study aimed to evaluate the effect of different feeding volumes on productive performance. 600 layers were used at 40 wk of age. The birds were housed in a shed, divided into 15 floor pens, and covered with wood shavings with access to external paddocks with 5.6m<sup>2</sup>. The ration was provided in the morning and in the afternoon 30 g of greens (*Pennisetum purpureum* Schum. cv. Mott) per bird was offered. The 3 treatments with 5 repetitions each (40 birds/replicate) were made up of different amounts of feed, where the reference was given from a commercial line with known feeding curve, as follows: T1, E051 receiving 93% (106 g/bird per day); T2, E051 receiving 100% (114 g/bird per day); and T3, E051 receiving 107% (122 g/bird per day). Feed was produced in mash form, based on corn and soybean meal. The nutritional profile

was extracted from the Commercial Line Management Guide, with AME content of 2,750 kcal/kg, CP = 16.0%, Ca = 3.74%, aP = 0.33%, and 0.72% digestible Lys, following the ideal protein profile as recommended by Brazilian Tables for Poultry and Swine, 2011. The measurements at wk 40 were body weight (g), laying rate (%), feed conversion per dozen eggs (kg/dz), egg mass (g/bird per day), and AME conversion (cal/g). Data were submitted to ANOVA and Tukey's test. There was no significant difference ( $P > 0.05$ ) for conversion per dozen eggs. For body weight ( $P = 0.0017$ ) and AME conversion ( $P < 0.0001$ ), T3 was statistically higher than the other treatments. For laying rate ( $P = 0.0001$ ) and egg mass ( $P = 0.0003$ ), T3 and T2 were significantly higher than the T1. It can be concluded that the E051 layer breed responded positively for the highest feeding level with 107% improved performance, showing that the lineage has specific nutritional requirements when feeding recommendation is compared with other commercial brown eggshell laying hens.

**Key Words:** egg mass, nutrition, performance, hen

**42 Effects of canthaxanthin associated with 25-OH-D<sub>3</sub> in antioxidant activity in yolks through incubation in quails.** Lucas P. Bonagurio<sup>\*1</sup>, Paula T. Pintro<sup>1</sup>, Carlos A. L. Oliveira<sup>1</sup>, Murray R. Bakst<sup>2</sup>, and Tatiana C. Santos<sup>1</sup>, <sup>1</sup>Department of Animal Science, University State of Maringá, Maringá, Paraná, Brazil, <sup>2</sup>US Department of Agriculture, Animal Biosciences and Biotechnology Laboratory, Beltsville Agricultural Research Center, Agricultural Research Service.

Canthaxanthin (Cx) is a carotenoid with antioxidant function and effects under stress conditions. In avian eggs, the yolk has many lipid compounds and they are very susceptible to oxidative processes. In this study, we evaluated the impact of varying levels of dietary CX + 25OH on the antioxidant activity of yolk of European quails through incubation. We used 240 quail breeders, distributed in a completely randomized design with 5 treatments (control diet 2,000 IU D<sub>3</sub>, 3 ppm CX + 1,380 IU 25OH, 6 ppm CX + 2,760 IU 25OH, 9 ppm CX + 4,140 IU 25OH, and 12 ppm CX + 5,520 IU 25OH) and 8 repetitions (2 males + 4 females). Eggs were stored in a room (20°C) for 0 or 8 d before incubation. From each treatment, 3 pools of 4 yolks were collected from fresh eggs and during incubation (2, 4, 6, 10, 15) and at hatch (residual yolk). Samples were frozen in liquid nitrogen and lyophilized for lipid extraction with methanol and trichloroacetic acid. The antioxidants were determined by thiobarbituric-reactive substances (TBARS) and percentage of 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging. The data were analyzed first as ANOVA and then as a regression by SAS 9.0 in the Proc Mixed. The TBARS values were similar in first days of incubation and increased in the last days and at hatch in all treatments. Yolks from the control group had higher values for all days analyzed when compared with yolks from supplemented treatments. In eggs that were stored before incubation, the values were higher than values observed in eggs without storage. The DPPH assay had a quadratic effect in function of days and treatments and storage had no effect. The DPPH free radical scavenging increased along incubation. In conclusion, supplementation of quail breeders with Cx + 25OH improved the antioxidant system in yolk, showed by reduction of thiobarbituric reactive substances and increment of DPPH free radical scavenging in yolks during eggs incubation when the nivel of supplementation was 6 ppm.

**Acknowledgments:** CNPq

**Key Words:** breeder, DPPH, thiobarbituric-reactive substance, radical scavenging, storage

**43 Energy levels in pelleted diets and ileal nutrient digestibility in broilers.** Emanuele C. Goes\*, Andréia Massuquetto, Vinicius G. Schramm, Rosiane A. Araujo, and Alex Maiorka, *Universidade Federal do Paraná, Curitiba, Paraná, Brazil.*

The objective of this study was to evaluate different energy levels in pelleted feeds on the coefficients of ileal nutrient digestibility in broilers. In the experiment, 576 male Cobb broilers from 35 to 48 d of age were distributed in a completely randomized design with 4 treatments and 8 replicates of 18 birds each. The treatments consisted of pelleted diets containing 4 energy levels (3,280, 3,200, 3,120, and 3,040 kcal respectively). The diets differ in the level of energy and concentration of inert compound. On d 48 of the experimental period, 2 birds per experimental unit were euthanized by cervical dislocation and the ileal content was collected, homogenized and stored for digestibility analysis. The coefficients of ileal apparent digestibility (CIAD) of dry matter (DM), crude protein (CP), starch, and energy were evaluated. The obtained data were submitted to analysis of regression. The CIAD of DM increased linearly in relation to the dietary energy level ( $y = 0.0143x + 31.993$ ;  $R^2 = 0.82$  and  $P = 0.05$ ). This result can be explained by the fact that the animals increased feed intake while it decreased dietary energy level. Thus, increasing the feed intake can result in higher passage rate and lower substrate exposure time to digestive enzymes and, consequently, lower the absorption of nutrients. No differences in the CIAD of CP, starch, and energy were detected ( $P > 0.05$ ). Therefore, we concluded that increasing the energy level in pelleted diets improved the ileal apparent digestibility of DM in broilers.

**Key Words:** digestibility, digestible energy, energy level, pelletizing

**44 Whole sorghum-based diets reduced *Clostridium* in the small intestine of broilers.** Naiara S. Fagundes\*<sup>1,2</sup>, Cristiano Bortoluzzi<sup>1</sup>, Rafaela Pereira<sup>1</sup>, Jaqueline M. Rafael<sup>1</sup>, Glaucia S. Napyt<sup>1</sup>, José Guilherme M. Barbosa<sup>1</sup>, and José Fernando M. Menten<sup>1</sup>, <sup>1</sup>University of São Paulo, Piracicaba, SP, Brazil, <sup>2</sup>FAPESP, São Paulo, SP, Brazil.

The aim of this study was to evaluate the intestinal microbiota of broilers fed ground or whole sorghum-based diets (SBD), as well the change between these diets. In this trial, 640 broilers were distributed to 16 pens and fed different diets: ground SBD (GS); whole SBD (WS); GS from 1 to 7 d (d) and WS from 8 to 21d (G-WS); and WS from 1 to 7d and GS from 8 to 21d (W-GS). A pool of samples of small intestine and cecum contents from 5 and 3 chickens (at 10d and 21d, respectively) was formed for each pen. The DNA isolation, and 16S gene amplification and sequencing were performed (MiSeq Illumina). After taxonomic classification (Greengenes Database), the Principal Coordinate Analysis (PCoA), and hierarchical clustering dendrogram were obtained (16S Metagenomics App, Illumina). The 5 genera most frequent in each intestinal segment were submitted to ANOVA (5%) and Tukey's test, in a factorial design (SAS 9.4). In the small intestine, interaction between age and diet were observed for *Lactobacillus* and *Staphylococcus*, but Tukey's test did not detect effect of diet in the first one. However, at 21 d, broilers that were being fed whole SBD (WS and G-WS) showed higher *Staphylococcus* level than those fed ground SBD (GS and W-GS). WS and G-WS diets propitiated lower *Clostridium*

level than the GS diet. Levels of *Corynebacterium* and *Brevibacterium* in the small intestine were not affected by diets. In the cecum, at 10 d, *Ruminococcus* level was higher with the use of WS diet than with GS and G-WS diets. In both ages, WS propitiated lower *Alkaliphilus* level than GS. The genera *Blautia*, *Fecalibacterium* and *Clostridium* were not affected by diets. The microbiota structure showed lower similarity and higher distance between ages, and also between the grain form (whole or ground SBD) at sampling day. However, the effect of diet was less evident in microbiota of cecum. In conclusion, the presence of whole sorghum in the diet showed greater effect in the intestinal microbiota than the abrupt change of diet, and the use of whole SBD changed the microbiota structure mainly due the decrease of *Clostridium* and an increase of *Staphylococcus* in the small intestine.

**Key Words:** milo, gut microbiota, microflora

**45 Effects of processing methods of shea butter (*Butyrospermum paradoxum*) cake meal on hematological and serum biochemical indices of broilers.** Paschal C. Aguihe\*<sup>1</sup>, Abiodun S. Kehinde<sup>1</sup>, Camilo I. Ospina-Rojas<sup>2</sup>, and Alice E. Murakami<sup>2</sup>, <sup>1</sup>Department of Animal Production and Technology, Federal College of Wildlife Management, New-Bussa, Niger, Nigeria, <sup>2</sup>Department of Animal Science, Universidade Estadual de Maringá, Maringá, Parana, Brazil.

Shea butter cake (SBC) is a by-product of the shea fat industry in West Africa and has the potential of being an alternative protein and energy source in poultry diets. A 42-d study was conducted to evaluate the effect of processing methods of SBC on hematological and serum biochemistry of broilers. Five experimental diets were formulated to contain raw, soaked-cooked, fermented and NaOH treated SBC at 20% dietary level as well as a control diet which contained no SBC. A total of 250 Arbor Acres 1-d-old chicks were randomly allocated to 5 treatments with 5 replicates of 10 birds each in a completely randomized design (CRD). Blood samples were collected from 2 birds per replicate and analyzed for hematological parameters such as pack cell volume (PCV), hemoglobin (Hb), white blood cells (WBC), red blood cells (RBC) and serum biochemical indices such as total protein (TP), albumin, globulin, glucose and cholesterol. All data were analyzed by the GLM procedure of SAS. Differences among means were separated with Tukey's multiple range tests. Proximate analysis of the SBC revealed 93.27% dry matter contained 14.60% crude protein and 4,361.971 kcal ME/kg as well as 0.21 mg/100 g tannin. Result revealed that soaking and cooking, NaOH and fermentation treatments reduced 83.33, 75.24, and 72.38% of tannin concentration, respectively, in the raw SBC. Mean values of WBC, RBC, TP, and glucose were significantly ( $P < 0.05$ ) lower in birds fed raw SBC diet but were improved ( $P < 0.05$ ) in birds fed processed SBC diets. Hb, albumin, globulin, and cholesterol did not show any significant ( $P > 0.05$ ) difference among the dietary treatments. Mean values obtained in this study were within the recommended margins. In conclusion, the processing methods were effective in reducing the tannin levels in SBC; thus, 20% processed SBCM could be fed to broilers without any apparent adverse effect on their health status.

**Acknowledgments:** The managerial assistance and support provided by the Provost/CEO, and management of the Federal College Wildlife Management is gratefully acknowledged.

**Key Words:** shea butter cake, processing, hematology, serum biochemistry, broiler



# Student Competition, Metabolism and Nutrition: Amino Acids I

**46 Metabolizable energy and digestible methionine + cysteine for pullets from 7 to 12 weeks of age.** Guilherme Souza Lima\*<sup>1</sup>, Sarah Gomes Pinheiro<sup>1</sup>, Fernando Guilherme Perazzo Costa<sup>1</sup>, Ricardo Romão Guerra<sup>1</sup>, Matheus Ramalho Lima<sup>2</sup>, Marcio Ladeira Ceccantini<sup>3</sup>, and Danilo Teixeira Cavalcante<sup>1</sup>, <sup>1</sup>Federal University of Paraíba, Areia, Paraíba, Brazil, <sup>2</sup>Federal University of the South of Bahia, Teixeira de Freitas, Bahia, Brazil, <sup>3</sup>Adisseo, São Paulo, Brazil.

We evaluated the effect of levels of digestible Met+Cys (dM+C) and metabolizable energy (ME) in pullets from 7 to 12 wk of age. The study was conducted in 4 × 3 factorial design (4 levels of dM+C: 0.522, 0.447, 0.497, 0.547%; 3 levels of ME: 2,755, 2,900, and 3,045 kcal/kg), a total of 12 treatments, 6 replicates of 15 pullets each. Variables were histology of the liver, villus of small intestine, nitrogen balance, and serological status. The villus height of the small intestine was affected by 0.522 and 0.447% dM+C and higher levels were obtained in 2,755 and 2,900 kcal/kg, respectively. The width of the villi of small intestine, the effect occurred only 0.497% dM+C, higher value in 2,900 kcal/kg, differ 2,755 kcal/kg. The crypt depth of the small intestine was influenced by the level of 0.522% dM+C, with higher value in 3,045 kcal/kg, differing from 2,900 kcal/kg. Alanine aminotransferase, aspartate aminotransferase and gamma aminotransferase were affected by treatments. Albumin has smaller values in 0.547, 0.447 and 0.547% dM+C levels in 2,755, 2,900 and 3,045 kcal/kg, respectively. In seric total protein, lower values were obtained with lower dM+C at the 3 levels of ME. As for the glucose, the lowest values were observed in 0.522, 0.447, and 0.522% dM+C, respectively, in 2,755, 2,900, and 3,045 kcal/kg. Creatinine was influenced only in the levels of 0.447 and 0.547% dM+C. The N retained:N intake ratio was negative in all treatments, with highest negative values in 0.447, 0.547, and 0.547% dM+C, respectively, with 2,755, 2,900, and 3,045 kcal/kg. In conclusion, it is recommended to have 0.497 or 0.547% dM+C in diets with 2,755 kcal/kg for pullets from 7 to 12 wk of age.

**Key Words:** amino acid, nutrition, physiology

**47 Effects of metabolizable energy and high-density nutrients on performance of Hy-Line laying hens.** Danilo Cavalcante\*<sup>1</sup>, Fernando Perazzo Costa<sup>1</sup>, Cristina Lima<sup>1</sup>, Gabrielle Castro<sup>1</sup>, Gabriel Pessoa<sup>2</sup>, and Eduardo Nogueira<sup>2</sup>, <sup>1</sup>UFPB, Areia, PB, Brazil, <sup>2</sup>Ajinomoto do Brazil, São Paulo, SP, Brazil.

The objective of this experiment was to determine the effect dietary ME and high-density nutrients (amino acids, Ca, and available P) on performance of Hy-Line W36 during egg production (from 44 to 64 wk of age). This study was a 3 × 3 factorial arrangement of 3 dietary ME levels (2,750, 2,950, and 3,150 kcal/kg) and 3 nutrient densities (5, 10, and 15%) more than Rostagno et al. (2011). A total of 432 birds were randomly assigned into 9 treatments (6 replicates with 8 birds per replicate). There were interactions between ME levels and nutrient densities for FI, EP, egg weight (EW), egg mass (EM), and FCR ( $P < 0.001$ ). Diets with high ME (3,150 kcal/kg) and high density (15%) caused the lowest FI (89.8 g/hen per day). In contrast the diet with the lowest level of ME (2,750 kcal/kg) and intermediate density (10%) caused the higher FI (108.2 g/hen per day). The intermediate ME (2,950 kcal/kg) and intermediate density (10%) resulted in greater EP (92.9%), most WE (63.1 g), EM (58.6 g), and better FCR (1.63 g/g). Diets with low ME (2,750 kcal/kg) and low density (5%) exhibited the poorest EP (83.1%),

EW (58.9 g), and EM (49 g/d) and lower FCR (2.13 g/g). In conclusion, diets containing 2,950 kcal/kg of ME and 10% high-density nutrients more than Rostagno et al. (2011) produced optimal egg performance for Hy-Line W36 laying hens aged from 44 to 64 wk.

**Acknowledgments:** The authors thank the Study Group on Poultry Technologies (Grupo de Estudos em Tecnologias Avícolas, 296 GETA) and Ajinomoto Animal Nutrition.

**Key Words:** amino acid, calcium, egg production, mineral, phosphorus

**48 Use of L-[<sup>15</sup>N] threonine as a tracer for broiler chickens.**

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Labeled amino acids can be used to evaluate physiological processes and to elucidate physiological issues. The purposes of this study were to compare the <sup>14</sup>N and <sup>15</sup>N recoveries in different broiler's tissues and to verify the distribution of the L-[<sup>15</sup>N] threonine in broiler tissues (4 to 9 d). Twelve male broilers (Cobb 500) were allocated in individual cages and fed a diet enriched with L-[<sup>15</sup>N] threonine (abundance = 98%, dosage = 69.6 mmol of L-[<sup>15</sup>N] threonine/kg bird) for 5 d. On d 4 and 9, the birds were slaughtered and the tissues were collected for analysis. The <sup>15</sup>N concentrations in the tissues were determined by an isotope ratio mass spectrometer. The <sup>14</sup>N and <sup>15</sup>N recoveries represented the <sup>14</sup>N and <sup>15</sup>N percentage ingested that was deposited into tissues. To calculate the depositions of L-[<sup>15</sup>N] threonine, we used the following equation:  $^{15}\text{ND} = W_t \times \%N_t \times [(Ab_t - Ab_{thr}) / (Ab_{nat} - Ab_{thr})]$ , where <sup>15</sup>ND is the <sup>15</sup>N deposited in the tissue (mg),  $W_t$  is the tissue weight (mg),  $\%N_t$  is the percentage of nitrogen,  $Ab_t$  is the isotope abundance of the tissue,  $Ab_{thr}$  is the isotope abundance of the tracer, and  $Ab_{nat}$  is the isotope abundance of the diet. We observed a small difference between the recoveries of <sup>14</sup>N and <sup>15</sup>N in all tissues analyzed, demonstrating that the properties of the isotopes were similar. For example, the <sup>14</sup>N and <sup>15</sup>N recoveries in body free of feathers were 67.02 and 67.35%, respectively. Analyses of the distribution of the L-[<sup>15</sup>N] threonine showed approximately 73.29% was found in the body free of feathers, 1.20% in the feathers, 10.23% in the excreta, 14.96% in the breast, 2.36% in the liver, 1.36% in the jejunum, 1.88% in the plasma, 0.57 in the kidneys, and 0.21% in the sartorium. In consideration of the threonine roles in the protein turnover as an essential amino acid for protein deposition and mucin synthesis, these data showed that threonine is well distributed in the tissues and most of the threonine was found in the breast and excreta. Furthermore, it demonstrated the use of stable isotopes as excellent tracers.

**Acknowledgments:** To CAPES and Fapesp for the financial support.

**Key Words:** metabolism, labeled amino acid, stable isotope

**49 Replacing sulfur amino acids with betaine on broiler**

**performance.** Patrícia Soster\*, Eveline Berwanger, Sergio L. Vieira, Liris Kindlein, and Pedro Henrique S. Ferzola, *Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.*

The objective of this study was to investigate the effects of replacing methionine with betaine on performance and carcass yield of broilers. A total of 1,920 Cobb × Cobb 500 male broilers were allocated into 96 floor pens, distributed into 8 treatments and 12 replications with 20 birds per pen. The dietary treatments consisted of a positive control (PC) formulated with 0.77 sulfur amino acid (AA):lysine ratio, a negative control (NC) without sulfur AA (DL-methionine) and without betaine (betaine HCl), and 6 increasing betaine inclusions by replacement of DL-methionine (20, 40, 60, 80, 100, and 120%). Corn-soybean meal diets were formulated based on local industry levels using a 3-phase feeding program: starter (1 to 14 d), grower (15 to 28 d), and finisher (29 to 35 d). Body weight gain (BWG), feed intake (FI), and feed conversion ratio corrected for weight of dead birds (FCR) were evaluated at 14, 28, and 35 d. Four broilers per pen were slaughtered at 35 d for carcass, abdominal fat, and breast fillet yield evaluation. Data were analyzed by PROC GLM SAS, and means were compared using the Tukey-Kramer test ( $P < 0.05$ ). Treatments with replacement levels of

100 and 120% of betaine had the highest cumulative FCR ( $P < 0.05$ ) and the lowest cumulative BWG ( $P < 0.05$ ) among treatments. No differences on FCR were observed in broilers fed diets at 20, 40, 60, and 80% levels of betaine from 1 to 35 d. Carcass yield was higher for the PC diet; however, no differences were observed when the PC was compared with replacements of 20 and 40% of betaine. Breast fillet yield was higher for betaine replacements up to 60% when compared with the betaine levels of 100 and 120%, and did not differ from PC. In conclusion, the substitution of betaine for DL-methionine impaired broiler chicken performance. Replacements up to 40% of methionine with betaine had no effect on breast fillet and carcass yields.

**Key Words:** betaine, broiler, DL-Methionine, carcass yield, performance

**Wednesday, October 5, 2016**  
**SYMPOSIA AND ORAL SESSIONS**

**Student Competition, Metabolism and Nutrition: Enzymes II**

**50 Digestibility of broiler chickens fed three different corn varieties and supplemented with carbohydrases.** Heitor V. Rios<sup>\*1</sup>, Sergio L. Vieira<sup>1</sup>, Catarina Stefanello<sup>1</sup>, Cristina Simões<sup>1</sup>, and José Otávio B. Sorbara<sup>2</sup>, <sup>1</sup>*Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil*, <sup>2</sup>*DSM Nutritional Products, São Paulo, SP, Brazil*.

A study was conducted to evaluate the effects of 3 different varieties of corn and 5 carbohydrase supplementations on energy and nutrient digestibility of broiler chickens. A total of 840 1-d-old Cobb 500 broiler chicks was placed in 60 battery cages. Seven birds per cage were randomly allocated and fed experimental diets from 16 to 24 d. Birds were distributed in a completely randomized design, using a factorial arrangement of 3 corn varieties (waxy, semi-hard, and semi-dent) and 5 carbohydrase combinations (no supplementation, amylase, xylanase, amylase + xylanase, and an enzymatic complex compound by xylanase and  $\beta$ -glucanase). The study was replicated twice over time. In the pre-experimental period, all birds were fed a common starter diet (3,050 of AME<sub>n</sub>/kg; 21.7% CP, 1.05% Ca, and 0.53% Av. P). On d 16, birds received semi-purified diets (95.91% of corn), formulated with 1,000 FYT of phytase, and celite at 1% was used as a marker. Total excreta collections were between 21 and 24 d, twice a day, to evaluate the total-tract retention of dry matter (DM), crude protein (CP), ether extract (EE), and apparent metabolizable energy corrected for balance of N (AME<sub>n</sub>). At 24 d, all birds were slaughtered to collect ileal content and determine the ileal digestibility of DM (iDM), CP (iCP), EE (iEE), and ileal digestible energy (iDE). Data were subjected to ANOVA and means, when significant, were compared by Tukey test ( $P < 0.05$ ). Broilers fed diets supplemented with carbohydrases had higher AME<sub>n</sub> and iDE compared with birds fed diets with no supplementation ( $P < 0.05$ ). No interactions between corn and carbohydrases were observed. Waxy corn had the lowest iEE among the varieties of corn ( $P < 0.05$ ). Results in this study indicated that the supplementation of carbohydrases ameliorated AME<sub>n</sub> and iDE. Different corn varieties can implicate in different nutrients digestibility for broiler chickens.

**Key Words:** broiler, digestibility, corn, carbohydrase

**51 Effects of  $\alpha$ -amylase and  $\beta$ -xylanase supplementation on growth performance and metabolizable energy of broiler chickens fed corn-soy diets.** Natalia C. Serafini<sup>1</sup>, Catarina Stefanello<sup>1</sup>, Sergio L. Vieira<sup>1</sup>, Liris Kindlein<sup>1</sup>, Gabriela O. Santiago<sup>1</sup>, Pedro H. S. Ferzola<sup>1</sup>, Nathalia M. Cordeiro<sup>\*1</sup>, and Jose O. B. Sorbara<sup>2</sup>, <sup>1</sup>*Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil*, <sup>2</sup>*DSM Nutritional Products, São Paulo, São Paulo, Brazil*.

An experiment was conducted to evaluate the effects of single or combined dietary supplementation of  $\alpha$ -amylase and  $\beta$ -xylanase on growth performance of broiler chickens fed corn-soy diets. A total of 1,800 slow feathering, Cobb  $\times$  Cobb 500 male broilers were randomly distributed into 8 treatments with 9 replicates of 25 birds each. Broilers were fed starter (1 to 21 d) and finisher diets (22 to 40 d) with a positive control diet (PC, with 3050 and 3170 kcal/kg of AME<sub>n</sub>, respectively); the other treatments were increases or reductions of 50 or 100 kcal/kg in AME<sub>n</sub>

(PC + 50, PC + 100, PC - 50 and PC - 100 kcal/kg). The PC - 100 kcal/kg was the negative control (NC). NC diet was supplemented with  $\alpha$ -amylase (80 kg-Novo  $\alpha$ -amylase units/kg),  $\beta$ -xylanase (100 fungal  $\beta$ -xylanase units/kg), and both enzymes combined at the same supplementation levels. Broilers fed the PC, PC + 50 and PC + 100 diets had lower FCR and higher BWG when compared with the NC diet ( $P < 0.05$ ). Regressing performance responses to AME<sub>n</sub> levels showed only linear significant adjustments ( $P < 0.05$ ). These were equated and solved for X in linear equations at different enzyme supplementations. Corresponding AME<sub>n</sub> estimates for BWG and FCR from 1 to 40 d were, respectively 98, 84, and 137 and 51, 27, and 43 kcal/kg for amylase,  $\beta$ -xylanase and amylase +  $\beta$ -xylanase. In conclusion, supplementing corn-soy diets with  $\alpha$ -amylase and  $\beta$ -xylanase led to increased dietary energy yields. Significant difference occurred in favor of  $\alpha$ -amylase when compared with  $\beta$ -xylanase supplementation whereas adding both enzymes in the same feed generated similar AME<sub>n</sub> to the single addition of  $\alpha$ -amylase.

**Key Words:** amylase, broiler, metabolizable energy, performance, xylanase

**52 Corn replacement with sorghum and a combination of protease, xylanase, and phytase on nutrient and energy utilization by broiler chicken.** Guilherme Aguiar Mateus Pasquali<sup>\*1</sup>, Monica Megumi Aoyagi<sup>1</sup>, Amanda da Lapa Silva<sup>1</sup>, Vitor Barbosa Fascina<sup>1</sup>, Everton Moreno Muro<sup>1</sup>, Paola Gentile Serpa<sup>1</sup>, Erika Salgado Politi Braga Saldanha<sup>2</sup>, and José Roberto Sartori<sup>1</sup>, <sup>1</sup>*College of Veterinary Medicine and Animal Science, São Paulo State University, Botucatu, São Paulo, Brazil*, <sup>2</sup>*APTA Regional, Brotas, São Paulo, Brazil*.

Sorghum can replace corn but due to factors such as kafirin, tannin and phytate, its nutrient and energy utilization by young broilers can be impaired, thus exogenous enzymes supplementation could alleviate these negative effects. An experiment was conducted to study the effect of corn replacement with sorghum and inclusion of a combination of exogenous protease, xylanase and phytase on nutrient and energy utilization by broiler at starter phase. A total of 150 male Cobb-500 chicks were randomly assigned in a 3  $\times$  2 factorial arrangement [0%, 50% and 100% replacement of corn with sorghum  $\times$  inclusion or not of enzyme blend containing protease (200g/ton) xylanase (150g/ton) and phytase (100g/ton)] with 5 replicates cages and 5 birds per cage. Prior to initiation of experimental diets birds were fed a common starter diet based on corn and soybean meal. From 11 to 21 d birds were fed experimental diets and total excreta collection was performed from 16 to 21 d post-hatch. Data were analyzed using a 3  $\times$  2 factorial arrangement followed by Tukey multiple comparison test with  $P < 0.05$  as significance level. There was interaction between level of corn replacement with sorghum and inclusion of exogenous enzymes on dry matter (DM) retention. Total replacement of corn with sorghum reduced DM retention however, enzyme supplementation increased the value of this parameter. Partial and total corn replacement with sorghum reduced nitrogen (N) retention. Including the enzyme blend increased N retention and AME<sub>n</sub> in all diets. Although not significant, responsiveness of N retention to enzyme supplementation of birds fed diets containing sorghum tended

to be higher (interaction  $P$ -value = 0.076) than those fed corn-based diets. It can be concluded that total replacement of corn with sorghum can be done if an enzymatic blend containing protease, xylanase and phytase is included to improve nutrient and energy utilization by broiler chicken at starter phase.

**Key Words:** carbohydrase, NSP-degrading enzyme, maize, nonstarch polysaccharide

**53 Growth performance, energy utilization, and starch digestibility of broiler chickens fed corn-soy diets supplemented with enzymes.** Cristina T. Simoes\*<sup>1</sup>, Catarina Stefanello<sup>1</sup>, Sergio L. Vieira<sup>1</sup>, Heitor V. Rios<sup>1</sup>, Gabriela O. Santiago<sup>1</sup>, and Jose O. Sorbara<sup>2</sup>, <sup>1</sup>*Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil*, <sup>2</sup>*DSM Nutritional Products, São Paulo, São Paulo, Brazil*.

A study was conducted to evaluate the effects of dietary  $\alpha$ -amylase and  $\beta$ -xylanase supplementation of corn-soybean meal basal diets formulated with or without supplemental phytase on growth performance, energy utilization and starch digestibility in broiler chickens. A total of 336 slow feathering, Cobb  $\times$  Cobb 500 male broilers were randomly distributed to 6 treatments having 8 replicates of 7 birds each. Birds were fed a common starter diet from 0 to 14 d (3,050 kcal/kg AME<sub>n</sub>, 21.7% CP, 1.05% Ca, and 0.53% nPP). The experimental diets were

provided afterward until 25 d. A  $2 \times 3$  factorial arrangement of 2 control diets (Basal = corn-soy diet without added phytase or PHY = corn-soy diet formulated with 1,000 phytase units/kg) and 3 carbohydrase supplementations (0, 80 kg-Novo  $\alpha$ -amylase units/kg, or 80 kg-Novo  $\alpha$ -amylase units/kg + 100 fungal  $\beta$ -xylanase units/kg) was used from 14 to 25 d. Excreta were collected from 21 to 24 d and all birds were euthanized at 25 d for jejunum and ileum content collection. Samples of feed, excreta, jejunal and ileal digesta were analyzed for determination of total-tract retention and ileal apparent digestibility. No interactions between diet and carbohydrase were observed. Broilers fed diets formulated with phytase or supplemented with amylase + xylanase had higher BWG and lower FCR ( $P < 0.05$ ) when compared with birds fed diets without carbohydrases. Relative to the basal diet, AME<sub>n</sub> was increased ( $P < 0.01$ ) by 70 kcal/kg and 99 kcal/kg when birds were fed the diet supplemented with amylase and amylase + xylanase, respectively. Starch digestibility in the jejunum and ileum was increased ( $P < 0.05$ ) by 3.5% and 2.4% respectively when birds were fed the diet supplemented with amylase + xylanase. Results from this experiment show that corn-soy diets having phytase and supplemented with amylase and xylanase led to increased growth performance, AME<sub>n</sub>, and starch digestibility in broilers. Furthermore, the efficacy of exogenous amylase and xylanase was independent of the presence of microbial phytase.

**Key Words:** amylase, broiler, metabolizable energy, starch, xylanase

## Extension and Instruction

**54 What are the thoughts about the myth of hormone use in broiler production of students from a Federal Institute of Education in Amazonas, Manaus, Brazil.** Glebson C. Freitas, Anísia K. L. Galvão, and Felipe F. Santos\*, *Instituto Federal de Educação, Ciência e Tecnologia do Amazonas (IFAM), Campus Manaus Zona Leste, Manaus, AM, Brazil.*

The study aimed to evaluate the level of information students have about the myth of hormone use in the production of broiler chickens. Our survey targeted students of the Federal Institute of Amazonas, Manaus, Amazonas, Brazil. Students surveyed were from 3 courses related to agricultural sciences (AS,  $n = 88$ ), veterinary medicine ( $n = 33$ ), agroecology ( $n = 36$ ), a technical course in agriculture ( $n = 19$ ), and 2 courses not related to this field (NAS,  $n = 62$ ), and secretariat ( $n = 31$ ) and informatics ( $n = 31$ ) technical courses. Students above legal age only were interviewed, and the study was approved by the Research Ethics Commission (Plataforma Brazil) under the number 1290725. The questionnaire consisted of multiple-choice questions and was divided into 2 sections, the first to describe the respondent profile and the second to access the main objective of this research. Most respondents have heard about the use of hormones in chicken production, 92% and 77.4% of AS and NAS students, respectively. Questioned about the use of hormones in broiler production, 50% of AS students were concerned that it may be harmful to human health, 12.5% thought that there is no threat because it causes no harm to human health, and 37.5% knew that hormones are not used in broiler production. Regarding NAS students, all of them consider that hormones are used in broiler production, and also believe that it is worrying because it is harmful to human health, with the exception of one respondent (98.4%). Also, 32.9% of AS and 67.7% of NAS students stated that hormone use is responsible for the fast growth rate of broilers, while 63.6% of AS and 11.3% of NAS students credits technological improvements for the fast growth rate. The myth around the use of hormones in broiler production is widespread, especially among NAS students, and is usually associated with the fast growth rate of broilers.

**Acknowledgments:** The authors thank IFAM the scholarship provided to the student Glebson C Freitas during the period of the study.

**Key Words:** chicken, meat, quality, consumer, marketing

**55 Quality of poultry litter with additional acidifying during different rainfall periods.** Nariane Silva Gonçalves<sup>1</sup>, Claudia Marie Komiyama<sup>2</sup>, Lidiane Staub<sup>3</sup>, Marcela Daiane Gouveia Moraes<sup>1</sup>, and Juliana de Fátima Pereira Lima<sup>1</sup>, <sup>1</sup>*Institute of Agricultural and Environmental Sciences, Federal University of Mato Grosso (ICAA-UFMT), Sinop, Mato Grosso, Brazil,* <sup>2</sup>*Faculty of Agricultural Sciences, Federal University of Grande Dourados (UFGD), Dourados, Mato Grosso do Sul, Brazil,* <sup>3</sup>*State University of Maringa (UEM), Maringá, Paraná, Brazil.*

The objective of this research was to evaluate the effects of acidification of poultry litter on the pH and ammonia from poultry litter in different periods of the year (rainy and dry). We used a completely randomized design in split plot in time ( $2 \times 2$ ), 2 seasons (rainy and dry) and 2 bed treatments (acidified and control) evaluated over time (0, 1, 14, 28, and 42 d), being evaluated in each collection, the parameters pH and ammonia emissions, with 12 repetitions per aviary. For this, 4 commercial poultry farms were used to rice straw, in that in 2 poultry houses used

acidification (activated calcium sulfate and expanded phyllosilicate) applied directly on the bed of chickens 2 d before accommodate chicks, the other 2 poultry houses were used as controls. The observed data were evaluated by ANOVA with the help of statistical program Sisvar (2010) using the Tukey test at 5% probability. Acidification of poultry litter caused a significant decrease ( $P < 0.0001$ ) from its pH (8.10) compared with control (8.44). Moreover, drought is responsible for chicken pH lower bed (8.22) as compared with the rainy season (8.32). The interaction was found for the treatment of the bed in different samples ( $P < 0.0001$ ), with a lower pH in the acidic treatment, in the samples 1 to 14 d (7.64 and 7.92, respectively). Acidification ( $P < 0.0001$ ) promoted lower emission of ammonia (0.65) compared with control (0.75) and the drought caused higher emissions of ammonia (0.76) that high precipitation (0, 65). There was a significant interaction between the treatment of bed and collections ( $P < 0.0001$ ), the acidifying proved effective in collection made with 1 and 14 d promoting lower emissions of ammonia (0.44 and 0.36 mg / h, respectively) compared with control. It was concluded that the treatment of poultry litter with acidification method was effective to reduce the pH and to reduce the ammonia volatilization in the first 14 d after application in poultry litter.

**Key Words:** ammonia, pH, chemical treatment

**56 Fermentation of poultry litter to control lesser mealworm beetles in a commercial aviary.** Mirian Garcia dos Santos\*<sup>1</sup>, Marcela Diana Gouveia de Moraes<sup>2</sup>, Thuanny Lúcia Pereira<sup>4</sup>, Fabricia de Arruda Roque<sup>4</sup>, Joyce de Paula<sup>2</sup>, Claudia Marie Komiyama<sup>3</sup>, Ana Paula Silva Ton<sup>2</sup>, Carlos Mezzalira Junior<sup>2</sup>, and Nariane da Silva Gonçalves<sup>2</sup>, <sup>1</sup>*State University of Maringa, Maringá, Paraná, Brazil,* <sup>2</sup>*Federal University of Mato Grosso, Sinop, Mato Grosso, Brazil,* <sup>3</sup>*Federal University of Grande Dourados, Dourados, Mato Grosso do Sul, Brazil,* <sup>4</sup>*University of São Paulo, São Paulo, São Paulo, Brazil.*

The majority of commercial broiler chickens worldwide are raised indoors in intensive production systems, and together there are some problems as presence of *Alphitobius diaperinus* (lesser mealworm beetles) adults and larvae, which are considered a problem in intensive broiler production. This study aimed at evaluating the effects of fermentation treatment of the poultry litter with cover of canvas in all length of aviary in the control of insect. During this experiment, we monitored the population of *A. diaperinus* (larvae and adults/m<sup>2</sup>) in 3 consecutive reuses, using a wooden sandwich-type trap placed in the poultry litter. Four commercial aviaries were used and were covered with rice straw in the second use, in 2 of 4 aviaries were treated with fermentation method and another aviary without any treatment (control). Data were analyzed in a completely randomized design with  $3 \times 2$ , 3 reuses and 2 treatments (control and fermented). A probability level of  $P \leq 0.05$  was chosen as the limit for statistical significance. The number of larvae had no effect ( $P > 0.05$ ) on any evaluated factors and between treatments. Except for the difference between poultry litter reuses ( $P < 0.05$ ), with higher population of larvae in the first and second reuse (15.200 and 16.311 larvae/m<sup>2</sup>, respectively) and lower in third reuse (7.965 larvae/m<sup>2</sup>). The population of adults were affected between reuses ( $P < 0.05$ ) with higher value in a first reuse (3.022 adults/m<sup>2</sup>) and lower in a second and third (1.467 and 489 adults/m<sup>2</sup>, respectively), which not differ from each other. There were treatment effects ( $P < 0.05$ ), control was greater (2.133 adults/m<sup>2</sup>) than in fermented litter (1.200 adults/m<sup>2</sup>). The interaction reused  $\times$  treatments ( $P < 0.05$ ) affected with lower population of

adults in a fermented litter and decrease in the course of reuse (1.733, 1.511 e 400 adults/m<sup>2</sup>; first, second and third reuse). Based on these results, the treatments of litter have shown fermentative method with canvas reduce number of adults *A. diaperinus*.

**Key Words:** trap, coleoptera, disinfection, reuse, poultry litter

# Metabolism and Nutrition: Enzymes I

**57 Effect of a high dose of phytase on broiler performance based on a 3-trial meta-analysis.** Vitor Barbosa Fascina\*, José Otávio Berti Sorbara, Keysuke Muramatsu, and Rafael Gustavo Hermes, *DSM Nutritional Products, São Paulo, São Paulo, Brazil.*

The objective of this study was to evaluate the effect of a high-dose inclusion of phytase (RONOZYME HiPhos GT, DSM Nutritional Products) on broiler performance. Three experiments were conducted between April 2015 and February 2016 in Brazil using meta-analysis. Corn/SBM diet (positive control diet, PC) were formulated to contain all nutrients, following the recommendations of the Brazilian Tables (2011). In all trials, a total of 3,300 slow-feathering, Cobb 500 male broilers were randomly distributed to 5 treatments (Trt) with 8 replicates (in 2 trials) and 12 replicates (in one trial). Treatments consisted of PC; negative control (NC) with Ca (-0.12% n = 1; -0.15% n = 2) and available P (aP) reduction (-0.14% n = 1; -0.15% n = 2); NC+1,000 FYT/kg feed; NC+2,000 FYT/kg feed; and NC+3,000 FYT/kg feed. Data were used in a meta-analysis conducted as a complete randomized design using the MIXED procedure of SAS (SAS Institute, 2002). The model included Trt (n = 5) as a fixed effect and trial (n = 3) as a random effect. Regressions were done on the effect of phytase levels (NC, NC+1,000, 2,000, and 3,000 FYT/kg) on performance measures. Feeding the PC and phytase supplementation Trts improved weight gain (WG) and adjusted feed conversion ratio (adjusted for 2.5 kg of body weight, FCR<sub>adj</sub>) ( $P < 0.0001$ ) when compare with NC. Based on regression analysis, phytase increased WG up to an inclusion of 2,424 FYT/kg and 2,269 FYT/kg at 21 and 40 d, respectively ( $WG_{21d} = 795.79644 + 0.0625497x - 0.0000129x^2$ ;  $R^2 = 0.79$ ;  $WG_{40d} = 2533.018254 + 0.190604x - 0.000042x^2$ ;  $R^2 = 0.77$ ). As phytase increased, FCR<sub>adj</sub> improved up to an inclusion of 2,153 FYT/kg and 2,092 FYT/kg at 21 and 40 d, respectively ( $FCR_{21d} = 1.44082 - 0.000055982x + 0.000000013x^2$ ;  $R^2 = 0.57$ ;  $FCR_{40d} = 1.8461220266667 - 0.000075318x + 0.000000018x^2$ ;  $R^2 = 0.85$ ). In conclusion, the inclusion of a high dose (2,100 to 2,450 FYT/g) of the

tested phytase resulted in improved performance over the NC, and same performance of PC.

**Key Words:** feed conversion ratio, feed cost, phosphorus, weight gain

**58 Effect of high inclusion rates of phytase on performance of broilers.** Leopoldo M. Almeida\*, Lucas N. E. Barrilli, Victor M. Taveira, Josiane C. Panisson, Marley C. Santos, and Alex Maiorka, *Federal University of Paraná, Curitiba, Paraná, Brazil.*

The aim of this research was to evaluate the effect of phytase superdosing on broiler performance fed with diets containing 7% rice bran. A total 936 male broilers (Cobb) were distributed in a randomized experimental design with 4 treatments and 9 repetitions of 26 birds per experimental unit. The diets were: positive control (PC, formulated to meet or exceed bird nutritional requirements) without phytase; negative control (NC), reduction of 0.192% Ca and 0.175% avP levels when compared with PC diet; and NC diet supplemented with 750 or 1500 FTU/kg phytase. Water and feed were supplied ad libitum throughout the experimental period. Rice bran was included by 7% to increase phytate P levels in all diets. The evaluated parameters were feed intake (FI), feed conversion ratio (FCR) and body weight gain (BWG) determined at 1 to 42 d of age, whereas carcass (CY), breast (BY), thigh and drumstick yield (TDY) were determined in 2 birds per pen at 42 d of age. The results are shown in Table 1. The data were analyzed by ANOVA and Tukey test at 5% probability level. The inclusion of phytase in broiler diet provided higher FI compared with the NC. However, the PC achieved the same performance (BWG and FCR) of treatment with 1500 FTU/kg phytase, probably because of the P levels available in the diet (PC) were sufficient to meet the nutritional requirements of production animals. There was no effect ( $P > 0.05$ ) of phytase levels on CY, BY nor TDY. Therefore, the inclusion of high levels of phytase in diets containing 7% rice bran was efficient for the productive parameters.

**Table 1.** Effects of treatments feed intake (FI), body weight gain (BWG), feed conversion ratio (FCR), carcass (CY), breast (BY), thigh and drumstick yield (TDY)

Treatment	FI (g)	BWG (g)	FCR	CY (%)	BY (%)	TDY (%)
CP	5,101 <sup>a</sup>	2,982 <sup>a</sup>	1.71 <sup>c</sup>	79.71	36.10	24.82
CN	4,793 <sup>b</sup>	2,734 <sup>bc</sup>	1.75 <sup>ab</sup>	78.58	37.07	28.29
CN+750	5,071 <sup>a</sup>	2,874 <sup>b</sup>	1.76 <sup>a</sup>	79.34	36.21	28.06
CN+1500	5,013 <sup>a</sup>	2,894 <sup>ab</sup>	1.73 <sup>bc</sup>	80.21	36.98	28.67
P-value	<0.001	<0.001	<0.001	0.133	0.574	0.373
CV (%)	3.45	4.10	1.66	1.80	4.79	18.40

<sup>a-c</sup>Different letters in the columns differ by Tukey test at 5% probability.

**Acknowledgments:** AB Vista

**Key Words:** body weight, carcass yield, feed intake, phosphorus, phytate

**59 Levels of phytase on broiler performance and carcass characteristics.** Lucas Barrilli\*<sup>1</sup>, Thiago Cancelli<sup>1</sup>, Simone Gisele Oliveira<sup>1</sup>, José Otávio B. Sorbara<sup>2</sup>, and Vitor Barbosa Fascina<sup>2</sup>, <sup>1</sup>*Federal University of Paraná, Curitiba, Paraná, Brazil*, <sup>2</sup>*DSM Nutritional Products, São Paulo, São Paulo, Brazil.*

The aim of this study was to evaluate broiler performance and carcass yield fed corn-soybean meal diets and supplemented with phytase. A

total 880 broiler chick males Cobb 500 were randomly distributed in 5 treatments with 8 replicates and 22 birds each one. Treatments were a Positive control diet (PC); Negative control diet (-0.15% Ca and avP) (NC); NC + 1,000 FYT/kg feed (RONOZYME HiPhos GT, DSM Nutritional Products); NC + 2,000 FYT/kg feed; and NC + 3,000 FYT/kg feed. Feed intake (FI), body weight gain (WG) and adjusted feed conversion ratio (adjusted for 2.7 kg of body weight, FCR<sub>adj</sub>) were evaluated. Also, it were evaluated carcass yield and cuts (breast and thigh+drumstick), and abdominal fat percentage of 3 birds with average weight of experimental unit ( $\pm 5\%$ ). Data were submitted to ANOVA, and means were compared by Tukey test ( $P < 0.05$ ). Regression equations were estimated ( $P < 0.05$ ) according to phytase levels and negative control diet. The phytase supplementation and PC improved the WG (2,610

g PC, 2,458 g, NC+1,000 FYT/kg, 2,668 g NC+2,000 FYT/kg, 2,669 g NC+3,000 FYT/kg) and FI, and FCR<sub>adj</sub> ( $P < 0.01$ ) (1.551 PC, 1.546 NC+1,000 FYT/kg; 1.538 NC+2,000 FYT/kg, 1.569 g:g NC+3,000 FYT/kg) compared with negative control (2,647 g WG, and 1.641 g:g FCR<sub>adj</sub>). The regression analysis showed linear effect to FI (FI<sub>42d</sub> = 3913 + 0.102x; R<sup>2</sup> = 0.34), and quadratic effect to WG and FCR<sub>adj</sub> (WG<sub>42d</sub> = 2464.2125 + 0.20828x - 0.00004750x<sup>2</sup>; R<sup>2</sup> = 0.50. Optimal level: 2,192 FYT/kg. FCR<sub>adj</sub> = 1.63857 - 0.00011712 + 0.0000003159375x<sup>2</sup>; R<sup>2</sup> = 0.38. Optimal level: 1,834 FYT/kg). It was not observed any differences in treatments for carcass characteristics ( $P > 0.05$ ). In conclusion, the optimal phytase supplementation to improve broiler performance is higher than usual 1,000 FYT/g used by industry.

**Key Words:** breast yield, enzyme, mineral reduction, regression, weight gain

**60 Extra-phosphoric effect of phytase on broiler performance from 1 to 21 days.** Jomara Broch\*<sup>1</sup>, Ricardo Vianna Nunes<sup>1</sup>, Cinthia Eyng<sup>1</sup>, Vitor B. Fascina<sup>2</sup>, Idiana Mara da Silva<sup>1</sup>, Cleison de Souza<sup>1</sup>, and Alexssandro Zaffari Almeida<sup>3</sup>, <sup>1</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, <sup>2</sup>DSM Produtos Nutricionais Brazil S.A, Mairinque, São Paulo, Brazil, <sup>3</sup>Universidade Federal da Grande Dourados, Dourados, Mato Grosso do Sul, Brazil.

The use of exogenous enzymes in non ruminant diets have been shown to be an important alternative in reducing the negative effects of anti-nutritional factors of food used in diets formulations. The inclusion of phytase in poultry diet has effective capacity to increase the availability and use of phytic phosphorus. The objective of this study was to evaluate the extra-phosphoric effect of phytase on performance of broilers from 1 to 21 d old. 920 broiler chicks were assigned in a completed randomized design to 5 treatments (T1: positive control (PC) without phytase; T2: negative control (NC) (reduction of 0.12% Ca and 0.14% of P<sub>available</sub>); T3: NC + 1000 FYT/kg (RONOZYME HiPhos GT 100 ppm), T4: NC + 2000 FYT/kg (RONOZYME HiPhos GT 200 ppm); T5: NC + 3000 FYT/kg RONOZYME HiPhos GT 300 ppm). The variables analyzed were weight gain (WG), feed intake (FI) and feed:gain (FG). The data were submitted to ANOVA to compare means by Tukey ( $P < 0.05$ ), and subsequent regression analysis excluding T1 (0% phytase). The performance was better ( $P < 0.05$ ) for the PC treatment and those with phytase inclusion (1000, 2000, and 3000 FYT/kg) than for birds

in the NC group. The WG showed a quadratic ( $P < 0.05$ ) response (WG = 797.398 + 0.0639312 × phytase - 0.0000107528 × phytase<sup>2</sup>; R<sup>2</sup> = 0.69), estimating a value of 893 g of WG when using the level of 2973 FYT of phytase. There was a linear response in FI and FG according to increase in phytase inclusion (FI = 1187.58 + 0.026021 × phytase; R<sup>2</sup> = 0.35; FG = 1.466959 + 0.0000230009 × phytase; R<sup>2</sup> = 0.29). At 21 d of age, the phytase inclusion increased chicken performance remained similar to PC. The great phytase level from 1 to 21 d of age is 2973 FYT/kg of diet.

**Key Words:** exogenous enzyme, extra phosphoric effect, nutrition, phytate, poultry

## 61 Levels of Phytase on the Digestibility of Diets for Broilers.

Thiago Cancelli\*, Lucas Barrilli, Emanuele Goes, Gabriela Cardoso Dal Pont, Vinícius Gonsales Schramm, and Simone Gisele de Oliveira, Universidade Federal do Paraná, Curitiba, Paraná, Brazil.

The increase of Phy in diets can promote change in gut cell renewal increasing the production of mucins and the reduction in protein and energy digestibility once phytic acid it is considered anti nutritional factor more irritating to the mucous, however when we used the enzyme P these changes were minimized. The objective of the trial was to evaluate the apparent digestibility coefficients (ADC) of dry matter (DM), crude protein (CP) and gross energy (GE) in diets from broilers with high level of phytate P (Phyp) and supplement with *superdosing* of phytase (Phy), the use of concentration of sialic acid (SA) as indicator of gut health. It was used on 936 Cobb one-day-old male broilers, distributed in a completely randomized design, into 4 treatments, 9 replicates of 26 birds on each. Treatments comprised a positive control (PC), a negative control (NC) (no enzyme, and reduction of 0 - 192% Ca and 0 - 175% vP), NC+750 and NC+1500 FTU. All the diets had rice bran added at 7%. At 21st day, 12 birds per treatment were euthanized and ileal content sampled for analysis of DM, crude protein, gross energy and SA. The ADC and SA were compared by ANOVA ( $P < 0.05$ ), and the means compared by Tukey test at 5% of probability (Table 1). Using superdosing phytase the ADC of DM, was numerically higher than the other treatments (65%), and although not significantly, different. Birds fed with NC+1500 had better DM digestibility than PC and NC ( $P < 0.001$ ). The PhyP may also reduce the protein solubility, and it interacts with digestive enzymes also affecting the digestibility of others nutrients, among them energy.

**Table 1.** Effects of the treatment on apparent digestibility coefficients ileal of dry matter (DM), crude protein (CP), digestible energy (DE) and concentration of sialic acid (SA) content ileal in broilers at d 21

Treatments	DM	CP	GE	SA
CP	60.63 <sup>bc</sup>	77.71 <sup>a</sup>	67.75 <sup>bc</sup>	2.81 <sup>b</sup>
CN	57.46 <sup>c</sup>	73.15 <sup>b</sup>	64.91 <sup>c</sup>	2.90 <sup>ab</sup>
CN+750	62.93 <sup>ab</sup>	78.24 <sup>a</sup>	68.53 <sup>ab</sup>	2.83 <sup>b</sup>
CN+1500	65.31 <sup>a</sup>	79.62 <sup>a</sup>	70.76 <sup>a</sup>	3.13 <sup>a</sup>
P-value	< 0.001	< 0.001	< 0.001	< 0.001
CV <sup>1</sup>	6.25	4.05	4.47	10.18

<sup>1</sup>CV = coefficient of variation.

<sup>a-c</sup>Different letters in the same column differ significantly by Tukey test ( $P < 0.05$ ).

**Key Words:** crude protein, digestibility energy, dry matter, phytase, superdosing

**62 Dietary supplementation of phytase and 1- $\alpha$ -hydroxycholecalciferol for broilers.** Marcelo Torretta\*<sup>1</sup>, Raquel

Andrade<sup>1</sup>, Juliana Batista<sup>1</sup>, Brunna G. S. Leite<sup>2</sup>, Fabricia A. Roque<sup>2</sup>, Carlos A. Granghelli<sup>2</sup>, Cristiane S. S. Araújo<sup>2</sup>, and Lúcio F. Araújo<sup>2</sup>, <sup>1</sup>Department of Nutrition and Technology, Vaccinar Ind. e Com. Ltd., Belo Horizonte, Minas Gerais, Brazil, <sup>2</sup>University of São Paulo, Pirassununga, São Paulo, Brazil.



This study was carried out to evaluate the effect of dietary supplementation of phytase and vitamin D3 (1- $\alpha$ -hydroxycholecalciferol) on performance and carcass yield for broilers. A total of 630 Cobb 500 male broiler chicks were assigned to 6 dietary treatments, consisting of 7 pens of 15 birds each, and were fed experimental diets from 1 to 42 d of age. The experimental treatments were: A = negative control (50% of Ca and P recommended by Rostagno et al., (2011)); B = Ca e P recommended by Cobb 500 manual (2011); C = Ca e P recommended by Rostagno et al., (2011); D = negative control + Phytase; E = negative control +  $\alpha$ D3; F = negative control +  $\alpha$ D3 + Phytase. Basal diets were formulated to contain corn and soybean meal. Data were analyzed using the GLM procedure of SAS appropriate for a completely randomized design. Feed intake (FI), body weight gain (BWG), and feed conversion ratio (FCR) were evaluated. At 42 d, birds were selected, fasted for 12hrs, slaughtered and their carcasses yield and cuts (breast and legs) evaluated. FI was not affected by treatments from 1 to 42 d ( $P > 0.05$ ), however; BWG was increased for treatments B, E and F when compare with the others ( $P < 0.05$ ). In addition, FCR was improved for treatments E and F when compare with treatments A and D ( $P < 0.05$ ). No difference was observed for carcass yield and cuts ( $P > 0.05$ ). We concluded it is possible to reduce 50% of Ca and P in the diet, however; supplementation with vitamin D3 (1- $\alpha$ -hydroxycholecalciferol) with or without phytase is required.

**Key Words:** calcium, enzyme, phosphorus, vitamin D<sub>3</sub>

### 63 An evaluation of incremental dietary calcium reduction

**on *Buttiauxella* sp. phytase efficacy in broilers.** Luis F. Romero<sup>\*1</sup>, Peter W. Plumstead<sup>3</sup>, Arun Kumar<sup>2</sup>, and Yueming Dersjant-Li<sup>1</sup>, <sup>1</sup>Danisco Animal Nutrition, DuPont Industrial Biosciences, Marlborough, UK, <sup>2</sup>The University of Queensland, Gatton, Australia, <sup>3</sup>University of Pretoria, Pretoria, South Africa.

Phytase enzymes have been shown to increase digestibility of P, Ca, energy and amino acids, allowing reduced total levels of these nutrients in feed formulation. However, the amount whereby dietary Ca should be reduced when adding phytase is not well understood and was the objective of this study. Four treatments (TRT) included a positive control (PC) formulated to the recommendations for the breed. A basal diet was made without inorganic Ca and P supplements and reductions of 68 kcal ME/kg, 0.02% dig AA and 0.03% Na vs PC. This basal diet was supplemented with *Buttiauxella* sp. phytase at 1000 FTU/kg, DCP and limestone, to provide 3 TRT with 0.174% less AvP and either 0.159, 0.189, and 0.234% less Ca (low, medium and high Ca reduction) vs PC. Inert filler was used to maintain the same ingredient composition in all phytase TRT except DCP and limestone. Male Ross 308 broilers were placed in 8 replicate pens of 37 birds in a randomized complete block design. Test diets were pelleted and fed ad libitum for 42 d. Twelve birds on d 10, and 5 birds on d 21, 35 and 42 were euthanized to measure tibia ash and ileal and fecal nutrient digestibility using AIA as marker at 10, 21 and 35 d. Treatment effects were tested by GLM model using SAS with significance at  $P < 0.05$ . High Ca reduction resulted in higher ileal P digestibility at d 10 and 35 compared with PC and low Ca reduction. Ileal and fecal Ca digestibility increased in a step wise manner at 35 d of age with incremental Ca reduction in the diets. Treatment had no effect on tibia ash at 10, 21 and 35 d of age. At 42 d, the high Ca reduc-

tion resulted in greater tibia ash vs low Ca reduction diet. Birds fed diet with phytase and high Ca reduction improved energy efficiency, using 191 kcal less energy to produce 1 kg live weight vs PC. Increasing Ca reduction level in diets supplemented with phytase improved P and Ca utilization, bone mineralisation and energy efficiency in broilers grown to 42 d of age.

**Key Words:** broiler, *Buttiauxella* phytase, calcium, available P, digestibility

### 64 Biochemical parameters of broilers fed a diet with low available phosphorus and inclusion of bacterial phytase.

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The use of phytase associated with low level of available phosphorus in diet for broiler reduces the antinutritional effect of phytate and improves utilization of phosphorus phytic. This study aimed to evaluate the effect of 3 commercial bacterial phytases derived from *Escherichia coli*, on plasma levels of calcium and phosphorus and serum alkaline phosphatase of broilers at 35 d old. A total of 2,100 one-day-old male Cobb chicks were housed in 70 pens in a completely randomized design in factorial arrangement, and reared to 35 d old. Positive control\* (PC\*) and negative control\*(NC\*) diets had nutritional value of phytase recommended by the manufacturer practiced (0.12% available phosphorus) relatively to positive control (PC) and negative control (NC) diets. The factorial design was 2 × 4 + 2: 2 levels of available phosphorus (aP) (CP\* - 0.33% (1 to 21d) and 0.28% (22 to 35d) aP) and (CN\* - 0.23% (1 to 21d) and 0.18% (22 to 35d) aP) × phytases (A, B, C, without) + positive control (0.45% (1 to 21d) and 0.40% (22 to 35d) aP without phytase) and negative control (0.35% (1 to 21d) and 0.30% (22 to 35d) aP without phytase) totalizing 10 treatments with 7 replicate pens. Inclusion of phytase decreased the level of calcium and increased of phosphorus in plasma of broilers fed diets CP\* in comparison to broilers fed diets CN\*. Absence of phytase in diet CN\* impaired the level of calcium and phosphorus in plasma of broilers. There was interaction between level of available phosphorus and inclusion of phytase ( $P < 0.05$ ) for the activity of alkaline phosphatase in serum showing increased activity of this enzyme in broiler fed diets CN\* without phytase, however the inclusion of phytase decreased the activity of alkaline phosphatase in serum. This experiment demonstrated it's possible to reduce the available phosphorus in diets CP\* with inclusion of phytase and keep the normal plasma levels of calcium and phosphorus and serum alkaline phosphatase.

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**Key Words:** plasma, serum, calcium, phosphorus

## Metabolism and Nutrition: Enzymes II

**65 Corn replacement with sorghum and a combination of exogenous protease, xylanase, and phytase on digestive organ size of broiler chicken.** Guilherme Aguiar Mateus Pasquali\*, Natani Cruz Alexandre, Daniella Aparecida Berto, Juliana Cristina Ramos Rezende, Jéssica Conteçote Russo, Livia Carrasco Dornelas, and José Roberto Sartori, <sup>1</sup>São Paulo State University, College of Veterinary Medicine and Animal Science, Botucatu, São Paulo, Brazil.

An experiment was conducted to evaluate the effect of a combination of protease, xylanase and phytase in corn- or sorghum-based diets on relative organs weight of broiler chicken at 21 and 42 d post-hatch. A total of 1,152 d-old male Cobb-500 chicks were randomly assigned in a 3 × 2 factorial arrangement [0%, 50% and 100% corn replacement with sorghum × inclusion or not of an enzyme blend containing protease (200g/ton) xylanase (150g/ton) and phytase (100g/ton)] with 6 replicates floor pens with 32 birds per pen. At 21 and 42 d post-hatch, 2 birds per experimental unit were removed from the floor pen, according to broiler average body weight, weighed and killed by cervical dislocation after fasting for 2 h. Subsequently, proventriculus, gizzard, small intestine, large intestine, liver and pancreas were removed and weighed. Afterward, relative weights were calculated in relation to broiler body weight. Gut was emptied and proventriculus and gizzard fat was removed before being weighed. Data were analyzed using a 3 × 2 factorial arrangement followed by Tukey multiple comparison test with  $P < 0.05$  as significance level. There was no interaction between level of sorghum and enzyme supplementation on relative organs weight at 21 and 42 d. Corn replacement with sorghum did not affect relative size of digestive organs at 21 and 42 d of age, neither did the inclusion of exogenous enzymes on d 42. Broiler fed diets containing exogenous enzymes presented reduced relative gizzard and small intestine weights at 21 d post-hatch. In summary, results of the present study indicate that the use of a combination of exogenous protease, xylanase and phytase reduces relative size of digestive organs such as gizzard and small intestine in young broilers at 21 d post-hatch, regardless the use of corn or sorghum as cereal grain in diets.

**Key Words:** carbohydrase, NSP-degrading enzyme, maize, nonstarch polysaccharide

**66 Effect of three xylanase plus beta-glucanase commercial enzyme products in varying energy content corn-soybean based diets on broiler performance.** Guilherme Aguiar Mateus Pasquali\*, Antonio Celso Pezzato, Juliana Célia Denadai, Tatiane Souza dos

Santos, Everton Moreno Muro, Mayara Rodrigues de Santana Eich, Leonardo Henrique Zanetti, and José Roberto Sartori, *College of Veterinary Medicine and Animal Science, São Paulo State University, Botucatu, São Paulo, Brazil.*

Effect of 3 enzyme products containing xylanase and  $\beta$ -glucanase activities in varying metabolizable energy (ME) content corn-soybean based diets on broiler performance from 1 to 35 d was evaluated. A total of 1,500 d-old male chicks were randomly assigned in a 2 × 4+2 factorial arrangement (high or low ME × inclusion or not of 0,01% of one of the 3 different commercial enzyme products all containing xylanase and  $\beta$ -glucanase + 2 positive controls). Birds were allotted to 10 dietary treatments with 6 replicate floor pens. Data were analyzed using a 2 × 4 factorial arrangement with  $P < 0.05$  as significance level. Dunnett test was performed to compare means with positive controls. Diets were formulated to contain -75kcal/kg and -0,33% CP (\*) relatively to positive control (PC) diets: High-ME PC: 3,100kcal/kg (1 to 21d) and 3,200kcal/kg (22 to 35d); High-ME\*: 3,025kcal/kg (1 to 21d) and 3,125kcal/kg (22 to 35d); Low-ME PC: 3,000kcal/kg (1 to 21d) and 3,100kcal/kg (22 to 35d); Low-ME\*, 2,925kcal/kg (1 to 21d) and 3,025kcal/kg (22 to 35d). No interaction between ME level and enzyme was observed. Including different enzyme products did not affect performance. Feeding high-ME\* diets (3,025kcal/kg and 3,125kcal/kg vs. 2,925kcal/kg and 3,025kcal/kg) improved weight gain and feed conversion ratio (FCR). Broilers fed high-ME PC diets (3,100kcal/kg and 3,200kcal/kg) showed improved FCR compared with birds fed low-ME PC diets (3,000kcal/kg and 3,100kcal/kg). Reducing energy (-75kcal/kg) and nutrient (-CP and aminoacids) contents in high-ME PC diets did not impair performance. Broilers fed low-ME\* diets (2,925kcal/kg and 3,025kcal/kg), containing or not enzyme supplementation, showed poorer FCR in comparison with birds fed high-ME PC diets (3,100kcal/kg and 3,200kcal/kg). Results indicate that supplementation of different enzyme products containing xylanase plus  $\beta$ -glucanase in corn-based diets did not affect performance regardless the energy density. Furthermore, broilers fed diets containing 3,025kcal/kg (1 to 21d) and 3,125kcal/kg (22 to 35d) show improved performance.

**Key Words:** NSP-degrading enzyme, carbohydrase, maize

# Metabolism and Nutrition: Amino Acids I

**67 Methionine sources and levels in broiler chick diets.** Victor Martins\*<sup>1</sup>, Cinthia Eyng<sup>2</sup>, Ricardo Vianna Nunes<sup>2</sup>, Thiago dos Santos Andrade<sup>2</sup>, Ademar Rodrigues de Oliveira Neto<sup>3</sup>, Idiana Mara da Silva<sup>2</sup>, and Lucas Wachholz<sup>2</sup>, <sup>1</sup>Universidade Federal da Grande Dourados, Dourados, Mato Grosso do Sul, Brazil, <sup>2</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, <sup>3</sup>Evonik Degussa Brazil Ltda.

The nutrition represents most of the costs in poultry production, and measures such as the use of different methionine sources for birds have been studied. The aim of the study was to evaluate 2 methionine sources (DL-Methionine (DLM) and Methionine Hydroxy-Analogue (MHA)) in different levels of supplementation on performance (experiment I and II) and carcass yield (experiment II) of broiler chickens. The birds were allotted to a complete randomized design in a 2 × 3 factorial arrangement (source methionine x supplementation level), divided into 2 experiments (1–21 and 22–42 d). In experiment I (1–21 d) were used 6 replicates per treatment with 25 birds at levels of 0.723; 0.831 and 1.046% of DLM and 0.725; 0.833 and 0.942% of MHA. In experiment II (22–42 d) were used 6 replicates per treatment with 20 birds at levels of 0.685; 0.780 and 0.874% of DLM and 0.687; 0.781 and 0.877% of MHA. The relationship between sources was set at 65%, 1g for each DLM was used 1.53g of MHA. The parameters evaluated in both were weight gain, feed intake and feed:gain. At 42 d of age, 2 birds per experimental unit were slaughtered to evaluate carcass yield, cut yield (breast, wing and leg), abdominal fat percentage and relative liver weight. The variables were subjected to ANOVA with subsequent development of orthogonal contrasts gathering the different methionine sources in each rated level. According to the data there were no interaction ( $P > 0.05$ ) between the source of methionine, and levels studied for feed intake, weight gain and feed:gain. The carcass characteristics results for the DLM (0.685%) and MHA (0.687%) contrast differed from each other, and provided an DLM carcass yield (75.91%) and leg (28.79%) above the MHA (74.89%) and (26.42%). Breast yield was higher in contrast 0.780% (DLM) as compared with 0.781% (MHA), obtaining the values 36.09% and 33.27%, respectively. The performance of the poultry in both phases (1–21 at 22–42 d of age) was similar. However, for the carcass yield, breast and leg yield, DLM showed better results compared with the MHA.

**Key Words:** amino acid, carcass yield, DL-methionine, growth performance, hydroxy-analogue methionine

**68 Apparent and standardized ileal digestibility of amino acid, total tract nutrient retention, metabolizable energy, and pancreas and liver weights in chickens fed sunflower meal and carbohydrases and phytase, alone or combined.** Connie Gallardo Vela\*, Julio Cezar Dadalt, and Messias Alves da Trindade Neto, *Department of Animal Science, University of São Paulo, Pirassununga, São Paulo, Brazil.*

Two assays were conducted to evaluate the effects of cocktail of  $\alpha$ -galactosidase, galactomannanase, xylanase and  $\beta$ -glucanase (GGXG) or *Saccharomyces cerevisiae*-derived phytase (Phy) individually or combined, on dry (DM) and mineral (MM) matters, N, Ca, P, NDF digestibility, apparent metabolizable energy (AME), apparent (AID) and standardized ileal digestibility (SID) of AA, and pancreas and liver weights in chickens fed sunflower meal (SFM). 245 male broilers (7 birds/pen) were fed with one reference diet (RD) and 4 corn-based

(Assay 1) or 4 corn-starch-based (Assay 2) diets containing 30% SFM as a sole source of protein in 2 GGXG (0 or 200 mg/kg) x 2 Phy (0 or 50 mg/kg) factorial arrangement. Oxide of chromium (0.3%) was used as indigestible marker. Excreta samples were obtained from d 16 to 18. All birds were killed on d 21 for ileal digesta, pancreas and liver collection. Data were submitted to variance analysis using SAS 9.2. Dietary enzymes improved ( $P < 0.05$ ) DM, N, AME use, AID and SID of AA, and liver and pancreas weight. For Assay 1; interaction ( $P < 0.05$ ) from GGXG x Phy was observed on DM and N digestibility, and AME use. Phy alone improved ( $P < 0.05$ ) MM, Ca and P digestibility. GGXG had significant ( $P < 0.05$ ) effects on NDF digestibility. For Assay 2; interaction ( $P < 0.05$ ) from GGXG x Phy was observed on AID of Arg, Lys, Met, Asp, Cys, Glu, Pro, Ser and Tyr; and SID of His, Ile, Leu, Lys, Met, Thr, Val, Ala, Asp, Cys, Glu, Gly, Pro and Ser. The SID means for 17 AA were: non-enzymatic diets, 83.47%; GGXG, 85.67%; Phy, 86.29%; and GGXG + Phy, 87.53%. GGXG had positive ( $P < 0.05$ ) effects on liver and pancreas weights. The combination of GGXG and Phy may be an effective nutritional strategy for improve AME, N, minerals and AA use, in SFM for broiler chickens.

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**Key Words:** amino acid digestibility, coefficient, energy, exogenous enzyme, nitrogen balance

**69 EAA:NEAA ratio and amino acid levels on performance of male broilers from 1 to 42 days.** Fernando Guilherme Perazzo Costa\*<sup>1</sup>, Matheus Ramalho Lima<sup>2</sup>, Marcio Ladeira Ceccantini<sup>3</sup>, Guilherme Souza Lima<sup>1</sup>, and Danilo Teixeira Cavalcante<sup>1</sup>, <sup>1</sup>Federal University of Paraíba, Areia, Paraíba, Brazil, <sup>2</sup>Federal University of the South of Bahia, Teixeira de Freitas, Bahia, Brazil, <sup>3</sup>Adisseo, São Paulo, SP, Brazil.

The aim was to evaluate EAA:NEAA ratio and amino acids levels on performance of male broilers from 1 to 42 d old. A total of 800 broilers from 1 d old Cobb 500 were used with initial weight of  $48.06 \pm 1.25$ g. The animals were distributed in 5 treatments of 8 replicates with 20 birds each. The experimental design used was completely randomized. The treatments were: control with EAA:NEAA 51:49; Treatment 2 (T2) and 3 (T3) with EAA:NEAA 49:51 and EAA:NEAA 52:49, respectively. Treatments 4 and 5, equal to T2 and T3, respectively, but with an increase of 10% in amino acids levels (10Aa). From 1 to 21 d, the treatment with EAA:NEAA 49:51 ratio + 10Aa was the best in feed intake (FI; 1540g;  $P = 0.0002$ ), final weight (FW; 1147g;  $P < 0.001$ ), weight gain (WG; 1099g;  $P < 0.001$ ) and feed conversion ratio (FCR; 1.401;  $P = 0.005$ ). The 10% increase in amino acids promoted higher FI (1502g;  $P = 0.0002$ ), FW (1120g;  $P < 0.001$ ), WG (1071g;  $P < 0.001$ ) and better FCR (1.402;  $P = 0.01$ ). In phase 22 to 35 d of age, the EAA:NEAA 49:51 ratio was higher FW (2416g vs 2360g;  $P = 0.034$ ) than the EAA:NEAA 52:48 ratio. In 36–42 d of age, treatment with 10% increase in amino acids improved WG in relation to others, but similar to EAA:NEAA 49:51 without the amino acid increase, and the EAA:NEAA 49:51 ratio had higher FI ( $P = 0.008$ ), higher FW ( $P = 0.005$ ), higher WG ( $P = 0.001$ ), than EAA:NEAA 52:48 ratio. In full period, from 1 to 42 d, the treatment EAA:NEAA 49:51 ratio + 10Aa, superior FW (3367g;  $P = 0.43$ ), WG (3319g;  $P = 0.044$ ), FI (5073g;  $P = 0.042$ ), but the FCR was not influenced (1.528;  $P = 0.679$ ). Evaluating the effect of the ratios EAA:NEAA, the best results were obtained with the EAA:NEAA 49:51 in FW (3312g;  $P = 0.005$ ), WG (3264g;  $P$

= 0.005) and FI (5021g;  $P = 0.004$ ), with no influence on FCR (1.539;  $P = 0.166$ ), and the nutritional density had no significant effect on the evaluated variables. It is concluded that the EAA:NEAA 49:51 ratio with increase of 10% in amino acids in feed, improves performance of male broilers from 1 to 42 d old.

**Key Words:** development, ideal protein, performance

**70 Blood biochemistry of broilers in the starter phase fed different levels of sulfur amino acids.** Lindolfo Dorcino Neto\*, Julyana Machado Martins, Genilson Bezerra Carvalho, Poliana Carvalho Martins, Pedro Rezende, Januaria Santos, Evelyn Oliveira, Thays Trentin, Danieli Martins, Fabyola Carvalho, and Marcos Café, *University Federal of Goias*.

We aimed to evaluate the effect of different dietary levels of methionine + cystine on blood biochemical parameters of broilers in the starter phase. A total of 900 Cobb 500 day-old male broiler chicks were distributed in a completely randomized design, with 5 treatments and 6 replicates of 30 birds. The treatments consisted of different levels of methionine + cystine. It was prepared a mash basal diet, based on corn and soybean meal and deficient in methionine and cystine, which was later supplemented with DL-Methionine 99% (0.00; 0.03; 0.07; 0.10; 0.13%) replacing corn starch, to meet the requirements proposed for each treatment, resulting, respectively, in experimental diets with 0.545; 0.616; 0.711; 0.782; 0.853% methionine + cystine. At 21 d old, the following blood parameters were evaluated: uric acid, albumin, alanine aminotransferase enzyme (AST), total protein (TSP), triglycerides, total cholesterol, high density lipoprotein (HDL) and low density lipoproteins (LDL). Data were subjected to ANOVA with 5% significance, with regression analysis performed among the levels of methionine and cystine, using the R statistical program. Increased levels of methionine + cystine in the diet promoted a linear increase in uric acid levels. It was observed a quadratic effect on albumin and TSP values, resulting in higher values in the levels of 0.744% and 0.803% of digestible methionine + cystine, respectively. There was no significant difference among treatments for the AST activity. There was an increasing linear effect on serum levels of total cholesterol and HDL, however, LDL and triglycerides levels responded quadratically, presenting the maximum values in 0.728 and 0.801% of digestible methionine + cystine, respectively. In conclusion, blood biochemical parameters of broilers in the starter phase were influenced by increasing levels of DL-methionine in the diet.

**Key Words:** blood parameter, methionine + cystine, poultry

**71 Arginine requirements for maintenance of poultry estimated in different unit systems.** Michele Bernardino de Lima\*, Nilva Kazue Samomura, Edney Pereira da Silva, Bruno Albino Leme, and Juliano César de Paula Dorigam, *Universidade Estadual Paulista, Jaboticabal, São Paulo, Brazil*.

Arginine is an essential amino acid for normal maintenance of tissue metabolism, but there are few studies estimating its requirements. In addition, many studies express the maintenance requirement in function of body weight ( $BW_{kg}$ ) or metabolic body weight ( $BW_{kg}^{0.75}$ ). However, there are differences in body composition of birds, especially regarding the fat content. Thus, the aim of this study was to determine the requirements of digestible arginine for maintenance using different unit systems. Forty-two adult roosters were housed individually in metabolic cages. The nitrogen balance trial lasted 5 d with 48 h of fasting (roosters receiving 60 mL of water+sucrose) and the last 72 h for feeding and excreta collection. Once a day, 40 g of the diet limiting in arginine

was provided by tube (during 3 d) to give a range of arginine intakes from 0 to 18.5 mg/ $BW_{kg}$  d. A nitrogen-free diet formulated to meet the rooster requirements for energy, vitamins, and minerals, was offered ad libitum during these 3 d. Excreta were collected during the last 3 d of the experiment and the nitrogen content of the excreta was analyzed. A linear regression between nitrogen retention (NR) and arginine intake (Arg) was performed using the PROC REG from SAS 9.2 software. The equations resulting for each unit were:  $NR = -39.9 (\pm 4.5) + 1.8 (\pm 0.1) \times Arg$  (mg/ $BW_{kg}$  d);  $NR = -62.2 (\pm 7.2) + 1.7 (\pm 0.1) \times Arg$  (mg/ $BW_{kg}^{0.75}$  d) and  $NR = -262.9 (\pm 30.4) + 1.7 (\pm 0.1) \times Arg$  (mg/ $BP_m^{0.73}$  d). The arginine required to maintain the body at zero NR was calculated to be 23 mg/ $BW_{kg}$  d. Considering the metabolic body weight, the arginine intake was 36 mg/kg  $BW^{0.75}$  d. Considering the degree of maturity ( $u = 1$ , for adult birds) and body protein content at maturity ( $BP_m^{0.73} \times u$ ), the daily amounts of arginine required for maintenance was calculated to be 151 mg/ $BP_m^{0.73}$ . Considering the estimates, the daily maintenance requirement of 151 mg of arginine/ $BP_m^{0.73}$  was concluded to be more adequate because this unit system consider the differences in body composition.

**Key Words:** dilution technique, maintenance, nitrogen retention, regression equation, rooster

**72 Bone development of broilers: manganese sources and arginine supplementation.** Alvaro Mario Burin Junior<sup>1</sup>, Adrieli Braga de Cristo<sup>1</sup>, Luis Miguel Fullber<sup>1</sup>, Eliana Thais Riffel<sup>1</sup>, Anete Rorig<sup>1</sup>, Alba Fireman<sup>2</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, *<sup>1</sup>Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil, <sup>2</sup>Zinpro Corporation, Piracicaba, São Paulo, Brazil*.

Arginine (Arg) through arginase is responsible for providing proline, an important amino acid in collagen synthesis. Manganese (Mn) activates several metalloenzymes that participate in the bone formation, including arginase. To investigate the participation of Mn as a cofactor of arginase on the bone development, this experiment was conducted. 1,800 one-day-old Cobb male broilers were employed, assigned in a completely random design, with 4 treatments and 9 replicates each treatment. It consisted in a factorial  $2 \times 2$  (2 Mn sources  $\times$  2 Arg:Lys ratio), with the treatments as it follows: T1: Inorganic Control (80 ppm  $MnSO_4$ ); T2: 40 ppm  $MnSO_4$  + 40 ppm Mn amino acid complex; T3: Inorganic Control + L-Arg (Arg:Lys 1.20); T4: 40 ppm  $MnSO_4$  + 40 ppm Mn amino acid complex + L-Arg (Arg:Lys 1.20). For treatments 1 and 2, the digestible Arg:Lys ratio was 1.12, considered normal using corn-soybean meal based diets. At the age of 45 d, the tibiotarsuses from 18 birds/treat. were submitted to the assessment of weight, length, diameter, Seedor index, strength, and cortical width. Histomorphometrics analyses were performed such as epiphyseal total area, hypertrophic area, growth plate, and growth plate thickness. Mn sources in association and Arg did not ( $P > 0.05$ ) alter the variables assessed for bone measurements. However, an interaction between the main effects was seen to diameter of the tibiotarsus. Mn sources in association had a lower diameter compared with inorganic Mn considering a Arg:Lys ratio of 1.12. Mn sources in association and birds supplemented with Arg (Arg:Lys ratio of 1.20) showed a higher ( $P < 0.05$ ) tibia diameter compared with those non-supplemented. There was interaction ( $P < 0.05$ ) for width of the growth plate of bones evaluated with 7 d. When diets were supplemented with Arg:Lys of 1.20 plus Mn sources together, there was a reduction of the thickness of the growth plate, arguably preventing the tibial discondroplasia. Diets supplemented with Arg:Lys ratio usually employed in commercial feed formulations, plus Mn sources in association or inorganic-Mn, met the requirement of bone measurements of broilers.

**Key Words:** arginase, organic manganese, bone strength, growth plate, tibia

**73 Study of manganese as a cofactor of arginase on the productive performance and carcass yield of broilers.** Alvaro Mario Burin Junior<sup>1</sup>, Adrieli Braga de Cristo<sup>1</sup>, Daianna Rosse Martins Gonçalves<sup>2</sup>, Elisângela Vanroo\*<sup>1</sup>, Jonas Rodrigo Lajter<sup>1</sup>, Alba Fireman<sup>3</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil, <sup>2</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil, <sup>3</sup>Zinpro Corporation, Piracicaba, São Paulo, Brazil.

Manganese (Mn) is a key component of enzymes involved in the antioxidant system, protein synthesis, and bone metabolism. Mn is a cofactor of arginase, enzyme that promotes arginine (Arg) breakdown into ornithine, proline, and polyamines. The aim of this experiment was to investigate the participation of Mn inorganic and organic sources as cofactor of arginase on the productive performance and carcass yield. For this trial 1,800 one-day-old Cobb 500 male broilers were assigned in a completely random design, with 4 treatments and 9 replicates each. It consisted in a factorial  $2 \times 2$  (2 Mn sources  $\times$  2 Arg:Lys ratio), with the following treatments: T1: Inorganic Control (80 ppm MnSO<sub>4</sub>); T2: 40 ppm MnSO<sub>4</sub> + 40 ppm organic Mn; T3: Inorganic Control + L-Arg (Arg:Lys 1.20); T4: 40 ppm MnSO<sub>4</sub> + 40 ppm Mn amino acid complex + L-Arg (Arg:Lys 1.20). For treatments 1 and 2, the digestible Arg:Lys ratio was 1.12, considered normal using corn-soybean meal based diets. For broilers from 1 to 45 d, there is an interaction between Mn sources  $\times$  Arg supplementation for feed conversion ratio (FCR) ( $P < 0.05$ ). FCR was statistically better ( $P < 0.05$ ) for birds fed with inorganic Mn and Arg supplementation, compared with inorganic Mn without Arg supplementation. Birds fed higher Arg:Lys ratio showed a higher level of urea compared with non-supplemented birds on the 21th ( $P < 0.05$ ) and 45th days ( $P = 0.051$ ). Arg, when metabolized by arginase, produces urea and ornithine. No statistical difference was observed on the carcass, cuts (breast, legs, wings) and abdominal fat deposition. Arg has been reported to participate as a secretagogue of insulin and GH secretion, which are mediated by IGF-I. It is known for prompting anabolic effects during skeletal muscle metabolism, such as the proliferation and differentiation of satellite cells, and the aggregation of myofibrillar protein. The association of organic and inorganic Mn sources met the requirement of broilers. Higher levels of Mn from organic source may be evaluated for better understanding of the contribution of Mn in the activity of arginase in modern strains of broilers.

**Key Words:** arginine, organic manganese, feed conversion ratio

**74 L-Arginine for broilers and the influence on blood lipids levels.** Sérgio Turra Sobrane Filho\*, Paulo Borges Rodrigues, Eduardo Machado Costa Lima, Márvio Lobão Teixeira de Abreu, and Sebastián Dorado Montenegro, *University of Lavras, Lavras, Minas Gerais, Brazil.*

The supplementation with L-arginine for broilers has been studied as a lipid metabolism modulator. Diets containing 18.75% CP were supplemented with L-arginine and the effects on blood lipids levels of broilers (29–42 d old) were evaluated. A total of 780 one-d-old males ( $1403 \pm 22$  g) and females ( $1294 \pm 50$  g) Cobb 500 broilers were distributed in randomized blocks with a  $2 \times 5$  factorial schedule (sex and additional levels of L-arginine – 0.0, 0.3, 0.6, 0.9, 1.2%), and 3 replications of 23 birds per boxes and 3 birds per cages. At 42 d old, 6 birds per treatment were subjected to 12 h fasting and subsequently blood samples were collected for serum lipogram analysis (total cholesterol - CT, triglycerides - TGL and HDL cholesterol - HDLc, LDLc and VLDLc). The data were submitted to ANOVA and polynomial regression with 5% of probability. No interactions between sex and L-arginine for all variables responses ( $P > 0.05$ ) were observed, neither isolated sex effect ( $P > 0.05$ ). By

increasing additional L-arginine levels, a linear decrease ( $P < 0.05$ ) in CT ( $CT = -14.67X + 134.47$ ;  $R^2 = 92.94$ ) and LDLc ( $LDLc = -12.23X + 32.48$ ;  $R^2 = 85.16\%$ ) blood content was detected. However, there was a quadratic effect ( $P < 0.05$ ) in TGL ( $TGL = 17.45X^2 - 23.10X + 53.10$ ;  $R^2 = 92.59\%$ ) and VLDLc ( $VLDLc = 3.50X^2 - 4.64X + 10.62$ ;  $R^2 = 92.64\%$ ) levels, resulting in 0.66% as the optimal supplementation level. For HDLc levels, no changes were found ( $P > 0.05$ ). A supplementation of 1.2% L-arginine reduced 13.1% the CT levels ( $118.78$  mg dL<sup>-1</sup>), whereas 0.66% L-arginine supplementation moderated the TGL levels in 13.5% ( $45.46$  mg dL<sup>-1</sup>). As observed in literature, these decreases can be associated with reduced expression of HMG-CoA reductase enzymes (cholesterol synthesis) and FAS (fatty acid synthase). However, up to 0.66% of L-arginine supplementation increased triglyceride levels by a raised arginine catabolism rate, with a consequently higher fatty acids synthesis. Supplementation of 0.66% L-arginine shows the best blood lipids relation, possibly reducing the fat content in broilers.

**Acknowledgments:** CNPq for financial support.

**Key Words:** amino acid, poultry, biochemical parameter

**75 Performance, carcass yield, and fiber diameters of pectoralis major muscle of broilers fed a low-protein diet supplemented with leucine and valine.** Iván C. Ospina-Rojas\*, Alice E. Murakami, Cristiane R. A. Duarte, Kelly C. Nunes, and Mirian G. Santos, *Universidade Estadual de Maringá, Maringá, Paraná, Brazil.*

A study was conducted to evaluate the standardized ileal digestible (SID) leucine (Leu) and valine (Val) requirements in low-CP diets, and their effects on performance, carcass yield and muscle fiber diameters of broilers from d 21 to 42 post-hatch. A total of 1,500 1-d-old male Cobb chicks were distributed in a completely randomized design  $5 \times 5$  factorial arrangement for a total of 25 treatments with 3 replicate pens ( $n = 75$ ) of 20 birds each. Treatments consisted of 5 SID Leu levels (1.00; 1.20; 1.40; 1.60 and 1.80%) and 5 SID Val levels (0.52; 0.67; 0.82; 0.97 and 1.12%). Common diet was fed to broilers until 20 d of age. There was interaction ( $P < 0.05$ ) between the SID levels of Leu and Val on feed intake and weight gain. There was a quadratic effect ( $P < 0.05$ ) of Leu and Val levels on gain-to-feed ratio with an optimization point at the levels of 1.19 and 0.86%, respectively. No interactions were observed ( $P > 0.05$ ) between the Leu and Val levels on carcass and parts yields, abdominal fat content or fiber diameters of the *Pectoralis major* muscle. There was a quadratic effect ( $P \leq 0.05$ ) of the SID levels of Leu and Val on breast yield and thigh, respectively. Dietary Leu supplementation incremented the breast yield at the level of 1.10%, while Val optimized thigh yield at the level of 0.71%. Abdominal fat decreased linearly ( $P < 0.05$ ) with increasing levels of SID Val and Leu levels. There was observed a quadratic effect ( $P < 0.05$ ) of Leu levels on fiber diameters of *Pectoralis major* muscle at 42 d, with the largest diameter estimated at the level of 1.24% Leu. However, SID Val levels did not influence ( $P > 0.05$ ) the muscle fiber diameters of *Pectoralis major* muscle. Based on gain-to-feed ratio, SID Leu and Val requirements are 1.19 and 0.86% respectively in low-protein diets for broiler chickens from d 21 to 42 post-hatch. Leu and Val interactions can influence the performance but not the carcass yield and fiber diameters of the *Pectoralis major* muscle of broilers fed low-protein diets.

**Key Words:** abdominal fat content, branched-chain amino acid, muscle fiber

**76 Tibia bone characteristics and incidence of tibial dyschondroplasia of broilers fed a low-protein diet with leucine and valine supplementation.** Iván C. Ospina-Rojas\*, Alice E.

Murakami<sup>1</sup>, Márcia I. Sakamoto<sup>2</sup>, Alceu K. Hirata<sup>1</sup>, and Humberto M. Lipori<sup>1</sup>, <sup>1</sup>*Universidade Estadual de Maringá, Maringá, Paraná, Brazil*, <sup>2</sup>*Universidade Camilo Castelo Branco, Descalvado, SP, Brazil*.

Two experiments were conducted to study the effect of standardized ileal digestible (SID) leucine (Leu) and valine (Val) levels on tibia bone characteristics and the incidence of tibia dyschondroplasia of broilers from d 1 to 21 (Experiment I) and d 21 to 42 post-hatch (Experiment II). Each experimental phase was evaluated independently. In both experiments, a total of 1,500 1-d-old Cobb 500 male broiler chickens were distributed in a completely randomized design 5 × 5 factorial arrangement for a total of 25 treatments with 3 replicate pens (n = 75) of 20 birds each. The SID Leu and Val levels were ranged from 1.00 to 1.96%, and 0.60 to 1.20% from d 1 to 21 post-hatch respectively, while d 21 to 42 post-hatch ranged from 1.00 to 1.80%, and 0.52 to 1.12%. Serum calcium and phosphorus, bone concentrations of calcium, phosphorus and ash, diameter and Seedor index of the tibia were not affected ( $P > 0.05$ ) by the treatments at 21 and 42 d of age. There was interaction ( $P < 0.05$ ) between the SID levels of Leu and Val on tibia breaking strength at 21 d, but not at 42 d of age ( $P > 0.05$ ). Tibia breaking strength was maximized in broilers from d 1 to 21 with the dietary levels of Leu and Val at 1.42 and 0.90% respectively. Dietary Leu levels reduced linearly ( $P < 0.05$ ) the hypertrophic zone of tibia cartilage at 21 d of age. Leucine and Val supplementation interact positively on bone strength of broilers from d 1 to 21 post-hatch. Leucine can be a useful AA for reducing the hypertrophic cartilage zone in broilers from d 1 to 21 but not from d 21 to 42 post-hatch.

**Key Words:** branched-chain amino acid, hypertrophic cartilage zone, tibia breaking strength

**77 Lymphocyte count of chicks from breeders at different ages and fed prestarter and starter diets with growing levels of digestible valine.** Larissa P. S. Gomides\*<sup>1,2</sup>, Fabyola B. Carvalho<sup>1</sup>, Marcos B. Cafe<sup>1,2</sup>, Guilherme X. da Silva<sup>1</sup>, Maria A. Andrade<sup>1</sup>, and Jose H. Stringhini<sup>1,2</sup>, <sup>1</sup>*Universidade Federal de Goiás, Goiânia, Goiás, Brazil*, <sup>2</sup>*CNPq researcher, Goiânia, Goiás, Brazil*.

Valine levels may affect the performance as well as the lymphoid organs and consequently poultry's immune system. Broiler breeders' age may affect the composition, size, hatching ability, egg weight, and chicks' initial weight. The objective of this study was to evaluate the effect of digestible valine levels and breeders' reproductive age on lymphocyte count in thymus, bursa, and spleen in chicks at pre-starter and starter stages. We used 400 one-day-old commercial Cobb chicks, from breeders at 37 and 52 wk of age. The chicks were housed in experimental batteries until 21 d of age, and fed different levels of digestible valine: 0.92%, 1.02%, 1.12%, and 1.22% in pre-starter ration and 0.83%, 0.93%, 1.03%, and 1.13% in starter ration. The experimental design was completely randomized with a 2 × 4 factorial arrangement (breeders' age x valine levels), totaling 8 treatments with 5 replicates (10 chicks per replicate). Lymphocyte count of lymphoid organs was evaluated. When necessary, the data were subjected to polynomial regression. Breeder's age affected positively lymphocytes production in the thymus at 7 d of age and in the bursa at 21 d of age, and chicks from 52-week-old breeders showed higher values. The spleen showed an interaction between breeder age and digestible valine levels at 7 d of age. When we followed the Brazilian Tables recommendations of 1.02% digestible valine for pre-starter stage, the spleen showed lower lymphocyte production for chicks from 37-week-old breeders. However, regression analysis showed that an increase in the inclusion levels of digestible valine in pre-starter diets, improved positively and linearly the lymphocytes production in the spleen. Chicks from 52-week-old breeders and fed 1.22% digestible valine presented the highest values of lymphocytes production in the spleen.

**Acknowledgments:** Sao Salvador Alimentos, CNPq, Ajinomoto, Asa Alimentos

**Key Words:** amino acid, bursa, poultry, spleen, thymus

# Student Competition, Animal Well-Being and Behavior

**78 Effect of different air velocities on quail behavior in the initial phase of posture.** Tatiany Carvalho dos Santos\*<sup>1</sup>, Richard Stephen Gates<sup>2</sup>, Ilda de Fátima Ferreira Tinôco<sup>1</sup>, Sérgio Zolnier<sup>1</sup>, Keller Sullivan Oliveira Rocha<sup>1</sup>, Carlos Gutemberg Souza Teles Júnior<sup>1</sup>, Márcia Gabrielle Lima Cândido<sup>1</sup>, and Luis Gustavo Figueiredo França<sup>1</sup>, <sup>1</sup>Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, <sup>2</sup>University of Illinois, Urbana, IL, USA.

The thermal environment affects the behavior of laying and better understanding of the effects of thermal environment on the behavior of laying can allow the inference of the welfare of the birds. As the need to better understand the behavioral responses of quail to the environment especially in the initial phase posture become necessary new studies related to the ambience. Therefore, the aim of this study was to evaluate the effect of different levels of air speeds in the behavior of Japanese quail in the initial phase posture submitted to thermoneutral temperature in climatic chambers. Were used 216 Japanese quails maintained in 4 climatic chambers at thermoneutral temperature (23°C) and relative humidity of 50 to 70%, where they were housed and distributed randomly into 2 galvanized wire cages. Each cage had 3 partition in which they were housed 27 birds/cage, 9 birds/distribution giving a density of approximately 155.6 cm<sup>2</sup>/bird. The ventilation system was distributed in each climatic chamber at thermoneutral temperature setting 4 treatments with average values of air flow, air 1.0 m/s: (chamber 1); 2.0 m/s: (chamber 2); 3.0 m/s: (chamber 3); 0.0 m / s (chamber 4 - Control). The behavioral assessment was performed using a ethogram with the following behaviors: Eating; Drink; Stop; Active and Others. The evaluation of the behavior was carried in 30 min intervals during the morning and in the afternoon. The behavior data were statistically analyzed by ANOVA and then the significant treatments were submitted to Tukey test ( $P < 0.05$ ). It was observed that the results indicate that the air speed levels did not affect ( $P < 0.05$ ) the behavior of birds for thermoneutrality 23°C (thermal comfort) for the morning. In the afternoon there was a significant difference ( $P < 0.05$ ) between the air velocity levels 0.0 and 1.0 m/s just to behavior stop, and these air velocity levels equal to others. It is concluded that the airspeed does not interfered in behavior in the morning but influenced in the afternoon.

**Acknowledgments:** Federal University of Viçosa, CAPES, AMBIAGRO

**Key Words:** animal welfare, coturnicultura, thermal comfort

**79 Environmental enrichment for conventional laying cages at different stocking densities.** Danielle Priscila Bueno Fernandes\*<sup>1</sup>, Iran José Oliveira Silva<sup>1</sup>, Sônia Maria de Stefano Piedade<sup>1</sup>, Luis Carlos Ferreira Almeida<sup>2</sup>, and Aérica Cirqueira Nazareno<sup>1</sup>, <sup>1</sup>Universidade de São Paulo, Piracicaba, São Paulo, Brazil, <sup>2</sup>Universidade Estadual Paulista, Registro, São Paulo, Brazil.

The objective of this research was to evaluate the effect of environmental enrichment in conventional cages for laying hens housed in different stocking densities. We used 240 laying hens ISA Brown with 19 to 60 wk of age, 8 replicates per treatment housed in conventional cages of a conventional California-style shed. The experimental design was completely randomized in a factorial 3 × 3 (stocking densities: 5, 3 and 2 birds/cage with 450, 750 and 1125 cm<sup>2</sup>/bird, respectively vs types of enrichment cages: strings, curtains, and without enrichment). The percentage of production of eggs, mortality rate, the temperature of the dry air, relative humidity, egg quality, physical performance and behavioral were recorded. Data of physical performance and meat spots

in the yolk and albumen were analyzed by chi-squared test and data of behavior were analyzed by Kruskal-Wallis test at 5% significance. The remaining data were submitted to ANOVA by F test, and when significant, means were compared by Tukey test at 5% significance. The results showed interaction among the factors for broken eggs, specific gravity, shell strength, shell thickness and eggshell percentage. However, all values remained normal levels for shell quality. The insertion strings improved the weight of eggs. The 2 types of environmental enrichment and densities 2 birds/cage decreased the incidence of meat spots on the yolk and albumen. The curtains and the strings in cages with 2 birds improved integrity of plumage and the health of the feet, respectively. Treatments with high stocking density, i.e., with 5 animals/cage, caused suppression of behavior, decreased the bird's access to resources of the cage, increased aggression and the percentage of dirty and abnormal eggs. It was concluded that the inclusion of strings and curtains improved welfare and egg quality of laying hens in the Brazilian systems of egg production, but its effect was improved in the densities of 2 birds/cage or 1125 cm<sup>2</sup>/bird.

**Key Words:** egg production, mortality, quality of eggs, behavior, economic loss

**80 Development of a behavioral classifier for identify thermal stress for broilers in the heating phase.** Márcia Gabrielle Lima Cândido\*, Ilda de Fátima Ferreira Tinôco, Carlos Gutemberg de Souza Teles Junior, Leticia Cibele da Silva Ramos Freitas, Robinson Osório Hernandez, Francisco de Assis Carvalho Pinto, Tatiany Carvalho dos Santos, and Luis Gustavo Figueiredo França, *Universidade Federal de Viçosa, Viçosa, MG, Brazil.*

The use of digital images has been highlighted for monitoring animal behavior, artificial vision system provides a possibility to accurate measurements, and assists in decision for making the temperature settings inside the facility. The objective of this study was to develop a classifier for cold stress for broilers based in image analysis. Were used 300 broiler chicks, in the second day of life. The treatments were: comfort literature (CL/33°C), comfort by Cassuce et al. (2013) (CC/30°C), mild cold (MDC/27°C), moderate cold (MOC/24°C) and severe cold (SC/21°C). In each climatic chamber were installed 4 video cameras, the images were processed and analyzed with MATLAB 7.12. Based on spatial distribution of birds a code was performed and seted a threshold for determining comfort, thermal stress and alert. The data were analyzed statistically by ANOVA (RM Anova), which considering 4 periods of measurements during the day for the same thermal environment. The averages were compared using the Tukey test at 5% significance. Images classified as Comfort was statistically similar in thermal conditions described as CC and CL, differing from the thermal conditions of SC, MOC and MDC what was expected by the classifier, Table 1. As for the rating Stress it is observed that only the data provided CL differ from the others. Regarding the classification Alert was observed that there were differences between the verified data provided by cold stress, regardless of the intensity of stress when compared with data recorded in the condition of comfort. The image analysis applied was efficient to classify the environments concerning the thermal stress.

**Table 1.** Average percentage of images classified as comfort, stress or alert

Ambient Classification	SV (21°C)	MOC (24°C)	MDC (27°C)	CL (33°C)	CC (30°C)
Comfort	27.9 ± 5.9 <sup>a</sup>	32.5 ± 5.7 <sup>a</sup>	34.0 ± 5.5 <sup>a</sup>	78.5 ± 10.2 <sup>b</sup>	79.8 ± 12.2 <sup>b</sup>
Thermal stress	27.7 ± 3.4 <sup>b</sup>	25.6 ± 2.6 <sup>b</sup>	36.4 ± 6.8 <sup>b</sup>	19.6 ± 8.9 <sup>a</sup>	19.2 ± 12.0 <sup>b</sup>
Alert	44.2 ± 5.2 <sup>b</sup>	41.8 ± 3.5 <sup>b</sup>	29.4 ± 9.1 <sup>b</sup>	1.8 ± 2.3 <sup>a</sup>	0.9 ± 0.5 <sup>a</sup>

<sup>ab</sup>Within a row, means with different superscript letters are different ( $P < 0.05$ ).

**Acknowledgments:** CAPES, CNPq, FAPEMIG, PIF PAF Alimentos

**Key Words:** ambience, comfort, image analysis, poultry

**81 The sound stimulation in artificial incubation (step 1): the noise of hatcheries and an estimate of loudness in eggs.** Ana C. Donofre\* and Iran J. Oliveira da Silva, *Animal Environment Research Nucleus, University of São Paulo, Piracicaba, São Paulo, Brazil.*

In artificial incubation the control of the physical environment factors ensures an appropriate embryonic development and great responses in the hatch of the broiler chicks. We believe that the external sound comes to chicken embryo and can influence many things, such as the behavior and performance of these birds after hatching. Our main research will evaluate the effect of positive sound stimuli (specific calls of the species) and negative (noise of the fans of the incubators) in the incubation of fertile eggs. But, first we evaluate the noise level in commercial hatcheries and develop an internal microphone for eggs (Step 1). In characterization the sound pressure level was measured with a decibel meter (Instrutherm) in 6 incubators and in several different locations (3 points for incubator). We found noise exceeding an average of 92 dB, which is very high. We also draw the sound frequency spectrogram of the incubators that showed a lack of rhythm sounds. Then we try to find out if the noise of the incubators or vocalizations of the species (being tested) comes in the embryo that is inside an egg. We have developed a system of internal microphones with Arduino that can collect the sound inside the eggs. Microphones were placed in a set of 30 eggs (15 full and 15 empty). Each egg was considered a repetition. It was calculated the difference in the electrical signal inside the egg and out of the egg. The results show that the eggshell does not protect the embryos from the external sound. We complement this information with the fact that the bird embryos hear from the 10th day of incubation and can respond physiologically to the sound. In step 1 of the main experiment we concluded that during embryonic development birds receive a high-intensity sound from incubators. In nature the sound that is present is the mother hen noise. Now, the next step is to evaluate the effect of addition of the chicken vocalizations in artificial incubation.

**Acknowledgments:** FAPESP - São Paulo Research Foundation

**Key Words:** hatching, welfare, decibel meter, Arduino, broiler chick

**82 Application of neural networks to determine average surface temperature of broiler chicks and load microclimate during transport.** Aérica Cirqueira Nazareno\*, Iran Jose Oliveira Silva, and Danielle Priscila B. Fernandes, <sup>1</sup>Luiz of Queiroz College of Agriculture, University of São Paulo, Piracicaba, SP, Brazil.

This study aimed to determine a model to predict average surface temperature of broiler chicks and live load microclimate conditions during transport by using neural networks. The research was conducted in the state of São Paulo, Brazil, by monitoring 9 shipments with different density of boxes using an air-conditioned truck with an average capacity of 380 boxes. Fourteen chick boxes were chosen on each shipment, assessing 5 chicks per box. The average surface temperature of chicks

(AST) was measured with an infrared thermometer in both loading and unloading. By assessing the container microclimate (center and inside boxes), air temperature (T) were recorded; thereby, 17 data loggers were placed, one per box (14), and 3 along the container. AST and truck microclimate were analyzed using artificial neural networks with a single layer and 3 neurons (T in the container ( $T_{cont}$ ) and inside the chick boxes ( $T_{box}$ ) and AST of chicks during the unloading ( $AST_{unload}$ )), interspersed as input and output variables, which were trained with the least mean square (LMS) algorithm, were performed using WEKA. In the descriptive analysis of the  $AST_{unload}$ ,  $T_{cont}$  and  $T_{box}$  presented arithmetic average of 37.1, 28.5 and 32.4°C, with maximum values of 40.0, 32.2 and 35.9°C and minimum of 30.9, 23.3 and 29.2°C. The standard error values of the variables  $AST_{unload}$  showed a low dispersion between the data and a homogeneous distribution (0.077, 0.115 and 0.079). Through the data of the variables used as input and output were developed the following regression models: prediction of the internal microclimate of chick boxes ( $T_{box} = 0.5685T_{cont} + 16.0909$ ) and prediction of the average surface temperature of chicks during transport ( $AST_{unload} = 0.3734T_{box} + 25.5358$ ), presented (+0.954 and +0.784) correlation coefficient. AST in the unloading showed a better prediction of AST during transport. The best prediction of microclimatic conditions was obtained inside the boxes during the shipment.

**Key Words:** broiler industry, ambience, neural network, air-conditioned truck

**83 Effect of using different sounds in runway test on performance, behavioral, and physiological traits of broiler chickens.** Salwan M. Abdulateef\*<sup>1</sup>, Ziyad T. M. Aldhanki<sup>2</sup>, and Saman A. Rashid<sup>3</sup>, <sup>1</sup>Al-Anbar University, Sulaymaniyah, <sup>2</sup>Al-Anbar University, Baghdad, <sup>3</sup>Sulaimani University, Sulaymaniyah.

This study was conducted at the experimental field of the Department of Animal Resources, College of Agriculture, Sulaymaniyah University, Iraq. From 24/08/2015 to 04/10/2015. The chicks were brought from a hatchery in Kasha in the Taslojh area. This study complementary to first experiment tested by 10 sound in use conditioned place preference (CPP) test. The sounds treatment that gave the best behavioral and physiological results in first experiment chosen in this experiment as follows: Movement of Chicken Feet (1), Regular Soft Timid Hens (2), Chicks Care (3) and Control (T4 without sound). Hatched chicks straight run ( $n = 160$ ), were randomly distributed among 4 treatments, which with 4 replicates (2 male – 2 female) per treatment and 40 chicks per replicate (10 chicks/treatment). The data reported as means ± SEM and subjected to 2-way, using a GLM model in the SAS system (SAS, 9.2) (SAS, 2004), followed by Duncan's multiple-range tests to analyze the differences among all treatments when the F-value was statistically significant ( $P < 0.05$ ). The results show significant increase ( $P < 0.05$ ) in live body weight cumulative, weight gain cumulative, relative growth rate cumulative to the broiler from 0 – 42 d to the Movement of Chicken Feet (1) and Chicks Care (3). Improvement ( $P < 0.05$ ) in the concentration of prolactin to Movement of Chicken Feet (1) and Chicks Care (3) in the all period at the age of 14 d. Significant improve ( $P < 0.05$ ) in histological examination at the along of the ganglion in the brain to Movement of Chicken Feet (1) and Chicks Care (3) in 42



d. Significant increase ( $P < 0.05$ ) in the number of times to approach, move away from the sound, in the stay of chicks near the sound and the percentage of the stay of chicks near the sound to the Chicks Care (3) and in the first and second weeks (14 d) in runway test.

**Acknowledgments:** These data were collected as part of the doctoral thesis by Sawlan M. Abdulateef. The authors are grateful to the College of Agriculture, Al-Anbar and Al-Sulaimani University, Iraq.

**Key Words:** broiler chicken, sound stimuli, runway test, performance, physiological trait

# Management and Production I

## 84 Cleaning and disinfection in broiler houses: efficiency and productivity against *Campylobacter jejuni*.

Maria Fernanda de Castro Burbarelli\*<sup>1</sup>, Karoline Deliberali Lelis<sup>1</sup>, Gustavo do Valle Polycarpo<sup>1</sup>, Carlos Alexandre Granghelli<sup>1</sup>, Carlos Eduardo Bellinghausen Merseguel<sup>1</sup>, Agatha Cristina de Pinho Carão<sup>1</sup>, Livia Maria Soares Queiroz<sup>1</sup>, Roberto Andrade Bordin<sup>3</sup>, Sabrina Ribeiro de Almeida Queiroz<sup>2</sup>, Maria Estela Gaglianone Moro<sup>2</sup>, Ricardo Luiz Moro Souza<sup>2</sup>, Andreza Maria Fernandes<sup>2</sup>, and Ricardo Albuquerque<sup>1</sup>, <sup>1</sup>Department of Animal Nutrition and Production, University of São Paulo, São Paulo, São Paulo, Brazil, <sup>2</sup>The Faculty of Animal Science and Food Engineering, University of São Paulo, Pirassununga, São Paulo, Brazil, <sup>3</sup>Nutrition, Animal Production, Health, FATEC-SP, São Paulo, São Paulo, Brazil.

Procedures of cleaning and disinfection in broiler production are necessary to maintain high standard of health, animal performance and meat quality. This study aimed evaluate productivity and efficiency of cleaning and disinfection program for broilers challenged with *Campylobacter jejuni*. Two subsequent lots were made, with 960 birds each, divided into 32 boxes with 30 birds. In the first, all birds were challenged orally with 105 cfu/mL *C. jejuni* strain atcc 33560. The second, before housing, 2 cleaning and disinfection programs were performed: Proposed (washing with acid and alkaline detergent at 4%, application of glutaraldehyde disinfectant 250g/L + formaldehyde 185g/L at 0.5% and disinfectant paraclorometacresol 210 g/L) and Common (wash with mild detergent to 4%) 16 boxes each. In second lot, total microorganism count was done before and after cleaning and disinfection. At slaughter was evaluated frequency of occurrence of *Campylobacter* spp. in living birds and carcasses after plucking and chiller. Broiler performance was also evaluated. The statistical tests used were the F test for performance and total count of microorganisms, Chi-squared test to *Campylobacter* frequency. After procedures, lower total microorganisms count was found in Proposed program feeders (0.67 vs 3.42 log<sub>10</sub>/cfu cm<sup>2</sup>,  $P < 0.01$  MSE = 0.563), walls (0.975 vs 3.099 log<sub>10</sub>/cfu cm<sup>2</sup>,  $P < 0.01$  MSE = 0.453) and floor (0.143 vs. 3.865 log<sub>10</sub>/cfu cm<sup>2</sup>,  $P < 0.0001$  MSE = 0.681). There was no difference in frequency of occurrence of *Campylobacter* spp. between treatments for live birds (7.5% vs. 20%,  $P > 0.05$ ) and carcass after plucking and chiller (20% vs. 5%,  $P > 0.05$  and 10% vs. 10%,  $P > 0.05$ ). Birds housed under Proposed conditions had higher body weight (2,717 vs. 2,532 g,  $P < 0.0001$  MSE = 0.025), weight gain (2,610 vs. 2,447 g,  $P < 0.01$  MSE = 0.028), feed intake (4,903 vs 4,760 g,  $P < 0.05$  MSE = 0.033) and better feed conversion (1.88 vs 1.95,  $P < 0.05$  MSE = 0.018) in the period of 1–42 d. Proposed protocol provides greater reduction of microbial load and positively influences productive performance of broilers challenged with *C. jejuni*.

**Acknowledgments:** FAPESP process 2013/02457-8

**Key Words:** biosecurity, campylobacteriosis, disinfectant, facility, health

## 85 Effect of sex on carcass and hepatic glycogen and fat in broiler chickens at 43 days old.

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The aim of this trial was to evaluate differences between broiler sex on dressing percentage, parts yield, abdominal fat, and hepatic glycogen and fat content at 43 d old. A total of 840 d-old broiler chickens (Cobb 500) were allotted in 24 boxes with 35 birds per pen in a completely randomized design. At d 43, 4 birds per pen were selected, totaling 96 broiler chickens, 48 males and 48 females. These birds were fasted for 8 h, weighed, stunned by eletronarcosis and slaughtered by bleeding. Afterward, birds were scalded, plucked in a rotary drum plucker and eviscerated. Dressing percentage and abdominal fat content were obtained in relation to body weight before slaughtering. Parts yield were obtained by relating each cut to eviscerated carcass weight. Livers were weighed, identified and frozen for fat and glycogen content determination. Hepatic fat content was analyzed as described by Folch et al. (1957), and hepatic glycogen, according to methodology described by Krisman et al. (1962). Hepatic data were expressed as percentage. Data were analyzed by ANOVA and significant differences were determined by Tukey test at 5% of probability. No difference was observed in hepatic parameters between sexes. Wing yield and abdominal fat were higher in females and males presented higher legs yield. Thus, it can be concluded that sex does not affect hepatic glycogen and fat, dressing percentage, breast and back yield at 43 d.

**Acknowledgments:** CNPq

**Key Words:** dressing percentage, female, male, metabolism.

## 86 Performance and morphometry of digestive organs of post-hatch fed and fasted broiler chicks.

P. G. Serpa, J. C. Denadai\*, G. A. M. Pasquali, M. M. Aoyagi, J. C. R. Rezende, M. R. Santana-Eich, E. M. Muro, and J. R. Sartori, *College of Veterinary Medicine and Animal Science, São Paulo State University (UNESP), Botucatu, São Paulo, Brazil.*

To evaluate the effect of feed and water deprivation for 48 h posthatch on growth performance and digestive organs morphometry of broiler chicks at 7 d after hatching, a completely randomized trial with 2 treatments (control and fasted) and 6 replicates of 35 birds each was carried out. A corn-soybean meal based diet was formulated to meet or exceed nutritional and caloric requirements. Fasted birds were held 48 h posthatch with no water or feed, whereas control birds were fed and watered ad libitum. At d 7, growth performance parameters (body weight, average daily gain, feed intake, feed conversion ratio and viability) were determined and at d 8, 2 birds with the average pen weight, were weighed and slaughtered after 2 h withdrawal. Proventriculus, gizzard, intestines, liver and pancreas were collected and weighed and expressed as a percentage of body weight. Data were analyzed by ANOVA and significant differences were determined by Tukey test at 5% of probability. Feed and water deprivation for 48 h posthatch depressed body weight in 26% ( $P > 0.0001$ ), weight gain in 35% ( $P > 0.0001$ ) and reduced feed intake in 30% ( $P > 0.0001$ ) at d 7. Feed and water deprivation also resulted in higher relative weight of proventriculus in 30% ( $P > 0.001$ ), gizzard in 26% ( $P > 0.05$ ) and small intestines in 12% ( $P > 0.05$ ) at d 8. Thus, withholding feed from posthatch chicks depressed growth performance without affecting organs development

**Acknowledgments:** CNPq

**Key Words:** delayed feed and water access, development, feed and water deprivation, growth performance, withdrawal

### 87 Evaluation of daily feed restriction in broiler chickens.

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The objectives of this work were evaluate the performance, glucose rate and economic index measured under 4 daily frequency of feed restriction in broiler chickens of 8–35 d of age. A total of 1,244 male chicks SF-Cobb 500 at 8 d of age were weighed and allotted in completely randomized design in 4 treatments with 9 replications of 34 chicks. The statistic analysis was performed by Tukey test ( $P < 0.05$ ). Feeding regimens consisted of ad libitum (AL, feed was always available), restriction in the morning and in the afternoon (RML, feed was always removed at 06:00–08:00 a.m./13:00–15:00 p.m.), restriction in the morning (RM, feed was always removed at 06:00–08:00 a.m.), and restriction in the afternoon (RL, feed was always removed at 13:00–15:00 p.m.) till 35 d of age. All chicken groups were fed diets of 8–21 and 22–35 d of age, respectively, with 21.2, and 19.8% of CP, and 3,050, and 3,150 kcal AME/kg. Chickens fed on AL, RML, RM and RL had similar LW, WG, FI and FCR of 8–21 d ( $P > 0.05$ ), but differences were observed ( $P < 0.05$ ) at 22–35 and 8–35 d in the FI and WG between AL, RML and RM treatments. Chickens fed on AL had minor FI than chickens fed on RML and RM of 22–35 d ( $2,081 \pm 56$ ,  $2,158 \pm 39$ ,  $2,150 \pm 40$  g) and 8–35 d ( $3,249 \pm 33$ ,  $3,310 \pm 37$ , and  $3,316 \pm 30$ ) and minor WG of 22–35 d ( $1,254 \pm 39$ ,  $1,315 \pm 22$ , and  $1,304 \pm 23$  g) and 8–35 d ( $2,127 \pm 25$ ,  $2,189 \pm 19$ , and  $2,179 \pm 20$  g), respectively. The glucose rate (mg/dL of blood) of chickens on RML, RM and RL were always lower compared of glucose rate of chickens on AL ( $163.86 \pm 15.3$ ,  $167.50 \pm 10.6$ ,  $149.39 \pm 15.5$  and  $189.11 \pm 5.3$ ), and decreased still more after fasting compared before and after fasting ( $148.18 \pm 13.8$ ,  $163.29 \pm 11.4$  and  $171.23 \pm 12.7$  mg/dL). Chickens group subjected on RML presented better economic efficiency index than chickens on AL feeding regimen.

**Acknowledgments:** Guaraves Foods Ltda

**Key Words:** economic efficiency index, feed conversion rate, glucose rate

### 88 Evaluation of commercial broiler lines using performance and mathematic models approach.

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Advances in broiler chicken production are associated with improvements in nutrition, handling and genetic. Currently, among the differences between broilers lines that are yielded for meat production, variations on performance and precocity are reported in literature. In this context, one trial was conducted to evaluate the performance and growth curve of 4 commercial broiler lines. A blind experiment with 2,400 birds, randomly distributed, performing a factorial scheme  $4 \times 2$  (4 broiler lines  $\times$  male and female), totaling 8 treatments with 10 replicates of 30 birds each. Performance was collected weekly through measurement of feed intake (FI), body weight gain (BWG), and feed conversion ratio (FCR). A nonlinear Gompertz model was applied using the live body weight (LBW), measured weekly, to evaluate a growth curve for each broiler line in function of LBW. A growth curve in function of BWG was also evaluated by deriving LBW equation. Differences were considered significant at probability of 5%. There were statistic differences between male and female, mainly for BWG and FCR ( $P < 0.05$ ). An interaction between factors occurred for most variables, exception for FCR, until fifth week of age. Among male broiler lines, line D showed the best performance results in all phases evaluated ( $P$

$< 0.05$ ); despite higher FI line D also showed higher BWG, which led to improvements on FCR. For female birds, line D also showed the best performance results ( $P < 0.05$ ), in fact, female line D birds showed a similar result as males from lines A, B, and C until third week old ( $P < 0.05$ ), which denote a precocity characteristic for this line. Contrasting the estimated values found by Gompertz with the observed values, showed that the model was a good parameter to estimate and evaluate the growth of chickens, in different lines. The precocity of the line D was predicted by the model proposed. Based on the results presented it was observed that there are differences between the performance of males and females, and between strains, but the differences occur at different levels within each lineage.

**Key Words:** commercial line, poultry, Gompertz, broiler performance

### 89 Performance and well-being of four different laying hen strains in aviary housing.

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The impetus to move to cage-free egg production by 2025 in the United States will require data on the production and well-being of different laying hen strains in that housing system. However, consumers' acceptance of a white egg coming from an aviary system is unknown as the precedence has been brown eggs in those housing systems. Therefore, the objective was to evaluate hen performance and well-being of 4 different laying hen strains (Bovans Brown, Hy-Line Brown, Hy-Line W-36, Dekalb White) in an aviary housing system. Brown strains (A, B) and white strains (C, D) were placed into a commercial aviary system at 17 wk of age. Four aviary rooms were used with each aviary divided into 4 sections with each section containing a different strain. This resulted in each strain being present in each room. The laying hens were stocked at a minimum of 929 cm<sup>2</sup> and fed the same diet. The production cycle was terminated at 79 wk of age. Hen-day (HD) eggs were gathered daily. Case weights (CW) were measured weekly and body weights (BW) were collected monthly. Fourteen birds per section were assessed for welfare quality (WQ) parameters quarterly. Data were collected in 28d periods for consistent analysis. The GLIMMIX statement in SAS 9.3 was used to analyze the data by strain, period and the interaction with 4 replicates per strain. Brown strains had heavier BW than white strains. However, at 79 wk strains D and B hens were 0.1 kg heavier than the other comparable strains ( $P < 0.05$ ). No differences were observed between CW with the brown strains, but during periods 5, 6, 7 strain D had a 0.7 kg heavier CW ( $P < 0.05$ ). Individual main effects ( $P < 0.05$ ) were more important than the interaction for HD. Overall, average HD was higher for both strains B and D ( $P < 0.05$ ). Most WQ parameters were similar across strains. 63% of all birds assessed had keel issues with brown strains having 1–8% of hens with more problems compared with the white strains. Overall, differences between strains were observed in the production parameters and WQ assessments with more differences being observed between the white strains than the brown strains.

**Key Words:** laying hen, welfare quality, aviary, egg, keel bone

### 90 Effects of single and multistage incubation under commercial conditions on broiler hatchling traits.

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Incubation parameters influence embryo development. This experiment was conducted to evaluate the effects of single (SS) and multistage (MS) incubation systems under commercial conditions on broiler hatchling traits. 240,000 eggs from paired breeder flocks of similar age were randomly distributed into 5 setters, one SS Jamesway and 4 MS Chick-Master machines. In the SS setter, machine set points were managed to maintain eggshell temperature close to 37.8°C, measured 4 times per day with pipe-probes connected to a thermistor to avoid opening the machine. In the hatchers temperatures were step down up to 35.6°C. In the 4 MS setters, set points were 37.5°C for 18.5 d of incubation and in the hatchers temperatures were step down up to 33.6°C at the end of incubation. At hatch, 20 chicks randomly selected from 10 different trays from each incubation system were sexed, weighed, killed and sampled for residual yolk, liver, proventriculus, gizzard, and heart weights, as well as intestine and ceca length. Data were analyzed as a completely randomized design with ANOVA to determine treatment effects and either Tukey's or *t*-test were used for mean separation. Chick BW did not vary ( $P > 0.05$ ) between the 2 incubation conditions. Chick BW and yolk-free BW were not affected ( $P > 0.05$ ) by incubation systems, but SS chicks were 2 g smaller than MS chicks. Liver relative weights of female chicks from MS were lighter ( $P < 0.05$ ) than those from females in the SS machine. No difference ( $P > 0.05$ ) due to incubation conditions was observed on liver relative weights for males. The proventriculus and gizzard relative weights were smaller ( $P < 0.05$ ) for males than females coming from the SS machine, but no difference was observed in the MS machine. No differences ( $P > 0.05$ ) between incubation systems or sex were observed on heart, intestine and ceca relative weights or lengths. In conclusion, the effect of incubation conditions on chicks was only detected on liver, proventriculus and gizzard relative weights. Elevated hatcher temperatures may have a bigger impact on embryo development.

**Key Words:** single stage, multistage, embryo development, temperature control, hatchling trait

**91 Vitamin E supplementation in ovo improves the hatchability of broiler breeder eggs.** Itallo C. S. Araújo\*, Mariana A. Mesquita, Matheus M. Reis, Gabriela C. Guareschi, Sabrina F. Pires, Nadja S. M. Leandro, and Roberto M. Jardim Filho, *Universidade Federal de Goiás, Goiânia, Goiás, Brazil.*

Embryonic nutrient supplementation by in ovo injection is a viable technology that can be used in research and industry. This study was conducted to evaluate the effects of vitamin E administered via in ovo injection on hatchability and embryo diagnosis. A total of 810 eggs from Cobb 500 broiler breeder flocks were distributed in a randomized block design, with 5 treatments. Treatments were: 1) eggs inoculated with 0.5 mL of sunflower oil (control group); 2) eggs inoculated with 15.0 mg/mL vitamin E/0.5 mL of sunflower oil; 3) eggs inoculated with 25.0 mg/mL vitamin E/0.5 mL of sunflower oil; 4) eggs inoculated with 35.0 mg/mL vitamin E/0.5 mL of sunflower oil and 5) eggs inoculated with 45.0 mg/mL vitamin E/0.5 mL of sunflower oil. At 18 d of incubation, eggs were sanitized with iodine alcohol (2%) and vitamin E solution was inoculated in the amniotic fluid. After inoculation, eggs were placed in air-permeable bags to isolate the treatment and distributed in hatchery trays. At hatch, hatchability of fertile eggs was calculated, and unhatched eggs, pipped eggs with dead or alive chicks, dead or alive chicks with some kind of anomaly, unpecked chicks, bacterial or fungal contamination and dead embryos caused by inoculation were counted and analyzed in the embryo diagnosis. Hatchability of fertile

eggs were analyzed with ANOVA and regression. Embryo diagnosis with Fisher test. A linear effect ( $P < 0.05$ ) was observed for hatchability of fertile eggs ( $Y = 75.1253 + 0.32245 \times \text{levels}$ ,  $R^2 = 0.616$ ). There were significant effects ( $P < 0.05$ ) of in ovo vitamin E supplementation on hatchability of eggs. The percentage of hatched eggs increased from 25.0 mg/mL vitamin E (89.62%). The best ( $P < 0.05$ ) hatchability of fertile eggs (92.32%) was observed in the group that was inoculated with 45.0 mg/mL of vitamin E. The inclusion of 15.0 mg/mL of vitamin E did not differ from the control group (83.54 and 84.04% respectively). There were no significant effects ( $P > 0.05$ ) of vitamin E supplementation for embryo diagnosis. In conclusion, in ovo injection of vitamin E at 18 d of incubation improve hatchability of fertile eggs.

**Key Words:**  $\alpha$ -tocopherol, broiler, in ovo feeding, neonate chick, oxidative status

**92 Effects of vitamin E supplementation in ovo on neonate chick quality.** Itallo C. S. Araújo\*, Raiana A. Noletto, Gabriela C. Guareschi, Matheus M. Reis, Marcos B. Cafê, and Nadja S. M. Leandro, *Universidade Federal de Goiás, Goiânia, Goiás, Brazil.*

The physical quality of newborn chicks is an important indicator of initial broilers performance. The objective was to evaluate the effects of vitamin E inoculation on neonate chick quality. A total of 810 eggs from Cobb 500 broiler breeder flocks were weighed and distributed in a randomized block design, with 5 treatments. Treatments were: 1) eggs inoculated with 0.5 mL of sunflower oil (control group); 2) eggs inoculated with 15.0 mg/mL vitamin E/0.5 mL of sunflower oil; 3) eggs inoculated with 25.0 mg/mL vitamin E/0.5 mL of sunflower oil; 4) eggs inoculated with 35.0 mg/mL vitamin E/0.5 mL of sunflower oil and 5) eggs inoculated with 45.0 mg/mL vitamin E/0.5 mL of sunflower oil. At 18 d of incubation, eggs were sanitized with iodine alcohol (2%) and vitamin E solution was inoculated in the amniotic fluid. At hatch, all neonate chicks were weighed and length were measured. Chicks (60/treatment) were slaughtered and the residual yolk was removed and weighed. Yolk free body weight and the relative percentage between chicks and eggs weight were calculated. Data were analyzed with ANOVA and regression. There was a linear effect ( $P < 0.05$ ) for chick length ( $Y = 17.088124 + 0.0513018 \times \text{levels}$ ,  $R^2 = 0.215$ ). Body weight were affected ( $P < 0.05$ ) by in ovo supplementation of vitamin E. The inoculation of 35.0mg/mL and 45.0 mg/mL of vitamin E increased body weight (45.65 and 45.95 g) compared with the control group (44.03 g) and groups that received 15.0 mg/mL and 25.0 mg/mL of vitamin E (45.14 and 45.23 g). Residual yolk weight and yolk free body weight were not affected by treatments ( $P > 0.05$ ). Relative percentage between chicks and eggs weight were affected ( $P < 0.05$ ) by in ovo supplementation of vitamin E. Treatments that received 25.0 mg/mL, 35.0mg/mL and 45.0 mg/mL of vitamin E in ovo had greater ( $P < 0.05$ ) relative percentage between chicks and eggs weight (69.81%, 70.33% and 70.72% respectively) than control group (68.52%). In conclusion, in ovo supplementation of vitamin E at 18 d of incubation improve the utilization of egg nutrients resulting in neonate chicks with better physical quality.

**Key Words:** alpha-tocopherol, broiler, fertile egg, in ovo feeding, oxidative status

## Management and Production II

**93 Quality of eggs in Brazil: correlations between parameters evaluated.** Jose Francisco Miranda\*<sup>1</sup>, Sergio Moretto<sup>1</sup>, Franz Roos<sup>1</sup>, Andreia Adami<sup>2</sup>, Leticia Bittencourt<sup>1</sup>, and Alexandre Sechinato<sup>1</sup>, <sup>1</sup>DSM, Nutritional Products, São Paulo, São Paulo, Brazil, <sup>2</sup>CEPEA, ESALQ-USP, São Paulo, São Paulo, Brazil.

The objective was to know the quality of eggs produced in Brazil and check some parameters of both internal as external quality: weight, albumen height, Haugh Unit, yolk color, eggshell thickness and resistance. This type of analysis can be a useful tool for the producer in monitoring the quality of the eggs; in addition, the continuous measurement of parameters of eggs may show an improvement in the quality. Therefore, samples were taken from eggs directly from farms in different regions of Brazil (different farming systems, management, climate, nutrition, age and breed), totaling 25 farms and 19,468 eggs analyzed from August 2012 to June 2015. Eggs were analyzed by Nabel Digital Egg Tester DET6000 and correlation analysis between the measured parameters was analyzed using the SAS statistical software. The results show that the highest correlation coefficient was 0.98 observed between albumen height parameter and Haugh unit, which was expected, because it uses the measure albumen height to calculate Haugh unit. Moderate negative correlation was observed between the age of layers and eggshell resistance ( $P = -0.41$ ) and moderate positive between eggshell resistance and eggshell thickness ( $P = 0.49$ ). The other correlations were considered weak. This study evaluated the quality of eggs in different regions of Brazil and the correlations between parameters that are important in assessing the freshness and eggshell quality.

**Key Words:** egg, quality, correlation, Brazil.

**94 Effects of early feeding on immune response, blood variables, intestinal microbiology, and meat peroxidation of broilers fed dietary growth promoters.** Yaha Sabah Abdulameer\*, *Animal Nutrition Department, Tehran University Tehran, Iran.*

This trial was carried out to evaluate the effect of immediate access to nutritional supplement post hatch on immune response, blood variables, and gut bacteriology of broiler chicks fed with or without growth promoters. A total of 1,200 male chicks were allotted according to 2 groups in the hatchery. The fed groups received early feeding (Vitagel) during transport until 24 h post hatch, and the deprived groups were restricted within transport box for 24 h post hatch without Vitagel or any nutrients. In the farm, the birds divided into negative control (basal diet) and positive control (Availmycin as antibiotic (AB); *Bacillus subtilis* as probiotic (PRO), and Bioherbal as herbal mixture (HM). The immune response against Newcastle disease virus (NDV) was significantly increased ( $P < 0.05$ ), whereas antibody titers (Ab) against sheep red blood cells (SRBC) were numerically high by Vitagel. The Ab titers against SRBC antigen enhanced ( $P \leq 0.001$ ) with PRO and HM significantly. Vitagel reduced the pathogenic bacteria (*Clostridium* spp. and *Escherichia coli*) ( $P \leq 0.05$ ), also it maintained on beneficial bacteria (*Lactobacilli* and *Bifidobacteria*). Growth promoters showed a significant reduction ( $P \leq 0.001$ ) in pathogenic bacteria and increase ( $P < 0.05$ ) in beneficial bacteria. The interactive effect of early feeding supplement and growth promoters observed markedly on intestinal microbiology ( $P \leq 0.01$ ) by increasing beneficial bacteria and reducing pathogenic bacteria. The lymphocyte (Lym) count was more with PRO or HM or interactive effect of Vitagel and PRO or HM ( $P \leq 0.05$ ), the heterophils (Het) to lymphocyte ratio (Het/Lym) and heterophils were lower ( $P \leq 0.01$ ) with interactive effect or PRO or HM. In conclusion, early feeding by Vitagel may be suitable for broiler chicks that exposure to nutritional and hatchery stresses. The early fed birds receiving growth promoters through their diets had a better health status.

**Key Words:** broiler meat stability, initial period, nutritional supplement

# Metabolism and Nutrition: Vitamins and Minerals I

**95 Effects of fat-soluble vitamin supplementation on broiler performance.** M. A. Costa\*, V. Ribeiro Junior, G. S. Viana, M. I. Hannas, H. S. Rostagno, and L. F. T. Albino, *Universidade Federal de Vicosa, Vicosa, MG, Brazil.*

This study was conducted to evaluate the effects of fat-soluble vitamins (FSV) levels on broilers performance from 8 to 42 d of age. A total of 1,250 male broilers Cobb 500 with an average initial body weight of 157.7 g ± 0.003 g were distributed in a randomized block design into 5 treatments with 10 replicates and 25 birds per pen. From 1 to 7 d of age, birds were fed a diet formulated to meet 50% of Rostagno et al. (2011) FSV nutritional recommendation, to exhaust the reserve from the yolk sac. Experimental diets were formulated based on a corn and soybean

meal to meet broiler requirements described by Rostagno et al. (2011), except for FSV. Treatments consisted of FSV levels of 0, 33.3, 66.7, 100, and 133.3% of FSV recommendations proposed by Rostagno et al. (2011) for broilers. Data were compared by Dunnett test (0% of FSV as control group) and regression analysis was performed. Significant effects were considered for  $P < 0.05$ . FSV levels linearly improved body weight ( $BW = 2.633 + 0.0006 X$ ,  $R^2 = 0.88$ ); and weight gain ( $WG = 2.465 + 0.0007 X$ ;  $R^2 = 0.94$ ). Feed-to-gain ratio linearly decreased as FSV supplementation increased ( $F:G = 1.571 - 0.00043X$ ;  $R^2 = 0.90$ ). Diets with FSV over 33.3% improved BW, WG, FI, Viab and PEI and F:G compared with control group. These results linearly improved with the higher levels of inclusion FSV supplementation on levels proposed by Rostagno et al. (2011).

**Table 1.** Effect of fat-soluble vitamins (FSV) supplementation on broiler performance from 8 to 42 d of age

Item1	FSV (%)					CV (%)	P-value	
	0	33.3	66.7	100	133.3		Lin	Quad
BW, kg	1.872	2.649*	2.683*	2.681*	2.715*	8.44	<0.001	0.982
WG, kg	1.714	2.492	2.502*	2.523*	2.557*	8.97	0.093	0.673
FI, kg	2.966	3.585*	3.852*	3.847*	3.882*	8.39	0.898	0.238
F:G, kg/kg	1.747	1.560*	1.541*	1.541*	1.519*	2.92	0.053	0.577
Viab, %	86.73	97.24*	96.80*	96.80*	96.80*	5.50	0.848	0.983
PEI	261.50	457.80*	462.46*	462.46*	480.60*	14.48	0.163	0.868

<sup>1</sup>BW = body weight; WG = weight gain; FI = feed intake; F:G = feed-to-gain ratio; Viab = viability; PEI = productive efficiency index; Lin = linear; Quad = quadratic.

\*Means followed by an asterisk differed from the control (Dunnett test,  $P < 0.05$ ).

**Key Words:** feed-to-gain ratio, performance, viability, weight gain

**96 Fat-soluble vitamins supplementation on broiler meat quality traits.** M. A. Costa\*, V. Ribeiro Junior, B. D. Faria, L. T. Lopes, M. I. Hannas, and H. S. Rostagno, *Universidade Federal de Vicosa, Vicosa, MG, Brazil.*

This trial was performed to evaluate the effects of dietary fat-soluble vitamins (FSV) supplementation on broiler meat quality traits. A total of 1,250 male broilers at 8 d of age and average initial body weight 157.70 g ± 0.003 g, were allotted into 50 pens with 25 broilers each one. Pens were assigned to 5 treatments in randomized block design with 10 pens per treatment. From the 1st to 7th d of age, birds were fed a basal diet formulated to meet 50% of Rostagno et al. (2011) FSV recommendation. Treatments consisted of FSV supplementation at 0;

33.3; 66.7; 100 and 133% of Rostagno et al. (2011) recommendations. At 42 d of age, 3 broilers of each pen were slaughtered and breast muscle was collected for meat quality analyzes. After ANALYSIS of variance, means were compared by Dunnett test, considering the level of FSV of 0% as control group. In addition, polynomial regression analyses were performed into FSV levels. Significant effects were considered when  $P \leq 0.05$ . Cooking loss (CL) was linearly decreased as dietary FSV supplementation increased. Shear force showed quadratic response; and was optimized by the FSV level of 73.91%. Meat color was affected by FSV level. The level of 133% decreased L\* value compared with control group. An interaction was observed between FSV level and storage time for malondialdehyde (MDA) production on breast meat, which increased as storage time increased (0, 4, and 7 d). However, at d 7 of storage, 100 and 133.3% of FSV supplementation supported equal MDA production that d 0. The level of 133.3% of Rostagno et al. (2011) FSV recommendation improves broiler meat quality.

**Table 1.** Meat quality traits of broilers at 42 d of age fed levels of FSV<sup>1</sup>

	FSV supplementation (%)					CV <sup>2</sup> (%)	P-value	
	0	33.3	66.7	100	133.3		Lin	Quad
TH	9.05	9.60	8.48	9.93	9.15	16.70	0.147	0.534
CL	18.43	18.92	16.99	16.36	16.90	17.26	<0.001	0.100
SF	2.116	2.052	2.299	2.173	1.914	16.84	0.266	<0.001
L*	57.43	55.42	55.47	55.52	53.35*	5.39	0.217	0.314

<sup>1</sup>FSV = fat-soluble vitamins; TH = thawing loss; CL = cooking loss; SF = shear force; CV = coefficient of variation; Lin = linear effect; Quad = quadratic effect.

\*Means within the same row with asterisk differed from the control group.

**Key Words:** nutrition, poultry, sensory characteristic

**97 Effect of vitamins A and D<sub>3</sub> in broiler chicken diets on performance, carcass yield, and meat quality.** Ana Flávia Q. M. Guerra<sup>1</sup>, Cristiane R. A. Duarte\*<sup>2</sup>, Alice E. Murakami<sup>1</sup>, Iván C. Ospina-Rojas<sup>1</sup>, Mayra D. Vargas<sup>1</sup>, and Marília C. F. Alves<sup>1</sup>, <sup>1</sup>Departamento de Zootecnia, Universidade Estadual de Maringá, Maringá, PR, Brazil, <sup>2</sup>Departamento de Ciências Biológicas, Universidade do Estado de Mato Grosso, Tangará da Serra, MT, Brazil.

Vitamins A and D are essential for the growth and development of broiler chickens; however, vitamin A can antagonize the action of vitamin D. Thus, this study evaluated the effects of vitamins A and D<sub>3</sub> in broilers diet on performance, carcass yield and meat quality. 1,520 one-day-old Cobb male chicks were distributed in a factorial design 5 × 4, with 5 levels of vit A (0; 9,000; 18,000; 36,000 and 54,000 IU/kg diet) and 4 levels of vit D<sub>3</sub> (200; 950; 1,700 and 2,450 IU/kg diet), with 4 replicates and 19 birds each. The vitamin supplement was free of vit D and A. Performance from 1 to 21 d of age and 1 to 42 d of age and carcass yield and meat quality—pH, lightness, redness and yellowness, cooking loss, shear force and water-holding capacity—at 42 d of age were evaluated. No interaction ( $P > 0.05$ ) was found between vit A and D<sub>3</sub> for performance, carcass yield and meat quality. Vit A supplementation linearly increased weight gain and feed intake from 1 to 21 d of age, whereas from 1 to 42 d of age, these parameters were quadratically influenced, with the highest weight gain and feed intake estimated at 35,193 and 37,016 IU vit A/kg diet, respectively. Vit D<sub>3</sub> also linearly increased the weight gain and feed intake ( $P < 0.05$ ) from 1 to 21 d of age. From 1 to 42 d of age, these parameters showed a quadratic effect, with the highest weight gain and feed intake predicted at 1,841 IU vit D<sub>3</sub>/kg diet and 1,900 IU vit D<sub>3</sub>/kg diet, respectively. Breast and thighs+drumstick yield presented a quadratic response ( $P < 0.05$ ), with the highest yields estimated at 29,430 and 30,630 IU vit A/kg diet, respectively. The same trend was observed for vit D<sub>3</sub> with the highest breast and thighs+drumstick yields predicted at 1,663 and 1,763 IU vit D<sub>3</sub>/kg diet, respectively. Vit A linearly decreased yellowness in the breast and thighs+drumsticks ( $P < 0.05$ ), whereas, vit D<sub>3</sub> had a quadratic effect ( $P < 0.05$ ) on redness in thigh meat, with the lowest level estimated at 1,559 IU vit D<sub>3</sub>/kg diet. The supplementation of a 35,195 IU vit A/kg diet and a 1,841 IU vit D<sub>3</sub>/kg diet from 1 to 42 d improves the performance without harming the carcass yield and meat quality.

**Acknowledgments:** CNPq/Brazil

**Key Words:** calcitriol, meat color, retinoic acid

**98 Effect of vitamin and mineral diet supplementation on oxidation and shelf life of broiler meat.** Mayra Vissotto Ribeiro<sup>1</sup>, Anete Rorig<sup>\*1</sup>, and Mauricio Canevese<sup>1</sup>, Luis Miguel Fulber<sup>1</sup>, Leticia Cardoso Bittencourt<sup>2</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil, <sup>2</sup>DSM Produtos Nutricionais Brazil SA, São Paulo, São Paulo, Brazil.

The consumption of meat can be ensured through a tasty, nutritious and safety meat supply for the consumers. The aim of this trial was to assess the effect of supplementation of commercial diets for broilers with optimized vitamin levels and a more bioavailable mineral source on the oxidation and shelf life of broiler meat. Eighteen hundred Cobb Slow-feathering male- chicks were housed in a completely randomized design following a factorial scheme 2 × 2 [Optimal vitamin Nutrition, OVN vs commercial levels and mineral sources-inorganic and carbon-amino-phospho-chelate (CAP)], adding up to 4 treatments and 9 replicates. The optimized vitamin levels followed the recommendations of the Optimum Vitamin Nutrition Guidelines (OVN, DSM) with a metabolite of the vitamin D<sub>3</sub>, 25 (OH) D<sub>3</sub> (69mg/kg of feed). At 42 d of age, 30

birds/treatment were slaughtered and samples of thighs and drumsticks were collected for further freezing. After 10 and 40 d of freezing, 10-g samples were taken for analysis of substances reactive to thiobarbituric acid (TBARS), obtained by the amount of malondialdehyde (MDA). Data were submitted to variance analysis. There was an interaction ( $P < 0.05$ ) between vitamin levels and mineral sources for MDA concentration (mg/sample kg) in the thigh meat, frozen for 10 d. According to the unfolding of the interaction, supplementation of OVN levels associated with CAP mineral source (0.45 mg/kg) resulted in a lower MDA, index that shows higher oxidative stability, when associated with inorganic source. (0.70 mg/kg). For 40 d of freezing, it was not found difference ( $P < 0.05$ ) between OVN supplementation and control, regardless of the mineral source used. Due to the high level of polyunsaturated fatty acids (PUFA), there is a greater susceptibility of poultry meat suffering oxidative processes than pork and beef, especially regarding lipid oxidation. The supplementation of broiler diets with optimized levels of vitamins and a more bioavailable mineral source can contribute to maintain the original flavor of the product and increase shelf life of the meat, decreasing the range of lipid oxidation.

**Key Words:** trace mineral, costumer, TBARS, flavor, fatty acid

**99 Efficacy of vitamin and mineral supplementation on meat quality and skin resistance of broilers.** Mayra Vissotto Ribeiro<sup>1</sup>, Joice Meri Schmidt<sup>1</sup>, and Daiane Horn\*<sup>1</sup>, Alexandre S. Sechinato<sup>2</sup>, José Maria Luvizotto Junior<sup>2</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil, <sup>2</sup>DSM Produtos Nutricionais Brazil SA, São Paulo, São Paulo, Brazil.

The aim of this work was to evaluate the effect of supplementation of commercial diets for broilers with optimized vitamin nutritional levels (OVN, DSM Nutritional Products) and a more bioavailable mineral source on the quality of broiler meat. Eighteen hundred Cobb Slow-male-chicks were divided into a completely randomized design following a factorial scheme 2 × 2 (vitamin levels-commercial and optimized vs mineral sources-inorganic and carbon-amino-phospho-chelate (CAP)), 4 treatments and 9 replicates. The optimized vitamin followed the guidelines of Optimum Vitamin Nutrition DSM and a metabolite of vitamin D<sub>3</sub>, 25 (OH) D<sub>3</sub> was added. At 42 d of age, 30 birds/treatment were slaughtered and the breasts submitted to different analyses. The skin of the thighs was removed and underwent assessments for breaking strength and elasticity. The tests were performed through a fixing device for shearing test and adjusted to a texturometer. Data were submitted to analyses of variance. The breast meat drip loss of birds fed with optimal vitamin levels was lower ( $P < 0.05$ ) when compared with the loss observed in the birds fed with commercial vitamin levels, regardless of trace mineral source. Regarding the shear strength, difference was no observed ( $P > 0.05$ ); however, the replacement of inorganic mineral by CAP resulted in less elastic muscular tissue ( $P < 0.05$ ) with higher softness, which provides breaking with lower resistance of the muscle fibers. About breaking strength and elasticity of the skin, the opposite effect was noted. The skin of the birds supplemented with CAP was more resistant to rupture considering a p value of 0.091. The resistance of the skin presents a significant variability (CV: 27.82%) due to the heterogeneous constituents of the cutaneous tissue and the intrinsic test conditions. The elasticity was similar ( $P > 0.05$ ) among the treatments. The optimal vitamin levels can play an important role in reducing meat drip loss by decreasing the negative effects of oxidation. More bioavailable mineral sources may bring extra benefits to improve broilers skin and meat quality.

**Key Words:** trace mineral, vitamin D, skin resistance, drip loss

**100 Trace mineral sources on duodenal mucosal repair of broilers challenged with *Eimeria* sp.** Mayra Vissotto Ribeiro<sup>1</sup>, Joice Meri Schmidt<sup>1</sup>, and Heloísa Lais Fialkowski Bordignon<sup>1</sup>, Alexandra Maria da Silva\*<sup>1</sup>, Leticia Cardoso Bittencourt<sup>2</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, <sup>1</sup>*Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil*, <sup>2</sup>*DSM Produtos Nutricionais Brazil SA, São Paulo, São Paulo, Brazil*.

The aim of this study was to assess the effect of carbon-amino-phospho-chelate as a mineral source on duodenal mucosa repair of broilers challenged with *Eimeria* sp. In this trial, 640 Cobb Slow-male-chicks, at 21 d of age, were divided into a completely randomized design following a 2 × 2 factorial scheme (inorganic mineral source or carbon-amino-phospho-chelate (CAP) vs challenge or not), totaling 4 treatments with 16 replicates of 10 birds each. The challenged group received commercial vaccine containing oocysts of *Eimeria* sp. in the crop, and the dose was 20 times above the dose recommended by the manufacturer (80,000 oocysts). At 28 d of age, 32 birds/treatment were slaughtered to collect duodenal fragments. The fragments were submitted to histological procedures. Length and width of the villi, and depth and width of the crypts were measured. Next, the villus:crypt ratio as well as the absorption surface area were calculated. Crypts were counted and divided by the number of villi to calculate the vili: crypts ratio. Data were submitted

to factorial ANOVA. There was a significant interaction between the mineral source and the enteric challenge for length and width of the villi and crypt depth. The enteric challenge in birds supplemented with an inorganic mineral source reduced ( $P < 0.05$ ) drastically the villus length (769  $\mu\text{m}$ ), while the replacement by CAP mineral kept the same length of villi observed for control animals (1,077  $\mu\text{m}$ ). The inclusion of CAP minerals in enteric challenging led to an increase ( $P < 0.05$ ) in the villus width when compared with control birds. For the crypt depth in a challenging situation, the supplementation of CAP minerals resulted in increased ( $P < 0.05$ ) depth. As a result, it indicates higher proliferative capacity compared with the inorganic source. CAP supplementation, regardless of enteric challenge, reveals greater ( $P < 0.05$ ) villus: crypt ratio and absorption area in comparison to the inorganic source. Diets supplemented with CAP mineral source can contribute to regeneration and proliferation of the intestinal mucosa of broilers when submitted to challenging enteric conditions.

**Key Words:** villus length, trace mineral, cell proliferation



# Immunology, Health, and Disease: Immunology I

**101 Control of severe respiratory disease caused by variant strains of infectious bronchitis virus using a combination of two heterologous IB vaccine strains in broilers in Mexico.** Juan Francisco Rios Cambre\*<sup>1</sup>, Hector Eugenio Merino Rosillo<sup>1</sup>, Everardo Trejo Martinez<sup>1</sup>, Francisco Cortes<sup>2</sup>, Arturo Sandoval<sup>2</sup>, and Adriana Rojas<sup>3</sup>, <sup>1</sup>MSD Salud Animal Mexico, Santiago Tlanguistenco, Estado de Mexico, Mexico, <sup>2</sup>Avicola San Andres, SA de CV, Tecamac, Estado de Mexico, Mexico, <sup>3</sup>Impexvet, SA de CV, Mexico, DF, Mexico.

For several years, severe respiratory distress, causing obstructive fibri- noid tracheobronchitis, has been reported in broiler flocks in Mexico. In recent years these problems appeared in broiler flocks regardless of the time of the year, causing high mortality, reduced daily weight gain and high feed conversion rates. In a central Mexico group of farms, comprising over 1.2 million broilers, where all showed very high mortality and decreased production parameters, several strains of Arkansas-related viruses were detected. The objective of this work was to demonstrate that the use of 2 different live virus vaccines, one from the Mass family, and the other from the 793B family, antigenically unrelated among themselves, which had previously shown their effectiveness in controlling Arkansas-related strains in vitro, could replicate such results in the field under problematic environmental conditions, such as high altitude, high stocking density and high market weight and late market age. In this way, we compared the results from the same group of farms, the first cycle no IB vaccine was applied, while the subsequent flocks were vaccinated with said vaccine complex at one day of age. As a result, while all previous flocks in all farms the average mortality was 20%, FCR was slightly over 2.00, daily weight gain was 53.9 g, the field virus was detected; the following cycle in the same farms the average mortality was 4.9%, FCR was 1.96 and daily weight gain was 54.3 g, all parameters were significantly different from the previous flock's, the vaccine virus was detected via molecular detection system, implying that the field virus was effectively displaced by the vaccine virus complex. This showed that the use of the Protectotype concept devised several years ago can be successfully applied in broilers grown under difficult management circumstances.

**Acknowledgments:** X Ovo Laboratories, Scotland, United Kingdom

**Key Words:** bronchitis, Arkansas strain, protectotype, broiler

**102 Histopathology and Bursal microscopic reaction to an immune complex IBD vaccine (V877 Strain) in SPF birds.**

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The objective of this study was to investigate the effect of a new IBD immune complex vaccine on Bursa histology and seroconversion in specific pathogen-free (SPF) birds vaccinated in ovo or subcutaneously. Experimental design - Vaccine: a new immune complex vaccine (V877 strain mixed with antiserum), Poulvac Magniplex, manufactured by Zoetis. Animals (300 White Leghorn SPF eggs) were randomly divided into 3 groups (T01 - no vaccine, T02 - in ovo vaccination, T03 - subcutaneously vaccination). At hatch birds were housed by group in separate HEPA filter isolation rooms. Sampling - Weekly, 6 bursas of Fabricius were selected from each treatment for histological evaluation to determine the level of bursal lesions. The Muskett parameters were adapted (scores 0 to 5). For each treatment group, 20 blood samples were collected for ELISA. Histologic analysis in SPF birds showed the

effect of the vaccine strain on the bursal parenchyma over time, where in all evaluations the Muskett score differed significantly from the unvaccinated control group. Kruskal Wallis test ( $P < 0.05$ ) was used. There was a clear trend of repopulation of the Bursa with lymphocytes after vaccination, which suggests that the functionality of the organ was regained. Because the birds had no passive antibodies, this effect was visible from the first evaluation performed at 7 d of age; its intensity was considered moderate. There weren't statistical differences between T02 and T03. In general, bursal lesions indicating vaccine virus replication were slightly detected from d 7 onward, reaching their peak at 28 d. There were also no vaccine-related clinical signs or increased mortality. The active seroconversion was observed in the T02 and T03 groups with titers of 1,583 and 2,959 respectively. The T01 group had absence of antibody titers. Based on the data presented in this study, it can be concluded that the immune complex vaccine works in a safe way even with absence of passive antibody producing moderate effects in the Bursa and stimulating active seroconversion in SPF birds vaccinated in ovo or subcutaneously.

**Key Words:** immune complex vaccine, IBDV, poultry, bursa of Fabricius, histopathology

**103 Histopathology and bursal microscopic reaction to an immune complex IBD vaccine (V877 Strain) in commercial birds.**

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The objective of this study was to investigate the effect of a new IBD immune complex vaccine on the bursa parenchyma in commercial birds under different level of maternal antibody. Experimental design - Vaccine: a new immune complex vaccine (V877 strain mixed with antiserum), Poulvac Magniplex, manufactured by Zoetis, was administered at hatchery in ovo. Test sites were commercial farms and animals were grouped separately during the experimental observation period. Observation 1: One group of 20,000 commercial broiler with high level of maternal antibody. Observation 2: One group of 20,000 commercial broiler with low level of maternal antibody. Weekly, 6 Bursas of Fabricius were selected for each treatment for histological evaluation to determine the level of bursal lesions and the onset of the virus replication in this organ. Muskett scale was adapted to characterize bursal damage. For each group, 20 blood samples were collected at 1, 21, and 42 d of age using the IDEXX kit to determine the kinetic serological profile of the different treatments. Means of Muskett scores in histological analysis of bursas were compared by Kruskal Wallis test ( $P < 0.05$ ). Bursal lesions indicated that vaccine virus replication were slightly detected from d 14 to 28 onward, reaching their peak at 28 d. Comparing observation 1 and 2, there is a strong evidence that passive antibodies interfere with the moment of virus activity and multiplication in the bursal parenchyma. ELISA titers at 1, 21 and 42 d were 8,088; 85 and 2,899 for Field observation 1 and 2,591; 2,907 and 6,821 for Field observation 2. Based on the data presented in this study, immune complex vaccine works with different levels of passive antibody and the vaccine virus starts to replicate at the most appropriate time to provide active immune response for the animal.

**Key Words:** Gumboro, maternal antibody, immune complex vaccine, vaccination, poultry

**104 Assessment of live vaccine against *Escherichia coli* in zootechnical parameters of broilers.** Renato Verdi\*<sup>1</sup>, Eduardo C. Muniz<sup>1</sup>, Dario K. Filho<sup>1</sup>, Matheus S. Resende<sup>1</sup>, and Diomar R. Barro<sup>2</sup>, <sup>1</sup>*Zoetis Ind. de Produtos Veterinários Ltda, São Paulo, SP, Brazil*, <sup>2</sup>*Agrodanieli, Tapejara, RS, Brazil*.

The search for efficient alternatives to control Colibacillosis in broilers is a necessity of modern poultry industry due to increasing resistance to available drugs and restrictions on the use of various antibiotics. The objective of this study was to evaluate the effect of a live vaccine of *E. coli* on key performance parameters of broiler chickens. This study was conducted in a commercial company, Agrodanieli in RS, Brazil. The study was performed in a week on/week off comparison, where all chicks hatched during the trial were vaccinated with Poulvac *E. coli* in the hatchery (week on) or followed regular management without preventive treatment (unvaccinated) to *E. coli* infection (week off). A total of 16 wk of production (8 wk for each treatment) were included in this trial, with approximately 1,1 million broilers per week. The final number for each treatment was 8.8 million broilers. Comparisons were done in between weeks pre-determined randomly (vaccinated vs non-vaccinated flocks). The model was a randomized complete block design with week as the experimental unit and individual flocks as subsamples. All hypothesis tests were conducted at the  $P \leq 0.05$  level of significance. Adjusted feed conversion (aFCR) was analyzed and the main effect of vaccination was found significant, with vaccinated flocks having significantly lower adjusted feed conversion. The European Production Efficiency Factor (EFPE) was found significantly higher in vaccinated female flocks than non-vaccinated. Average daily gain was found significantly higher for the vaccinated female flocks as compared with non-vaccinated. Proportion viability was analyzed by a generalized linear mixed model (log-linear model) and vaccination was not found to be a significant factor. The results of this study demonstrate the effectiveness of the broiler vaccination on improve productivity and helping the reduction or rational use of antibiotics.

**Key Words:** AroA genetically modified live vaccine, *Escherichia coli*, vaccination, feed conversion, broiler

**105 Performance and anticoccidial effects of Magni-Phi in coccidia-vaccinated broilers.** Kenneth W. Bafundo\*<sup>1</sup> and Greg F.

Mathis<sup>2</sup>, <sup>1</sup>*Phibro Animal Health Corp., Teaneck, NJ, USA*, <sup>2</sup>*Southern Poultry Research, Inc., Athens, GA, USA*.

A series of 4 floor pen studies was carried out to evaluate the efficacy and performance responses of Magni-Phi (MP, a triterpenoid saponin) when used in combination with a standard coccidiosis vaccine. Trials 1 and 2 assessed the effects of MP (0 and 250 ppm) in birds receiving Coccivac at hatching. Trial 3 was designed to determine the ideal period of use for MP in coccidia-vaccinated broilers: vaccinated birds without MP were compared with vaccinates receiving MP (250 ppm) from either 0 to 18, 0 to 42 or 18 to 42 d of age. In Trial 4, MP was compared with salinomycin (40 ppm) for its ability to affect performance and limit oocyst production in vaccinated birds during the 18 to 35 d time period. In each trial, male Cobb chicks were spray vaccinated with Coccivac at the hatchery and then placed in floor pens containing used litter; 45 birds per pen were used. Treatments in every test were replicated 8 times using RCB designs; bird performance was measured at 18, 28 and 42 d. In each study, fecal oocyst production (oocysts/gram of feces) was determined at d 18 and 28. In all trials significance was determined at  $P < 0.05$ . Pooled results of trials 1 and 2 demonstrated that MP significantly improved adjusted FCR responses of birds vaccinated for coccidiosis at both 28 and 42 d. In addition, significant reductions in OPG were recorded in MP treatments. In Trial 3, administration of MP significantly improved feed conversion values at d 42 compared with vaccinated controls, and birds receiving MP throughout their lives showed better feed conversions than all other treatments. MP significantly reduced oocyst production at d 28. Data from Trial 4 indicated that MP was statistically equivalent to salinomycin in performance variables at d 35 and 42, but provided significant reductions in OPG compared with salinomycin and the vaccine alone. Overall, these tests demonstrated that MP can complement the use of a live coccidiosis vaccine by providing significant improvements in feed conversion and significant reductions in number of oocysts shed during critical periods of the growth cycle.

**Key Words:** coccidiosis, triterpenoid saponin, anticoccidial effect, coccidia vaccination

# Metabolism and Nutrition: Feed Additives I

## 106 Relative availability of organic calcium for layer hens.

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To estimate the relative availability of calcium citrate 120 Hy-Line Brown layer hens of 40 wk of age placed in cages were fed one of the following diets: D1, low calcium (0.5% Ca), D2 and D4 both with medium calcium (2.16% Ca), and D3 and D5 both with the recommended calcium level (3.82% Ca). Diets D2 and D3 were supplemented with calcium carbonate whereas D4 and D5 with calcium citrate. D1 contained no calcium carbonate nor citrate. All diets were formulated to contain 2800 kcal/kg EM and 14.6% crude protein. Experimental diets were assigned to cages under a Completely Randomized Design with 5 treatments and 4 replications each. Production rate, feed intake, feed conversion ratio, egg mass and specific gravity, shell weight and density, Haugh units and tibia ash content were evaluated within a period of 4 wk. Data were processed and regression curves obtained having the amount of calcium intake as the independent variable. All the variables were tested to determine linear trends with SAS software. Curves were adjusted to a common intercept and the relative availability was estimated as the relation of the slopes of the linear regression curves obtained for both additives. Values ranging from 103 to 119% for performance and from 83 to 98% for egg quality were found. The results show an interesting opportunity for the use of calcium citrate as a feed additive to improve performance in specific situations.

**Key Words:** calcium citrate, relative availability, regression, organic calcium, egg quality

## 107 Effect of organic calcium on egg production and quality.

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Three experiments were conducted with 96 Hy-Line Brown layer hens each over 35 wk of age to evaluate the effect of calcium citrate (CIT) on performance and egg quality. All the diets were formulated according to the genetic line nutritional recommendations with the exception of calcium due to the treatments. In Experiment 1, the effect of 3 products, claiming to have different solubility (H, high; M, moderate; L, low), was tested against calcium carbonate (CAR) on performance on a Completely Randomized Design with 4 treatments and 4 replications each (T1, CAR; T2, CIT-H; T3, CIT-M, T4, CIT-L). Experiment 2 was designed to estimate, by regression, the effect of CIT-H on performance and egg quality on a same-calcium-intake basis: T5, standard diet supplemented with CAR; T6 to T8, diets with different calcium and CIT-H contents but with no CAR. Experiment 3 was designed to determine the correlation coefficient of egg yolk pigmentation to dietary CIT-H intake under a Completely Randomized Design with 4 treatment diets supplemented with CIT-H and/or CAR: T9, 100% CAR; T10, 1/3 CAR replaced by CIT-H; T11, 2/3 CAR replaced by CIT-H; T12, 100% CIT-H. Data were processed with SAS and GraphPad software. In Experiment 1 a negative effect ( $P < 0.05$ ) was shown on egg production rate among CIT treatments due to differences in feed intake associated to CIT-H. In Experiment 2 better performance ( $P < 0.05$ ; egg production rate, egg mass, feed conversion ratio) was found for CIT-H supplemented hens on a same-calcium-intake basis; however, a negative effect ( $P < 0.05$ )

was also found on egg quality. In Experiment 3 a significant ( $P < 0.05$ ) negative correlation was found between CIT-H intake and egg yolk pigmentation. In conclusion, CIT presents a positive effect on laying performance but also a negative effect on egg quality and pigmentation associated to CIT-H.

**Key Words:** calcium citrate, egg quality, organic calcium, regression, egg pigmentation

## 108 Yolk and albumen chemical composition and weight of components of eggs laid by broiler breeders supplemented with conjugated linoleic acid.

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We aimed to evaluate the egg, albumen, yolk and shell weights and the chemical composition of eggs laid by broiler breeders supplemented with CLA. Two 58 wk old broiler breeder commercial flocks, Cobb 500, were fed a commercial diet; however, one of them was supplemented with 0.025% of CLA. After 26 d of supplementation, 30 eggs per flock were selected for evaluation of the weight of its components and determination of the chemical composition of yolk and albumen. The eggs, shells, yolks and albumens were weighted before yolks and albumens were grouped into 6 pools of 5 units each, to determine the percentage of dry matter, and percentages of mineral matter, ether extract and crude protein, in the dry matter and in the natural matter. It was adopted a completely randomized design, consisting of 2 treatments with 30 replicates for weight evaluations, and 6 replicates for chemical evaluations. Data were submitted to ANOVA and F test to compare the means, through the R software. The egg, albumen and shell weights were not affected by the inclusion of CLA in the diet. However, breeder supplemented with CLA showed higher yolk weight ( $P < 0.009$ ) compared with control treatment. Breeders fed CLA produced eggs which albumens showed lower percentage of dry matter ( $P < 0.051$ ), lower percentage of protein in natural matter ( $P < 0.001$ ), higher percentage of mineral matter both in natural matter ( $P < 0.001$ ) and in the dry matter ( $P < 0.001$ ). Regarding the yolk, there was no effect of the treatments ( $P > 0.05$ ) on the evaluated variables. In conclusion, CLA can lead to the production of eggs with greater weight of yolk, without, however, changing its basic chemical composition. Although the albumen weight was not affected, there was a greater mineral deposition when the breeder were supplemented with CLA. More studies should be conducted to confirm possible changes in the yolk fatty acids profile, usually reported when CLA is added to the diet of layers or breeders.

**Acknowledgments:** CNPq, Asa Alimentos, BASF

**Key Words:** breeder metabolism, breeder nutrition, egg quality, omega-6, nutrient transfer

## 109 Association of symbiotic and nutritive gel with broiler performance.

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In this study, a symbiotic (PoultryStar, sol) supplementation on broiler performance associated with a nutritive gel in the hatchery were evaluated. 400 male neonate Cobb 500 chicks were fed in the hatchery and then transported to experimental facilities and allotted in battery cages, in 5 treatments and 8 replicates of 10 birds each. Treatments were: T1 – negative control; T2 – Gel in hatchery; T3 – Gel plus symbiotic in hatchery; T4 – Gel plus symbiotic in the hatchery and symbiotic in water in the battery; T5 – symbiotic in water in the battery. Symbiotic was offered during 3 d, before, on the first day and a day after diet change and once a week, so T4 received the symbiotic in the hatchery and d 2,3,7,10,11,12,14,22,23,24,28 (12 time points) and T5 at d 2,3,4,7,10,11,12,14,22,23,24,28 (12-time points). All groups remained in a 24 h period of fasting of feed and water as a stressing factor, after hatchery expedition. live weight, average weight gain, feed intake and feed conversion in the total period (1 to 42 d of age) were evaluated. Statistical analysis was performed using ANOVA and Tukey test applied for means comparison using Software R. significant differences were obtained for final weight at 42 d of age. Broilers from negative control presented lower live weight compared with the group supplemented with the nutritive gel product in the hatchery. The early supplementation of nutritive gel and symbiotic can stimulate the beneficial microbiota and contribute to start the microbiota establishment and gastrointestinal development, which reflected in an improved performance. Thus, the symbiotic tested increased broiler performance.

**Acknowledgments:** Asa Alimentos, Biomin, CNPq

**Key Words:** broiler, nutritive gel, performance, symbiotic

**110 Betaine as a functional ingredient in post-eclosion and pre-starter diets.** Fabyola B. Carvalho<sup>1</sup>, Roberto M. Jardim Filho<sup>1</sup>, Lucas G. Goncalves<sup>1,2</sup>, Marcos B. Cafe<sup>1,2</sup>, and Jose H. Stringhini<sup>1,2,3</sup>, <sup>1</sup>Universidade Federal de Goiás, Goiânia, Goiás, Brazil, <sup>2</sup>Sao Salvador Alimentos, Itaberai, GO, Brazil, <sup>3</sup>CNPq, Goiânia, Goiás, Brazil.

Just after eclosion, the transition period between embryonic life and the intake of exogenous diet submits the neonate chick to both hydric and nutritional stress, which may impact performance. In this transition period, betaine can be useful for it acts as a methyl donor and an osmoregulation agent. This experiment was carried out to evaluate the adequate dosis of betaine in post-eclosion and pre-starter diets for broiler chicks. 250 d-old Cobb-500 chicks were allotted in a completely randomized design in transportation boxes. After 24 h, chicks were transferred to heated batteries. Five levels of betaine, 0.00, 0.07, 0.13, 0.20, and 0.26%, in 1.8 mm pelleted diets were evaluated. Three gram per chick were offered in transportation boxes and ad libitum in batteries until 7 d of age. Data obtained were statistically analyzed using ANOVA. For betaine supplementation, a polynomial regression analysis was applied. After 24 h, intake was low, probably because of pellet diameter, which was not adequate to this phase, resulting in an average weight reduction of 2.52 g for chicks of all treatments ( $P > 0.10$ ). Treatments did not affect the vitelline sac retraction ( $P > 0.10$ ), but they interfered linearly and positively with ileum crypt depth ( $Y = 32.6342 + 0.0401451X$ ,  $R^2 = 0.85$ ). Chick's weight at 7 d increased ( $P = 0.091$ ) up to 0.129% due to betaine addition ( $Y = 187.131 + 0.0910690X - 0.350668x^2$ ,  $R^2 = 0.97$ ). A quadratic effect was observed ( $P = 0.04$ ) for feed intake, which augmented up to 0.152% with betaine increase ( $Y = 187.131 + 0.0910690X - 0.350668x^2$ ,  $R^2 = 0.97$ ). Betaine supplementation also affected ( $P = 0.079$ ) jejunum villi height ( $Y = 303.754 - 0.457143X + 2.39011X^2$ ,  $R^2 = 0.65$ ), with a minimum height of 0.095%. Villus: crypt ratio of jejunum reduced quadratically ( $P = 0.049$ ) up to 0.09% ( $Y = 5.20261 - 0.0074454X + 0.00425619X^2$ ,  $P = 0.087\%$ ,  $R^2 = 0.74$ ). In conclusion, the supplementation of 0.13% betaine in pre-

starter diets increased chick's weight at 7 d of age, and supplementation values above 0.1% can increment the development of intestinal villus of chicks at pre-starter phase.

**Acknowledgments:** Sao Salvador Alimentos, CNPq, BTEch

**Key Words:** transportation box, transition period, vitelline sac, villi development

**111 Meta-analysis of effect of canthaxanthin on the quality production of broiler breeds and laying hens.** Angélica Londero\*, Alexandre Pires Rosa, Anelcir Scher, Camila Borba Santos Giacomini, Carlos Eduardo Bonilla Vivas, Daniele Pozzebon Rosa, Mariane de Oliveira Fernandes, and Luciana Potter, *Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil.*

The aim of this study was to evaluate, by meta-analysis, the effect of canthaxanthin in diets of broiler breeders and layers on production and quality of eggs. For this purpose were examined data of researches conducted between the years 2008 to 2015 of the Poultry Laboratory of the Federal University of Santa Maria (UFSM). The experiments involved 1292 hens, totaling 844 broiler breeders (Cobb 500) and 448 laying hens (Isa Brown and Novogen). Broiler breeders were placed in an open-sided house, divided into pens consist of 6 nests. Each pen was equipped with an automatic drinker, one tube feeders to females, and a trough-type feeder to the roosters. Laying hens were placed in experimental facilities equipped with metal cages with Nipple drinker and feeder. All data were derived from hens feed with corn and soybean meal, and adding 6mg/kg canthaxanthin (CAROPHYLL Red 10%, DSM Nutritional Products). Variables analyzed were: egg production (EP), egg yolk, albumen and shell weight, egg specific gravity (SG) and yolk color. Data were evaluated weekly to 3 eggs by replicate coming from broiler breeders and laying hens. Variables analyzed to egg incubation in the experiments that involved broiler breeders were hatchability of fertile eggs (HF), hatchability of total eggs (HT) and fertility of eggs (F). Data were subjected to proc mixed and means compared a level of 5% significance. Statistical procedures were performed using the SAS software. Broiler breeders and laying hens fed with diets supplemented with canthaxanthin showed highest EP ( $P = 0.0003$ ). Egg weight ( $P = 0.6923$ ), yolk ( $P = 0.7878$ ), albumen ( $P = 0.3317$ ) and shell weight ( $P = 0.3317$ ) did not differ between treatments. The SG was highest in eggs of hens fed without the supplementation of canthaxanthin in the diet ( $P = 0.0099$ ). Egg yolk color was highest in eggs from hens fed with canthaxanthin in the diet ( $P < 0.0001$ ). The HF, HT and F were highest in eggs from hens fed with 6mg/kg of canthaxanthin in the diet ( $P < 0.0001$ ). The addition of canthaxanthin in broiler breeders and layers showed a positive effect on production and egg quality.

**Key Words:** feed additive, egg production, yolk color, hatchability, fertility

**112 Internal egg quality from laying hens fed corn-based diet with the addition of canthaxanthin.** Daniele P. Rosa\*<sup>1</sup>, Alexandre P. Rosa<sup>1</sup>, Angélica Londero<sup>1</sup>, Catiane Orso<sup>1</sup>, Mariane O. Fernandes<sup>1</sup>, and José F. Miranda<sup>1</sup>, <sup>1</sup>Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil, <sup>2</sup>DSM Nutritional Products, São Paulo, SP, Brazil.

The aim of this study was to evaluate the effects of canthaxanthin on corn-based diets and its effects on hens' internal egg quality. It was used 320 ISA Brown hens from 20 to 48 wk of age, distributed in a completely randomized design with 2 treatments, 10 replicates of 16 birds each one. Treatments were: NC negative control diet and CTX

diet with the addition of 6mg/kg canthaxanthin (Carophyll Red 10%, DSM Nutritional Products). The parameters analyzed were: Haugh unit (HU), yolk index (YI), egg weight (EW), yolk and albumen percentage (%Y and %A), mg of total carotenoids/kg of yolk (C), yolk color (YC), vitelline membrane resistance (VMR) and lipid oxidation (TBARS). To determine internal quality 3 eggs were selected per repetition according to EW (within an interval for variance of 2.5%). To determine yolk carotenoids concentration a kit containing a portable photometer iCheck was used. Data were submitted to ANOVA ( $P < 0.10$ ). Statistical procedures were performed using SAS software. Canthaxanthin supplementation presented higher C in yolk (23.43) ( $P < 0.001$ ), HU (90.79) ( $P = 0.10$ ) and YC (12.6) ( $P < 0.001$ ), compared with NC (14.72, 89.79 and 5.7). No differences were observed between treatments for EW, %Y, %A, YI, VMR and TBARS ( $P > 0.10$ ). Canthaxanthin supplementation in corn-based diets is beneficial to the improvement of some internal quality parameters of eggs, such as concentration of carotenoids in yolk, Haugh unit and Yolk index.

**Key Words:** corn, carotenoid, vitelline membrane, lipid oxidation

**113 Effects of corn-based diets supplemented with canthaxanthin on performance and egg quality of laying hen.** Daniele P. Rosa<sup>\*1</sup>, Alexandre P. Rosa<sup>1</sup>, Angélica Londero<sup>1</sup>, Mariane O. Fernandes<sup>1</sup>, Catiane Orso<sup>1</sup>, Adrian S. Ertmann<sup>1</sup>, Alexandre B. Mariani<sup>1</sup>, and José F. Miranda<sup>2</sup>, <sup>1</sup>Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil, <sup>2</sup>DSM Nutritional Products, São Paulo, SP, Brazil.

The aim of this study was to evaluate the effects of corn-based diets, with or without the addition of canthaxanthin, on the productive and qualitative parameters of laying hen eggs. It was used 320 Isa Brown hens (20 to 48 wk of age) in a completely randomized design with 2 treatments, 10 replicates of 16 birds each one. Treatments were: a Negative Control (NC) and other it the addition of 6mg/kg canthaxanthin (CTX, Carophyll Red 10%, DSM Nutritional Products). Performance was evaluated considering the productive parameters: laying rate (LR), body weight (BW), daily feed intake (DFI), feed conversion per dozen eggs (FCR/DZ), feed conversion per egg mass (FCR/EM), egg weight (EW) and egg mass (EM). Egg qualitative parameters were: yolk color (YC), specific gravity (SG) and albumen pH (pH). YolkFan DSM was used to measure egg yolk color in a 1 to 15 scale, 1 – light yellow and 15 – dark orange. Data were submitted to ANOVA ( $P < 0.10$ ). Statistical procedures were performed using SAS software. Birds fed CTX diet showed better results for LR (88.21%) ( $P = 0.0205$ ) and higher BW (1703g) ( $P = 0.0634$ ) than NC diet (84,82% and 1669g). Canthaxanthin supplementation also increased YC (12.6) ( $P < 0.0001$ ), presented better EM (22.23 kg) ( $P = 0.0679$ ) and FCR/DZ (1.39) ( $P = 0.1004$ ) compared with NC. DFI, FCR/EM, EW, SG and pH did not showed differences between treatments ( $P > 0.10$ ). Canthaxanthin supplementation improved laying rate, yolk pigmentation, egg mass and feed conversion rate per dozen eggs.

**Key Words:** feed additive, carotenoid, laying rate, egg yolk

**114 Performance of broilers fed with canthaxanthin and 25-hydroxycholecalciferol.** Douglas V. Bonamigo<sup>\*1</sup>, Alexandre P. Rosa<sup>1</sup>, Catiane Orso<sup>1</sup>, Mariane O. Fernandes<sup>1</sup>, Pedro S. Feltrin<sup>1</sup>, Ana C. Cougo<sup>1</sup>, Rafael Hermes<sup>2</sup>, and José F. Miranda<sup>2</sup>, <sup>1</sup>Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil, <sup>2</sup>DSM Nutritional Products, São Paulo, São Paulo, Brazil.

The purpose of this study was to evaluate the effect of MaxiChick and its active ingredients, canthaxanthin combined with 25-hydroxycholecalciferol (25-OH-D3) in broilers feed. Two experiments were made to evaluate the effects on male and female chicks: 1500 and 1680 male and female one-day old Cobb-500 broilers were used, distributed in a completely randomized design, with 2 treatments of 15 replicates of 50 birds each for male chicks and 56 birds each for female chicks. Male broilers were raised during 42 d and female broilers during 43 d. Treatments were: T1: Control Diet and T2: Control Diet + 0.1% MaxiChick until 21 d of age. Parameters measured on a weekly basis were: weight gain (WG), feed consumption (FC) and feed conversion rate (FCR). At 42 d of age, 6 male broilers were selected, with an average weight by replicate, for further slaughter and measurement of cuts and carcass yield. Female broilers were evaluated at 28 d of age for carcass yield, and at 43 d of age for cuts and carcass yield. Six birds were selected by replicate, with the same average weight. Data were subjected to ANOVA. Male broilers fed with MaxiChick showed a significantly higher ( $P < 0.05$ ) BW at 14 and 21 d of age (551g vs 544g) (1072g vs 1055g) in respect of those fed with control diet. As far as female broilers, significant results ( $P < 0.05$ ) were found for breast yield at 43 d of age in those birds supplemented with MaxiChick (41.16% vs 40.44%). It is therefore concluded that the addition of the commercial product MaxiChick, based on Canthaxanthin and 25-hydroxycholecalciferol (25-OH-D3), has different effects on male and female birds, probably due to growth speed. In male chicks, benefits were found during the initial phase with better weight gain values until diet supplementation; whereas in females, for the same period, there was a significant contribution for breast yield at 43 d of age.

**Key Words:** vitamin D, feed conversion rate, weight gain, nutrition, carcass yield.

**115 Effect of supplementation of Vitamin E on productive parameters of laying hens.** Mariane O. Fernandes<sup>\*</sup>, Alexandre P. Rosa, Angélica Londero, Daniele P. Rosa, Catiane Orso, Alexandre B. Mariani, Adrian S. Ertmann, Janaina S. Moura, and Lourdes B. Brittes, Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil.

The objective of this study was to evaluate the effect of supplementation of Vitamin E on productive parameters of laying hens. The experiment was carried out at Poultry Science Laboratory of the Federal University of Santa Maria, with 128 laying hens of Novogen Brown lineage (40 to 55 wk of age). A completely randomized design was used with 2 treatments, 8 replicates of 8 laying hens each. The treatments were: DC, negative control diet; and DVitE, diet with addition of 200 mg/kg of vitamin E (acetate dl- $\alpha$ -tocopherol). The parameters evaluated were laying rate (LR), body weight (BW), daily feed intake (DFI), feed conversion per dozen eggs (FCR/DZ), feed conversion per egg mass (FCR/EM), egg weight (EW) and egg mass (EM). The laying rate and egg weight were calculated weekly for each replicate. All variables were performed at the end of each period (28 d). All data were subject to ANOVA (ANOVA) using the SAS statistical program. Laying hens fed with DVitE showed better results for LR ( $P = 0.0309$ ), EM ( $P = 0.0378$ ), FCR/DZ ( $P = 0.0289$ ) and FCR/EM ( $P = 0.0878$ ). The variables DFI, BW and EW showed no differences among the treatments ( $P > 0.10$ ). Supplementation of Vitamin E provides a positive effect on egg production, egg mass, conversion per dozen and egg mass, demonstrating to be an excellent additive used in diets of laying hens.

**Key Words:** feed additive, production performance, feed conversion, laying hen

**116 Effects of functional oil supplementation on hatchability and embryo mortality.** Jean Paulo Contini, Anete Rorig, Luis Miguel Fullber, Fernanda Kaiser de Lima\*, Daiane Horn, Joice Meri Schmidt, and Jovanir Inês Muller Fernandes, *Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil.*

The intensification of poultry production has led to the use of antibiotics to maintain production levels. However, antibiotics have been banned by many countries. Phytogetic additives may be an alternative to replace these products due to their anti-inflammatory and antioxidant activities, and to their modulating effects on the intestinal microbiota. The aim of this trial was to evaluate how the supplementation of functional oils in breeder diets affected hatchability and embryo mortality. A total of 16,400 females and 1,722 males Ross AP 95 were evenly divided and placed in 2 similar breeder houses. The treatments consisted of commercial feed + antibiotic growth promoter (bacitracin methylene disalicylate; BMD) or commercial feed + functional oils (essential, Oligo Basics Agroind Ltda; active ingredients: cashew nut shell liquid and castor oil). Diets were supplemented from the 26th to the 46th week of the breeders' life. Every 4 wk (26th, 30th, 34th, 38th, 42th, and 46th), 5,040 eggs/treatment were collected/treatment and hatched in single-stage incubators. The eggs were divided into 30 floors (168 eggs/floor) in one incubation trolley per treatment and assessed for hatchability, chick weight, and embryo diagnosis (mortality from 0 to 3, 4 to 10, 11 to 17, and 18 to 21 d, and alive pipped eggs). Data were analyzed by logistic regression, using the SAS GENMODE procedure with 2 treatments and 30 replicates (floor of the incubation trolley) of 168 birds each. As expected, all variables behaved quadratically ( $P < 0.05$ ) as they followed the production curve of the breeders. However, at 26, 30 and 46 wk, hatchability was increased ( $P < 0.05$ ) when functional oils were supplemented. Also, at 26, 30, 38, and 46 wk, chick weight was lower ( $P < 0.05$ ) for the functional oil treatment. Finally, functional oil supplementation resulted in lower mortality ( $P < 0.05$ ) from 0 to 3 d at wk 46 and alive pipped eggs at wk 26. In conclusion, the use of functional oils as additives in broiler breeder diets may be an effective strategy in maintaining productive and reproductive levels.

**Key Words:** phytogetic additive, growth enhancer, microbiota, hatching, breeder diet

**117 Effects of functional oil supplementation on broiler breeder fertility and yolk lipid peroxidation.** Jean Paulo Contini, Joice Meri Schmidt\*, Mauricio Canevese, Anete Rorig, Alexandra Maria da Silva, Adrieli Braga de Cristo, and Jovanir Inês Muller Fernandes, *Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil.*

Phytogetic additives can play important roles in avian reproduction by maintaining antioxidant defenses in spermatozoa and embryonic tissues. The aim of this trial was to evaluate the effects of functional oils in breeder diets on fertility and on lipid peroxidation of the yolk. A total of 16,400 females and 1,722 males Ross AP 95 were evenly divided and placed in 2 similar breeder houses. The treatments consisted of commercial feed + antibiotic growth promoter (bacitracin methylene disalicylate; BMD) or commercial feed + functional oils (Essential, Oligo Basics Ltda.; active ingredients: cashew nut shell liquid and castor oil). Diets were supplemented from the 26th to the 46th week of the breeder's life. Every 4 wk, 5,040 eggs/treatment were collected and incubated for fertility assessment. Every 8 wk a sample of 45 eggs/treatment was collected to determine lipid oxidation. The amounts of 2-thiobarbituric acid reactive substances (TBARS) were expressed as mg malondialdehyde (MDA) per kg yolk. Data were analyzed by logit regression, using the procedure GENMODE. Functional oils improved fertility ( $P < 0.05$ )

at wk 38 (98.41%) and 46 (96.90%) compared with AGP (96.32 and 94.52%, respectively). At the end of the trial, functional oils increased the fertility in about 1%. Also, whereas the concentration of MDA in eggs from birds supplemented with functional oils decreased linearly during the experiment, a quadratic effect ( $P < 0.05$ ) was observed for birds supplemented with AGP, where MDA concentration decreased from wk 25 to 33, and increased from wk 41 to 46. Oxidative stress has been attributed to affect the fertility and physiology of spermatozoa. In avian species, the female stores the sperm in tubules, which contain antioxidant enzymes to minimize damage due to lipid peroxidation and maintain sperm membrane integrity. A large proportion of the sperm membrane is composed of polyunsaturated fatty acids that are highly susceptible to oxidative damage. In conclusion, the supplementation of functional oils decreased the lipid oxidation of the yolk and improved fertility parameters.

**Key Words:** sperm storage tubule, oxidative stress, egg, PUFA

**118 Effects of a commercial blend of cashew nut shell liquid and castor oil or monensin on the growth performance of broilers challenged with *Eimeria* spp.** Priscila O. Moraes\*<sup>1</sup>, Rodrigo Borille<sup>2</sup>, Fernanda L. Gouvêa<sup>1</sup>, Bruna Schroeder<sup>1</sup>, Lucas Vilella<sup>1</sup>, and Andréa M. L. Ribeiro<sup>1</sup>, <sup>1</sup>*Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil*, <sup>2</sup>*Universidade Federal da Grande Dourados, Dourados, MS, Brazil.*

The objective of this study was to evaluate whether a commercial mixture of cashew nut shell liquid and castor oil (essential, Oligo Basics Agroind Ltd., Cascavel, Brazil) would produce results similar to those of monensin in chickens inoculated with coccidiosis. A total of 864 one-day-old male chicks (Cobb) were randomly assigned to 6 treatments (8 pens/treatment and 18 birds/pen) in a 3 × 2 factorial design with 3 additives: control (no additive), 100 ppm of monensin, and 0.15% of Essential; and 2 challenge levels at 14 d of age: no challenge and inoculation by gavage of 1 mL of a solution containing sporulated oocysts of *Eimeria tenella* ( $10 \times 10^3$ ), *Eimeria acervulina* ( $200 \times 10^3$ ), and *Eimeria máxima* ( $80 \times 10^3$ ). Data were analyzed using PROC GLM (SAS 9.2) by ANOVA. The statistical model included the effects of additives and challenge and their interactions in the analysis of all variables. Treatments did affect live weight (LW), average daily feed intake (ADFI), average daily gain (ADG) and feed conversion rate (FCR) during the pre-challenge period. Coccidiosis inoculation negatively affected ( $P < 0.05$ ) performance parameters in all treatments. Challenged birds supplemented with monensin showed higher LW, ADG, ADFI and better FCR ( $P < 0.05$ ) than the other 2 treatments, 1 wk post inoculation. However, 2 wk post inoculation, birds supplemented with Essential showed higher ADG and better FCR than control or monensin supplemented birds ( $P < 0.05$ ), which resulted in similar LW for monensin and Essential birds, and lower LW for control birds ( $P < 0.05$ ) at 35 d of age. Overall, whereas the performance of unchallenged birds was not influenced by treatment, the performance of chickens challenged with coccidiosis and supplemented with monensin or Essential was better than that of control birds at 42 d of age. Thus, Essential improved the performance of broilers infected with coccidia from the second week on after infection, keeping the performance at 42 d of age similar to that of monensin.

**Key Words:** coccidiosis, monensin, castor oil, cashew nut shell liquid, health challenge

**119 Digestibility of nutrients of growing broilers fed diets containing yerba mate (*Ilex paraguariensis*) extract.** Dannielle Leonardi Migotto\*<sup>1</sup>, Aline Mondini Calil Racanici<sup>1</sup>, José Fernando

Machado Menten<sup>2</sup>, Maicon Sbardella<sup>2</sup>, and Daniel Rodrigues Cardoso<sup>3</sup>, <sup>1</sup>University of Brasilia, Brasilia, Distrito Federal, Brazil, <sup>2</sup>Escola Superior de Agronomia Luiz de Queiroz (ESALQ), University of São Paulo, Piracicaba, São Paulo, Brazil, <sup>3</sup>University of São Paulo, São Carlos, São Paulo, Brazil.

Yerba mate (*Ilex paraguayensis*) is a plant commonly used in several South American countries to prepare a beverage through an aqueous infusion of dried leaves and stems. This beverage is known for its bitter taste and diuretic, besides choleric, hypocholesterolemic, anti-inflammatory, and stimulant properties in humans (Schinella et al., 2000, Filip et al., 2001). The main objective of this study was to assess the effects of the addition of lyophilized extracts of yerba mate in broilers diets on nutrient digestibility. The metabolism trial was conducted using 90 one-day-old female Cobb 500 broiler chicks distributed in 15 cages (6 birds per cage) in a randomized design with 3 treatments and 5 repetitions. The broiler chicks were fed ad libitum diets formulated to achieve nutritional requirements according to Rostagno et al. (2011) until 17 d of age with the addition 0; 250 and 750 mg of lyophilized extract of yerba mate /kg. The method of total excreta collection was applied during 5 consecutive days (from 12 to 17 d of age) after 4 d of adaptation period. The addition of yerba mate extracts did not improve ( $P > 0.05$ ) the results of AME and AMEn, digestibility of dry matter (DDM), crude protein (DCP), ether extract (DEE) and crude energy (DCE). In conclusion, the addition of yerba mate extract to broilers diets did not result in increasing nutrient metabolism.

**Acknowledgments:** The ESALQ, University of São Paulo, Piracicaba, SP, Brazil, and University of São Paulo, São Carlos, SP, Brazil.

**Key Words:** plant extract, natural additive, stimulant property, metabolism coefficient.

**120 Evaluation of an emulsifier in broiler diet.** B. G. S. Leite<sup>\*1</sup>, M. A. Bonato<sup>2</sup>, R. L. C. Barbalho<sup>2</sup>, F. A. Roque<sup>1</sup>, L. V. Sanfelice<sup>3</sup>, and L. F. Araújo<sup>1</sup>, <sup>1</sup>University of São Paulo, Pirassununga, SP, Brazil, <sup>2</sup>ICC Industrial Trade Import Export Ltd., São Paulo, SP, Brazil, <sup>3</sup>Faculty of Anhanguera Leme, Leme, SP, Brazil.

The objective of this current study was to evaluate the performance of broilers 1–42 d fed with or without inclusion of emulsifier. It was used 1200 male broilers Cobb 500 in a completely randomized design in a  $2 \times 2 \times 2$  factorial (2 sources of oil – acidulated soybean oil soapstock and soybean oil; 2 energy levels – reduction of 80 and 100 kcal; inclusion of emulsifier or not) + a basal diet with acidulated soybean oil soapstock and a basal diet with soybean oil. A total of 10 treatments with 10 replicates of 12 birds each were studied. Basal diets were formulated to contain corn and soybean meal. For performance was evaluated: body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR). The data analyzed were using the Tukey test at 5% significance. There was no significant difference for FI from 1 to 42 d. However, the acidulated soybean oil soapstock with reduction of 80kcal for energy and emulsifier inclusion had a better BWG ( $P \leq 0.001$ ) and the acidulated soybean oil soapstock with reduction of 100 kcal for energy and emulsifier inclusion had inferior FCR ( $P \leq 0.001$ ). Analyzing the contrast between the treatments, it was observed that there was no significant effect between the responses for the control group and the birds of the treatment with acidulated soybean oil soapstock with reduction of 80 kcal for energy and emulsifier inclusion. Overall, the supplementation of acidulated soybean oil soapstock with reduction of 80 kcal for energy and emulsifier inclusion did not affect the performance. However, birds fed acidulated soybean oil soapstock with reduction of 100 kcal for energy and emulsifier inclusion had a negative effect on performance.

**Key Words:** acidulated soybean oil soapstock, energy reduction, performance, soybean oil

## Metabolism and Nutrition: Feed Additives II

**121 Performance and organs yield of broilers fed with diets supplemented with different levels of protected zinc.** Rafael Araújo Nascimento\*<sup>1</sup>, Brunna Garcia de Souza Leite<sup>1</sup>, Fabricia de Arruda Roque<sup>1</sup>, Lívia Maria Soares Queiroz<sup>1</sup>, Priscila Spinola Zorzetto<sup>1</sup>, Maria Fernanda de Castro Burbarelli<sup>1</sup>, Fernando Toledano<sup>2</sup>, and Lúcio Francelino Araújo<sup>1</sup>, <sup>1</sup>University of São Paulo, São Paulo, São Paulo, Brazil, <sup>2</sup>Biosen, Salto, São Paulo, Brazil.

A study was conducted to evaluate the performance and relative organs weight of broilers from one to 21 d-old, fed with diets supplemented with levels of zinc protected (Zn). Therefore, we used 210 chicks 1-d, Cobb 500, from a local commercial hatchery, distributed in 3 treatments: C) control diet, adequate nutritional levels, following the recommendations of Rostagno et al. (2011), without addition of antibiotic and anticoccidial; C + 0.03%) control diet plus 0.03% of protected Zn; C + 0.05%) control diet plus 0.05% of protected Zn; distributed in a completely randomized design with 10 replicates per treatment and 7 animals by repetition, housed in cages for metabolic assay. Data were analyzed as the homogeneity of variances and as residual normality and when did not meet these assumptions were logarithmic transformed. Variance analysis was performed using the GLM procedure of SAS 9.2 and when significant the Tukey test was performed for the medium. It was used significance level at 5%. To obtain performance data, animals weigh and food leftover were analyzed on d 21 using a digital balance ( $e = 0.002$ ). For evaluating yield of gizzards and intestines, 2 birds from each treatment were randomly selected, individually weighed and euthanized by cervical dislocation, intestine (duodenum to colon) and gizzard were collected and weighed separately. There was no significant difference for feed intake ( $P = 0.599$ ) and feed conversion ( $P = 0.137$ ), but the birds fed with diets supplemented with 0.05% protected Zn showed higher weight gain ( $P = 0.041$ ). There was no significant difference ( $P < 0.05$ ) for body weight values ( $P = 0.110$ ) and intestine yield ( $P = 0.483$ ) as well as for weight gain ( $P = 0.773$ ) and yield of gizzard ( $P = 0.340$ ). The addition of 0.05% Zn in broiler diets improves animals weight gain without affecting feed intake and feed conversion.

**Key Words:** gizzard yield, growth promoter, intestinal yield, poultry, weight

**122 Yerba mate (*Ilex paraguariensis*) in broiler diets.** Kelly C. Nunes\*<sup>1</sup>, Alice E. Murakami<sup>1</sup>, Márcia I. Sakamoto<sup>2</sup>, Iván C. Ospina-Rojas<sup>1</sup>, Mirian G. Santos<sup>1</sup>, and Caio H. Souza<sup>1</sup>, <sup>1</sup>Universidade Estadual de Maringá, Maringá, Paraná, Brazil, <sup>2</sup>Universidade Camilo Castelo Branco, Descalvado, São Paulo, Brazil.

Yerba mate is a tea known to have beneficial effects on human health due to its antioxidant properties, as it contains flavonoids and phenolic compounds. The objective of this study was to evaluate the dietary addition of yerba mate, in powder form, on performance, carcass yield and meat quality of broilers from 1 to 42 d old. A total of 690 1-d-old Cobb 500 male broiler chickens were distributed in a completely randomized design with 5 treatments (0, 0.15, 0.30, 0.45, and 0.60% of yerba mate) and 6 replicates of 23 birds each. All data were analyzed using the PROC GLM of SAS software. A linear decrease ( $P < 0.05$ ) in the feed intake was observed as dietary concentration of yerba mate increased. Feed conversion improved linearly ( $P < 0.05$ ) with increased dietary levels of yerba mate. Weight gain was not affected ( $P > 0.05$ ) by the experimental diets. There was no effect ( $P > 0.05$ ) of dietary levels of yerba mate on the carcass and parts yields. The values of a\*, b\*, pH and

water-holding capacity in breast and thigh meats were not affected ( $P > 0.05$ ) by the treatments. However, by comparing the dietary levels of yerba mate with the control group, the brightness of the thigh (L\*) was higher ( $P < 0.05$ ) in birds fed 0.45% of yerba mate. Yerba mate addition in broiler diets can improve feed conversion without adverse effects on carcass yield or meat quality of broiler chickens from 1 to 42 d old.

**Key Words:** antioxidant, broiler performance, meat quality, phenolic compound

**123 Supplementation of green tea in laying Japanese quail diets.** Alceu K. Hirata\*, Alice E. Murakami, Ivan C. Ospina-Rojas, Mayra D. Vargas, Humberto M. Lipori, and Caio H. Souza, *Universidade Estadual de Maringá, Maringá, Paraná, Brazil.*

Polyphenols and flavonoids, are substances with high potential antioxidant in its chemical composition and are present in many plants, such as green tea. They can act in the oxidation-reduction of lipids and fight the free radicals produced by the body. The objective of this study was to evaluate the supplementation of green tea in the diet of laying quails on performance and egg quality. A total of 180 Japanese quails (*Coturnix coturnix japonica*) were distributed in a completely randomized design with 5 dietary treatments (0, 0.15, 0.30, 0.45, and 0.60% green tea supplementation) and 6 replicates of 6 birds each. The productive performance characteristics evaluated were: egg production, feed intake and feed conversion (kg/kg and kg/dz). The quality of eggs was assessed using indices such as egg weight, Haugh unit, specific gravity, percentage and shell thickness. All data were analyzed using the GLM procedure of SAS software and evaluated by regression analyses. Statistical significance was established at  $P < 0.05$ . Egg production showed a quadratic effect ( $P < 0.05$ ) due to inclusion levels of green tea with a maximum production estimated at 0.31% of green tea. Feed conversion (kg/dz) improved linearly ( $P < 0.05$ ) with increased dietary levels of green tea. The egg shell was influenced by the inclusion of green tea with a decreasing linear effect ( $P < 0.05$ ) for the specific gravity, shell percentage and shell thickness. Dietary green tea supplementation can improve the feed conversion, but reduces egg shell quality of laying Japanese quail.

**Key Words:** additive, egg quality, green tea, laying Japanese quail, performance

**124 Guava residue extract as an antioxidant in broiler diets.** Raiana Almeida Noleto\*, Julyana Machado da Silva Martins, Janaina da Silva Moreira, Maria Izabel Amaral Souza, Mariana Alves Mesquita, and Nadja Suzana Mogyca Leandro, *Escola de Medicina Veterinária e Zootecnia, Campus Samambaia, Universidade Federal de Goiás, Goiânia, Goiás, Brazil.*

This study was conducted to evaluate the effects of inclusion of guava residue extract on parameters of pH, color and oxidative stability of broiler meat. A total of 600 male Cobb 500 chicks were placed in 25 pen in a completely randomized design with 5 treatments and 5 replicates of 24 chickens each. Treatments were: 1) basal diet (control group); 2) 200 mg/kg of vitamin E; 3) 1,000 mg/kg of guava residue extract; 4) 1,300 mg/kg of guava residue extract; 5) 1,600 mg/kg of guava residue extract. At 42 d of age, 2 broilers from each repetition (10 chicks/treatment) were slaughtered. Breast meat and thigh + drumstick were collected to determine pH, color and oxidative stability. After meat



processing, samples were stored at 4°C for 24 h and pH and meat color were measured. Oxidative stability was determined by thiobarbituric acid reactive substances (TBARS) after 60 d of storage at -20°C. Data were analyzed with ANOVA and means compared by Tukey's test (5%). Breast meat and thigh + drumstick pH were affected by treatments ( $P < 0.05$ ). It was observed that thigh + drumstick from control group had higher pH than groups that were supplemented with vitamin E and 1,600 mg of guava residue extract. It was observed significant differences ( $P < 0.05$ ) for breast meat pH, which the broilers that received vitamin E had lower pH compared with broilers that received 1,300 mg or 1,600 mg of guava residue extract. Meat color was not affected by treatments ( $P > 0.05$ ). There were significant effects ( $P < 0.05$ ) between TBARS values of thigh + drumstick at 60 d of storage, with higher values in the group that received 1,600 mg of guava residue extract and lower values in the group that was supplemented with 200 mg of vitamin E. TBARS values of breast meat were not affected by treatments ( $P > 0.05$ ). In conclusion, different levels of guava residue extract did not affect chicken meat color and lipid oxidation, however it changed the pH of thigh + drumstick.

**Key Words:** additive, colorimetry, oxidative stability, pH, *Psidium guajava*

**125 Evaluation of the effects of Varium on growth performance of broiler chickens.** Luiz Bier\*, San Ching, Sara Johnston, Fang Chi, and Ron Cravens, *Amlan International, Chicago, IL, USA.*

We used 2,880 straight-run Cobb 500 chicks to evaluate the effects of 6 products in development on growth performance of broiler chickens. Birds were challenged by adding used litter from birds that were under a slight bacterial challenge to each pen on d 4. The trial was conducted at Virginia Diversified Research (Harrisonburg, VA, USA) as a randomized complete block with 12 pens/treatment and 30 birds/pen. Treatment means were separated by LSD with significance set at  $P < 0.05$ . Starter crumbles were fed from d 0 to 18 and grower and finisher pellets were supplied from d 18 to 32 and d 32 to 41, respectively. Treatments were 1) control (CON); 2) CON with bacitracin methylene disalicylate at 50 g/907 kg from 0 to 32 d and virginiamycin at 20 g/907 kg from d 32 to 41 (PCON); 3) CON + a phytogetic product and a fatty acid (PFA); 4) CON + yeast blend 1 (YB1); 5) CON + yeast blend 2 (YB2); 6) CON + yeast blend 3 (YB3); 7) CON + a clay/metal blend (CLM); and 8) CON + Varium. Varium is a blend of a processed calcium montmorillonite, a fermentable fiber, and an organic acid designed to improve gut health and shown to protect against biotoxins. The 41-d body weights of birds fed PCON or Varium were significantly heavier ( $P < 0.05$ ) than body weights of birds from all other treatments except PFA. The 0 to 41 d feed/gain of the PCON group was lower ( $P < 0.05$ ) than all groups except there was no difference between the PCON and products YB2 and Varium ( $P > 0.05$ ). Because of the challenge from the dirty litter added on d-4 mortality was high during this trial. Overall mortality was 8.63% for birds fed the PCON group, which was lower than the CON and PFA, CLM, or Varium ( $P < 0.05$ ). The 41-d data demonstrated the efficacy of the bacitracin methylene disalicylate/virginiamycin as it had the highest numerical pen weights and lowest numerical feed: gain. However, birds fed Varium had live weights and feed conversion at d-41 that were statistically ( $P > 0.05$ ) equal to the results shown by the PCON birds. Thus, broiler chickens raised under adverse conditions will benefit from the presence of Varium in their diets.

**Key Words:** antibiotic, broiler, Varium, feed conversion, growth

**126 Effects of *Baccharis dracunculifolia* extract on turnover and metabolism of broiler pectoral muscle.** Everton M. Muro\*, Lucas S. F. Lopes<sup>1</sup>, Antonio C. Pezzato<sup>1</sup>, Armando C. C. Neto<sup>1</sup>, Mayara R. Santana Eich<sup>1</sup>, and Paola G. Serpa<sup>2</sup>, <sup>1</sup>Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista, Botucatu, São Paulo, Brazil, <sup>2</sup>Instituto de Biociências, Universidade Estadual Paulista, Botucatu, São Paulo, Brazil.

Facing the prohibition of performance enhancer antibiotics in broiler chicken diets, there is a growing need for safe and natural substitutes that maintain both performance and animal health. Thus, this study aimed to evaluate the inclusion of *Baccharis dracunculifolia* hydro alcoholic extract in broiler diet as a substitute for PEA, and its effects, up to 21 d of age, on live weight, weight gain, weight of breast and breast mass gain, as well as pectoral muscle carbon turnover and the contribution of growth rate (k) and metabolic rate (m) to the isotopic turnover (k+m) of the same muscle. Were allotted 350 d-old male Cobb chicks, casually distributed in 3 treatments: control diet (CD) without PEA and *B. dracunculifolia* extract (BDE); CD+0.2% BDE, and CD+PEA. The data were analyzed by GLM procedure of SAS. The breast muscle was analyzed by isotope-ratio mass spectrometry and the breast weight was recorded, the data were plotted in OriginPro software and the turnover rate was derived in metabolic and growth rate. No differences ( $P > 0.05$ ) among the performance parameters analyzed were observed at 7 and 14 d of age, but, at 21 d, CD+PEA showed greater weight gain and body weight when compared with other treatments, whereas CD and CD+0.2% BDE did not differ. CD+PEA had the highest growth rate (k) and metabolic rate (m) when compared with CD; CD+0.2% BDE had the lowest growth rate (k), close to CD, but the metabolic rate (m) higher than CD+PEA, indicating excessive breast carbon mobilization without proper deposition. This results suggest irritant activity of the extract, and the breast, as the largest muscle in the chicken body, acts as a carbon deposit, from where the carbon is mobilized to damaged tissues or increased metabolic activity the results suggest irritant activity of the extract. The inclusion of BDE at a concentration of 0.2% did not improve the performance of broiler chickens, thus cannot be recommended as a substitute for performance enhancer antibiotics.

**Key Words:** muscle deposition, phytogetic, plant extract, poultry, stable isotope

**127 *Bacillus licheniformis*-based probiotic: a tool to prevent subclinical necrotic enteritis in broilers.** Alfred Blanch\*, Dorthe Sandvang<sup>1</sup>, Fernando Araujo<sup>2</sup>, Tina Styrisshave<sup>1</sup>, Mickaël Rouault<sup>1</sup>, and Joren Verbeke<sup>3</sup>, <sup>1</sup>Chr. Hansen A/S, Hørsholm, Denmark, <sup>2</sup>Chr. Hansen, Valinhos, Brazil, <sup>3</sup>Poulpharm, Izegem, Belgium.

Necrotic enteritis (NE) caused by *Clostridium perfringens* has become a grave economic problem in modern poultry production. The use of probiotic to prevent the NE lesions in poultry gut and reduce subsequent bird mortality has been suggested especially for antibiotic free broiler productions. Purpose of this study was to investigate the effect of *Bacillus licheniformis*-based probiotic on the pathogenesis of subclinical NE. Two identical studies were performed to assess the effect of a *Bacillus licheniformis* product (CH200/ DSM5749) on NE frequency and NE lesion scores in chickens. Male Ross 308 broilers were distributed in 3 treatment groups: UC: untreated control, AMOX: amoxicillin 20 mg amoxicillin/kg body weight and BL: *Bacillus licheniformis* 1.2E+06 cfu/g feed with 48 birds per group. On d 19 to 22, approximately 10E+9 cfu *C. perfringens* were orally administered 3 times per day to all birds. NE lesions were determined on d 24 to 26 (0-6 score). Frequency of NE and NE scores were analyzed using logistic and linear regression models, respectively. Statistical significance was assessed at  $P \leq 0.05$ .

Results show that this specific *B. licheniformis* product significantly decreases NE frequency in chickens and seems to reduce NE severity. NE lesion scores significantly differed between UC and AMOX in both trials and between UC and BL in the second trial, as shown in Table 1. Conclusion: Addition of this *Bacillus licheniformis* product in poultry

diets should be considered in antibiotic free broiler productions to prevent subclinical NE. This effect might be due to the immunological modulation, competitive exclusion and the intestinal morphology strengthening executed by this probiotic.

**Table 1.**

	NE <sup>1</sup> frequency (%)	NE frequency (%)	Mean NE lesion score	Mean NE lesion score
	Trial I	Trial II	Trial I	Trial II
UC	47	41	1.75	1.70
AMOX	0*	28	0.56*	1.27*
BL	19*	24*	1.22	1.25*

<sup>1</sup>NE = necrotic enteritis; UC = untreated control; AMOX = amoxicillin; BL = *Bacillus licheniformis*.

\*Marked figures represent treatment group statistical significant different from untreated control (UC);  $P \leq 0.05$ .

**Key Words:** broiler, necrotic enteritis, *Clostridium*, *Bacillus licheniformis*

**128 Yeast mannan oligosaccharide and/or nucleotides from different sources in broilers diet.** Melina A. Bonato<sup>\*1</sup>, John Schliefer<sup>2</sup>, Ricardo L. C. Barbalho<sup>1</sup>, Brett S. Lumpkins<sup>3</sup>, and Greg F. Mathis<sup>3</sup>, <sup>1</sup>ICC Industrial Comércio Exportação e Importação Ltd., São Paulo, SP, Brazil, <sup>2</sup>Quality Technology International Inc., Elgin, IL, USA, <sup>3</sup>Southern Poultry Research Inc., Athens, GA, USA.

This study evaluated the effects of supplementation of each of 4 yeast mannan oligosaccharide and/or nucleotide sources on broiler performance. For this, 3,000 one-day-old Cobb male chicks were distributed in a completely randomized block design, with 6 treatments and 10 blocks with 6 replicates (0.29 m<sup>2</sup>/bird). The treatments were: T1- Control diet (no additive supplemented); T2- Diet with Bacitracin Methylene Disalicylate [BMD] (55 g/MT from 0 to 42 d); T3- Diet with yeast cell wall from *Saccharomyces cerevisiae* (YCW - 0.5 kg/MT from 0 to 42 d); T4- Diet with yeast cell wall from *Saccharomyces cerevisiae* (MOS 1 - 0.5 kg/MT 1 from 0 to 42 d); T5- Diet with inactive yeast cells from *Pichia guilliermondii* (MOS 2 - 0.5 kg/MT from 0 to 42 d); T6- Diet with nucleotide source from *Saccharomyces cerevisiae* (YNU - 1 kg/MT from 0 to 14 d and 0.5 kg/MT from 14 to 42 d). Built-up litter was used. Study criteria included body weight gain (BWG, kg), feed intake (FI, kg), feed/gain ratio (FGR), and mortality rate (%) at 28 and 42 d. The data were analyzed using the SAS LSD test ( $P \leq 0.05$ ) to separate means when ANOVA F values are significant ( $P \leq 0.05$ ). The birds supplemented with BMD had greater FI (+5.2%) when compared with MOS 2 ( $P < 0.05$ ) at 28 d. For BWG, birds fed diets with BMD (+4.8%) and YCW (+4.0%) showed the best results when compared with MOS 2 ( $P < 0.05$ ). However, the birds treated with YNU had best FGR (-2.0%) compared with control ( $P < 0.05$ ) at 28 d. The treatments had no effect ( $P > 0.05$ ) on FI, BWG, or mortality rate at 42 d. However, diets supplemented with BMD (-2.1%) or MOS 2 (-2.8%) had improved ( $P < 0.05$ ) FGR compared with control birds whereas birds treated with YNU showed best FGR (-3.2%) when compared with control and MOS 1. In summary, this study demonstrated that broiler diets supplemented with BMD, MOS 2, or YNU significantly improved feed/gain ratio from 0 to 42 d on built-up litter compared with control diets.

**Acknowledgments:** Special thanks to researchers from Southern Poultry Research.

**Key Words:** bacitracin, prebiotic, *Saccharomyces cerevisiae*, performance

**129 Effect of partial replacement of methionine with betaine on performance of broiler chicken reared in high stock density.**

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This study evaluated the effect of different inclusions of betaine in partial replacement of methionine in diets for broilers reared in high stock density on performance from 1 to 42 d post-hatch. A total of 1,736 d-old male broiler chicks (Cobb) were distributed in a completely randomized design in a 4 × 2 factorial arrangement, 4 betaine inclusion levels and 2 stocking densities (13 and 18 birds/m<sup>2</sup>) with 7 replicate floor pens. Experimental diets were formulated into 4 phases according to age: 1 to 7 d, 8 to 21 d, 22 to 35 d and 36 to 42 d; however, betaine levels were similar in the 2 last phases. Dietary treatments consisted of: PC (positive control, meeting nutritional requirements; negative control (NC) diets were formulated to contain -20% digestible methionine. Different levels of betaine-HCl 95% were supplemented in NC diets: NC+B1 (DL-methionine 0.093; 0.069; 0.062; 0.065% + betaine 0.101; 0.090; 0.085; 0.080%); NC+B2 (DL-methionine 0.093; 0.069; 0.062; 0.065% + betaine 0.300; 0.200; 0.150; 0.150%) and NC+B3 (DL-methionine 0.093; 0.069; 0.062; 0.065% + betaine 0.450; 0.300; 0.225; 0.225%). Data were submitted to ANOVA and means were compared by Tukey test ( $P < 0.05$ ). Birds fed betaine supplemented diets (NC+B2 and NC+B3) replacing DL-methionine showed similar feed conversion ratio to PC. Lower betaine supplementation diets (NC+B1) replacing DL-methionine impaired feed conversion ratio in comparison with PC diets. Weight gain and feed intake were not affected by betaine nor stock density. These results suggest that in adequate amounts, betaine-HCl can replace DL-methionine without compromising broiler performance. High stock density impaired all performance parameters (weight gain, feed intake, feed conversion ratio and production efficiency index), suggesting that 18 birds/m<sup>2</sup> can impair broiler performance. Including 0.3% (1 to 7d); 0.2% (8 to 21d); 0.15% (22 to 35d) and 0.15% (36 to 42d) of betaine HCl in replacement to 20% of digestible methionine requirement did not impair broiler performance even under stress conditions by high stock density.

**Acknowledgments:** CNPq

**Key Words:** additive, methyl group, nutrition, osmoprotection, stress

**130 Silymarin as a liver protector for Japanese quail fed diets contaminated with aflatoxin.** Márcia I. Sakamoto<sup>\*1,2</sup>, Alice

E. Murakami<sup>1</sup>, Iván C. Ospina Rojas<sup>1</sup>, Kelly C. Nunes<sup>1</sup>, Alceu K. Hirata<sup>1</sup>, and Andrezza M. Fernandes<sup>3</sup>, <sup>1</sup>Universidade Estadual de Maringá, Maringá, Paraná, Brazil, <sup>2</sup>Universidade Camilo Castelo Branco, Descalvado, São Paulo, Brazil, <sup>3</sup>Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, Pirassununga, São Paulo, Brazil.

Aflatoxins may be present in corn-based animal feed and causes hepatotoxic and hepatocarcinogenic effects. Poultry are extremely sensitive to the toxic action of aflatoxins, resulting in large economic losses to producers. Silymarin, an extract from the *Silybum marianum* L. plant containing various flavonolignans that performing protective effect on the liver and restorative, with its ability to inhibit free radicals. Thus, the objective of this study was to evaluate the silymarin extract in Japanese quail diets (*Coturnix coturnix japonica*), challenged with aflatoxins on performance and blood characteristics of birds, during 60 d. A total of 90-d-old 240 Japanese quails were distributed in a completely randomized design in 3 × 2 factorial arrangement (additives x contaminated or not with aflatoxins - 3 ppm), totaling 6 treatments with 5 repetitions of 8 birds each. The additives were: silymarin (500 g/ton), adsorbent (1 kg/ton) and an additive free diet (positive control). The aflatoxin based of *Aspergillus parasiticus* presented 1350 mg AFB1, 68.3 mg AFB2 and 176.7 mg AFG1 concentrations. The data were analyzed by ANOVA – completely randomized, followed by comparisons with Tukey test and contrasts (SAS software). There was no interaction ( $P > 0.05$ ) between the additives and aflatoxins factors for any parameter measured. However, the addition of aflatoxin in diets reduced ( $P < 0.05$ ) egg weight (10.14 vs.10.96 g) and feed intake (26.06 vs.27.65 g/bird per day) and, consequently, impaired feed conversion - kg/kg (2.86 vs. 2.80) compared with non-challenged group. Similarly, there was an increase in the blood concentration of AST (348.60 vs. 261.74 U/L) and GGT (7.863 vs. 5.288 U/L) to birds challenged with dietary aflatoxins, which can characterize liver damage by toxins. There was no effect ( $P > 0.05$ ) of treatments on the final viability of birds, challenged or not with aflatoxins (98.33 vs. 99.17, respectively). In conclusion, the silymarin and adsorbent evaluated were not able to mitigate the damage caused in Japanese quail fed diets with aflatoxins.

**Acknowledgments:** Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq.

**Key Words:** additive, *Aspergillus parasiticus*, liver enzyme

**131 Effect of inclusion of zootechnical additives on the performance of Japanese quails.** Marina Jorge de Lemos<sup>1</sup>, Daniele Santos de Souza\*<sup>2</sup>, Lígia Fátima Lima Calixto<sup>1</sup>, Karol Andrea Afonso Torres Kordido<sup>3</sup>, Carlos Augusto Oliveira<sup>1</sup>, and Thiers Pascoal Pinho<sup>1</sup>, <sup>1</sup>Universidade Federal Rural do Rio de Janeiro, Seropédica, Rio de Janeiro, Brazil, <sup>2</sup>Universidade Estadual Paulista Júlio de Mesquita Filho, Botucatu, São Paulo, Brazil, <sup>3</sup>Universidade Estadual do Norte Fluminense, Campos dos Goytacazes, Rio de Janeiro, Brazil.

The zootechnical advantage of the effect of the additive has been demonstrated in egg production. The progressive ban on the use of antibiotics as performance enhancers in many countries, has intensified research into alternative additives. They are still scarce data zootechnical advantage of its use in quails, therefore aimed to compare the effect of inclusion of different additives (antibiotic (A), prebiotic (PRE), probiotic (PRO) and symbiotic (SYM)) in feed on performance over a full cycle of production of Japanese quails. Distributed (360 Japanese quail) in randomized design in a split plot scheme, comprising the first period (9 to 23 wk) and the second period (24 to 39 wk) with 5 treatments, 8 replications 9 birds in diet consisting treatments reference (TR) without additives (control); TR + 147 g / t antibiotic (zinc bacitracin); TR + 1.5 kg / t

prebiotic (*Saccharomyces cerevisiae*); TR + 300g / t probiotic (*Bacillus subtili*); TR + symbiotic (probiotic + prebiotic). Were evaluated feed consumption (FC), egg production (EP), average egg weight (AEW), feed conversion per mass and per dozen eggs (FCM, FCD) and viability (V). The use of additives affect ( $P < 0.05$ ) positive performance of the quails, this being best effect depending on the production period. There interaction ( $P < 0.05$ ) inclusion of additives and period in all parameters. Analyzing the 2 periods, the inclusion of additives, regardless of type, it was most effective ( $P < 0.05$ ) reduction in FC in the first period, and A and more efficient additives SYM ( $P < 0.05$ ). The rise in EP was more effective ( $P < 0.05$ ) in the first period, the AEW was higher ( $P < 0.05$ ) in the second period, FCM and FCD eggs was better ( $P < 0.05$ ) in the first period and V was not affected ( $P > 0.05$ ). It is advantageous to include additives in the feed of Japanese quails especially during the first production phase. The SYM and the additives were more effective in reducing the FC indicating that the second may overwrite the first playing zootechnical advantage for quails.

**Key Words:** antibiotic, prebiotic, probiotic, productive period, symbiotic

**132 Kaolin use on the performance of Japanese quails.** Daniele Santos de Souza\*<sup>1</sup>, Lígia Fátima Lima Calixto<sup>2</sup>, Carlos Alberto da Silva Filho<sup>2</sup>, Carlos Augusto de Oliveira<sup>2</sup>, Édison José Sousa<sup>3</sup>, and Felipe Dilelis de Resende Sousa<sup>2</sup>, <sup>1</sup>Universidade Estadual Paulista Júlio de Mesquita Filho, Botucatu, São Paulo, Brazil, <sup>2</sup>Universidade Federal Rural do Rio de Janeiro, Seropédica, Rio de Janeiro, Brazil, <sup>3</sup>Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil.

Kaolin is a clay that is used as an inert ingredient in the poultry feed. Studies have shown its function as an additive, when used at higher concentrations, promoting a better performance. Among other factors clays promote absorption and reduced transit rate of digesta improving the digestibility of nutrients and as a consequence, productivity (Safaeikatouli et al., 2012). In this context, this study aimed to evaluate the performance of Japanese quails produced with increasing levels of kaolin in feed during the production phase. One hundred 90 2 Japanese quails distributed in a completely randomized design with 4 treatments and 6 replications of 8 birds each were used. The treatments consisted in the supply of 4 diets with increasing levels of kaolin (0%, 1.5%, 3.0%, 4.5%) for the following parameters: feed intake (g / bird / day) egg production (%), feed conversion per dozen eggs and viability. The results were submitted to variance analysis and estimated the effects of kaolin levels by analyzing the variables by methods of linear and quadratic regression according to the best fit obtained for each variable. As kaolin levels increased, the results showed linear effect ( $y = 29.1807 + 0.2562x$ ,  $R^2 = 0.92$ ). The feed consumption was reduced ( $P < 0.05$ ). The production, feed conversion per dozen eggs decreases and the viability of the birds was improved.

**Acknowledgments:** We thank CAPES for granting the scholarship; Cao do Brazil company for the donation of the kaolin used; the technician Ilza for processing the histological material and the trainees who helped prepare this study.

**Key Words:** additive, clay, *Coturnix coturnix japonica*, feed consumption, inert ingredient

**133 Financial analysis of kaolin use in the production of quails.** Daniele Santos de Souza\*<sup>1</sup>, Marina Jorge de Lemos<sup>2</sup>, Lígia Fátima Lima Calixto<sup>2</sup>, Sérgio Muniz Oliveira<sup>2</sup>, Edison Jose Fassani<sup>3</sup>, and Tulio Leite Reis<sup>2</sup>, <sup>1</sup>Universidade Estadual Paulista Julio de Mesquita Filho, Botucatu, São Paulo, Brazil, <sup>2</sup>Universidade Federal

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Kaolin, when incorporated at higher levels than the recommended as inert, can work as an additive, performing functions that are reflected in zootechnical advantage for birds, but are rare or non-existent studies assessing the financial viability of the incorporation of this clay as an additive to animal feed. In this context, the objective was to assess the financial feasibility of adding increasing levels of kaolin in quail feeding in the production phase. One hundred 90 2 Japanese quails distributed in a completely randomized design with 4 treatments and 6 replications of 8 birds each were used, which received 4 diets with different levels of kaolin (0%, 1.5%, 3.0%, 4.5%). The financial analysis considered: feed consumption, egg production, feed conversion, feed cost, the amount paid to producers for quail eggs and the costs usually involved with quail production. To evaluate the cost per kg of feed of each treatment was considered the average price of feed ingredients and kaolin (price converted to real dollars) in the state of Rio de Janeiro. The IRR (internal rate of return), the NPV (net present value) and the cost benefit of kaolin used in quail feed were calculated and the results were submitted to variance analysis and estimated the effects of kaolin levels through regression linear and quadratic as the best fit obtained

for each variable. The improved performance of the birds ( $P < 0.05$ ) as were increasing levels of kaolin in feed. The IRR relative to production parameter percentage of egg production was higher with the inclusion of 1.5% of kaolin in feed of Japanese quails in relation to other treatments. The NPV showed positive values for all levels tested kaolin. The financial cost benefit analysis kaolin use in feed Japanese quail demonstrated that treatment with inclusion of 1.5% of kaolin was the most financially viable in relation to other treatments.

**Acknowledgments:** We thank CAPES for granting the scholarship, Cao do Brazil company for the donation of the kaolin used, the technician Ilza for processing the histological material, and the trainees who helped prepare this study.

**Key Words:** additive, clay, cost benefit, egg production, internal rate of return

## Student Competition, Metabolism and Nutrition: Amino Acids II

**134 Bioefficacy of different sources of methionine relative to DL-methionine in starter phase (1 to 21 days) of broilers chickens.** Vanessa Silva\*<sup>1</sup>, Raquel Mencalha<sup>1</sup>, Nei Arruda<sup>2</sup>, Sabrina Alcebiades<sup>1</sup>, and Antonio Bertechini<sup>1</sup>, <sup>1</sup>Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil, <sup>2</sup>Evonik Degussa Brazil Ltda, São Paulo, São Paulo, Brazil.

The objective was to determine the effective replacement of sources L-Methionine 99% (L-Met); DL-methionyl-DL-Methionine 97%, dipeptide, (Met-Met); 84% Methionine hydroxy analog (MHA-Ca) compared with DL-methionine (DLM) in the starter phase of broilers. A total of 2,275 d-old male Cobb 500 were obtained from a commercial hatchery and allotted in the 91 floor pens (2 × 1.1 m) containing new wood shavings, with tubular feeders and nipple drinkers. Feed and water were provided *ad libitum* all experimental time. The experiments consisted of 13 treatments with 7 replicates in a completely randomized design. The treatments were: Basal diet (0.571% SID Met+Cys), 3 levels of inclusion for each product: DLM (0.100; 0.200 and 0.300%), L-Met (0.100; 0.200 and 0.300%), Met-Met (0.102; 0.204 and 0.306%) and MHA-Ca (0.113; 0.225 and 0.338%). For measure the biological efficacy of the test products compared with DL-Met, the data were analyzed by exponential regression at 21 d old, whereas feed conversion ratio (FCR) and body weight (BW) were measured. The results of BW were showed by exponential regression ( $Y = 0.879 + 0.189 * (1 - e^{-12.897*(DLM + 0.964LM + 1.083MetMet + 0.650MHA)})$ ;  $R^2 = 99\%$ ) the Relative Bioavailability: DLM = 100%; L-Met = 96% (68 – 124%); Met-Met = 108% (76 – 141%) and MHA-Ca = 65% (47 – 82%). The only significant difference was for MHA-Ca, because the confidence interval (47–82%) is smaller than the concentration of MHA-Ca (84%). Regarding FCR, the exponential regression ( $Y = 1.421 - 0.183 * (1 - e^{-7.086*(DLM + 0.854LM + 1.164MetMet + 0.619MHA)})$ ;  $R^2 = 97\%$ ) showed Relative Bioavailability of DLM = 100%; L-Met = 85% (54 – 116%), Met-Met = 116% (73 – 160%) and MHA-Ca = 62% (39 – 85%). Summarizing, the result presented showed no difference in the Bioavailability of DLM, L-Met and Met-Met, however the MHA-Ca showed results below of 65% in the starter phase, therefore, there is a difference between methionine sources for broilers chickens.

**Acknowledgments:** Evonik Degussa do Brazil Ltda

**Key Words:** bioavailability, performance, biological efficacy

**135 Comparing bioefficacy of different sources of methionine relative to DL-methionine in the grower phase (22 to 42 days) of broilers chickens.** Raquel Mencalha\*<sup>1</sup>, Ariane Helmbrecht<sup>2</sup>, Nei Arruda<sup>2</sup>, Lislaine Batista<sup>1</sup>, and Antonio Bertechini<sup>1</sup>, <sup>1</sup>Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil, <sup>2</sup>Evonik Degussa Brazil Ltda, São Paulo, São Paulo, Brazil.

This study was conducted to investigate the bioefficacy of L-Methionine 99% (L-Met); DL-methionyl-DL-Methionine 97%, dipeptide, (Met-Met); 84% Methionine hydroxy analog (MHA-Ca) compared with DL-methionine (DLM) in the grower phase of broilers. A total of 2,275 d-old male Cobb 500, where they were raised for 21 d in floor pens, with diet based corn/soybean meal to attendance the nutritional recommendations by Cobb 500. The chicks were divided into 13 treatments in 7 reps with 25 birds each in a completely randomized design. The treatments were: Basal diet (0.548% SID Met+Cys), 3 levels of inclusion for each product: DLM (0.090; 0.180 and 0.270%), L-Met (0.090; 0.180 and 0.270%), Met-Met (0.092; 0.184 and 0.276%) and MHA-Ca (0.101; 0.203 and 0.304%). For measure the biological efficacy of the test

products compared with DL-Met, the data were analyzed by exponential regression at 42 d old, whereas feed conversion ratio (FCR) and body weight (BW) were measured. The results of BW ( $1.778 + 0.266 * (1 - e^{-8.296*(DLM + 0.901LM + 1.094MetMet + 0.425MHA)})$ ;  $R^2 = 92\%$ ) showed relative bioavailability of DLM = 100%; L-Met = 90% (41 – 160%); Met-Met = 109% (33 – 150%) and MHA-Ca = 42% (13 – 72%), however there was only significant difference for MHA-Ca, because the confidence interval (13–72%) is smaller than the concentration of MHA-Ca (84%). For FCR, the results obtained were the same (significant effect for MHA-Ca) according the exponential regression ( $Y = 1.950 - 0.2789 * (1 - e^{-8.114*(DLM + 0.907LM + 1.021MetMet + 0.441MHA)})$ ;  $R^2 = 99\%$ ). The Relative Bioavailability of DLM = 100%; L-Met = 91% (37 – 144%); Met-Met = 102% (41 – 163%) resulted no difference between these sources, while MHA-Ca = 44% (16 – 73%). In conclusion, in the grower phase of broiler chickens, there are no difference of DLM, L-Met and Met-Met, nevertheless, MHA-Ca showed values below 44% in this trial for broilers in the grower phase.

**Acknowledgments:** Evonik Degussa do Brazil Ltda.

**Key Words:** methionine source, broiler performance, relative efficiency

**136 Comparison of bioavailability of methionine hydroxyl analogue calcium salt relative to DL-methionine for broilers in growth phase.** Fernando P. Antayhua\*, Nilva K. Sakomura, Leticia Soares, Juliano P. Dorigam, and Bruno B. Leme, *Universidade Estadual Paulista, Jaboticabal, São Paulo, Brazil.*

A dose response experiment was conducted to determine the relative bioavailability of Methionine Hydroxyl Analogue Calcium Salt (MHA-Ca) compared with DL-Methionine (DL-Met) as sources of Met activity for broilers. A total of 1890 male broilers Cobb 500 with 21 d of age were distributed in a complete randomized design with 9 treatments, 7 replicates with 30 birds each. Treatments consisted of one basal diet (BD), adequate in all nutrients with exception of digestible Met plus cystine (dMet+Cys), and 4 graded inclusions of both DL-Met (0.054; 0.156; 0.259; 0.463% DL-Met) and MHA-Ca (0.063; 0.183; 0.302; 0.540% MHA-Ca) added to the BD to obtain levels of dMet + Cys that ranged from 0.594 to 0.994% of dMet+Cys. Body weight gain (BWG), feed intake (FI), feed conversion rate (FCR), carcass yield (CY), abdominal fat (AF) and breast yield (BY) were measured in this trial. For the analysis, 5% of significance was considered in the adjustment of exponential models. Multi-exponential regression model was used to determine bioavailability of MHA-Ca in relation to DL-Met supplementation for each variable and it was calculated by dividing the slope of MHA-Ca by the slope of DL-Met. Broilers fed diets supplemented with MHA-Ca and DL-Met improved BWG, FCR, CY and BY in relation to broilers fed basal diet, whereas AF was reduced. The resulting models were BWG =  $1833.1 + 279.6 * (1 - e^{-(11.132 * DL-Met + 6.632 * MHA-Ca)})$ ,  $R^2 = 0.52$ ; FCR =  $1.844 + 0.247 * (1 - e^{-(9.878 * DL-Met + 6.452 * MHA-Ca)})$ ,  $R^2 = 0.89$ ; CY =  $74.914 + 2.592 * (1 - e^{-(8.218 * DL-Met + 3.976 * MHA-Ca)})$ ,  $R^2 = 0.44$ ; AF =  $2.246 + 0.573 * (1 - e^{-(8.063 * DL-Met + 7.813 * MHA-Ca)})$ ,  $R^2 = 0.40$ ; and BY =  $23.508 + 5.460 * (1 - e^{-(5.546 * DL-Met + 3.131 * MHA-Ca)})$ ,  $R^2 = 0.77$ . Thus, bioavailability of MHA-Ca relative to DL-Met was 52% for BWG and 57% for FCR, whereas for CY, AF and BY were 43%, 87% and 50%, respectively. In conclusion, biological effectiveness of MHA-Ca is lower than DL-Met in performance and carcass variables in growing broilers.

**Key Words:** amino acid, bioefficacy, multi-exponential regression, performance, carcass

**137 Growth performance, carcass quality, and occurrence of white striping and wooden breast in broilers fed diets with increasing lysine levels.** Bárbara Moreira dos Santos\*, Sergio Luiz Vieira, Rafael Fontana Abs da Cruz, Liris Kindlein, Raissa Menezes, and Maieli Rohr, *UFRRGS, Porto Alegre, Rio Grande do Sul, Brazil.*

Two experiments were conducted to evaluate growth performance, carcass quality and occurrence white striping (WS) and wooden breast (WB) in broilers fed diets with increasing digestible Lys levels from 12 to 28 d (Exp. 1) and from 28 to 42 d (Exp. 2). A total of 1,200 Cobb × Cobb 500 male broilers were allocated each experiment using a completely randomized design with 6 treatments, 8 replicates and 25 birds per pen. Increasing dig. Lys levels were equally spaced from 0.77 to 1.17% in Exp. 1 and from 0.68 to 1.07% in Exp. 2. Birds and feeds were weighed at 12 and 28 d in Exp. 1 and at 28 and 42 d in Exp. 2 to calculate body weight gain (BWG), feed conversion ratio corrected for the weight of dead birds (FCR), and feed intake (FI). Four birds per pen were randomly selected from each replication and processed at 35 and 42 d in Exp. 1 and Exp. 2, respectively. Increasing dietary dig. Lys levels positively affected ( $P < 0.01$ ) BW gain and carcass weight in both Exp. 1 and 2. Body weight, carcass and weight, and breast yield increased quadratically ( $P < 0.01$ ) when broilers were fed diets with increasing levels of dig. Lys. In Exp. 1, maximum responses at 35 d for BW, carcass weight, and breast weight were obtained using 1.08%, 1.07%, and 1.07% of dig. Lys, respectively. In Exp. 2, maximum responses at 42 d for BW gain, carcass weight, and breast weight of broilers were obtained using 0.99%, 0.98%, and 0.98% of dig. Lys, respectively. Quadratic increases ( $P < 0.01$ ) were observed for breast meat yields at 35 and 42 d, with maximum responses obtained with 1.08% and 1.01% dig. Lys, respectively. White striping and WB occurrences were 32.3 and 85.9% in Exp. 1, and 87.1 and 89.2% in Exp. 2. White striping and WB presented linear responses to growth performance variables in Exp. 1, whereas quadratic responses were observed for all variables in Exp. 2. In conclusion, increasing Lys levels improved growth performance and carcass traits and induced the occurrence of WS and WB lesions probably due to dig. Lys dietary levels that maximized the genetic potential for growth and breast meat yields.

**Key Words:** broiler, breast myopathy, lysine, performance

**138 Arginine and manganese supplementation on the immune competence of broilers challenged with vaccine against *Salmonella Enteritidis*.** Heloísa Lais Fialkowski Bordignon\*<sup>1</sup>, Alvaro Mario Burin Junior<sup>1</sup>, Arielle Aparecida Lara<sup>1</sup>, Alessandra Snak<sup>1</sup>, Nelson Luis Mello Fernandes<sup>1</sup>, Alba Fireman<sup>2</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, <sup>1</sup>*Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil,* <sup>2</sup>*Zinpro Corporation, Piracicaba, São Paulo, Brazil.*

Manganese (Mn) activates several metalloenzymes, including arginase. Arginase, in turn, is the enzyme that promotes the arginine (Arg) breakdown into proline and polyamines. Hence, it is necessary to consider that a competition between arginase and nitric oxide synthase (NOS) might happen. Nitric oxide is an important regulating molecules of the immune system. The aim of this study was to assess the immune modulation of Arg and Mn in broilers. 320 one-day-old Cobb male broilers were weighted and randomly assigned to a factorial  $2 \times 2$  design (2 Mn sources x 2 Arg:Lys ratio) composing 4 treatments and 8 replicates each treatment, with 10 birds each replicate. The treatments consisted of T1: Inorganic Control (80 ppm MnSO<sub>4</sub>); T2: 40 ppm MnSO<sub>4</sub> + 40 ppm Mn amino acid complex; T3: Inorganic Control + L-Arg (Arg:Lys 1.20); T4: 40 ppm MnSO<sub>4</sub> + 40 ppm Mn amino acid complex + L-Arg (Arg:Lys 1.20. For treatments 1 and 2, the Arg:Lys ratio was 1.12 (1.32% Lys dig). At 9 d of age, the birds were challenged with an intramuscular *Salmonella Enteritidis* vaccine. Blood samples were obtained of 8 birds/treat 7 d after the challenge to flow cytometry (immune cells phenotypes) and 21 d after the challenge an Indirect ELISA analysis (IgM and IgG). Supplementation of the inorganic Mn source resulted in higher ( $P < 0.05$ ) amount of general mucosa CD4, non-activated and activated CD8, and APC (Antigen Presenting Cell) compared with Mn sources in association. For humoral response, there was no effect of the main factors. The interaction can be seen to IgM. The supplementation of inorganic Mn resulted in higher humoral protection (increased IgM levels) only when associated with Arg ( $P < 0.05$ ). However, the Mn sources in association resulted in high levels of IgM in commercial levels of Arg. The association of both inorganic and Mn amino acid complex sources resulted in a short, effective cellular response, reducing the number of lymphocytes of challenged birds, but resulting in more immunogenic stimulus for the production of antibodies, regardless Arg supplementation.

**Key Words:** lymphocyte, IgM, flow cytometry, organic manganese

# Microbiology and Food Safety

## 139 Fosfomycin: a potent antimicrobial used to reduce non-typhoidal *Salmonella enterica* serovars in Brazilian broilers.

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Reduction of foodborne pathogens in poultry production is essential to ensure food safety. Some *Salmonella* serovars shows great importance in public health as *Salmonella* Enteritidis (SE), *S. Thyphimurium* (ST) and *S. Heidelberg* (SH). Reduction of *Salmonella* in birds on the field is the main goal in poultry industry. This study was performed at Mercolab Laboratory, to evaluate the antimicrobial fosfomycin (FOS 350, 35% calcium fosfomycin, Ourofino Animal Health, Brazil) in reducing or eliminate infection caused by SE, ST and SH in broiler chickens. A total of 180 Cobb chicks, 3 d old were orally infected with  $10^6$  cfu/mL of each *Salmonella* serovar. Birds were divided into 6 groups, housed in floor pen: ST (G1-control and G2-fosfomycin), SE (G3-control and G4-fosfomycin) and SH (G5-control and G6-fosfomycin). Fosfomycin (40 mg/kg/lw) was offer by water 24h after inoculation, during 5 d. Before start treatment (24h after *Salmonella* serovars inoculation) 8 (n = 8) broilers/group were euthanized and the cecum were collected to perform bacterial cell count. To evaluate fosfomycin action 24h and 48h after the end of the treatment 11 chicks from each group were euthanized per period, and bacterial counts were performed. Counts were expressed in  $\log_{10}$  and analyzed by Kruskal Wallis in SPSS Statistics 8.0 software, using 5% of significance level, between control and challenge in the same serovar. The therapeutic treatment with fosfomycin in both periods (24h and 48h) in all treated groups G2-24h, 1.027b) and 48h (1.000b), G4-24h, 1.118b and 48h (1.189b) and G6-24h, 1.652b and 48h (2.683b) showed reduction in bacterial load from cecum samples, compared with the non treated groups: G1-24h, 5.178a and 48h (5.410a); G3-24h, 4.331a and 48h (4.539a) and G5-24h, 6.809a and 48h (6.836a). Fosfomycin treatment reduces significantly the cecum colonization and consequently reduces bird's *Salmonella* excretion.

**Key Words:** fosfomycin, broiler, salmonella, cecum colonization, antibiotic

## 140 Antibacterial activity of disinfectants against *Salmonella Heidelberg*, *S. Enteritidis*, and antibiotic-resistant *S. Enteritidis*.

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Disinfection is a vital step to ensure a microorganism load reduction at animal infections. Most common commercial biocides used on livestock are quaternary ammonium, sodium hypochlorite or glutaraldehyde. Bacteria pathogenic to chickens include *Salmonella enterica*, with a high prevalence of prevalence of serovars Enteritidis and Heidelberg in Brazilian poultry flocks. A total of 60% of *Salmonella* strains isolated are resistant to at least one antibiotic. The objective of this experiment was to evaluate the antibacterial efficiency of commercial hypochlorite disinfectants against *S. Heidelberg* (SH), *S. Enteritidis* (SE) and *S. Enteritidis* resistant to rifampicin (SER). Microbiology analyses were adapted from Kich et al. (2004) using a bacterial suspension of  $10^8$  cfu/mL<sup>-1</sup>. Two commercial disinfectants were tested: Product A was a 12% sodium hypochlorite concentrated solution diluted down to obtain a final concentration of 2%, to equate in strength to Product B, 2% ready-to-use biocide. For each product, 2 dilutions were used: 1:10 and 1:20, and compared with a control group (no disinfectant added), with 5 plates repetitions for group. Product A was effective for all *Salmonella* at both dilutions tested ( $P < 0.01$ ). Product B inhibited SH growth at both dilutions; however, it could not control SE ( $1.25 \times 10^2$  cfu/mL<sup>-1</sup>) and SER ( $3.0 \times 10^2$  cfu/mL<sup>-1</sup>) at the 1:20 ( $P < 0.01$ ). Bacterial growths can vary considerably in their response to disinfectants and resistance is often intrinsic but it may also be genetically acquired. SER showed considerable growth in the presence of biocide, which can be explained by studies that showed an expression of target site mutations of antibiotic-resistant microorganisms that leads to biocide accommodation, that allows an exchange of antibiotic and biocide resistance mechanisms. This evaluation of antibacterial activity demonstrated a variation depending on dilution, product used and strain. This demonstrates the importance of the correct choice and in vitro evaluation of biocide to ensure appropriate disinfection.

**Key Words:** disinfection, sodium hypochlorite, biocide dilution, *Salmonella enterica*, antibiotic resistant

# Metabolism and Nutrition: Nutrition I

**141 Digestibility of increasing levels of cassava flour waste in Pekin duck Beijing diets (*Anas boschas*).** Ismael França\*<sup>1</sup>, Karla P. Picoli<sup>1</sup>, Elena S. Setelich<sup>1</sup>, Jaqueline Garcia<sup>1</sup>, Raul Block<sup>1</sup>, Cinthia Eyn<sup>2</sup>, Ricardo V. Nunes<sup>2</sup>, and Inês Andretta<sup>3</sup>, <sup>1</sup>Instituto Federal Catarinense, Campus Rio do Sul, Rio do Sul, Santa Catarina, Brazil, <sup>2</sup>Universidade Estadual do Oeste do Paraná, Campus Marechal Cândido Rondon, Marechal Cândido Rondon, Paraná, Brazil, <sup>3</sup>Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.

Pekin duck production is traditional in the Alto Vale do Itajaí region of Santa Catarina due the typical German culture as well as the ducks' use as biological control for invading species and pests in the rice fields, generating a constant demand for animals. However, feed is one of the factors that increase production costs, especially for the elderly slaughter of birds. In this context, residues from cassava (*Manihot esculenta* C.) processing, such as flour waste, could be an alternative in animal feed as a partial substitute for corn. Thus, this study aimed to determine the energy content of cassava flour waste (CFW) in Pekin duck diets. For the digestibility assay, 100 Pekin ducks were used (initial weight 1.390 kg,  $P > 0.05$ ), at 28 d of age, and distributed in a randomized experimental design comprised of 4 diets with different levels (0%, 10%, 20%, and 30%) of substitution of corn by the CFW, with 5 replicates of 5 birds each. The experiment lasted 19 d: 14 d for adaptation to the experimental conditions and 5 d of total excreta collection. Dry matter, gross energy and nitrogen, apparent metabolizable energy (AME), and apparent metabolizable energy corrected by nitrogen balance (AMEn) were measured. Data were subjected to regression analysis and ANOVA, followed by Dunnett's test ( $P < 0.05$ ), using the SAEG software for statistical analysis. The mean values of AME were 3,049 kcal, 3,102 kcal, 2,487 kcal, and 2,331 kcal of AME/kg, while the AMEn values were 3,050 kcal, 2,774 kcal, 2,340 kcal, and 2,244 kcal of AMEn/kg for 0%, 10%, 20%, and 30% CFW, respectively. The inclusion of an increasing percentage of CFW resulted in a quadratic response ( $P < 0.05$ ) in AME values, with the maximum point estimated at 11.59% of CFW inclusion, using the equation  $y = -0.521x^2 - 12.08x + 3106$  ( $R^2 = 0.81$ ). Compared with the control group, AME value was lower for 20% and 30% CFW inclusion ( $P < 0.05$ ). These results indicate that the best level of CFW inclusion for the AME value was 11.59%.

**Acknowledgments:** IFC/CNPq/Brazil

**Key Words:** alternative feed, nutritional value, production waterfowl

**142 Evaluation of the trial period of Japanese quails under different levels of metabolizable energy.** Diana M. Correa Castiblanco\*, Edney Pereira Da Silva, Silvana Martinez Baraldi Artoni, Elaine T. Santos, Michele Bernardino De Lima, Jessica L. Gonzalez Guzman, Saliha Samidi, Gabriela D. Censão, and Naudin A. Hurtado Lugo, FCAV, Universidade Estadual Paulista, Jaboticabal, São Paulo, Brazil.

The quail creation is currently an economic activity of large-scale production, and the productivity of this important branch of the poultry sector affords the problem of use the birds as an animal model. Thus, the aim of this study was to evaluate the broken line model adjustment considering data obtained by different means of combinations of duration of adaptation and data collection in Japanese quails. 300 Japanese quails were distributed in a completely randomized design with 10 metabolizable energy levels, ranging from 1,500 to 3,250 kcal/kg.

Each treatment had 6 replications of 5 birds each. Eleven combinations between adaptation and data collection were studied (in weeks): (1:4; 5:10); (1:4; 5:10); (1:4; 5:10); (1:4; 5:10); (1:4; 5:10); (1:4 - 5:10); (1:4 - 5:10); (1:4 - 5:10); (1:4 - 5:9); (1:4 - 5:8); (1:4 - 5:7); (1:4 - 5:6); (1:4 - 5); (1:9 - 10); (1:8 - 9:10); (1:7 - 8:10); (1:6 - 7:10); (1:5 - 6:10), respectively. The variables analyzed were feed intake (FI) and egg output (EO) by kilogram of metabolic weight. Was used model  $Y = L + U \times (R - X)$ , where  $X > R$  ( $R - X = 0$ ), where  $Y$  is the response FI (g / kgPC0,75) and EO (EO g / kg PC0,75);  $X$  is the dietary energy concentration. (kcal/kg);  $L$  is the response plateau;  $R$  is the break point; and  $U$  is the slope of the model. Statistical analyses SAS software. The estimated values for  $L$ ,  $U$ ,  $V$ , and AIC for FI ranges from  $82.5 \pm 0.6$  to  $82.2 \pm 2.0$ ;  $0.007 \pm 0.001$  to  $0.006 \pm 0.002$ ;  $3259 \pm 0.09$  to  $2730 \pm 381$ ;  $36.3$  to  $58.9$  for combination 4 and 8, respectively. The estimated values for  $L$ ,  $U$ ,  $V$ , and AIC for EO ranges from  $28.2 \pm 0.1$  to  $31.3 \pm 2.9$ ;  $-0.0016 \pm 0.001$  to  $-0.0021 \pm 0.001$ ;  $2877 \pm 74$  to  $3161 \pm 162$ ;  $44.8$  to  $61.5$ , for combination 8 and 6 respectively. The ideal period of adjustment and data collection parameters presented with values of  $L = 28.2 \pm 0.8$ ;  $U = -0.0019 \pm 0.001$ ;  $R = 2877 \pm 74$  and  $44.8$  AIC lower for FI and  $L = 83.4 \pm 0.9$ ;  $U = 0.009 \pm 0.001$ ;  $R = 3074 \pm 125$  and AIC =  $36.3$  for EO. The best combination where there was a stabilization of the responses was 4 wk of adaptation and 3 wk of data collection for FI and 8 wk of adaptation and 2 wk of data collection for EO.

**Key Words:** adaptation period, collection period, *Coturnix coturnix japonica*, egg production, egg weight

**143 Using stable isotope carbon to estimate pectoralis major turnover in broilers fed diet containing animal meal.** R. G. Ferreira Netto\*<sup>1</sup>, J. C. Denadai<sup>1</sup>, V. C. Pelicia<sup>1</sup>, J. R. Sartori<sup>1</sup>, R. S. S. G. Oliveira<sup>1</sup>, M. K. Maruno<sup>1</sup>, A. C. Pezzato<sup>1</sup>, and M. M. P. Sartori<sup>3</sup>, <sup>1</sup>College of Veterinary Medicine and Animal Science, São Paulo State University (UNESP), Botucatu, São Paulo, Brazil, <sup>2</sup>Institute of Bioscience, São Paulo State University (UNESP), Botucatu, São Paulo, Brazil, <sup>3</sup>College of Agriculture Science (UNESP), Botucatu, São Paulo, Brazil.

Distinct stable isotopes have been used as tracers in organs and animal diet. Estimating the turnover in several animal tissues at any stage of animal's life is information that will work of base for other works in the area of traceability of animal ingredients in broiler feeding, as well as in the metabolism and physiology area, which uses the technique of stable isotopes. To determine the pectoral muscle (*Pectoralis major*) turnover of broiler chicks during growth phase through the natural variation of carbon-13 existent between  $C_3$  and  $C_4$  plants 200 one-day-old male Cobb chicks were used. At birth, the isotopic signature of carbon-13 of bird tissues was similar to their female broiler breeders which consumed a diet containing predominantly  $C_4$  plants (based on corn). Since birds were housed, they received diets containing predominantly  $C_3$  plants (based on rice) containing poultry viscera meal to evaluate the turnover of pectoral muscle (*Pectoralis major*). Blood plasma samples were collected at 28, 29, 31, 33, 36, 39, 42, 49, 56, 63 and 77 d old (5 birds/day) to determine the isotopic ratio of carbon by mass spectrometry (IRMS). Then, obtained isotopic ratios were analyzed through the first-order exponential equation ( $\delta^{13}C(t) = \delta^{13}C(f) + [\delta^{13}C(i) - \delta^{13}C(f)]e^{-kt}$ ) of Origin software resulting in the equation:  $\delta^{13}C = -26.3\text{‰} + 6.4\text{‰} e^{-0.0746t}$  ( $R^2 = 0.99$ ), with a half-life ( $\ln(2)/k$ ) of 9.3 d and 61.4 d to complete exchange, namely about 50% of the pectoral muscle (*Pectoralis*



major) turnover during growth phase occurs in 9.3 d and takes 61.4 d to total turnover in broilers receiving diet containing poultry viscera meal.

**Acknowledgments:** FAPESP

**Key Words:** carbon-13, metabolism, tracer, poultry viscera meal

**144 The use of stable carbon isotopes for estimating turnover of blood in broiler chicks from 7 to 28 days of age.** L. C. Dornelas\*<sup>1</sup>, V. C. Pelícia<sup>1</sup>, J. C. Denadai<sup>1</sup>, J. R. Sartori<sup>1</sup>, A. K. Ito<sup>1</sup>, C. Ducatti<sup>2</sup>, M. M. Aoyagi<sup>1</sup>, and G. A. M. Pasquali<sup>1</sup>, <sup>1</sup>Faculdade de Medicina Veterinária e Zootecnia, UNESP, Botucatu, SP, Brazil, <sup>2</sup>Instituto de Biociência, UNESP, Botucatu, SP, Brazil.

Distinct stable isotopes have been used as tracers in organs and animal diet. Estimating the turnover in several animal tissues at any stage of animal's life is an information that will serve of base for other works in the area of traceability of animal ingredients in broiler feeding, as well as in the metabolism and physiology area, which uses the technique of stable isotopes. To determine the turnover of blood in broiler chicks at the initial phase of growth through the natural variation of carbon-13 existent between C<sub>3</sub> and C<sub>4</sub> plants, 100 one-day-old Cobb males were used. The birds were obtained from arrays fed diets containing predominantly C<sub>4</sub> cycle plants (based on corn and soybeans). The isotopic signature of carbon-13 of bird tissues was similar to their female broiler breeders. Since birds were housed, they received diets containing predominantly C<sub>3</sub> plants (based on rice) to evaluate the turnover of blood. Blood samples were collected at 7, 8, 11, 13, 15, 17, 19, 21, 24 and 28 d old (6 birds/day) to determine the isotopic ratio of carbon by mass spectrometry (IRMS). To measure quantitatively the speed of carbon replacement in birds tissues by the diet, after a certain time interval, exponential data adjustment ( $\delta^{13}\text{C}$ ) was carried out using the method of first-order exponential regression expressed by equation  $(\delta^{13}\text{C}(t) = \delta^{13}\text{C}(f) + [\delta^{13}\text{C}(i) - \delta^{13}\text{C}(f)]e^{-kt})$  of Minitab software, resulting in the equation  $\delta^{13}\text{C} = -26,66 - 5,77 e^{-0,2653(t-7)}$  ( $r^2 = 0,98$ ). With a half-life ( $\ln 2/k$ ) of 2,61 d and 11,29 d to complete exchange. The blood metabolic rate showed that it can be used as a tissue indicative of processes for traceability.

**Acknowledgments:** FAPESP, CNPq

**Key Words:** development, metabolism, tracer

**145 Using stable isotope carbon to estimate blood plasma turnover in broilers fed diet containing animal meal.** J. C. Denadai\*<sup>1</sup>, J. R. Sartori<sup>1</sup>, V. C. Pelícia<sup>1</sup>, R. S. S. G. Oliveira<sup>1</sup>, R. G. Ferreira Netto<sup>1</sup>, C. Ducatti<sup>2</sup>, P. C. Araújo<sup>1</sup>, and M. M. P. Sartori<sup>3</sup>, <sup>1</sup>Faculdade de Medicina Veterinária e Zootecnia da Universidade Estadual Paulista (UNESP), Botucatu, São Paulo, Brazil, <sup>2</sup>Instituto de Biociências da Universidade Estadual Paulista (UNESP), Botucatu, São Paulo, Brazil, <sup>3</sup>Faculdade de Ciências Agrônomicas da Universidade Estadual Paulista (UNESP), Botucatu, São Paulo, Brazil.

Distinct stable isotopes have been used as tracers in organs and animal diet. Estimating the turnover in several animal tissues at any stage of animal's life is information that will work of base for other works in the area of traceability of animal ingredients in broiler feeding, as well as in the metabolism and physiology area, which uses the technique of stable isotopes. To determine the blood plasma turnover of broiler chicks during growth phase through the natural variation of carbon-13 existent between C<sub>3</sub> and C<sub>4</sub> plants 200 one-day-old male Cobb chicks were used. At birth, the isotopic signature of carbon-13 of bird tissues was similar to their female broiler breeders which consumed a diet containing predominantly C<sub>4</sub> plants (based on corn). Since birds were housed, they received diets containing predominantly C<sub>3</sub> plants (based

on rice) containing poultry viscera meal to evaluate the turnover of blood plasma. Blood plasma samples were collected at 28, 29, 31, 33, 36, 39, 42, 49, 56, 63, and 77 d old (5 birds/day) to determine the isotopic ratio of carbon by mass spectrometry (IRMS). To measure quantitatively the speed of carbon replacement in birds tissues by the diet, after a certain time interval, exponential data adjustment ( $\delta^{13}\text{C}$ ) was carried out using the method of first-order exponential regression expressed by equation  $(\delta^{13}\text{C}(t) = \delta^{13}\text{C}(f) + [\delta^{13}\text{C}(i) - \delta^{13}\text{C}(f)]e^{-kt})$  of Origin software resulting in the equation:  $\delta^{13}\text{C} = -25,7\% + 9,2\% e^{-0,5053t}$  ( $R^2 = 0,98$ ), with a half-life ( $\ln 2/k$ ) of 1.4 d and 9.2 d to complete exchange, namely about 50% of the blood plasma turnover during growth phase occurs in 1.4 d and takes 9.2 d to total turnover in broilers receiving diet containing poultry viscera meal, confirming the importance of blood plasma in providing information about recent diet of broilers on traceability studies.

**Acknowledgments:** FAPESP, CNPq

**Key Words:** carbon-13, metabolism, tracer, poultry viscera meal

**146 Effects of the interaction between feed form and apparent metabolizable energy levels on broiler performance.** Bruno Daniel Gonçalves\*, Dubois Alvaro Medina, Utpatel Rodrigo, Peroni Ellen de Fátima Carvalho, and Penz Junior Antônio Mário, *Cargill Animal Nutrition, Campinas, SP, Brazil.*

Different papers had shown negative correlation between apparent metabolizable energy (AME) levels and pellet quality, associated to dietary fat inclusion. Furthermore, both, AME level and pellet quality (amount of fines), are known to influence feed intake of broilers. The objective of this study was to evaluate the interaction between feed form (FF) and AME levels on broiler performance fed corn-soybean meal diets. 3,040 d-old Cobb500 chicks were allocated to 20 treatments, arranged in a factorial 4 × 5 design, with 4 AME levels and 5 FF. Each treatment was replicated in 8 pens, with 19 birds each. AME levels increased in steps of 100 kcal, adding soybean oil. Up to 21 d of age, all birds were fed the same crumble diet. For each AME level, diet was provided in 5 different FF: mash; pellet; 100%pellet (with fines removed, simulating a good quality pellet); pellets without fines plus crumbles (in a proportion of 50% each, simulating a poor quality pellet) and crumble. Except for AME, all diets were isonutritives. Feed intake (FI), weight gain (WG) and feed conversion ratio (FCR), from 21 to 42 d of age, were analyzed, using mixed models (SAS, 2012), with treatments being compared by Tukey test ( $P < 0.05$ ). When the effect of AME level was detected, regression curves were obtained. Interaction between AME and FF was observed for FI. Increasing AME levels had no effect on crumble or mash diets, but decreased linearly FI of broilers fed diets with other FF. FI and WG were affected by FF. Pellet had higher FI and WG than 100% pellet, which was higher than pellet+crumble. Mash and crumble had the lowest FI and WG. Pellet had better FCR than mash diets, with the other FF having intermediate results. Increasing AME level improved FCR linearly. In conclusion, performance of broilers fed 100% pellet diet (with no fines) was slightly worse than pellet. However, when interaction effect was observed, FI of 100% pellet was higher than pellet only in low AME diets. This tendency was reversed in higher AME levels, which it is associated to a correction of excessive pellet hardness with higher inclusion of soybean.

**Key Words:** pellet quality, fines, hardness, fat, mash

**147 Evaluation of commercial broiler lines fed high and low energy metabolizable diets—performance and carcass yield.** Edwin Alberto Cañas Mendoza\*<sup>1</sup>, Erika Rodrigues<sup>2</sup>, Bernardo Nogueira<sup>1</sup>, Matheus de Paula Reis<sup>1</sup>, and Antonio Gilberto

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A total of 3,456 broiler chickens were raised with the objective to study performance and carcass yield of 3 strains of broiler chickens (A, B and C), receiving 2 nutritional plans (high and low energy levels). The chicks were randomly distributed in 96 experimental plots of 36 birds each, performing a factorial scheme  $3 \times 2 \times 2$  (strain  $\times$  nutritional plan  $\times$  sex), totaling 12 treatments with 8 replications each. A basal diet was formulated to meet the following energy levels: 3000, 3100, 3150, and 3200 kcal of apparent metabolizable energy (AME) for the ages of 1–7, 8–21, 22–35, and 36–42, respectively. The ratio between crude protein (CP) and ME were kept the same between high and low energy diets, performing the following levels of CP and lysine in the basal diet for each respectively age: 22.34, 21.54, 19.9, and 18.6% of CP and 1.34, 1.29, 1.19, and 1.12% of lysine. The ratios for limiting amino acids, lysine basis, followed Rostagno et al. (2011) recommendation. The measurements collected were performance and carcass yield. A 3-way ANOVA was employed to determine the main effects and their interaction by a Proc GLM. Tukey's student range test was used to show the difference of a factor inside another, and also to evaluate the differences between strains. *t*-test was applied to show the main difference effect of energy level and sex. Significance level of 5% was applied. In the period from day one to 21, among birds fed with high-energy diet, lines B and C had increased BWG in contrast with line A ( $P < 0.05$ ), regardless bird sex. For the total rearing period, line B had the highest BWG when fed a high-energy diet. There was no significant interaction between the factors studied for carcass yield and breast shape ( $P > 0.05$ ). However, it was possible to identify statistic difference between lines ( $P < 0.05$ ). The line A showed the greatest YD, nevertheless, the YB and YC were lower in contrast with lines B and C. From the observed data it can be concluded that different commercial broiler lines showed different results through a variation of metabolizable energy in diet.

**Key Words:** Broiler line, poultry, metabolizable energy, carcass trait

**148 Citrus pulp in broiler diets.** Mayra Diaz\*, Alice Murakami, Leonardo Zanetti, Marcia Izumi, and Ivan Camilo Ospina, *Universidade Estadual de Maringá, Maringá, Paraná, Brazil*.

Two experiments were performed to study the effect of dietary levels of citrus pulp on performance and metabolism of broilers during starter and grower phases. In Experiment I (metabolism assay), a total of 108 21-d-old Cobb 500 male broiler chickens were distributed in a completely randomized design with 3 treatments (basal diet and test diet = basal diet + 10 or 20% of citrus pulp) and 6 replicates of 6 birds each. The total excreta collection was performed in a trial period of 10 d (5 d of adaptation and 5 d of excreta collection). In Experiment II, a total of 966 1-d-old Cobb 500 male broiler chicks were distributed in a completely randomized design with 6 treatments (0, 2, 4, 6, 8 and 10% dietary inclusion of citrus pulp) and 7 replicates of 23 birds each. Performance, carcass yield, serum levels, bone variables, intestinal morphology, meat quality and economic feasibility were evaluated. The obtained results were analyzed using SAEG statistical software (2007). Following ANOVA, whenever a difference was found, the degrees of freedom were decomposed into polynomials and analyzed by regression for the different relationships – linear or quadratic ( $P < 0.05$ ). The calculated nutrient contents of citrus pulp were: 1,311 kcal of AME/kg DM, 4.6% CP, 30.9% neutral detergent fiber and 36.9% acid detergent fiber. Citrus pulp can be included up to 10.0% in broiler diets without adverse effects on weight gain ( $P = 0.068$ ), feed intake ( $P = 0.093$ ) and feed conversion ( $P = 0.071$ ), carcass yield ( $P = 0.131$ ), meat quality ( $P > 0.05$ ), intestinal morphometry ( $P > 0.05$ ), and with improved economic indices. By comparing the dietary levels of citrus pulp with the control diet, birds fed 10% of citrus pulp had lower serum levels of total cholesterol. This result could have been due to fiber content in the citrus pulp, which may reduce cholesterol levels in blood by increasing bile acid excretion.

**Key Words:** by-product, meat quality, performance

## Metabolism and Nutrition: Nutrition II

**149 Effect of feeding detoxified shea butter (*Butyrospermum paradoxum*) cake meal on performance characteristics of broiler chicken.** Paschal C. Aguihe<sup>\*1</sup>, Abiodun S. Kehinde<sup>1</sup>, Camilo I. Ospina-Rojas<sup>2</sup>, and Alice E. Murakami<sup>2</sup>, <sup>1</sup>Department of Animal Production and Technology, Federal College of Wildlife Management, New-Bussa, Niger, Nigeria, <sup>2</sup>Department of Animal Science, Universidade Estadual de Maringá, Maringá, Parana, Brazil.

Shea butter cake (SBC), a by-product of the indigenous technology for the extraction of fat from the seed of shea butter tree in West Africa and has been seen as a cheaper alternative for dietary energy sources but has some nutritional limitation. This study was conducted to determine the effect of detoxified shea butter cake meal (SBCM) on performance of broiler chicken for 42 d. A total of 250 1-d-old Arbor Acres chicks were randomly allocated to 5 dietary treatments with 5 replicates of 10 birds each in a completely randomized design. The experimental dietary treatments were as follows: T<sub>1</sub> containing 0% SBCM (maize based control diet), T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> contained raw SBCM, soaked-cooked SBCM, NaOH SBCM and fermented SBCM, respectively, always replacing 20% of maize meal in the control diet. The cost/kg weight gain was calculated as the product of cost/kg feed and feed-to-gain ratio of birds. All data were analyzed using ANOVA by the GLM procedure of SAS. Differences among means were separated with Tukey's multiple range tests. Proximate and tannin composition of SBCM were analyzed in triplicates as described by AOAC (2000) which contained 93.27% DM, 14.60% CP and 4361.97 kcal ME/kg (estimate based on prediction equation), and 0.21 mg/100g tannin. Soaking and boiling, sodium hydroxide (NaOH) treatment and fermentation reduced 83.33, 75.24 and 72.38% of tannin concentration respectively. The results showed that all parameters measured were significantly ( $P < 0.05$ ) affected by the detoxification methods. Daily weight gain, feed intake and feed-to-gain ratio were similar ( $P > 0.05$ ) among the birds fed control and detoxified SBCM diets but reduced ( $P < 0.05$ ) in the birds fed raw SBCM diet. Cost/kg weight gain reduced ( $P < 0.05$ ) with the inclusion of detoxified SBCM in the broiler diets. In conclusion, the different detoxification methods were effective in improving the nutritive value of SBC and making it a potentially useful feed ingredient in reducing feed cost in poultry diet. **Acknowledgments:** The managerial assistance and support provided by the Provost/CEO and management of The Federal College Wildlife Management is gratefully acknowledged.

**Key Words:** broiler, performance, nutritive value, processing, shea butter cake

**150 Dehydrated cassava starch residue in the feed of broilers from 21 to 42 days supplemented or not with carbohydrases.** Idiana Mara da Silva<sup>\*</sup>, Jomara Broch, Ricardo Vianna Nunes, Cinthia Eyng, Israel Costa Pires Filho, and Lucas Wachholz, *Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.*

The dehydrated cassava starch residue (*Manihot esculenta crantz*; DCSR) can be used as an energetic ingredient for non ruminants. For being a fibrous ingredient, carbohydrases enzymes can be used to improve the feed value. In view of this, the study aimed to evaluate the effect of different levels of DCSR with or without the carbohydrases supplementation on performance and carcass characteristics of broilers from 21 to 42 d. 950 male broilers were assigned in a completely randomized 2 × 5 factorial arrangement, composed of the supplementa-

tion or not of carbohydrases enzymes (amylase - Ronozyme A, 400 g ton<sup>-1</sup>; xylanase - Ronozyme VP, 200 g ton<sup>-1</sup>; β glucanase - Ronozyme WX2000, 50 g ton<sup>-1</sup>) and 5 levels of inclusion of DCSR (0, 2.5, 5.0, 7.5, and 10%), resulting in 10 treatments with 5 replicates. At 42 d of age, the performance parameters (weight gain - WG, feed intake - FI and feed:gain - F:G) were evaluated. To determine the carcass characteristics (carcass yield and portion yield - whole breast, thigh, and legs with their skin and bones) 2 birds per pen were selected and slaughtered. Data were submitted to ANOVA to verify main effects of the studied factors and their interactions. Means were compared by the F test ( $P < 0.05$ ). When a significant ( $P < 0.05$ ) main effect of dietary DCSR level was detected, a regression analysis was then performed. There was a significant interaction ( $P < 0.05$ ) between DCSR level/enzyme supplementation on F:G during the period from 21 to 42 d of age. The F:G linearly increased ( $P < 0.05$ ) in the birds fed the non-enzyme supplemented diet. For breast yield, there was a significant interaction ( $P < 0.05$ ) between DCSR level/enzyme supplementation, with a quadratic response ( $P < 0.05$ ) and highest and lowest value estimated at 4.06% and 5.76% for non-supplemented and supplemented treatment, respectively. There was no interaction ( $P > 0.05$ ) between the studied factors to the other variables. The DCSR diet inclusion impaired broiler performance and carcass characteristics, however, enzyme supplementation was able to maintain the F:G.

**Key Words:** by-product, exogenous enzyme, nutrition, performance, poultry

**151 Economic analysis of broilers supplemented with probiotic and organic acids.** Robert Guaracy Aparecido Cardoso Araujo<sup>\*1</sup>, Adriano Barbieri<sup>1</sup>, Gustavo do Valle Polycarpo<sup>2</sup>, Kelry Mayara da Silva<sup>1</sup>, Gabriela Ventura<sup>1</sup>, and Valquíria Cação Cruz-Polycarpo<sup>1</sup>, <sup>1</sup>University of Estadual Paulista, Dracena, SP, Brazil, <sup>2</sup>University of São Paulo, Pirassununga, SP, Brazil.

The aim of this study was to evaluate the economic viability of broilers supplemented with probiotic and organic acids, isolated or associated, as an alternative to antibiotic growth promoters. Nine hundred male Cobb chicks were used and housed in 30 floor pens in a completely randomized design featuring a 2 × 2 + 1 factorial scheme: with or without probiotic, with or without organic acids and a positive control treatment with avilamycin plus monensin, totaling 5 treatments and 6 replications. The diets were based of corn and soybean meal. The economic study evaluated the cost of feed, gross income, operating earnings, profit margin and final cost/bird. The profitability indicators used in this work were: gross income, which consists of multiplying the total kilograms obtained per treatment by the average unit price of poultry paid to producers; operating earnings, which represents the difference between gross income and total cost of production; and profit margin, which refers to the rate of gross income, which consists of available resources, in relation to the net income obtained, multiplied by 100. The economic evaluation was based on animal performance for the period from 1 to 42 d of age. The cost of each experimental diet was calculated according to the prices of ingredients, based on quotes obtained in December 2014, when the economic analysis was carried out. All data were submitted to ANOVA through orthogonal contrasts. Birds fed diets containing antibiotics had higher costs 4.86 real/bird, income 7.97 real/bird and profits 3.11 real/bird. The higher costs were mainly from higher feed intake that generated therefore a higher body weight of birds fed antibiotics. Despite the higher cost, the income generated from the birds fed antibiotics 7.97 real/

bird was significant and higher than the income of the birds that did not consume antibiotics 7.55 real/bird, surpassing spending and generating higher profits, making the antibiotic treatment the more economically viable. Under the challenge conditions imposed in this study, the organic acids and probiotics isolated or associated, do not alter the results of the economic analysis.

**Key Words:** cost, economy, income, production, profit

**152 Metabolizable energy of full-fat soybean without or with protease supplementation in diets for broilers.** Felipe Santos Dalólio\*, Luiz Fernando Albino, Horácio Rostagno, Diego Ladeira, and Maurílio Xavier Júnior, *Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.*

This study aimed to determine values of nitrogen-corrected apparent metabolizable energy (AMEn) of 9 toasted FFSB samples, without or with the addition of monocomponent protease. In these experiment, to determine the energy values, the method of excreta collection was used with 1120 broiler chicks at 13 d old and average weight of  $420.0 \pm 5.0$  g, distributed in randomized blocks in a  $10 \times 2$  factorial arrangement with 9 FFSB (30% included) plus a control diet (70%) without or with the addition of protease (200 ppm in the on top form), totaling 20 treatments with 8 replicates and 7 birds per cage. Data set for the experiment were submitted to ANOVA, and means were analyzed by Student-Newman-Keulls (SNK) test at 5%. Overall, the protease enhanced values of AMEn compared with those without addition. The enzymatic activity of protease provided an average of 150 kcal/kg, which is 4.5% more energy in the FFSB samples evaluated in this study. This indicates better utilization of CP from the FFSB, providing greater amount of amino acids available for protein metabolism and other nutrients. When analyzing the average marginal effect on the type of FFSB in the use of energy, it is clear that the sample 7 was higher than sample 4 ( $P < 0.05$ ), however, did not differ from the others. The variability among AMEn values found in this study are due to variability between soil type, planting, cultivating and mainly due to thermal processing. Although all samples are submitted to the same type of thermal browning, it was observed that lack of standardization. Sample 4 was the most varied in relation to the other. Furthermore, it showed trypsin inhibitor and urease indexes outside the recommended rate. The average values of AMEn of toasted FFSB by 3207 kcal/kg, but the greatest AMEn values were observed when protease was supplemented in diets. Thus, it is recommended the supplementation of a monocomponent protease to optimize energy and nutrient utilization, and to alleviate the adverse effects of inadequate thermal treatment.

**Acknowledgments:** The authors thank CAPES, CNPq and Fapemig.

**Key Words:** exogenous enzyme, metabolizability, monocomponent, poultry

**153 Effects of autolyzed yeast from *Saccharomyces cerevisiae* supplementation on broiler performance and intestinal gene expression.** José Guilherme M. Barbosa\*, Glaucia S. Komatsu, Jaqueline M. Rafael, Naiara S. Fagundes, Rafaela Pereira, and Jose Fernando M. Menten, *University of São Paulo, Piracicaba, São Paulo, Brazil.*

A study was conducted to evaluate the effects of autolyzed yeast from *Saccharomyces cerevisiae* on broiler performance and intestinal gene expression. A total of 1120-d-old Ross AP-95 male chickens were distributed in a completely randomized design fed 4 diets with 7 replications: Negative control (NC- no additive supplemented); Positive control

(Zinc Bacitracin - 55 g/t); NC + autolyzed yeast from *Saccharomyces cerevisiae* - 2 kg/t (Sinergis); NC + autolyzed yeast from *Saccharomyces cerevisiae* - 4 kg/t (Sinergis). The autolyzed yeast was provided by Aleris. The corn soybean meal basal diet was formulated with inclusion of 5% poultry by-product meal and 5% wheat bran, and at 7 d of age, all birds were vaccinated against coccidiosis at the manufacturer recommended doses by eye drops to induce immune challenges. Body weight gain (BWG, kg), feed intake (FI, kg) and feed/gain ratio (FCR) were evaluated from 1 to 35 d. The intestinal gene expression of Claudin-1, IL-1 $\beta$  and IL-4 was accessed 24 h post vaccination and at 21 d by using Real Time PCR. The General Linear Model (GLM) procedures of SAS was used to analyze the data and means were separated by Tukey's Test when significant ( $P < 0.05$ ). At 35 d, FCR was improved by 1.63% in the birds fed with 4 kg/t of yeast (1.569) when compared with the birds in the NC treatment (1.595), and it was similar to the FCR obtained in the birds fed zinc bacitracin (1.568). Diets supplemented with 4 kg/t yeast led to an improvement in the BWG of 2 and 1.24% compared NC and PC diets, respectively (2.447 vs. 2.399 and 2.417). At 21 d of age, the supplementation of 4 kg/t of yeast 2 and half-fold upregulated the expression of IL-1 $\beta$ , without affecting the expression of IL-4. Supplementing 4 kg/t of autolyzed yeast may be considered as an alternative to antibiotic growth promoters due to the beneficial effect on the performance and modulation of the intestinal immune system by upregulating a proinflammatory cytokine.

**Acknowledgments:** We acknowledge Aleris for the financial support and CNPQ for the student scholarship.

**Key Words:** broiler, intestinal gene expression, *Saccharomyces cerevisiae*

**154 Effects of a nutritional supplement on the immune and redox responses of broilers to LPS challenge.** Rebeca Alves Weigel\*<sup>1</sup>, Breno C. B. Beirão<sup>2</sup>, Tobias Fernandes Filho<sup>2</sup>, José Luciano Andriguetto<sup>3</sup>, Daniely Salvador<sup>1</sup>, and Luiz Felipe Caron<sup>3</sup>, <sup>1</sup>*Quimtia SA, Colombo, Paraná, Brazil*, <sup>2</sup>*Imunova Biological Analysis, Curitiba, Paraná, Brazil*, <sup>3</sup>*Federal University of Paraná, Curitiba, Paraná Brazil.*

One of the consequences of intensive animal production is environmental challenge. Modulation of the immune system is a very sought after mechanism to improve animal health. The goal of this study was to determine the immune and redox effects of a nutritional supplement in broilers under experimental challenge. Thus, broilers were reared from hatch. On d 1, 10 blood and liver samples were collected from all animals, regardless of grouping. On d 2, 10 samples/group were collected. Treated groups received on the first 3 d a balanced feed supplement containing high energy and palm fat. At this date, one supplemented group and one control group were challenged with LPS from *Salmonella enteritidis* (1 mg/kg IP). Controls received only the carrier, totalizing 4 experimental groups. Further sampling (8 birds/group) was carried out at 12 h, 36h and 12 d post-challenge. Analysis was performed with 2-way ANOVA and Tukey *post-hoc* test ( $P < 0.05$ ). LPS challenge was effective in inducing immune changes, confirmed by the statistical significance against the control group for the CD8<sup>+</sup>CD28<sup>+</sup> T lymphocytes, and Kul<sup>+</sup>MHCII<sup>-</sup> cells – suppressors monocytes – 12h after LPS. At this date, the nutritional supplement could not revert the effect of LPS on the Kul<sup>+</sup>MHCII<sup>-</sup> cells, but it did diminish the effect of the challenge on the CD8<sup>+</sup>CD28<sup>+</sup> cells. The redox response seems to have started at 36h, when groups differed for catalase (CAT), Superoxide-dismutase (SOD), Glutathione-S-transferase (GST), lipoperoxidation (LPO) and total liver Protein (LP), indicating that both challenged groups suffered oxidative damage, but at lower level in the supplemented group. At d

12 after challenge no effect was seen on immune cells, but the effect on Reduced Glutathione (GSH) showed a faster oxidative stress recovery for the supplemented group. Overall, the nutritional additive effectively altered redox and immune parameters. Modulation of the immune response may have been the cause of milder oxidative stress, therefore preventing some of the deleterious effects of the LPS challenge.

**Key Words:** additive; feed; immune; cytometry; redox

#### 155 Electrolyte balance and sodium levels in broilers diets.

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The objective of the current study it was evaluating the electrolyte balance (EB) and sodium (Na) levels for broilers from 1 to 21 d. A total of 840 chicks, male, Cobb 500, 1 d old, were allocated to a completely randomized design in a 2 × 4 factorial arrangement (2 Na levels - 0.21 and 0.23%, and 4 EB values - 160, 200, 240, 280 mEq/kg) totalizing 8 treatments with 7 repetitions of 15 birds each. Diets were corn and soybean meal based and formulated according to Rostagno et al. (2011). Feed intake (FI), feed conversion ratio (FCR), and body weight gain (BWG) were evaluated. Data were analyzed using the GLM procedure of SAS appropriate for a completely randomized design for a factorial arrangement of treatments. Feed intake was higher to birds fed to 0.23% Na ( $P < 0.023$ ). The feed conversion was not influenced by treatments ( $P > 0.05$ ). There was an interaction between treatments for weight gain. The use of 0.23% Na and 280 mEq/kg showed the best weight gain ( $P < 0.001$ ). In conclusion, for broilers fed typical Brazilian commercial diets, the level of 0.23% Na and 280 mEq demonstrated to improve the performance.

**Key Words:** acid-basic, electrolyte, metabolic disorder, mineral, performance

#### 156 Effect of different crude protein levels on the body composition of broiler.

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The performance and deposition of protein and fat in broilers can be influenced by sex and protein intake, i.e., male broilers have better feed efficiency and body protein deposition while females accumulate higher amount of fat in the body, notably in the finisher phase. Thus, the aim of this study was to evaluate the effect of 3 crude protein levels (CP) on protein and fat deposition in both sexes. We used 720 broilers Cobb500 (360/sex) distributed in a completely randomized design with a 3 × 2 factorial arrangement (3 levels of CP x 2 sexes) and 6 replicates of 20 birds each. The trial lasted 56 d and was divided in 4 periods: from 1 to 14, 15 to 28, 29 to 42 and 43 to 56 d. The diets attended all the nutrient requirements according to Brazilian Tables, varying the CP in 70, 100, and 130% in each period and maintaining the same optimum amino acid ratio. Birds were slaughtered at the end of each period to determine protein and fat composition in the body. Statistical analysis were performed using SAS software and the means were compared by Duncan's test at 5% of probability. According to the results, the CP intakes influenced the body protein deposition in the broilers ( $P < 0.05$ ) only in the period from 1 to 14 d. In other periods, the results did not differ ( $P > 0.05$ ) between sex and CP levels, indicating that these birds probably reached their maximum CP deposition. In the periods from 1

to 14, 15 to 28 and 29 to 42 d there were differences in fat deposition ( $P < 0.05$ ) between the CP levels and interaction between sex and CP levels. In the final period (43–56 d) females deposited more fat ( $P < 0.05$ ). In conclusion, the protein and fat deposition are affected by sex and different CP levels and a higher weight gain could not be from only the protein deposition.

**Key Words:** protein deposition, fat deposition, poultry, sex

#### 157 Glycosaminoglycans, vitamin C, and B6 in ovo feeding in body weight and organs weight of chicks.

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The glycosaminoglycans (GAGs) polysulfated such as chondroitin and glucosamine have anti-inflammatory action. Ascorbic acid acts on the immune system and is essential for collagen formation. The principal metabolic function of vitamin B6 is amino acid metabolism. The purpose of this study was to verify if the supplement injection of GAGs, vitamin C and B6 influence the chicks' weight and organs after hatching. One hundred and 4 (184), fertile, broiler eggs (Ross) were used. The experimental design was completely randomized with 5 treatments (non-injected; injected with solution based; injected with 50mL of solution based+50mg of chondroitin sulfate; injected with 50mL of solution based+50mg of glucosamine sulfate and injected with 50mL of solution based+50mg of chondroitin sulfate+100 mg of glucosamine sulfate. For each 200 mL of solution based was composed: amphotericin 2 mL, gentamicin 17 µL, vitamin C (ascorbic acid) 3.3 g e vitamin B6 (pyridoxine) 40 mg. Statistical analyses were performed using the SAS. The data were analyzed according to the Proc Mixed for mixed models, with the collection of ages 1, 7 and 14 d old after hatching to body weight, liver, heart and bursa and 1 and 7 d of age to yolk sac as repeated measures. The obtained weight of the birds and weight of heart, liver, bursa and yolk sac, was from 6 birds per treatment in different ages. There was a significant difference ( $P < 0001$ ) for the birds' weight and weight of the heart, liver, bursa and yolk sac for all ages. There was significant interaction between treatments and the age for weight of the heart ( $P < 0034$ ) and bursa ( $P < 0001$ ). The heaviest heart weight 3.94 g that was observed at 14 d of age with treatment 50mL of solution based+50mg of chondroitin sulfate. For the bursa, the highest weight was 1.23 g which was observed at 14 d of age with treatment 50mL of solution based+50mg of glucosamine sulfate. The supplementation with GAGs, vitamin C and B6 influenced in the weight of the heart and bursa in broilers at 14 d of age.

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**Key Words:** ascorbic acid, chondroitin, glucosamine, incubation

#### 158 Reproductive tract development of Bovans White laying hens fed different levels and sources of dietetic crude fiber.

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We aimed to evaluate the percentage of abdominal fat and the relative weight of ovary, oviduct and breast in Bovans White commercial laying hens fed increasing levels of crude fiber (CF) and 2 sources of fiber, evaluated at 18 and 24 wk old. The study was carried out at UFGD Experimental Aviary, where 462 d-old Bovan White chicks were housed, distributed in a completely randomized design, in a  $3 \times 2 + 1$  factorial arrangement, with 3 levels of crude fiber in the diet (2.5%, 3.0% and 3.5%), 2 fiber sources (sugarcane bagasse: insoluble, and wheat bran: soluble) and a control treatment (corn and soybean), with 6 replicates of 11 birds each. At the end of each phase, one bird per replicate, with an average weight of treatments, was slaughtered for removal of its ovary, oviduct and abdominal fat, to obtaining the organs relative weights and determining the effects of fiber levels and sources on laying hens reproductive development. Data were subjected to ANOVA and Tukey test at 5% of significance for means comparison, with the help of Minitab 16. It were obtained a greater relative weight of oviduct, ovary and abdominal fat (2.18% 1.83% and 3.67%, respectively) in birds fed 3.5% CF ( $P < 0.05$ ), and higher breast percentage (16.8%) with the use of wheat bran to 18 wk old birds. At 24 wk old, there was no effect of treatments on the breast and abdominal fat percentage in these birds ( $P > 0.05$ ). However, an interaction occurred for oviduct and ovary weights, with greater weights of oviduct (7.1%) and ovary (2.9%), when 3.5% of fiber where used. The use of sugarcane bagasse and 3.5% CF led to the lowest oviduct weight (3.8%), while the use of wheat bran and 2.5% FB led to the lowest ovary weight (1.7%). Results corroborate with those obtained by Araújo et al. (2013) with the use of diets with 2.5% crude fiber and wheat bran. The use of wheat bran in the diet had a positive effect with the level of 3.5% CB on the development of the reproductive tract of lightweight laying hens.

**Acknowledgments:** FAPEG, CNPq, Mercoaves, Hendrix, Tectron

**Key Words:** bagasse, egg production, nutrition, wheat bran

**159 Relationship of betaine, choline, and methionine digestible in laying hen diets.** Almir Ferreira Silva\*<sup>1</sup>, Carlos Boa Viagem Rabello<sup>1</sup>, Guilherme Rodrigues Nascimento<sup>1</sup>, Helena Emília Cavalcanti Costa Cordeiro Manso<sup>1</sup>, Julia Silva Barros<sup>1</sup>, and Rafael Santos Aquino<sup>2</sup>, <sup>1</sup>Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil, <sup>2</sup>Instituto Federal do Sertão Pernambucano, Salgueiro, Pernambuco, Brazil.

DL-methionine has increased greatly in price, so betaine can partially replace in some research with chickens. Moreover, few studies have been conducted taking into consideration supplementation or not choline chloride in laying hens diets. The objective of this study was to evaluate the effect of Betaine in partial replacement of DL-methionine 99% or partial and total choline chloride 60% on performance and quality of eggs. 216 laying hens Dekalb White, 24 wks old were allocated in cages (562.5cm<sup>2</sup>/hens). The experiment lasted 144 d. The experimental design used was the completely randomized, consisting of 6 treatments, 6 repetitions and 6 birds/replications. The treatments were: T1–positive control (CP); T2–negative control (NC), reduced methionine requirement (30%) and no choline supplementation; T3- reduced methionine (30%) and choline supplementation; T4- NC + 0.06% betaine in replacement 50% of choline chloride; T5 NC + 0.08% betaine in replacement of 75% of choline chloride; T6- NC + 0,12% betaine in replacement of choline total. The variables evaluated were: feed intake (g/h/d); egg production (% and g/h/d), feed conversion ratio (g:dz and g:kg), and quality of the eggs (haugh unit, weight and percentage of the yolk, the albumen and shell). The results were submitted variance analyses and applied tukey test ( $P < 0.05$ ) and the regressions analyses was used only to study betaine levels SAS software 2009 version through. The NC had the worse results for productive parameters. Feed intake, egg production and feed conversion ratio were influenced by the betaine levels. The quadratic regression model showed 0.06% betaine supplementation the laying hens had the best performance and 0.07% showed the best quality (haught unit) of the eggs; this levels showed similar response yolk and shell weight comparative the laying hens fed control diet. In conclusion, betaine can be included in laying hen's diet until 0.07% can with reduction of methionine and coline without affecting without affecting the performance and quality of eggs.

**Acknowledgments:** Uniave Agrodistribuidora

**Key Words:** albumen, feed conversion, feed intake, performance

## Physiology and Reproduction

**160 Effects of canthaxanthin and 25-OH-D3 on reproductive parameters of quail breeders.** Lucas P. Bonagurio<sup>1</sup>, Carlos A. L. Oliveira<sup>1</sup>, Murray R. Bakst<sup>2</sup>, and Tatiana C. Santos\*<sup>1</sup>, <sup>1</sup>*Department of Animal Science, State University of Maringá, Maringá, Paraná, Brazil,* <sup>2</sup>*Beltsville Agricultural Research Center, USDA Agricultural Research Service, Beltsville, Maryland, USA.*

The impact of varying levels of dietary canthaxanthin (Cx) + 25-hydroxycholecalciferol (25-OH-D3) on fertility levels and perivitelline layer (PL) sperm numbers in 26 wk and 40 wk old European quail were compared. Ninety quail breeders were distributed in a completely randomized design with 5 treatments control diet (2,000IU 25OH), 3ppm Cx+1,380IU 25-OH-D3, 6ppm Cx+2,760IU 25-OH-D3, 9ppm Cx+4,140IU 25-OH-D3, and 12ppm Cx+5,520IU 25-OH-D3) and 9 repetitions (male + female couple). At 26 and 40 wk of age, males and females were paired for 24 h. During the next 12 d all eggs were broken-out and classified as fertilized or unfertilized and sperm in the PL counted. Data were analyzed with binomial distribution and LOGIT link function (fertility) or gamma distribution and inverse link function (sperm number). Fertility levels and PL sperm numbers were different at 26 and 40-wks and were quadratically influenced in function of day after copulation and treatments. Eggs from quails fed any level of Cx+25-OH-D3 at 26-wks maintained the probability of fertile above 96% until the 1–5th day after copulation, while the control group had levels above 90% by the 1–3rd day after the copulation. At 40-wks of age, the control group only reached 70% fertility on 1–2nd day post-copulation whereas the supplemented treatments groups sustained fertility > 90% for the first 5 d. Sperm numbers in the PL was highest in the first days after copulation, with better results at 6ppm Cx+2,760IU 25-OH-D3, and then decreased over time and in older breeders (40-wks) treatments with supplementation kept a lot of sperms, similar to that observed in young ones (26-wks). The increased sperm numbers in the PL and the subsequent higher fertility levels observed with the quail fed diets with supplemental Cx+25-OH-D3 were most likely due to either sperm viability and/or increased numbers of sperm reaching and surviving in the oviductal sperm storage tubules. Furthermore, dietary CX+25-OH-D3 appears to sustain fertility in 40 wk old quail when compared with control group. Whether this is applicable to other commercial avian breeders needs to be investigated.

**Acknowledgments:** CNPq

**Key Words:** breeders, fertility, perivitelline layer, egg, sperm.

**161 Study of the pectoralis and supracoracoideus muscles growth in European and Japanese quails.** Isabelle N. Kaneko\*<sup>1</sup>, Christian D. N. Figueroa<sup>1</sup>, Flavia K. Cruz<sup>1</sup>, Fernanda L. A. Almeida<sup>2</sup>, Carlos A. L. Oliveira<sup>1</sup>, and Tatiana C. Santos<sup>1</sup>, <sup>1</sup>*Department of Animal Science, State University of Maringá, Maringá, Paraná, Brazil,* <sup>2</sup>*Department of Morphological Science, State University of Maringá, Maringá, Paraná, Brazil.*

The objective of this study was to describe the morphological development of breast muscle, pectoralis and supracoracoideus, from last embryo stage to 35 d in European and Japanese quails. The experimental design was a factorial of 2 quail's type and 10 ages (incubation: 13, 15 and hatch; post hatch: 4, 7, 10, 14, 21, 28 and 35 d). Additionally, at 35 d results from fiber morphology were analyzed by sex. Pectoralis and supracoracoideus muscles from embryos and quails (n = 6) were dissected to determine the weight (total and relative) and fiber morphology. Muscles samples were frozen at liquid nitrogen and prepared by NADH-TR histochemistry stain. Growth curves for body weight, total breast and muscles weights were determined by Gompertz growth model. Breast and muscles relative weights, fiber number/area and diameter of fibers did not adjust to the Gompertz model then were submitted to ANOVA and regression analysis. European quails were precocious in relation to Japanese, with maximum growth rate at 16 and 19 d, respectively. However, regarding muscle growth, both types of quails showed maximum growth rate at 21 d. Supracoracoideus muscle had highest growth rate in relation to the pectoral muscle, although the pectoral muscle represented the majority of breast. With Gompertz equation derivation was observed that the supracoracoideus reached the maximum growth rate 2 d before the pectoralis muscle. Histologically, in both quails and along the development, the pectoralis and supracoracoideus muscles fascicles were composed by type IIA muscles fibers surrounded by IIB. In European and Japanese quails, the fibers from the supracoracoideus muscle showed higher diameter compared with the fibers of the pectoralis muscle. At 35 d, in males of European quails the fiber types IIA showed higher and IIB lower frequency in relation to the females, and in the Japanese quails was the opposite. However, European quails had a higher diameter of muscle fibers. In conclusion, the breast muscles parameters and growth curves were similar between European and Japanese quail, with higher precocity to European quails.

**Key Words:** breast, Coturnix, Gompertz, muscle, NADH

# Thursday, October 6, 2016

## SYMPOSIA AND ORAL SESSIONS

### Metabolism and Nutrition: Amino Acids II

#### 162 Performance and carcass yield of broilers in the growth phase (22–42 days) fed different levels of sulfur amino acids.

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It was aimed to determine the digestible methionine + cystine requirements for male broilers in the growing phase (22–42 d). A total of 900 Cobb 500 day-old male broiler chicks were distributed in a completely randomized design, with 5 treatments and 6 replicates of 30 birds. The treatments consisted of different levels of methionine + cystine. It was prepared a mash basal diet, based on corn and soybean meal without addition of methionine, which was later supplemented with DL-Methionine 99% (0.00; 0.03; 0.07; 0.10; 0.13%) replacing the inert material, resulting, respectively, in experimental diets with 0.514; 0.571; 0.647; 0.704; 0.761% digestible methionine + cystine. At 42 d old, weight gain, feed intake and feed conversion were evaluated, and one bird per replicate, 6 per treatment, were separated based on the average weight of the replicate, for evaluation of the carcass yield (eviscerated carcass without feet, neck, and head), abdominal fat, breast, thigh + drumstick and wings. Data were submitted to ANOVA with 5% significance, and regression was performed among the levels of methionine+cystine, using the R statistical program. A higher weight gain and higher final weight were observed to the level of 0.667% methionine + cystine, and feed conversion was lower for the level of 0.716%. There was no difference ( $P > 0.05$ ) in feed intake. No differences ( $P > 0.05$ ) were found among treatments for wings, abdominal fat and breast yield. However, carcass and thigh + drumstick yield linearly increased with increasing levels of sulfur amino acids in the diet. Considering the conditions under which the experiment was conducted, it is recommended for maximum performance of male broilers, levels of methionine + cystine of 0.716% with a methionine + cystine / lysine relation of 61% to the growth phase (22–42 d).

**Key Words:** digestible methionine + cystine, feed conversion, feed intake, poultry production, weight gain

#### 163 Lysine effect on performance, protein deposition and carnitine concentration in the pectoralis major muscle in broilers.

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The aim of the study was to evaluate the effects of diets with digestible lysine (dig lys) levels on carnitine concentration performance in the *Pectoralis major* muscle, weight gain and protein deposition in male broilers. From 8 to 42 d, a total of 252 male broilers Cobb 500 were distributed in metabolic cages in 4 treatments with 7 experimental units of 9 birds each. The treatments consisted of diets containing 4 levels of dig lys, 1.016; 1.099; 1.182 and 1.265% for the period from 8 to 21 d and 0.923; 0.998; 1.073 and 1.148% for the period from 22 to 42 d of age. Weekly one bird per experimental unit was collected to determine protein deposition. To quantify the concentration of carni-

tine, by the enzymatic method, 5 g of the *Pectoralis major* muscle of 4 birds per treatment were collected at 42 d of age. Data were analyzed by the ANOVA procedure of SAS. Differences between means were evaluated by the Student-Newman-Keuls test at 5% significance level. It was observed that in the period from 8 to 21 d the level of 1.182% provided greater weight gain (916 g) and feed conversion (1.315 g/g) compared with other levels. Similarly it was observed that in the period 22–42 the level 1.148% of dig lys showed higher weight gain (1710 g) and a greater feed conversion (1.999 g/g), compared with other levels. Although it was not observed significant differences between protein gain rates (13.49; 14.16; 15.19; 15.22 g/bird per day) at 42 d of age, the carnitine concentration (44.6; 58.2; 50.6; 68.5 micromol/100 g) was statistically different between lysine levels. The levels 1.182 and 1.073% of digestible lysine provided higher performance, protein deposition and carnitine concentration in the studied periods.

**Acknowledgments:** COPEs - UFS

**Key Words:** amino acid, feed efficiency, carnitine

#### 164 Increasing tryptophan levels of diets formulated with high levels of animal by-products.

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The importance of animal by-products (ABP) in poultry diets has increased over the last years, mainly because of increasing costs of soybean meal. Besides the quality of these ingredients, it should be addressed the balance of digestible amino acids, in relationship to lysine and, especially, tryptophan. Thus, the objective of the present study was to evaluate different ratios of digestible tryptophan:lysine (T:L), using diets formulated with high level of animal by-products (ABP). 288 d-old Cobb 500 male chicks were allocated in a randomized block design, in 6 treatments, with 8 replicates (cage with 6 chicks). Treatments consisted of a positive control vegetal diet (VEG) with corn, soybean meal and phosphate and with T:L of 0.180%; a negative control (ABP0) formulated with ABP (meat and bone meal, feather meal, poultry by-products meal) with T:L ratio of 0.150%. Then, L-tryptophan was added to ABP0, to formulate diets (ABP1, ABP2, ABP3 and ABP4), with T:L ratios of 0.165, 0.180, 0.195 and 0.21%, respectively. Body weight (BW), feed intake (FI) and feed conversion rate (FCR) were recorded from 0 to 38 d of age. Data were analyzed using mixed models (SAS, 2012) and the following contrasts were used: C1 = VEG vs ABP0; C2 = VEG vs ABP2 (both diets having the same T:L of 0.180%). C3 and C4 were used to check the linear or quadratic response of increasing T:L on performance, from treatments ABP0 to APB4. In all analysis, differences were assumed to be statistically significant if  $P < 0.05$ . Broilers fed ABP0 diet had worse FCR and BW than VEG ( $P < 0.05$ ). On the other hand, no differences were found between VEG and ABP2 diets, indicating that lower T:L ratio and not ABP itself, was detrimental to performance. Increasing T:L increased FI linearly, and exerted a quadratic effect in both BW and FCR, with optimum T:L was calculated as 0.187 and 0.179% respectively. In conclusion, diets with high inclusion



of ABP and with low T:L can impact negatively broilers performance. Inclusion of synthetic tryptophan can mitigate this effect.

**Key Words:** ideal protein, meat and bone meal, feather meal, amino acid, performance

**165 Influence of lighting program on amino acid requirements in a broiler breeders flock.** Nayara Tavares Ferreira\*<sup>1</sup>, Nilva Kazue Sakomura<sup>1</sup>, Letícia Soares<sup>1</sup>, and Robert Mervyn Gous<sup>2</sup>, <sup>1</sup>*Faculdade de Ciências Agrárias e Veterinárias, UNESP, Jaboticabal, Brazil,* <sup>2</sup>*University of KwaZulu-Natal, Pietermaritzburg, South Africa.*

Lighting program (LP) for broiler breeders influences the age at first egg (AFE), and consequently in the egg production (EP) and amino acid requirement (AAR). This study aimed to model the AAR for broiler breeder flock in response to 2 LP during the rearing period. It developed a stochastic model, which has generated a population of 200 birds with normal distribution, with appropriate means and standard deviation, from 20 to 40 wk of age. As a model input was considered body weight (BW,  $2.34 \pm 0.05$  kg), and the LP (8h an increase to 16h light/d at 100 d of age (LP-A) =  $184 \pm 29$  d; and 140 d of age (LP-B) =  $176 \pm 11$  d) to estimate the AFE. Also, was estimate the internal cycle length (ICL =  $25.4 + 8.99 \times 0.75^{AFE} + 0.072 \times AFE$ , hour) to determine the rate of ovulation. The weights of yolk (YW =  $18.03 \times 1 - e^{-0.015 \times (AFE-103.4)} \times e^{-0.001 \times AFE}$ ), albumen (AW =  $14.38 \times YW^{0.375}$ ) and shell (SW =  $0.358 \times (YW+AW)^{0.687}$ ) were calculated. The data of BW, AFE, ICL, YW, AW and SW were used in an Excel spreadsheet to determine the AAR in function of LP by the equation:  $AAR = (AA_{Bm} \cdot P_m^{0.73} \cdot u) + (AA_g \cdot BWG) + (AA_y \cdot YW + AA_a \cdot AW)$ , where  $AA_{Bm}$  and  $AA_g$  are the AA composition of ideal protein for maintenance and body weight gain (BWG), 73 and 75 for Lys and 60 and 36 for Met+Cys, respectively. AAR for production of YW and AW are 477 and 378 for Lys and 338 and 418 for Met+Cis, respectively.  $P_m$  is body protein weight at maturity (kg); u is the degree of maturity, in this case = 1. The requirements of Lys were  $571 \pm 303$  and  $466 \pm 258$  and Met+Cys were  $501 \pm 303$  and  $399 \pm 258$  at 24 wk of age. For 28 wk of age, the requirements of Lys were  $718 \pm 352$  and  $927 \pm 265$  and Met+Cys were  $635 \pm 352$  and  $832 \pm 265$ . For 32 wk of age the requirements of Lys were  $910 \pm 336$  and  $957 \pm 308$  and Met+Cys were  $812 \pm 336$  and  $855 \pm 308$  mg/d, for LP-A and B, respectively. In conclusion, it is important to point out the great range of AFE by applying an inappropriate LP and consequently more variation of AAR, in this case, LP-A is higher compared with B.

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**Key Words:** requirement, simulation, stochastic model

**166 Metabolizable energy and digestible methionine + cysteine for pullets from 1 to 6 weeks of age on physiology parameters.**

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The aim was to evaluate the effect of levels of digestible Met+Cys (dM+C) and metabolizable energy (ME) to pullets from 1 to 6 wk of age. The study was conducted in a factorial  $4 \times 3$  (4 levels of dM+C, 0.732, 0.576, 0.640, 0.704%, and 3 levels of ME, 2755, 2900 and 3045kcal/

kg), a total of 12 treatments, 6 replicates of 15 pullets each. Variables: histology of the liver, villus of small intestine, nitrogen balance and serological status. It had no significant effect on liver. It had no significant effect on the height of the villus of the small intestine. Greater width of the villus was observed with 0.732% dM+C with 2775 and 2900kcal/kg, and increased crypt depth with 0.576% dM+C with 2755kcal/kg. The alanine aminotransferase levels had higher values of 0.576 and 0.704% dM+C and 2900 and 3045kcal/kg, respectively. The aspartate aminotransferase had higher value with 0.640% dM+C and 2755kcal/kg. Gamma-glutamyltransferase values were greater value observed in 2900 and 3045kcal/kg with 0.732% dM+C. Creatinine and total protein were not affected by treatments. The albumin had higher values in levels of 2900 and 3045kcal/kg, with 0.704% of dM+C. Glucose had highest values were observed in the levels of 0.640% dM+C with 2755kcal/kg and 0.704% dM+C associated with 2900 and 3045kcal/kg. The intake and nitrogen excretion were increased with increase dM+C and reduced with increase of ME, with higher N retention in 0.704% dM+C and 2755kcal/kg. In conclusion, it is recommended 0.640 or 0.704% dM+C in diet with 2755kcal/kg for pullets from 1 to 6 wk of age.

**Key Words:** amino acid, nutrition, physiology

**167 Responses of Japanese quails to methionine intake.** Miry-elle Freire Sarcinelli\*, Nilva Kazue Sakomura, Edney Pereira Silva, Juliano Cesar de Paula Dorigam, Katiani Silva Venturini, and Larissa Vargas, *Universidade Estadual Paulista, Jaboticabal, São Paulo, Brazil.*

The objective of this study was to determine the optimal methionine intake for Japanese quails, using the association of polynomial quadratic with the plateau of the broken-line model. Three hundred 90 2 Japanese quails with 16 wk of age were distributed in a completely randomized design with 7 treatments (methionine levels), 7 replicates and 7 quails per experimental unit. A diet with high protein level (summit) and a nitrogen-free diet were formulated. Both diets had the same level of minerals, vitamins and energy. The methionine content of the summit diet was 13 g/kg, considering 1.2 times the methionine requirement recommended by the Brazilian Tables and 1.4 times the requirements of the remaining amino acids to create a relative deficiency of 20% of methionine. The intermediary methionine levels (2.70; 4.32; 5.40; 6.80; 8.10; 9.50 and 10.79g/kg) were obtained by successive dilutions of the summit diet with the nitrogen-free diet. The eighth treatment was added (1.56g of DL-Methionine, in 2.70 diet) to confirm if methionine was the first limiting amino acid. The trial lasted 3 wk of adaptation and 4 wk of data collection. The additional response observed in the eighth treatment confirmed that methionine was the first limiting amino acid in the diets. The variables measured in this study were feed conversion (g/g), egg production (%) and egg mass (g). The first intersection of the polynomial quadratic curve with the plateau of the broken-line model was calculated to determine the optimum methionine intake that provide the maximum feed conversion, egg production and egg mass. Thus, it was estimated the methionine intake of 148; 180; 204 mg/quail/day for feed conversion (R<sup>2</sup> = 98%), egg production (R<sup>2</sup> = 98%) and egg mass (R<sup>2</sup> = 99%), respectively. In conclusion, we recommend using 204 mg/quail/day or 0.960% of digestible methionine for Japanese quails to maximize egg mass due to the market's interests.

**Acknowledgments:** Fapesp, CNPq, Ajinomoto

**Key Words:** egg production, egg output, egg weight, model

**168 Prediction of the valine requirement for Japanese quail using the saturation kinetics model.** Karla M. Martinez\*, Nilva K.

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The use of a prediction model to estimate the valine requirements for egg protein deposition can help to improve the nutritional knowledge in quails, enabling maximum use of the amino acid (AA) for egg production. Thus, the objective of this study was to evaluate the response of different valine intakes (iVal) for egg protein deposition. Two hundred 80 Japanese quails (25 wk old) were distributed in a completely randomized design, consisting of 7 treatments (1.96, 3.53, 5.09, 6.66, 7.84, 8.62 and 9.41 g/kg of valine), 7 replications with 5 quails per replication. The trial lasted 7 wk, with the first 3 weeks for adaptation and the last 4 for data collection. The experimental diets were formulated using the dilution technique. The variables evaluated were valine intake (iVal) and valine deposition in the egg mass (dVal). The dVal was determined at 0.9% of the egg mass. Both variables were related to metabolic weight. These variables were subjected to an adjustment of the saturation kinetics model (SKM):  $dVal = (b \cdot Km^n + dVal_{max} \cdot iVal^n) / (Km^n + iVal^n)$ , where  $dVal_{max}$  is the maximum theoretical deposition of valine, Km is the intake of valine for  $1/2(dVal_{max} + b)$ , n is the apparent kinetic order, and b is the intercept on dVal-axis. It was also possible to calculate the efficiency (Eff) using the following equation:  $Eff = (dVal - b) / iVal$ . The result was conditioned by the degree of limitation of the AA tested. The parameters adjusted for SKM were:  $b = 3.66 \text{ mg/kg}^{0.75}$ ,  $Km = 306 \text{ mg/kg}^{0.75}$ ,  $n = 3.59$  and  $dVal_{max} = 345 \text{ mg/kg}^{0.75}$ . Although the maximum theoretical response for dVal was  $345 \text{ mg/kg}^{0.75}$ , this value represents an asymptotic response and cannot be used for practical recommendation. Therefore, the iVal required to achieve 95% of  $dVal_{max}$  ( $dVal = 328 \text{ mg/kg}^{0.75}$ ) was estimated to be  $692 \text{ mg/kg}^{0.75}$ . In addition, the utilization efficiency of valine to achieve  $328 \text{ mg/kg}^{0.75}$  was calculated to be 47% ( $Eff = (328 - 3.66) / 692$ ). In conclusion, the valine intake recommended for 95% of the maximum valine deposition in the egg mass is  $692 \text{ mg/kg}^{0.75}$  per day with an efficiency of 47%.

**Key Words:** amino acid, valine deposition, egg mass, efficiency, metabolic weight

**169 Performance of Japanese quails (*Coturnix coturnix japonica*) fed with different levels of glutamine in different thermal environments.** F. A. Roque<sup>1</sup>, J. Paula<sup>2</sup>, M. D. G. Morais<sup>2</sup>, T. L. Pereira<sup>1</sup>, L. Staub<sup>3</sup>, N. S. Gonçalves<sup>2</sup>, A. P. S. Ton<sup>2</sup>, and C.M. Komiyama<sup>4</sup>, <sup>1</sup>University of São Paulo, Pirassununga, SP, Brazil, <sup>2</sup>Federal University of Mato Grosso, Sinop, MT, Brazil, <sup>3</sup>State University Maringa, Maringa, PR, Brazil, <sup>4</sup>Federal University of Grande Dourados, Dourados, MS, Brazil.

While reducing deleterious effects of heat stress on laying hens, the addition of glutamine, a non-essential amino acid, to the feed can enhance the productivity of the latter animals when submitted to heat stress. The objective of the current study was to evaluate the performances of Japanese quails (*Coturnix coturnix japonica*) fed with different levels of glutamine and reared in different thermal environments. A total of 210 Japanese quails of 49 d age ( $160.5 \pm 6.45 \text{ g}$ ) were used 2 periods of 28 d with 5 repetitions and 7 birds per experimental unit. The characteristics evaluated were: egg production (EP) and feed conversion per gram of eggs produced (FC/g). A completely random design was used in sub-divided split-plot, with 2 temperatures thermoneutral ( $22^\circ\text{C} \pm 2,15$ ) and heat stress ( $30^\circ\text{C} \pm 2,47$ ) and 3 glutamine levels (0.0; 1.5, and 3.0%) in each subplot. Means were compared with the Tukey-Kramer test with a confidence level of 5% (p-value). The logarithm ( $\text{Log } X+10$ ) was used to correct and homogenize variances between treatments. There was a significant effect in EP ( $P < 0.05$ ) when considering the

period of production and levels of glutamine for the egg production of  $83.67 \pm 9.74\%$  in the second period and  $68.61 \pm 13.63\%$  in the first and when birds received 3,0% ( $75.56 \pm 9.65\%$ ) of glutamine. The 1.5% level has not proven to be statistically different to the others. For FC/g, an effect ( $P < 0.05$ ) was also observed for EP in relation with levels of glutamine and of the period production. The best values of FC/g eggs were recorded for the 3.0% levels ( $2.40 \pm 0,25$ ) in comparison to the control ( $2.79 \pm 0,65$ ). The 1.5% supplementation was not proven significantly different to the 3.0% one or to the control ( $2,54 \pm 0,54$ ). Eventually, when evaluating the effect of the production period, better values were obtained for the second period ( $2,39 \pm 0,37$ ) compared with the first period ( $2,77 \pm 0,60$ ). The temperature did not influence the analyzed variables, however addition of glutamine in feed led to better performances of the laying quails.

**Key Words:** heat stress, period, temperature, thermoneutral, welfare

#### 170 Ideal ratio of amino acids for Redbro Plume chickens.

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The nutritional requirements of slow-growing birds are different from those of conventional broilers. There are several differences in the authoring system and management environment, especially those related to the time of the production cycle. In addition, nutritionists based on the ideal ratio of amino acids for broilers to calculate the diets of these birds. The object of the study was through the nitrogen balance technique estimate the ideal proportions of essential amino acids: methionine and cystine, threonine, tryptophan, arginine, valine, isoleucine and leucine:lysine, for Redbro line plume males in 3 growth stages (initial: 14 to 28 d, growth: 42 to 56 d; end: 70 to 84 d). 72 individually birds were 72 individually allocated in metabolic cages per experiment. The control treatment was formulated according to the nutritional recommendations suggested for chickens lineage Redbro plume, but the ideal relations of amino acids used was suggested by Brazilian tables. The diets with different amino acids were obtained by limiting dilution of the control diet with corn starch (70%) and supplemented with crystalline amino acids, amino acid except for the study. The nitrogen balance test was divided into 5 d of adaptation and 2 periods of excreta collection (10 d/period). Data were subjected to ANOVA and applied Dunnett's test for performance variables and mathematical models used by Goettingen suggested method. The estimated values for amino acids: lysine ratio were 67, 73 and 71 methionine+cystine; 63, 69 and 69 threonine; 17, 18 and 17 tryptophan; 105, 102 and 103 arginine; 85, 80 and 78 valine; 67, 67 and 68 isoleucine; 104, leucine 109 and 108, for initial phase, growing and finishing, respectively. These data provide support for more precise formulations diets for chickens Redbro plume, as is scarce information about this strain.

**Key Words:** balance technique, free range, genetics, lysine, metabolism

**171 Herbal methionine (Methiorep) as a substitute for synthetic methionine: effect on growth performance of finisher broilers.** John Olayinka Makinde\*<sup>1</sup> and Michael Inuwa<sup>2</sup>, <sup>1</sup>Federal University, Gashua, Yobe, Nigeria, <sup>2</sup>Federal College of Wildlife, New Bussa, Niger, Nigeria.

An experiment was conducted with 120, 4 wk old broilers to evaluate the effect of herbal methionine (methiorep) as substitute for synthetic

methionine on growth performance of finisher broilers. Five isocaloric and isonitrogenous diets were formulated and Diet 1 (control), comprised of 0.25% methionine (NRC, 1994) while diet 2, 3, 4 and 5 comprised of 25%, 50%, 75% and 100% methioren as substitute for methionine in the diets. The birds were randomly allocated to 5 experimental treatments of 24 birds per treatment while each treatment was replicated 3 times with 8 (8) birds per pen in a completely randomized design. The study lasted 28 d. The results of growth performance revealed that body weight gain, average feed intake and FCR during starter period were not significantly ( $P > 0.05$ ) influenced by dietary treatments. Significant difference ( $P < 0.05$ ) was however observed on cost per kg feed. The cost per kg feed decreased as the level of methioren increased in the

diets. It was concluded that Methioren can completely substitute for Methionine in the diets of finisher broilers without adverse effect on growth performance of birds.

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**Key Words:** methionine, methioren, growth performance, finisher broiler

## Immunology, Health, and Disease: Immunology II

**172 Performance and anticoccidial effects of Magni-Phi in salinomycin-fed broilers.** Kenneth W. Bafundo\*<sup>1</sup> and Greg F. Mathis<sup>2</sup>, <sup>1</sup>Phibro Animal Health Corp., Teaneck, NJ, USA, <sup>2</sup>Southern Poultry Research Inc., Athens, GA, USA.

Magni-Phi (Phibro Animal Health) is a triterpenoid saponin feed additive that has been shown to exert anticoccidial effects in broilers that complement the use of ionophores and coccidiosis vaccines. A series of 3 floor pen studies was carried out to evaluate the efficacy and performance responses of Magni-Phi (MP, 250 ppm) when used in combination with salinomycin (66 ppm). Trial 1 was conducted as a pilot study where salinomycin was fed both alone and in combination with MP for a 28 d period. Trials 2 and 3 utilized 2 × 2 factorial designs to evaluate the effects of MP and salinomycin, both alone and in combination, in their ability to improve performance under coccidiosis challenge. In all experiments, each treatment was replicated 8 times. In trials 1 and 2, birds were reared on used litter containing field isolates of coccidial oocysts; in trial 3, coccidia were known to be tolerant to ionophore medication. Performance and oocysts per gram of feces at 18 and 28 d were used as variables in all tests, and final performance was determined at 42 d. Pilot study results indicated that MP + salinomycin significantly improved performance at 28 d compared with salinomycin alone; oocyst production was significantly reduced ( $P < 0.05$ ) in birds receiving MP + salinomycin. The results of Trials 2 and 3 indicated that both MP and salinomycin significantly improved 28 and 42 d performance compared with controls, with the best weights and feed conversions recorded in treatments simultaneously receiving MP and salinomycin. In both cases, the MP and salinomycin responses were shown to be additive. Similarly, oocyst production was significantly reduced by both salinomycin and MP when fed alone, but the lowest oocyst output was recorded in treatments receiving both products concurrently. These results provide additional evidence for the anticoccidial effects of MP and, as in previously reported studies, illustrate the additive responses of MP and ionophore medication.

**Key Words:** coccidiosis, triterpenoid saponin, salinomycin, additivity

**173 Performance and immunity of broiler chickens fed diets supplemented with organic zinc.** Raissa G. D. Menezes\*<sup>1</sup>, Sergio L. Vieira<sup>1</sup>, Liris Kindlein<sup>1</sup>, Cesar Pontin<sup>1</sup>, and Nathália Cordeiro<sup>2</sup>, <sup>1</sup>Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, <sup>2</sup>Universidade Luterana do Brazil, Canoas, Rio Grande do Sul, Brazil.

A study was conducted to evaluate performance and immunological aspects of broilers fed diets supplemented with increasing levels of organic zinc (Zn). A total of 1,960 1 d-old male chicks Cobb x Cobb 500 were placed into 70 floor pens, distributed in a completely randomized design with 7 treatments, 10 replicates and 28 birds each. The dietary treatments consisted of increasing levels of organic zinc (Zn (HMTBA) 2) at intervals of 16 ppm (0, 16, 32, 48, 64, 80, and 96ppm). At 1 d birds were revaccinated to Gumboro for subsequent immunological tests. A 4 phases feeding program was used: pre-starter (1 to 14 d), starter (15 to 21 d), grower (22 to 28 d) and final (29 to 38 d). Body weight gain, (BWG), feed intake (FI) and feed conversion rate corrected for the weight of dead birds (FCR) was measured at 14, 21, 28 and 38 d. Blood collection was made for cellular immunity evaluation (7, 14, 21, 28, and 38 d) and humoral immunity (21, 28, and 38 d). At 38 d, 4 birds

per treatment were sacrificed for carcass and commercial cuts yield. Myopathies white striping and wooden breast, incidence of scratches on the skin, pododermatitis evaluation, breast calluses and bruises were also evaluated at 38 d. Breast samples were collected to measure pH, water retention capacity and cooking loss. Left tibia was collected for mineral concentration evaluation. Data were analyzed using the SAS and regression equations were estimated for increasing levels of Zn. Nonparametric data were compared by Kruskal Wallis test. Body weight gain increased linearly with Zn supplementation and feed conversion ratio decreased linearly ( $P < 0.05$ ) with supplementation of increasing levels of organic zinc. For carcass quality variables there was a negative linear fit for scrapes and bruises. Broilers fed diets supplemented with 16 ppm Zn had lower rate of hematoma at 38 d. For most of the evaluated parameters and immune response, linear regressions were obtained, so we cannot estimate optimum levels of Zn supplementation, because the maximum response could not be observed until the highest tested level of 96 ppm.

**Key Words:** immune response, broiler, immunity, performance, zinc

**174 Ophthalmic lesions of broilers housed in positive pressure and negative pressure systems: a histopathological preliminary study.** Adrien Wilhelm Dilger Sanches\*<sup>1</sup>, Antonio Leonardo Kraieski<sup>1</sup>, Georgia Caetano de Almeida Almeida<sup>2</sup>, Elisabeth Santin<sup>1</sup>, and Fabiano Montiani-Ferreira<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Curitiba, Parana, Brazil, <sup>2</sup>Universidade Tuiuti do Paraná, Curitiba, Parana, Brazil.

The current models of broiler housing using forced ventilation can be classified in positive and negative pressure systems. The aim of this preliminary study was to evaluate the presence, the kind and the differences of ocular lesions between these 2 managements by the means of histopathology. The eyes were from healthy, 20 d old, chicken broilers (males from lineage ROSS AP91) originated from 12 different poultry farms. Five farms used the positive and 7 used the negative pressure system. were divided in 2 groups: positive pressure housing (PPH) and negative pressure housing (NPH). The PPH group was represented with 23 eyes and the NPH group by 35 eyes. The findings were described, quantified and compared with those already reported in the literature. The different types of lesions were given a numeric score that varied from zero (no lesion) to 3 (most severe lesion). The histological changes found were corneal epithelial cell edema, uveitis, corneal mitotic index, conjunctival epithelial metaplasia, conjunctival cell proliferation (hyperplasia), conjunctival congestion, lymphoid follicular hyperplasia and inflammatory cell infiltrate. Statistical analyses (Student's t- test and Mann-Whitney test) showed that congestion was significantly higher  $P = 0.045$  in samples of the negative pressure group. Additionally, squamous metaplasia and epithelial proliferation were only observed in samples of the negative pressure system and were statistically significant (percentiles comparison test). The other parameters were not significant by the evaluation of the tests used. Some of these lesions, the uveitis and conjunctivitis, are described as being connected with high levels of ammonia plus inadequate levels of air dust and litter moisture. Also the statistical analysis indicate that the evaluated atmosphere inside negative pressure system is more deleterious to ocular health than the one found in the positive system.

**Key Words:** Keratoconjunctivitis, uveitis, conjunctiva, hyperplasia, metaplasia

## Processing and Products

**175 Antioxidant capacity of yerba mate (*Ilex paraguariensis* A. St. Hil) extract added to pre-cooked chicken breast meatballs.** Débora Euclides M. da Costa, Cristiane Bovi de Lima, Thais Chiozzini de Souza, Samara Aquino Amador, Dannielle L. Migotto, and Aline Mondini C. Racanicci\*, *Universidade de Brasília, Brasília, DF, Brazil.*

The objective of this study was to investigate the effect of the addition of lyophilized yerba mate extract (YME) on the oxidative stability of breast meat lipids. Fresh, deboned and ground chicken breast meat with 0.5% salt was divided into 5 treatments: negative control with no antioxidant (NC); 0.05%, 0.10%, 0.15% and 0.20% of YME per kilogram of meat. Meatballs (30g ± 0.5) were produced for each treatment, vacuum-packed and pre-cooked in water-bath (100°C during 10 min), re-packed in oxygen permeable plastic bags and stored at 4°C up to 10 d in a completely randomized design. To evaluate the antioxidant activity of the extract, the accumulation of secondary lipid oxidation compounds was monitored during storage using TBARS (Thiobarbituric Acid Reactive Substances) method every 2 d in duplicate in 2 chilled stored meatballs samples. TBARS averages were compared using PROC GLM and PROC REG was applied to estimate optimal YME concentration using SAS 5.1. The addition of 0.5, 0.10, 0.15 and 0.20% YME to breast meat reduced ( $P < 0.0001$ ) the production of secondary lipid oxidation compounds in pre-cooked meatballs during chilled storage when compared with NC. In addition, TBARS values decreased ( $P < 0.0001$ ) as the YME concentration increased in meatballs ( $Y = 72.44 - 0.080x + 0.00002x^2$ ;  $R^2 = 0.98$ ) indicating 0.18%YME the most effective concentration to minimize TBARS under the conditions of this study. In conclusion, YME can be a natural alternative to protect chicken breast meatballs from lipid oxidation during chilled storage.

**Key Words:** natural antioxidant, yerba mate, lipid oxidation, oxidative stability of chicken meat, TBARS

**176 Histomorphometric measurements of broiler breast fillets presenting wooden breast and white striping conditions.** Tamara Zinn Ferreira<sup>\*1</sup>, Janaina Matte Weiss<sup>1</sup>, Ítalo da Silva<sup>1</sup>, Débora Botéquio Moretti<sup>2</sup>, Vladimir Pinheiro Nascimento<sup>1</sup>, Sérgio Luiz Vieira<sup>1</sup>, and Liris Kindlein<sup>1</sup>, <sup>1</sup>*Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil,* <sup>2</sup>*Universidade de São Paulo, Piracicaba, SP, Brazil.*

BBroiler breast myopathies had emerged within the poultry industry with significant impacts on visual quality of meat. Conditions known as wooden breast (WB, hardness of raw fillet) and white striping (WS, white striations parallel to muscle fibers) are the main issues. This study aimed to evaluate histomorphometric characteristics of the *Pectoralis major* muscle from Cobb 500 male broilers (3.2 kg live weight) slaughtered at 42 d of age presenting WB and WS myopathies. Representative breast fillets from each degree of severity (NORM, MOD WS, SEV WS and WB) were randomly collected (n = 40/10 from each degree) in a processing plant. To this, slides were prepared and stained using

hematoxylin and eosin and Masson's Trichrome and evaluated to the dimensional morphometric analysis (area, muscle fiber diameter and density) using Pro-Plus image analysis software and 3-dimensional measurements (partial volume of muscle and connective tissue) that was estimated by point-counting stereology using the M42 testing system. Exploratory analysis of the data were conducted through the correlation matrix, ANOVA and Dunnett test. Fiber diameter ( $\mu\text{m}$ ) as well as density (fibers/cm<sup>2</sup>) showed that WB had increased fiber diameter (22.2) and lower density (250.9) when compared with NORM muscle (19.5 and 329.4, respectively). With regards to WS, higher densities ( $P = 0.004$ ) and smaller diameters ( $P < 0.001$ ) of muscle fiber were observed in the MOD (456.7; 19.2) and SEV (460.8; 19.1) degrees when compared with NORM. There was no statistical difference in the partial volume of muscle and connective in fillets affected to WS; however fillets with WB had lower muscle's volume (41.0%) and increased connective tissue (10.7%) when compared with NORM fillets (57.8% and 5.8%, respectively). The results from the present study showed that muscle fibers with WB and WS had morphometric characteristics of muscle degeneration with a replacement of connective tissue in fillets affected to WB condition.

**Key Words:** broiler, morphometric measurement, myopathy, wooden breast, white striping.

**177 Energy levels and feed physical form on broiler performance.** Gabriela C. Dal Pont\*, Andréia Massuquetto, Vitor A. B. Zavelinski, Thiago Cancelli, Everton L. Krabbe, and Simone G. Oliveira, *Federal University of Paraná, Curitiba, Paraná, Brazil.*

The aim of this study was to evaluate the interaction between increasing energy levels in mash and pelleted diets on broiler performance. We used 1,152 Cobb male broiler chicks from 35 to 47 d distributed in a completely randomized design in a 2 × 4 factorial arrangement (2 diets physical form and 4 energy levels) with 8 replicates of 18 birds each. Treatments consisted of mash and pelleted diets, with 4 different energy levels (3,280, 3,200, 3,120, and 3,040 kcal/kg of dry matter) obtained with increasing oil (post pellet application) and decreasing of inert addition. Water and feed were supplied ad libitum. The broilers and diets were weighed on d 35 and 47 to calculate weight gain (WG), feed intake (FI), and feed conversion ratio (FCR). All data were submitted to ANOVA, and means compared by the Tukey's test ( $P < 0.05$ ). No interaction between the variables was observed ( $P < 0.05$ ). Broilers fed pelleted diets had greater FI and WG ( $P < 0.01$ ), and better FCR ( $P < 0.05$ ). When energy levels were evaluated, the FI was not affected ( $P > 0.05$ ) but the lower level (3,040 kcal) showed the lower WG and the worst FC ( $P < 0.01$ ). The others energy levels were equal for performance parameters. Pelleted diet provided better performance than mash because they allow easier feed apprehension and less energy is spent for FI, improving WG. The thermal process may also have increased the nutrient digestibility or all these factors together can have improved the performance of broilers. Decreasing dietary energy by reducing the amount of oil affect WG and FC.

**Table 1.** Feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) of broilers from 35 to 47 days fed mash or pelleted diets with different energy level.

	FI (g)	WG (g)	FCR (g/g)
Energy level (kcal/kg)			
3280	2,579	1,442 <sup>a</sup>	1,790 <sup>b</sup>
3200	2,608	1,431 <sup>a</sup>	1,825 <sup>b</sup>
3120	2,625	1,423 <sup>a</sup>	1,848 <sup>b</sup>
3040	2,644	1,380 <sup>b</sup>	1,920 <sup>a</sup>
Physical form			
Mash	2,489	1,337	1,865
Pelleted	2,739	1,501	1,826
<i>P</i> -value physical form	<0.0001	<0.0001	0.0124
<i>P</i> -value energy level	0.1766	0.0002	<0.0001
<i>P</i> -value form * energy	0.0908	0.1729	0.8537
CV (%)	3.14	2.63	3.35

<sup>ab</sup>Different letters in the same column differ significantly by Tukey test ( $P < 0.05$ ).

**Key Words:** Energy, mash, performance, pelleting, processing

**178 Causes of poultry carcass condemnation in slaughterhouses.** Tamara Zinn Ferreira\*, Morgana Zortea, Janaína Matte Weiss, Silvana de Castro Caldas, Saionara Araújo Wagner, Sérgio Luiz Vieira, and Liris Kindlein, *Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.*

Brazil has a prominent place in the world-wide poultry scene with a highly competitive sector where the low cost of production has led to the growth of industries involved. However, sanitary problems can compromise the exportation of poultry products, so measures must be adopted to attain better results in relation to this point. To this, the aim of this study was to identify the main causes of poultry condemnations in slaughterhouses under federal inspection located at Rio Grande do Sul (RS) and Brazil. This work was carried out by survey data generated by the Federal Inspection Service based on the total and partial condemnations and the total of birds slaughtered in 2015. The descriptive analysis (percentage) and frequency was used to analyze the data by chi - square test. According to data, in this year; 5,210,526,198 birds

were slaughtered in Brazil with 693,354,403 (13.3 %) of them from Rio Grande do Sul. Of this total slaughtered, 0.58 % of the carcasses were classified to total condemnation and 5.6 % to partial condemnation. The three main causes of total condemnation in RS were disgusting aspect (23.1%), cachexia (14%) and fecal/biliar contamination (12.8 %). On the other hand, the causes of partial condemnation were contamination (34.2 %), contusion (16.8 %) and dermatosis (10 %). Comparing to the Brazilian average it was observed that disgusting aspect (34.4 %) and contamination (17.8 %) were higher than in RS however, cachexia (12.3 %) it was lower. For partial condemnations the losses by contamination (44.7 %), dermatosis (30.1 %) and contusion (32.3 %) were lower, was higher than in RS. Considering these results, Brasil losses more carcasses for partial condemnation due contamination, biliar or fecal, than the Rio Grande do Sul average and this can be minimized with special care in the farm and during the slaughter. The partial condemnation is the cause of great economic losses in the poultry industry, so more studies about the main sources of the causes of condemnation are needed.

**Key Words:** condemnation, post mortem, carcass, fecal contamination

## Animal Well-Being and Behavior

**179 Pre-slaughter mortality of broiler chickens during transportation according to distance and season.** Pedro Marins de Albuquerque Faria Silva\*<sup>1</sup>, Vinicius Machado dos Santos<sup>2</sup>, Bruno Stefano Lima Dallago<sup>1</sup>, Aline Mondini Calil Racanicci<sup>1</sup>, and Francisco Ernesto Moreno Bernal<sup>1</sup>, <sup>1</sup>Universidade de Brasília (UnB), Brasília, DF, Brazil, <sup>2</sup>Instituto Federal de Educação, Ciência e Tecnologia de Brasília (IFB), Brasília, DF, Brazil.

Although transportation of broiler chickens to the slaughterhouse is an essential component for the poultry industry, it is considered stressful, since birds are exposed to different stress factors like withdrawal of food and water, acceleration and vibration. Besides that, the weather condition can affect negatively the microclimate in broiler loads, particularly in high temperature and relative humidity associated with poor road conditions may reduce broiler chickens welfare and increase the average of mortality. The objective of this study was to evaluate the influence of environment climate on broiler chicken mortality during the transport to the slaughterhouse in different seasons and distances in Brasília, Brazil. Twelve broiler loads, average of 3640 birds per load, 7 birds per box, under commercial conditions were monitored and environmental temperature and relative humidity were obtained from the National Institute of Meteorology. The birds were, on average, 48 d old, and were batch mixed (males and females). The experiment followed a completely randomized experimental design with 12 loads arranged in factorial with 2 seasons (winter and summer) x 2 distances (less than 15 km and 90 km or more) with 3 replications. Death on arrival (DOA %) was evaluated at the slaughterhouse considering the total number of birds transported per load. Data were analyzed using PROC GLM (SAS System v. 9.3). In general, mortality rate found in this study were considered acceptable, since values were lower than 0.5%. Mortality rate showed no difference between 15 km (0.19%) and 90 km (0.15%) distance during the summer. However, during winter, considered a dry season, long distances affected negatively ( $P < 0.05$ ) mortality rate (0.22%) than short distance (0.11%). We hypothesized that low humidity season can result in higher mortality. There was no interaction between the factors time and season for the mortality rate. In conclusion, particular attention must be given to transportation of broilers for longer distances, especially during the winter period to reduce pre-slaughter mortality.

**Key Words:** dead on arrival, microenvironment, transportation, welfare

**180 Thermal programming and nutrition in ovo of ascorbic acid on the behavior of broilers.** Sarah Sgavioli\*<sup>1,2</sup>, Elaine T. Santos<sup>3</sup>, Liliana L. Borges<sup>3</sup>, Thays C. O. Quadros<sup>3</sup>, Diana C. M.

Castiblanco<sup>3</sup>, Paulo H. M. Rodrigues<sup>4</sup>, and Isabel C. Boleli<sup>3</sup>, <sup>1</sup>College of Agricultural Sciences, Federal University of Grande Dourados, Dourados, Mato Grosso do Sul, Brazil, <sup>2</sup>Ilender Pharm. Corp., Paulínia, São Paulo, Brazil, <sup>3</sup>Department of Animal Morphology and Physiology, College of Agricultural and Veterinary Sciences, São State University, Jaboticabal, São Paulo, Brazil, <sup>4</sup>Department of Nutrition and Animal Production, College of Veterinary Sciences and Animal Sciences, São Paulo University, Pirassununga, São Paulo, Brazil.

The aim of this study was to determine if high incubation temperature associated or not with in eggs ascorbic acid (AA) injection before incubation can affect the behavior of broiler raised under different environmental temperature conditions. A total of 540 1-d-old chicks (Cobb) were assigned to a completely randomized design in a 3 × 3 factorial arrangement in referring to the 3 incubation treatments: incubation at 37.5°C, incubation at 39°C and incubation at 39°C with in eggs vitamin C before incubation (6 ug AA/100 mL water) and 3 setting environmental temperatures: cold, control and hot, even with the collection time (7, 14 and 35 d) as split plot and times of day (morning and afternoon) as sub-sub-divided plots. Data were analyzed according to the Proc Mixed for mixed models, with the help of the SAS package. The behaviors parameters analyzed (water intake and diet, resting inactive, exploration and comfort) not had their frequencies significantly influenced by incubation treatments ( $P > 0.05$ ) (21.39; 10.84; 10.55; 66.02; 9.30; 2.70; 0.05; 0.40 and 0.14%, respectively). There were interaction between the collection time and times of day for water intake and diet, resting inactive, exploration and comfort ( $P < 0.05$ ). In general in the morning period, the birds overexpress the behavior of water intake and diet and exploration ( $P < 0.05$ ) and in the afternoon the frequent behaviors were to be resting inactive and comfort ( $P < 0.05$ ), furthermore, with the increase in the birds age had reduced the behaviors of water and diet intake and exploration ( $P < 0.05$ ) and increased the behavior of resting inactive and comfort ( $P < 0.05$ ). The exploration behavior varied greatly according with the ages and temperatures tested. Through a descriptive analysis it was observed that the birds did not express the behavior of aggression. With regard to the behavior of heat dissipation and heating, they were expressed most frequently at 35 and 7 d of age ( $P < 0.05$ ), respectively. The results indicate that high temperatures with or without AA injection weren't effective to decrease or avoid the effects of heat stress during the broilers rearing.

**Key Words:** in egg injection, manipulation, temperature, welfare

## Metabolism and Nutrition: Vitamins and Minerals II

**181 Response of Zn methionine-hydroxy-analogue chelate on performance, carcass quality, gut health, and immunology of male broilers.** Raquel Araujo\*<sup>1</sup>, Ricardo Gonzalez-Esquerria<sup>1</sup>, Cesar Pontin<sup>2</sup>, Sergio Vieira<sup>2</sup>, Danilo Cavalcante<sup>3</sup>, and Fernando Perazzo Costa<sup>3</sup>, <sup>1</sup>Novus do Brazil Ltd., Indaiatuba, SP, Brazil, <sup>2</sup>Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, <sup>3</sup>Universidade Federal da Paraíba, Areia, PB, Brazil, <sup>4</sup>Universidade Federal do Paraná, Curitiba, PR, Brazil.

Two floor-pen trials studied the effect of graded levels of Zn from Zn-Methionine-Hydroxy Analogue Chelate (Zn-MHAC; Novus International Inc.) on performance, carcass and meat quality traits, gut health, and immune response in broilers. A total of 1,080 and 1,960 Cobb 500 d-old cockerels were allotted to 9 or 10 reps for trials 1 (E1) and 2 (E2), respectively. Five (0, 16, 32, 64 and 128ppm in E1) or 7 (from 0 to 96 ppm in grades of 16 ppm in E2) levels of Zn from Zn-MHAC were fed in conditions near to commercials. Broilers were fed a corn-SBM (E1) or corn-SBM-PBM (E2) isonutritional diets across treatments except for Zn. Performance was evaluated at 42d and 38d for E1 and E2, respectively. For E2, carcass and meat quality were evaluated at 38 d using 4 birds per pen. The ileal index on histological changes of intestinal villi (ISI) was obtained as an indicator of gut health. Immune responses were tested by blood flux cytometry and IBD titers. Analysis of variance and regression analyses were performed. Qualitative parameters and lesions (%) were analyzed by the Kruskal-Wallis test. PERFORMANCE: For E1, BWG, FCR and production efficiency (EPI) improved significantly showing a third degree curve ( $P < 0.05$ ) to graded levels of Zn-MHAC with optimal performance reached at 35 to 39ppm of Zn. In E2, BWG, EPI and livability improved linearly with Zn-MHAC addition ( $P < 0.05$ ) at 38d. CARCASS: Carcass and thighs yields (%), breast weight and yield improved with Zn-MHAC addition ( $P < 0.05$ ) while breast pH, white striping, and wooden breast score and occurrence were not affected. MEAT QUALITY: Cooking loss, skin scratches size and incidence of meat bruises dropped after Zn-MHAC supplementation ( $P < 0.05$ ). GUT HEALTH and functionality improved at 38 d as evidenced by a lower ISI score. IMMUNE FUNCTION: Three populations of lymphocytes increased linearly ( $P < 0.05$ ) and a trend toward greater Ig titers against IBD and lower Ig CV's was observed ( $P < 0.1$ ). In conclusion, Zn-MHAC may improve live performance, carcass and meat quality traits, gut health, and immune responses of broilers fed practical diets.

**Key Words:** gut health, Mintrex Zn, organic mineral, carcass quality

**182 Performance and carcass yield of broiler chickens fed corn-soy diets with increasing selenium supplementation using Zn-L-selenomethionine.** Maieli Rohr\*, Sergio L. Vieira, Liris Kindlein, Henrique S. Cemin, Tamara Z. Ferreira, and Silvana M. Rauber, UFRGS, Porto Alegre, Rio Grande do Sul, Brazil.

The objective of this study was to evaluate growth performance, carcass and breast yield of fed diets with increasing selenium levels from Zn-L-selenomethionine and to determine Se requirements using an organic source. A total of one thousand 8 hundred 70 2 male broilers Cobb 500

x Cobb 500 were housed into 72 floor pens and evaluated from 1 to 42 d. Birds were distributed in a completely randomized design with 6 treatments, 12 replications and 26 birds each. Corn-soybean meal diets were supplemented with 0, 0.2, 0.4, 0.6, 0.8, or 1.0 ppm of Se from Zn-L-selenomethionine. Each treatment had 12 replications of 26 birds. Body weight gain (BWG), feed conversion ratio corrected for the weight of dead birds (FCR), and feed intake (FI) were evaluated at 7, 21, 35, and 42 d. At 42 d, 4 birds per experimental unit were selected for carcass and breast yield evaluation. Data were submitted to ANOVA, and when significant, means were compared by Tukey test at 5% significance. Data were fitted to linear and quadratic responses, and requirements were estimated by a quadratic polynomial regression. No effects were observed on body weight gain (BWG) in pre-starter phase, feed conversion ratio (FCR) in grower phase, and BWG and FCR in finisher phase. Quadratic responses ( $P < 0.05$ ) were observed in FCR in pre-starter phase, BWG in grower phase, and BWG and FCR in starter phase and in the overall period of 42 d. Carcass yield presented a quadratic improvement ( $P < 0.01$ ), whereas breast yield response was linear ( $P < 0.01$ ). Requirement for FCR in pre-starter phase was 0.45 ppm. In starter phase, Se requirements were estimated as 0.75 ppm for BWG and 0.71 ppm for FCR. Requirements for grower phase were estimated as 0.62 ppm for BWG. In the overall period, estimates were 0.64 ppm for BWG and 0.67 ppm for FCR. Thus, increasing levels of Se supplemented in corn-soybean diets resulted in improved growth performance, carcass and breast yield. Selenium requirements determined in the present study are significantly higher than previous recommendations.

**Key Words:** broiler, carcass, performance, requirement, selenium

**183 Levels of inorganic and complexes minerals on broilers carcass yield.** Josiane Carla Panisson\*<sup>1</sup>, Andréia Massuquetto<sup>1</sup>, Jean Fagner Durau<sup>1</sup>, Gabriela Cardoso Dal Pont<sup>1</sup>, Alba Fireman<sup>2</sup>, and Simone Gisele De Oliveira<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Curitiba, Parana, Brazil, <sup>2</sup>Zinpro Corporation, Piracicaba, São Paulo, Brazil.

The research's objective was to evaluate the inclusion of inorganic (I) and complexes (C) minerals on broilers carcass yield (CY). It was used on 1,540 Cobb one-day-old male, distributed in a completely randomized design, into 7 treatments (T) and 10 replicates of 22 birds on each. The broilers were supplied with feed and water ad libitum. The T varied on the source, I (Sulfates for Zn, Mn, Cu, Fe, sodium selenite and calcium iodide) and amino acid C, and inclusion of trace minerals, made by premix (Table 1). The feed was the same for all the T, varied only the premix. At 42nd, 20 birds per T were used for CY, breast (BY) and thigh + drumstick yield (TDY), abdominal fat content (AFC) and drip loss (DL). The DL was estimated by measuring of the raw meat after storage at 2°C for 48 h. The data were submitted to analyses of variance ( $P < 0.05$ ) and compared by Tukey test at 5% of probability (Table 1). The CY, AFC and DL weren't significantly different ( $P > 0.05$ ). The T with all the mineral C presented trend was better BY than T with only Zn Mn Cu complexed ( $P = 0.068$ ). The T with CZnMn presented better TDY than T with C and I ( $P = 0.032$ ). In summary, the use of complexes mineral or inorganic can alter the breast and thigh + drumstick yield.



**Table 1.** Levels (ppm) of inorganic (I) and amino acid complexes (C) minerals in broilers diets, and carcass (CY), breast (BY), thigh + drumstick yield (TDY), abdominal fat content (AFC) and drip loss (DL) at 42nd d broiler fed with different levels of inorganic (I) and amino acid complexes (C) minerals

	Zn		Mn		Cu		Fe		Se	
	I	C	I	C	I	C	I	C	I	C
I	80		80		14		50		0.3	
C Zn		40	80		14		50		0.3	
C Zn Mn		40		40	14		50		0.3	
C Zn Mn Cu		40		40		7	50		0.3	
C Zn Mn Cu Fe		40		40		7		25	0.3	
C Zn Mn Cu Fe Se		40		40		7		25		0.15
C & I	40	40	40	40	7	7	25	25	0.15	0.15
		CY(%)		BY(%)		TDY(%)		AFC(%)		DL(%)
I		82.5		28.57 <sup>ab</sup>		22.80 <sup>ab</sup>		2.1		2.8
C Zn		81.9		29.76 <sup>ab</sup>		22.58 <sup>ab</sup>		2.1		2.8
C Zn Mn		82.7		29.07 <sup>ab</sup>		23.19 <sup>a</sup>		2.3		2.9
C Zn Mn Cu		81.6		28.71 <sup>b</sup>		22.62 <sup>ab</sup>		2.0		3.0
C Zn Mn Cu Fe		82.2		29.09 <sup>ab</sup>		23.14 <sup>ab</sup>		2.1		2.7
C Zn Mn Cu Fe Se		82.1		30.12 <sup>a</sup>		22.51 <sup>ab</sup>		2.0		2.6
C & I		81.4		29.68 <sup>ab</sup>		22.15 <sup>b</sup>		1.9		2.7
<i>P</i> -value		0.100		0.068		0.032		0.179		0.817
SEM <sup>1</sup>		0.1382		0.1319		0.0903		0.0350		0.0755

<sup>ab</sup>Different letters differ significantly by Tukey test ( $P < 0.05$ ).

<sup>1</sup>SEM = standard error mean.

**Key Words:** abdominal fat, breast, carcass, drip loss, mineral premix

**184 Levels of inorganic and complexes minerals on litter and foot quality of broilers.** Jean Fagner Durau\*, Andréia Massuquetto, Lucas Schmidt Bassi, Isabella de Camargo Dias, Leopoldo Malcorra de Almeida, and Alex Maiorka, <sup>1</sup>Universidade Federal do Paraná, Curitiba, Paraná, Brazil.

The study objective was to evaluate the effects of inorganic (I) and complexed (C) minerals (M) on litter (L) and foot quality of broilers. The study used 1540 one-day-old male broilers, in a completely randomized design, with 7 treatments (T) of 10 replicates of 22 birds each. The birds were housed in pens with woods shavings with a density of 11 birds/m<sup>2</sup>. The T varied on the source, I and amino acid C, and the inclusion

of trace M (Table 1). The LQ was evaluated on the 41st d, using scores of 0 to 4 to represent, dry and flaky; dry but not easy to move with foot; leaves imprint of foot and will form a ball if compacted; sticks to boots and sticks readily in a ball if compacted and sticks to boots once the cap or compacted crust is broken, respectively. The litter moisture (LM) of all pens was evaluated, the sample were oven-dried at 105°C for 6 h. At 42nd d, on each T was analyzed 100 pairs of paws for FPLS using the scores of 1 to 4 to represent, no lesions, up to 25, between 25 and 50 and more than 50% of damage, respectively. The LQ and FPLS were compared using Kruskal-Wallis test and LM submitted to ANOVA at 5% of probability (Table 1). The LQ and LM were not different ( $P > 0.05$ ). Birds fed diets with all the minerals with C source tended to have decreased FPLS ( $P = 0.063$ ) compared with the T with C and I. The complexed minerals can improve the foot health of broilers.

**Table 1.** Levels (ppm) of inorganic (I) and amino acid complexed (C) minerals in broilers diets, and litter quality (LQ), moisture (LM), and foot pad lesions score (FPLS) of 42-d-old broilers fed with different levels of inorganic (I) and amino acid complexed (C) minerals

	Zn		Mn		Cu		Fe		Se	
	I	C	I	C	I	C	I	C	I	C
I	80		80		14		50		0.3	
C Zn		40	80		14		50		0.3	
C Zn Mn		40		40	14		50		0.3	
C Zn Mn Cu		40		40		7	50		0.3	
C Zn Mn Cu Fe		40		40		7		25	0.3	
C Zn Mn Cu Fe Se		40		40		7		25		0.15
C & I	40	40	40	40	7	7	25	25	0.15	0.15
		LQ <sup>1</sup>				LM (%)				FPLS <sup>2</sup>
I		3.65				35.2				1.54 <sup>ab</sup>
C Zn		3.67				35.4				1.64 <sup>ab</sup>
C Zn Mn		3.55				38.2				1.53 <sup>ab</sup>
C Zn Mn Cu		3.52				35.3				1.58 <sup>ab</sup>
C Zn Mn Cu Fe		3.77				36.5				1.67 <sup>ab</sup>
C Zn Mn Cu Fe Se		3.55				37.0				1.51 <sup>a</sup>
C&I		3.55				38.4				1.76 <sup>b</sup>
P		0.355				0.313				0.063
SEM		0.0343				0.5046				0.0224

<sup>1</sup>Median of score of 0 to 4.

<sup>2</sup>Median of score of 1 to 4.

**Acknowledgments:** UFPR, Zinpro Corporation

**Key Words:** complexed, foot, litter, quality, zinc

**185 Blood parameters of broiler breeder hens fed diets supplemented with different levels and sources of copper.** Douglas D. B. Maria\*, Sergio L. Vieira, Eveline Berwanger, Liris Kindlein, Silvana M. Rauber, and Cristina T. Simões, *UFRGS, Porto Alegre, RS, Brazil.*

Copper Cu is a mineral present in the ceruloplasmin structure, enzyme with the function of iron oxidation making it available for the hemoglobin formation. The objective of this study was to evaluate blood parameters of broiler breeder hens using increasing Cu levels and 2 sources (organic or inorganic) for 5 periods of 28 d each. Two hundred 20 broiler breeders Cobb 500, obtained from a commercial farm, were placed in individual cages and distributed in a completely randomized design with 11 treatments and 20 replicates. A semi-purified diet with marginal levels of Cu (2.44 ppm) was formulated in which 5 levels of this mineral were added: 2.44; 5.94; 9.44; 12.44; 16.44, and 19.94 ppm. Copper sources used were Cu sulfate pentahydrate (inorganic source) and Cu AA Complex (organic source). Birds were evaluated at 25 to 28, 29 to 32, 33 to 36, 37 to 40, and 41 to 44 wk generating a factorial arrangement  $2 \times 5 \times 5 + 1$ . At the end of each period, blood samples were collected (3 birds per treatment) for hemoglobin (Hb) and hematocrit (Ht) analyses, and also to measure ceruloplasmin activity (Cp) and copper concentration. Data were analyzed using the PROC MIXED SAS and, when significant, means were compared using Tukey test ( $P < 0.05$ ). Copper levels were subjected to nonlinear regression analysis and no differences were observed between both mineral sources. However, blood parameters were affected by the tested levels and periods ( $P < 0.05$ ). Hemoglobin and Ht decreased with hen's age, whereas higher Cu concentration in serum was observed between 33 to 36 wk. Based on results, it can be suggested that 7.30 ppm of Cu was the requirement able to maximize Hg of broiler breeders (LRP;  $R^2 = 0.39$ ); 9.70 ppm (LRP;  $R^2 = 0.34$ ) was needed for the serum concentration of Cu, and

9.91 ppm (LRP;  $R^2 = 0.27$ ) was the requirement for the Cp activity. In conclusion, copper from inorganic and organic sources had influence on blood parameters and its deficiency can affect Hb, Ht, serum concentration and Cp for broiler breeder hens.

**Key Words:** broiler breeder, copper sulfate, hemoglobin, hematocrit, ceruloplasmin

**186 Nano particle size copper at high levels affects broiler chicken performance and bone strength.** Edenilse Gopinger\*<sup>1</sup>, Eduardo G. Xavier<sup>1</sup>, Ning Lu<sup>2</sup>, Young Dal Jang<sup>2</sup>, Ding Wang<sup>2</sup>, Sunday A. Adedokun<sup>2</sup>, Kun Dong<sup>2</sup>, and Merlin D. Lindemann<sup>2</sup>, <sup>1</sup>Universidade Federal de Pelotas, Pelotas, RS, Brazil, <sup>2</sup>University of Kentucky, Lexington, KY, USA.

The effect of feeding nano copper oxide (<50nm) in broiler chicken diets fed at levels above the requirement (8 mg/kg) was evaluated. Chicks (n = 150) averaging 58.3g were allotted to 10 treatments at random, from outcome groups of weight following 3 d on a common diet. There were 5 chicks per pen for a total of 3 complete replications. The experiment was conducted for 14 d. Chicks were fed a semi-purified diet (0.9 mg/kg total Cu) based on casein and dextrose with graded levels of added Cu (0, 200, 400, 800 mg/kg) from feed-grade  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , nano CuO, and feed-grade CuO. Body weight, weight gain, feed consumption, and tibia strength were measured. Chicks fed diets with 800ppm  $\text{CuSO}_4$  had the lowest final weight (137.3g), even lower than chicks fed the negative control diet (340.3g). This was the direct effect of a linear reduction of feed intake with increased levels of  $\text{CuSO}_4$  in the diets (483.1, 357.7, 192.3g, respectively), which reduced weight gain 77% (346.2, 207.9, 78.8g;  $P < 0.01$ ). Similarly, chicks fed nano CuO also showed a significant 24.8% reduction of weight gain (354.5, 334.0, 266.6g;  $P < 0.01$ ) with increased levels of Cu in the diets, and a tendency of reduction of feed intake with increased Cu. Conversely, chicks fed feed-grade CuO showed a tendency of increased feed intake (462.9, 457.1, 500.4g) and a significant linear increase of weight gain (336.9, 347.3, 385.5g) with increased levels of CuO in the diets ( $P < 0.01$ ). Chicks fed both  $\text{CuSO}_4$

and nano CuO had a linear reduction of tibia strength with increased levels of Cu in the diet ( $P < 0.01$ ), while the ones fed CuO showed a quadratic response (7.94, 6.93, and 8.53 kgf). The results obtained indicated a toxic effect of high levels of CuSO<sub>4</sub> in the diets of chicks. Additionally, the results observed for chicks fed nano CuO were more similar to the ones fed CuSO<sub>4</sub> than the ones fed the regular CuO.

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**Key Words:** nano copper, nano mineral, poultry, tibia strength

**187 Inorganic zinc levels in the diet of broiler chickens on relative weight of organs of the immune system and zinc content in the tibia.** A. K. Ito\*, J. R. Sartori, A. C. Pezzato, J. C. R. Rezende, J. C. Denadai, M. M. Aoyagi, and T. S. Souza dos Santos, *College of Medicine Veterinary and Animal Science, São Paulo State University (UNESP), Botucatu, São Paulo, Brazil.*

The objective of the current study was to evaluate 5 increasing levels of inorganic zinc (50%, 75%, 100%, 125% and 150% of the nutritional requirement for each phase) in diet for broiler chickens challenged by *E. coli* LPS inoculation and its effects on relative weight of organs and zinc content in the tibia of the birds. A total of 1,155 d-old broiler chicks were allotted to 5 treatments and 7 replicate floor pens with 33 birds each. At 35 d post-hatch, 2 birds per pen were selected, one was challenged by inoculation of lipopolysaccharide of *Escherichia coli* in the abdominal cavity and the other was inoculated with saline solution (control group). The birds were killed 48h after the inoculation and the organs were collected and weighed. Data were analyzed in a 5 × 2 factorial arrangement (5 zinc dietary levels x challenged or not with *E. coli* LPS) and 5% as significant level. Effects of dietary zinc level were analyzed by regression analysis ( $P < 0.05$ ). The organs thymus and bursa of Fabricius were not affected by the levels of zinc and challenge, only relative weight of the spleen was increased when birds were submitted to challenge with *E. coli* LPS. Zinc content in the tibia was not affected by dietary zinc levels. Broiler chickens challenged with *E. coli* LPS showed higher relative weight of spleen. Diets with higher or reduced

levels of zinc did not affect the weight of organs of the immune system and tibia zinc content.

**Acknowledgments:** To CNPq for providing scientific initiation scholarship to the first author.

**Key Words:** bone, challenge, lipopolysaccharide, lymphoid tissue, mineral

**188 Bioavailability and digestibility of phosphorus from different sources for broilers.** Maurílio L. X. Junior\*<sup>1</sup>, Sandra C. Salguero<sup>1</sup>, Luiz F. T. Albino<sup>1</sup>, Horacio Rostagno<sup>1</sup>, Juan Vieyra<sup>2</sup>, and Irineu Brugalli<sup>2</sup>, <sup>1</sup>Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, <sup>2</sup>Yara Brazil, Porto Alegre, Rio Grande do Sul, Brazil.

The goal of this study was determine true ileal digestibility and phosphorus (P) bioavailability of different sources in broiler diets. Four hundred chicks from 8 to 21 d of age were randomly distributed in 10 treatments with 8 replicates and 5 birds each. A corn-soybean meal diet was formulated to meet broiler requirements according to The Brazilian Tables for Poultry and Swine (Rostagno et al., 2011), except to P (0.150% non-phytate P). We evaluated 4 different P sources: dicalcium phosphate (DCP), monocalcium phosphate (MCP), monodicalcium phosphate (MDCP) and monosodium phosphate (MSP). The P sources (MCP, MDCP, and MSP) were added to the basal diet at 0.075 and 0.150% of non-phytate P (nPP). However, for DCP, the P levels were included at 0.075; 0.150; and 0.250% nPP. Additionally, a low-P diet was formulated to determine the endogenous P losses. At d 21, birds and feed were weighted to determine weight gain (WG), feed intake (FI), feed-to-gain ratio (F:G). In addition, all birds were slaughtered to collect the right tibia and ileal content to perform lab analysis and determine tibia ash content (%) and true P digestibility, respectively. All data were submitted to ANOVA using the PROC GLM of SAS Statistical package (SAS Institute, 2008). The relative effectiveness of P sources was calculated using a Multiple Linear Regression considering DCP as standard P source (Sakomoura and Rostagno, 2007). Tibia ash, WG and F:G were linearly influenced by P levels for each P source ( $P < 0.05$ ). These variables used to calculate the P bioavailability of the sources (Table 1). The average P bioavailability of the phosphates were 135% to MCP, 116% to MDCP, and 127% to MSP compared with DCP (100%). The true P ileal digestibility of phosphates were 62% to DCP, 71% to MCP, 62% to MDCP, and 77% to MSP.

**Table 1.** Bioavailability and true P ileal digestibility of the different phosphates used in broiler diets

Phosphates	Bioavailability (%)				True P ileal digestibility coefficients (%)
	Weight gain	Tibia ash	Feed-to-gain	Average	
Dicalcium phosphate	100	100	100	100	62
Monocalcium phosphate	127	109	168	135	71
Monodicalcium phosphate	116	115	116	116	62
Monosodium phosphate	112	108	162	127	77

**Key Words:** phosphate, broiler, digestibility

**189 Effect of dietary supplementation of optimized vitamin levels and trace mineral sources on the Black Bone syndrome occurrence in broilers.** Mayra Vissotto Ribeiro<sup>1</sup>, Adrieli Braga de Cristo\*<sup>1</sup>, and Jonas Rodrigo Layter<sup>1</sup>, José Maria Luvizotto Junior<sup>2</sup>, Alexandre S. Sechinato<sup>2</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná,

Brazil, <sup>2</sup>DSM Produtos Nutricionais Brazil, São Paulo, São Paulo, Brazil.

Broilers have grown so fast that their bones have shown low levels of mineralization. As a result, it allows the extravasation of the medullary content on the bone surface, which alters the color of the meat. This effect is very clear especially after cooking, and, due to the darker aspect of the bone, it has been classified as the black bone syndrome. The aim

of this study was to assess the effect of optimized vitamin levels and trace mineral sources on the occurrence of black bone syndrome in broilers. 1,800 Cobb Slow-male-chicks were divided into a completely randomized design of  $2 \times 2$  factorial scheme: Optimal Vitamin Nutrition (DSM Nutritional Products recommendations) vs commercial levels and mineral sources: inorganic vs carbon-amino-phospho-chelate (CAP), adding up to 4 treatments and 9 replicates. To evaluate the black bone syndrome, after 42 d the right tibia of 30 birds/treatment was cooled for further lengthwise measurements of lightness, redness and yellowness indexes using a colorimeter Minolta. The left tibias of the birds were frozen for 60 d, thawed and submitted to the same measurements. Then, they were roasted and reassessed. Data were submitted to ANOVA. Diets supplemented with CAP mineral source showed higher ( $P < 0.05$ ) yellowness index and lightness values in the adjacent muscle tissue of fresh and chilled tibias when compared with diets with inorganic mineral, regardless of the vitamin levels. It was not found interaction between treatments ( $P > 0.05$ ). Inorganic mineral supplementation resulted in higher ( $P < 0.05$ ) redness index (2.52) compared with CAP (1.70). This result indicates that supplementation with CAP may have contributed to the mineralization and lower porosity of the bones, which limited the extravasation of blood in the adjacent muscle tissue of the tibia. The minerals supplemented under more bioavailable sources, besides offering greater stability, bring benefits from a biochemical protection that can occur when they are employed in the diet. Thus, they are considered an important strategy to improve bone quality in broilers.

**Key Words:** trace mineral, bone porosity, lightness

**190 The effect of vitamin A and zinc on performance, thyroid hormones and some liver enzymes in heat-stressed broilers chicks.** Mehrdad Modaresi\*, Majid Toghiani, and Masoud Moazeni, *Department of Animal Science, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran.*

This study was carried out to investigate the effect of different levels of vitamin A and zinc on performance, thyroid hormones and some liver enzymes of broilers in heat stress condition. 420 one day-old broiler chicks (Ross 308) were used in a completely randomized experimental design with  $2 \times 3$  factorial arrangements with 6 treatments and 5 replicate pens. Dietary treatments included 2 levels of vitamin A (1,000 and 2,000 IU/kg) and 3 levels of zinc (100, 150 and 200 mg/kg). Broilers received dietary treatments from 1 to 42 d in heat stress condition. Growth performance parameters (body weight gain, feed intake and feed conversion ratio) were determined biweekly. At d 42 blood samples were taken to measure thyroid hormones (TSH,  $T_4$ ,  $T_3$ ) and liver enzymes (AST, ALT, ALP). The data were analyzed by SAS (2008) and Means were compared for significant ( $P \leq 0.05$ ) differences by using the LSMEANS. Body weight were not affected significantly but feed intake and feed conversion ratio significantly were affected by dietary treatments and decreased in overall growth period in broilers fed 2,000 IU/kg vitamin A plus 150 mg/kg zinc ( $P < 0.05$ ). Serum  $T_3$  and  $T_4$  showed significant increase in 2,000 IU/kg vitamin A plus 150 mg/kg zinc ( $P < 0.05$ ). Serum concentration of AST and ALT were not changed. ALP amount in 1,000 IU/kg vitamin A plus 100 mg/kg zinc and 2,000 IU/kg vitamin A plus 100 mg/kg zinc were not changed significantly but decreased in other groups ( $P < 0.05$ ). These results indicated that, 2,000 IU/kg vitamin A plus 150 mg/kg zinc could be increasing thyroid hormones and improve feed conversion ratio in heat-stressed broiler chicks.

**Acknowledgments:** This study was supported by Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran.

**Key Words:** vitamin A, zinc, performance, broiler, heat stress

## Metabolism and Nutrition: Feed Additives III

### 191 Supplementation of broiler breeders and their offspring with antibiotic growth promoters or functional oils: chicken performance, antioxidant capacity, and carry over effects.

Jean Paulo Contini<sup>1</sup>, Daianna Rosse Martins Gonçalves\*<sup>2</sup>, Daiane Horn<sup>1</sup>, Elisângela Vanroo<sup>1</sup>, Thais Lina Taniguti<sup>1</sup>, Heloisa Lais Fialkowski Bordignon<sup>1</sup>, and Jovanir Inês Muller Fernandes<sup>1</sup>, <sup>1</sup>Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brazil, <sup>2</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.

Phytogenic additives have been shown to have antioxidant activity and contribute to lipid protection against oxidative damage. Supplementation of such products may thus yield a positive carry over effect from the breeder to the offspring. A 2 × 2 factorial design (maternal effect: supplementation of enramycin or functional oils; offspring effect: supplementation of bacitracin methylene disalicylate (BMD) or functional oils), with 9 pens per treatment and 40 birds per pen was used to evaluate the effects of a commercial blend of functional oils (Essential, Oligo Basics Ltda.; active ingredients: cashew nut shell liquid and castor oil) or antibiotic growth promoters (AGP) on performance, antioxidant capacity and carry over effects. At 42 d of age, blood was collected from 2 birds per pen, to determine both the serum antioxidant capacity by the DPPH test (2,2-Diphenyl-1-picrylhydrazyl) and the lipid oxidation by measuring the TBARS (thiobarbituric acid reactive substances). At the 7th day there was a positive maternal effect on FCR ( $P < 0.05$ ) due to enramycin and a maternal by offspring interaction ( $P < 0.05$ ) for feed intake, where functional oils increased feed intake when they were only fed to the breeders or only to the offspring, but not when they were fed to both. However, no differences were seen for any performance parameter at 42 d of age. Also, TBARS were not affected by treatment. Interestingly, there was a maternal x offspring interaction for the DPPH test at 42 d ( $P < 0.05$ ). When breeders were supplemented with AGP and the offspring with functional oils, higher levels ( $P < 0.05$ ) of DPPH were observed. Already, the inclusion of functional oils in the breeders diet resulted in high levels of DPPH in the offspring. In conclusion, the supplementation functional oils did not negatively affect the productive performance of the offspring when either the maternal or the offspring diet was supplemented when compared with AGP. Functional oils improved the antioxidant capacity of the chickens when they were only fed to the offspring.

**Key Words:** DPPH, oxidative stress, broilers, TBARS

### 192 Organic acids promote mitigating action of stress in broiler chickens in the initial phase.

Kelry Mayara da Silva\*<sup>1</sup>, Robert Guaracy Aparecido Cardoso Araujo<sup>1</sup>, Claudia Harumi Oka<sup>1</sup>, Gustavo do Valle Polycarpo<sup>2</sup>, Paulo Henrique Yamada<sup>3</sup>, and Valquíria Cação Cruz-Polycarpo<sup>1</sup>, <sup>1</sup>UNESP, University Estadual Paulista, Dracena, Brazil, <sup>2</sup>University of São Paulo, Pirassununga, Brazil, <sup>3</sup>UNESP - University of Estadual Paulista, Botucatu, Brazil.

The aim of this research was to evaluate the effect of organic acids in the diet of broiler chickens as an alternative to antibiotic growth promoters on the immune system. 840 male Cobb broiler chicks were randomly distributed with 7 replicates and 30 birds per experimental unit. The dietary treatments were: T1- basal diet - without additives (BD) - unchallenged birds; T2- basal diet - without additives (BD) - challenged birds; T3- BD + organic acids - challenged birds; T4- BD + antibiotic plus anticoccidial - challenged birds. The organic acids were a blend

composed of lactic (40%), propionic (5%) and butyric acid (1%) with addition of 8 kg/t. The utilized antibiotic was avilamycin 20% added with 50 g/t and the anticoccidial was sodium monensin 40% added with 300 g/t, allotting 10 and 120 ppm of active principle, respectively. The broilers were challenged by inoculation orally at 11 d with  $2 \times 10^5$  sporulated oocysts/mL of *Eimeria acervulina* and  $2 \times 10^4$  sporulated oocysts/mL of *E. maxima* and *E. tenella*. At 0 (before challenge), 3 (14 d-old) and 10 d post-inoculation (21 d-old) blood samples were drawn from 56 birds previously identified for hematological analysis. All data were submitted to ANOVA followed by Tukey test. Differences between treatments for erythrocytes, total leukocytes, total protein and glucose were observed ( $P < 0.05$ ). Birds that received the inclusion of organic acids showed to be effective to promote early and effective defense in the immune system by presenting mitigating effect of stress. This effect is represented by the glucose levels of 243.75 g/dL, below the values found in other treatments ( $P < 0.05$ ) and also maintained within normal values found in healthy birds (from 200 to 500 mg/dL). During the 3 stages of analysis, birds of all treatments showed marked anemia, represented by the low hematocrit concentration. It is concluded that organic acids are effective to replace the antibiotic growth promoters on immunity of broilers under the mentioned experimental conditions.

**Acknowledgments:** We thank Nutriacid/Btech for donating the organic acids.

**Key Words:** antimicrobial additives, challenge, *Eimeria*, immunology, stress.

### 193 Organic acids in replacement to antibiotic growth promoters in the initial phase of broiler chickens on growth performance.

Valquíria Cação Cruz-Polycarpo\*<sup>1</sup>, Kelry Mayara da Silva<sup>1</sup>, Gustavo do Valle Polycarpo<sup>2</sup>, Robert Guaracy Aparecido Cardoso Araujo<sup>1</sup>, Victor Hugo Alderenike Amaral<sup>1</sup>, and Gabriela Ventura<sup>1</sup>, <sup>1</sup>UNESP, University of Estadual Paulista, Dracena, Brazil, <sup>2</sup>University of São Paulo, Pirassununga, Brazil.

The aim of this study was to evaluate the effect of organic acids administered in the diet of broiler chickens from 1 to 21 d as an alternative to antibiotic growth promoters on the performance. 840 male Cobb broiler chicks were distributed in a completely randomized design with 7 replicates and 30 birds per experimental unit. The dietary treatments were: T1- basal diet - without additives (BD) - unchallenged birds; T2- basal diet - without additives (BD) - challenged birds; T3- BD + organic acids - challenged birds; T4- BD + antibiotic plus anticoccidial - challenged birds. The organic acids were a blend composed of lactic (40%), propionic (5%) and butyric acid (1%) with addition of 8 kg/t. The utilized antibiotic was avilamycin 20% added with 50 g/t and the anticoccidial was sodium monensin 40% added with 300 g/t, allotting 10 and 120 ppm of active principle, respectively. The broilers were challenged by inoculation orally at 11 d of age with  $2 \times 10^5$  sporulated oocysts/mL of *Eimeria acervulina* and  $2 \times 10^4$  sporulated oocysts/mL of *E. maxima* and *E. tenella*. All data were submitted to ANOVA followed by Tukey test. At 21 d, broilers of the negative control (unchallenged) presented same BW, FI and FCR ( $P > 0.05$ ) of the broilers fed with antibiotic plus anticoccidial (challenged), showing the control action of those drugs in the gastrointestinal tract, even with direct contact with pathogens. However, the organic acids inclusion did not increased the broiler performance, which presented lower results than the antibiotic growth promoters ( $P < 0.05$ ) and the same results of BD - without challenge ( $P > 0.05$ ). In conclusion, the tested organic acids are not a

viable alternative on the broiler performance to replace antibiotic growth promoters in the challenge conditions presented.

**Acknowledgments:** We thank Nutriacid/Btech for donating the organic acids.

**Key Words:** butyric acid, lactic acid, propionic acid, challenge, eimeria

**194 Tributyrin increases yield of broilers noble cuts.** José M. Assaff<sup>1</sup>, Sarah Sgavioli\*<sup>1,2</sup>, Alessandro A. Bandeira<sup>1</sup>, Iesser D. Salah<sup>1</sup>, Hirã G. Azevedo<sup>1</sup>, and Rogério Iuspa<sup>1</sup>, <sup>1</sup>*Ilender Pharm. Corp., Paulínia, São Paulo, Brazil*, <sup>2</sup>*Federal University of Grande Dourados, Dourados, Mato Grosso do Sul, Brazil*.

The present trial was designed to evaluate the effect of tributyrin on the broiler's carcass yield and cuts. A total of 880,000 broilers, Cobb mixed lots were housed in 44 commercial poultry farms, conventional, with negative pressure. The broilers were randomly distributed in a 2 × 2 factorial arrangement, with 2 treatments (with and without tributyrin at 3 kg/ton in 1 - 5 d old broilers) and 2 sex (male and female). The product used in this trial tributyrin (C4 Powder SI) was provided by Ilender Pharmaceutical Corporation (Lima, Peru). At 45 d of age 440 birds were selected, 10 birds/farm were slaughtered and subsequent carcass yield and cuts were evaluated. After the preliminary analysis, the datas were submitted to ANOVA using the GLM procedure of SAS (SAS Institute, 2003) considering the probability of 5%. There was a significant ( $P < 0.05$ ) for the inclusion of tributyrin to yield thigh + drumstick, thigh, drumstick, breast, steak and sassami with higher yield of cuts in birds fed tributyrin (0.75; 0.40; 0.33; 1.24; 1.27 and 0.21%, respectively). Carcass yield was lower for birds fed tributyrin ( $P < 0.05$ ) (1.41%). There were a higher yield of thigh + drumstick and thigh ( $P < 0.05$ ) (0.65, 0.40%) for males, while for sassami, wing and highest yields were obtained for females ( $P < 0.05$ ) (0.08 and 0.30%). We conclude that the inclusion of 3 kg/ton of tributyrin during the pre-starter phase results in higher yield cuts for broilers, of both sex.

**Key Words:** butyric acid, butyrin glyceride, commercial poultry farm

**195 Effect of lemon pulp as an antibiotic growth promoter substitution on performance and some serum biochemical parameters in broiler chickens.** Majid Toghyani\* and Reihaneh Basir, *Department of Animal Science, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran*.

This experiment was conducted to investigate the effect of dried lemon pulp (DLP) as an antibiotic growth promoter substitution on performance and some serum biochemical parameters in broiler chicks. A total of 280, day-old broilers (Ross 308) were randomly assigned to 4 treatments with 5 replicates based on a completely randomized design. Dietary treatments included control, antibiotic growth promoter (flavophospholipol), 5 and 10 g DLP/kg diet. Broilers received dietary treatments from 1 to 42 d. Body weight of broilers were measured at 1, 14, 28 and 42 d, feed intake was measured at the same periods and feed conversion was calculated, accordingly. At d 42, 2 birds per replicate were slaughtered for determination of carcass and organ weights and also blood samples were taken for measuring serum antioxidant capacity, triglyceride, total cholesterol, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol. The data were analyzed by SAS (2008) and Means were compared for significant ( $P \leq 0.05$ ) differences by using the LSMEANS. The obtained results showed that dietary supplementation of flavophospholipol increased final body weight and improved feed conversion ratio of broilers compared with those fed diets supplemented

with DLP and control ( $P < 0.05$ ). Inclusion of DLP to broilers diet had not significant effect on body weight, feed consumption and feed conversion. Carcass yield, abdominal fat and lymphoid organs (bursa of Fabricius and spleen) weight were not affected significantly by dietary treatments. Broilers fed 10 g/kg DLP had a significantly higher serum concentration of total antioxidant capacity, cholesterol and HDL cholesterol ( $P < 0.05$ ). Serum concentration of triglyceride and LDL cholesterol were not affected by dietary treatments. The results suggested that dietary inclusion of 5 and 10 g/kg DLP as an antibiotic growth promoter substitution failed to induce any significant improvement on growth performance of broiler chickens. Nevertheless application of DLP in the diet proved to have antioxidant activity.

**Key Words:** broiler, lemon pulp, antibiotic, performance, antioxidant

**196 Effect of supplementing exogenous protease in low protein poultry by-product meal based diets on growth, carcass response and nutrient digestibility in broilers.** Tahir Mahmood\*<sup>1</sup>, Muhammad A. Mirza<sup>1</sup>, Haq Nawaz<sup>1</sup>, Muhammad Shahid<sup>2</sup>, Muhammad Athar<sup>3</sup>, and Mubashar Hussain<sup>1</sup>, <sup>1</sup>*Institute of Animal Sciences, University of Agriculture, Faisalabad, Punjab, Pakistan*, <sup>2</sup>*Department of Biochemistry, University of Agriculture, Faisalabad, Punjab, Pakistan*, <sup>3</sup>*Hi-Tech Feeds (Pvt) Ltd., Lahore, Punjab, Pakistan*.

A 3 × 2 × 2 experiment using 3 levels (0, 3 and 6%) of poultry by-product meal (PBM), 2 levels (19 and 18%) of crude protein (CP) and 2 levels of exogenous protease (with and without) was undertaken to examine the effect on growth performance, carcass response and nutrient digestibility in broilers. The experiment was statistically analyzed in 3 × 2 × 2 factorial design under CRD by generalized linear method of ANOVA using MINITAB. The significant means were separated by Tukey's test. The birds (n = 1920) were randomly divided into 48 replicates with 4 replicates under each treatment (40 birds/replicate). Six iso-caloric diets (ME 2850) were formulated with 2 CP levels (19 and 18%). Each diet was divided into 2 parts. One was supplemented with exogenous enzyme (200 g/ton) while the other part was not supplemented. Supplementation of enzyme increased feed intake ( $P < 0.001$ ) and body weight gain ( $P < 0.001$ ). The feed: gain was also improved ( $P < 0.01$ ) by supplementation of protease during d 1–21 and d 1–35. However, feed intake and body weight gain ( $P < 0.001$ ) were decreased with decreasing level of CP during d 1–21 and d 1–35. Increasing level of PBM from 3 to 6% decreased feed intake and body weight gain ( $P < 0.001$ ) during d 1–21. Feed: gain was poor ( $P < 0.05$ ) during this period. Carcass characteristics remained unaffected ( $P > 0.05$ ) by all the dietary treatments. No effect of reducing CP level on AME, AME<sub>n</sub> and apparent digestibility co-efficient for nitrogen was noted. However, nitrogen retention (N<sub>ret</sub>) was decreased ( $P < 0.001$ ) when CP level was decreased. Inclusion of PBM also had no effect on nutrient digestibility. A significant ( $P < 0.05$ ) PBM and CP interaction was noted on AME, N<sub>ret</sub> and AME<sub>n</sub>. The addition of enzyme improved all these parameters. In conclusion, CP could not be reduced to below 19% in 3% PBM based diet supplemented with exogenous protease.

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**Key Words:** poultry by-product meal, protease, broiler, nutrient digestibility, carcass response

**197 Effect of aqueous *Moringa oleifera* (Lam) leaf extracts on growth performance and carcass characteristics of Hubbard broiler chickens.** Olushola John Alabi\*<sup>1,2</sup>, Abduganuyu Dele

Malik<sup>1</sup>, Theophilus Zubairu Adama<sup>1</sup>, and Jones Wilfred Ngambi<sup>2</sup>,  
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Two hundred and 40 d-old Hubbard broiler chicks were used to study the effect of aqueous *Moringa oleifera* leaf extracts (AMOLE) on growth performance of broiler chickens. They were randomly allocated to 6 treatments with 4 replicates, and each replicate containing 10 chicks. The completely randomized experimental design was used. The treatments contained AMOLE<sub>0+</sub> (positive control with antibiotic treatment), AMOLE<sub>0</sub> (negative control with water), AMOLE<sub>60</sub>, AMOLE<sub>90</sub>, AMOLE<sub>120</sub> and AMOLE<sub>150</sub> containing 60, 90, 120 and 150 mL of moringa extracts, respectively. The extract was administered in the drinking water. The experiment lasted for 42 d. All data collected were analyzed using one way ANOVA. AMOLE treatments significantly ( $P < 0.05$ ) influenced the final body weight, feed intake, water intake, growth rate, FCR and dressing percentage, as well as weight of the large intestines and lungs. However, there were no significant ( $P > 0.05$ ) differences in the initial weight and all other carcass parameters. Chickens on positive

control had the highest final body weight and growth rate (2392.00 g and 53.61 g, respectively) and the ones on 150 mL/l of AMOLE had the least (2042.00 g and 45.37 g, respectively). On feed intake, chickens on positive control had the highest (84.70 g) and the ones on 90 mL/liter of AMOLE had the lowest (73.19 g); while the results of feed conversion ratio (FCR) indicate that chickens on AMOLE<sub>90</sub> and AMOLE<sub>120</sub> performed better ( $P < 0.05$ ) than the positive control treatment. Chickens on the AMOLE treatments had similar dressing percentages though that of positive control was highest (94.93%); while those on AMOLE<sub>60</sub> and AMOLE<sub>150</sub> had the highest large intestine and lung weights, respectively. It could, therefore, be concluded that up to 120 mL of aqueous *Moringa oleifera* leaf meal extracts can be included in the diet of broiler chickens for improved feed conversion efficiency and as a cheap source of plant growth promoter in broiler chicken production.

**Key Words:** aqueous, *Moringa Oleifera*, extract, performance

## Metabolism and Nutrition: Enzymes III

**198 Effect of xylanase+ $\beta$ -glucanase on the performance and digestibility of broilers fed corn/soybean meal based diet.** Daniella C. Z. Donato\*<sup>1</sup>, Luciana G. Franco<sup>1</sup>, Mauricio S. Cunha<sup>1</sup>, Ana Paula A. Oliveira<sup>1</sup>, Nilva K. Sakomura<sup>2</sup>, and Henrique S. Nogueira<sup>2</sup>, <sup>1</sup>Danisco Animal Nutrition, DuPont Industrial Biosciences, Paulinia, São Paulo, Brazil, <sup>2</sup>Departamento de Zootecnia, FCAV/UNESP, Jaboticabal, São Paulo, Brazil.

The effect of xylanase and  $\beta$ -glucanase has already been proven in broilers fed diets containing high levels of soluble non-starch polysaccharides (NSP). However, soluble and total NSP content in corn and soybean meal are low compared with viscous cereals, and therefore, diets having large proportions of corn are not expected to show significant improvement when supplemented with NSP enzymes. A trial was conducted to verify the effect of xylanase+ $\beta$ -glucanase (XB) on the performance and digestibility of broilers fed corn/soybean meal diet ( $\approx$ 3.3% total arabinoxylan) and to determine its optimum inclusion level. A total of 1,440 Cobb 500 male chicks were divided into 6 treatments with 8 replicate pens of 30 birds each distributed in a completely randomized design. Treatments consisted of Positive Control (PC; diet meeting the nutritional requirements of the birds, with no enzyme); Negative Control (NC; reduction of 120 kcal/kg ME in starter phase, and 150 kcal/kg in finisher phase, with no enzyme); NC + 610 + 76U/kg; NC + 1,220 + 152U/kg; NC + 1,830 + 228U/kg; NC + 2,440 + 304U/kg xylanase+ $\beta$ -glucanase, respectively. Performance parameters were evaluated during starter (1–21 d), finisher phase (21–42 d), and the entire period (1–42 d). Apparent digestible energy (ADE) and ileal digestibility of nitrogen (N) and dry matter (DM) were determined at 21 d of age. All parameters were evaluated by Tukey test with 5% of significance. The supplementation of 1,830 + 228U/kg XB was able to increase ( $P < 0.01$ ) BWG in finisher phase (5.8%) and the entire period (4.9%), when compared with NC. The same enzyme level also showed similar FCR ( $P < 0.01$ ) as PC in finisher phase. When evaluating digestibility of the diets, 1,830 + 228 and 2,440 + 304U/kg XB showed similar DM digestibility and ADE as PC. The level of 1,830 + 228U/kg XB also showed similar N digestibility as PC. Although there is no protease in this enzyme product, the cell wall breakdown caused by XB likely contributed to better access to protein and starch in cells, improving digestibility and bird performance.

**Key Words:** apparent digestible energy, carbohydrase, enzyme, ileal digestibility, poultry

**199 Effects of full fat soybean meal source and protease on standard amino acids digestibility in broilers.** Vinicius Duarte de Oliveira\*<sup>2</sup>, Maurilio de Lucas Xavier Junior<sup>1</sup>, Luiz Fernando Teixeira Albino<sup>1</sup>, Horácio Santiago Rostagno<sup>1</sup>, Anelcir Scher<sup>3</sup>, José Otávio Berti Sorbara<sup>4</sup>, and Vitor Barbosa Fascina<sup>4</sup>, <sup>1</sup>Universidade Federal de Viçosa, Viçosa, MG, Brazil, <sup>2</sup>Universidade Estadual Paulista, Jaboticabal, SP, Brazil, <sup>3</sup>JBS Foods, São Paulo, SP, Brazil, <sup>4</sup>DSM Nutritional Products, São Paulo, SP, Brazil.

A study was conducted to evaluate the effects of an exogenous protease on amino acids digestibility in 9 different full fat soybean meal (FFSB) in Brazil. A total of 1,120 males, Cobb 500, 24 d old chicks were allocated in metabolic cages. The experiment was a factorial arrangement with  $9 \times 2$  (FFSB x protease inclusion – 0 and 15,000 PROT/kg feed - RONOZYMEProAct, DSM Nutritional Products), plus a Protein Free Diet (PFD) with and without protease. There were 20 experimental diets (treatments), with 8 replicates and 7 birds each. The design was

conducted in 2 blocks with 4 replicates per treatment in each block, under the same conditions just separated by time. PFD was formulated to determine the amino acid endogenous losses, while in the rest of the diets, 40% of the starch was replaced with a soybean product, according to the treatment. Protease was added on top. For all diets, 1% of acid insoluble ash was added as an indigestible marker. At 28 d of age, all birds were euthanized by cervical dislocation to collect ileal content. Data were submitted to ANOVA, and means were compared by Tukey test ( $P < 0.05$ ). It was observed interaction ( $P < 0.05$ ) between FFSB and protease to standard Met digestibility. The sample number 8 of FFSB (36.33% CP and 0.502% total Met) with or without protease supplementation showed lower Met digestibility when compared with other FFSB. The different sources of FFSB differ amino acid digestibility ( $P < 0.05$ ). Supplementation with protease led to improvements in the standard of amino acid digestibility ( $P < 0.05$ ). Protease increases +1.75% Lys, +5.98% Thr, +3.01% Met, +4.62% TAAS, +4.29% Val, +2.96% Ile, +2.77% Leu, +2.53% total aas, +2.3% essential aas, +1.98% no-essential aas, and +3.04% CP. Protease supplementation improves the digestibility of amino acids in different FFSB.

**Acknowledgments:** DSM Nutritional Products, JBS Foods, Fapemig, UFV e Capes

**Key Words:** protease, protein free diet, soybean, vegetal protein

**200 Growth performance and energy release of broiler chickens fed corn-soybean meal diets supplemented with an enzymatic complex.** Pablo I. Dos Santos\*, Heitor V. Rios, Sergio L. Vieira, Liris Kindlein, Patricia S. De Carvalho, and Catarina Stefanello, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.

A study was conducted to evaluate the effects of an enzyme complex (EC) composed by carbohydrases on growth performance and energy utilization of broilers. A total of 2,016 1-d-old male chicks Cobb 500 x Cobb 500 were allocated into 72 floor pens, distributed in a completely randomized design with 9 treatments, 8 replicates and 28 birds per pen. Corn-soybean meal diets were formulated using 1% of celite as a indigestible marker. Treatments consisted of a control diet formulated with industry levels of apparent metabolizable energy (AME) and digestible amino acids (AA dig.) without the addition of the EC, and 8 diets with reductions of AME (- 80 kcal/kg or - 120 kcal/kg) and AA dig (-3% and -6%). Diets with energy and AA dig. reductions were supplemented or not with 50 mg/kg of an carbohydrase complex (Rovabio T-Flex Advanced, Adisseo). A 3 phase feeding program was used: starter (1 to 21 d), grower (22 to 35 d) and finisher (36 to 42 d). Body weight gain (BWG), feed intake (FI) and feed conversion ratio corrected for weight of dead birds (FCR) were evaluated at 14, 21, 35, and 42 d. At 21 and 42 d, 4 birds per pen were slaughtered for ileal content collection to determine ileal digestible energy (IDE) and dry matter digestibility (DM). Broilers fed diet with - 120 kcal/kg and - 3% AA dig. supplemented with the CE had lower FCR ( $P < 0.05$ ) compared with the same energy and AA levels without enzyme supplementation. Birds fed the lowest nutritional levels (- 120 kcal/kg and - 6% AA dig.) with the addition of EC showed higher IDE at 21 d compared with treatment with the same levels without EC supplementation. It was noted higher DM digestibility for the treatment with reductions of 80 kcal/kg and 3% AA dig. with EC in relation to treatment without EC. The supplementation of 50 mg/kg of the carbohydrase complex had improved broiler's performance and energy utilization. Broilers fed diets with the lowest energy and digest-



ible amino acids levels had the higher digestibility improvements with the carbohydrases supplementation.

**Key Words:** broiler, carbohydrase, performance, digestibility

**201 Enzymatic complex utilization in diets with dried yeast from sugarcane.** Regina Fialho de Sousa<sup>1</sup>, Miliane Alves da Costa<sup>\*2</sup>, Edna Teles Dos Santos<sup>1</sup>, Leilaine Rocha Barros Dourado<sup>1</sup>, Mirian Lima Fernandes<sup>1</sup>, and Rain Malta<sup>1</sup>, <sup>1</sup>University Federal of Piauí, Bom Jesus, Piauí, Brazil, <sup>2</sup>University Federal of Goiás, Goiânia, Goiás, Brazil.

The objective of this study was to evaluate the use of enzymatic complex in diets with dry yeast sugarcane (*Saccharomyces cerevisiae*) on the growth performance of broiler chickens in the period 1–21 d of age. A total of 700 male day-old Cobb 500 chicks were distributed in 35 pens in a completely randomized design 2 × 3 factorial, with 2 levels of enzymatic complex (0 and 200 g/ton); 3 yeast inclusion levels (0, 6 and 12%), with 7 treatments and 5 replicates of 20 birds each. The enzymatic complex was composed of α-galactosidase, galactomannans, xylanase and β-glucanase. At 21 d of age weight gain (WG), feed intake (FI) and feed conversion ratio (FCR) were measured. Data were subjected to ANOVA and the means were compared using SNK test ( $P < 0.05$ ). Estimates of the level of yeast were established by linear and polynomial regression models. There was no interaction between the yeast levels and the addition of the enzymatic complex on the performance of the animals. Yeast levels (0, 6 and 12%) provided increased ( $P < 0.05$ ) in feed intake (869; 903; 915) and feed conversion ratio (1.36; 1.46; 1.50), and reduction in weight gain (639; 618; 612). There was an increasing linear effect ( $P < 0.05$ ) for feed intake ( $FI = 872.11 + 3,936NL$ ,  $R^2 = 0.92$ ) and feed conversion ( $FC = 1,371 + 0,113NL$ ,  $R^2 = 0.94$ ) of the birds with the addition of yeast in the diet, and decreasing linear effect on weight gain ( $WG = 636,88 - 2,24NL$ ,  $R^2 = 0.90$ ) in phase 1 to 21 d of age. There was also no significant difference on the use of enzymatic complex in the diets. Yeast use affect negatively the performance of broilers from 1 to 21 d. The inclusion of the enzymatic complex does not change the performance during the study period.

**Key Words:** *Saccharomyces cerevisiae*, galactomannan, xylanase, β-glucanase

**202 Effect of enzyme blend in diets on performance of broiler chickens.** João P. S. S. Silva<sup>1</sup>, José H. Vilar Da Silva<sup>\*1</sup>, José Jordão Filho<sup>1</sup>, Vitor B. Fascina<sup>2</sup>, Thiago S. Melo<sup>1</sup>, and Silvana C. L. Santos<sup>1</sup>, <sup>1</sup>Federal University of Paraíba, Bananeiras, Paraíba, Brazil, <sup>2</sup>DSM Nutritional Products, São Paulo, São Paulo, Brazil.

A study was conducted to examine the effects of enzymes blend (EB) in a diet with reduction of nutrients on performance of chickens. A total of 900 chicks, males SF-COBB 500, were fed 6 dietary treatments of 8–21 d old. Positive control diet (PC) had 21.2% CP, 3,050 kcal/kg AME, 0.84% Ca, 0.40% aP, 1.22% DLys, 0.88% DMet+Cys, 0.79% DThr and 0.24% DTrp, however, negative control diet (NC) had 2.55% of reduction of AME (–80 kcal/kg), CP (–0.54%), DLys (–0.03%), DMet+Cys (–0.02%), DThr (–0.02%), Ca (–0.02%), aP (0.01%) and 3.75% of reduction of DTrp (–0.009%), NC+EB1 (15,000 PROT/kg of protease + 80 KNU/kg amylase + 1,000 FYT/kg phytase), NC+EB2 (15,000 PROT/kg protease + 80 KNU/kg amylase + 2,500 FYT/kg phytase), NC+EB3 (15,000 PROT/kg protease + 80 KNU/kg amylase + 1,000 FYT/kg phytase + 100 FXU/kg xylanase), and NC+EB4 (15,000 PROT/kg protease + 80 KNU/kg amylase + 2,500 FYT/kg phytase + 100 FXU/

kg xylanase) were arranged in completely randomized design, each of 6 treatments had 10 replicates of 15 chicks. The chicks group fed PC, NC+EB1, NC+EB2, NC+EB3, NC+EB4 had, respectively better WG (911.20a, 910.95a, 894.90a, 902.04a, 915.50a, and 860.95b g) and FCR (1.171b, 1.186b, 1.207b, 1.190b, 1.168b and 1.266a g/g) compared NC ( $P < 0.01$ ). However, chicks group fed NC diet supplemented with all EB presented same performance of chicks group fed PC diet ( $P > 0.05$ ). The supplementation with protease, amylase, phytase and xylanase of diets based on corn-soybean meal with reduction mean of 2.5% in AME, CP, EAA, Ca and aP improves broiler performance.

**Acknowledgments:** Guaraves Foods, and DSM Nutritional Products

**Key Words:** corn, enzyme, nutrient reduction, soybean meal

**203 Effect of feeding different sources of exogenous proteases in broilers diets containing 1000 FTUs of phytase.** Ricardo Gonzalez-Esquerre<sup>\*1</sup>, Raquel Araujo<sup>1</sup>, Douglas Haese<sup>2</sup>, João Luís Kill<sup>3</sup>, Dawster Sant'Anna<sup>3</sup>, and Carolina Possatti<sup>3</sup>, <sup>1</sup>Novus do Brazil Ltda, Indaiatuba, São Paulo, Brazil, <sup>2</sup>Universidade Vila Velha, Vila Velha, ES, Brazil, <sup>3</sup>Centro de Tecnologia Animal Ltda, Domingos Martins, ES, Brazil.

An experiment was conducted to evaluate the effect of commercial proteases on broiler performance in diets with phytase supplemented at 1000 FTU's. A total of 3,325 Cobb 500 d-old male chicks were randomly assigned to 5 treatments of 19 replicates each. Treatments consisted of a Positive Control (PC), Negative Control (NC, with 5% reduction in AAs and 50kcal vs. PC) and NC plus one of 3 Proteases (Prot-A, Prot-B or Prot-C fed at 500, 200 and 125g per ton according to manufacturers' recommendations, respectively). Phytase (Phytaverse, Novus International Inc.) was included in all diets at 1000 FTUs and formulated at 0.19% of Av. P and Ca, plus AA and ME. A density of 10 birds/m<sup>2</sup>, reused litter, and commercial-like feeder space were imposed to broilers fed mash Corn/SBM/Meat and bone meal/Poultry by-product meal based diets. Performance was evaluated at the end of each feeding phase (14, 28 and 42d). Carcass, breast and pancreas percentages from 4 birds/pen were evaluated at 42d. Data were analyzed by ANOVA and Tukey Test. At d 14, BWG was higher for PC and FCR was better for PC and Prot-A compared with Prot-C ( $P < 0.01$ ). Prot-A improved FCR at levels similar to PC and greater than NC and Prot-B ( $P < 0.01$ ) at 28d. Proteases tested did not present differences among them for BWG at 42d, but Prot-A was the only significantly different ( $P < 0.05$ ) from NC. Prot-A improved FCR compared with NC, Prot-B and Prot-C ( $P < 0.01$ ), reaching PC results ( $P > 0.05$ ). European efficiency index was significantly higher ( $P < 0.01$ ) for PC and Prot-A compared with NC and Prot-C. Feed intake was unaffected by treatments in any age ( $P > 0.05$ ). The BW of the sampled birds did not resemble treatment averages, reflecting the challenges to obtain representative samples of birds. Carcass yield was higher for Prot-B than PC, NC and Prot-C ( $P < 0.05$ ) but not different from Prot-A; while breast yield was lower for Prot-B vs. all other treatments ( $P < 0.01$ ). Pancreas percentage did not present differences ( $P > 0.05$ ). These results suggest that proteases promote additional benefits in diets containing with 1000 FTUs phytase and that Protease Prot-A was most effective.

**Key Words:** protease, phytase, performance, broiler

**204 Effect of an exogenous protease on the standardized ileal digestibility of soybean meal and feather meal in semi-purified diets fed to broiler chickens.** Luke P. Barnard<sup>\*1</sup>, Ahmed M. Amerah<sup>1</sup>, Luis F. Romero<sup>1</sup>, and Nilva K. Sakomura<sup>2</sup>, <sup>1</sup>DuPont

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The aim was to investigate the effect of an exogenous subtilisin protease enzyme on the standardised ileal digestibility of crude protein (CP) and amino acids (AA) of soybean meal (SBM) and feather meal (FM) in broilers fed semi-purified diets. There were 5 treatments; 1. A protein free diet (PFD), 2. PFD + SBM, 3. PFD + SBM + 10,000U/kg subtilisin protease (from Danisco Animal Nutrition, DuPont Industrial Biosciences), 4. PFD + FM, 5. PFD + FM + 10,000U/kg subtilisin protease. Each treatment was replicated 9 times with 15 birds/ replicate (20 birds/ replicate for PFD treatment); test diets were fed from d15–21. Treatments 2–4 were formulated to be isonitrogenous (20% CP); dietary energy was provided by corn starch and soy oil, celite was used as an inert marker. Feed and water was available *ad libitum* for the duration of the study. At study termination, birds were euthanized and contents of the lower ileum were collected by gentle flushing with distilled water. Digesta and diets were analyzed for CP, AA and celite to calculate digestibility. Data were analyzed using JMP 11.0 and significance was considered at  $P < 0.05$ . Protease significantly increased ileal CP digestibility of FM from 73.4% to 76.5%, and numerically ( $P > 0.05$ ) improved ileal CP digestibility of SBM from 86.4% to 88.1%. This corresponded to an increase in the digestibility of the undigested fraction of CP by 20.2 and 12.3% for FM and SBM, respectively. There was a significant positive correlation between the apparent undigested fraction of an AA and the increase in digestibility of that AA with protease supplementation for SBM ( $R^2 = 0.45$ ,  $P < 0.05$ ). This work showed that exogenous subtilisin protease can increase ileal CP digestibility of FM. In SBM, the uplift in AA digestibility from protease was linked to the inherent digestibility of the AA in the ingredient.

**Key Words:** Broilers, protease, protein, amino acids, digestibility

## 205 Effect of an exogenous protease on the standardized ileal digestibility of rapeseed meal and meat and bone meal in

**semi-purified diets fed to broiler chickens.** Luke P. Barnard\*<sup>1</sup>, Ahmed M. Amerah<sup>1</sup>, Luis F. Romero<sup>1</sup>, and Velmurugu Ravindran<sup>2</sup>, <sup>1</sup>DuPont Industrial Biosciences, Danisco Animal Nutrition, Marlborough, UK, <sup>2</sup>Monogastric Research Centre, Massey University, Palmerston North, New Zealand.

The aim was to investigate the effect of an exogenous subtilisin protease enzyme on the standardised ileal digestibility of crude protein (CP) and amino acids (AA) of rapeseed meal (RSM) and meat and bone meal (MBM) in broilers fed semi-purified diets. There were 5 treatments; 1. A protein free diet (PFD), 2. PFD + RSM, 3. PFD + RSM + 8,000U/kg subtilisin protease (from Danisco Animal Nutrition, DuPont Industrial Biosciences), 4. PFD + MBM, 5. PFD + MBM + 8,000U/kg subtilisin protease. Each treatment was replicated 8 times with 4 birds/ replicate; test diets were fed from d25–34. Treatments 2–4 were formulated to be isonitrogenous (18% CP); dietary energy was provided by corn starch and soy oil, TiO<sub>2</sub> was used as an inert marker. Feed and water was available *ad libitum* for the duration of the study. At study termination, birds were euthanized and contents of the lower ileum were collected by gentle flushing with distilled water. Digesta and diets were analyzed for CP, AA and an inert marker to calculate digestibility. Data were analyzed using JMP 11.0 and significance was considered at  $P < 0.05$ . Protease increased ileal CP digestibility of RSM and MBM ( $P < 0.05$ ). There was an increase in the digestibility of the undigested fraction of CP by 11.7 and 16.5% for RSM and MBM, respectively. There were also significant positive correlations between the apparent undigested fraction of an AA and the increase in digestibility of that AA with protease supplementation, for RSM ( $R^2 = 0.67$ ,  $P < 0.05$ ) and MBM ( $R^2 = 0.49$ ,  $P < 0.05$ ). This work showed that exogenous subtilisin protease can significantly increase ileal CP digestibility of RSM and MBM. The magnitude of the response to protease was different on different ingredients. The response to the protease on AA digestibility depended on the inherent digestibility of the AA without protease supplementation.

**Key Words:** Broilers, protease, protein, amino acid, digestibility