

# Metabolism and Nutrition—Feed Additives

**227 Effects of different probiotic application methods and diet types on performance, carcass characteristics, serum lipids, jejunal histomorphology, cecal microflora population and immune responses in broiler chickens.** M. Shivazad\*, M. H. Mohammadi Ghasem Abadi, M. Riahi, A. Zali, and M. Adib Moradi, *University of Tehran, Tehran, Iran.*

This study was conducted to assess the effects of different short-term water-soluble probiotic application methods (PAM), by a probiotic containing *Enterococcus faecium*, to reduce probiotic application cost with 2 types of diet (TOD) on performance, carcass characteristics, serum lipids, jejunal histomorphology, cecal microflora population and immune responses in broiler chickens. Five hundred sixty day-old male Ross 308 chicks were randomly distributed in a completely randomized design with 4 × 2 factorial arrangement consisting of probiotic spray in hatchery (PSH), the first 3 d probiotic application via drinking water (TW), PSH plus the first 3 d probiotic application via drinking water (PSH+TW) and a negative control, each with 2 TOD (corn or wheat-based diet). Each of the 8 treatments was fed to 5 replicates (14 birds/pen) from 0 to 42 d of age based on 3 phases of feeding (starter 0–10 d, grower 11–24 d, and finisher 25–42 d). The results indicate that the performance of starter and grower period were significantly improved ( $P < 0.05$ ) by corn and wheat based diet, respectively. Although PSH improved broiler BW gain (BWG) in the grower period ( $P < 0.05$ ), it did not improve final BWG. The PSH+TW treatment had negatively significant effect ( $P < 0.05$ ) on final BWG. Corn based diet had a significantly positive effect ( $P < 0.05$ ) on carcass characteristics, whereas PAM did not. PAM and wheat-based diet had a significant effect ( $P < 0.05$ ) on reduction of serum cholesterol and HDL at 42 d of age, respectively. Corn-based diet and PAM significantly ( $P < 0.05$ ) reduced jejunal epithelium thickness and goblet cell number at 44 d of age. Wheat-based diet had significantly ( $P < 0.05$ ) higher number of cecal *E. coli* population at 44 d of age. Neither TOD nor PAM had any significant effects ( $P > 0.05$ ) on immune responses at different periods of age. These results suggest that TOD had no significant effect on final BW but influenced carcass characteristics. In conclusion, short-term probiotic application method is not recommended for this probiotic.

**Key Words:** broiler, diet type, probiotic

**228 Response of broiler breeders and their progeny to dietary nucleotide supplementation.** M. A. Bonato\*<sup>1</sup>, R. L. C. Barbalho<sup>1</sup>, R. Albuquerque<sup>2</sup>, R. J. G. Pereira<sup>2</sup>, C. S. S. Araújo<sup>2</sup>, and L. F. Araújo<sup>3</sup>, <sup>1</sup>JCC Brazil, São Paulo, São Paulo, Brazil, <sup>2</sup>Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Pirassununga, São Paulo, Brazil, <sup>3</sup>Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, Pirassununga, São Paulo, Brazil.

Two trials were conducted to evaluate the effect of the dietary supplementation of free nucleotides, from a yeast source, on performance of broiler breeders and their progeny. The first trial, 80 Cobb broiler breeders were distributed in a completely randomized design (CRD), with 2 treatments; 0 and 5 kg/MT of yeast product, equivalent to 0.3 kg/MT of free nucleotides, from 25 to 45 wk of age. Each treatment consisted of 10 replicates, 4 breeders each. Breeders were inseminated at 35 and 45 wk of age. Eggs were collected from d 3 through d 10 post-insemination and then incubated. Egg production (EP%), egg fertility (EF%), hatchability of incubated eggs (HIE%), and fertile eggs (HFE%), total embryonic mortality (TEM%), and chick weight (CW,

g) were evaluated. In the second trial, 240 male chicks were distributed in CRD in a factorial arrangement 2 × 2 (progeny derived from broiler breeders which were supplemented or not, and progeny supplemented or not, at 5 kg/MT of yeast product), resulting in 4 treatments with 5 replicates, 12 birds each. Study criteria included BWG, FI, and F/G at 42 d. Data were analyzed using the GLM (SAS) and means compared by Tukey ( $P = 0.05$ ). Nucleotide supplementation of the breeder diet improved ( $P < 0.05$ ) EP (2.6 and 2.9%), EF (2.5 and 2%), HIE (6.7 and 2.6%), HFE (9 and 6.9%), TEM (36.5 and 34.5%) and CW (2.2 and 4.4%), respectively for hens from 25 to 35 and 36 to 45 wk. There was no interaction ( $P > 0.05$ ) between breeders and offspring supplementation, for either breeder age. Offspring from 35 and 45 wk old breeders fed nucleotide-added diets had better ( $P < 0.05$ ) BWG (2.7 vs. 2.6 and 2.86 vs 2.73 kg) and F/G (1.71 vs. 1.91 and 1.66 vs. 1.74), respectively versus chicks from unsupplemented hens. The supplemented offspring groups had better ( $P < 0.05$ ) F/G (1.75 vs. 1.86 and 1.67 vs. 1.73) compared with nonsupplemented broilers from 35 and 45 wk breeders, respectively. This study demonstrated that nucleotide supplementation of broiler breeder increased the number of live chicks by 13%, on average, and had a positive carryover effect on the progeny's performance for BWG (+4.3%, on average) and F/G (+9.5%, on average).

**Key Words:** egg production, broiler, feed conversion, yeast

**229 The effects of Varium on broilers challenged to induce necrotic enteritis.** S. Ching\*<sup>1</sup>, F. Chi<sup>1</sup>, S. L. Johnston<sup>1</sup>, G. R. Goss<sup>1</sup>, B. S. Lumpkins<sup>2</sup>, G. F. Mathis<sup>2</sup>, and R. L. Cravens<sup>1</sup>, <sup>1</sup>Amlan International, Chicago, IL, <sup>2</sup>Southern Poultry Research, Athens, GA.

Three hundred twenty day-old chicks (Cobb × Cobb) were used in an experiment to evaluate the effects of products on growth performance, lesion scores, and mortality of broilers when challenged to induce necrotic enteritis. Tested products were Varium (V), a precursor to the Varium (PV) formula, and virginiamycin (VM). There were 5 treatments: (1) Control (C); (2) C challenged to induce necrotic enteritis (NE); (3) C + PV at 0.25%; (4) C + V at 0.25%; and (5) C + VM at 20 g/ton. There were 8 pens of chicks per treatment with 8 chicks in each pen. Data were analyzed using the Student's *t*-test using  $P < 0.05$  to indicate significant difference. Chicks had ad libitum access to feed and water. On d 14 of the 28-d experiment, all birds were orally challenged with ~5,000 oocysts of *Eimeria maxima*. On d 19, 20, and 21, all birds, except those on treatment 1, were given a broth culture of *Clostridium perfringens* 10<sup>8</sup> cfu/mL isolated from a clinical case of necrotic enteritis that produces both  $\alpha$  and Net B toxins. Weights of birds and feed were taken on d 14 and 28 for calculation of gain and feed conversion. Three birds per pen were euthanized on d 21 for intestinal lesion scoring (scale = 0 to 3), and mortality due to necrotic enteritis was noted. Adding Varium or virginiamycin improved weight gain relative to the necrotic enteritis control for d 14 to 28, with Varium increasing gain for the entire feeding period. Both Varium formulas or virginiamycin improved feed conversion relative to the necrotic enteritis infected control. Adding Varium decreased lesion scores relative to the necrotic enteritis control. Varium decreased mortality relative to the necrotic enteritis control and was equal to the virginiamycin. Therefore, adding Varium to diets for broiler chicks decreased the effects of a necrotic enteritis challenge.

**Key Words:** necrotic enteritis, *Clostridium perfringens*, *Eimeria maxima*

### 230 Effects of dietary supplementation of a yeast product in broiler chickens challenged with *Clostridium perfringens*. D.

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Dietary addition of probiotic/prebiotic yeast products derived from *Saccharomyces cerevisiae* can have beneficial effects on gut health in poultry. It has been suggested that reducing toxin production by *Clostridium perfringens* (CP) might be a key mode of action, although there is limited published information available. The objective of this study was to investigate if addition of a commercial source of *Saccharomyces cerevisiae* could improve broiler performance when challenged with CP in a necrotic enteritis (NE) disease model. Ross 308 male broiler chicks (1,024) were assigned to 64 pens (16 birds/pen) in a completely randomized block design with a factorial arrangement of 2 levels of yeast product (0 or 100 ppm) and 4 challenge conditions (no challenge or challenge on d 14 with 1 of 3 strains of CP varying in virulence) in a 23-d study. Addition of yeast product increased d 14 body weight (+2.5%,  $P = 0.006$ ) in pre-challenge period. Birds fed 100 ppm of the product were heavier at d 23 (+3%,  $P = 0.032$ ) compared with the non-supplemented group. The effect of CP strain on d 23 body weight was also significant as challenged birds were lighter compared with non-challenged ones ( $P = 0.0001$ ). Addition of yeast product had no significant effects ( $P > 0.05$ ) on average daily gain and feed conversion ratio during d 14 to 23; however, the effect of CP strain on these variables was significant ( $P = 0.0001$ ). There was no significant effect ( $P > 0.05$ ) of yeast product on NE-related mortality, NE lesion scores or ileal CP counts, although it reduced total mortality ( $P = 0.045$ ). The effect of CP strain on all these variables were significant ( $P = 0.0001$ ). There was no significant interaction effect between yeast product and CP strain on any measured variable. The present results suggest that yeast product had beneficial effects in non-challenged birds, warranting further investigation.

**Key Words:** necrotic enteritis, *Clostridium perfringens*, yeast, *Saccharomyces cerevisiae*, broiler chicken

### 231 Effect of a feed additive containing mixed enzymes and direct fed microbial combination on performance of turkeys.

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This study determined the response of turkeys supplemented with a feed additive containing mixed enzymes (xylanase, amylase, and protease) and direct-fed microbial (DFM, containing 3 *Bacillus* strains). Three treatments were tested using day-old Hybrid Converter poults in a completely randomized design with 6 replications per treatment (18 poults/pen). Treatments were a positive control (PC), a negative control (NC, with reduction of 100 kcal ME/kg) and NC+ additive (test). Diets were based on corn/soy/DDGS (6%) containing 500FTU/kg phytase, fed in crumbles or pellet form at ad libitum in 4 phases: 1–28 d, 29–42 d, 43–56 d, and 57–84 d. Body weight and feed intake (FI) were measured per phase. Treatment means were compared using Student's *t*-test. The feed additive significantly improved body weight gain (BWG) during d 1 to 28, reduced feed conversion ratio (FCR) and calorie conversion (CC, kcal/kg of BWG) during 1–28 d and 57–84 d compared with NC and not different from PC. Overall, 84-d data showed that the test group was 115 g heavier in BWG, and exhibited 6 points lower FCR ( $P = 0.09$ ) and 200 kcal lower energy consumed per kg BWG ( $P = 0.09$ ) compared with NC (Table 1). In conclusion, supplementation of the additive con-

taining mixed enzymes and DFM improved feed and energy utilization efficiency in turkeys during 84 d of feeding.

**Table 1.** Effect of a feed additive containing mixed enzymes and DFM on performance of turkeys

Period/trait	PC	NC	Test
1–28 d			
BWG, g	870 <sup>c</sup>	914 <sup>b</sup>	934 <sup>a</sup>
FI, g	1,333 <sup>b</sup>	1,483 <sup>a</sup>	1,470 <sup>a</sup>
FCR	1.53 <sup>b</sup>	1.62 <sup>a</sup>	1.57 <sup>b</sup>
CC, kcal/kg of BWG	4,455 <sup>ab</sup>	4,555 <sup>a</sup>	4,417 <sup>b</sup>
5–84 d			
BWG, g	3,572	3,487	3,700
FI, g	9,491 <sup>b</sup>	10,010 <sup>a</sup>	9,575 <sup>ab</sup>
FCR	2.66 <sup>ab</sup>	2.89 <sup>a</sup>	2.60 <sup>b</sup>
CC, kcal/kg of BWG	8,455 <sup>ab</sup>	8,891 <sup>a</sup>	7,985 <sup>b</sup>
1–84 d			
BWG, g	7,377	7,322	7,437
FI, g	15,797 <sup>b</sup>	16,499 <sup>a</sup>	16,275 <sup>ab</sup>
FCR	2.14 <sup>b</sup>	2.25 <sup>a</sup>	2.19 <sup>ab</sup>
CC, kcal/kg of BWG	6,663 <sup>AB</sup>	6,784 <sup>A</sup>	6,584 <sup>B</sup>

Values not sharing a common superscript differ significantly (<sup>a-c</sup>;  $P < 0.05$ ) or almost significantly (<sup>A-C</sup>;  $P < 0.10$ ).

**Key Words:** turkey, growth performance, enzyme, DFM, feed efficiency

### 232 Prebiotics and probiotics used alone or in combination and effects on pullet growth, and intestinal microbiome. D.

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A study was conducted examining the effects of prebiotics, probiotics separately and in combination on growth parameters, fecal and cecal microbiota. Six dietary treatments consisted of (1) control; (2) control +  $1 \times 10^9$  cfu/kg of feed *Pediococcus acidilactici*; (3) control +  $2 \times 10^9$  cfu/kg of feed live yeast (*Saccharomyces cerevisiae*); (4) control + 0.91 kg/ton MOS; (5) control +  $1 \times 10^9$  cfu/kg of feed *Pediococcus acidilactici* and + 0.91 kg/ton MOS; and (6) control +  $2 \times 10^9$  cfu/kg of feed live *Saccharomyces cerevisiae* + 0.91 kg/ton MOS. During the brooder phase (0–4 wk), 600 Bovan white pullet chicks were randomly assigned to 60 pens. At 5 wks of age, pullets were moved to 36 grower pens with 10 chicks per pen. At 17 wk, all pullet chicks were moved to a tiered layer unit with 4 layers per pen. Measurements included feed intake (biweekly until 4 wks of age, then weekly), weekly egg production starting at 19 wk, biweekly body wt, body wt gain and FCR were calculated. Microbial sampling was as follows: fecal *Salmonella* Enteritidis (SE) prevalence testing at wk 15, 19, and 22 of age. Fecal and cecal *Escherichia coli*, *Enterobacteriaceae*, and coliform testing was conducted at 12, 16, 20, and 22 wk of age and *Salmonella* counts were determined at 16, 20, and 22 wk of age. Body wt gain tended to be higher ( $P \leq 0.085$ ), with  $1 \times 10^9$  cfu/kg *Pediococcus acidilactici* (0–4 wk). Control rations tended to have higher feed intake from 11 to 13 wk of age ( $P \leq 0.094$ ). There were not significant differences between treatments for SE prevalence, *E. coli*, coliform, *Enterobacteriaceae* or *Salmonella* fecal counts. Cecal *E. coli* and coliform counts were not affected by treatment. There was a significant treatment by time effect for *Enterobacteriaceae* cecal counts

( $P \leq 0.051$ ). *Enterobacteriaceae* counts spiked at 16 wk of age and decreased through the study for all treatments, except for MOS. There were trends of improved performance, but no difference on pathogenic bacteria populations.

**Key Words:** prebiotic, probiotic, pullet, growth, bacteria

**233 The use of GalliPro to improve broiler performance in protein-reduced diets.** D. Harrington<sup>\*1</sup>, E. Scott-Baird<sup>2</sup>, and A. B. Kehlet<sup>1</sup>, <sup>1</sup>*Chr. Hansen A/S, Hørsholm, Denmark*, <sup>2</sup>*ADAS Drayton, Stratford upon Avon, United Kingdom*.

The global poultry industry is under constant pressure to manage production including feed cost and feed efficiency and evaluate chemical alternatives. Alternatives such as probiotics have been used successfully in commercial poultry production globally. GalliPro, a unique strain of *Bacillus subtilis*, exhibits increased protease activity compared with other commercially available probiotics and may confer benefits of increased nutrient digestibility in addition to other probiotic effects. A study was conducted to evaluate the effect of GalliPro on broiler performance fed diets with reduced protein levels reared for 42 d. A total of 552 birds (Ross 308) were allocated to 6 treatments and fed standard wheat/barley/soy-based rations with average reducing predicted digestible protein (DP) levels: (T1) 100% of included DP; (T2) 100% DP + GalliPro ( $8.0 \times 10^5$  cfu/g feed) (GP); (T3) 97.27% DP; (T4) 97.57% DP+GP; (T5) 97.91% DP+GP; and (T6) 98.70% DP. At 7 d used litter from a commercial poultry farm was introduced to all pens to provide a low bacterial and coccidial challenge. At 28 d, birds in T6 did not differ significantly in weight compared with T1 and T2. By d 42, birds in T2 were significantly heavier than all others (3.00 kg), while birds in T1 and T6 were not significantly different (2.82 and 2.83 kg, respectively) but significantly heavier than T3–5. Birds in T2 had the lowest FCR (1.59) although this was not significantly different from T1 (1.66) and T6 (1.64). Mortality did not differ significantly between treatments, although T2, T3 and T6 were lower than T1 (2.22, 2.22, 3.11 and 4.33%, respectively). On d 43, litter quality score was better in T3–6 compared with T1 and T2. EPEF was highest in T2 followed by T6 (440 and 397, respectively). This study demonstrates that the supplementation of feed with GalliPro can compensate bird performance when diets are reduced in digestible protein by 1.51% with a concurrent improvement in litter quality, most likely by improving diet digestibility. GalliPro can also improve the performance of birds on standard diets.

**Key Words:** *Bacillus subtilis*, protein, broiler, performance

**234 The use of GalliPro to improve broiler performance in energy-reduced diets.** A. B. Kehlet<sup>\*1</sup>, L. M. da Silva<sup>2</sup>, S. C. Salguero<sup>2</sup>, L. F. Albino<sup>2</sup>, H. S. Rostagno<sup>2</sup>, and D. Harrington<sup>1</sup>, <sup>1</sup>*Chr. Hansen A/S, Hørsholm, Denmark*, <sup>2</sup>*Universidade Federal de Viçosa, Viçosa, Brazil*.

Feed accounts for approximately 70% of the cost of broiler production. There is an ongoing need to improve feed efficiency as well as look for alternative ingredients and reduce the reliance on chemical growth promotion. Probiotics, such as the *Bacillus subtilis* based GalliPro is used successfully in commercial poultry production globally. GalliPro exhibits increased enzyme activity compared with many commercially available probiotics and may confer benefits of increased nutrient digestibility. A study was conducted to evaluate the effect of GalliPro on the performance of broilers fed diets with reduced metabolizable energy levels. A total of 1,760 birds (Cobb 500) were allocated to 8 treatments (10 replicates/treatment) and reared for 40 d on reused bedding. Birds

were fed a corn-soy-based basal ration with 4 metabolizable energy (ME levels) where 100% ME = (3,075–3,200) kcal/kg and with/without GalliPro (GP) ( $8.0 \times 10^5$  cfu/g feed) as follows: (T1) 100% ME; (T2) 98% ME; (T3) 96% ME; (T4) 94% ME; (T5) 100% ME+GP; (T6) 98% ME+GP; (T7) 96% ME+GP; and (T8) 94% ME+GP. Data were subject to ANOVA, and standard curve and linear equation procedures were used to estimate the average ME contribution of GalliPro. By d 42, birds fed GP irrespective of energy level were significantly heavier than controls (2.57 and 2.61 kg, respectively). FCR did not differ significantly overall between GP and controls (1.71 and 1.72, respectively) nor did mortality (2.05 and 2.27%, respectively). Within energy level, performance with GalliPro supplementation was always numerically but not significantly improved. Liveweight of T5, T6, and T7 was numerically higher than T1. The estimated ME contribution of GP was +36 kcal/kg feed. In conclusion, GalliPro can significantly improve liveweight in broilers. In addition, GalliPro can contribute an estimate +36 kcal/kg feed. This has implications for the use of bacilli in poultry production for both their probiotic effects and their potential to offer flexibility in feed formulation.

**Key Words:** *Bacillus subtilis*, energy, broiler, performance

**235 Effect of two marigold-based yellow pigments on chicken pigmentation.** M. Blanch<sup>\*1</sup>, R. Gonzalez-Esquerria<sup>1</sup>, M. Vazquez-Anon<sup>1</sup>, and C. Lopez-Coello<sup>2</sup>, <sup>1</sup>*Novus International Inc., St Charles, MO*, <sup>2</sup>*FMVZ-UNAM, Mexico*.

Skin pigmentation is a key factor in poultry meat consumer acceptance and perceived quality and it is influenced by xanthophylls added in the diet. Xamacol Liquid Max (XLM) is the new generation of marigold liquid products developed by Novus Int. (Missouri). The objective of this study was to compare the pigmentation efficiency of XLM with a major commercial marigold product high in zeaxanthin (COM) in broilers. A total of 2,800 Ross 308 1 d-old unsexed broilers were used until 45 d of age. A basal sorghum/soya commercial diet was used comprising 3 phases: starter (1–21 d, no pigments), grower (22–35 d, 75 ppm yellow + 1 ppm canthaxanthin) and finisher (36–45 d, 85 ppm yellow + 2 ppm canthaxanthin). There were 8 treatments: 2 products (XLM and COM) at 3 equimolar levels of yellow pigment (75, 85 and 100%, with respect to Mexican commercial practice) plus 2 negative controls (with and without additional red pigment). Each treatment had 7 replicates of 50 birds/pen. Skin color was evaluated at pectoral pterilium area of 8 birds per pen (4 males and 4 females) at 45 d in live birds and in cold carcasses using a Minolta CR-300 Spectrophotometer. Data were analyzed by 1-way ANOVA and 2 × 3 factorial design. In vivo measurements showed higher yellowness (CIE b\*) in XLM group compared with COM in males (24.4 vs 21.8;  $P < 0.0001$ ) and females (27.3 vs 24.7;  $P = 0.0003$ ); and lowest dose of XLM (XLM70%) showed equivalent yellowness than highest dose of COM (COM100%). Females in XLM presented lower redness (CIE a\*) than in COM (1.08 vs 1.55;  $P = 0.003$ ), still the numerical difference was very low. Skin yellowness in cold carcasses was higher with XLM than COM in males (53.0 vs 50.1;  $P = 0.0004$ ) and females (53.1 vs 50.1;  $P = 0.0004$ ), showing equivalent pigmentation in XLM70% than in COM100%. In summary, XLM showed a higher pigmentation than COM on broiler skin pigmentation in both live broilers and cold carcasses, so lower levels of XLM could be used to attain similar yellowness than COM fed at commercial levels.

**Key Words:** broiler, pigment, yellow xanthophylls

**236 Energy utilization and growth performance of chickens fed wheat and maize based diets with and without essential oils supplementation.** V. Pirgozliev\*<sup>1</sup>, A. Beccaccia<sup>1,2</sup>, S. P. Rose<sup>1</sup>, D. Dimitrov<sup>3</sup>, and D. Bravo<sup>4</sup>, <sup>1</sup>Harper Adams University, Edgmond, United Kingdom, <sup>2</sup>University of São Paulo, Brazil, <sup>3</sup>Trakia University, Stara Zagora, Bulgaria, <sup>4</sup>Pancosma S.A., Geneva, Switzerland.

Essential oils are plant derived products used as an alternative for antibiotics as growth promoters. A total of 128 male Ross 308 chicks were used in a small floor pen study to investigate the effects of dietary supplementation of a mixture of essential oils including 5% carvacrol, 3% cinnamaldehyde and 2% capsicum (XT, Pancosma S.A.) on dietary apparent metabolizable (AME), net energy for production (NEp), and bird growth performance. Four diets (maize- and wheat-soybean based, with and without XT) were fed to the birds from 7 to 21 d of age. The diets were formulated to be adequate in protein (215 g/kg diet) but marginal in AME (2,890 kcal/kg) and slightly high in non-starch polysaccharides than breeders' recommendation and the control diets supplemented with XT (100 g/tonne). The diets were provided in mash form ad libitum throughout the experiment. The treatments were allocated in a randomized complete block design with each treatment having 8 replicate floor pens with 2 birds per pen. Supplementing maize diets with XT improved daily feed intake, weight gain and carcass protein retention ( $P < 0.05$ ) compared with wheat diets. Dietary AME was not influenced ( $P > 0.05$ ) by the cereal type or XT inclusion. Birds fed the XT supplemented maize diet had greater ( $P < 0.05$ ) daily AME intake, but no response was observed from the birds fed XT supplemented wheat diets ( $P > 0.05$ ). Feeding XT improved ( $P < 0.05$ ) dietary NEp and there was no interaction with the cereal type. Dietary NEp coupled with total carcass energy retention and carcass composition.

**Key Words:** plant extracts, chick, metabolizable energy, net energy, cereals

**237 Supplementation of plant oil extracts for laying hens on the antioxidant activity of eggs stored at different temperatures.** A. M. C. Racanicci\*<sup>1</sup>, G. R. Oliveira<sup>1</sup>, C. B. Tanure<sup>1</sup>, C. B. Lima<sup>1</sup>, D. L. Migotto<sup>1</sup>, G. N. Soares<sup>1</sup>, T. C. Souza<sup>1</sup>, L. M. C. S. Ribeiro<sup>1</sup>, J. S. Moreira<sup>2</sup>, and E. M. Oliveira<sup>2</sup>, <sup>1</sup>University of Brasilia, Brasilia, DF, Brazil, <sup>2</sup>University of Goiás, Goiânia, GO, Brazil.

The objective of this study was to evaluate the antioxidant effect of the addition of oil extracts of *Copaifera langsdorffii* (copaiba, COP) and *Pterodon emarginatus* (sucupira, SUC) to laying hens, observing the evaluation of oxidative processes during egg storage at room temperature (RT) and refrigerated at 4°C (RE). A total of 140 laying hens (ISA-Brown) were fed experimental diets based on corn and soybean meal (CP, 15% and ME, 2900 kcal/kg) with the inclusion of 3 levels of COP (0.03, 0.06, and 0.09%), 2 levels of SUC (0.03 and 0.06%) plus a negative-control treatment. Eggs were collected during 3 consecutive days at 37 d of age of hens, stored during 30 d at different temperatures (RT and RE) in a completely randomized design, treatments arranged in 2 × 3 × 2 factorial plus additional control (CON). The evaluation of lipid oxidation was performed at 0, 7, 14, 21, and 30 d of storage (RT and RE) using 3 egg yolks/treatment using the TBARS method (thiobarbituric acid reactive substances) and expressed in micromoles of malonaldehyde per kilogram of raw egg yolks (μmol of MDA/kg). Means were analyzed using mixed model procedures (SAS system). No significant interaction was observed between dietary treatments; however, it was between temperature of storage (RT and RE) and, as expected, between days of storage. TBARS values did not differ ( $P < 0.05$ ) until 7 d of storage (RT and RE), but increased for RT eggs (0.4028 μmol of MDA/kg), differing ( $P < 0.05$ ) from the RE eggs (0.2953 μmol

of MDA/kg) at 14 d. After 30 d, TBARS values from RE eggs group (0.5034 μmol of MDA/kg) were significantly ( $P < 0.05$ ) lower than RT group (0.5970 μmol of MDA/kg). Although the dietary addition of plant oil extracts did not protect eggs against lipid oxidation during storage, it can be concluded that refrigerated storage was effective to retard lipid oxidation.

**Key Words:** laying hen, raw eggs, natural antioxidant, lipid oxidation, TBARS

**238 Dietary moringa leaf meal on growth performance, internal organ development and meat yield traits of broiler chicken.** M. S. K. Sarker\*<sup>1</sup>, H. Khatun<sup>1</sup>, M. M. Rahman<sup>1</sup>, S. Faruque<sup>1</sup>, M. F. Sharmin<sup>2</sup>, and M. N. Islam<sup>1</sup>, <sup>1</sup>Bangladesh Livestock Research Institute, Dhaka, Bangladesh, <sup>2</sup>Tokyo University of Marine Science and Technology, Tokyo, Japan.

Around the world, scientists are searching alternative to antibiotic-use in feed. Moringa (*Moringa oleifera*), a potential plant in Bangladesh, is considered to use as broiler feed additives to know its growth promoting effect, internal organ development and meat quality considering suitable inoculation level and antibiotic replacement ability. Two hundred 70 d old broiler chicks were studied and the groups were control (basal diet), commercial growth promoter (basal diet + 0.05% OTC), 0.5, 1.0, 1.5, and 2.0% *M. oleifera* leaf meal with basal diet. The birds were randomly distributed in each treatments with 3 replications having 15 chicks in each floor pens and provided starter diet for 3 wk and finisher diet for the next 2 wk. All other management conditions were standard. Moringa leaf meal significantly ( $\leq 0.05$ ) enhanced growth of broiler chicks compared with control diet. Among the 4 levels 1.5% was found suitable in terms of final weight gain and feed conversion efficiency. Addition of moringa leaf meal didn't affect ( $\geq 0.05$ ) on internal organ development and dressing yield. Meat compositions among the groups were not affected but significantly reduced TBARS value was recorded which indirectly indicate its antioxidant potentiality. Considering the findings it can be concluded that moringa leaf meal is replaceable in place of antibiotic in terms of growth performance, internal organ development and meat yield traits.

**Key Words:** moringa meal, growth performance, antibiotic, internal organ, meat yield

**239 The effect of Aloapur (lactylate product) on growth performance of 0- to 28-day-old broilers challenged with *Clostridium perfringens*.** S. Powell\*<sup>1</sup>, D. Melchior<sup>1</sup>, B. Boomsma<sup>2</sup>, and S. Kok<sup>2</sup>, <sup>1</sup>Cargill Animal Nutrition, Elk River, MN, <sup>2</sup>Corbion, Gorinchem, the Netherlands.

Research was conducted to evaluate the inclusion and efficacy of Aloapur in a corn-soybean meal diets for broilers (Ross 708) challenge with *Clostridium perfringens*. Treatments had 12 replications with 5 broilers per pen. The broilers were fed a 2-phase feeding program consisting of starter (0–14 d) and grower (14–28 d) periods. Treatment diets consisted of a Control (C: no antibiotic growth promotant), C + BMD, C + Virginiamycin, and 4 levels of Aloapur (1, 2, 3, and 4 kg/T). Growth response, feed intake, feed efficiency were measured on d 7, 14, and 28. A linear ( $P \leq 0.003$ ) and quadratic ( $P \leq 0.041$ ) effect of increasing Aloapur was observed on body weight (d 28) and overall (0–28 d) average daily gain (ADG). Body weight and ADG increased up to an inclusion of 2 kg/T with no further increase at 3 and 4 kg/T. Birds fed the negative control had lower body weight and ADG compared with birds fed 2 kg/T of Aloapur. A linear effect of increasing Aloapur was observed for overall average daily feed intake (ADFI;  $P \leq 0.048$ ) and gain:feed (GF;  $P \leq$

0.048). Birds fed with and without additives had similar ADFI to birds fed 2 kg/T of Aloapur except for birds fed BMD which had a higher ADFI. Birds fed the control diet and BMD had lower GF than birds fed 2 kg/T of Aloapur. These data indicates that the optimal inclusion of Aloapur with a clostridia challenge is 2 kg/T. Aloapur at the right inclusion provides beneficial effect in broilers challenge with clostridia reared without antibiotic growth promotants.

**Key Words:** broiler, Aloapur, BMD, virginiamycin, *Clostridium perfringens*

**240 Reducing *Salmonella* Enteritidis colonization in White Leghorn SPF chickens using a feed-supplemented natural growth promoter product.** A. Kovács\*<sup>1</sup>, R. Breitsma<sup>1</sup>, L. Vandi<sup>1</sup>, P. Massi<sup>2</sup>, and G. Tosi<sup>2</sup>, <sup>1</sup>*Biomin Holding GmbH, Herzogenburg, Lower Austria, Austria*, <sup>2</sup>*Instituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna, Brescia, Italy*.

Supplementing feed with a natural growth promoter product can reduce *Salmonella* Enteritidis counts in White Leghorn cecum content. A 25-day trial was conducted to study the effects of dietary supplementation with a blend of formic, propionic and acetic acids combined with cinnamaldehyde and a permeabilizing substance (NGP, Biotronic Top3, Biomin, Austria) on the reduction of *S. Enteritidis* counts in White Leghorn cecum. From day of hatch, 60-d-old White Leghorn SPF chickens were randomly assigned to 3 treatments of 20 chicks each and placed in poultry isolators. A control group received a commercial layer pullet diet with no antibiotic or NGP, trial group 1 (NGP 1) received 1 kg of NGP/ton of feed, and trial group 2 (NGP 2) received 2 kg of NGP/ton. At d 15, chickens were eye-drop inoculated with 10<sup>5</sup> cfu of *S. Enteritidis* field strain 208876/201. At 5 (20 d of age) and 10 (25 d of age) days postinfection (dpi), 10 chickens per group were euthanized and cecum content was taken for bacteriological analyses (Table 1). The counts (cfu/g) of cecum sample were determined by counting the bacterial colonies. The results of the study showed a significant ( $P < 0.05$ ) reduction in *S. Enteritidis* counts in the cecal content of birds. Due to the NGP supplementation in the diet, *S. Enteritidis* counts in the cecum and therefore colonization were significantly lower.

**Table 1.** *Salmonella* Enteritidis counts in the cecal content of tested birds (log cfu/g)

Time	Control	NGP 1 kg/t	NGP 2 kg/t
5 dpi	2.25 <sup>a</sup> ± 0.60	0.87 <sup>b</sup> ± 0.93	0.66 <sup>b</sup> ± 0.85
10 dpi	2.63 <sup>a</sup> ± 0.95	1.29 <sup>b</sup> ± 0.75	1.05 <sup>b</sup> ± 1.13

<sup>a,b</sup>Values not sharing the same letter within a column were significantly different ( $P < 0.05$ ).

**Key Words:** *Salmonella*, permeabilizer, cinnamaldehyde, acid, broiler

**241 Effects of a combination of benzoic acid and essential oil compounds combined or not with Halquinol on broilers performance and health.** A. Londero<sup>1</sup>, A. P. Rosa<sup>1</sup>, R. Hermes\*<sup>2</sup>, D. Garcez<sup>2</sup>, C. B. Santos<sup>1</sup>, C. E. B. Vivas<sup>1</sup>, J. Forgiarini<sup>1</sup>, T. S. Toledo<sup>1</sup>, C. Orso<sup>1</sup>, G. D. Schirmann<sup>1</sup>, H. M. Freitas<sup>1</sup>, and K. P. Pontin<sup>1</sup>, <sup>1</sup>*Federal University of Santa Maria, Santa Maria, 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 effect of a commercial available product (consisting of benzoic acid and essential oils) in broilers performance fed a corn and soybean meal based diet, as an alternative to antibiotic growth promoters (AGP). It was used 1,550 one-day-old

Cobb 500 males, randomly assigned in 5 treatments with 10 replicate pens of 31 birds each. Treatments were (1) diet without AGP, a negative control (NC); (2) with 30 ppm of Halquinol (AGP); (3) with 300 ppm of Crina Poultry Plus from 1 to 42 d (CPP); (4) AGP from 1 to 21 d and CPP from 22 to 42 d (AGP/CPP); and (5) diet with AGP and CPP from 1 to 42 d (AGP&CPP). The diets had the same nutrient levels. These diets had no addition of coccidiostats or any type of enzyme. Data were submitted to ANOVA and Tukey's test. There were no significant differences on feed intake between treatments. However, the AGP diet increased ( $P < 0.05$ ) the body weight on d 42 (2.70 kg) compared with birds of NC (2.60 kg), but it was not significantly different from CPP (2.66 kg), AGP/CPP (2.65 kg) and AGP&CPP (2.64 kg). The feed conversion rate and European productive efficiency index were better ( $P < 0.05$ ) in AGP (1.71; 358), compared with NC (1.80; 330), but again not significantly different from CPP (1.74; 354), AGP/CPP (1.75; 346), and AGP&CPP (1.76; 347) from 1 to 42 d. The results suggest that the use of this product, associated or not with Halquinol, can be used as an alternative to the antibiotic growth promoters without negative effect on broiler performance.

**Key Words:** alternative antibiotic, broiler, Crina Poultry Plus

**242 Effects of coated sodium butyrate (CM 3000) feed additive on performance, *Salmonella* Enteritidis prevalence and immune status of broiler chickens.** M. A. Tony\*<sup>1</sup>, and M. M. Hamoud,<sup>2</sup> <sup>1</sup>*Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt*, <sup>2</sup>*Department of Poultry Diseases, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt*.

Sodium butyrate is a sodium salt of a volatile short-chain fatty acid (butyric acid). Butyric acid is a major type of short-chain fatty acids derived naturally from bacterial fermentation of undigested dietary fiber. An experiment was conducted to determine the effects of commercial coated sodium butyrate (CM 3000) feed additive on performance, *Salmonella* Enteritidis prevalence and immune status of broiler chickens. Two hundred twenty-five 1-d-old chicks (Hubbard breed) were randomly distributed into 3 treatment groups (3 replicates each) using 25 chicks per replicate on floor pens. Control (C) birds were offered non-supplemented basal diets. Treatments 1 and 2 (T1 and T2) were fed diets containing CM 3000 300 and 500 g/ton feed respectively. Feed and water were offered ad libitum for 35 d experimental period. Feed consumption and body weight were recorded weekly to calculate body weight gain and feed conversion. Blood samples were collected by time intervals to evaluate the immune status of the birds against some vaccines. At the end of the experimental period 12 birds were chosen randomly from each group to compare carcass yield. Bacteriological swabs were taken from the liver and at the end of the intestinal tract to examine the prevalence of *Salmonella* Enteritidis. The results revealed that body weight gain was significantly ( $P < 0.05$ ) improved in chicks fed on CM 3000 containing diets compared with control one. Supplementation of diets with CM 3000 increased significantly feed intake ( $P < 0.05$ ) and improved feed conversion. The best feed conversions were recorded in T2 group. Dressing percentage, liver weights and the other carcasses yields were non-significantly different between groups. The butyrate used significantly enhanced immune responses measured against vaccines and reduced significantly *Salmonella* Enteritidis ( $P < 0.05$ ) in the samples collected from T1 and T2 versus those collected from control group. In conclusion, exogenous administration of slow-release butyrate (CM 3000) is capable of improving performance, enhancing immunity and disease resistance in broiler chickens.

**Key Words:** sodium butyrate, broiler, performance, salmonellosis