
**NONRUMINANT NUTRITION:
THE IMPACT OF FEED ADDITIVES
ON THE HEALTH AND PERFORMANCE
OF SWINE AND POULTRY**

1314 (T177) Evaluating the toxicity of metabolites derived from the trichothecene biotransformation using Biomin BBSH 797 in vitro. S. Schaumberger^{*1}, and U. Hofstetter², ¹*BIOMIN Holding GmbH, Herzogenburg, Austria*, ²*Biomin Holding GmbH, Herzogenburg, Austria*.

Biomin BBSH 797, a *Gen. nov. sp. nov.* of the family *Coriobacteriaceae* isolated from bovine rumen fluid, is able to specifically detoxify trichothecenes in the intestinal tract of animals. The live strain is able to produce enzymes that reduce the epoxide group of these mycotoxins, which results in the formation of non-toxic metabolites. The objective of this trial was to prove that the metabolite de-epoxy-deoxynivalenol (DOM-1), formed during the degradation of deoxynivalenol (DON), has lower toxicity. The lymphocyte proliferation assay (LPA) was used to show the effects of DON and DOM-1 on the clonal proliferation on isolated chicken lymphocytes. Lymphocytes were cultured with DON (10–0.08 µg/mL) and DOM-1 (232–1.18 µg/mL). As a control, the mitogen Concanavaline A (ConA) was used. The number of proliferated cells was quantified with a colorimetric immunoassay after in vitro stimulation. 5-Bromo-2'-deoxyuridine (BrdU) was added and incorporated into the DNA of proliferating cells. Incorporated BrdU was measured with an ELISA-method. The absorbance values directly correlated with the amount of DNA synthesis and hence the number of proliferating cells. Results show that at a concentration of 15 µg DON/mL the proliferation of lymphocytes was lower in comparison to ConA. After adding 0.3 µg DON/mL to the cells only one-third of them could proliferate whereas at a concentration of 0.63 µg DON/mL the growth of the lymphocytes stopped. In comparison, the metabolite DOM-1 only stopped the proliferation of cells at a concentration of 113 µg DOM-1/mL. The results show that the metabolite DOM-1 is almost 500 times less toxic than DON.

Key Words: Biomin BBSH 797, trichothecene, biotransformation

1315 (T178) Effects of dietary supplementation of β-mannanase on ileal digestibility of fiber and viscosity of jejunal digesta in nursery pigs fed corn and soybean meal-based diets. I. Park^{*1}, T. J. Pasquetti^{1,2}, and S. W. Kim¹, ¹*North Carolina State University, Raleigh*, ²*Bolsista do, CNPq, Brazil*.

This study is to determine the effects of β-mannanase (CTCZYME, CTCBIO Inc., Seoul, South Korea) on ileal di-

gestibility of nutrients and viscosity of jejunal digesta in nursery pigs fed corn and soybean meal-based diets. Forty-eight barrows at 6 wk of age (initial BW: 15.7 ± 1.1 kg) were assigned to four dietary treatments with different levels of β-mannanase (0, 200, 400, and 600 Unit/kg feed). Experimental diets contained 56.4% corn, 30.0% soybean meal, 10.0% DDGS, and 3.7% others. Pigs were housed individually in metabolism crates and received experimental diets at a fixed amount based on BW of pigs (daily feed allowance = 0.09 × BW^{0.75} kg) for 11 d. Chromium oxide (0.3%) in experimental diets as an indigestible marker was provided from d 8 to 11. Actual feed intake, any feed refusals, and BW were measured on d 7 and 12 to monitor growth. On d 12 after 8 h of last meal, pigs were euthanized to collect digesta from jejunum and ileum. Digesta from jejunum were used to measure viscosity with a viscometer (DV+, Brookfield Engineering Laboratories, Inc., MA). Digesta from ileum were used to measure apparent ileal digestibility of energy, NDF, and ADF. Tissues from jejunum were fixed for morphological evaluation. The data were analyzed using PROC MIXED of SAS based on randomized complete block design. Morphology of jejunum was not affected by dietary supplementation of β-mannanase. Viscosity of digesta in jejunum tended to decrease linearly ($P = 0.076$, 5.2 to 3.8 mPa·s) with increasing supplementation of β-mannanase. Dietary β-mannanase also tended to increase ($P = 0.093$, 53.4 to 64.7%) apparent ileal digestibility of energy in a quadratic manner at the highest digestibility at 600 Unit of β-mannanase per kg feed. There was no change in ileal digestibility of NDF and ADF by supplemental β-mannanase indicating that the increase in energy digestibility is not due to the release of monosaccharides from mannans by β-mannanase. Collectively, dietary supplementation of β-mannanase enhanced energy utilization in nursery pigs by reducing viscosity of digesta potentially enhancing digestibility of nutrients.

Key Words: ADF, β-mannanase, energy utilization, NDF, pigs, viscosity

1316 (T179) Effects of dietary supplementation of selenium-enriched probiotics on productive performance and intestinal microflora of weanling piglets raised under high ambient temperature. C. Lv¹, T. Wang^{*2}, S. F. Liao², and K. Huang¹, ¹*Nanjing Agricultural University, Nanjing, Jiangsu, China*, ²*Mississippi State University, Starkville*.

Probiotics have been suggested as one of the most desirable alternatives to feed antibiotics for swine. The objective of this study is to evaluate the efficacy of a selenium-enriched probiotics (SeP) preparation on productive performance and intestinal microflora of piglets raised under high ambient temperature. Forty-eight crossbred weanling piglets (28 d old) randomly allotted into 12 pens (four piglets/pen) and four dietary treatments (three pens/treatment) were fed ad libitum for 42 d a basal diet (control; Con), or the basal diet supplemented with

probiotics (Pro), sodium selenite (ISe), or the SeP preparation. The basal diet contained 0.16 mg/kg-diet of total intrinsic Se, and the ISe and SeP preparations elevated the total Se level to 0.46 mg/kg-diet. The Pro and SeP preparations contained equivalent amounts of *Lactobacillus acidophilus* and *Saccharomyces cerevisiae* (approximately 10^{11} and 10^9 CFU/mL, respectively). Blood and fecal samples were collected on d 0, 14, 28, and 42 post-initiation of the feeding trial. The SeP group had higher final BW ($P < 0.05$), greater ADG ($P < 0.05$), lower FCR ($P < 0.01$), and lower diarrhea incidence ($P < 0.01$) than the Pro, ISe or Con group. Blood Se concentration and GSH-Px activity were both higher ($P < 0.01$) in the SeP group than in the Pro, ISe or Con group. On d 28 and 42, the serum concentrations of T3 were higher ($P < 0.01$) and T4 lower ($P < 0.01$) in the SeP group than in the ISe, Pro or Con group. On d 28, the serum T3 in the ISe group was higher ($P < 0.01$) than in the Pro or Con group, and on d 28 and 42 the serum T4 were lower ($P < 0.01$) in the ISeP group than in the Pro or Con group. Also on d 28 and 42, the fecal counts of *Lactobacillus* bacteria was higher ($P < 0.01$) while *Escherichia coli* lower ($P < 0.01$) in the SeP or Pro group than in the ISe or Con group. The results of RFLP showed that the fecal microbial flora in the SeP group changed the most (numerically) as compared to the Pro or ISe group. In conclusion, the overall results of this study indicate that this SeP preparation may serve as a better alternative to antibiotics than pure probiotics for using as a growth promoter for piglets.

Key Words: probiotics, selenium, pig, productive performance, fecal microflora, glutathione peroxidase, thyroid hormone

1317 (T180) Growth performance and carcass characteristics of pigs fed high-fiber diets supplemented with *Bacillus* spp. expressing multi-enzyme activities.

A. Owusu-Asiedu¹, R. Lizardo², J. Brufau², and A. Awati¹, ¹DuPont Industrial Biosciences- Danisco Animal Nutrition, Marlborough, Wiltshire, United Kingdom, ²IRTA-Mas de Bover, Constantí, Tarragona, Spain.

Increasing the amount of cereal byproducts such as corn distillers-dried grain with solubles; CDDGS, and wheat bran; WB in swine diets decreases pig performance and negatively affects carcass characteristics. The current study evaluated the potential of specifically selected *Bacillus* spp. direct fed microbial product with multi-enzyme activities (BDFM) to counteract the negative effect in pigs fed diets containing 20% CDDGS and 20% WB. Ninety-six Pietrain X (Landrace X Duroc) pigs (initial BW 31.60 ± 1.30 kg) were used in a 14-wk study. Pigs were blocked by BW and sex and randomly assigned to two dietary treatments with three pigs/pen and 16 replicate pens/treatment. The basal diets were formulated to meet the nutritional requirements of the pigs and contained corn and SBM and cereal byproducts. The NE and digestible

Lys in the basal starter, grower and finisher phases diets were; 9.77, 9.85, and 9.71 MJ/kg, and 1.01, 0.93, and 0.85%, respectively, and AA were adjusted on ideal protein basis. The *Bacillus* product containing 3×10^8 CFU/g was added at 0 (Control) or 500 g/MT of feed in the test diet (BDFM). Pigs were allowed to consume the assigned experimental diet for the entire study period, and ADG, ADFI and G:F determined. Backfat and loin depth were measured at slaughter using a Fat-O-Meater device and carcass lean meat percentage determined. Data were analyzed using the Proc PROC MIXED in SAS. Overall, ADFI (1910 vs. 1887; SEM = 27.34) and ADWG (762 vs. 779 g/d; SEM = 11.20) were not affected ($P > 0.05$) by BDFM supplementation. However, compared with Control, pigs fed the BDFM supplemented diet had improved ($P < 0.05$) overall G:F ratio (0.400 vs. 0.413; SEM = 0.004). Carcass weight and killing-out percentage tended to improve ($P < 0.10$), whereas backfat depth was reduced (16.8 vs. 15.1 mm; $P = 0.01$) and lean meat percentage improved (58.9 to 61.5%; $P = 0.01$) with BDFM supplementation compared with control. In conclusion, dietary inclusion of specifically selected *Bacillus* spp. expressing multi-enzyme activities improved feed efficiency and carcass characteristics in pigs fed high fiber-based diets.

Key Words: *Bacillus* spp., dietary fiber, pigs

Table 1317.

	Control	BDFM	SEM	P-value
Growth Performance (d0 to 97)				
Overall ADG, g/d	761.8	778.6	11.10	0.29
Overall ADFI, g/d	1910.0	1887.2	27.34	0.56
Gain:Feed	0.400	0.413	0.004	0.04
Carcass Characteristics				
Carcass weight, kg	78.8	79.5	0.272	0.08
Kill out percent, %	74.2	74.9	0.255	0.09
Backfat depth, mm	16.8	15.1	0.462	0.01
Lean meat, %	59.8	61.5	0.453	0.01

1318 (T181) Effects of star anise (*Illicium verum*) on growing performance and antioxidant status of sows and nursing piglets.

G. Y. Wang¹, C. Yang², Y. X. Guo¹, Z. Yang³, and Y. Wang⁴, ¹College of Animal Science, Shandong Agricultural University, Tai-an, China, ²College of Life Science, Shandong Agricultural University, Taian, China, ³College of Animal Science, Shandong Agricultural University, Taian, China, ⁴Agriculture and Agri-Food Canada, Lethbridge, AB.

To investigate the effects of star anise (*Illicium verum*) that was processed to particle sizes of 300 μ m on performance and antioxidant status of sows and nursing piglets. Thirty sows (Landrace \times Large White) at 85 d of gestation were randomly allocated into 5 treatments with 6 replicates in a complete randomized design. Pregnant sows were fed corn-soybean meal

based diets and supplemented with 0, 2.5, 5.0, 7.5 and 10.0 g/kg diet of star anise (SA) powder, respectively. After farrowing, all sows were fed a lactation diet without star anise until weaning and litter size was standardized to 10 piglets by cross-fostering within 24 h postfarrowing. ADFI, body weight loss of lactating sows, body weight and eliminating ratio of piglets of each replicate were measured weekly. Blood samples from 6 sows and 12 piglets per treatment were obtained at weaning to determine the serum antioxidant enzymatic activities. All treatments had similar body weight loss of sows, birth weight, body weight at d 7 and mortality rates of piglets. However, pregnant sows supplemented with 5 g/kg SA had higher ($P < 0.05$) average daily gain and body weight of piglets at d 14 and d 21 as compared with that of control. With pregnant sows supplemented SA at the level of 2.5 to 10 g/kg, lactating sows had higher ($P < 0.05$) activities of superoxide dismutase (SOD) than the control. In lactation period, concentration of malondialdehyde (MDA) was lower ($P < 0.05$) with dietary supplementation star anise from late pregnancy to the end of breastfeeding at the level of 5.0 g/kg. The activities of glutathione peroxidase (GSHPx) and total antioxidant capacity (T-SOD) in serum of lactating sows were increased by the addition SA at levels of 5.0 and 7.5 g/kg. As compared with that of control, all additions of star anise had lower ($P < 0.05$) MDA, however, piglets had higher ($P < 0.05$) activities of SOD, T-SOD and GSHPx in serum with pregnant sows supplemented SA at the level of 2.5 to 10 g/kg. Dietary supplementation star anise from late pregnancy to the end of breastfeeding improved growing of piglets and serum antioxidant status of lactating sows and weaning piglets. The optimum supplementation rate of SA in the pregnant sow's diet appeared to be between 2.5 and 5 g/kg diet.

Key Words: star anise, sow, piglets, growing performance, antioxidant status

1319 (T182) The effects of Calibrin-Z or a Calibrin-Z-based blended product on post-weaning performance of nursery pigs.

S. L. Johnston^{*1}, F. Chi¹, S. Ching¹, R. Cravens¹, and O. Adeola²,
¹Amlan International, Chicago, IL, ²Purdue University, West Lafayette, IN.

One hundred ninety-two pigs (BW = 5.8 kg, 21 d old) were used in an experiment to evaluate the effects of two clay-mineral products on the post weaning performance of nursery pigs. The two products were a clay-mineral product, Calibrin-Z (Z), and a Calibrin-Z-based blended with a fermentable fiber and an organic acid (CBZ). There were four treatments: 1) Control (C); 2) C+Z at 0.2%; 3) C+CBZ at 0.1%; and 4) C+CBZ at 0.3%. The experiment was conducted as a randomized complete block design with weight and sex as blocking factors. There were four pens of gilts and four pens of barrows per treatment, with six pigs per pen. Pigs had ad libitum access to feed and water. The trial lasted 35 d, diets were corn and soy-

bean meal-based complex nursery diets, all ingredients were commercially available so mycotoxins concentration would be those commonly found in commercial diets. There were decreasing amounts of whey, plasma, soy protein concentrate, fish-meal and lactose as the trial progressed. No differences ($P > 0.1$) in ADG were seen during the experiment with values for ADG for d 0 to 35 of 302 g for the C fed pigs vs. an average of 324.4 g for the pigs fed the two products. There was a significant improvement ($P < 0.05$) in the G:F ratio from diet supplementation from the two products from d 21 to 28, but there was no difference ($P > 0.1$) between products indicating that either product would increase feed efficiency. Furthermore, there was a linear ($P < 0.05$) improvement in G:F from d 21 to 28 when pigs were fed increasing concentrations of CBZ. During the last 2 wk, there was a tendency ($P < 0.10$) for improved G:F with diet supplementation from the two products, again with no difference ($P > 0.1$) between products, and a tendency ($P < 0.10$) for linear improvement in G:F with addition of CBZ. For the overall period there was a tendency ($P < 0.10$) for linear improvement in G:F from increasing concentration of CBZ and an improvement in G:F ($P < 0.05$) from dietary supplementation from Z or CBZ, with overall G:F ratios of 653 g/kg for the C pigs vs. an average of 680 g/kg for the pigs fed the C or CBZ, with no difference ($P > 0.1$) between the two products. Thus, supplementing the diet of nursery pigs with Calibrin-Z based products improved feed efficiency.

Key Words: feed efficiency, nursery, pigs

1320 (T183) Nutrient digestibility of rice bran, with or without exogen enzymes, for weaned piglets.

J. C. Dadalt*, G. D. V. Polycarpo, C. Gallardo, P. D. A. P. Ribeiro, B. Alves, and M. A. D. T. Neto,
University of São Paulo, Pirassununga, Brazil.

The objective of the current study was to evaluate the digestibility of dry matter (DM), crude protein (CP), mineral matter, apparent digestible (DE) and metabolizable (ME) energy, and nitrogen retention of rice bran (RB), with or without exogen enzymes inclusion, in weaned piglets. Twenty-five crossbred barrows with initial weight 6.86 kg \pm 1.3 kg, were allotted in a completely randomized design under five treatments and five replicates. The experimental unit was represented by one pig within its respective metabolic cage. The experimental period was 10 d, 5 d of adaptation and 5d of total feces and urine collection. The treatments were: Control diet (CD); CD + 30% rice bran (CD + RB); CD + 30% RB + 200 mg/kg of carbohydrase (CD+RB+Carb); CD + 30% RB + 50 mg/kg of phytase (CD+RB+Phy); CD + 30% RB+ Carb + Phy (CD+RB+Carb+Phy). The control diet was based on corn (61.33%), skim milk powder (10%) and dried whey (15%). The enzymes used were: commercial phytase with an activity of 10,000 FTU/g; carbohydrase providing 10% of Galactomananase, 10% of Xylanase, 10% of β -glucanase, 60% of malted barley and 10% of α -galactosidase. Isolated or combined with carbohydrase,

phytase did not influence ($P > 0.05$) the digestibility of rice bran nutrients. These results would be associated with adverse factors such as animal and nutritional profile of feedstuff. The DE– 3062 kcal/kg and ME– 3029 kcal/kg were similar to Brazilian tables for poultry and pigs (2011). The apparent digestibility coefficients of DM, CP, mineral matter and nitrogen retention were 65.47%; 72.58%; 36.59% and 62.21%, respectively. These results were similar some found in the literature using growing and finishing pigs, however, there are different results. The current study suggests that the used enzymes are not effective to improve nutritional value of gross energy, DM, CP and MM of rice bran for young pigs after weaning.

Key Words: carbohydase, metabolism, phytase

Table 1320. Digestibility coefficients of rice bran for weaned piglets

Variables	Ingredients				P-values	SEM
	RB	RB+ Carb	RB+ Phy	RB+ Carb+ Phy		
DM %	65.47	68.76	68.38	67.38	05730	0.866
CP %	72.58	76.13	75.45	75.26	08424	1.401
N retention %	62.21	63.69	64.12	65.40	09206	1.525
MM %	36.59	42.20	44.28	45.56	07090	2.774
DE (kcal/kg)	3062	3201	3123	3093	06105	40.677
ME (kcal/kg)	3029	3165	3089	3058	06255	40.915
ME:GE %	66.85	69.87	68.17	67.50	06271	0.813

1321 (T184) The improvements in growth, bone mineral status and nutrient digestibility in pigs following the addition of phytase is accompanied by modifications in ileal nutrient transporters.

S. Vigers^{*1}, T. Sweeney², D. N. Doyle¹, C. J. O’Shea¹, and J. V. O’Doherty¹, ¹*School of Agriculture and Food Science, University of College Dublin, Ireland,* ²*College of Agriculture, Food Science and Veterinary Medicine, University College Dublin, Belfield, Ireland.*

Phytase improves growth performance, nutrient digestibility and bone structure in pigs. However, little is known about its effect on ileal nutrient transporter gene expression. Before the start of the experiment all pigs were allowed an adaption period of 14 d and were fed a standard weaning diet. Forty-eight weaner pigs (11.75kg, sem 0.75) were randomly assigned to one of three experimental diets for a period of 44 d to measure growth performance. Following this six animals per treatment were randomly selected and slaughtered to measure the coefficient of apparent ileal nutrient digestibility (CAID), coefficient of apparent total tract nutrient digestibility (CATTD) and ileal nutrient transporter gene expression. The experimental treatments were as follows, 1) a high phosphorus (HP) diet containing 5.9 g/kg total P (tP), 3.2 g/kg available P (aP) and 6.8 g/kg calcium (Ca), 2) a low phosphorus (LP) diet containing 4.5 g/kg (tP), 1.8 g/kg aP and 5.2 g/kg Ca and 3) a phytase (PHY) diet containing the LP diet + 1000 FTU/kg of phytase. The addition of PHY increased ADG (700 g/day vs. 610 g/day sem

0.02; $P < 0.05$), final BW (43kg vs. 37kg sem 1.02; $P < 0.01$) and decreased FCR (1.74 vs. 2.05 sem 0.09; $P < 0.05$) compared with the LP diet. Pigs offered the PHY diet had higher CAID of gross energy (748 g/kg vs. 699 g/kg vs. 700 g/kg, sem 7.0; $P < 0.001$) compared to the HP and LP diets, respectively. Pigs offered the PHY diet had a higher CAID of nitrogen (716 g/kg vs. 669 g/kg sem 14.3; $P < 0.05$) compared to the HP diet. The addition of PHY improved the CATTD of Ca (766 g/kg vs. 487 g/kg vs. 451 g/kg sem 42.96; $P < 0.001$) and P (558 g/kg vs. 220 g/kg vs. 389 g/kg sem 43.12; $P < 0.001$) compared to both LP and HP, respectively. The PHY diet had increased gene expression of PEPT1 (1.40 vs. 0.47 sem 0.29, $P < 0.05$) and a tendency towards increased gene expression of FABP2 (1.67 vs. 0.73 sem 0.37 $P < 0.10$) compared to the LP diet. The LP diet had lower gene expression of SGLT1 (1.32 vs. 0.51 sem 0.31) and GLUT2 (0.26 vs. 1.26 sem 0.29) ($P < 0.05$) compared to the HP diet. In summary, offering a diet supplemented with PHY improves growth performance and ileal and nutrient digestibility. PHY addition increases the gene expression of the peptide transporter PEPT1 and tended to increase the fatty acid transporter FABP2.

Key Words: phytase, nutrient transporter gene expression, pigs

1322 (T185) Effects of bromelain supplementation on growth performance, nutrient digestibility, blood profiles, fecal microbial shedding, fecal score, and fecal noxious gas emission in weanling pigs.

M. M. Hossain*, H. L. Li, and I. H. Kim, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 140 weanling pigs [(Yorkshire × Landrace) × Duroc] with an average BW of 6.75 ± 1.48 kg were used in a 6-wk trial. Pigs were randomly allotted to one of four experimental treatments according to their initial BW (7 pens per treatment with 5 pigs per pen). Dietary treatments were: CON, basal diet; T1, CON + 0.05% bromelain; T2, CON + 0.10% bromelain; T3, CON + 0.20% bromelain. The experiment was divided into two phases (d 1 to 14 and d 15 to 42). All diets, in mash form, were formulated to meet or exceed the nutrient requirements (NRC, 2012) for weanling pigs. Feed intake and BW were monitored at the end of each phase. T3 treatment had greater (342 vs. 305 g; 409 vs. 387 g; $P < 0.05$) ADG and ADFI than CON treatment in phase 1. In phase 2, the ADG was improved (from T1 to T3: 612, 616, 637 vs. 583 g; $P < 0.05$) in all bromelain treatments compared with CON treatment, ADFI and G:F ratio of T3 treatment was higher (833 vs. 803 g; 0.765 vs. 0.726; $P < 0.05$) compared with CON treatment. Overall, T3 treatment showed greater (539 vs. 490 g; 691 vs. 664 g; $P < 0.05$) ADG and ADFI than CON. Moreover, pigs fed bromelain diets increased (0.769, 0.770, 0.780 vs. 0.738; $P < 0.05$) G:F ratio compared with those fed CON diet. Pigs fed bromelain diets increased (2 wk: 79.06,

79.96, 79.42 vs. 77.98%; 78.51, 78.86, 78.43 vs. 75.69%; 6 wk: 74.49, 74.67, 75.02 vs. 72.70%; 69.43, 70.78, 71.32 vs. 73.39%; $P < 0.05$) the ATTD of dry matter and nitrogen compared with those fed CON diet at wk 2 and wk 6. On d 42, the blood creatinine in CON group was higher (1.30 vs. 1.04, 0.97, 0.88 mg/dL; $P < 0.05$) compared with those in bromelain treatments. The concentration of fecal *E. coli* counts were decreased (6.22 vs. 6.41 log₁₀cfu/g; $P < 0.05$) in T2 treatment compared with CON treatment. The fecal NH₃ emission in T2 and T3 treatments decreased (17.72, 17.33 vs. 22.95 ppm; $P < 0.05$) compared with CON. In conclusion, dietary supplementation with 0.2% bromelain has been shown to improve the growth performance, ATTD of DM and N, and decreased *E. coli* and excreta NH₃ emission in weaning pigs.

Key Words: bromelain, growth, performance, fecal microbial, weanling pigs

1323 (T186) Effect of nutrifen supplementation with different levels of metabolic energy on growth performance, nutrient digestibility, meat quality, blood profile, excreta microflora, and excreta gas emission of broiler chickens. H. Shin,

A. Hosseindoust, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 816 ROSS 308 both male, female 1-d old, body weight 45.2 ± 0.7 g broiler chicken were used in this 4-wk trial to evaluate the effect of nutrifen supplemented to broiler chicken diets containing different levels of metabolizable energy. Experimental diets consisted of two different levels; high energy diet (HE) and low energy diet (LE, 100kcal lower than HE diet, ME in HE diet: phase 1, 2950 kcal/kg; phase 2, 3100 kcal/kg) and the experimental treatments were: 1) LCON (low energy diet); 2) LNF (LCON + nutrifen 0.09%); 3) HCON (high energy diet); and 4) HNF (HCON + nutrifen 0.09%). There were 12 replications and 17 chickens per replication in each treatment. Results showed that HNF treatment enhanced body weight gain (431 vs. 398 g; 1523 vs. 1470 g; $P < 0.05$) compared with LCON treatment at d 14 and 28. There was no effect ($P > 0.05$) on carcass and meat quality among treatments. However, yellowness in high energy level diets was increased (HCON and HNF vs. LCON and LNF: 8.53, 8.55 vs. 7.95, 7.69; $P = 0.036$) compared with that in low energy level diets. Digestibility of dry matter in nutrifen treatments was higher (LNF and HNF vs. LCON and HCON: 77.43, 77.70 vs. 74.95, 75.47%; $P = 0.025$) than that in CON treatments. As to nitrogen digestibility, HNF treatment was higher (67.87 vs. 64.90%; $P < 0.05$) compared with that in LCON treatment. Total cholesterol in LNF treatment was decreased (106.8 vs. 117.8, 118.9mg/dL; $P < 0.05$) than that in LCON and HCON treatments. Also, total cholesterol of chickens fed with nutrifen diets was decreased (LNF and HNF vs. LCON and HCON: 106.8, 114.1 vs. 117.8, 118.9 mg/dL; $P < 0.05$) compared with those fed with CON diets. Ammonia gas emission in LNF

treatment was decreased (34.8 vs. 42.9, 40.3 ppm; $P < 0.05$) than that in HCON and HNF treatments. Moreover, low energy level treatments were decreased (LCON and LNF vs. HCON and HNF: 38.8, 34.8 vs. 42.9, 40.3 ppm; $P = 0.003$) excreta ammonia gas emission compared with high energy level treatments. No interaction effect was observed in this trial. These results showed that adding nutrifen at a level of 0.09% in diet can improve the growth performance, nutrient digestibility, blood cholesterol contents of broiler chickens.

Key Words: broiler chickens, energy level, growth performance, nutrifen

1324 (T187) Effect of fermented organic rare earth (ORE) on growth performance, nutrient digestibility, blood profiles, meat quality, relative organ weight, excreta microflora, and noxious gas emission in broiler chickens. Y. Liu, S. D. Upadhaya, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

This study was to evaluate the effect of fermented organic rare earth (ORE) in broiler chickens. A total of 765 ROSS 308 1-d-old broilers, BW of 48.97 ± 0.11 g, were used in this 4-wk feeding trial, 1 to 14 d for starter and 15 to 28 d for finisher. Dietary treatments included 1) NC (Basal diet, free antibiotics diet), 2) ORE1 (NC + fermented ORE 0.05%), 3) ORE2 (NC + fermented ORE 0.10%), 4) ORE3 (NC + fermented ORE 0.15%), and 5) PC (Antibiotics diet, NC + tiamulin 0.1%). All birds were allotted into one of five treatments with nine replications (17 birds per replication) in a completely randomized design. At the starter stage, feed intake (FI) was increased (1.250 vs. 1.284; $P < 0.05$) in ORE2 compared with NC. At the finisher stage, BW gain (BWG) tended to increase (NC, ORE1, ORE2, ORE3: 953, 973, 976, 992 g; linear, $P = 0.061$) as the level of fermented ORE increased in the diets. The FCR in PC was improved (1.699 vs. 1.764, $P < 0.05$) compared with the NC. At the end of the trial, DM (78.31 vs. 75.52%; $P < 0.05$; linear, $P = 0.050$) and GE (79.96 vs. 76.61%; $P < 0.05$; linear, $P = 0.010$) in treatment ORE3 increased compared with NC, and they also increased as the level of fermented ORE increased in the diets. The DM digestibility in PC was higher (78.49 vs. 75.52%; $P < 0.05$) than that in NC. The pH value of breast muscle in ORE2 increased (5.58 vs. 5.41; $P < 0.05$) compared with PC. Yellowness (NC, ORE1, ORE2, ORE3: 15.51, 15.34, 16.14, 17.17; linear, $P = 0.003$) increased with the increasing amount of fermented ORE in the diets. And the lower value of drip loss was observed in broiler chickens fed the diet with 0.15% fermented ORE (3.14 vs. 4.32%; $P < 0.05$) than PC treatment. There was a tendency to increase the weight of liver (NC, ORE1, ORE2, ORE3: 2.95, 2.86, 3.23, 3.23; $P < 0.01$) as the amount of fermented ORE increased in the diet. However, there was no influence on the relative organ weight, excreta microflora, and noxious gas emission. In conclusion, the results from this study demonstrate that feeding

0.10 or 0.15% fermented ORE improved growth performance, nutrient digestibility, and meat quality in broiler chickens.

Key Words: broiler chicken, excreta microflora, fermented organic rare earth, growth performance, meat quality, nutrient digestibility

1325 (T188) Apparent total tract digestibility and ileal digestibility of dry matter, nitrogen, energy and amino acids in conventional, *Bacillus subtilis* fermented and enzyme treated soybean meal fed to weanling pigs. H. Yun, E. Balolong Jr., and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

This experiment was conducted to determine the apparent total tract digestibility (ATTD), apparent ileal digestibility (AID) and standardized ileal digestibility (SID) dry matter, nitrogen, energy and amino acids of six soybean products. The products were soybean meal (SBM), fermented soybean meal A (FSMA), fermented soybean meal B (FSMB), fermented soybean meal C (FSMC), enzyme treated soybean meal (ETSM) and speciality soya protein (HP300). There are six treatments: SBM, FSMA, FSMB, FSMC, HP300 and N-free dietary treatments. In the experiment, six [(Landrace × Yorkshire) × Duroc] weanling barrows with average BW 8.99 ± 0.40 kg were surgically equipped with simple T-cannulas approximately 15 cm before the ileo-cecal junction and allowed to a 6-wk feeding trial. Results of the experiment showed that FSMC and HP300 had the greatest (90.03, 89.35%; $P < 0.05$) ATTD for most AA, but the ATTD for Arg, Ile, Lys, Met and Phe in FSMB similar to FSMC. Piglet fed FSMC and HP300 had higher (89.02, 88.86 vs. 85.84%; 88.19, 87.69 vs. 84.42%; $P < 0.05$) DM and energy digestibility compared to SBM. AID of DM, N and energy and total AA in FSMB, FSMC and HP300 were higher (82.40, 82.71, 82.59 vs. 78.45%; 82.54, 83.24, 82.95 vs. 79.33%; 81.26, 82.27, 81.68 vs. 76.77%; 80.90, 81.45, 80.78 vs. 77.83%; $P < 0.05$) than SBM in which the value was highest in the FSMC diet. The AID of Isoleucine was greater in pigs fed FSMB and HP300 than in FSMA. The AID of Arg, Leu, Phe and Val in FSMC was greatest of all the other soybean meals. The AID of Lys (74.73%) and total AA (77.90%) in FSMA was the least ($P < 0.05$) among the entire soybean products, but the AID for most other AA in FSMA was not different from the value of AID of AA in SBM. The SID of His (82.28%), Lys (78.65%) and total AA (82.34%) in FSMA was the least ($P < 0.05$) among all the protein sources but SID for most other AA in FSMA was not different from the SID of AA in SBM. In conclusion, dietary supplementation of FSMC and/or HP300 can improve the ATTD, AID and SID of DM, N, energy, total AA and most of the essential amino acids in weanling pigs.

Key Words: amino acids, apparent ileal digestibility, apparent total tract digestibility, fermented soybean meal, hamlet protein, weanling pigs

1326 (T189) Effect of bromelain supplementation on growth performance, nutrient digestibility, blood profiles, fecal score, fecal microflora and noxious gas emission in sows and piglets. M. Jung, Y. Lei, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

This study was conducted to investigate the effect of dietary bromelain on growth performance, nutrient digestibility, blood profiles, and fecal microflora of sows and piglets. Twenty sows (Landrace × Yorkshire) were randomly assigned to three dietary treatments. Dietary treatments included: 1) CON (basal diet), 2) T1 (basal diet + 0.05% Bromelain), 3) T2 (basal diet + 0.10% Bromelain), 4) T3 (basal diet + 0.20% Bromelain). Individual piglet BW was assessed on d 0, 7, 14, and 21 (weaning), and 7 d after weaning to calculate ADG. Fecal *Lactobacillus* and *E. coli* shedding were measured by using MacConkey agar plates and lactobacilli medium III agar plates. No difference ($P > 0.05$) was observed on body weight loss, parity, litter number, weanling pig number, backfat, estrus interval and ADFI in sows. The birth weight of litter from CON treatment was lower (1.343 vs. 1.510, 1.491 kg; $P < 0.05$) compared with T2 and T3 treatments and the piglets of T3 group also had higher (6.953 vs. 6.073 kg; $P < 0.05$) weanling weight compared with CON group. Moreover, T3 treatment had a higher (212 vs. 182 g; $P < 0.05$) ADG than CON treatment. However, there is no difference ($P > 0.05$) in piglet survival rate and stillbirth rate among treatments. After weaning of piglets, the ATTD of N in sows fed with T3 diet was higher (68.95 vs. 63.96, 64.55%; $P < 0.05$) compared with sows fed with CON and T1 diets. The ATTD of E and DM showed no difference ($P > 0.05$) among treatments. The blood BUN of sows in T3 group was lower (12.0 vs. 15.7 mg/dL; $P < 0.05$) compared with CON group. Moreover, the BUN of piglets in T3 group was lower (12.6 vs. 15.9 mg/dL; $P < 0.05$) compared with T1 group. There was no difference ($P > 0.05$) in WBC, RBC, lymphocyte, IgG and creatinine observed among treatments in sows and piglets. The fecal *Lactobacillus* of sows fed with T2 and T3 diets were higher (7.39, 7.40 vs. 7.28 log₁₀ cfu/g; $P < 0.05$) compared with sows fed with CON diet. Moreover, the fecal *E. coli* concentration of sows fed with T2 and T3 diets were lower (6.26, 6.28 vs. 6.57 log₁₀ cfu/g; $P < 0.05$) compared with sows fed with CON diet. In conclusion, the addition of 0.2% Bromelain in the diet can improve weaning BW in piglets and increase nutrient digestibility of sows during lactating period.

Key Words: Bromelain, performance, piglet, sow

1327 (T190) Effect of Calsporin on growth performance, nutrients digestibility, organ weight, meat quality and excreta and intestinal microflora and slurry noxious gas emission in broiler chickens. H. Beak, H. L. Li, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

This study was conducted to determine the effect of dietary Calsporin supplementation on growth performance, nutrient digestibility, relative organ weight, meat quality, intestinal microbial flora, and slurry noxious gas emissions in broilers. A total of 816 1-d-old male ROSS 308 broilers (BW of 46.06 g \pm 0.67 g; 16 pens/treatment and 17 broilers/pen) were used in a 5-wk study. Broilers were randomly allotted to 1 of 3 dietary treatments and Calsporin BBS, which contains 1×10^9 CFU/g *Bacillus subtilis* C-3102.: T1) CON, basal diet, T2) CON + 300 ppm Calsporin (3×10^5 CFU/g), and T3) CON + 600 ppm Calsporin (6×10^5 CFU/g). The T3 enhanced BW gain (BWG) (700 vs. 658 g; $P < 0.05$) compared with the CON treatment during the d 8 to 21. During d 22 to 35, T3 showed greater BWG (843 vs. 801 g; Linear, $P < 0.05$) and better feed conversion ratio (FCR) (1.665 vs. 1.792; Linear, $P < 0.05$) than those in CON. The FCR (1.686 vs. 1.792; Linear, $P < 0.05$) in T2 was linearly improved compared with CON. In the overall period, the BWG (1630, 1662 vs. 1573 g; $P < 0.05$) and the FCR (1.544, 1.534 vs. 1.624; $P < 0.05$) in T2 and T3 were higher than the control. The apparent total tract digestibility (ATTD) of dry matter (DM) (73.43 vs. 76.54, 77.20%; $P < 0.05$) and energy was linearly increased (75.34 vs. 78.83, 79.87%; $P < 0.05$) by Calsporin inclusion in the diet. Slurry NH₃ emissions were linearly reduced (9.9 vs. 8.2, 7.8 ppm; $P < 0.05$) by dietary supplementation of Calsporin. The *Lactobacillus* counts in cecum and ileal were linearly (6.25, 6.59, 7.16 log₁₀cfu/g; $P < 0.05$) increased by Calsporin inclusion in the diet. Dietary supplementation of Calsporin linearly reduced *E. coli* counts in cecum (6.12, 5.74, 5.43 log₁₀cfu/g; $P < 0.05$) *Cl. Perfringens* counts in large intestine (3.14, 2.97, 2.86 log₁₀cfu/g; $P < 0.05$) and excreta (3.31, 3.17, 3.03 log₁₀cfu/g; $P < 0.05$), and *Salmonella* counts in cecum (2.66, 2.23, 2.13 log₁₀cfu/g; $P < 0.05$), ileal (2.87, 2.58, 2.42 log₁₀cfu/g; $P < 0.05$), large intestine (3.04, 2.59, 2.44 log₁₀cfu/g; $P < 0.05$) and excreta (2.88, 2.76, 2.61 log₁₀cfu/g; $P < 0.05$). In conclusion, results indicate that Calsporin inclusion can improve BWG and FCR, increase cecum *Lactobacillus* counts and reduce intestinal *E. coli*, *Cl. Perfringens* and *Salmonella* counts, especially at 6×10^5 CFU/g.

Key Words: growth performance, probiotics, fecal microbial, broilers

1328 (T191) Evaluation of Korean aged garlic extract (AGE) by *Leukonostoc citreum* SK2556 on production achievement, meat quality, relative organ weight, targeted *Escherichia coli* colony, slurry gas emission and hematological profiles in broilers. J. W. Park, S. D. Upadhaya, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

The aim of this study was to investigate the effects of dietary supplementation of Korean aged garlic extract (AGE) fermented by *Leukonostoc citreum* SK2556 on growth performance, meat quality, excreta microbiota, slurry gas emission and blood profiles in broilers. A total of 765 broilers were randomly allotted to 5 treatments with 9 replications per treatment and 17 chicks per pen in this 5-wk trial. The experiment lasted for 5 wk and dietary treatments were as follows: 1) NC (basal diet, no antibiotics); 2) PC (NC + 5ppm enramycin); 3) AGE1 (NC + 0.05% aged garlic extract); 4) AGE2 (NC + 0.1% aged garlic extract); 5) AGE3 (NC + 0.2% aged garlic extract). The broilers were weighed and feed intake were recorded on d 1, 14, 28, and 35 for calculating BW gain (BWG), feed intake (FI), and feed conversion ratio (FCR). All data were subjected to GLM procedures of SAS (1996) as a randomized complete block design, with pen as the experimental unit. Differences among treatments were separated by Duncan's multiple range test; $P < 0.05$ was considered statistically significant. Broiler fed with AGE2 treatment showed significantly higher ($P < 0.05$) disparity in BWG compared to NC treatment (910 g vs. 842 g) at the d 15 to d 28. In the same time, FCR was higher ($P = 0.0454$) in NC (1.95) treatment compared with AGE3 (1.83) and AGE2 (1.81). Growth performance was increased in AGE3 (1756 g) and AGE2 (1735 g) than NC (1638 g) diet ($P < 0.05$) though FCR value was decreased ($P = 0.012$). Liver weight was decreased in AGE3 (28.27%) and AGE2 (28.27%) compared to NC (40.60%) treatment ($P = 0.0478$). On analyzing of different profiles of breast meat, only redness (a*) was improved in NC treatment than AGE2 (15.94 vs. 12.23; $P < 0.05$). With regards to *E. coli* load (log₁₀cfu/g), broiler fed NC (6.70) showed distinctly higher count than AGE2 (6.54; $P < 0.05$). The percentage of lymphocyte in blood presented higher in numeric value in AGE1 treatment which was followed by PC, AGE2, NC and AGE3 respectively ($P > 0.05$). In conclusion, our findings demonstrated that the administration of AGE at a level of 0.1 and/or 0.2% can improve body weight gain but reduce the FCR, liver weight as percentage, and *E. coli* load without significant change in other criteria in broiler.

Key Words: aged garlic extract, broilers, *Leukonostoc citreum* SK2556, enramycin, growth performance, microflora

1329 (T192) The effect of vitality mineral liquid complex on production performance, nutrient digestibility, blood characteristics, egg quality and excreta microflora in laying hens. M. Mohammadi Gheisar, J. P. Lee, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 360 Hy-line brown laying hens (40-wk-old), were used in this 5-wk experiment to evaluate the effect of vitality mineral liquid complex on production performance, nutrient digestibility, blood characteristics, egg quality, and excreta microflora in laying hens. Laying hens were randomly allocated into 5 dietary treatment groups which consisted of: 1) CON (normal water), 2) I2 (pH 2.2, Ion water), 3) P2 (pH 2.2, polymerization water), 4) I3 (pH 3.0, Ion water), and 5) P3 (pH 3.0, polymerization water). In this study, feed intake and egg broken rate was unaffected ($P > 0.10$), but egg production was increased in I3 and P3, respectively, when compared to CON treatment (96.63, 96.45 vs. 94.55; $P < 0.05$) at wk 3, egg production in P3 was higher (96.85 vs. 94.74; $P < 0.05$) than CON treatment at wk 5. Nutrient digestibility of the Ca in P2, I3, and P3 treatment, respectively, was higher (56.50, 57.58, 55.27 vs. 51.15%; $P < 0.05$) than CON treatment. The blood profile of calcium counts was increased (26.05, 27.23, 27.70 vs. 22.45; $P < 0.05$) in P2, I3, and P3 treatments compared with CON treatment and phosphorus counts was improved (5.28 vs. 4.58; $P < 0.05$) in I3 treatments compared with CON treatment. Moreover, effect of vitality mineral liquid complex improved the eggshell thickness (40.44 vs. 39.72 mm²; 40.59 vs. 39.68 mm²; $P < 0.05$) with P3 treatment at 4 and 5 wk of trial. The inclusion of I3 and P3 diets showed a lower (2.24, 2.19 vs. 2.40 log₁₀cfu/g; 6.24, 6.20 vs. 6.50 log₁₀cfu/g; $P < 0.05$) amount of excreta *Salmonella* and *E.coli* counts compared with CON diets. Our results indicated the vitality mineral liquid complex improve the egg production, calcium, phosphorus counts in blood, and decrease the *Salmonella* and *E.coli* counts in laying hens.

Key Words: Egg production, egg quality, laying hens, mineral, nutrient digestibility

1330 (T193) Effects of nutrifen on growth performance, nutrient digestibility, blood profiles, fecal microflora, fecal gas emission, and fecal score in weanling pigs. D. Jung*, H. L. Li, and I. H. Kim, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 135 weanling pigs (7.96 ± 1.03kg; 28 d of age) were used in a 42-d feeding trial to evaluate the effect of nutrifen on growth performance, apparent total tract digestibility (ATTD), blood profiles, fecal microflora, fecal gas emission and fecal score. Pigs were randomly distributed into 1 of 3 treatments on the basis of BW (9 replicate pens per treatment with 5 pigs per pen). Dietary treatments were: CON, basal diet; NF1, basal

diet + 0.1% nutrifen; NF2, basal diet + 0.2% nutrifen. The diets were fed during the experiment in 2 phases: d 0 to 14, and 15 to 42. All diets, in mash form, were formulated to meet or exceed the nutrient requirements (NRC, 2012) for weanling pigs. Feed intake, BW and incidences of diarrhea were monitored at d 14 and 42. Incidences of diarrhea were monitored using a fecal scoring system. At the end of each phase two pigs per pen were bled for serum and fresh fecal samples were collected to determine nutrient digestibility and noxious gas emission. Average daily gain (ADG) was greater (337, 338 vs. 316 g; $P < 0.05$) in nutrifen supplemented pigs during d 0 to 14. During d 14 to 42, ADG and Gain:Feed ratio (G:F) was higher in NF2 treatment compared with that of CON. ADG and G:F was greater (500, 509 vs. 481 g, $P < 0.05$; 0.699, 0.714 vs. 0.676, $P < 0.05$) in nutrifen supplemented pigs during d 0 to 42. Energy digestibility was higher (82.56, 83.13 vs. 79.05%; $P < 0.05$) in nutrifen supplemented pigs compared to CON at d 42. At d 42, pigs fed with NF2 diet had lower (4.83 vs. 6.45 10⁶/μl; $P < 0.05$) blood RBC concentration compared with those fed CON. IgG concentration was greater (525, 532 vs. 499 mg/dL; $P < 0.05$) in nutrifen treatments compared with that of CON. HDL-cholesterol concentration in NF2 treatment higher (40 vs. 33, 34 mg/dL; $P < 0.05$) compared with that in other treatments. The fecal *Lactobacillus* and *E. coli* counts, and fecal score showed no difference ($P > 0.05$) among treatments. The ammonia emission concentration in NF2 treatment decreased (9.7 vs. 13.6 ppm; $P < 0.05$) compared with that in CON treatment. In conclusion, nutrifen could increase growth performance, energy digestibility, IgG and HDL-cholesterol, decrease fecal gas emission without impact on fecal microflora and fecal score in weanling pigs.

Key Words: blood profiles, growth performance, nutrient digestibility, nutrifen, weanling pigs

1331 (T194) Effect of rare earth element-yeast on egg production, nutrient digestibility, egg quality, blood profiles, excreta gas emission, and excreta microbiota in laying hens. J. H. Cho*, L. Cai, and I. H. Kim, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

Rare earth elements (REE) are considered as an alternative to antibiotic because they have the similar action to antibiotic. Rare earth elements-yeast, an improved form of organic REE, may be more effective when fed to livestock because of the lower REE concentration. The objective of this study was to determine the effects of REE-yeast on egg production, nutrient digestibility, egg quality, blood profiles, excreta gas emission, and excreta microbiota in laying hens. A total of 216 ISA brown laying hens at 52 wk of age were used in this 5-wk feeding trial. Treatments consisted of soybean meal based diets supplemented with 0, 0.05, and 0.1% REE-yeast. All birds were allotted to one of three treatments with six replicates (12 hens per replication). All diets were formulated according to

recommendations of the manual of the breeder for ISA brown and to meet NRC (1994). During wk 1 and 2, laying hens fed 0.05% and 0.1% REE-yeast had a higher egg production (90.33, 92.67 vs. 87.00%; 90.33, 92.50 vs. 86.67%; $P < 0.01$) than those fed diets without REE-yeast and egg production improved (linear, $P < 0.01$) as dietary REE-yeast increased in the diet. During wk 3, 4, and 5, laying hens fed 0.1% REE-yeast had a higher egg production (92.50 vs. 86.83%; 92.33 vs. 86.33%; 92.17 vs. 85.67%; $P < 0.05$) than those fed without REE-yeast. Nitrogen digestibility (65.22, 66.31, 69.22%; linear, $P = 0.03$) increased with increasing REE-yeast levels in the diet, and the greatest value was observed in laying hens fed 0.1% REE yeast. In wk 4, laying hens fed REE-yeast had higher yolk height (9.25, 9.58, 9.72 mm; linear, $P < 0.01$) and Haugh unit (92.79, 96.63, 97.11; linear, $P = 0.01$) increased with increasing REE-yeast in diets. In wk 5, Haugh unit (94.53, 97.17, 95.60; $P < 0.05$) increased quadratically with increasing REE-yeast levels in the diet. At the end of experiment, ammonia tended to decrease linearly (15.25, 13.25, 12.75 ppm; $P < 0.1$) with increasing REE-yeast in the diet. However, effects were not observed in blood profiles and excreta microbiota. In conclusion, dietary supplementation with REE-yeast improved egg production, nutrient digestibility, and egg quality in laying hens.

Key Words: egg production, egg quality, laying hen, nutrient digestibility, rare earth elements-yeast

1332 (T195) Effects of *Bacillus subtilis* on growth performance, relative organ weight, meat quality, salmonella population, and blood profiles in broilers. J. H. Cho*, M. Begum, and I. H. Kim, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 720 male and female ROSS308 broiler chicken (1 d old, initial BW 46.12 ± 0.51 g) were used in this 4-wk trial (5 treatments with 9 replications/treatment and 16 chicks/pen). Dietary treatments were: 1) CON (basal diet), 2) A (CON + 0.1% *Bacillus subtilis* B2A 1.0×10^9 cfu), 3) B (CON + 0.1% *Bacillus subtilis* B2A 1.0×10^7 cfu), 4) C (CON + 0.1% *Bacillus subtilis* B2A 1.0×10^8 cfu), and 5) D (CON + 0.1% *Bacillus subtilis* B2A 1.0×10^9 cfu). The broilers were weighed and feed intake were recorded on d 1, 8, 18, and 28 for calculating body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR). All data were subjected to GLM procedures of SAS (1996), with pen as the experimental unit. Differences among treatments were separated by Duncan's multiple range tests; $P < 0.05$ was considered statistically significant. During 1 to 8 d, BWG was higher (163 vs. 149 g; $P < 0.05$) in treatments D compared with treatment A. During 19 to 28 d, FI (1359 vs. 1242 g) and FCR were higher (1.776 vs. 1.613; $P < 0.05$) in CON compared with treatment D. Overall (1 to 28 d), birds from CON treatment had higher ($P < 0.05$) FI (2286 vs. 2126 g) and FCR (1.658 vs. 1.538) than D treatment. The

drip loss of birds from treatment A was lower (3.14 vs. 6.18%; $P < 0.05$) than that of treatment C on d 1. No difference ($P > 0.05$) was observed in relative organ weight and blood profiles among treatments. However, the salmonella populations in chicken fed with CON diet was higher (3.88 vs. 2.73, 2.83, 2.64, 2.75 \log_{10} cfu/g; $P < 0.05$) compared with those fed with other four diets in large intestine. Moreover, the salmonella populations in CON treatment was higher (2.67 vs. 2.18 \log_{10} cfu/g; $P < 0.05$) than that in treatment B in small intestine. In conclusion, *Bacillus subtilis* B2A partially improved FCR, while decreasing salmonella populations in big or small intestine without any adverse effect on relative organ weight and blood profiles in broilers.

Key Words: *Bacillus subtilis*, blood profiles, broilers, growth performance, meat quality, salmonella populations

1333 (T196) The effect of *Salicornia herbacea* and *Dendropanax morbifera* on the growth performance, meat quality, fecal microbial population and fecal noxious gas emission in broilers. J. P. Lee, M. M. Hossain, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

This experiment was conducted to examine the effect of *Salicornia herbacea* and *Dendropanax morbifera* as a phyto-genic additive on performance, carcass traits, fecal microbial population and fecal noxious gas emission of broiler chicks. In this study, 680 1-d-old chicks (Ross 308) were allocated to five treatments with eight replicates (17 birds/replication) based on a completely randomized design. Diet was same for all treatments, but two different liquid phyto-genic additives used as these treatments: CON, basal diet; SAL1, 1cc/l *S. herbacea*; SAL2, 5cc/l *S. herbacea*; SAL3, 10cc/l *S. herbacea*; DPM, 5cc/l *D. morbifera*. All broilers were fed maize-soybean meal-based diets that were formulated to meet or exceed the National Research Council (1994) nutrient recommendations. The broilers were weighed and feed intake were recorded on d 1, 7, 21, and 35 for calculating BW gain (BWG), feed intake (FI), and feed conversion ratio (FCR). At d 35, two birds were randomly selected from each replication (16 broilers/treatment) and slaughtered by cervical dislocation for meat quality. During d 8 to 21, broilers fed with SAL2, SAL3 and DPM diets increased (968.3, 987.5, 994.2 vs. 963.4 g; $P < 0.05$) BWG with those used CON treatment. During d 22 to 35, broilers fed with SAL1, SAL2 and SAL3 diets increased (729.0, 728.2, 729.3 vs. 684.4 g; $P < 0.05$) BWG compared with those used CON treatment. Overall, birds in CON treatment had the lowest BWG and highest feed conversion ratio at d 35, compared with SAL1, SAL2, SAL3 and DPM treatments (1820.4 vs. 1887.3, 1885.1, 1892.1, 1873.8 g; 1.468 vs. 1.388, 1.394, 1.383, 1.406; $P < 0.05$). The application of *S. Herbacea* and *D. Morbifera* had no significant effect on the

organ weights of chicken liver, breast muscle, gizzard, kidneys, or spleen, and was similar among all treatments. The relative weight of abdominal fat, however, was reduced (22.09, 21.30 vs. 29.55%; $P < 0.05$) in the treatments which were supplemented with *S. Herbacea* (SAL2 and SAL3) compared with that of the control. The result of excreta microbial analysis and fecal noxious gas emission did not show any significant effects. In conclusion, the result of this study showed that addition of *S. herbacea*, *D. morbifera* have a positive influence on growth performance and they can be considered as a growth promoter substitution for broiler chicks.

Key Words: broilers, *Salicornia herbacea*, *Dendropanax morbifera*, growth performance, meat quality

1334 (T197) The effect of salmonella inhibitors supplementation on egg production, egg quality, blood profiles, and excreta salmonella in laying hens.

J. H. Cho*, H. Shin, and I. H. Kim, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

This study was conducted to investigate the effect of salmonella inhibitors supplementation on egg production, egg quality, blood profiles and excreta salmonella in laying hens. A total of 288 ISA-brown laying hens (40-wk-old) were selected for a 5-wk feeding trial. Hens were randomly allocated into 6 treatments with 4 replications per treatment, and 12 hens per replication, according to a completely randomized design. The experimental treatments included: 1) NC (basal diet), 2) PC (basal diet + 0.1% virginiamycin, antibiotics), 3) A (NC + 0.1% *Bacillus subtilis* 1.0×10^{10} cfu/kg), 4) B (NC + 0.1% *Bacillus subtilis* RX71.0 $\times 10^{10}$ cfu/kg) and 5) C (NC + 0.1% *Bacillus subtilis* B2A 1.0×10^{10} cfu/kg), 6) D (NC+0.1% *Bacillus subtilis* RX7 1.0×10^9 cfu/kg). Daily records of egg production and feed consumption were kept throughout the experimental period. Egg production was expressed as an average production of hen per day, which was calculated from the total number of eggs divided by the number of experimental time (week as a unit) and summarized on an average basis. All data were arranged to evaluate by analysis of variance following the GLM procedure in a completely randomized design using the SAS software program (SAS Institute, 1996). Laying hens were blocked with identical age. The difference among treatment was compared using the Duncan's multiple range tests. The treatment effect was observed significant with the probability value below 0.05. Egg production was higher (96 vs. 90, 91%; $P < 0.05$) in treatment B than in NC and PC treatments at 3 wk. Eggshell thickness was higher (40.87 vs. 40.24, 40.32 mm^2 ; $P < 0.05$) in treatment D than in NC and PC treatments at 1 wk. B and D treatments had higher (41.17, 41.17 vs. 40.48, 40.51, 40.64, 40.53 mm^2 ; $P < 0.05$) eggshell thickness than those in other treatments at 3 wk. But no differences ($P > 0.05$) on eggshell color, egg weight, yolk height, yolk color, haugh unit and eggshell strength were observed

during the whole experiment. There was no difference ($P > 0.05$) in WBC, RBC, lymphocyte and haptoglobin among dietary treatments. Excreta salmonella was higher (2.59 vs. 2.23, 2.28, 2.28, 2.28, 2.29 \log_{10} cfu/g; $P < 0.05$) in NC treatment compared with those other treatments. In conclusion, dietary salmonella inhibitors have no effects on eggshell color, egg weight, yolk height, yolk color, haugh unit and eggshell strength and blood profiles in laying hens. However, *Bacillus subtilis* supplementation improved egg production, eggshell thickness and excreta salmonella in laying hens.

Key Words: egg production, eggshell thickness, excreta salmonella, laying hens, salmonella inhibitors

1335 (T198) Feed additives affects RNA expression in the brush border membrane in broilers.

M. F. Fernandez Alarcon^{*1}, J. P. Steibel^{2,3}, L. S. Antonio⁴, R. Lunedo¹, G. Baldissera¹, R. L. Furlan¹, and L. R. Furlan⁵, ¹Dep. of Animal Morphology and Physiology, Sao Paulo State University, Jaboticabal, SP, Brazil, ²Michigan State University, East Lansing, ³Dep. of Fisheries and Wildlife, Michigan State University, East Lansing, ⁴Dep. of Biological Sciences–Biochemistry, University of São Paulo, Bauru, Brazil, ⁵Aquaculture Center, Sao Paulo State University, Jaboticabal, Brazil.

Probiotics and essential oils have been investigated as replacements for antibiotic growth promoters (AGP) by improving the performance and gut health of chickens. However, studies reported contrasting responses from these additives in intestinal digestion and absorption. We investigated the effects of addition of *Bacillus subtilis* (probiotic), an essential oil blend (carvacrol, cinnamaldehyde, cineol and pepper extract) and their combination in the performance and expression of genes related to digestion and absorption in Coob broilers, by RT-qPCR. Basal diet was used as negative control and the avilamycin AGP as positive control. One thousand, three hundred twenty male broiler chicks from Coob strain were divided among five treatments, in six pens of 44 chicks each. Birds were raised following breeder's recommendations. Performance was assessed in terms of feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) recorded at 7, 21, and 42 d of age. At these same ages, one bird per pen ($N = 6$), was slaughtered to collect the mucosa of the ileum for RT-qPCR analysis. The investigated genes were: aminopeptidase N (APN), sucrase isomaltase (SI), maltase-glucoamylase (MGA), intestinal transporter peptide-1 (PEPT1), transporter of glucose and galactose Na^+ dependent-1 (SGLT-1), glucose transporter, galactose and fructose independent Na^+ -2 (GLUT-2) and ATP ase Na^+/K^+ (ATP1A-1). Except for an increased feed intake presented in birds fed probiotics in relation to fed AGP at 21 d, no differences were found in broiler performance during the experiment. Regarding gene expression, at 7 d, birds treated with AGP presented lower ($P < 0.05$) expres-

sion of ATP1A-1 mRNA than the negative control. At 21 d, birds fed with the combination of probiotics and essential oil showed lower mRNA concentration of MGAM than those fed with AGP. In addition, no difference was observed in gut gene expression at 42 d. The lack of difference in growth performance between treatments could be due to the environment in which the birds were raised, more hygienic than that normally found in poultry farms. Moreover the changes in ATP1A-1 and MGAM RNA expression observed herein highlight the role of feed additives in host gut enzymes and transporter gene expression. These results encourage analysis of brush border enzymes activity, jejunum morphometry and indirect absorption trials of glucose in the jejunum, which are underway.

Key Words: broiler, feed additives, gene expression, intestine, RT-qPCR

1336 (T199) Apparent digestibility of wheat bran nutrients with or without exogen enzymes addition in weaned piglets. J. C. Dadalt*, P. D. A. P. Ribeiro, G. D. V. Polycarpo, C. Gallardo, G. D. Ricci and M. A. D. T. Neto, *University of São Paulo, Pirassununga, Brazil.*

Non-ruminant animals have a limited capacity for food digestion with low digestibility as those with high fiber or phytic acid contents. Some researches indicated that enzyme additions may decrease the effects of antinutritional factors present in vegetable feedstuffs, improving its digestion and nutrient utilization. Using weaned piglets, this study evaluated the apparent digestibility of dry matter (DM), crude protein (CP), mineral matter, energy (DE) and, metabolizable energy (ME) and N retention of the wheat bran (WB) supplied or not with exogen enzymes. Twenty-five crossbred barrows with initial weight $9.35 \text{ kg} \pm 1.61 \text{ kg}$, were allotted in a completely randomized design under five treatments and five replicates. The experimental unit was represented by one pig within its respective metabolic cage. The experimental period was 10 d, in which 5 d for cage adaptation and 5 d for feces and urine collection. The treatments were: Control diet (CD); CD + 30% wheat bran (WB); CD + 30% WB + 200 mg/kg of carbohydrase (WB+Carb); CD + 30% WB + 50 mg/kg of phytase (WB+Phy); CD + 30% WB+ Carb + Phy (WB+Carb+Phy). The control diet was based on corn (61.33%), skim milk powder (10%) and dried whey (15%). The enzymes were commercial phytase (10,000 FTU/g), carbohydrase providing 10% of Galactomananase, 10% of Xylanase, 10% of β -glucanase, 60% of malted barley and 10% of α -galactosidase. Data were analyzed by ANOVA and LS Means using the GLM procedure (SAS Inst. Inc., Cary, NC). Significance was defined as $P < 0.05$. Carbohydrase and phytase combination improved the digestibility coefficients ($P < 0.05$) in most of the variables, excepting nitrogen retention which did not show statistical difference among treatments. Wheat bran without enzyme addition had lower values for DE and ME (2862 and

2804 kcal/kg), respectively. The higher values observed for DE and ME were: WB+Carb+Phy (3164 and 3082 kcal/kg) without statistical difference with WB+Carb (3098 and 3056 kcal/kg) ($P = 0.4785$ and $P = 0.9766$) and WB+Phy (3051 and 2996 kcal/kg) ($P = 0.0970$ and $P = 0.5421$) (values expressed on dry matter). Lower digestibility of CP was observed for WB and WB+Phy (72.52 and 73.98%) respectively, which statistical results were similar to WB+Carb diet (75.69%) ($P = 0.9324$). The enzymes showed an effective improvement on digestibility of wheat bran for young pigs after weaning.

Key Words: carbohydrase, metabolism, phytase

1337 (T200) Evaluating the effects of *Salicornia* extract on performance, egg quality and blood profile of laying hens. I. H. Kim*, H. L. Li, and M. M. Hossain, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

An experiment was conducted to evaluate the effects of adding *Salicornia* extract to the drinking water of laying hens on their performance, egg quality, and blood profile. A total of 216 Hy-line Brown at the age of 40 wk were used in a 10-wk experiment. The birds were allotted into 3 experimental treatments and there were 24 replications per treatment with three birds per pen. Treatments consisted of CON (basal diet), T1 (1 cc *Salicornia* extract water per liter drinking water), and T2 (5 cc *Salicornia* extract water per liter drinking water). Daily records of egg production and feed consumption were kept throughout the experimental period. Egg production was expressed as an average production of hen per d, which was calculated from the total number of eggs divided by the number of experimental time (wk as a unit) and summarized on an average basis. A total of 42 salable eggs (no shell defects or cracks) were randomly collected biweekly from each treatment at 1700 h (three eggs per replication). The egg quality of the collected eggs was then determined at 2000 h on the day of collection. Laying hens were blocked with identical age. The difference among treatment was compared using the Duncan's multiple range test. The treatment effect was observed significant with the P value < 0.05 . Addition of *Salicornia* extract to the drinking water of laying hens didn't show any negative effects on performance, egg quality, and blood profile. Treatments T1 and T2 increased egg production remarkably (86.3 vs. 89.0, 91.0%; $P < 0.05$) at the first wk compared with CON. Moreover, at last week, the egg production in T1 was significantly higher (91.3 vs. 86.0%; $P < 0.05$) than CON treatment. Birds in T2 treatment showed improved (111.2 vs. 110.6 g; $P < 0.05$) feed intake compared with CON at first week. The ratio of broken shell was decreased (7.6 vs. 11.3%; 8.3 vs. 12.1%; 7.8 vs. 10.6%; 9.2 vs. 11.1%; 8.6 vs. 13.6%; $P < 0.05$) in T2 treatment than that in CON treatment in 1, 4, 6, 8, and 10 wk. The results of this study showed that addition of *Salicornia* extract can improve the egg shell quality, thereby

decreasing the rate of breaking eggs and increasing the benefit of production in commercial farms.

Key Words: blood profile, breaking eggs rate, egg production, laying hens, *Salicornia*

1338 (T201) Effect of material bioconversion natural complex on the growth performance, nutrient digestibility, fecal microbiota, fecal score, fecal moisture and pH in weanling pigs. M. Jung, Y. Lei, and I. H. Kim*, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 150 pigs [(Yorkshire × Landrace) × Duroc], BW of 6.57 ± 0.49 kg, were used in a 6-wk trial to investigate the effects of material bioconversion natural complex (STR) on growth performance, nutrient digestibility, fecal microflora, fecal score, fecal moisture, and pH in weanling pigs. STR is a propolis feed additive contained more than 60% propolis and 6% of total flavonoid in powder form and produced from fermentation of mulberry leaves and turmeric with bacterial of mulberry yellow mushroom. Pigs were randomly allocated into 1 of 5 dietary treatments on the basis of BW and sex [6 replicate pens per treatment with 5 pigs (2 gilts and 3 barrows) per pen]. Dietary treatments were: 1) NC (basal diet, free of antibiotics), 2) PC (NC + 3 ppm Tiamulin), 3) STR-1 (NC + 0.1% STR1), 4) STR-2 (NC + 0.1% STR2), 5) STR-3 (NC + 0.1% STR3). STR1, STR2, and STR3 contain 1.5, 3, and 6% of active complex powder, respectively. Apparent nutrient digestibility was measured following the procedures by the AOAC (2000). Throughout the experimental period, pigs fed with STR-2 and STR-3 diets had higher (487, 492 vs. 474 g; $P < 0.05$) ADG compared with pigs fed with NC diet and the G/F ratio of STR-3 treatment was higher (0.720 vs. 0.692; $P < 0.05$) than that of NC treatment. The apparent total tract digestibility (ATTD) of dry matter was higher (1 wk: 83.96 vs. 82.22%; 3 wk: 85.92 vs. 82.47%; 6 wk: 81.05 vs. 77.23%; $P < 0.05$) in STR-3 treatment than in NC treatment. The ATTD of nitrogen was higher (79.98, 78.69, 78.87 vs. 76.54%; $P < 0.05$) in STR-1, STR-2, and STR-3 treatments than in NC treatment at wk 3. The ATTD of energy was higher (83.75 vs. 82.23% and 82.70 vs. 79.23%; $P < 0.05$) in STR-3 treatment than in NC treatment at wk 1 and 6, respectively. The fecal score of pigs fed with STR-3 diet was lower (3.00 vs. 3.18; $P < 0.05$) compared with pigs fed with STR-2 diet during wk 4. Moreover, fecal *Escherichia coli* concentration of pigs fed with STR was lower (5.75, 5.75, 5.76 vs. 5.90 \log_{10} cfu/g; $P < 0.05$) compared with pigs fed with NC diet. In conclusion, inclusion of STR3 (an antibiotic free diet) at a level of 0.1% could increase growth performance, nutrient digestibility, and decrease fecal score and fecal microbiota in weanling pigs.

Key Words: growth performance, fecal score, nutrient digestibility, STR, weanling pig

1339 (T202) Effects of microencapsulated *Enterococcus faecalis* and enzyme supplementation on piglet response to an *Escherichia coli* (K88) challenge.

H. S Chen^{1,2}, D. E Velayudhan^{*1}, A. K Li³, Y. Z Feng², D. Liu², Y. L Yin⁴, and C. M. Nyachoti¹, ¹University of Manitoba, Winnipeg, Canada, ²Institute of Animal Husbandry, Harbin, China, ³Academy of State Administration of Grain, Beijing, China, ⁴Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha, China.

The objective of this study was to determine the effect of dietary probiotic microencapsulated *Enterococcus faecalis* and multi-enzyme complex (MC) in enterotoxigenic *Escherichia coli* K88 (ETEC)-challenged piglets fed wheat-barley soybean based diets. Thirty-six, 21-d-old weanling pigs with an initial BW of 6.7 ± 0.6 kg were allotted in a completely randomized design to 4 dietary treatments; a wheat-barley soybean based negative control (NC) with no antimicrobial growth promoters (Diet A), NC + MC (Diet B), NC + probiotic (Diet C) and NC + MC + probiotic (Diet D). Piglets were housed individually in cages. Diets were formulated to meet or exceed NRC 2012 specifications for weaned pigs. MC supplied 500, 50, 400, 1200, 450, and 45 units of pectinase, cellulase, mannanase, xylanase, glucanase, and galactanase, respectively, per kg of diet. The probiotic was added at the rate of 10 mg (1.0×10^{11} cfu/g) per kilogram of diet. Pigs were acclimated to treatments for a 7-d period. On d 8, pigs were weighed, blood sampled for determining baseline immunological parameters (IL6 and TNF α) and then orally challenged with 6 mL (5×10^{10} cfu/mL) of the freshly grown ETEC K88 inoculum. At 6, 12, 24, 48, and 150 h post-challenge, blood samples were taken, performance measures and fecal consistency scores were recorded, and on d 14 all pigs were killed to obtain intestinal tissue and digesta samples to evaluate GIT morphology, microbial ecology, and immunological parameters. Data were analyzed using the PROC MIXED of SAS. No significant enzyme x probiotic interaction was observed for any of the parameters evaluated. During pre-challenge, pigs receiving enzyme, probiotic and combination of both improved the ADG ($P = 0.03$) by 49, 62, and 51% and G:F ($P = 0.04$) by 25, 32, and 32%, respectively. However, during the post-challenge period only a numerical improvement in G:F was observed for Diet C when compared with Diet A (0.70 vs. 0.59). Also, pigs fed Diet C had greater ($P = 0.05$) ileal villus height than those receiving the NC. Moreover, Diet C significantly reduced the severity of diarrhea ($P = 0.04$) by 12% during the challenge phase compared to pigs fed NC. In summary, the results indicate that dietary supplementation of microencapsulated *Enterococcus faecalis* in weaned pigs challenged with ETEC was effective in maintaining gut health and thereby controlling post-weaning diarrhea.

Key Words: *Escherichia coli*, probiotic, piglets

1340 (T203) Sodium alginate addition improves water stability and utilization of extruded feed for farmed saltwater crocodiles (*C. porosus*).

M. Francis¹, T. J. Wester*¹, P. C. H. Morel¹, and B. H. P. Wilkinson², ¹*Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Palmerston North, New Zealand*, ²*Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand*.

Saltwater crocodile (*C. porosus*) farming in Papua New Guinea is an emerging industry that supplies high quality raw skins for fashion industries worldwide. Extruded animal by-product feed (non-heat treated feed forced through a die at low pressure) is used to get a consistent high quality feed; however, this feed disintegrates quickly in water which leads to loss of nutrients, inefficient feed conversion ratio, and water contamination. We evaluated Na alginate as a binding agent to improve feed stability in water and determined its effect on nutrient availability in a digestibility trial. A 24-h in vitro water solubility test of exudated chicken by-product-based diets (35% minced chicken carcasses, 15% chicken blood, 5% poultry offal meal, 5% pulped eggs, 15% wheat millrun, and 25% supplement, as-fed basis) with and without 1.5% Na alginate and 1.9% CaCO₃ added showed the inclusion of Na alginate improved the dry matter retention in feed by 12.6-times ($P < 0.05$). These diets were then compared in vivo in a digestibility trial. Ten juvenile crocodiles (2.2 to 2.4 yr of age, 1.2 to 1.9 kg BW) were chosen from farm raised stocks and fed exudated chicken by-product-based diets with and without 1.5% sodium alginate and 1.9% CaCO₃ added. Animals were fed 2% BW for 12 d, with feces collected the last 5 d. Animals were then slaughtered and digesta sampled from the ileum. Acid insoluble ash was used as an internal marker. There were no differences in any amino acid, N (65.0 vs. 55.8%, SE = 12.2%), and organic matter (46.8 vs. 39.6%, SE = 12.8%) digestibility at the ileum between diets with and without alginate, respectively. However, fecal digestibility of organic matter (69.8 vs. 39.2% SE = 9.1%) and energy (72.2 vs. 44.4%, SE = 8.3%) were greater in alginate containing diets ($P < 0.05$). This shows that alginate addition does not have deleterious effects on digestion in crocodiles, and because it improves feed stability in water, should greatly enhance nutrient uptake and feed efficiency. Results will be used to formulate diets with increased feed utilisation and decreased feed wastage, with the ultimate goal of increasing economic return to Papua New Guinea while decreasing effluent discharge and pollution of the ecosystem.

Key Words: saltwater crocodile, ileal digestibility, sodium alginate

1341 (T204) Impact of allicin on enzyme activity, cytokine secretion, and gene expression dynamics in oxidative- and endotoxin-stressed porcine intestinal epithelial cells.

N. L. Horn*¹, G. Miller², K. M. Ajuwon¹, and O. Adeola¹, ¹*Dep. of Animal Sciences, Purdue University, West Lafayette, IN*, ²*Biomatrix, Princeton, MN*.

Environmental stress and endotoxins can negatively affect gastrointestinal function by influencing cellular antioxidant systems, tight junctions, and inflammatory mediators. Allicin is a botanical derived from garlic that has anti-inflammatory and antioxidant properties. The objective of the current study was to determine if allicin could mitigate oxidative and endotoxin stress using an IPEC cell model. The experiment was arranged as a 2 × 2 × 2 factorial of allicin (0 or 40 μM), oxidative stressor, hydrogen peroxide (0 or 100 μM), and endotoxin stressor, lipopolysaccharide (0 or 10 μg/ml). Cells were incubated with allicin or lipopolysaccharide (LPS) for 18 h or with hydrogen peroxide for 3 h approximately 1 wk following confluency. Trans-epithelial resistance (TER), reactive oxygen species (ROS), antioxidant enzymes, interleukin 8 and 1 β (IL-8 and IL-1β), and tumor necrosis factor α (TNF-α) secretion were measured. Gene expression was measured by RT-PCR for cytokines IL-8, IL-1β, and TNF-α and tight junction proteins claudin 1 (CL-1), occludin (OC), and zonula occludens 1 (ZO-1). Treatment did not affect TER although addition of allicin to hydrogen peroxide- and LPS-treated cells reduced ($P < 0.05$) ROS. Allicin decreased superoxide dismutase (SOD) activity ($P < 0.001$), whereas hydrogen peroxide increased SOD activity ($P = 0.02$). Furthermore, addition of allicin to hydrogen peroxide-treated cells restored SOD activity similar to untreated cells ($P < 0.05$). Addition of allicin to hydrogen peroxide- and LPS-treated cells decreased catalase activity ($P < 0.05$). There was an increase in TNF-α and IL-8 gene expression due to LPS ($P < 0.001$) although there was no effect of hydrogen peroxide or allicin ($P > 0.05$). Experimental treatment had no effect on tight junction gene expression ($P > 0.05$). There was an increase ($P < 0.001$) in IL-8 secretion due to LPS which was further increased ($P < 0.05$) by addition of allicin to LPS-treated cells and hydrogen peroxide incubation increased ($P = 0.01$) TNF-α secretion. Based on the results from the current study, allicin can ameliorate oxidant effects of hydrogen peroxide and LPS as well as alter cytokine secretion in IPEC cells.

Key Words: allicin, hydrogen peroxide, lipopolysaccharide

1342 (T205) Evaluation of a new probiotic strain of *Bifidobacterium longum* subsp. *infantis* CECT 7210 to improve health status of weaning piglets orally inoculated with *Salmonella typhimurium*.

E. Barba-Vidal^{*1}, L. Castillejos², V. F. Buttow Roll³, M. Rivero⁴, J. A. Moreno Muñoz⁴, and S. Martín-Orúe¹, ¹*Animal Nutrition and Welfare Service Dep. of Animal and Food Sciences Universitat Autònoma de Barcelona, Bellaterra, Spain*, ²*Animal Nutrition and Welfare Service, Dep. of Animal and Food Sciences, Universitat Autònoma de Barcelona, Bellaterra, Spain*, ³*Dep. of Animal Science, Faculty of Agronomy Eliseu Maciel, Federal University of Pelotas, Pelotas, Brazil*, ⁴*Laboratorios Ordesa S. L., Parc Científic de Barcelona, Spain*.

A new probiotic strain of *Bifidobacterium longum* subsp. *infantis* CECT 7210 (Laboratorios Ordesa, S.L.) was evaluated on an oral challenge against *Salmonella typhimurium*. Seventy-two animals (28 d old, 7.7 ± 1.27 kg) were distributed during an experimental period of 16 d in 24 pens and 4 experimental groups in a 2×2 factorial design: with or without probiotic (10^9 CFU/day in 2-mL water suspension) and inoculated with *Salmonella* (5×10^8 CFU) or placebo. Animals were fed ad libitum a multicereal diet with selected protein sources (soybean meal 44, fishmeal and bovine sweet whey), without antibiotics and that met NRC 2012 requirements. The probiotic was administered orally and individually on a daily basis. Feed consumption and body weights were monitored during the whole experimental period. After an adaptation week the animals were challenged. From this moment onward fecal shedding of *Salmonella* [d 0, 1, 3, and 7 post-inoculation (PI)], fecal consistency (d 1, 2, 3, 5, and 7 PI) and rectal temperature (24 and 48 h PI) were assessed. On d 4 and 8 PI, one animal from each pen was euthanized and blood, intestinal content and tissue samples were collected. Blood was obtained to assess the inflammatory response (TNF- α and plasma Pig-Map); intestinal content to assess the presence of *Salmonella* in colon as well as fermentation products (lactic acid and volatile fatty acids) and tissue samples to evaluate microscopic ileal morphology. All parameters responded significantly to infection ($P < 0.05$). The administration of the probiotic tended to increase average daily gain (ADG) of the animals during the postinoculation period (d 0 to 7 PI; 145 vs. 226 g/d, $P = 0.067$) and increased the overall ADG (d 0–16; 90 vs. 150 g/d, $P = 0.042$). Moreover, it significantly reduced febrile response of infected animals at 48h PI (39.48 vs. 39.06°C, Probiotic*Day, $P = 0.003$) and improved fecal consistency (1.62 vs. 1.95, $P = 0.014$). A reduction of *Salmonella* counts at 48 h ($P = 0.028$) and d 4 PI ($P = 0.056$) were also observed. In addition, the probiotic promoted an increase of ileal intraepithelial lymphocytes on d 8 PI (0.86 vs. 1.32, $P = 0.015$) and also a numerical reduction in TNF- α (87.70 vs. 72.11 pg/dL, $P = 0.12$). No significant changes in

fermentation products were registered related to the probiotic ($P > 0.05$). Results demonstrate that oral administration of the probiotic *Bifidobacterium longum* subsp. *infantis* CECT 7210 improves growth, reduce clinical response and improve some immunitary parameters of pigs orally challenged with *Salmonella typhimurium*.

Key Words: probiotic, *Salmonella*, weaning, *Bifidobacterium*

1343 (T206) A standardized blend of capsicum oleoresin, cinnamaldehyde and carvacrol improves performance of lactating sows. C. Oguey¹ and C. Bruneau^{*2}, ¹*Pancosma, Geneva, Switzerland*,

²*Pancosma, St.-Hyacinthe, QC, Canada*.

The main concern in sow farming is to optimize progeny performance during suckling and minimize fertility concerns. In monogastric animals, a standardized blend of capsicum oleoresin, cinnamaldehyde and carvacrol (XT, XTRACT 6930, Pancosma) was shown to positively affect fat digestibility and immune modulation. Therefore, given these modes of action, XT should be beneficial to the performance of lactating sows. As scarce information is available on this matter, a study was designed to evaluate the effect of XT supplementation on performance of sows raised under commercial conditions. A total of 428 sows were randomly allocated from 15 d before farrowing until piglets' weaning to one of the two treatments: CT: basal diet and XT: basal diet supplemented with 100 g/t XT. Animals had ad libitum access to feed and water. Sows' ADFI during gestation and lactation, backfat loss during lactation and weaning to estrus interval were individually recorded. Piglet birth weight, number of piglets born alive, mummies and weaned, and piglets weights at birth and weaning were evaluated per sow. Results were statistically analyzed by ANOVA, using the treatment, the parity and their interaction as fixed effects. Results showed that XT did not affect sow ADFI during gestation and lactation, backfat loss, the numbers of piglets born alive and mummies, and piglets' weight gain during suckling ($P > 0.28$). However, the interaction treatment*parity had a significant impact on lactation ADFI ($P < 0.05$). More specifically, XT increased ADFI during lactation of primiparous sows compared to CT (+4.1%, $P < 0.05$). XT supplementation tended to increase the number of piglets weaned per sow (+0.2 piglets/sow, $P = 0.09$) and to reduce pre-weaning mortality (-15.8%, $P = 0.09$). Finally, XT significantly decreased the weaning to estrus interval by 2.2 d ($P = 0.04$). These results suggest that XT has the potential to improve sow performance during lactation under commercial conditions, through more piglets weaned per litter and improved fertility.

Key Words: phytonutrients, sow performance

1344 (T207) Zilpaterol hydrochloride improves growth performance of meat producer Japanese quails.

H. Dávila-Ramos and J. C. Robles-Estrada*,

Universidad Autonoma de Sinaloa, Culiacan, México.

Zilpaterol hydrochloride (ZH) is a β -adrenergic agonist that was approved in México (2002) and the United States (2006) to promote growth and carcass dressing in beef cattle. However has been tested in other species such as lambs and poultry. The objective of this experiment was determinate the effect of zilpaterol hydrochloride supplementation during 21 d on growth performance of meat producer Japanese quail (*Coturnix coturnix japonica*). Two hundred twenty Japanese quails (both sexes; 90.3 ± 1.19 g) were distributed in 20 birdcages with four treatments (five birdcages per treatment). Treatments consisted in different doses (0, 0.20, 0.25, and 0.30 mg/kg of live weight/d) of zilpaterol hydrochloride supplementation, the basal diet contained 55% ground corn grain and 35% soybean meal (24%CP and 2.9 Mcal/kg of ME). Quails were weighted weekly and adjusted zilpaterol dose. The results were analyzed with completely randomized design and comparing means of treatments with orthogonal contrasts and orthogonal polynomials. Zilpaterol supplementation increased final live weight (5.6%; $P \leq 0.01$), total weight gain (9.7%; $P \leq 0.01$), feed conversion (6.1%; $P \leq 0.01$) and feed intake (2.8%; $P = 0.02$). Similarly, supplementation with 0.30 mg/kg of live weight increases the final live weight, total weight gain and feed conversion ($P \leq 0.01$) when compared with control treatment, however this dose showed no changes in feed intake ($P = 0.24$). No significance difference ($P \geq 0.21$) were showed in all variables when compare minimum and maxim dose (0.20 vs. 0.30 mg/kg of live weight), neither differences were detected for linear ($P \geq 0.25$) and quadratic ($P \geq 0.14$) analysis. These results indicated that zilpaterol supplementation in meat producer Japanese quail improve the growth performance without changes between doses. Levels below 0.20 mg/kg live weight need to be tested to determine the max inclusion rate needed.

Key Words: zilpaterol hydrochloride, *Coturnix coturnix japonica*, growth performance

1345 (T208) Effects of increasing levels of curcumin on growth performance and immune response of nursery pigs.

M. R. Bible*, S. D. Carter, H. Kim, and K. F. Coble, *Oklahoma State University, Stillwater.*

Curcumin (CUR), a curcuminoid in turmeric, has antimicrobial and anti-inflammatory properties that may be beneficial to pigs. Two experiments (Exp.) were conducted to determine the effect of increasing levels of CUR on growth performance and immune response. Pigs were weaned at 21 d, blocked by BW, and allotted randomly to dietary treatments (trts) in a randomized complete block design (RCBD). Each experiment utilized corn-soybean meal based diets with a 4-phase feeding program. Growth performance was calculated for d 0 to 21

and 0 to 42. Exp. 1 (6 reps/trt) used 168 pigs (6.2 kg) with the following trts: carbadox (55 mg/kg; AB), 12, 23, and 46 mg/kg of CUR. Exp. 2 (7 reps/trt) used 112 pigs (6.0 kg) with the following trts: carbadox (55 mg/kg; AB), 46, 93, and 186 mg/kg of CUR. On d 20, selected pigs were challenged with an *E. coli* lipopolysaccharide (LPS). Rectal temperatures (RT) were measured and blood collected for analysis of tumor necrosis factor- α (TNF- α) and C-reactive protein (CRP) at h 0 and 3, 6, 12, and 24 h post-injection (PI). Data were analyzed as a RCBD using a GLM/PROC MIXED. In Exp. 1, there were no differences ($P > 0.10$) in growth performance for d 0–21. Curcumin did not affect ($P > 0.10$) ADG, but decreased ADFI and improved G:F ($P < 0.08$) for d 0–42 compared to the AB. As CUR increased, ADFI decreased and G:F increased ($P < 0.08$; quad). In Exp. 2, ADG ($P = 0.09$; quad) and ADFI decreased ($P = 0.009$; linear) as CUR increased for d 0 to 21. Compared to the AB, CUR decreased ($P = 0.03$) ADFI. For d 0 to 42, CUR decreased ($P < 0.06$; linear) ADG and G:F; and decreased ($P < 0.04$) ADG and G:F compared to AB. For the LPS challenge in Exp. 1, there was a numerical decrease in TNF- α at h 3 PI followed by a decrease ($P = 0.05$; quad) in CRP at h 6 PI as CUR increased. For Exp. 2, increasing CUR decreased ($P < 0.07$; linear) RT at h 0 and 3 PI. As CUR increased, TNF- α tended ($P = 0.09$; linear) to increase at h 6 PI. However, CUR decreased ($P < 0.10$; linear) CRP at h 0, 3, 6, and 24 PI. Compared to the AB, CUR decreased ($P < 0.03$) CRP at h 0, 3, and 6 PI. When data were combined for both experiments, the optimum response in growth performance and immune response was between 46 and 93 mg/kg of CUR.

Key Words: curcumin, growth performance, immune response

1346 (T209) Mannan oligosaccharides and β -glucan in diets for weaned piglets.

U. V. Luna*, J. G. Caramori Junior, G. S. S. Corrêa, S. D. Assis, E. Brusamarello, J. C. R. Ribas, M. A. Souza, A. B. Corrêa, B. S. Vieira, E. Rovaris, and S. A. P. V. Barbosa, *Federal University of Mato Grosso, Cuiabá, Brazil.*

The objective of this study was to evaluate the effect of supplementation with mannan oligosaccharides, β -glucan and antibiotic in diets for castrated male piglets during the nursery phase (21 to 54 d of age) on performance, morpho-histological characteristics of the intestinal mucosa and occurrence of diarrhea. A total of 368 piglets of the same strain, weaned to 21 d of age, with average weight of 6.9 kg were distributed in a completely randomized design with four treatments: 1) control [basal diet without supplementation: 36.05% corn, 18.4% Soybean meal (45%), 2.9% Soybean oil, 2.5% Crystal sugar, 40% de Pig Mix e 0.15% kaolinite); 2) basal diet + 1500 g mannan oligosaccharides/t of diet; 3) basal diet + 500 g β -glucan/t of diet; and 4) basal diet + 250 g colistin/t of diet. These were used with four replications with 23 animals per experimental unit. The man-

nan oligosaccharides and β -glucan were extracted cell wall of yeas *Saccharomyces cerevisiae*. The piglets were weaned to 21 d of age, heavy and distributed in experimental unit. Performance was assessed through weight gain, feed intake and feed conversion. The morpho-histological characteristics of the intestinal mucosa studied were villus height, intestinal crypt depth, villus circumference and villus height: crypt depth of duodenum, jejunum and ileum ratio. The occurrence of diarrhea was observed daily by the evaluation of fecal score. Not there was a difference for weight gain ($P = 0.0750$; averages: 14.000, 13.635, 14.018, 12.605 kg), feed intake ($P = 0.1574$;

averages: 28.053, 28.577, 29.202, 26.920 kg) and feed conversion ($P = 0.2239$; averages: 2.005, 2.098, 2.084, 2.134 kg) the piglets the diets receiving control, mannan oligosaccharides, β -glucan and antibiotic, respectively. Thus, it is concluded, that the use of mannan oligosaccharides, β -glucan and antibiotic in the diet of castrated male piglets in the nursery phase did not affect performance and occurrence of diarrhea. The use β -glucan increases villus height and crypt depth in the duodenum and ileum and the villus circumference the jejunum.

Key Words: additives, diarrhea, intestinal morphology