

Metabolism and Nutrition—Feed Additives

379P Effect of lipid sources, lysophospholipids and organic acids addition on microbiology of jejunal digesta of broilers at starter phase. G. V. Polycarpo*¹, S. R. L. Maganha¹, F. S. Munin¹, M. F. C. Burbarelli¹, A. C. P. Carão¹, P. A. P. Ribeiro¹, C. E. B. Merseguel¹, K. S. Andrade¹, J. C. Dadalt¹, S. Rodrigues², J. A. D. Fávero², R. L. M. Sousa¹, V. C. Cruz-Polycarpo³, and R. Albuquerque¹, ¹University of São Paulo, Pirassununga, Brazil, ²Kemin South America, Indaiatuba, São Paulo, Brazil, ³São Paulo State University, Dracena, Brazil.

The metabolizable energy values varies depending on the quality of lipid sources, which may be better or worse utilized. The low utilization provides substrate for development of undesirable intestinal microflora. Additionally, the growth of unwanted bacteria in gut affect the absorption of lipids, generating a retroactive cycle. Therefore, the aim of this study was to evaluate diets containing different lipid sources supplemented or not with lysophospholipids and organic acids on the jejunal microbiology of broilers. Male Cobb chicks were allotted in a completely randomized design featuring a 2 × 2 × 2 factorial arrangement: soybean oil or beef tallow and supplemented with or without lysophospholipids and organic acids, with 8 replications. At 14 d, samples shaved from jejunum of one bird were collected. Esculin bile acid, Brewer and MacConkey media were used to isolate gram-positive cocci, total anaerobes and enterobacteria, respectively. The unit of measure used was cfu / log₁₀. The diets were corn and soybean meal-based. The lysophospholipids were composed mainly of lysolecithins, which is an emulsifier produced from soybean lecithin by the enzyme phospholipase A₂ activity. The composition of organic acids was: lactic (40%), acetic (7%) and butyric acid (1%). There was an interaction ($P = 0.0443$) between lipid sources and lysophospholipids inclusion on gram-positive cocci. In diets without lysophospholipids, soybean oil presented lower amounts of gram-positive cocci than beef tallow (3.766 vs. 7.239, $P = 0.0020$). However, the lysophospholipids presence was effective in diets with beef tallow (4.997 vs. 7.239, $P = 0.0410$), providing in these diets the same results of diets with soybean oil and lysophospholipids (4.997 vs. 4.643, $P > 0.05$). The total anaerobes were found in smaller quantity in diets containing soybean oil, regardless of additives inclusion (7.215 vs. 8.483, $P = 0.0006$). There was no presence of enterobacteria in samples. In conclusion, diets with soybean oil provide a lower microbial growth in the jejunum of broilers, whereas the addition of lysophospholipids decreases the presence of gram-positive cocci in diets with beef tallow.

Key Words: tallow, soybean oil

380P Dietary fructooligosaccharide supplementation as an antibiotic alternative on growth performance, intestinal morphology and immune responses of broiler chickens. Y. Shang*¹, J. H. Kim², and W. K. Kim³, ¹Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada, ²Poultry Science Division, National Institute of Animal Science, Chungnam, Republic of Korea, ³Department of Poultry Science, University of Georgia, Athens, GA.

A study was conducted to investigate the effect of dietary fructooligosaccharide (FOS) supplementation as an alternative to antibiotics on growth performance, small intestine morphology, lymphoid organ weight and splenic cytokine gene expression of broiler chickens. A total of 180 day-old-male Ross 308 chicks were randomly allocated to 3 dietary treatments (n = 60) including (1) positive control (PC), a wheat-corn-soybean meal based diet according to the NRC requirement; (2) negative

control (NC), as PC without antibiotics virginiamycin and monensin; and (3) NC+FOS, as NC supplemented with 0.5% of FOS. On d 21, segments of duodenum, jejunum and ileum were collected for intestinal morphology measurement, and the bursa of Fabricius and spleen were excised for lymphoid organ weight measurement. The expression of interleukin (IL)-1 β , IL-2, IL-6, IL-10, IL-18, toll-like receptor (TLR)-4 and interferon (IFN)- γ were determined using quantitative real-time polymerase chain reaction (qRT-PCR) from spleen tissues. Feed intake, BW gain, feed conversion ratio and mortality did not exhibit significant difference among the treatments during the entire experimental period. Relative weight of the bursa was over 0.2% of BW among all treatments. No significant difference was observed on relative lymphoid organ weight. Villus height, crypt depth and total mucosa thickness were significantly increased ($P < 0.05$) in the ileum of broiler chickens fed NC+FOS, whereas no difference was seen in duodenum and jejunum. The expression of splenic IL-18 was 2.4 and 2.0 fold upregulated in chickens fed NC and NC+FOS, respectively, when compared with PC ($P = 0.02$). The NC+FOS diet also elevated splenic IL-1 β expression by 4.8 fold when compared with PC ($P = 0.03$). However, IL-2, IL-6, IL-10, TLR-4, and IFN - γ resulted in no statistical difference among dietary treatments. In summary, FOS supplementation improved ileal mucosa thickness and structure. It also demonstrated protective effects on immune responses of broiler chickens when supplemented as a dietary antibiotic alternative.

Key Words: fructooligosaccharide, antibiotic alternative, intestinal morphology, immune response, broiler chicken

381P The effects of Varium on broilers. S. Ching*¹, S. L. Johnston¹, F. Chi¹, B. S. Lumpkins², G. F. Mathis², and R. L. Cravens¹, ¹Amlan International, Chicago, IL, ²Southern Poultry Research, Athens, GA.

Six hundred forty day-old chicks (Cobb × Cobb) were used in an experiment to evaluate the effects of new products on growth performance broilers. Tested products were (1) the product Varium (V); (2) a product with the same ingredients but at different concentrations than the Varium (PV) formula; and (3) BMD. The Varium products are a blend of a processed calcium montmorillonite blended with a fermentable fiber and an organic acid. There were 4 treatments: (1) Control (C); (2) C+PV at 0.25%; (3) C+V at 0.25%; and (4) C+ BMD at 50 g/ton. There were 8 pens of chicks per treatment with 20 chicks in each floor pen. Data was analyzed using the Student's *t*-test. Chicks had ad libitum access to feed and water. The trial lasted 42 d and weights of birds and feeders were conducted on d 19, 35, and 42 for calculation of weight gain and feed conversion. Diets were changed at weigh dates. At d 19 there was no difference between treatments for weight gain ($P > 0.05$); however, by d 35 weight gain of birds fed any product was higher ($P < 0.05$) than for those fed the control. Birds fed diets with BMD had higher wt gain than those fed PV ($P < 0.05$) with those fed V having weight gain that was not different ($P > 0.05$) than either BMD or PV. At 42 d the birds fed V had higher weight gain than birds fed the control ($P < 0.05$), and equal to those fed BMD ($P > 0.05$). Feed conversion was improved by BMD at d 19 ($P < 0.05$), whereas those fed the diet containing V were not different ($P > 0.05$) than C or BMD. On d 35, both V and BMD birds had better feed conversion than the control ($P < 0.05$) but were not significantly different than each other ($P > 0.05$). At d 42, feed conversion was better when any of the products were

added compared with the birds fed the control diet ($P < 0.05$). Overall feed conversion was better for the birds fed the V formula ($P < 0.05$) compared with the PV formula while BMD was not different than the V or PV formula ($P > 0.05$). Feeding Varium to broilers can improve weight gain and feed conversion.

Key Words: broiler, feed conversion, weight gain

382P Effect of conjugated linoleic acid and lutein on growth performance and immune response of broiler chickens dosed with lipopolysaccharide. M. L. Moraes^{*1,3}, A. M. L. Ribeiro¹, E. Santin^{2,3}, and K. C. Klasing³, ¹Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, ²Universidade Federal do Paraná, Curitiba, Brazil, ³University of California, Davis.

This study investigated the effects of conjugated linoleic acid (CLA) and lutein on growth performance and immune response of broiler chickens subjected to an immune challenge using *Salmonella* LPS. Cobb chicks (360; 1 to 22 d of age) were allotted to a 3 × 2 factorial arrangement of CLA (0, 1, and 2%) and lutein dietary levels (0 and 50 mg/kg). At d 8 and 15, birds were injected with bovine serum albumin (BSA) for assessment of IgY production, and at d 20, with LPS. Samples of liver, spleen and duodenum were collected at 3 and 16 h post-LPS challenge for rtPCR analysis of RXR α , RXR γ , PPAR α , PPAR γ , TLR-4, IL-1 β , IL-2, IL-10, IL-12 gene expression quantification. Growth data indicated that there was an interaction between CLA and lutein: CLA promoted poorer results for BW, BWG and feed efficiency from d 1 to 20, but this effect was reversed when lutein was included in the 1% CLA diet ($P < 0.05$). The LPS increased ($P < 0.01$) the liver:BW ratio at 3 h post-injection and decreased ($P < 0.01$) the BWG at 3, 16 and 40 h, but this responses were not affect by the dietary treatments. Production of IgY against BSA was increased ($P < 0.05$) in the group fed 2% CLA. Lutein decreased ($P < 0.05$) nitric oxide in the plasma at d 21. LPS downregulated ($P \leq 0.08$) PPAR α mRNA in the duodenum and liver, and PPAR γ and RXR α in the spleen, but these effects were not reversed by CLA or lutein as it was first hypothesized. While LPS upregulated ($P \leq 0.09$) IL-1 β and IL-12 mRNA expression, lutein decreased ($P \leq 0.07$) these pro-inflammatory cytokines in the liver. Lutein also decreased ($P \leq 0.09$) splenic and hepatic TLR-4 mRNA. Increasing dietary CLA to 2% increased ($P \leq 0.1$) hepatic RXR α mRNA. These findings suggest that CLA and lutein were anti-inflammatory and CLA also had beneficial effect on the humoral immune system when included in the diet at 2%. The dietary CLA decreased performance, but this effect was reversed when lutein was included.

Key Words: broiler, CLA, immune response, lutein, performance

383P Effect of grape proanthocyanidin supplementation on performance, immune functions, and redox status of broilers challenged with *Eimeria tenella*. J. Y. Yang, H. J. Zhang*, J. Wang, H. Y. Yue, S. G. Wu, and G. H. Qi, *Feed Research Institute of Chinese Academy of Agricultural Sciences, Beijing, China.*

A study was conducted to determine the effect of grape proanthocyanidin (GPC) on performance, immune functions and redox status of broilers challenged with *Eimeria tenella*. Three hundred fifty day-old Cobb-500 chickens were randomly divided into 5 groups: positive control (0 mg/kg GPC), negative control (0 mg/kg GPC), low-dose group (7.5 mg/kg GPC, L), middle-dose group (15 mg/kg GPC, M), and high-dose group (30 mg/kg GPC, H). On d 14, negative control and GPC supplemented groups were infected by 5×10^4 *Eimeria tenella* via oral administration,

while positive control by the same volume of saline. All chickens were fed corn-soybean meal diet. Each treatment consisted of 6 replicates with 10 birds each. The results showed (1) the growth parameters in all groups had no difference before infection ($P > 0.05$), but GPC supplementation in L and M groups improved ADG and reduced FCR ($P < 0.05$) compared with negative control; (2) GPC at any level could reduce bloody excrement on the 5th day post infection (PI) and oocyst output on the 7th day PI ($P < 0.05$), and remit lesion damage; (3) GPC in L and M groups increased total antioxidant capacity and total SOD activity, and decreased malondialdehyde level in plasma on d 8 and d 14 PI ($P < 0.05$); (4) L and M groups lowered plasma nitric oxide (NO) content and inducible nitric oxide synthase (iNOS) activity on d 8 PI than the negative control ($P < 0.05$); (5) GPC supplementation increased lysozyme content on the 8th and 14th day PI ($P < 0.05$); (6) GPC in L and M groups increased NO and IFN- γ levels, iNOS activity, and gammadelta T cell percent in intestinal mucosa on d 8 PI ($P < 0.05$). Overall, GPC can relieve oxidative stress and inflammatory response, and increase plasma lysozyme content after infection; furthermore, GPC might increase gammadelta T cell percent and activate them to release cytokine to modulate immune under *Eimeria tenella* challenge.

Key Words: grape proanthocyanidins, performance, immune function, redox status, broiler

384P Effects of experimental direct-fed microbial (DFM) formulations on broiler performance in a challenge study. S. Moore¹, J. Rubach¹, V. Mani^{*1}, G. Mathis², and M. Poss¹, ¹Kemin Industries, Inc., Des Moines, IA, ²Southern Poultry Research, Athens, GA.

A 28 d battery cage study was conducted to evaluate the effects of experimental direct-fed microbial (DFM) formulations on mortality and performance in broilers artificially infected with *Clostridium perfringens*. Cobb 500 × 500 male broiler chicks (448) used in the study were assigned to 8 treatments with 8 replications per treatment and 8 birds per cage. Birds in treatments (T) 2 to 8 were inoculated with 5,000 oocytes of *Eimeria maxima* on d14 of the trial. On d19 and 20, the same birds were orally inoculated with 1.00E+E8 cfu/mL *Clostridium perfringens*. Necrotic enteritis lesion scoring of the intestine, mortality due to necrotic enteritis, and selected performance parameters were evaluated. On d 21, all DFM treatments resulted in mortality levels that were similar to bacitracin methylene disalicylate (BMD) ($P > 0.05$) with T5 (*Bacillus subtilis* PB6 (PB6) + *B. coagulans* (BC) + calcium carbonate), T6 (PB6 + green tea extract (GTE)), T7 (PB6 + BC + GTE) and T8 (PB6 + BC + mannan oligosaccharide (MOS)) lower than T2 (infected/not treated) ($P < 0.01$). In addition, T5, T6 and T7 were not different from T1 (not infected/not treated) ($P > 0.05$). Interestingly, the severity of intestinal lesion scores did not correlate with mortality levels. During the infection period (d14–21), T5 and T7 resulted in the lowest feed:gain and were lower ($P < 0.01$) than T1 and T2. Weight gain (WG) in T7 was the highest of all infected birds ($P < 0.05$). Over the entire trial (d0–28), T5 resulted in the lowest feed:gain of all infected birds ($P < 0.01$) while T7 showed the highest numerical WG of all DFM treatments and was statistically not different ($P > 0.05$) from BMD. In summary, in a Clostridial challenge model, the data indicate that the combination of *Bacillus subtilis* PB6 and *Bacillus coagulans* with or without GTE could provide reduced mortality due to necrotic enteritis and improved feed:gain in broilers.

Key Words: direct-fed microbial, feed:gain, necrotic enteritis, *Bacillus subtilis* PB6, *Bacillus coagulans*

385P Effect of garlic essential oil supplementation on performance, nutrients digestibility, lipids profile, cecal metabolites and ileal microbial population in broiler chickens. H. Hashemipour* and V. Khaksar, *Ferdowsi University of Mashhad, Khorasan Razavi, Iran.*

This trial was conducted to evaluate the effect of garlic essential oil (GEO) at 3 levels (0, 150, and 300 mg/kg diet) on performance, nutrients digestibility, lipids profile, cecal metabolites and ileal microbial population in Ross-308 male broiler chickens. Each of the 3 diets was fed to 6 replicates of 15 chicks each from d 0–42 in 3 diet phases (0–10, 11–24 and 25–42 d). On d 18 of experiment, 3 birds per replicate were used in a metabolic trial to determine nutrients digestibility. On d 10, 24, and 42 d of age, the growth performance was evaluated by recording live body weight, feed intake and FCR. On d 24 and 42 of the experiment, 2 birds per replicate were selected and their blood samples were collected from the wing vein and serum HDL, LDL, triglycerides and cholesterol were determined by an enzymatically method. These birds were also considered for assessing the ileal microbial population and volatile fatty acids concentration. The inclusion of GEO enhanced ($P < 0.05$) FCR and body weight gain, but had no effect on feed intake compared with control birds. The digestibility of dry matter, crude protein and ether extract were improved ($P < 0.05$) by feeding GEO on d 24. Addition of 300 mg/kg of GEO to the diet increased ($P < 0.05$) HDL level and decreased ($P < 0.05$) cholesterol, triglycerides, LDL on d 24 and 42. Supplementation with GEO showed a higher proportion of cecal acetic and propionic acids on d 24. Ileal microbial population was improved by the GEO in terms of the increment and reduction in the population of *Lactobacillus* and *Escherichia coli*, respectively on d 24 and 42. Thus, this research suggests that feed supplementation with garlic essential oil improved nutrients digestibility and ileal microbial composition which can clarify the enhanced performance through the administration of GEO to the diet of broilers.

Key Words: garlic essential oil, performance, nutrient digestibility, intestinal microbiota, broiler

386P Evaluating the impact of dietary mannan-oligosaccharides (MOS) on broiler performance and intestinal microflora. R. A. Silva*, H. M. Yakout, W. Zhai, M. B. Farnell, C. S. Sharma, C. D. McDaniel, and A. S. Kiess, *Mississippi State University, Mississippi State, MS.*

Mannan-oligosaccharides (MOS) are a mixture of carbohydrates and proteins derived from the cell wall of *Saccharomyces cerevisiae* that provide the intestine with valuable nutrients for beneficial bacteria while competitively excluding intestinal pathogens. A study was conducted to evaluate if MOS-products would affect performance and intestinal microflora of broilers. A total of 800, day-old male Ross × Ross 708 broilers were placed on used litter in 50 floor pens (5 treatments, 10 replicate pens/treatment, 16 chicks/pen). Dietary treatments consisted of (1) a basal diet + 0% MOS (negative control), (2) basal diet + MOS product 1 (2 lbs/ton in starter diets and 1 lb/ton in grower and finisher diets; positive control), (3) basal diet + MOS product 2 (2 lbs/ton in starter diets and 1 lb/ton in grower and finisher diets), (4) basal diet + MOS product 2 (0.8 lbs/ton in starter diets and 0.4 lb/ton in grower and finisher diets), (5) basal diet + MOS product 2 (0.4 lbs/ton in starter diets and 0.2 lb/ton in grower and finisher diets). Feed and BW were weighed at 0, 14, 28, and 42 d. On those same days, 1 bird per pen was euthanized, the distal ileum was removed and *Lactobacillus* and total coliforms were isolated from 1 g of the ileal tissue with gut contents. *Lactobacillus* and total coliforms were cultivated on de Man, Rogosa, Sharpe or eosin methylene blue media plates under appropriate incubation

temperatures and environments, respectively. Results indicated that regardless of dietary MOS supplementation level BW, feed consumption, feed conversion ratio, ileal coliforms, or ileal *Lactobacillus* levels were not significantly affected across all evaluated experimental time periods. However, correlation analysis revealed that ileal coliforms increased ($P < 0.05$) as BW increased at 28 d ($r = 0.28$), but decreased at 42 d ($r = -0.27$). In conclusion, MOS supplements had no effect on broiler performance or intestinal bacteria.

Key Words: broiler, performance, microflora, mannan-oligosaccharides, prebiotic

387P Supplementation of citric and benzoic acids on the morphometry of the intestinal mucosa of broiler chickens. V. C. Cruz-Polycarpo¹, I. L. Saes¹, G. V. Polycarpo*², R. L. Saes¹, J. B. Freschi¹, A. Barbieri¹, R. V. Ferreira¹, T. S. Santos¹, and R. G. A. Cardoso¹, ¹São Paulo State University, Dracena, Brazil, ²University of São Paulo, Pirassununga, Brazil.

The Brazilian poultry industry has undergone major changes due to different factors: genetic-edge, new technologies application in relation to the ambience, efficient management and proper nutrition. Since prohibition of the use of antibiotics as growth promoters, other additives have been studied, among them, the organic acids. This research was conducted to evaluate the effects of the inclusion of isolated or associated organic citric acid and benzoic acid in feed for broilers, their influence on the intestinal morphology was observed. Four treatments have been used: T1: control treatment: diet formulated without added organic acids; T2: diet with inclusion of citric acid; T3: diet with inclusion of sodium benzoate; T4: diet containing a mixture of citric acid and sodium benzoate. 840 male Cobb strain chicks with one day old were used, distributed in a completely randomized design featuring a 2 × 2 factorial arrangement (citric acid supplementation or not and sodium benzoate supplementation or not) with 7 replications. It was analyzed intestinal morphology data obtained for the period from 1 to 21 and 1 to 42 d of age: villus height (VH), villus width (VW) and crypt depth (CD) of the duodenum and jejunum. Resulting data were analyzed by SAS (2008) and subjected to ANOVA by PROC MIXED at 5% significance. When necessary, the differences between treatments were analyzed by Tukey test. The results of this study showed that at 21 d of age there was interaction between the mixture of citric acid and benzoic only for VH in the portion of jejunum ($P = 0.0456$). Broiler chickens supplemented with benzoic acid alone showed higher VH jejunum than broiler supplemented with both acids. There was a significant effect of citric acid to VW ($P = 0.0026$) and CD ($P = 0.0119$) jejunum at this age. At 42 d of age there was effect of the use of citric acid ($P = 0.0209$) only for the variable CD duodenum. It may be concluded from this research that at 21 d of age, only the jejunum of broiler chickens is influenced by the use of organic acids and, at 42 d of age only the CD duodenum of poultry undergoes changes when administered citric acid specifically.

Key Words: additives, intestinal morphology, organic acids, poultry

388P Bixin from annatto (*Bixa orellana* L.) as a natural antioxidant on broiler meat products. F. G. Luiggi*^{1,3}, E. O. Oviedo-Rondón³, A. M. C. Racanicci², D. L. Migotto², C. B. Lima², G. R. Oliveira², G. N. Soares², T. C. Souza², J. R. Sartori¹, and M. M. P. Sartori¹, ¹Universidade Estadual Paulista, Faculdade de Medicina Veterinária e Zootecnia, Botucatu, São Paulo, Brazil, ²Universidade de Brasília, Brasília, Distrito Federal, Brazil, ³North Carolina State University, Raleigh, NC.

Bixin is a carotenoid present in annatto seeds (*Bixa orellana* L.). An experiment was conducted with 900 Cobb broilers to evaluate the antioxidant capacity of bixin, and its effects on meat quality when added to broiler diets. Broilers were housed in floor pens, simulating common commercial conditions. A completely randomized design with 6 treatments and 6 replicate pens (25 broilers/pen) was used. Treatments consisted of 0% (control), 0.05%, 0.10%, 0.15%, 0.20% and 0.25% of bixin added to basal diets through the bixin fat extract at 7% which was used to replace soybean oil. Diets were formulated without addition of synthetic antioxidant, and minimum levels of selenium and vitamin E. Broilers were slaughtered at 42 d of age to collect breast and leg meat, and abdominal fat. The lipid oxidation was measured by an accelerated testing model, based on thiobarbituric acid reactive substances. Inclusion levels of 0.05% of bixin resulted in reduced oxidation ($P < 0.05$) of breast meat after 4 d of storage (-2°C). In the leg meat, higher levels of bixin (0.25%) were required to prevent oxidation effects ($P < 0.05$), possibly due to the greater amount of fat and different muscle type. In the abdominal fat no effect of treatments ($P > 0.05$) was observed. It was concluded that bixin can be used as a natural antioxidant in broiler meat products, but further studies are needed to determine the best inclusion level.

Key Words: antioxidant, carotenoid, feed additive, meat quality, poultry

389P Effect of Biostrong 510 and anticoccidial program on growth performance, litter quality and foot pad score in broilers. K. W. Purser¹, C. L. Novak², and L. Jungbauer³, ¹Nutriquest, Mason City, IA, ²Purina Animal Nutrition, Kansas City, MO, ³Delacon, Steyregg, Austria.

Study objective was to determine the effect of the phytogetic feed additive Biostrong 510 (BSG) on performance, litter quality and foot pad score of broilers when implementing 2 different anticoccidial programs. A total of 2,160 straight-run 1-d-old Hubbard M-99 × Cobb 500 chicks were utilized in a 2×2 factorial design (48 pens, 45 birds per pen). BSG was fed at either 0 or 300 mg/kg complete feed in conjunction with an anticoccidial program of either spray vaccination (Coccivac-B, 0.21 mL per chick, VAC) or anticoccidial drugs (amprolium at 125 mg/kg in starter, deoquinatate at 30 mg/kg in grower and no drug in the withdrawal, ACD). No antibiotics or other anticoccidials were used. Treatments were replicated in 12 blocks, randomized with blocks of 4 pens each. All pens began with approximately 10 cm of built-up litter top-dressed with fresh pine shavings. Feed additives were added to an all-vegetable basal starter diet fed in crumble form from d 0 to 18 and basal grower and withdrawal diets fed as pellets from d 18 to 30 and 30 to 46, respectively. Response parameters over the 46-d trial are shown in Table 1. No main effect interactions were observed ($P > 0.20$).

Table 1 (Abstract 389P).

Item	VAC only	ACD only	BSG+VAC	BSG+ACD	PSE	P-BSG	P-ACD
BWG, kg	2.43	2.55	2.50	2.59	0.01	<0.001	<0.001
FI, kg	4.38	4.51	4.40	4.51	0.03	0.81	<0.001
FCR	1.75	1.72	1.72	1.69	0.005	<0.001	<0.001
Litter score ¹	2.83	2.67	2.58	2.33	0.15	0.06	0.17
Pad score ²	1.62	1.68	1.51	1.46	0.07	0.02	0.95

¹Litter score, d 46: 0 = extremely dry to 5 = extremely wet.

²Pad score, d 46: 0 = intact foot pads to 2 = severe lesions (>1 cm lesions).

Birds fed ACD exhibited more desirable performance vs. VAC birds ($P < 0.001$). BSG addition improved weight gain, feed conversion ($P < 0.001$) and foot pad score ($P = 0.02$) with both programs. Litter from birds fed BSG tended to be dryer ($P = 0.06$). These results indicate BSG addition improved bird performance and foot pad score with both anticoccidial programs.

Key Words: broiler, phytogetic

390P The effect of Aloapur (lactylate product) on growth performance of 0- to 43-day-old broilers challenge with *Clostridium perfringens*. S. Powell¹, D. Melchior¹, B. Boomsma², and S. Kok², ¹Cargill Animal Nutrition, Elk River, MN, ²Corbion, Gorinchem, the Netherlands.

Aloapur is a lactylate product that reduced viable *Clostridium* species in internal in vitro trials. Therefore, this experiment 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 6 replications with 16 broilers per pen. The broilers were fed a 3 phase feeding program consisting of pre-starter (0–7 d) starter (7–21), and grower (21–43 d) periods. Treatment diets consisted of a positive control (PC; BMD), negative control (no additive), and 3 levels of Aloapur (1, 2, and 4 kg/T). Growth response, feed intake, feed efficiency were measured on d 7, 14, 21, 28, 35, and 43. Breast weight and fat pad yield were measured on d 43 from 2 birds per treatment replicate. During the pre-starter period (0–7 d) there was no difference ($P > 0.10$) in ADG, ADFI, and FCR for birds fed all the treatments. During the starter period (8–21 d) during which the challenge was given there was no difference ($P > 0.10$) in body weight gain, feed intake or feed efficiency for birds fed all treatments. During the grower period (21–43 d) after the challenge there was a tendency for a linear effect for average daily gain ($P = 0.119$) and feed intake ($P = 0.115$) in birds fed increasing levels of Aloapur. Birds fed the 2 kg/T Aloapur had the highest feed intake and average daily gain. However, birds fed the antibiotic had better ($P = 0.003$) feed efficiency than birds fed the negative control, 1 kg/T and 4 kg/T Aloapur. The birds fed the 2 kg/T Aloapur had similar feed efficiency to the birds fed antibiotic. On d 28 there was a linear ($P < 0.043$) and quadratic ($P < 0.003$) response on body weight to the inclusion of Aloapur. Similar quadratic ($P < 0.026$) response on body weight was observed on d 35 to the inclusion of Aloapur. On d 43 there was no difference ($P > 0.10$) in breast meat and fat pad yield for birds fed the different treatments. In conclusion birds fed the 2 kg/T Aloapur had similar feed efficiency to birds fed antibiotic (0–43 d) and a 6.18% higher body weight at d 35 compared with birds fed no additive.

Key Words: broiler, Aloapur, BMD, breast meat yield, *Clostridium perfringens*

391P Assessment of gastrointestinal microflora shifts in conventional flock raised chickens fed with commercial prebiotics. S. I. Lee^{*1,2}, S. H. Park^{1,2}, and S. C. Ricke^{1,2}, ¹*Cell and Molecular Biology Program, Department of Food Science, University of Arkansas, Fayetteville, AR*, ²*Department of Food Science, University of Arkansas, Fayetteville, AR*.

Prebiotics are referred as nondigestible food ingredients that can stimulate the growth of one or more beneficial bacteria in the gastrointestinal tract. Biolex MB40 is composed of brewers' yeast cell walls that are obtained during the production of soluble brewers' yeast extracts. The aim of this study was to evaluate the effects of prebiotics Biolex MB40 on gastrointestinal tracts of conventionally raised chickens using a PCR-based denaturing gradient gel electrophoresis (PCR-based DGGE) technique. Chickens were randomly selected and distributed into 3 groups; negative, positive and treatment group. A negative control (NC) group was fed a non-medicated feed, while treatment groups were fed either 0.05% antimicrobial growth promoter (PC, positive control, AGP, BMD50) or 0.2% Biolex MB40 (without AGP) respectively. At 1, 2, 4, and 6 wk, 10 chickens from each group were randomly selected for necropsy and the ceca were extracted for whole DNA isolation. According to the basic local alignment searching tool (BLAST) analysis of the PCR-based DGGE, *Bacteroides dorei* and *Bacteroides rodentium* appeared in the negative control group 2- and 4-wk samples but were less frequent in the 6-wk samples. Both treatment groups (PC and MB40) exhibited similar patterns for the 4- and 6-wk samples. In the PC group, a partial 16s RNA sequence of *B. dorei* was detected in the 2-wk sample, but appeared to decrease over time. *Barnesiella viscericola* was significantly increased in all groups at 4 wk, while *Clostridiales* group of *Firmicutes* were detected in all treatment groups. *Proteobacterium* species was only observed in the PC group at 6 weeks. In conclusion, the MB40 treated group microbial populations appeared to be almost identical with the NC group after 4 wk, but the MB40 limited *B. rodentium* before 4 wk when compared with the NC group.

Key Words: prebiotic, DGGE, sequencing

392P In vitro evaluation of hypocholesterolemic effect of candidate probiotics supplements in poultry feeding. S. N. Nahashon^{*1}, K. Sri Harsha¹, and A. K. Kilonzo-Nthenge², ¹*Department of Agricultural and Environmental Sciences, Tennessee State University, Nashville, TN*, ²*Department of Family and Consumer Sciences, Tennessee State University, Nashville, TN*.

Probiotics are live microbial feed supplements that confer beneficial effects to the host, including changes in metabolic activities to the host's benefit. We hypothesized that probiotics have the potential to sequester cholesterol, minimizing its concentration in poultry and poultry products. Increasing health concern and economic implications of high cholesterol is triggering a shift in selective choice of food that contains less fat and cholesterol. The aim of this study was to determine the potential for *Lactobacillus acidophilus*, *Lactobacillus reuteri*, and *Bifidobacterium longum* combined with the fructo-oligosaccharide Levan to consume cholesterol in de Man, Rogosa, and Sharpe (MRS) broth. To the MRS broth *L. acidophilus* and *L. reuteri* were added individually and in multiple combinations and they were cultured at 20 h and 24 h at 37°C anaerobically in the presence of 0, 0.3, and 0.5% oxgall to assay the cholesterol uptake. *B. longum* was incubated at 48 and 72 h in MRS added with 0.05% L-cysteine hydrochloride at 37°C at 0, 0.3, 0.5% oxgall. The uptake of cholesterol by *L. acidophilus*, *L. reuteri*, and *B. longum* at 0, 0.3, and 0.5% oxgall concentrations and 20, 24 and 48 h was assayed. Incubation was 44.24, 36.3, and 31.6%, 62.87, 42.12, and 24.11%, and 29.13, 36.23, and 37.44%, respectively. These findings

demonstrate that although there was a marked reduction in coliform forming units associated with higher concentrations of bile or oxgall, these high concentrations of bile were also associated with an increase in clearance of cholesterol in the MRS media by these microbes, especially *Bifidobacterium*. Also, Levan from *Bifidobacterium* was successfully isolated, characterized and evaluated for its efficacy in cholesterol reduction in vivo. In this study the effect of Levan a fructo-oligosaccharide from *L. reuteri* also significantly reduced cholesterol in vivo with and without bile. Therefore, the probiotics *L. reuteri* and *B. longum* seem to have potential to reduce cholesterol directly or indirectly through production of levan.

Key Words: probiotics, direct-fed microbial, cholesterol reduction, poultry performance

393P Effect of dietary supplementation of barbatimão (*Stryphnodendron adstringens*) and pacari (*Lafoensia pacari*) alcoholic extracts on breast and thigh meat quality. C. B. Lima^{*}, A. M. C. Racanacci, D. L. Migotto, G. R. Oliveira, T. C. Souza, and S. Armador, *University of Brasilia, Brasilia, DF, Brazil*.

This study aimed to determine the effects of the dietary supplementation with extracts of pacari and barbatimão on the protection of breast and thigh meat, evaluating quality characteristics such as pH, color (L*, a*, and b*), cooking weight loss (CL), and shear force (SF). Seven dietary treatments, formulated with alcoholic extracts of pacari (PAC) and barbatimão (BAR) in 3 different concentrations (200, 400, and 600 ppm) plus a negative control (CONT), were fed to broilers from 1 to 41 d of age. Total of 70 birds (10 per treatment) were slaughtered, breast and thigh meat were collected and kept chilled (4°C) for 24 h. Color (CIELAB), and pH were evaluated in triplicate on breast and thigh meat and cooking weight loss (%) and shear force (kgf) were evaluated in triplicate in breast meat only. Data was analyzed using General Linear Model (SAS statistical software) and means were compared by Dunnett test. When compared with CONT, dietary supplementation of PAC or BAR did not affect pH and color of breast meat, however, CL was reduced ($P < 0.05$) for BAR400 and increased ($P < 0.05$) for PAC400. Means of SF were significantly reduced ($P < 0.05$) by the addition of natural antioxidants when compared with CONT, except BAR200, suggesting increased tenderness in breast meat. In thigh meat, the addition of natural extracts did not show significant effects on pH and a* values when compared with CONT. Means of L* and b* were not statistically different from CONT, except for the addition of the lower concentration of PAC (PAC200) that resulted in highest values. In conclusion, results indicate that dietary supplementation of BAR and PAC extract might be beneficial to meat quality, because the alcoholic extracts improved breast meat tenderness, when compared with CONT, and possibly maintained color b* compounds stability in thigh meat.

Key Words: plant extract, Brazilian plant, meat quality, breast, dark meat

394P Dietary essential oils have an immune modulating effect when fed to broiler chickens reared on recycled litter. V. Pirgözliev^{*1,2}, S. P. Rose¹, L. Mullen³, M. W. C. D. Pallyeguru⁴, and D. Bravo⁵, ¹*Harper Adams University, Edgmond, United Kingdom*, ²*Scottish Agricultural College, Ayr, United Kingdom*, ³*Brighton and Sussex Medical School, Falmer, United Kingdom*, ⁴*Veterinary Research Institute, Peradeniya, Sri Lanka*, ⁵*Pancosma S.A., Geneva, Switzerland*.

Essential oils are plant derived products added to the feed of healthy animals reared in common practical conditions to improve their performance, differentiating them from the plant products used for veterinary purposes (Windisch et al. 2008). Four-hundred day-old Ross 308 male chicks were allocated to 40 floor pens, 10 birds in each pen. The birds were placed on litter that had been used previously in another broilers study. Birds were fed ad libitum 1 of 4 mash diets from 0 to 21 d of age. There were 2 controls basal diets based on either wheat or maize and were formulated to be containing the same amount of ME (2,890 kcal/kg) and CP (215 g/kg). These basal diets were supplemented with either no additive, or a mixture of essential oils including 5% carvacol, 3% cinnamaldehyde, and 2% capsicum (XTRACT 6930, Pancosma S.A.) at 100 g per tonne. The diets did not contain any coccidiostat or antimicrobial growth promoters, prophylactic or other similar additives. At 21 d age one bird from each pen, with a body weight nearest to the pen average weight, was killed by cervical dislocation and the left cecal tonsil was collected and the relative expression of CD40L and IL-12p40 genes was assessed. Birds fed XTRACT supplemented diets appear to have a lower CD40L expression ($P < 0.001$) compared with control fed birds. Feeding XTRACT reduced the IL-12p40 expression in wheat ($P < 0.05$) but not in maize ($P > 0.05$) fed birds. The studied genes are expressed mainly by activated macrophages and dendritic cells, and are indicators of innate immunity and also amplifiers of specific immune reactions for an infectious agent. Innate immunity is the first line of infection against the opportunistic pathogens. The lack of effect of supplementary XTRACT in IL-12p40 expression in maize fed birds may be probably due to lower level of pathogens in the gut flora of the maize fed birds. However, feeding XTRACT modulated the immune reactions in broiler chickens.

Key Words: phytonics, chick, immune gene expression

395P Effects of garlic (*Allium sativum*) powder as replacement for antibiotic on performance, blood serum, and gastrointestinal morphology in broiler chicks. L. Safareh, A. Karimi*, G. A. Sadeghi, and A. Vaziry, *University of Kurdistan, Sanandaj, Kurdistan, Iran.*

The aim of this experiment was to evaluate the effects of virginiamycin, garlic powder or their combination on performance, blood serum and small intestine morphology in broiler chicks. A total of 360 one-day broiler chick (Cobb 500) was used in a completely randomized design to evaluate the effect of 6 treatments in 4 replicate each contained 15 chicks. Dietary treatments included T₁: Corn-SBM diet as control; T₂: T₁ plus recommended level of virginiamycin (200 g/ton; RL-Virg); T₃: T₁ plus garlic powder (1% of basal diet); T₄: T₃ plus 75% of RL-Virg.; T₅: T₃ plus 50% of RL-Virg.; and T₆: T₃ plus 25% of RL-Virg. Results showed that chicks fed the RL-Virg. diets had significantly ($P < 0.05$) higher feed intake during 1 to 10 d, higher relative weight of proventriculus at 41 d, serum glucose and cholesterol levels at 27 d. Birds fed RL-Virg. diet also had significantly ($P < 0.05$) higher width of base of the villi of jejunum and lower level of serum cholesterol and total glyceride at 47 d. Addition of garlic powder (T₃) to the diet did not have significant ($P > 0.05$) effects on performance, relative weight of gastrointestinal organs, and blood serum metabolites, however, significantly ($P < 0.05$) increased villi height: crypt depth in duodenum, and villus height and base width in jejunum. Supplementation of basal diet with combination of garlic powder and 75% of RL-Virg had significantly ($P < 0.05$) improved body weight at 11 and 23 d, feed intake during 1 to 10 and 11 to 22 d of age, and serum glucose and cholesterol level at 22 d. In addition they had significantly ($P < 0.05$) higher villus height, villus height to crypt depth of jejunum. The difference among birds fed combination of garlic powder and 25 or 50% of RL-Virg diets

versus control was not significant ($P > 0.05$). In conclusion, the findings indicates that combination of garlic powder (1%) and reduced level of virginiamycin have a significant potential to improve broiler chicks performance and gastrointestinal morphology, and reduce the level of virginiamycin inclusion in broiler diet.

Key Words: virginiamycin, garlic powder, performance, morphology

396P Effects of star anise, salvia miltiorrhiza, and ginger root on laying performance, antioxidant status and egg quality of laying hens. C. W. Yang*¹, Y. Cao², Z. B. Yang², and Y. Wang³, ¹*College of Life Science, Shandong Agricultural University, Tai-an, Shandong, China,* ²*College of Animal Science, Shandong Agricultural University, Tai-an, Shandong, China,* ³*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB, Canada.*

The use of Chinese herbal as natural antioxidants has gained increasing interest due to the global trend of restriction in use of synthetic substances. To investigate the effects of dried star anise (SA; *Illicium verum*), *Salvia miltiorrhiza* (SM), and ginger root (*Zingiber officinale*) that was processed to particle sizes of 300 µm on laying performance, egg quality and antioxidant status of laying hens. In total, 675 Hy-Line brown laying hens at 40 wk of age were randomly allocated into 5 treatments (TRT) with 5 replicates in a complete randomized design. The 5 TRT were (1) Control, laying hens fed corn-soybean meal diets; (2) TRT 1 + 150 mg/kg BHT; (3) TRT 1 + 5 g/kg SA; (4) TRT 3 + 10 g/kg SM; (5) TRT 3 + 10 g/kg ginger. Laying rate, average egg weight, egg mass, ADFI and feed conversion of each replicate were measured weekly. At d 28 and 56 of the experiment, blood samples from 9 laying hens per treatment were obtained to determine serum antioxidant enzymatic activities, and 18 eggs were randomly picked out from each treatment to determine egg quality. All laying hens had similar ADFI and average egg weight. However, laying hens supplemented with BHT, SA, SM, and ginger had higher ($P < 0.05$) laying rate, egg mass and feed conversion than the control group. As compared with that of control and BHT treatment, supplementation of SA, SM and ginger increased ($P < 0.05$) the activities of superoxide dismutase (SOD), glutathione peroxidase and total antioxidant capacity, but reduced ($P < 0.05$) malondialdehyde (MDA) in serum of laying hens at d 28 and d 54. Laying hens supplemented with BHT had higher ($P < 0.05$) SOD at d 28 and lower ($P < 0.05$) MDA at d 54. All laying hens had similar egg shape index and egg yolk. However, laying hens supplemented with BHT, SA, SM and ginger had higher Haugh Units than the control, dietary supplementation of SA improved eggshell thickness and egg yolk color, and supplementation of SM increased eggshell thickness of laying hens at d 28 and d 54 ($P < 0.05$). Dietary supplementation of SA, SM and ginger could improve laying performance, serum antioxidant status and egg quality.

Key Words: star anise, *Salvia miltiorrhiza*, ginger, laying performance, antioxidant status

397P Effects of *Rosmarinus officinalis*, Iranian green propolis, earthworm, and vitamin E on performance and blood parameters in Japanese quail. N. Khaleghi Miran¹, M. A. Karimi Torshizi¹, S. Rahimi*¹, M. R. Bassami², and S. Babaei¹, ¹*Tarbiat Modares University, Tehran, Iran,* ²*Ferdwosi University of Mashhad, Mashhad, Iran.*

Natural feed additives are generally believed to be safer and healthier and less subject to hazards for humans and animals. The present study was arranged to evaluate the effects of *Rosmarinus officinalis*, Iranian green propolis, earthworm (*Eisenia fetida*) meal, and vitamin E on performance and blood parameters of Japanese quail at 42 d of age. A total of 160

mixed-sex quail chicks were distributed in a completely randomized design to 5 treatments with 4 replicate and 8 birds/cage. The diets were formulated based on soybean-corn, to meet NRC (1994) requirements. Experimental groups included control diet (not supplemented), rosemary leaves meal 5000 mg/kg (R), ethanolic extract of propolis 5000 mg/kg (P), earthworm meal 5000 mg/kg (EW) and vitamin E 150 mg/kg. Daily weight gain (DWG), FC and FCR for the overall experiment were assessed. At d 42, total cholesterol (TC), triglycerides (TG), LDL, HDL and glucose (GL) were measured in 2 birds from each replicate at the completion of the experiment by enzymatic diagnostic kit (Pars Azmoon). The data were analyzed by GLM procedure of SAS. There was a significant difference between vitamin E, EW and R with the rest of the groups in terms of DWG ($P < 0.05$). Daily FC and FCR were affected by the groups ($P < 0.05$); the highest and lowest daily FC was obtained in birds fed with diets containing vitamin E and P respectively. The administration of experimental groups improved FCR compared with control ($P < 0.05$). There was a 9% reduction in glucose level for R, 13% in total-cholesterol for R and P, 11% and 16% in triglycerides for R and P respectively, 30%, 26%, 23% and 18% in LDL-cholesterol for vitamin E, R, P and EW, respectively ($P < 0.01$). The results confirm the positive effects of R, P, and vitamin E on blood parameters without any negative effect on performance indices. Earthworm meal increased DWG significantly ($P < 0.05$), but it had minor effects for improvement of blood parameters. Results of our study showed that R had a hypoglycemic effect which improved the lipid profile, whereas P was effective only on lipid profile.

Key Words: rosemary, propolis, earthworm, vitamin E, blood parameters

398P Effects of propolis, honey, royal jelly, and bee pollen on the growth performance and blood parameters of quail (*Coturnix coturnix japonica*). S. Babaei¹, S. Rahimi*¹, M. A. Karimi Torshizi¹, N. Khaleghi Miran¹, G. A. Nehzati², and N. Razmgah¹, ¹Tarbiat Modares University, Tehran, Iran, ²University of Tehran, Tehran, Iran.

Honey bee products have lots of flavonoids, organic compounds, fatty acids, and others. These chemical components can improve growth performance and blood parameters of the birds. This study was conducted to determine the effects of alcoholic extract of propolis, honey, royal jelly and bee pollen on the growth performance and blood parameters of Japanese quail. One hundred and 60 d-old quail chicks were placed in 20 cages under a completely randomized design. Cages were randomly assigned to 5 treatments: (1) control diet based corn and soybean meal without supplementation; (2) ethanolic extract of propolis 1000 ppm (AEP); (3) pollen powder 1000 ppm (PO); (4) royal jelly 100 ppm (RJ); and (5) 2.2% aqueous honey (H). A 30% AEP tincture was prepared by adding 600 g of propolis to 1400 mL of 70% ethanol (w/v). This was mixed and kept in a glass container, shaken twice daily, filtered after one week and kept at 4°C until it was used. The blood samples were taken from 2 birds of each replicate at d 42 of experiment. Body weight gain, FCR and FI were determined weekly. Serum triglyceride, cholesterol, LDL, HDL and glucose were determined in blood samples drawn at the end of experiment using commercial biochemical kits (Pars Azmoon). The data were analyzed by GLM procedure of SAS. The results showed that BWG and FCR were improved when compared with control group. Supplementation of honey reduced FCR compared with control and other treatment groups ($P < 0.01$). There were no significant differences in feed intake between treatments. WG increased in H treatments (16.87%), RJ treatment (12%), PO treatment (9.27%), and AEP treatment (2.03%) in compared with the control treatments.

However, quail chicks fed with bee products tended to have lower serum glucose, cholesterol, triglyceride and LDL level than birds fed the control diet ($P < 0.01$). The highest increase in serum HDL level was observed in H and RJ groups. In conclusion, honey bee products result improvement in growth performance and some of blood parameters of quail. Therefore, AEP, RJ, H, and PO can be recommended as growth promoters in quail production.

Key Words: growth performance, blood parameters, bee pollen, propolis, royal jelly

399P Effects of α -lipoic acid supplementation in different stages on growth performance, antioxidant capacity and meat quality in broiler chickens. Z. Y. Guo¹, J. L. Li¹, L. Zhang¹, Y. Jiang², F. Gao*¹, and G. H. Zhou¹, ¹College of Animal Science and Technology, Nanjing Normal University, Nanjing, China, ²Ginling College, Nanjing Normal University, Nanjing, China.

This experiment was conducted to investigate the effect of basal dietary supplementation with 500 mg/kg α -lipoic acid (LA) on growth performance, antioxidant capacity and meat quality in different stages in broiler chickens. Total 240 Arbor Acre chickens were randomly assigned into 4 treatment groups, each treatment containing 6 replicates of 10 chickens each. Group 1 was the control group without LA supplementation; group 2 was supplied with LA in the starter period; group 3 was supplied with LA in the grower period; group 4 was supplied with LA in the whole period. The results showed that LA supplementation improved average feed intake (AFI) and body weight gain (BWG) in all 3 experimental groups, especially in group 2 ($P < 0.05$). LA supplementation significantly decreased abdominal fat yield in group 3 and 4 ($P < 0.05$). LA supplementation all improved hepatic total antioxidant capacity (T-AOC), the level of glutathione (GSH), the activities of total-superoxide dismutase (T-SOD), catalase (CAT) and glutathione peroxidase (GSH-Px), in particular in the group 4 ($P < 0.05$). LA supplementation decreased the activity of liver xanthine oxidase (XO) in all experimental groups ($P < 0.05$), and that of liver monoamine oxidase (MAO) in group 3 ($P < 0.05$). The activities of liver CAT and XO in group 2 were higher than that in groups 3 ($P < 0.05$). LA supplementation elevated the pH_{24h} ($P < 0.05$) and decreased drip loss in breast meat in groups 3 and 4 ($P < 0.05$). In conclusion, LA supplementation can improve the growth performance, antioxidant properties and meat quality in broiler chicken. LA supplementation in the starter period can improve growth performance and supplementation in the grower and whole periods can improve carcass characteristics. There was no significant difference in meat quality of broiler chickens fed on LA-supplemented diet in different stages.

Key Words: α -lipoic acid, growth performance, antioxidant property, meat quality, broiler

400P Comparison the effect of probiotic and three herbal extracts (garlic, thyme, and caraway) on egg quality. A. R. Behnamifar¹, S. Rahimi*¹, M. A. Karimi Torshizi¹, Z. Mohammadzadeh¹, and A. Rahimi², ¹Tarbiat Modares University, Tehran, Iran, ²Islamic Azad University, Tehran, Iran.

The purpose of this study was finding an appropriate and safe feed additive to increase egg quality in laying hens. The study was conducted to compare the response of laying hens to dietary supplementation with direct-fed microbial (Primalac) and 3 herbal extracts (garlic, thyme and caraway) throughout the 2-mo experimental period. Total of 60 laying hens (Tetra-SL) which had been in production for 85 weeks were

randomly allocated in a completely randomized design considering 5 treatments with 4 replicates and 3 birds in each. Group 1 received a layer basal diet with no supplementation which served as control. The second, third, and fourth groups received basal diet with 1 mL of herbal extracts (garlic, thyme, and caraway)/L drinking water respectively. The fifth group fed the basal diet plus 1 g of probiotic/kg of diet. Primalac contains a minimum of 1.0×10^8 cfu of *Lactobacillus* sp. organisms per gram. The responses were considered as egg weight, shell thickness, shell strength, Haugh unit, yolk weight, yolk color, and yolk cholesterol. The results showed no significant difference in egg quality, egg weight, shell thickness, shell strength, Haugh unit, yolk weight, and yolk color between the treatments. However, yolk cholesterol was significantly ($P < 0.01$) decreased by adding 1 mL of garlic extract/L in drinking water supply. The result show garlic extracts have great potential when low cholesterol egg is desired and other feed additives used in this experiment have not influenced on egg quality parameters measured in this experiment.

Key Words: egg quality, garlic, thyme, caraway, probiotic

401P Effect of dietary supplementation with α -lipoic acid on growth performance, antioxidant capacity, and meat quality in broiler chickens.

Z. Y. Guo¹, J. L. Li¹, L. Zhang¹, Y. Jiang², F. Gao^{*1}, and G. H. Zhou¹, ¹College of Animal Science and Technology, Nanjing Agricultural University, Nanjing, China, ²Ginling College, Nanjing Normal University, Nanjing, China.

This study investigated dietary supplementation with α -lipoic acid (LA) on growth performance, antioxidant capacity and meat quality in broiler chickens. In total, 240 day-old male Arbor Acres broilers were randomly allocated to 1 of 5 experimental diets supplemented with 0, 250, 500, 750, or 1,000 mg/kg LA respectively. Compared with the control group, supplementation with 500 and 750 mg/kg LA increased the average feed intake (AFI) and body weight gain (BWG) during the starter period ($P < 0.05$), grower period ($P > 0.05$) and throughout the whole period. In addition, supplementation with 1000 mg/kg LA significantly decreased AFI and BWG during the starter period ($P < 0.05$), grower period and throughout the whole period ($P > 0.05$). LA supplementation improved antioxidant properties and, in part, depended on glutathione levels. These improvements also reflect the activities of total superoxide dismutase, catalase (CAT) ($P < 0.05$), and glutathione peroxidase ($P = 0.069$), all of which increased in the liver. In contrast, LA supplementation significantly decreased malondialdehyde (MDA) levels in the liver ($P < 0.05$). In addition, the activities of xanthine oxidase (XO) and monoamine oxidase (MAO) gradually decreased ($P < 0.05$). LA supplementation increased the activity of nitric oxide synthase (NOS) in the liver ($P < 0.05$). The activity of myeloperoxidase (MPO) and the ultrastructural mitochondrial components were not affected by dietary LA. LA supplementation improved meat quality through increasing pH_{24h} ($P < 0.05$), decreasing drip loss ($P < 0.05$) and shear force value ($P < 0.05$). However, dietary LA (1,000 mg/kg) exhibited a higher cook loss compared with other treatments ($P < 0.05$). In conclusion, supplementation with high doses of LA negatively affected on the growth performance, but 500 and 750 mg/kg LA doses supplementation promoted their growth performance, increased antioxidant capacity, and improved meat quality.

Key Words: α -lipoic acid, growth performance, antioxidant capacity, meat quality, broiler

402P Antioxidant activity of dietary plant oil extracts in raw eggs stored chilled. A. M. C. Racanicci^{*1}, G. R. Oliveira¹, C. B. Tanure¹, C. B. Lima¹, D. L. Migotto¹, G. N. Soares¹, T. C. Souza¹, L. M. C. S. Ribeiro¹, J. S. Moreira², and E. M. Oliveira², ¹University of Brasília, DF, Brazil, ²University of Goiás, Goiânia, GO, Brazil.

Brazilian native plants originally found in cerrado biome, such as copaiba (*Copaifera langsdorffii*; COP) and sucupira (*Pterodon emarginatus*; SUC) are used to produce oilresins particularly rich in phenolic compounds, known to be efficient natural antioxidants. To study the antioxidant effect of the dietary supplementation of COP and SUC oilresins to laying hens, eggs were stored at 4°C in the dark during 60 d. One hundred forty ISA-Brown laying hens were fed experimental diets based on corn and soybean meal (CP, 15% and ME, 2900 kcal/kg) with the addition of 3 levels of COP (0.03, 0.06, and 0.09%) \times 2 levels of SUC (0.03 and 0.06%) + negative-control (NC) with no antioxidants. At 37 wk of age, eggs were collected during 3 consecutive days and stored at 4°C up to 60 d in a completely randomized design and a 2 \times 3 factorial arrangement plus NC. The chemical analyses were performed at 0, 7, 14, 21, 30, 35, 42, 49 and 60 d in 3 egg yolks/treatment using the TBARS (thiobarbituric acid reactive substances) method to evaluate the progression of lipid oxidation. TBARS values were expressed in μmol of malonaldehyde per kg of raw egg yolks (μmol of MDA/kg). Data were analyzed using mixed model procedures (SAS system). As expected, TBARS increased significantly ($P < 0.05$) along the storage period. Until 30 d, dietary treatments showed no influence on TBARS values. At 35 d of storage, COP 0.03% reduced ($P < 0.05$) TBARS values (0.3047 μmol MDA/kg) when compared with SUC 0.03% (0.5067 μmol MDA/kg). However, at the end of storage time, TBARS values were not differ from NC, except COP 0.09% that showed higher ($P < 0.05$) values suggesting pro-oxidant effect. In conclusion, the use of oil extracts was not effective to improve protection against lipid oxidation in chilled eggs.

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

403P Performance of broilers fed diets containing organic acids isolated and associated during starter phase. V. C. Cruz-Polycarpo^{*1}, G. V. Polycarpo², J. B. Freschi¹, A. Barbieri¹, T. S. Santos¹, R. G. A. Cardoso¹, I. L. Saes¹, R. L. Saes¹, L. G. F. Bueno¹, T. J. Menezes¹, J. A. Oliveira¹, K. V. B. Balieira¹, and R. V. Ferreira¹, ¹São Paulo State University, Dracena, Brazil, ²University of São Paulo, Pirassununga, Brazil.

Since prohibition of the use of antibiotics as growth promoters, other additives have been studied, among them, the organic acids. These acids are rarely described in the literature, particularly when used alone because their use is generally made using blends, obtained from a mixture of acids. So, a study was conducted to evaluate the effects of including isolated or combined citric and benzoic acids in the feed of broilers, and observed their influence on the performance from 1 to 21 d old. A total of 840 day-old male Cobb chicks were housed, allotted in a completely randomized design featuring a 2 \times 2 factorial arrangement: citric acid supplementation or not and sodium benzoate supplementation or not. There were 7 replications with 30 broilers per experimental unit (density = 12 birds/m²). Mean initial chick weight was 41.90 g. The different feeds featured similar energy and amino acid levels within each breeding phase, and were formulated based on corn and soybean meal. Water and feed were supplied ad libitum. At 14 d old, broilers were inoculated with 1 mL of solution provided orally, containing 1×10^5 sporulated oocysts of *Eimeria acervulina* per bird. The results of this study indicated that there was no interaction

($P > 0.05$) between the effects evaluated and no significant differences were observed at 21 d of age for the following studied variables: body weight gain (BWG), average feed intake (AFI), feed:gain ratio (F:G), and viability. Although significant differences were not obtained in the performance of broilers at 21-d-old, we observed optimal values for the variables studied. This can be explained by the challenge promoted by *Eimeria*, which may possibly have been low and ineffective, due to the excellent environmental and hygienic conditions of the experimental house. Based on the results obtained and the conditions under which the experiment was conducted, it can be concluded that there is no effect of citric and benzoic addition, used isolated or combined, on the performance of broilers during starter phase.

Key Words: additive, organic acid, performance, poultry

404P Effect of intra-egg inoculation of *Bacillus subtilis* on the chick quality hatched and corporal weight. L. L. Borges, T. C. O. Quadros*, V. R. Almeida, J. B. Matos Junior, S. Sgavioli, G. M. A. R. Garcia, E. T. Santos, and S. M. Baraldi-Artoni, *Faculty of Agriculture and Veterinary Sciences, Jaboticabal, São Paulo, Brazil.*

The good quality and weight of chickens ensures better livability and growth during the first days of the life of broilers. This study examined the inoculation in ovo of *Bacillus subtilis* during incubation and how it influences the chick quality hatched and body weight. We used 500 fertile eggs (Cobb), from broiler breeder hens at 43 wk old, within the range of egg weight of 66 ± 2 g distributed equally in 5 incubators with automatic control of temperature, turning and moisture. The experiment was setup as a randomized design with 5 treatments with 100 eggs per treatment. The treatments consisted of a control (eggs not inoculated), and eggs inoculated with 0.1 mL of *Bacillus subtilis* in 4 concentrations, 0, 10^6 , 10^7 , and 10^8 cfu. At 18 d of age, *Bacillus subtilis* was injected into the air sac. At hatch, all the chicks were weighed individually and chick quality was assessed, based on physical criteria, such as activity, feathering, eyes, conformation of legs, inspection of navel area, remaining membrane and yolk absorption. The quality score was defined as the sum of the scores quoted for all characteristics within a total scale of 100. The data was analyzed using the general linear model (GLM) procedure of SAS. In case of significant effect, the comparison of the averages was performed using 5% probability of Tukey test. According to the data, none of the treatments had chicks with quality scores of 100; they were mostly at an average of 90 ± 2 . There wasn't significant effect observed with quality scores ($P > 0.05$). The same results were observed to body weight, where there was not a significant effect among the treatments. The results indicated that the inoculation of *Bacillus subtilis* don't change the quality and weight of chicks, and thus can be applied and improved in future studies.

Key Words: probiotic, bacteria, broiler, embryo, injection

405P Effect of pyrroloquinoline quinone on egg cholesterol content and anti-oxidation capacity. L. M. Sun^{1,2}, H. J. Zhang^{1,2}, S. G. Wu^{1,2}, H. Y. Yue^{1,2}, J. Wang^{1,2}, and G. H. Qi^{*1,2}, ¹Key Laboratory of Feed Biotechnology of Ministry of Agriculture, Beijing, China, ²Feed Research Institute of Chinese Academy of Agricultural Sciences, Beijing, China.

This experiment was conducted to evaluate the effect of dietary pyrroloquinoline quinone (PQQ) on performance, egg quality, total cholesterol (TC) content, and antioxidant capacity of eggs in laying hens. Three hundred sixty Jing-Hong hens aged 23 wk were randomly divided into 5 treatments with 6 replicates of 12 hens. The 5 treatment diets were

made based on the same basal diet, and supplemented with 0 (control group, CON), 0.08, 0.8, 1.6 mg/kg PQQ, and 100 mg/kg vitamin E (VE), respectively. The experiment lasted for 8 wk. The result showed that dietary PQQ at all levels could increase ADFI ($P < 0.05$) compared with CON. The 0.08 mg/kg PQQ group had higher laying rate ($P < 0.05$) than CON. There was no significant difference in average egg weight ($P > 0.05$). PQQ showed no effects on eggshell strength, Haugh unit and yolk color ($P > 0.05$), but 0.16% PQQ group increased albumen height ($P < 0.05$) compared with CON. The 0.8 mg/kg PQQ group decreased plasma and egg TC content ($P < 0.05$) and plasma malondialdehyde level ($P < 0.05$) compared with CON. PQQ did not affect plasma high- and low-density lipoprotein cholesterol levels ($P > 0.05$). PQQ did not affect Vitelline membrane strength (VMS) of fresh eggs ($P > 0.05$), but increased VMS after 3 weeks of storage at 4°C ($P < 0.05$) compared with CON, which partially reflected its anti-oxidative function. Thirty gram of egg samples from 0.8 mg/kg PQQ, CON and VE groups were used to analyze antioxidation capacity at 90°C with an initial oxygen pressure of 6×10^5 Pa. The inflexion of rapid oxygen pressure decreasing appeared 9 and 4 h later in PQQ group than in CON and VE group, respectively. Overall, dietary PQQ can improve egg quality and prolong egg shelf life by increasing egg anti-oxidation capacity; PQQ can improve laying performance at 0.08mg/kg, whereas decrease plasma and egg TC at 0.8 mg/kg.

Key Words: pyrroloquinoline quinone, laying hen, performance, cholesterol, antioxidation

406P The effects of a direct fed microbial on broiler performance during natural *Clostridium perfringens* exposure. D. Paiva*, E. Kimminau, C. Ott, A. Calvert, C. Honaker, and A. McElroy, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Bioactive dietary ingredients that modulate the immune system or alter intestinal integrity can have a considerable impact on nutrient utilization, disease status, and resulting bird performance. Probiotics are among these dietary ingredients that have immunomodulatory characteristics. Opti-Bac L is a probiotic that contains *Bacillus licheniformis* as the active bacterium. The objective of this study was to evaluate different dosages of Opti-Bac L (Huvepharma Inc., Peachtree City, GA) on broiler performance during a natural *Clostridium perfringens* exposure. Day-old Cobb 500 male broilers were obtained from a commercial hatchery, weighed and randomized (32 birds/pen) into 4 treatment groups. This 42-d study consisted of a randomized complete block design that evaluated the inclusion level of Opti-Bac L at 0, 0.25, 0.5, and 1.0 lb/ton (18 replicate pens/treatment). All diets (formulated to meet or exceed nutrient requirements for Cobb 500 male broilers) were medicated and contained a *Bacillus subtilis* at 10 g/ton. Birds were placed on used litter from a previous flock that exhibited clinical signs of necrotic enteritis to include a natural exposure to *C. perfringens*. Birds and feed were weighed on d 0, 14, 35, and 42, and body weight (BW), BW gain (BWG), feed intake, and feed conversion (FC) were calculated for each of these periods and cumulatively. Mortality was recorded daily, and average FI and FC were adjusted for mortality. Significance is reported at $P < 0.05$. Birds fed 0.25 and 0.5 lb/ton of Opti-Bac L were significantly heavier and gained more weight than the other treatments from d 0 to 14 and d 0 to 35. No differences in BW or BWG were observed from d 0–42. FI was not significantly affected by Opti-Bac L supplementation regardless of grow out period. Birds supplemented with 0.5 lb/ton of Opti-Bac L had more efficient FCR than the other treatments from d 0 to 35 and d 0 to 42. There were no significant differences in mortality among treatments. In conclusion, data from this study suggested that Opti-Bac L inclusion

at 0.5 lb/ton was beneficial to performance in the *C. perfringens* positive environment with improvements in FCR, BW and BWG.

Key Words: *Clostridium perfringens*, *Bacillus licheniformis*, probiotic

407P In vitro evaluation of the potential for select bacteria and yeast as probiotics in poultry production. S. N. Nahashon*¹, B. R. Dixon¹, and A. K. Kilonzo-Nthenge², ¹Department of Agricultural and Environmental Sciences, Tennessee State University, Nashville, TN, ²Department of Family and Consumer Science, Nashville, TN.

Probiotics are live microbial feed supplements that enhance host's health and overall performance. However, their mode of action and ideal host gastrointestinal tract (GIT) environment are still obscure. The aim of this study was to ascertain ideal GIT conditions that favor establishment, growth and competitive exclusion properties of the probiotics *Bifidobacterium longum*, *Lactobacillus plantarum* and *Saccharomyces boulardii*. These microorganisms were assayed for their ability to (1) tolerate and survive varying pH levels and bile concentrations, (2) attach to chicken GIT mucosa, and (3) challenge pathogenic microorganisms. Performance of the microbes at pH range of 7–2 and bile concentrations of 1–3% were evaluated. Growth or decline in cfu/mL was assayed every 1 h for 6 h. Chick duodenal tissue was inoculated with either of the experimental microbes for 1hr at 37°C in 10% CO₂ and later assessed for attachment using scanning electron microscopy. The probiotic microorganisms were challenged with pathogenic *S. pullorum*, *S. typhimurium*, *S. enteritidis*, *C. coli*, *C. lari*, *C. jejuni*, *E. faecalis*, *E. faecium*, and *E. coli* using the agar spot test method. Recovery of *B. Longum*, *L. plantarum*, and *S. boulardii* were significantly higher ($P < 0.05$) at pH range of 5–7, 4–7 and 2–7, respectively. In the presence of bile, the average recovery of these microbes was 1.5, 7.2 and 3.8 cfu/mL, respectively. *B. longum* and *L. plantarum* showed remarkable ability to attach by obvious changes in the cell surface and cytoskeleton where they were anchored. *S. boulardii* was also present on the cell surface, but no changes were observed on the epithelial cell surface. On the other hand, *B. longum* and *L. plantarum* showed the ability to positively inhibit all pathogenic microbes with the exception of *B. longum* falling short of inhibiting *E. faecium*. *S. boulardii* only showed positive inhibition toward *C. lari* and *C. jejuni*. In conclusion, these microbes have a strong potential for use as probiotics in poultry feeding although *B. longum* and *S. boulardii* seem to be adversely affected by acidic pH and bile salts, respectively.

Key Words: probiotics, poultry health, microbial feed supplements, bacteria, yeast

408P Evaluation of probiotic bacterial strains and prebiotic yeast cell wall on starter broiler performance in birds subjected to bursa vaccine and *Clostridium perfringens* challenge. R. A. Abdaljaleel*, J. Fowler, M. Hashim, A. Haq, and C. A. Baily, Texas A&M University System, College Station, TX.

The aim of this study was to evaluate the effects of a probiotic product containing *Enterococcus faecium*, *Bacillus subtilis*, and *Lactobacillus casei* strains at 10⁶ cfu/bird/day and a prebiotic yeast cell wall (YCW) on the performance of starter broilers subjected to an infectious bursal disease (IBD) vaccine and *Clostridium perfringens* challenge. A total of 240 day-old broiler chicks were distributed in 2 Petersime battery brooder units (48 pens; 5 birds per pen). Six treatments were assigned to pens for a 21 d trial. A basal industry-type broiler starter diet was prepared and divided into 6 equally sized portions that included negative

control, YCW 125 ppm, YCW 250 ppm, probiotic + YCW125 ppm, and probiotic + YCW 250 ppm. Birds were vaccinated with a commercial IBD vaccine via eye drop at 10 d of age followed by *Clostridium perfringens* challenge (3 mL oral gavage) on d 16 and 17 of the study. The results showed that YCW product performed as well as the probiotic throughout the experiment, while there was a significant main effect ($P \leq 0.05$) for YCW dose in the post challenge feed-to-gain ratios, with the YCW 250 ppm dose showing improved feed conversion when compared with negative control. On the other hand, the probiotic had no effect on feed-to-gain ratios while the YCW product (Lesaffre) showed a dose dependent response during the challenge phase.

Key Words: probiotic, prebiotic, performance, challenge, broiler

409P Dietary supplementation of yerba mate (*Ilex paraguayensis*) extract on broiler performance. D. L. Migotto*¹, A. M. C. Racanicci¹, J. F. M. Menten², M. Sbardella², D. R. Cardoso³, and C. B. Lima¹, ¹University of Brasilia, Brasilia, Distrito Federal, Brazil, ²University of São Paulo, Piracicaba, Brazil, ³University of São Paulo, São Carlos, Brazil.

Yerba mate (*Ilex paraguayensis*) is a plant commonly used in several South American countries to prepare beverages through an aqueous infusion of its dry and ground leaves. This beverage is savored for its bitter flavor and has diuretic, anti-inflammatory and stimulant properties reported (Schinella et al., 2000). The antioxidant potential of the Yerba mate is probably related to the high percentage of phenolic compounds present in the extract of the plant's leaves. Due to this information, interest regarding the use of this plant in food preservation, especially in meat, has increased. Therefore, the main objective of this study was to assess the effects of the utilization of lyophilized extracts of yerba mate (YM) in broilers diets on performance. One thousand four hundred female 1-d-old Ross broiler chicks (initial weight 43.65 g ± 1.04) were distributed in 36 floor pens (40 chicks each) in a completely randomized design, with 6 treatments with 6 replicates. Chicks were fed ad libitum until 38 d with a basal diet formulated to meet the nutritional requirements of female chicks on pre-starter, starter, grower and finisher phases (Rostagno et al., 2011). Dietary treatments consisted of the addition of 5 different concentrations of lyophilized extract of YM (0, 250, 500, 750, and 1,000 mg/kg) plus a positive control (125 mg of vit. E/kg). Feed intake and live weight were assessed weekly to obtain weight gain and feed:gain ratio, and mortality was registered daily. Statistical analyses were performed with PROC MIXED (SAS system) and averages were compared using orthogonal contrasts. At 38 d of age, dietary treatments did not affect significantly ($P < 0.05$) broilers weight gain (2,162.45 ± 51g), feed intake (5,344.84 ± 127.58 g) and feed:gain ratio (2.51 ± 0.02). Even though the utilization of yerba mate extracts did not exhibit positive effects on performance of broilers, more studies are needed to evaluate the antioxidant activity postmortem.

Key Words: natural antioxidant, feed conversion, live weight, weight gain, vegetable extract

410P Cecal microbiota of chickens fed with diets containing crude propolis as alternative growth promoter. C. Eying*¹, A. E. Murakami², A. A. Pedrosa³, C. R. A. Duarte², and I. C. Ospina-Rojas², ¹Universidade Federal da Grande Dourados, Dourados, Mato Grosso do Sul, Brazil, ²Universidade Estadual de Maringá, Maringá, Paraná, Brazil, ³Private Company, Visalia, CA.

The prohibition of the use of some antibiotic as performance enhancers is intensifying the search for alternative ingredients to be used as

modulators of the intestinal microbiota. Propolis, a substance produced by bees, is known for its natural antimicrobial properties. In this study, we characterized the cecal microbiota of broiler chickens fed with diets containing levels of crude propolis (CP) using fluorescent in situ hybridization (FISH) measured by fluorescent activated cell sorting. One hundred sixty-eight birds were randomly distributed in 6 treatments (0, 100, 200, 300, 400, and 500 ppm of CP per kilo of diet) with 7 replicates and 4 birds per experimental unit, and raised in cages until 21 d of age. Fluorescent probes were used against the principal bacterial groups in cecal samples collected at 21 d of age. Results showed that the CP affected the composition of the bacterial community. A minimum concentration of *Clostridiaceae* was observed when 240 ppm of CP was used in chicken diets. Levels of *Clostridiaceae* were significant lower when 200 and 300 ppm of CP were used in chicken diets compared with control treatment (0 ppm of CP). Low level of *Enterobacteriaceae* was observed in birds that received feed supplemented with 400 ppm CP when compared with the control group. Levels of *Gammaproteobacteria*, excluding *Enterobacteriaceae*, were lower when 221 ppm of CP was adopted. Species related to *Lactobacillus* spp. had similar distribution to the control group when levels of 100, 300, 400 and 500 ppm were used. However, the proportion of *Lactobacillus* spp. was decreased when 213 ppm of CP was supplemented on bird diets. The supplementation of CP seems to have an antimicrobial effect on the cecal microbiota of chicken.

Key Words: antimicrobial, cecum, flow cytometry, fluorescence in situ hybridization, microbiota

411P Effect of GalliPro on ileal protein digestibility and metabolizable energy in energy-reduced diets. D. Harrington*¹, L. M. da Silva², S. C. Salguero², L. F. Albino², H. S. Rostagno², and A. B. Kehlet¹, ¹*Chr. Hansen A/S, Hørsholm, Denmark*, ²*Universidade Federal de Viçosa, Viçosa, Brazil*.

Probiotics, such as the *Bacillus subtilis*-based GalliPro is used successfully in commercial poultry production globally. The increased enzyme activity exhibited by GalliPro compared with other commercially available probiotics may confer benefits of increased nutrient digestibility in addition to other probiotic effects. A study was conducted to determine the ileal protein digestibility coefficient and metabolizable energy (ME) value from birds fed diets with reduced energy levels supplemented with GalliPro. A total of 320 birds (Cobb 500) were allocated to 8 treatments (8 replicates/treatment) and reared for 22 d on reused bedding. At 22 d, birds were transferred to metabolism cages and kept for 8 d. Throughout the study birds were fed a corn-soy based basal ration with 4 ME levels where 100% ME = (3075–3200) kcal/kg and with/without GalliPro (GP) (8.0×10^5 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; T8: 94% ME+GP. Feed contained 0.5% Cr₂O₃ as a marker. Excreta were collected from 26 to 30 d and ileal contents taken at 31 d. Data were analyzed by ANOVA. GP significantly increased apparent ME corrected for nitrogen (MEn) compared with controls, 23–34 kcal/kg dry matter (DM) across the 4 energy reduced diets. The highest MEn were observed in T6 and T8 compared with T2 and T4 respectively (3389, 3331, 3360, 3297 kcal/kg DM, respectively). Ileal protein digestibility (IPD) was significantly higher in GP groups (86.0%) than controls (85.6%), an average 0.4% increase, while ileal DM (IDM) was numerically higher in GP birds than controls (72.93% and 72.86%, respectively). IDM in T7 and T8 was higher than T3 and T4, respectively; in other GP birds, IDM was lower than controls. In conclusion, GalliPro can significantly increase MEn and IPD in broilers. There is a trend for GP to compensate for energy reduction in diets through increased MEn and IPD with more pronounced effects observed in diets containing 150 kcal less than standard.

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