

Nonruminant Nutrition: Feed Additives

970 Benefits of a synthetic antioxidant on improving growth performance in broiler chicks. J. Zhao*, F. Yan, C. Atwell, D. Macaraeg, M. Vazquez-Anon, J. D. Richards, R. J. Harrell, S. Carter, and T. Hampton, *Novus International Inc.*

This study examined the benefits of a synthetic antioxidant (AOX, AgradoPlus, Novus International Inc., St. Charles, MO) on improving performance in broilers. A total of 1152 ROSS 308 male birds were randomly allotted to one of the 4 dietary treatments with 12 pens per treatment and 24 birds per pen. The trial was a 2x2 factorial design with 2 types of soybean oil (fresh vs. oxidized) with or without AOX (0.025%). Oxidized soybean oil was produced by bubbling oxygen in a heated container up to 48 h to reach a target peroxide value (PV) of 200mEq/kg and 6 mEq/kg in the final diets. In the starter phase (d0–10), feed efficiency was significantly impaired with oxidized oil treatments ($P = 0.001$). Birds fed AOX gained more ($P < 0.05$) and ate more ($P < 0.05$) regardless of oil type (interaction, $P > 0.10$). In the grower phase (d10–23), birds fed oxidized oil gained less, ate less, and had lower overall performance index ($P < 0.05$) than birds fed fresh oil. Dietary AOX eliminated the negative effects of oxidized oil on performance ($P < 0.05$). The best performance was observed on birds fed fresh oil with AOX. Overall (d0–39), oxidized oil decreased feed efficiency (6%, $P < 0.001$), weight gain (7.5%, $P < 0.001$), and feed intake (2.3%, $P = 0.11$) compared with birds fed fresh oil. Birds fed AOX ate more ($P = 0.01$) regardless of oil type (interaction, $P = 0.34$), and gained more ($P < 0.001$) especially in birds fed oxidized oil (interaction, $P = 0.05$). The final body weight was 2.848, 2.876, 2.637, and 2.743 kg for birds fed fresh oil without and with AOX and for birds fed oxidized oil without and with AOX, respectively. In summary, oxidized oil impaired weight gain, feed intake, and feed efficiency. Birds fed AOX had better weight gain and feed efficiency regardless of oil type, and the benefits of AOX were more profound in oxidized oil groups.

Key Words: antioxidant, broiler, performance

971 Probiotic, prebiotic and yeast supplementation in broiler diets from 1 to 42 days of age: 1. Productive performance and economic efficiency. S. A. Riad¹, H. M. Safaa*¹, F. R. Mohamed¹, S. S. Siam², and H. A. El-Minshawy³, ¹Animal Production Department, Faculty of Agriculture, Cairo University, Giza 12613, Giza, Egypt, ²Poultry Breeding Department, Animal Production Research Institute, Dokki, Giza, Egypt, ³Ministry of Agriculture, Dokki, Giza, Egypt.

A total of 630 Arbor Acres broiler chicks at one-day old was used to study the effect of probiotic, prebiotic and/or yeast supplementation on the productive performance traits and economic efficiency. Chicks were divided randomly into 6 treatments and housed at deep litter in an open house system. Each treatment replicated 3 times (35 chicks per replicate). Treatments were as follows: T1 (control; chicks fed corn-soy basal diet) and in the other treatments diets were supplemented with 1g probiotic/kg diet as *Lactobacillus acidophilus* (T2), 1g yeast/kg diet as *Saccharomyces cerevisiae* (5×10^{12} CFU/g; T3), 1g prebiotic/kg diet as mannan-oligosaccharide (T4), 1g probiotic+1g prebiotic/kg diet (T5) or 1g yeast+1g prebiotic/kg diet (T6). Basal diet contains 23.1% CP and 3103 Kcal AME/kg for the starter diet (0–21 d) and 20.0% CP and 3207 Kcal AME/kg for the finisher diet (21–42 d). Body weight at 42 d was heavier ($P \leq 0.0001$) by about 29.5, 21.2, 12.4, 11.3 and 9.9% than control in the T6, T5, T4, T3 and T2, respectively. Moreover, feed conversion ratio was 2.08, 1.80, 1.84, 1.82, 1.63, 1.61 for T_i (i = 1, 2, ..., 6, respectively). For all traits, the best values were obtained in T6 fol-

lowed by T5 then T4. Also, T6 gave the best relative economic efficiency (14.86% more than control group). It could be recommended from this study to supplement the biological additives to broiler diet from 0 to 42 d of age as above mentioned because it has a positive effect on the broiler performance and the economic efficiency.

Key Words: probiotic, prebiotic, yeast, broiler performance, economic efficiency

972 Starter feed supplementation level effects of coated sodium butyrate (ADIMIX) on growth performance of broilers. R. D. Malheiros* and P. R. Ferket, *North Carolina State University, Raleigh.*

Dietary supplementation of butyric acid (BA) has been shown to support enteric development and intestinal health of neonatal animals, but BA's benefit to overall growth performance is variable because of its volatility in finished feed. ADIMIX (Nutriad, Inc.) is a coated sodium butyrate product (30% activity) that is less volatile and has more favorable handling characteristics for feed manufacturers than the concentrated BA. Commercial broilers were randomly assigned to 32 floor pens containing 30 birds each and provided feed and water ad libitum until 49 d. Starter feed (pellet-crumbled) treatments consisting of 4 dietary supplementation levels of ADIMIX (0, 0.015, 0.03, and 0.06% BA) were subjected to 8 replicate pens per treatment from 1 to 14 d. Subsequently, all birds were fed pelleted grower and finisher diets that did not contain ADIMIX. Body weight (BW) and feed intake was determined at 7, 14, 21, 42, and 49 d and feed/gain (FCR) was calculated. At 3, 8, and 14 d, 4 birds/treatment were sampled for gut histology evaluation. There were no treatment effects on mortality rate. BW at 14 d increased linearly ($P < 0.01$) as the level of BA increased (457 g vs 470 g for 0 vs 0.06% BA), but no effects on 1–14 d FCR was observed. Histomorphometric analysis was associated with early treatment effects on BW. The positive starter feed treatment effects were observed throughout the experiment, with 0.015% BA (0.05% ADIMIX) resulting in a 3% and 2% improvement in 42 d BW ($P < 0.02$) and 49 d BW ($P < 0.10$), respectively. A linear improvement in 1–42 d FCR by up to 3% was also observed as the level of BA increased in the Starter feeds. Dietary supplementation of BA as ADIMIX in starter feeds has a lasting positive effect on broiler growth performance.

Key Words: broilers, butyric acid, growth performance

973 Investigation on the effects of antibiotic growth promoters alternatives on broiler performance. M. Shivazad*^{1,2}, N. Ghazvini², and S. N. Mousavi², ¹University of Tehran, Tehran, Iran, ²Varamin-Pishva branch, Islamic Azad University, Varamin, Iran.

A study was conducted to evaluate the effects of organic acid (butyric acid and propionic acid), probiotics (*Pediococcus acidilactici*), prebiotics (mannanoligosaccharides) and formalin as potential alternatives to antibiotic growth promoters (AGP) in broiler chickens. Dietary treatments included an antibiotic free diet (CTL-), a positive control (CTL+) containing antibiotic (Avilamycin) and an antibiotic free diet containing butyric acid (Baby C4), Mannanoligosaccharides (BioMOS), Propionic acid (Formycin Gold), Probiotics (Bacto cell) or Formalin (37% formaldehyde). Feed intake was not affected by dietary treatments. Addition of Avilamycin significantly improved weight gain during 1–14 d but the effect was not continued. Birds fed BioMos and butyric acid were significantly heavier than negative controls during 14–28, 28–42 and 1–42 d ($P < 0.05$). Butyric acid treatments improved FCR throughout

the experiment. Avilamycin and probiotics improved FCR for d 1–14 and 1–42. BioMos had highest breast meat percentage among all treatments ($P < 0.05$). Dietary treatments had no significant effect on jejunum morphology (villus length, villus width and crypt depth). The results of this study indicated that addition of butyric acid and MOS to the diet could be an alternative to the use of antibiotics as growth promoters in broiler production.

Key Words: broiler, antibiotic growth promoters, probiotics

974 Dietary supplementation of *Spirulina platensis* in Austra-White chicken improves proximate composition of meat. A. Kollanoor Johny*¹, K. P. Sreekumar², S. C. Nair², and P. Kuttinarayanan³, ¹Department of Animal Nutrition, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, Kerala, India, ²Department of Animal Physiology, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, Kerala, India, ³Center of Excellence in Meat Science and Technology, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, Kerala, India.

Spirulina platensis, a blue-green alga is generally regarded as a rich source of protein, fats, vitamins and minerals. Although there are a few studies indicating its potential to enhance color of egg yolk and meat, the effect of *Spirulina* on the proximate composition and minerals including zinc and iron, of chicken meat has not been explored. The study was undertaken to determine the effect of dietary *Spirulina* on the proximate composition of chicken meat. Twelve, Austra-White male (egg-type) chicken were divided randomly into 2 groups of 6 birds each; control and experimental and were reared in battery cages with ad libitum access to feed and water. They were fed iso-nitrogenous and iso-caloric standard layer rations with the experimental group receiving 2.5% of dried *Spirulina* powder for a period of 6 mo, starting from the third month of age. At the completion of the trial, birds were sacrificed to collect meat and blood samples for proximate, mineral and serum analyses. The experiment was replicated 2 times. *Spirulina*-fed group showed significant improvement ($P < 0.05$) in total protein, fat and ash content of the meat samples. The concentrations of zinc, iron, magnesium, manganese, sodium, and potassium in meat did not differ between the groups, however, the serum concentrations of zinc and iron in the spirulina-treated group were significantly higher ($P < 0.05$) compared with that in the control. Analysis of plasma lipid profile revealed significant lowering of plasma total lipids and cholesterol ($P < 0.05$). Results of the study indicate that dietary supplementation of *Spirulina platensis* improves the proximate composition of chicken meat.

Key Words: *Spirulina platensis*, Austra-White chicken, meat, minerals

975 Increased fiber digestion and decreased fecal output in pigs fed fibrolytic bacteria. C. Ziemer*¹, S. Arcidiacono², A. Ragauskas³, and M. Morrison^{4,5}, ¹National Laboratory for Agriculture and the Environment, ARS, USDA, Ames, IA, ²U.S. Army Natick Soldier Center, Natick, MA, ³Institute of Paper Science and Technology, Georgia Institute of Technology, Atlanta, GA, ⁴Department of Animal Science, Ohio State University, Columbus, ⁵CSIRO Livestock Industries, St. Lucia, QLD, Australia.

Fiber digestibility increases when pigs are fed for longer periods of time, suggesting adaptation of intestinal microbiota with increased concentrations of fiber utilizing bacteria. We investigated whether feeding fiber utilizing bacteria to pigs would result in improved fiber digestion and reduce fecal output. Treatments were arranged as a 2×4 factorial with

2 diets and 4 bacterial treatments, with random assignment of pigs. Pigs, housed as 2 groups of 24, were fed either conventional or 20% distillers dried grains with solubles + 10% soybean hulls diet ad libitum with free water access. Treatments consisted of no bacteria (A) or one of 3 *Bacteroides* isolates (B, C and D); isolated from fecal enrichments with cellulose and xylan. Bacteria were fed to pigs once daily (0900 h) using a 50:50 mixture of bacteria in growth medium and food grade glycerol (dosage of 10^{10} bacterial cells/d). After 3 weeks, 24 pigs, at a time, were moved into metabolism crates for 11 d. On d 7 to 11 total dietary intake, fecal output, and urinary output were measured and feed, feed refusals and feces were sampled to determine nutrient digestibilities. Blood was taken on d 1 and 11 to analyze plasma for energy metabolites. Data were analyzed as $2 \times 2 \times 4$ randomized block design with 2 groups of pigs, 2 dietary treatments and 4 bacterial treatments; no interactions were significant and these were removed from final model. Initial pig BW averaged 61.1 kg, after 50 d the final pig BW averaged 103.6 kg. Feed intake was not affected by diet or bacterial treatment. The effects of increased fiber in the diet were as expected. Treatment B resulted in the most desirable effects when fed to pigs. Fecal output (g/d, $P = 0.13$) and fecal output/intake (g/g, $P = 0.07$) were decreased when treatment B (by 19.8% and 19.4%, respectively) was fed compared with no bacteria (A). Plasma glucose (mg/dL, $P = 0.10$) and cholesterol (mg/dL, $P = 0.14$) were increased in pigs fed B compared with no bacteria (A) by 5.3 and 10.4%, respectively. Bacterial treatment B demonstrated promise as a method to improve utilization of high fiber diets fed to pigs while maintaining performance.

Key Words: pig, fiber digestion, fecal output

976 Effects of dietary resveratrol supplementation on egg production and egg yolk lipid peroxidation. K. Sahin*¹, F. Akdemir², C. Orhan¹, M. Tuzcu³, A. Hayirli⁴, and N. Sahin¹, ¹Department of Animal Nutrition & Nutritional Disorders, Faculty of Veterinary Medicine, Firat University, Elazig 23119, Turkey, ²Department of Animal Nutrition & Nutritional Disorders, Faculty of Veterinary Medicine, Dicle University, Diyarbakir 21100, Turkey, ³Department of Biology, Faculty of Science, Firat University, Elazig 23119, Turkey, ⁴Department of Animal Nutrition & Nutritional Disorders, Faculty of Veterinary Medicine, Ataturk University, Erzurum 25240, Turkey.

Resveratrol, a polyphenol derived from red grapes, berries, and peanuts, have anti-inflammatory, antioxidant, and immunomodulatory activities. The objective of this study was to investigate the effects of dietary resveratrol supplementation on performance and serum and egg yolk antioxidant status in quails (*Coturnix coturnix japonica*). A total of 150 5-wk-old quails were allocated randomly to 3 dietary treatments: basal diet and basal diet supplemented with 200 and 400 ppm resveratrol. Each diet was offered to 10 cages of 5 birds in each, for 12 wks. Serum and egg samples were collected at the beginning (wk 4) and end (wk 16) of the experimental period for tumor necrosis factor (TNF- α), malondialdehyde (MDA), vitamin A and vitamin E. Data were subjected to ANCOVA using the MIXED Procedure. There was no treatment effect on feed intake and egg production as well as egg quality. There was no dietary resveratrol supplementation effect on serum and egg yolk vitamin A levels. Serum MDA (0.56 vs. 0.88 mg/l, $P < 0.03$) and TNF- α (18.24 vs. 21.43 pg/ml, $P < 0.008$) levels were lower and serum vitamin E level (5.72 vs. 3.56 mg/l, $P < 0.008$) was higher for quails supplemented with resveratrol than for quails fed the basal diet. Serum MDA ($P < 0.02$) and TNF- α ($P < 0.05$) levels decreased linearly and serum vitamin E level ($P < 0.01$) increased linearly with increasing dietary resveratrol supplementation. Egg yolks from quails supplemented with resveratrol contained less MDA than those from

quails fed the basal diet (0.21 vs. 0.15 µg/g, $P < 0.002$). In response to increasing dietary resveratrol level, egg yolk MDA content decreased linearly ($P < 0.0003$). To our knowledge, this is the first experiment dealing with antioxidant and anti-inflammatory effects of resveratrol in poultry. In conclusion, inclusion of resveratrol up to 400 ppm into quail diets enhanced antioxidant status of birds and improved egg stability, which could be important to consumers.

Key Words: resveratrol, antioxidant status, Japanese quail

977 The effect of feeding Original XPC to turkey breeder hens and progeny on starter poult performance and early breast muscle development. P. R. Ferket^{*1}, R. D. Malheiros¹, M. J. Wineland¹, J. L. Grimes¹, and D. T. Moore², ¹North Carolina State University, Raleigh, ²Diamond V, Inc., Cedar Rapids, IA.

This study investigated the use of a *Saccharomyces cerevisiae* fermentation product in turkey breeder diets and subsequent progeny diets. A commercial breeder farm provided 2 diets to Hybrid Converter breeder hens starting at 29.5 weeks of age before the onset of lay: control diet or the control diet containing 0.075% XPC. At approximately 33.5 weeks of age, eggs were collected from both breeder flocks and transported to NC State University where they were incubated. Male poults were randomly divided at hatch into 4 treatments with 10 pens/treatment and 15 poults/pen. Treatments were arranged as a 2X2 factorial, consisting of 2 dietary XPC levels for breeders (0 and 0.075%) and 2 dietary XPC levels for progeny (0 and 0.125% 1–42 d and 0.0625% 43–63 d). Poults were raised in a curtain-sided, floor pen facility, and provided feed and water ad libitum. Body weights (BW) and feed consumption was determined at 21, 42, and 63 d and feed/gain (FCR) calculated. At 14 and 42 d, 4 poults/treatment were sampled for breast muscle yield. There were no significant ($P > 0.05$) breeder effects or breeder × progeny treatment interaction effects on BW or FCR throughout the experiment. However, the positive effects of dietary XPC supplementation on the growth performance of progeny was highly significant ($P < 0.0001$). BW of progeny fed XPC was greater than controls at 21 d (579 g vs. 509 g, $P < 0.0001$), 42 d (2595 g vs. 2417 g, $P < 0.0001$) and 63 d (6057 g vs. 5480 g, $P < 0.0001$). However, FCR of progeny fed XPC was better than controls only from 1 to 21 d (1.59 vs. 1.71 $P < 0.0001$). Dietary XPC supplementation increased % breast muscle yield at 14 d (15.22% vs. 12.31%, $P < 0.0001$), but no significant effects were observed on % breast muscle at 42 d. Feeding poults XPC during the starter phase improves feed intake and body weight gain for the entire period and improves feed conversion and breast muscle yield early in the phase.

Key Words: turkeys, fermentation product, growth performance

978 Use of a *Bacillus amyloliquefaciens* probiotic in broiler farms. J. J. Mallo^{*1}, M. I. Gracia², P. Honrubia¹, and G. Sedano³, ¹Norel SA, Madrid, Spain, ²Imasde Agroalimentaria SL, Madrid, Spain, ³Nutysler SL, Burgos, Spain.

Ten farms involving 2,240,000 male and female broilers were used to evaluate the efficacy of a probiotic (Ecobiol; EU Zootechnical Feed Additive number 4b1822; containing 1×10^9 CFU of *B. amyloliquefaciens* CECT 5940 per g) on animal performance. The probiotic was added to the feed at a ratio of 1 kg/ton. Feeds were presented in pelleted form and analyzed for the probiotic concentration. In 9 farms, the former productive results of the farms were used as control, and they were compared with the productive results of the farm when the probiotic was added to the feed. In one farm, 3 buildings (10,000 broilers each)

received the control feed and 3 buildings received the probiotic. In this farm, samples of feces were taken to analyze lactobacilli and coliform bacteria (CFU/g) at d 7 and 35. The experimental data were tested for homogeneity, pooled and combined in a meta-analysis. Parameters analyzed were final body weight (g), feed conversion (feed/gain) and mortality (%) for the whole period. At the end of the experimental period broilers fed the probiotic showed better feed conversion (−3.0%, 2.01 vs. 1.95 g/g; $P = 0.0262$) and less mortality rate (−36%; 8.3 vs. 5.3%; $P < 0.0001$) than controls. No significant differences were observed in body weight (2,632 vs. 2,678 g; $P = 0.3701$). Probiotic supplementation of diets increased Lactobacilli counts of feces at 7 d (8.14×10^8 vs. 1.73×10^9 CFU/g; $P = 0.0013$) and at 35 d of age (2.46×10^8 vs. 5.45×10^8 CFU/g; $P = 0.0024$). Coliform bacteria counts were significantly decreased by the use of the probiotic at 7 d (5.74×10^7 vs. 2.94×10^7 CFU/g; $P = 0.0268$) but only numerically at 35 d (1.56×10^7 vs. 9.74×10^6 CFU/g; $P = 0.1627$). It is therefore concluded that the probiotic tested improves feed conversion and reduces mortality in farms, possibly because of a better intestinal balance.

Key Words: probiotic, *Bacillus amyloliquefaciens*, broiler

979 Chemical and nutritive composition of low-fiber canola: The effects of seed coat color and enzyme supplementation. W. Jia^{*1}, M. Mogielnicka¹, A. Rogiewicz¹, G. Rakow², D. Hickling³, and B. A. Slominski¹, ¹University of Manitoba, Winnipeg, Manitoba, Canada, ²Agriculture and Agri-Food Canada, Saskatoon, Saskatchewan, Canada, ³Canola Council of Canada, Winnipeg, Manitoba, Canada.

Canola breeding programs undertaken to improve meal quality without compromising oil content in the seed has led to the development of yellow-seeded *Brassica napus* and *B. juncea* canola. The objective of the current study was to evaluate the chemical and nutritive composition of meals derived from black- and yellow-seeded *B. napus* canola and canola-quality yellow-seeded *B. juncea*. In comparison with its black-seeded counterpart, meal derived from yellow-seeded *B. napus* canola contained more protein (49.8 vs. 43.8% DM), more sucrose (10.2 vs. 8.8% DM) and less dietary fiber (24.1 vs. 30.1% DM). Lower fiber content in yellow-seeded *B. napus* canola was reflected in lower content of lignin with associated polyphenols (3.7 vs. 7.1% DM). *B. juncea* canola showed intermediate levels of crude protein, sucrose and dietary fiber (47.4, 9.2 and 25.8%, respectively). Seed fractionation study demonstrated that the reduction in fiber content of yellow-seeded *B. napus* was a consequence of a bigger seed size, which averaged 3.9, 2.9 and 2.5 mg/seed, respectively, for yellow- and black-seeded *B. napus* and *B. juncea* canola, a lower contribution of the hull fraction to the total seed mass (11.0 vs. 15.9 and 13.7 g/100 g of seed), and a lower fiber content of the hull fraction (5.0 vs. 9.1 and 8.2 g/100 g of seed). The nutritive value of canola meal samples was investigated with broiler chickens fed corn/soybean meal-based diets containing 30% of meals from 3 to 17 d of age. A significantly higher ($P < 0.05$) total ileal digestibility of amino acids (88.8%) was observed in birds fed the yellow-seeded *B. napus* diet when compared with those fed diets containing black-seeded *B. napus* (83.5%) or *B. juncea* (84.2%) canola. In a second study, meal AME_n values for yellow- and black-seeded *B. napus*, and *B. juncea* were determined with broiler chickens (from 14 to 19 d of age) and were 2190, 1904, and 1736 kcal/kg DM, respectively. Enzyme addition significantly increased the AME_n values from 1943 to 2249 kcal/kg DM, on average, with the most pronounced effect observed for *B. juncea* canola (from 1736 to 2356 kcal/kg DM).

Key Words: canola meal, chemical composition, nutritive value