

Nonruminant Nutrition: Health

T166 Effects of supplemental zinc amino acid complex on physiology and performance in heat-stressed growing pigs. M. V. Sanz-Fernandez^{*1}, S. C. Pearce¹, L. R. Long¹, N. K. Gabler¹, J. F. Patience¹, M. E. Wilson², M. T. Socha², R. P. Rhoads³, and L. H. Baumgard¹, ¹Iowa State University, Ames, ²Zinpro Corporation, Eden Prairie, MN, ³Virginia Polytechnic Institute and State University, Blacksburg.

Heat stress (HS) reduces livestock productivity and this may in part be caused by leaky gut. We have recently demonstrated that supplementing Zn amino acid complex (ZnAA) improves intestinal barrier function in HS pigs (Sanz-Fernandez et al., 2012). Consequently, we hypothesized that ZnAA would improve pig performance during HS. Crossbred gilts (n = 59; 43 ± 6 kg BW) were subjected to 3 experimental periods (P). During P-1 (20 d), pigs were housed in groups in thermo-neutral (TN) conditions (19°C, 61% RH) and ad libitum fed 1 of 3 diets: 1) control (120 ppm of Zn from ZnSO₄; n = 29), 2) control + 100 ppm ZnAA from Availa Zn (Zinpro Corporation; Zn220; n = 14), and 3) control + 200 ppm ZnAA from Availa Zn (Zn320; n = 16). Pigs remained on their diets throughout the whole experiment. During P1 (5 d), pigs were moved into individual pens in TN conditions. During P2, half of the controls (n = 13), and all the Zn220 and Zn320-fed pigs were exposed to constant HS conditions (36°C, 50% RH) and fed ad libitum; the other half of the control pigs (n = 16) remained in TN conditions and were pair-fed (PF) with the HS pigs to eliminate the confounding effects of dissimilar feed intake (FI). Pigs were sacrificed at d 1 or 7. As expected, there were no treatment differences in rectal temperature (Tr) or respiration rates (RR) during P1. During P2, HS pigs had increased Tr ($P \leq 0.01$; 40.23 vs. 38.37°C) and RR (114 vs. 37 bpm) compared with PF pigs. Within the HS groups, Tr linearly increased ($P \leq 0.05$) with increasing levels of ZnAA (40.6 vs. 40.31°C). Heat stress markedly reduced FI ($P \leq 0.01$; 60%), and ZnAA did not ameliorate this decrease. There were no treatment differences in ADG during P-1, but during P1 there was a quadratic response ($P \leq 0.05$) as Zn220-fed pigs outgained (8.5%) controls and Zn320-fed pigs. On d 1 of P2, pigs in all treatments lost a similar amount of BW (3.24 kg). By d 7, the PF pigs tended ($P \leq 0.10$) to lose more BW than the HS pigs (3.63 vs. 0.02 kg), but feeding ZnAA did not improve BW loss. Data from this small experiment indicate that supplementing ZnAA did not prevent reduced performance during severe HS.

Key Words: heat stress, zinc amino acid complex, pig

T167 Evaluation of the antioxidative capacity of *Lactobacillus plantarum* in vitro and its antioxidative effect on weaned pigs. H. F. Ji,^{*} J. Wang, L. Hou, S. X. Wang, D. Y. Zhang, H. Liu, and Y. M. Wang, *Institute of Animal Husbandry and Veterinary Medicine, Beijing Academy of Agriculture and Forestry Sciences, Beijing, China.*

This study was conducted to evaluate the antioxidative capacity of *Lactobacillus plantarum* and its effects on antioxidant enzyme levels in weaned pigs. The strain of *Lactobacillus plantarum* was originally isolated from the gastrointestinal tract of healthy weaned pigs in our laboratory and strains were identified by the China Center of Industrial Culture Collection. The antioxidative capacity of *Lactobacillus plantarum* was analyzed in vitro. Resistance of this strain to reactive oxygen species (ROS), such as hydrogen peroxide, superoxide anions, hydroxyl radicals, and DPPH (1,1-diphenyl-2-picrylhydrazyl) was determined. The result showed that over 90% of *Lactobacillus plantarum* cells were viable after 240 min of incubation in the presence of 1.0 mmol/L hydrogen peroxide.

The free radical scavenging activity of *Lactobacillus plantarum* against superoxide anions, hydroxyl radicals, and DPPH increased along with the increase of *Lactobacillus plantarum* concentration. Subsequently, 48 piglets weaned at 28 d of age (8.02 ± 0.49 kg BW), were divided into 3 dietary treatments comprising of a basal diet or the basal diet supplemented with chlortetracycline at 50 mg/kg or 5.1 × 10⁷ *Lactobacillus plantarum* cfu/g diet. The experiment lasted 4 weeks. Data were analyzed statistically by using ANOVA procedures of SAS (SAS 1996). The results showed that the supplementation of *Lactobacillus plantarum* had higher average daily gain compared with basal diet control (505 vs. 463 g/d; $P < 0.05$) and lower feed conversion ratio compared with basal diet and antibiotic control (1.62 vs. 1.78, 1.71; $P < 0.05$). Supplementation of *Lactobacillus plantarum* increased serum superoxide dismutase (127.6 U/ml; $P < 0.05$) and glutathione peroxidase (478.4 U/ml; $P < 0.05$), while malondialdehyde levels decreased (4.10 nmol/ml; $P < 0.01$) in serum of weaned pigs. In general, *Lactobacillus plantarum* had high antioxidant capacity and its supplementation improved the antioxidant status of weaned pigs, and it could be used to alleviate oxidative stress and increase growth performance of weaned pigs.

Key Words: *Lactobacillus plantarum*, antioxidative capacity, weaned pig

T168 Evaluation of Oleobiotec in the diet of broilers challenged with *Clostridium perfringens* compared with an antibiotic administered continuously in feed. V. Noirot, P. Etienne, M. Champagnac, and D. Eclache,^{*} *Laboratoires Phodé, Terssac, France.*

The product Oleobiotec (Laboratoires Phodé, France), a formulation of plant active principles among which spices extracts and characterized essential oils, was tested on male broiler chickens challenged with *Clostridium perfringens* on a Canadian experimental farm. Three hundred 1-d-old Ross × Ross broiler chickens were divided into 2 groups of 6 replicate pens of 25 birds. They were slaughtered at 38 d at a minimum weight of 2.5 kg. The control group was fed basal diet supplemented with 55 ppm of bacitracin methylene disalicylate (BMD-110). The treated group received the same basal diet supplemented with Oleobiotec (200, 150 and 100 ppm in starter, grower and finisher feeds, respectively). Contamination of the litter was carried out by dispersing the litter of clostridia infected flocks. Microbial pressure was increased by high dose (× 40) of a live anticoccidial vaccine (Coccivac) at 9 d and by a diet rich in wheat. The chickens did not receive any in-feed anticoccidials. The chickens were weighed individually at 0, 7, 17, 30, and 38 d. Feed intake and feed conversion ratio were evaluated for each pen and group at weighing time. Dead birds were recorded daily. Contamination of the litters was checked by pen at 21 and 38 d using the most probable number (MPN) method using McGrady's probability table and was not significantly different between treatments (J21: 39 vs. 195 MPN of spores/g; J38: 47 vs. 70 MPN of spores/g for control and Oleobiotec respectively, $P > 0.05$). Death rate was lower with Oleobiotec (3.4%) than with BMD (6.0%), but the difference was not significant ($P > 0.05$). Body weight at 30 d of age was reduced with Oleobiotec (1831 g vs. 1881 g for the control, $P < 0.05$). Oleobiotec produced similar results on average daily gain and feed conversion ratio to BMD ($P > 0.05$). In this study, Oleobiotec enabled us to obtain similar performances on broilers challenged with *Clostridium perfringens* to bacitracin zinc.

Key Words: plant extract, broiler chicken, *Clostridium perfringens*

T169 Ingestion of a novel galactoglucomannan oligosaccharide-arabinosyl (GGMO-AX) complex affected growth performance and fermentative and immunological characteristics of broiler chicks challenged with *Salmonella typhimurium*. T. A. Faber*¹, R. N. Dilger¹, M. Iakiviak¹, A. C. Hopkins², N. P. Price³, and G. C. Fahey Jr.¹, ¹University of Illinois, Urbana, ²Temple-Inland, Diboll, TX, ³National Center for Agricultural Utilization Research (NCAUR), ARS-USDA, Peoria, IL.

Fermentable carbohydrates may enhance the ability of the gastrointestinal tract to defend against a pathogenic infection. We hypothesized that a galactoglucomannan oligosaccharide-arabinosyl (GGMO-AX) complex would positively affect immune status and prevent colonization and shedding in *Salmonella typhimurium* (ST)-infected chicks. Using a completely randomized design, one day old commercial broiler chicks (n = 240; 4 replications/treatment; 5 chicks/replication) were assigned to 1 of 6 dietary treatments differing in concentration of GGMO-AX (0, 1, 2, or 4%) or containing 2% Safmannan (Saf) or 2% short-chain fructooligosaccharides (scFOS). Cellulose was used to make diets iso-total dietary fiber (TDF). On d 10 post-hatch, an equal number of chicks on each diet were inoculated with either phosphate buffered saline (sham control) or ST (1×10^8 cfu). All birds were euthanized on d 10 post-inoculation (PI) for collection of intestinal contents and select tissues. Overall, body weight gain and feed intake of chicks was greater ($P < 0.05$) in infected chicks PI, except for weight gain on d 0–3 PI. Gain:feed was affected ($P < 0.05$) by diet, with Saf-fed chicks having the highest G:F. The GGMO-AX substrate demonstrated prebiotic-like effects as indicated by increased cecal short-chain fatty acid concentrations, decreased cecal pH, and increased populations of *Lactobacillus* spp. and *Bifidobacteria* spp. as dietary GGMO-AX concentration increased. Excreta ST populations on d 5 and 10 PI, and ileal and cecal ST populations, tended to be affected ($P < 0.10$) by diet. Messenger RNA expression of IFN- γ in the cecal tonsils was the only cytokine independently affected by infection and diet ($P < 0.01$). Chicks fed 2 and 4% GGMO-AX had similar expressions of IFN- γ and IL-1 β , regardless of infection, suggesting that ST virulence was suppressed. Dietary supplementation with GGMO-AX resulted in prebiotic-like effects, but did not limit ST intestinal colonization or shedding, but possibly decreased the virulence of ST within the digestive tract.

Key Words: chick, galactoglucomannan oligosaccharide (GGMO), *Salmonella typhimurium*

T170 Effects of oligosaccharides in a soybean meal-based diet on fermentative and immune responses in broiler chicks challenged with *Eimeria acervulina*. T. A. Faber*¹, R. N. Dilger¹, A. C. Hopkins², N. P. Price³, and G. C. Fahey Jr.¹, ¹University of Illinois, Urbana, ²Temple-Inland, Diboll, TX, ³National Center for Agricultural Utilization Research (NCAUR), ARS-USDA, Peoria, IL.

Fermentable oligosaccharides, particularly those found in soybean meal (SBM), may modulate fermentation in the ceca, thus affecting intestinal immune responses to intestinal pathogens. We hypothesized that fermentable oligosaccharides found in SBM would positively affect cecal fermentation and intestinal immune status in chicks challenged with an acute coccidiosis (*Eimeria acervulina*) infection and fed either a SBM-based diet or a semi-purified soy protein isolate- (SPI) based diet. Using a completely randomized design, day-old broiler chicks (n = 200; 5 replications/treatment; 5 chicks/replication) were assigned to one of 4 SBM- or SPI-based diets containing either dietary cellulose (4%) or a fermentable carbohydrate, galactoglucomannan oligosaccharide-arabinosyl (GGMO-AX) complex (4%). On d 9 post-hatch, an equal

number of chicks on each diet were inoculated with either distilled water (sham control) or *E. acervulina* (1×10^6 oocysts) and then euthanized on d 7 post-inoculation (PI). Overall, body weight gain and feed intake were greater ($P < 0.01$) for SBM-fed chicks, regardless of infection status. Gain:feed ratio was greater ($P \leq 0.05$) for SPI-fed chicks except during d 3–7 PI. Infection status, but not fiber source, affected propionate, isobutyrate, isovalerate, and total BCFA concentrations ($P \leq 0.02$). Soybean meal-based diets resulted in greater ($P \leq 0.04$) SCFA and BCFA concentrations than SPI-based diets. Messenger RNA fold changes of all duodenal cytokines were greater ($P \leq 0.01$) for infected chicks, and SBM-fed chicks had greater ($P < 0.01$) IFN- γ and IL-12 β expression compared with SPI-fed chicks. Cecal tonsil cytokine expression was also affected ($P \leq 0.02$) by infection; however, protein source only affected ($P < 0.01$) IL-1 β expression in this tissue. Overall, a SBM-based diet, compared with a semi-purified SPI-based diet, resulted in greater weight gain, feed intake, and SCFA production regardless of infection status, and also greater duodenal cytokine expression in *E. acervulina*-infected chicks, which is hypothesized to be related to the oligosaccharides found in SBM.

Key Words: chick, coccidiosis, galactoglucomannan oligosaccharide (GGMO)

T171 Effect of *Lactobacillus gasseri* from chicken origin on the production performance, intestinal flora, and immune function of broiler chickens. X.-H. Teng,* X. Li, and J. Li, College of Animal Science and Technology, Northeast Agricultural University, Harbin, Heilongjiang, China.

Many studies have shown that *Lactobacillus* dominates in normal animal intestinal tract and it is very important to maintain a healthy body. The objective of this research was to determine the effect of *L. gasseri*, which was separated, filtrated and prepared from chicken cecum in our laboratory, on production performance, intestinal flora and immune function of broiler chickens. A total of 150 AA broiler chickens at 1 d of age were randomly divided into 5 groups by sex and body weight, with 3 replicates per group and 10 chickens (5 female and 5 male) per replicate. The test data was analyzed by SPSS 16.0. A control group received the basal diet, while groups 1, 2, 3 and 4 received the basal diet supplemented with 1) 5mg/kg Flavomycin, 2) 1% lactobacillus of plant origin (as control group using a commodity product), 3) 0.73% *L. gasseri*, and 4) 0.73% *L. gasseri* plus 0.02% xylooligosaccharide, respectively. The results showed that average daily gain and average daily feed intake of 6-week-old broiler chickens in control group was lower ($P < 0.05$) than in groups of 1, 3 and 4. There was no difference ($P < 0.05$) in feed/gain ratio between control and treatment groups. For the intestinal flora, the number of *Lactobacillus* in the control group was lower ($P < 0.05$) than in groups of 2,3 and 4, but the number of *E. coli* in the control group was higher ($P < 0.05$) than in groups of 2, 3 and 4. Concentrations of IgA and IgG, weights of the thymus and bursa of Fabricius, and spleen index scores in the control group were lower ($P < 0.05$) than in groups of 3 and 4. Additionally, spleen index scores in group 1 was higher ($P < 0.05$) than in control group. There were no significant differences ($P > 0.05$) for other response variables in group of 1 compared with control group. The results suggested that addition of *L. gasseri* to diets could improve production performance and may alter intestinal flora and immune function of broiler chickens compared with a flavomycin-containing diet.

Key Words: *Lactobacillus gasseri*, production performance, immune function

T172 Effect of supplementing curcumin as feed additive on the performance, biochemical profile, immune response and carcass characteristics in broilers. M. Pavani¹, Y. Ramana-Reddy^{*1}, P. Gopal-Reddy², S. R. Sakunthala-Devi¹, T. Monika¹, M. Sudhakar-Reddy¹, and A. Gopal-Reddy¹, ¹*S.V. Veterinary University, Tirupati, Andhra Pradesh, India*, ²*Tuskegee University, Tuskegee, AL*.

An experiment was designed to study the effect of curcumin at 0.0, 0.1, 0.2 and 0.3% level in the feed on the performance, serum biochemical profile, immune response and carcass characteristics in broilers. One hundred sixty broiler chicks (vencobb strain) were randomly divided into 4 equal groups having 8 replicates of 5 each and fed the experimental diets (starter 0–3 wk; finisher 4–6 wk) for 6 weeks with 0.0, 0.1, 0.2 and 0.3% curcumin. Sera samples were collected for biochemical profile on d 42. All the biochemical parameters studied were estimated by commercially available kits (M/S Qualigens India Ltd.). Cell mediated (PHA-P response) and humoral (SRBC titers) responses were observed by Corrier and Deloach, (1990) and Wegmann and Simthies, (1966) methods, respectively. Eight birds from each treatment were slaughtered at the end of the experiment for studying the carcass characteristics. The experimental data was analyzed by completely randomized design (CRD). The average daily gain (g), feed intake (g/d) and feed efficiency (kg/kg gain) in broilers were not affected by the curcumin levels in the diet. Serum glucose, total protein, albumin, triglycerides, creatinine, urea (mg/dl), SGOT, SGPT and alkaline phosphatase (IU/L) were also not influenced by the level of curcumin in the diet. However, cholesterol level (mg/dL) was significantly ($P < 0.01$) lower in broilers fed diets with different levels of curcumin compared with those fed control diet. Further, humoral and cell mediated responses were significantly ($P < 0.01$) higher in broilers fed diets with different levels of curcumin compared with control but the responses were not significantly different among the broilers fed diets with 0.1, 0.2 and 0.3% level curcumin. Dressing percentage and vital organs weight (g/kg carcass wt) such as liver, heart and gizzard were similar among the broilers fed experimental diets. Weights of the lymphoid organs (g/kg carcass wt), spleen, bursa and thymus was significantly ($P < 0.05$) higher in broilers fed curcumin supplemented diets but among the different levels of curcumin, the values were not significantly different.

Key Words: curcumin, broilers, performance

T173 Effect of a mixture of turmeric and capsicum oleoresins on performance and oocyst excretion of broilers challenged with coccidiosis. C. Oguey^{*1}, V. Brito², A. Casarin³, and M. Forat³, ¹*Pancosma, Geneva, Switzerland*, ²*Euronutec, Queretaro, Mexico*, ³*Instituto Internacional de Investigacion Animal, Queretaro, Mexico*.

Capsicum and turmeric are known to stimulate innate immunity. So combining these 2 plant extracts should improve performance of birds infected by *Eimeria*. The objective of this trial was to evaluate the effect of a mixture of capsicum and turmeric oleoresins (XT, XTRACT 6986, Pancosma) on performance and oocyst excretion of broilers challenged with coccidiosis. One day old male broilers were randomly allocated for 52 d to 1 the 2 following treatments (48 birds * 12 cages / treatment): PC = 50 ppm Roxarone + 110 ppm Monensin + 7.5 ppm Avilamycine, and XT = 50 ppm Roxarone + 110 ppm Monensin + 100 ppm XT. All birds were challenged to *Eimeria* spp. via litter spray at d14. FI, BW, BWG, FCR and oocyst excretion (expressed as log₁₀) were recorded. Data were analyzed using GLM procedure of SAS. Before challenge, no oocysts were excreted and FI, BWG and FCR were similar between PC and XT ($P > 0.37$), showing the positive effect of XT on performance in the absence of infection. After challenge, final BW, BWG and FCR were also similar between PC and XT ($P > 0.25$). This demonstrated that

the substitution of avilamycine with XT can maintain the performance of challenged birds. Oocyst excretions of *E. acervulina* and *E. maxima* were similar between the 2 treatments ($P > 0.32$). For *E. tenella*, birds in XT excreted the same amount of oocysts after 14 and 21 d of infection compared with PC (respectively 0.97 vs. 1.69 log after 14 d, $P = 0.25$ and 3.62 vs. 4.04 log after 21 d, $P = 0.12$) but excreted more oocysts 28 d after challenge (3.354 vs. 2.608 log, $P = 0.02$). This suggests that XT did not have the same effect as avilamycine on oocysts shedding. However, XT could be used to substitute this drug with no negative effect on performance of broilers challenged with coccidiosis.

Key Words: phytonutrients, poultry, coccidiosis

T174 Preventive supplementation with L-arginine and glutamine improved self-renewing of intestinal mucosa in LPS-injected rats. X. Wu^{1,2}, C. Zhang^{1,2}, Z. Ruan², Z. Deng¹, and Y. Yin^{*1,2}, ¹*State Key Laboratory of Food Science and Technology and College of Life Science and Food Engineering, Nanchang University, China*, ²*Institute of Subtropical Agriculture, Chinese Academy of Sciences, China*.

To evaluate the effect of preventive supplementation with L-arginine and glutamine on self-renewing of intestinal mucosa in lipopolysaccharide (LPS)-injected rats, 40 Sprague Dawley rats (average weight of 185 ± 15 g) were randomly divided into 5 treatment groups: control groups A (CA) and B (CB), both receiving daily oral supplementation with 0.9% saline, 300 mg/kg per day arginine (Arg), 300 mg/kg per day glutamine (Gln), or 150 mg/kg per day each of Arg plus Gln (AG). At 10:00am on d 15, animals were injected with 4 mg/kg LPS (groups CB, Arg, Gln, and AG) or sterile saline (group CA) after oral supplementation. Four hours later, all animals were killed for blood and intestinal mucosa collection. Real-time PCR was used to detect mRNA abundance of β -catenin, proliferating cell nuclear antigen (PCNA), vascular endothelial growth factor (VEGF), and hepatocyte growth factor (HGF) in intestinal mucosa. Data were analyzed as a one-way ANOVA. The results showed that plasma amino acids in the AG group tended to be similar with the control group. The combination of Arg and Gln supplementation mitigated morphology impairment (lower villus height, $P < 0.05$) in jejunum induced by LPS. Overall, LPS administration resulted in a significant increase in VEGF and HGF mRNA abundance in jejunum ($P < 0.05$). The combination of Arg and Gln increased PCNA mRNA abundance in both jejunum and ileum ($P < 0.05$), while they also increased β -catenin and decreased VEGF in ileum ($P < 0.05$). There were no differences in mRNA expression of these genes between the Arg and Gln groups ($P > 0.05$). Arg only increased PCNA mRNA abundance in jejunum and Gln decreased VEGF mRNA in jejunum ($P < 0.05$). These results suggest combined oral supply of Arg and Gln has more favorable effects on proliferation and differentiation of stimulated intestinal epithelium cells in LPS-induced rats compared with Arg or Gln alone.

Key Words: arginine, glutamine, intestinal epithelium cells

T175 Effects of different levels of dihydromyricetin from *Ampelopsis grossedentata* in feed on growth performance, immune and antioxidative activities in *Sarotherodon* sp. X. Shu¹, I. C. Cai^{1,2}, and Y. L. Yin^{*1}, ¹*Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha, Hunan, China*, ²*Institute of Biological Resources, Jiangxi Academy of Science, Jiangxi, Nanchang, China*.

The experiment was conducted to study effects of adding dihydromyricetin (DMY), natural herb extract from *Ampelopsis grossedentata* in feed on growth performance, immune and antioxidative activities in fish. In this experiment, a total of 720 *Sarotherodon* sp. with average

body weight of 13.57 g was randomly allocated to 24 glass tanks and assigned to 6 treatments: 5 levels of DMY (0.1%, 0.2%, 0.4%, 0.8% and 1.6%) and one control (basal diet). Feed was offered to the fish twice daily during the 8-week trial. Feed intake (FI) and survival rate were recorded daily, and live weight gain (WG), average daily gain (ADG) and feed efficiency were calculated. At 4 and 8 wk of age, 5 fish from each group were randomly selected to collect blood into sterile centrifuge tubes for further analysis. Data was analyzed as a complete randomized design by the one-way ANOVA using SPSS, and Duncan multiple range test was used to compare treatment means. The results suggested that treatment with 0.1%, 0.2%, 0.4% and 0.8% DMY were

not different ($P > 0.05$) from the control, but 1.6% DMY enhanced ($P < 0.05$) body weight gain and decreased ($P < 0.05$) feed conversion. The serum content of total protein increased ($P < 0.05$) and the activities of serum lysozyme (LSZ), superoxide dismutase (SOD) and catalase (CAT) were improved ($P < 0.05$) in all treatments containing DMY. Fish survival rate was also improved with DMY addition compared with the control treatment, with survival being highest for the 0.4% DMY treatment. In conclusion, dietary supplementation of 0.1% to 1.6% DMY can improve *Sarotherodon* sp. performance, survival, and serum indices.

Key Words: fish, nutrition, growth