

Nonruminant Nutrition: Feed Additives

T128 The effects of Paylean® and α -lipoic acid on growth performance and carcass characteristics of finishing pigs. J. R. Bergstrom*, J. L. Nelssen, R. D. Goodband, M. D. Tokach, J. M. DeRouchey, and S. S. Dritz, *Kansas State University, Manhattan.*

A total of 48 gilts (initially 96 kg) were used to evaluate the effects of Paylean® and α -lipoic acid on late finishing pig performance and carcass characteristics. Pigs were blocked by weight and randomly allotted to one of four dietary treatments in a 22-d experiment. There were 2 pigs per pen and 6 pens per treatment. Pigs were fed corn-soybean meal-based diets formulated to 0.95% true ileal digestible lysine. Treatments were arranged as a 2 × 2 factorial with main effects of Paylean® (0 or 10 ppm) and α -lipoic acid (0 or 300 ppm). There were no Paylean® × α -lipoic acid interactions ($P > 0.36$) observed. For the overall study, ADG, final weight, and G:F were increased ($P < 0.04$) for pigs fed Paylean®. Pigs fed Paylean® had increased ($P < 0.04$) hot carcass weight (HCW), yield, loin eye area at the 10th-rib (LEA), and standardized fat-free lean (SFFL). Average backfat thickness (Avg. BF) tended ($P < 0.06$) to decrease for pigs fed Paylean®. Tenth-rib backfat increased ($P < 0.05$) for pigs fed α -lipoic acid. In conclusion, pigs fed 10 ppm Paylean® had improved growth performance and carcass characteristics. Feeding 300 ppm of α -lipoic acid did not affect growth performance, but did tend to increase 10th-rib fat depth.

Table 1. Growth and carcass data

Paylean®, ppm	0		10		SEM	P<	Paylean® α -lipoic acid	P<
	0	300	0	300				
ADG, g/d	932	1011	1127	1098	62	0.04		NS
G:F	0.37	0.37	0.43	0.42	0.02	0.01		NS
Final wt., kg	116.2	117.8	120.5	119.9	1.6	0.04		NS
HCW, kg	81.3	83.3	86.2	87.8	1.3	0.01		NS
Yield, %	70.4	70.8	71.7	72.9	0.6	0.02		NS
Avg. BF depth, mm	22	23	18	21	1	0.06		NS
10 th rib BF, mm	14	19	13	15	1	NS		0.05
LEA, cm ²	48.9	47.0	53.7	53.5	2.3	0.03		NS
SFFL, kg	46.4	45.3	50.4	50.0	0.9	0.01		NS

Key Words: Pigs, Paylean®, α -Lipoic Acid

T129 Effects of tannin added to low-iron antibiotic-free diet on performance, hematology, iron status, fecal microflora and incidence of diarrhea in weaned pigs. S. H. Lee, P. L. Shinde, J. Y. Choi, I. K. Kwon, S. I. Park, and B. J. Chae*, *Kangwon National University, Chuncheon, Kangwon-Do, Republic of Korea.*

This study investigated the effects of tannin added to low Fe antibiotic-free diets on the performance, hematological status, fecal microflora and incidence of diarrhea in weaning pigs. One hundred and eight weaned pigs (Landrace × Yorkshire × Duroc, 6.46 ± 1.04 kg initial body weight) were allotted to 3 treatments each comprising of 4 replicates with 9

pigs in each. The basal diet for each phase (Phase 1: d 0 to 14; Phase 2: d 15 to 28) was formulated to contain minimum Fe and the mineral premix used was prepared without addition of FeSO₄. Dietary treatments were: basal diet (low-Fe antibiotic free diet, T1), basal diet added with tannin (Albumin tannate, 0.025%, T2) and basal diet added with Fe and antibiotic (T3). Two piglets from each pen were bled at 14 and 28 d of experiment to determine their hematological status and plasma Fe concentration while feces were collected on d 14 to enumerate the microbial populations. Pigs fed with T1 diets had lower ($P < 0.05$) ADG (242 vs 264 and 271 g/d) and higher incidence of diarrhea (37.5%) than pigs fed T2 (26.4%) and T3 (36.1%) diets. The population of total anaerobic bacteria was highest in the feces of pigs fed T1 diet and lowest in those fed T2 diet, while the populations of *Bifidobacterium* spp. and *Lactobacillus* spp. was higher in pigs fed T1 diet than pigs fed T2 and T3 diets. The hematological status on d 14 was not affected by dietary treatments but on d 28 pigs fed T2 diets had lower ($P < 0.05$) erythrocyte count, hemoglobin and hematocrit values. The plasma Fe concentration on d 14 was lower ($P < 0.05$) in pigs fed T2 (87 μ g/dl) diet than pigs fed T3 (128 μ g/dl) diet while on d 28 pigs fed T1 and T2 diet had lower ($P < 0.05$) plasma Fe (86 and 70 vs 127 μ g/dl) than pigs fed T3 diet. These results suggest that tannin added to diets low in Fe without antibiotics resulted in performance of pigs comparable to pigs fed high Fe diets with antibiotics but tannin added to diets reduced incidence of diarrhea. However, tannin added to low Fe diets had a negative influence on the hematological and plasma Fe status.

Key Words: Tannin, Weanling Pigs, Fecal Microflora

T130 Effect of *Euchaena mexicana* Schrad diets on nutrient digestibility and nitrogen metabolism for Wulong Goose. B. W. Wang*, M. A. Zhang, X. P. Wu, G. L. Liu, and X. H. Jia, *Qingdao Nongye University, Qingdao, Shandong Province, China.*

One trial was conducted to study nutrition digestibility of *Euchaena mexicana* Schrad (EMC) diets for Wulong Goose. Thirty-two geese of 9 months old were selected and divided into four groups randomly, with eight geese in each group. Four groups were fed with the isocaloric and isonitrogenous diets of different EMC contents (12, 19, 25 and 31%), respectively. The results showed that, as dietary EMC increased, dry matter (DM) digestibility was decreased significantly, meanwhile the digestibility of crude fiber (CF), neutral detergent fiber (NDF) and acid detergent fiber (ADF) increased significantly ($P < 0.05$). The ratio of apparent essential amino acid (EAA) digestibility (except Leu) among the four groups had significant difference ($P < 0.01$). the content of NH₃-N in feces dropped ($P > 0.05$). There were no significant differences in net protein utilization (NPU), N apparent digestibility, N deposition and Ca apparent digestibility in different groups ($P > 0.05$). The apparent digestibility of P in different groups elevated, while there was significant difference between group D and A ($P < 0.01$), and there was significant difference between group D and B ($P < 0.05$).

Key Words: Wulong Goose, *Euchaena mexicana* Schrad, Nitrogen Metabolism

T131 Feeding different levels of zearalenone on growth, vulva size, and organ weight in postweanling female pig. Z. B. Yang¹, H. Zao¹, C. C. Chen², and F. Chi³, ¹Shandong Agricultural University, Taian, Shandong, PRC, ²Chaoyang University Technology, Taichuang, Taiwan, ROC, ³Oil Dri Corporation of Amercia, Chicago, IL.

A total of twenty postweanling female pigs (L × Y × D) weaned at d-21 with an average of 6.77±0.46 kg were used in the study. The pigs were randomly divided into four treatments with 5 pigs per treatment. Pigs were fed a corn-soybean meal-whey based diet with an addition of 0, 1, 2, or 3 ppm of zearalenone (ZEA, Fermentek, Israel) for 18 days. Feeds contained 0.90, 1.67, 2.33 and 4.33 ppm of ZEA in the four test diets individually. Pigs were weighed at the beginning and the end of trial. Feed intakes were recorded daily. Vulva length and width were measured at 3 days intervals. Pigs were killed at the end of trial, and individual organs were obtained and weighed. No differences were observed between treatments on weight gain, feed intake, or feed efficiency. However, vulva length and width were increased significantly (P<.05) as dietary ZEA concentration increased. When comparing the vulva size between d-1 and d-18 of each treatment, the size were 111, 174, 173, and 430% increased respectively in treatments 1, 2, 3, and 4. Organ sizes including uterus, ovary, kidney, liver, heart, lung, spleen, stomach, and intestines are shown in the Table 1. The size of reproductive system, kidney and liver were increased linearly as dietary ZEA increased (P<.05) On the other hand, heart, lung, spleen, and GI etc organ sizes showed no difference between treatments after feeding 18 days of ZEA. Due to increased size of liver, kidney and reproductive tract, a trend of decreased dressing percentage as dietary ZEA concentrations increased was obtained although it was not significantly different between treatments (P>.05).

Table 1. Percent organ weights to body weight of individual pig feeding different levels of zearalenone

Treatment	ZEA Intake, ppm	Ovary, Uterus	Kidney	Liver	Dressing %
1	0.90	.0625 a	.430 a	2.429 a	73.47
2	1.67	.0986 ab	.451 ab	2.535 ab	75.11
3	2.33	.1214 b	.502 b	2.759 b	72.46
4	4.33	.2410 c	.511 b	2.751 b	71.69

a, b, c - a significant difference between treatments (P < .05)

Key Words: Zearalenone, Vulva Size, Organ Weight

T132 Effect of probiotic and enzyme on fatty-liver performance and major cecum microorganisms in Landes Goose. B. W. Wang*, S. H. Yu, M. A. Zhang, L. Wang, B. Yue, L. Z. Jing, X. X. Wei, Y. C. Wang, Y. C. Fan, Q. L. Wang, Q. Zhang, and P. Sun, *Qingdao Nongye University, Qingdao, Shandong Province, China.*

To study the effect of probiotics and enzyme on fatty-liver performance, ninety 13-week-old Landes geese were selected and divided into three groups randomly, with five replicates each group and six each. The group one was the control and fed the basal diets, group two and three were the experiment groups fed the diets with an inclusion level of 0.3% probiotics and 0.3% enzyme respectively. The feeding trial lasted four weeks to measure the somatotype indexes, quality of fatty-liver and selected the cecums to culture microorganism. The results showed that,

in comparison with the control, the body oblique length, body weight and carcass weight in group two and three increased significantly (P < 0.05). With an average liver weight exceeding 1000g, there was an significant increase between the two groups and the control (P < 0.05), while the content of water, crude protein, crude fat and composition of fatty acid of liver in the two groups were not influenced (P > 0.05). The number of lactobacillus in the second group was 7.63 ± 0.52, increased by 4.53 times (P < 0.01), and the number of bifidobacterium was 6.34 ± 0.62, increased by 3.64 times (P < 0.01), and the number of escherichia coli was 5.43±0.46, reduced 66.62% (P < 0.01). The number of lactobacillus in third group was 7.48 ± 0.41, increased by 3.89 times (P < 0.05), the number of bifidobacterium was 5.62 ± 0.36, increased by 3.24 times (P < 0.05) and the number of *Escherichia coli* was 5.62±0.36, reduced 48.71% (P < 0.05). It was showed that, probiotic and enzyme preparation could promote the growth of lactobacillus and bifidobacteria, inhibit the growth of *E.coli* and maintain the good microorganism environment in intestinal in different extent; and promote the growth of Landes geese and formation of fatty-liver, improve the fatty-liver level, with no influence on the quality of fatty-liver.

Key Words: Landes Goose, Fatty-Liver Weight, Cecum Flora

T133 Study on the ferment characteristics and application effect of *Penicillium oxalicum* Currie & Thom producing pectinase. B. W. Wang*, L. Z. Jing, F. Y. Long, B. Yue, M. A. Zhang, S. H. Yu, Y. C. Wang, X. X. Wei, Q. Zhang, and Q. Feng, *Qingdao Nongye University, Qingdao, Shandong Province, China.*

Pectin was anti-nutrition determinant in animal feed. If one kind of effective enzyme which could degrade pectin was produced, the feed cost would be reduced and the problem that foodstuff competition between human and livestock would be eased. In order to determine process conditions of crude enzyme of pectinase and its effect on digestion and absorption of goose, the ferment condition was determined and the crude enzyme of pectinase was made. While twenty-four-month -old Wulong geese were selected and divided into four groups at random, and six geese in each group. Total feces collection method was adopted to determine the digestion of some nutrients. The content of pectinase in each experiment diet was 0.0%, 0.1%, 0.2% and 0.3%. The results indicated that the optimal composition of substrate was glucose 0.9g, (NH₄)₂SO₄ 1.2g, KH₂PO₃ 0.7g relative to 15g substrate; The best primary pH and time of ferment were 4.5 and 60h; The best temperature and optimum inoculum size were 30°C and 1.5ml. Combination with 5-fold concentration produced the highest gain rate of 89.89% (P<0.01). Under the same level of nutrition, the digestion of crude fiber was respectively 20.55%, 26.33%, 37.59%, 30.76% with the increasing of pectinase content; The concentration of NH₃-N in the third group was 1.20 mg/kg and significantly lower than other groups (P<0.01); The digestion of AA were relatively high (72.19%~94.27%). The apparent digestibility of Ca, P and the bacterium number of *Bifidobacterium*, *Lactobacillus* and Yeast in the feces in different groups first increased and then decreased with the increasing level of pectinase. So, supplementation with pectinase could increase the availability of nutrient in diet.

Key Words: *Penicillium oxalicum* Currie & Thom from Goose, Fermentation Characteristics, Digestion

T134 Live weight dependent responses to adding an enhanced milky flavor (Luctarom® Advance) to a piglet nursery feeding program. E. Roura*¹, G. Tedó¹, X. Puigvert², and I. Ipharragere¹, ¹Lucta SA, R+D Feed Additives, Barcelona, Spain, ²Universitat de Girona, Girona, Spain.

A trial was conducted with 192 Landrace × Large White newly weaned 23d-old pigs to study different dosing programs of an enhanced milky flavor (Luctarom® Advance) in feeds. Piglets were randomly allocated in a factorial design with 3 blocks of 8 pens according to initial body weight (light=5,78 kg; intermediate =6,66 kg; heavy=7,38 kg) and 4 dietary treatments differing only in amount of flavor. The pre-starter phase (0 to 14 d) flavor doses were 0 (T1) or 1500 ppm (T2, T3 and T4). The starter phase (14 to 28 d) flavor doses were 0 (T1), 500 (T2), 1000 (T3) or 1500 (T4) ppm. In the 1st week post weaning, the 3 equally flavored treatments on average resulted in 25% higher ADFI ($p < 0.05$) than T1 (90 vs 72 g). In the 2nd week, a flavoring by block interaction ($p < 0.05$) was observed because adding flavor increased ADG more in the light (from 182 to 242 g) than in the heavy (231 to 269 g) while decreased ADG in the intermediate (238 vs 223 g) groups. In the 1st week of the starter phase, T4 pigs ADG (555 g) was significantly higher ($p < 0.01$) than gains for T1 (485 g), T2 (457 g) or T3 (470 g). Furthermore a treatment by block interaction ($p < 0.05$) was observed showing that lowering the flavor dose to only 500 ppm (T2) compared to T4 (1500 ppm) had a live weight dependent response on ADG such that the light pigs grew similarly in both treatments (500 vs 498 g) but grew less in the intermediate (503 vs 554 g) and heavy (382 vs 609 g) groups. Overall piglets in T4 compared to T1 showed a 10% increase in ADG (345 vs 314 g, $P = 0.16$). We conclude that adding the enhanced milky flavor to feed results in higher ADG in weanling pigs compared to a non-flavored group. In the pre-starter phase, flavor addition is more effective among the lightest pigs. Decreasing flavor doses from pre-starter to starter diets results in a live weight dependent response in ADG such that the heavier the pigs the bigger the drop in the improvement in performance compared to the fully flavored group.

Key Words: Piglet, Growth, Flavor

T135 Identification of the porcine umami taste receptor dimer responsible for the taste of amino acids. E. Roura*¹, R. Holt², and K. C. Klasing², ¹Lucta SA, R+D Feed Additives, Barcelona, Spain, ²University of California, Davis.

Humans and mice perceive the umami taste via a trans-membrane heterodimeric receptor consisting of T1R1 and T1R3 proteins that are G-protein coupled to intracellular calcium release. To identify the porcine umami taste receptor, vallate papilla tissue samples were obtained from a 6-month-old male pig and total RNA was extracted, purified, and reverse transcribed. A porcine expressed sequence tag (EST) with high homology to human T1R3 was located in a public domain library (pig ESTs database from Iowa State University). The RACE PCR technique was used to obtain cDNA for adjacent 3' and 5' regions of the T1R3 EST sequence. Candidate PCR products were sequenced and the RACE process was repeated until the full length 2568 nucleotide sequence was determined. To obtain the pig T1R1 receptor sequence, degenerate PCR primers were designed that covered areas of high homology to the mouse, human, and cat genes. Primer sets were found that amplified a portion of the T1R1 and the complete 2535 nucleotide T1R1 sequence was obtained using the RACE PCR technique. Full length products of T1R1 and T1R3 were amplified by PCR, sequenced, and found to have

high (>80%) homology to respective genes from other mammals. The open reading frame of T1R1 and T1R3 was recombined into pcDNA6.2/V5-DEST Gateway vectors for expression in mammalian cells. CHO-K1 cells were transfected with both full-length pig taste receptors constructs and a mouse G alpha 15 G protein sub-unit construct. Transfected cells were seeded into 96-well-plates, loaded with a calcium detection dye cocktail and then exposed to individual amino acids. Ligand binding was determined by fluorescence using an ELISA plate reader. The porcine umami taste receptor was most sensitive to non-essential amino acids, with glutamic acid and alanine giving strong responses. In general, essential amino acids gave lower responses. These results indicate that the porcine umami receptor is tuned to detect amino acids.

Key Words: Pig, Umami, Taste Receptor

T136 Effect of virginiamycin on apparent ileal digestibility of amino acids by growing pigs. L. L. Stewart*¹, B. G. Kim¹, B. R. Gramm², R. D. Nimmo², and H. H. Stein¹, ¹University of Illinois, Urbana, ²Phibro Animal Health Co., Ridgefield Park, NJ.

Virginiamycin (VIR) improves the digestibility of energy and phosphorus, but effects of VIR on AA digestibility have not been documented. Thus we investigated the influence of VIR on apparent ileal digestibility (AID) of AA in growing pigs. A total of 15 barrows with an initial BW of 35.0 ± 2.7 kg were surgically equipped with a T-cannula in the distal ileum. Animals were randomly allotted to 3 dietary treatments during a 4-wk experiment. Dietary treatments included: 1) basal diet based on corn-soybean meal, 2) basal plus 11 ppm VIR, and 3) basal plus 22 ppm VIR. During wk 1, pigs were fed only a basal diet; during wk 2 to 4, treatment diets were provided. Ileal samples were collected on d 6 and 7 of each week. As presented in Table 1, the AID for most indispensable AA were improved in pigs fed 11 ppm VIR (Ile, Leu, Lys, Met, Phe, Trp, and Val; $P < 0.05$) or 22 ppm VIR (Ile, Leu, Met, Phe, Thr, Trp, and Val; $P < 0.05$) during wk 2 to 4. The AID for some dispensable AA were also increased in pigs fed 11 ppm VIR (Ala, Asp, and Tyr; $P < 0.05$) or 22 ppm VIR (Ala, Cys, Glu, Pro, and Tyr; $P < 0.05$). However, the AID of AA was indifferent between pigs fed 11 ppm VIR and those fed 22 ppm VIR. The present results indicate that dietary VIR improves ileal digestibility of most indispensable AA and that this effect is not further enhanced by providing more than 11 ppm VIR.

Table 1. Apparent ileal digestibility of indispensable AA during wk 2 to 4

Item	Virginiamycin, ppm			SEM	P-values	
	0	11	22		0 vs. 11	0 vs. 22
Arg	88.2	89.1	88.7	0.53	0.27	0.53
His	82.1	83.5	83.5	0.57	0.08	0.08
Ile	80.0	81.8	82.2	0.57	0.04	0.01
Leu	81.0	83.1	83.5	0.56	0.01	< 0.01
Lys	81.5	84.1	83.2	0.75	0.01	0.12
Met	83.1	85.6	85.3	0.62	< 0.01	0.02
Phe	80.3	82.4	82.6	0.57	0.01	< 0.01
Thr	71.6	73.4	73.9	0.80	0.11	0.05
Trp	73.2	78.3	79.3	0.90	< 0.01	< 0.01
Val	76.0	78.7	79.8	0.71	0.01	< 0.01

Key Words: Virginiamycin, Amino Acids, Digestibility

T137 Effect of β -glucanase on performance and apparent nutrient digestibility in weaned piglets. E. Grilli^{*1}, I. Kühn², A. Panciroli¹, and A. Piva¹, ¹*DIMORFIPA, Ozzano Emilia, Bologna, Italy*, ²*AB Enzymes GmbH, Darmstadt, Germany*.

Aim of the study was to evaluate the addition of β -glucanase (ECON-ASE[®] Barley P 700, AB Enzymes GmbH) on piglets growth performance and nutrient digestibility during 6 post-weaning weeks. Three-hundred and twenty four male piglets weaned at 21-28d (7.5 \pm 0.5 kg BW) were divided into 3 groups of 18 pens each (6 pigs per pen): a control group, receiving a barley-based diet (CTR); the ECO1 group, receiving the same diet added with β -glucanase at 17,500 BU/kg, and the ECO2 group, with enzyme added at 24,500 BU/kg. Animals were fed a 2-phase diet with no antimicrobials added. Piglets were weighed on the day of the study start (d0), at the end of the first phase (d19), and at the end of the study (d42). Feed intake was recorded daily. ADG and G:F were calculated between 0-19d, 20-42d, and 0-42d. From d15 to d19, and from d38 to d42 samples of fresh feces from 14 pens per treatment were collected daily to be analyzed for nutrient digestibility. Data were analyzed with 1-way ANOVA. During the period 0-19d ECO1 and ECO2 piglets had higher feed intake than piglets fed the CTR diet (+9.4% and +6.9%, respectively; $P < 0.05$). The ECO1 group piglets had higher ADG and BW at 19d when compared to CTR (+15%, and +5.7%, respectively; $P < 0.05$). Throughout the study (0-42d), ECO1 and ECO2 piglets tended to have higher ADG and higher BW when compared to CTR (ADG: +5.8%, and +7.6%, respectively, $P = 0.12$; BW: +4.6% and +5.1%, respectively, $P = 0.13$). Despite increased feed intake, G:F (0-42d) was significantly higher for the ECO2 group than for other groups (+6% than CTR group, $P = 0.047$). During the first phase (d15 to d19) DM fecal digestibility was improved by 5.6% in ECO1 than in CTR ($P = 0.02$) and crude protein and gross energy digestibilities were higher in ECO1 group than in CTR (+7.1%, and +8.6%, respectively; $P < 0.05$). Effects were similar but not significant in ECO2 group. Data demonstrated that especially during the first phase the enzyme stimulated feed intake and fecal apparent digestibility, thus improving growth performance of weaning piglets when their diet was supplemented with β -glucanase either at 17,500 BU/kg or at 24,500 BU/kg.

Key Words: Barley, β -Glucanase, Piglets

T138 Dietary supplementation of oregano essential oils on the performance of broilers under high altitude condition. L. Betancourt¹, C. Ariza-Nieto^{*2}, F. Rodriguez², V. Phandanouvong², A. Padilla¹, M. Hernandez¹, M. Hume³, D. Nisbet³, and G. Afanador-Tellez², ¹*Universidad Salle, Bogota, Colombia*, ²*CORPOICA, Bogota, Colombia*, ³*USDA, ARS, FFSRU, College Station, TX*.

This study evaluated the supplementation of the essential oils (EO) of different varieties of oregano in a feeding program for broilers maintained at high altitude. Two hundred and seventy 1-d old Hybro male broiler chicks were placed in 30 brooder cages under a completely randomized design. Cages were randomly assigned to 6 treatments: 1) control (C); 2) antibiotic, 500 ppm Chlortetracycline (AB); 3) 50 ppm of EO from *O. vulgare* H ground in Greece (OG); 200 ppm of EO from 3 varieties ground in Sabana of Bogota-Colombia, 4) *O. vulgare* H. (OBH), 5) *O. vulgare* L. (OBL) and 6) *O. marjoricum* (OBM). Broiler performance was determined at 3, 7, 14, 21, 28, 35 days of age. From day 21 to 25 chromium oxide (Cr₂O₃) was added at 0.5 g/kg of diet as indigestible marker for the digestibility study. Four chicks from each treatment were randomly selected for morphology measurements. Intestinal tissues were

collected from duodenum, jejunum, and ileum to measure crypt depth and villus height. The composition of essential oils was analyzed by GC/MS. Clear differences were observed between the oregano varieties with wide ranges in the content of carvacrol (3.7% to 50.8%) and thymol (4.7% to 21.5%). The minimal inhibition concentration (MIC) of the EO were tested on *Salmonella* Typhimurium ATCC 14028 and *Escherichia coli* ATCC 25922 using microdilution in broth. OBL showed the highest inhibitory activity with a MIC of 1.25 mg/ml and 0.63 mg/ml on *S. Typhimurium* and *E. coli*, respectively. Broilers supplemented with OBM had greater villus: crypt ratio in duodenum compare to OG group. Broilers supplemented with AB showed greater ileum protein digestibility (88.9%) when compared to C, OBGL, and OBGH (84.0, 82.8, and 76.2%, respectively), but similar to OBM (85.7%) and OG (84.7%). Broilers supplemented with OBM had greater ($P < 0.05$) body weight gain compared to OG on days 7 and 14 (101.9 vs. 93.9 g) and (244.0 vs. 222.6 g), respectively. Group OBL reduced mortality in 11.1% compared to group C. Oregano EO supplementation showed a biological growth potential on broilers under high altitude conditions.

Key Words: Oregano Essential Oils, Broiler, Gastrointestinal Health

T139 Isolation of a *Bacillus licheniformis* DK42 producing cellulase and xylanase, and properties of the enzymes. M. J. Kim, S. J. Lim, and D.-K. Kang^{*}, *Dankook University, Cheonan, Chungnam-do, Rep. of Korea*.

Cellulase and xylanase play an important role in improvement of the nutritional value of animal feeds. A bacterium DK42 producing xylanase and cold-active cellulase was isolated from pig feces. The isolate, DK42 strain, was found to be the Gram-positive, non-motile, catalase-positive, and spore-forming strain. Under an electron microscope, the cells were observed to be rod-shaped. The isolate was named as *Bacillus licheniformis* DK42, on the basis of carbon utilization and 16S rRNA gene sequences analysis. The extracellular cellulase and xylanase were partially purified by ammonium sulfate precipitation. Cellulase exhibited an optimum temperature and pH at 45C and 6.0, whereas xylanase exhibited an optimum temperature and pH at 55C and 6.0. Especially cellulase maintained approx. 50% of its maximum activity even at 4C, indicating that it is cold-active. Both cellulase and xylanase were stable after 2hr at 35C, whereas they lost their activities after 30min at 65C. The zymogram analysis of ammonium sulfate-precipitated fraction showed a distinct cellulase activity band on native PAGE.

Key Words: Cellulase, Xylanase, *Bacillus*

T140 Effect of dietary probiotic and/or prebiotic on humoral immune response of Ross broiler chickens. H. Ziaei^{*1}, M. A. Karimi Torshizi², M. Bashtani¹, H. Farhangfar¹, H. Naemipour¹, and A. Zeinali¹, ¹*Birjand University, Birjand, Iran*, ²*Tarbiat Modarres University, Tehran, Iran*.

An experiment was conducted on 240 one-day old male Ross broiler chickens to evaluate the efficiency of antibiotic alternatives growth promoters on bird immune response system. Chicks were fed in a block completely randomized design with 4 replicate pens (15 birds per pen). Experimental treatments were: (T1= control, T2= control + 15 ppm of Virginiamycin, T3= control + 15 mg probiotic Protexin /kg diet, T4=

control diet + 10 mg prebiotic Immnuwall /kg diet). For experimental immunization, four birds of 18 and 27 days old from each replicate were injected intravenously (brachial vein) with 0.1 ml of 0.5% sheep red blood cells (SRBC). Blood samples were collected after 5 days of inoculation to measure the antibody production. The results of the present study indicated that the antibody production was significantly ($P<0.05$) higher in experimental units treated under T3 and T4 as compared with the other treatments in 24 and 32 days of age. In addition, for the traits under consideration, non-significant difference ($P>0.05$) was found between treatments 1 and 2. It is therefore suggested that supplementation of diets with Probiotic and Prebiotic could increase immune function against the pathogens resulting in improving growth performance of broilers.

Key Words: Broiler, Probiotic, Prebiotic

T141 Assessment of the antimicrobial activity of carvacrol, cinnamaldehyde and capsicum oleoresin in stomach, jejunum, and cecum digestive content of weaned pigs using fermentation assay.

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The measurement of gas produced as a fermentation end product in vitro was used to study the antimicrobial effect of a plant mixture (XT) containing carvacrol (CAR), cinnamaldehyde (CIN) and capsicum (CAP). Increasing doses from 0 to 10000 µg/mL of the mixture were tested in stomach, jejunum and cecum contents 1 and 2 weeks after weaning at 21 days of age. No inhibition of the gas production was found in stomach and cecum content using 10000 µg/mL of XT. In jejunum, 10000 µg/mL produced a partial decrease on the gas production (20.0 vs. 29.5 mL, $P=0.001$). The different components of XT were tested separately using intestinal content of animals 1 week after weaning. Formic acid (FA) was included in the tests as a reference. In the stomach, CAR totally inhibited the gas production at 10000 µg/mL, whereas CIN and FA induced a partial inhibition (0.8 and 4.5 vs. 14.3 mL, $P<0.001$, respectively). CAP did not show any effect on stomach gas production until 10000 µg/mL. All compounds produced a decrease of gas production in jejunum content at 1000 µg/mL. However the effect of CAR, CIN and FA was more marked than the CAP effect compared to negative control (15.5, 16.0, 21.0 and 25.8 vs. 29.5 mL, $P<0.001$, respectively), and all three inhibited gas production at 10000 µg/mL whereas the CAP effect was unchanged. CAR, CIN and CAP were then tested in older animals, 5 weeks after weaning. CAR at 1000 µg/mL and CIN at 500 µg/mL both reduced gas production in jejunum (17.5 and 14.0 vs. 37.7 mL, $P<0.001$, respectively). The doses of 3000 µg/mL of CAR and 2000 µg/mL CIN partially inhibited gas production in cecum (21.5 and 24.4 vs. 28.8 mL, $P<0.001$, respectively). CAP was only active at doses higher than 10000 µg/mL. These experiments demonstrate that CAR and CIN present good antimicrobial activity at doses similar to the acidifiers.

Key Words: Plant Extracts, Formic Acid, Pig

T142 Effects of essential oils supplementation on growth performance, nutrient digestibility, blood characteristics, fecal noxious gas concentration and meat quality in growing-finishing pigs.

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Ninety six crossbred pigs (Landrace×Yorkshire×Duroc) were used to determine the effects of essential oils (AROMEX[®] ME) supplementation on growth performance, nutrient digestibility, immune response, fecal noxious gas and meat quality of growing-finishing pigs. Treatments were 1) NC (control diet without antibiotics), 2) PC (NC + 44 mg/kg tylosin to 6th wk; 20 mg/kg avilamycin to 16th wk) and 3) AROMEX[®] ME (NC + 0.01% AROMEX[®] ME). At 16 weeks body weight was higher ($P<0.05$) in PC and AROMEX[®] ME treatments (110.972 kg and 113.491 kg) than in the NC treatment (102.206 kg). During the all period of the trial, ADG (0.854 kg) and G/F (0.474) were significantly improved ($P<0.05$) by AROMEX[®] ME supplementation compared with NC treatment (0.802 kg and 0.436). Both of antibiotics (1.798 kg) and AROMEX[®] ME (1.802 kg) supplementation significantly decreased ($P<0.05$) ADFI compared with NC treatment (1.838 kg). At the end of 16 weeks, total protein and lymphocyte concentration of blood were increased ($P<0.05$) in PC (7.99 g/dL and 65.48%) and AROMEX[®] ME (7.93 g/dL and 64.48%) treatments compared with NC treatment (7.83 g/dL and 57.40%). IgG concentration was increased ($P<0.05$) in AROMEX[®] ME treatment (1428 mg/dL), compared with NC (1296 mg/dL) and PC treatments (1303 mg/dL). WHC was increased ($P<0.05$) in AROMEX[®] ME treatment (38.64%) compared with other treatments (32.05% and 34.24%). TBARS of NC (0.032 MDA mg/ 1000g) and PC (0.030 MDA mg/ 1000g) treatments were higher ($P<0.05$) than AROMEX[®] ME treatment (0.012 MDA mg/ 1000g). AROMEX[®] ME supplementation significantly reduced ($P<0.05$) ammonia (84.18ppm) and mercaptans (0.62ppm) emission compared with NC (92.92ppm and 0.75ppm) and PC treatments (94.02ppm and 0.87ppm) at the 7 days of the gas evaluation. In conclusion, the dietary addition of essential oils and antibiotic into diets for growing-finishing pigs improved growth performance, nutrient digestibility, and immune response. Essential oils can be used to partly replace antibiotics in diets for pigs without negative affects on growth performance, meat quality and reduced noxious gas emission.

Key Words: Essential Oil, Fecal Noxious Gas Concentration, Blood Profile

T143 Effects of dietary *Rhodopseudomonas capsulata*, *Rhizopus oligosporus* & *Aspergillus oryzae* on growth performance nutrient digestibility and blood characteristics in growing pigs.

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The current study was conducted to investigate the effects of dietary complex probiotics supplementation on growth performance, nutrient digestibility, blood characteristics and noxious gas emission of manure slurry in growing pigs. A total of forty eight pigs with an initial body weight of 20.12 kg were allotted to three dietary treatments (two pigs per pen with eight pens per treatment). Probiotics contained *Rhodopseudomonas capsulata*, *Rhizopus oligosporus* & *Aspergillus oryzae*. Dietary treatment included: 1) CON (basal diet), 2) Pro1 (basal diet + 0.1% complex probiotics) and 3) Pro2 (basal diet + 0.2% complex probiotics). The experiment lasted six weeks. Blood samples were acquired from the cervical vein into K₃EDTA vacuum tubes and clot activator vacuum tubes from 2 pigs in each pen at the end of the

experiment. Collected fresh feces and urine samples were stored in 2.6 L plastic boxes. After fermentation period, Gastec fas sampling pump was used for gas detection. One hundred mL of the headspace air in each plastic box was sampled approximately 2.0 cm above the slurry surface. Through the entire experimental period, ADG was increased with the increased complex probiotics supplementation level (linear effect, $P < 0.05$). However, neither ADFI nor gain/feed was influenced by the dietary treatments. Complex probiotics supplementation increased DM digestibility (linear effect, $P < 0.05$). Also, N digestibility was improved, with the Pro1 treatment having the highest value (linear and quadratic effect, $P < 0.05$). Supplementation of complex probiotics did not affect the WBC, RBC, lymphocyte and BUN concentrations in blood. The $\text{NH}_3\text{-N}$ emission from manure slurry was decreased with the increased level of complex probiotics supplementation (linear and quadratic effect, $P < 0.05$). Similarly, H_2S emission of manure slurry was also decreased significantly when complex probiotics was included in diet (linear effect, $P < 0.05$). In conclusion, dietary supplementation of complex probiotics can increase growth performance and decrease noxious gas emission of manure slurry in growing pigs.

Key Words: Complex Probiotics, Noxious Gas, Pig

T144 Effect of dietary organic acid mixture (lactic acid, formic acid, citric acid, butyric acid and phosphoric acid) on growth performance, organ weight, blood immunological parameter and intestinal villi morphology in broilers. H. D. Jang^{*1}, J. S. Yoo¹, Y. Huang¹, T. X. Zhou¹, J. H. Cho¹, J. D. Hancock², and I. H. Kim¹, ¹*Dankook University, Cheonan, Chungnam, Korea*, ²*Kansas State University, Manhattan*.

The study was conducted to evaluate the effects of dietary organic acid mixture (lactic acid, formic acid, citric acid, butyric acid and phosphoric acid) on growth performance, organ weight, blood immunological parameter and intestinal villi morphology in broilers. Dietary treatments were included 1) CON (basal diet), 2) OA1 (basal diet + 0.1% organic acid mixture) and 3) OA2 (basal diet + 0.2% organic acid mixture). Each treatment were allotted to twenty broilers per pen with eight replicate pens per treatment in a completely randomized design. Daily weight gain, feed intake and feed/gain were not significantly different among the treatments. In organ weight, gizzard was significantly higher in OA2 than CON (Linear effect = 0.034). However, spleen and intestine were not significantly different among the treatments. In blood immunological parameters, RBC, WBC and lymphocyte were not significantly different. In intestinal villi morphology, villi length was increased in OA1 compared to CON (Quadratic effect = 0.050). Water content of feces was not significantly different among the treatments. In conclusion, 0.1% organic acid mixture was effective to improve gizzard and villi length in broilers.

Key Words: Complex Organic Acid, Blood Immunological, Intestinal Villi

T145 Effects of dietary supplementation of blended essential oil on growth performance, nutrient digestibility, blood profiles, fecal characteristics in weanling pigs. Y. Huang^{*1}, J. S. Yoo¹, H. J. Kim¹, Y. Wang¹, Y. J. Chen¹, J. H. Cho¹, J. D. Hancock², K. Y. Whang³, and I. H. Kim¹, ¹*Dankook University, Cheonan, Chungnam, Korea*, ²*Kansas State University, Manhattan*, ³*Korea University, Seoul, Korea*.

One hundred and twenty five crossed [(Duroc × Yorkshire) × Landrace] pigs (6.21 ± 0.02 kg initial body weight and 21 d average age) were used in the current experiment to determine the influence of dietary supplementation of blended essential oil on growth performance, nutrient digestibility, blood profiles, fecal characteristics in weanling pigs. Treatments were 1) NC (antibiotic free diet), 2) PC (NC diet + 44 mg/kg of tylosin), 3) T1 (NC diet + 0.1% of essential oil), 4) T2 [NC diet + 0.1% of essential oil (with 0.3% Benzoic acid)] and 5) T3 (NC + 22 mg/kg of tylosin and 0.05% of essential oil). ADG was improved ($P < 0.05$) in pigs fed 0.1% of essential oil with 0.3% Benzoic acid (295 g) at d 14 compared with PC and T1 treatments (266 g and 269 g). At the end of experiment, dry mater digestibility was improved ($P < 0.05$) in T3 treatment (78.67%) compared with T1 treatment (77.09%). Lymphocyte concentration in blood was greater ($P < 0.05$) in T3 treatment (64.78%) compared with NC treatment (50.14%). Fecal pH was the greatest ($P < 0.05$) in PC treatment (8.36) compared with NC, T1, T2, and T3 treatments (8.07, 8.06, 7.61 and 7.58, respectively). Amonia emission was increased ($P < 0.05$) in PC treatment compared with T1, T2, and T3 treatments (146.67, 70.00 and 74.67). Diarrhea appearance and score were tended to decrease in essential oil treatments partially. In conclusion, supplementation of blended essential oil could replace antibiotics to improve growth performance and remain the amonia emission with Benzoic acid supplementation.

Key Words: Essential Oil, Growth Performance, Fecal Characteristic

T146 Effects of reducing dietary crude protein, yucca and multi-carbohydase supplementation on egg production performance, nutrition digestibility, and fecal noxious gas contents in laying hens. Y. Huang^{*1}, Y. Hyun², H. S. Kim², Y. Wang¹, H. J. Kim¹, S. O. Shin¹, and I. H. Kim¹, ¹*Dankook University, Cheonan, Chungnam, Korea*, ²*Seoul Feed, Co. LTD., Seoul, Korea*.

The emissions of fecal noxious gases, including ammonia (NH_3), constitute principal concerns for the Korean poultry industry. The principal objective of this study was to determine whether different crude protein (CP) levels and several different supplementation techniques could reduce fecal gas emission and maintain the production performance of laying hens. Chickens were fed with the following diets: 1) T1 (CP 18%); 2) T2 (CP 16.5% + yucca 0.02%); 3) T3 (CP 15% + yucca 0.02%); 4) T4 (CP 15% + yucca 0.02% + α -1,6-galactosidase and β -1,4-mannanase multi-carbohydase 0.05%). Egg production, egg weight, eggshell breaking strength, eggshell thickness, nutrient digestibility, and fecal noxious gas emission characteristics were evaluated. Egg production and egg weight were not consistently altered by any of the treatments. Eggshell breaking strength and eggshell thickness were both significantly reduced by T3 and T4 treatments at the end of experiment ($P < 0.05$). Digestibility of amino acids (AA), with the exception of Gly, were significantly decreased by feeding low CP diet ($P < 0.05$). However, carbohydase supplementation significantly improve the digestibility of AA in the low CP treatments ($P < 0.05$). Dry matter (DM) digestibility was increased with reducing dietary CP levels ($P < 0.05$). Fecal sulfureted hydrogen (H_2S) and NH_3 emissions were significantly decreased in T3 and T4 treatments ($P < 0.05$). In conclusion, our results indicate that 1) Eggshell breaking strength, eggshell thickness, nutrient digestibility, and noxious gas emissions may be decreased by reductions in dietary CP. 2) Considering the decreasing levels of CP in the yucca treatment groups, yucca may exert some positive effects on egg production and weight. 3) Multi-carbohydase supplementation can significantly improve AA digestibility. 4) The reduction of dietary CP and yucca and multi-

carbohydrase supplementations would be expected to improve nutrient digestibility and fecal noxious gas emission in laying hens.

Key Words: Laying Hens, Yucca, Amino Acid Digestibility

T147 Effect of dietary microbial phytase on laying performance, egg quality, phosphorus utilization and nutrient utilization in laying hens. H. D. Jang^{*1}, Y. Hyun², H. S. Kim¹, I. W. Hwang³, J. S. Yoo¹, Y. J. Chen¹, J. H. Cho¹, and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Seoul Feed, Co. LTD., Seoul, Korea, ³EASY BIO System, Inc, Seoul, Korea.

The study was conducted to evaluate the effects of dietary microbial phytase on egg productivity, egg quality, phosphorus utilization and nutrient digestibility in laying hens. The animals used in the experiment were a total of 120 ISA brown laying hens (32 weeks old). Dietary treatments included 1) CON (basal diet), 2) LP (Low phosphorus diet) 3) NG (Low phosphorus diet + 0.03% Natuphos[®]Granule), 4) NC (Low phosphorus diet + 0.03% Natuphos[®] Classic). The laying hens were allotted at 6 laying hens per block with five replicate pens per treatment by completely randomized design. Through the whole period of experiment, egg production was significantly increased in CON and NG treatments compared to LP treatment ($P < 0.05$). CON, NG and NC treatments significantly increased their egg shell breaking strength and egg shell thickness compared to LP treatment ($P < 0.05$). Albumin height was higher in CON and NG treatments than LP treatment ($P < 0.05$). CON, NG and NC treatments resulted higher yolk color and haugh unit than LP treatment ($P < 0.05$). Calcium and Inorganic phosphorus contents in blood were higher in NG treatment compared to LP treatment ($P < 0.05$). Calcium retention of CON, NG and NC treatments were higher than LP treatment ($P < 0.05$). Phosphorus retention was increased in NG and NC treatments compared to CON and LP treatments ($P < 0.05$). LP treatment significantly increased their nitrogen, calcium and phosphorus excretion compared to CON, NG and NC treatments ($P < 0.05$). Dry matter digestibility and nitrogen digestibility were greater in NG treatment than CON, LP and NC treatments ($P < 0.05$). Crude ash was increased in CON, NG and NC treatments compared to LP treatment ($P < 0.05$). Calcium digestibility and phosphorus digestibility were significantly improved in NG and NC treatments than CON and LP treatments ($P < 0.05$). In conclusion, NG treatment improved egg production, egg quality, inorganic calcium and phosphorus, calcium and phosphorus retention and nutrient digestibility and decreased nitrogen and phosphorus excretion in laying hens.

Key Words: Microbial Phytase, Egg Quality, Laying Hens

T148 Effects of dietary biotite on growth performance, blood immunological parameters, stress concentration of serum and fecal malodor gas emission in growing pigs. H. D. Jang^{*1}, J. D. Kim², J. W. Hong³, J. S. Yoo¹, J. H. Cho¹, Y. K. Jeong⁴, and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²CJ CheilJedang, Seoul, Korea, ³DAESANG Famsco, Anseong, Korea, ⁴SEOBONG Biobestech, Co., LTD, Seoul, Korea.

This study was conducted to evaluate the effects of biotite on growth performance, blood immunological parameters, stress concentration of serum and fecal malodor gas emission in growing pigs. 96

pigs[(Landrace × Yorkshire) × Duroc, 29.45 ± 1.35kg average initial body weight] were used in 42d growth trial. Dietary treatments included CON (basal diet), Solt2 (Basal diet+ Biotite 0.2%), Solt4 (Basal diet + Biotite 0.4%) and Solt6 (Basal diet + Biotite 0.6%). The pigs were assigned to the treatments according to body weight and each treatment had 6 replicates of 4 pigs per pen in a randomized complete block design. Nitrogen digestibility was significantly higher in Solt4 treatment than CON and Solt2 treatments (Linear effect = 0.016). Gross energy in Solt4 and Solt6 treatments was higher than CON treatment (Linear effect = 0.008, Quadratic effect = 0.019). There were not significantly difference on blood immunological (RBC, WBC, Lymphocyte and IgG) and stress parameter (cortisol, epinephrine and norepinephrine) among the treatments. At 5 day and 10 day, hydrogen sulfide was reduced in Solt treatment compared to CON treatment (5 day, Linear effect = 0.009, Quadratic effect = 0.037; 10 day, Linear effect = 0.009). At 5 day, acetic acid was significantly reduced in Solt treatments compared to CON treatment (Linear effect < 0.001, Quadratic effect < 0.001). At 15 day, acetic acid was significantly decreased in CON and Solt6 treatments compared to Solt2 and Solt4 treatments (Quadratic effect = 0.023). At 5 day and 10 day, Solt treatments was significantly decreased their total mercaptans compared to CON treatments (5 day, Linear effect = 0.029, Quadratic effect = 0.037; 10 day, Linear effect = 0.029). For the whole period, ammonia was significantly reduced in Solt2 and Solt4 treatments compared to CON and Solt6 treatments (5 day, Quadratic effect = 0.038; 10 day, Quadratic effect = 0.045; 15 day, Quadratic effect = 0.038). In conclusion, biotite improved nitrogen digestibility and gross energy digestibility. Also, it decreased fecal malodor gas emission in growing pigs.

Key Words: Biotite, Growth Performance, Fecal Malodor Gas Emission

T149 Use of fluidized bed technology for the development of sustained-release carvacrol pellets for a feed additive application. J.-P. Meunier^{*1}, J.-M. Cardot², and M. Alric², ¹Pancosma Research, Geneva, Switzerland, ²University of Auvergne, France.

In the field of animal feeding, the development of microencapsulated plant extract formulations intended to prolong the release of the active ingredients in the digestive tract requires to take into account a major technical limitation. The microparticles, before being consumed by the animal, must be incorporated in the feed and the whole must undergo a steam-pelleting phase. The feed will be subjected to high temperature and pressure before passing through a die to be transformed into pellets. The objective of this study was to assess the benefit of fluidized bed spray granulation applied to carvacrol microencapsulation into a core based on maltodextrin. Different amounts of hydrogenated rapeseed oil were applied on the core as coating to modify carvacrol release kinetics. The efficacy of the coating was tested in vitro using a flow through cell apparatus (CFC system). The time to achieve T90% values of dissolution increased with the increase in coating level from 10% to 30% (w/w) ($P < 0.05$), indicating the ability of the process to slow down release depending on the amount of hydrogenated rapeseed oil applied. Nevertheless, as CFC systems are ill suited for experiments with solid feed and thus limit their predictive values, follow-up studies were performed on the formulation coating at 30% using an in vitro dynamic model (TIM) that simulated more closely the digestive environment. A lower quantity of carvacrol dialyzed was recorded under fed condition vs. fasting condition with 19.1% ± 1.0 vs. 37.5% ± 2.7 respectively. This suggests a possible interaction between carvacrol and the feed matrix. Moreover, 47.7 ±

3.9% of the total carvacrol was dialyzed after 8 h digestion when feed had been granulated vs. $19.1 \pm 1.4\%$ when feed had not, which suggests that the feed granulation process could lead to a partial degradation of the microspheres. This study demonstrates the potential and the limitations of this technology to encapsulate feed additives.

Key Words: Carvacrol, Microencapsulation, In Vitro Model

T150 Effects of phytase and/or 25-hydroxyvitamin D3 inclusion on the performance, mineral balance and bone parameters of finisher pigs fed low phosphorus diets. D. A. Gahan, J. J. Callan, and J. V. O'Doherty*, *University College, Dublin, Ireland.*

Two 2×2 factorial experiments, a performance experiment and a mineral balance study were conducted to investigate the effects of *Peniophora lycii* (*P. lycii*) phytase enzyme and/or 25-hydroxyvitamin D3 on growth performance, mineral balance and bone parameters when offered to grower-finisher pigs (42 to 101 kg live weight). The dietary treatments were (T1) low-phosphorus (P) diet; (T2) low-P diet + 750 U/kg phytase; (T3) low-P + 25-hydroxyvitamin D3 (25-OHD3) diet, and (T4) low-P + 750 U/kg phytase and 25-OHD3 diet. Pigs offered both phytase (734 vs 710 g/day; se 0.008) and 25-OHD3 (736 vs 708 g/day; se 0.008) diets had higher carcass daily gains compared with non-phytase and non-25-OHD3 diets ($P < 0.05$). There was an interaction between phytase and 25-OHD3 on the apparent digestibility of ash ($P < 0.01$), P ($P < 0.001$), calcium (Ca) ($P < 0.001$) and on P ($P < 0.05$) and Ca ($P < 0.05$) retention. Pigs offered phytase only diets had higher ash ($P < 0.01$), P ($P < 0.001$) and Ca ($P < 0.01$) digestibility, and a higher P and Ca ($P < 0.05$) retention than pigs offered unsupplemented diets. However, when the combination of phytase and 25-OHD3 were offered, there was no effect on ash, P and Ca digestibility while P and Ca retention decreased compared with 25-OHD3 only diets. Pigs offered phytase diets had higher bone ash ($P < 0.01$), bone P ($P < 0.01$) and bone Ca ($P < 0.05$) concentrations than pigs offered non-phytase diets. Pigs offered phytase diets had significantly lower faecal P ($P < 0.05$) and higher urinary P excretion ($P < 0.05$) compared with non-phytase diets. Pigs offered 25-OHD3 diets had a higher nitrogen retention ($P < 0.05$) compared with non-25-OHD3 diets. In conclusion, pigs offered either phytase or 25-OHD3 diets had higher carcass daily gains compared with non-phytase and non-25-OHD3 diets. The beneficial effects of microbial phytase supplementation on ash, Ca and P digestibility were adversely affected when the combination of phytase and 25OHD3 were offered to pigs.

Key Words: Pigs, Phytase, 25-Hydroxyvitamin D3

T151 Effect of reducing dietary crude protein, yucca and multi-carbohydrase supplementation on growth performance, meat quality, nutrient digestibility, and fecal noxious gas contents in broilers. Y. Huang*¹, Y. Hyun², H. S. Kim², H. J. Kim¹, Y. J. Chen¹, J. H. Cho¹, J. D. Hancock³, and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Seoul Feed, Co. LTD., Seoul, Korea, ³Kansas State University, Manhattan.

Increased attention by regulatory agencies regarding agriculturally-generated atmospheric pollutants necessitates the consideration of emission reduction strategies in the feeding of broilers. The emissions of noxious gases, including ammonia (NH_3), are principal concerns of

the Korean poultry industry. The principal objective of this study was to determine whether different crude protein (CP) levels and several different supplementations could reduce the gas emission characteristics and effects on the growth performance of broilers. A total of 480 2-d-old Arbor Acre broilers were allotted to 4 treatment groups, each group included 6 replicates of 20 birds. The birds were fed on period 1: 1) T1 (CP 21%, ME 2969 kcal/kg); 2) T2 (CP 19%, ME 2863 kcal/kg + yucca 0.02%); 3) T3 (CP 17%, ME 2885 kcal/kg + yucca 0.02%); 4) T4 (CP 17%, ME 2881 kcal/kg + yucca 0.02% + α -1,6-galactosidase and β -1,4-mannanase multi-carbohydrase 0.1%) and period 2: 1) T1 (CP 19%, ME 3086 kcal/kg); 2) T2 (CP 17%, ME 2977 kcal/kg + yucca 0.02%); 3) T3 (CP 15%, ME 2978 kcal/kg + yucca 0.02%); 4) T4 (CP 15%, ME 2978 kcal/kg + yucca 0.02% + α -1,6-galactosidase and β -1,4-mannanase multi-carbohydrase 0.1%). Growth performance, carcass yield, nutrient digestibility, and fecal noxious gas emission characteristics were evaluated. Dry matter (DM) and nitrogen (N) digestibility were negatively affected ($P < 0.05$) by low dietary CP without carbohydrase. Digestibility of amino acids (AA) were significantly decreased by low CP diet ($P < 0.05$). However, carbohydrase supplementation can significantly improve AA digestibility in low CP treatment ($P < 0.05$). Breast yield was decreasing while abdominal fat yield was increasing with the decline of dietary CP levels ($P < 0.05$). Fecal NH_3 emission was significantly decreased in low CP treatments ($P < 0.05$). In conclusion, carbohydrase can be used to maintain AA digestibility when reduced CP diet is supplied and yucca supplementation and reduction in the CP level exert beneficial effects on the reduction of ammonia emissions.

Key Words: Broiler, Low Crude Protein, Carbohydrase

T152 Effect of dietary phytase on growth performance, carcass parameter, meat quality, nutrient digestibility and phosphorus utilization in broilers. H. D. Jang*¹, J. S. Yoo¹, H. J. Kim¹, S. O. Shin¹, Y. Huang¹, T. X. Zhou¹, Y. J. Chen¹, J. H. Cho¹, Y. K. Han¹, and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Sungkyunkwan University, Suwon, Korea.

The study was conducted to evaluate the effects of dietary phytase on growth performance, carcass parameter, meat quality, nutrient digestibility and phosphorus utilization in broilers. The experiment 1 was a total of 480 broilers (BW: 37.79g). Dietary treatments were included 1) CON (basal diet), 2) LP (Low phosphorus diet) and 3) CP (Low phosphorus diet + 0.05% coating phytase). The Broilers were allotted at 20 broilers per block with 8 replicate pens per treatment by completely randomized design. The experiment 2 was a total of 96 broilers (BW: 1,038g). Dietary treatments were included 1) CON (control), 2) LP (Low phosphorus diet), 3) NP (Low phosphorus diet + 0.05% normal phytase) and 4) CP (Low phosphorus diet + 0.05% coating phytase). The broilers were allotted at 3 broilers per block with 8 replicate pens per treatment by completely randomized design. Weight gain was significantly increased in CON compared to LP and CP treatments ($P < 0.05$). Calcium contents in blood was improved for CP treatment compared to LP treatment ($P < 0.05$). Carcass and CIE a^* of breast were significantly increased in CON compared to LP treatment ($P < 0.05$). WHC of breast was improved for CON and CP treatments compared to LP treatment ($P < 0.05$). Digestibility of dry matter and nitrogen were higher in CON compared to LP treatment ($P < 0.05$). Crude ash was greater in CON than CP treatment ($P < 0.05$). Calcium was improved for broiler fed CON and CP treatments compared with those fed LP treatment ($P < 0.05$). Digestibility of phosphorus was significantly reduce in LP treatments than CON and CP treatments ($P < 0.05$). Calcium retention was higher in

CON and CP treatments than LP treatment ($P < 0.05$). Phosphorus excretion was significantly reduced in NP treatment compared to CON and LP treatments ($P < 0.05$). Nitrogen and calcium excretion were significantly reduced in CON treatment compared to others ($P < 0.05$). In conclusion, CP treatment improved calcium contents in blood, WHC and pH of meat, digestibility of calcium and phosphorus, dry matter and calcium intake, nitrogen retention and calcium retention and decreased F/G and phosphorus excretion in broilers.

Key Words: Phytase, Meat Quality, Broilers

T153 Effects of δ -aminolevulinic acid and vitamin C supplementation on egg performance and quality and hematological characteristics in laying hens. Y. J. Chen^{*1}, I. H. Kim¹, K. Y. Whang², J. C. Park³, J. H. Cho¹, J. S. Yoo¹, Y. Wang¹, Y. Huang¹, H. J. Kim¹, and S. O. Shin¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Korea University, Seoul, Korea, ³National Institute of Animal Science, RDA, Cheonan, Chungnam, Korea.

This experiment was conducted to evaluate the effects of δ -aminolevulinic acid (ALA) and vitamin C supplementation on egg performance and quality and hematological characteristics in laying hens. A total of 252 Hy-line brown hens were randomly allotted to 6 dietary treatments: 1) CON (basal diet), 2) VC (basal diet with vitamin C 500 ppm), 3) ALA1 (basal diet with ALA 5 ppm), 4) ALA2 (basal diet with ALA 10 ppm), 5) AV1 (ALA1 diet with vitamin C 500 ppm) and 6) AV2 (ALA2 diet with vitamin C 500 ppm). There were 7 replications with 6 layers in adjacent three cages per each. During the 6-week experimental period, egg production was increased ($P < 0.05$) in AV2 (85.1%) treatment compared to other treatments (81.5, 79.7, 79.2, 79.7, 79.8) whereas egg weight was not influenced by dietary treatments. Egg shell color, thickness and breaking strength were not affected by ALA or vitamin C addition. Egg albumin height ($P < 0.05$) was higher in two AV (9.35, 9.42) treatments than other treatments (8.73, 8.44, 8.50, 8.76). Haught unit was greater ($P < 0.05$) in AV2 treatment (93.35) compared to CON (83.37), VC (86.10) and two ALA treatments (83.74, 83.18). Yolk color unit concentration was higher ($P < 0.05$) in ALA2 (8.85) and two AV treatments (8.90, 8.65) than other treatments (7.64, 8.08, 7.87). For the hematological characteristics, ALA and vitamin C had no effects on WBC, hematocrit, total protein, albumin and total iron binding capacity. Two AV treatments had greater ($P < 0.05$) RBC, hemoglobin and iron concentration compared to other treatments. The AV2 treatment (79.0%) also had greater ($P < 0.05$) lymphocyte concentration compared to CON, VA and AV1 treatments (70.8, 71.0, 66.5%). In conclusion, combine administration of ALA and vitamin C has positive influence on egg quality and can improve iron status of laying hens.

Key Words: δ -Aminolevulinic Acid, Egg Quality, Laying Hens

T154 Evaluation of supplemental α -aminolevulinic acid and vitamin C on growth performance, blood characteristics, immune organ weight and iron status in broilers. Y. J. Chen^{*1}, C. Y. Lee², I. H. Kim¹, J. H. Cho¹, J. S. Yoo¹, Y. Wang¹, Y. Huang¹, H. J. Kim¹, and S. O. Shin¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Jinju National University, Gyeongnam, Korea.

To evaluate the effect of δ -aminolevulinic acid (ALA) as immune modulator, 480 Arbor Acre male broilers were administrated 1 of 6 dietary

treatments. There were 4 replications per treatment and 20 broilers per cage. Dietary treatment included: 1) CON (basal diet); 2) VC (basal diet + vitamin C 500 mg/kg); ALA1 (basal diet + ALA 5 mg/kg); ALA2 (basal diet + ALA 10 mg/kg); AV1 (ALA1 + vitamin C 500 mg/kg) and AV2 (ALA2 + vitamin C 500 mg/kg). Treatment diets were provided for 5 weeks. The growth performance was not affected throughout the experimental period. Serum total protein (3.50 vs. 2.68 g/dL), albumin (1.62 vs. 1.32 g/dL) and hematocrit (26.7 vs. 24.2%) concentrations were higher ($P < 0.05$) in AV2 treatment than that in CON treatment. Serum hemoglobin concentration was increased ($P < 0.05$) 20%, 22%, 15% and 13% in AV2 treatment compared with CON, VC, ALA1 and ALA2 treatments, respectively. Iron concentration in serum was elevated ($P < 0.05$) in AV2 treatment (111.6 μ g/dL) compared with CON (73.0 μ g/dL) and VC (111.6 μ g/dL) treatments. However, the total iron binding capacity was not influenced by dietary treatment. The RBC concentration was higher ($P < 0.05$) in AV2 treatment than CON and VC treatments. AV2 treatment had greater ($P < 0.05$) liver weight than CON, VC and ALA1 treatments (2.74 vs. 2.33, 2.34, 2.35 g/100g BW). Liver iron concentration was higher ($P < 0.05$) in AV treatments (100.5, 93.5 μ g/dL) than other treatments while breast meat iron concentration was only increased in AV2 treatment (7.9 μ g/dL) compared to other treatments. The evaluated lightness of breast meat color was higher ($P < 0.05$) in AV1, AV2 and VC treatments (54.8, 54.7, 53.8) than other treatments. However, redness and yellowness were not affected by dietary treatment. In conclusion, dietary supplementation of δ -aminolevulinic acid combine with vitamin C can improve the immunity and iron status of broiler.

Key Words: δ -Aminolevulinic Acid, Iron Status, Broiler

T155 Effects of a microencapsulated blend of organic acids and natural identical flavors supplement to weaned pig diet. E. Grilli^{*1}, V. Pizzamiglio¹, M. R. Messina¹, L. Jørgensen³, H. Maribo³, R. Manini², and A. Piva¹, ¹DIMORFIPA, Ozzano Emilia, Bologna, Italy, ²Vetagro Srl, Reggio Emilia, Italy, ³Danish Pig Production, Copenhagen, Denmark.

Aim of the study was to investigate the effect of a microencapsulated supplement containing citric, sorbic acids, and natural identical flavors on piglets growth performance, mortality, and productivity during the 9 post-weaning weeks. The study was conducted at Danish Pig Production with the approval of the Danish Plant Directorate. Piglets were weaned at 5 weeks (7.6 kg BW), immediately divided in 2 groups (38 pens each, 7 pigs per pen), and were fed 2 experimental diets: the control non-medicated diet (CTR), or the control diet added with the microencapsulated blend at 3,000 ppm (Aviplus[®]; EP1391155B1, Vetagro Srl, Italy). Piglets received a 2-phases diet: the phase 1 was fed from d0 to d14 (20.7% CP, 6.3% EE), and the phase 2 from d14 to d63 (19.7% CP, 5.7% EE). The pigs were weighed per pen on d0, d14, and d63; the feed consumption was calculated at the same time intervals; mortality and treatments for diarrhea and other diseases were recorded. Performance data were analysed for normal distribution and prevalence of outliers, and were subjected to ANOVA with SAS; mortality was analysed with chi-square test. The Aviplus[®] group had higher ADG and G:F values than CTR in phase 1 (+22%, and +18%, respectively, $P < 0.05$), and higher G:F in phase 2 (+2%). The improvement registered in phase 1 was reflected in the overall period of the study (0–63 d: +5.7%, and +2.9% for ADG, and G:F, respectively, $P < 0.05$). Mortality was numerically higher for CTR than Aviplus[®] fed piglets (2.6% vs 1.2%, respectively, $P = 0.2$). The production value index calculated according to the Danish Pig Production procedure, was significantly higher for

the Aviplus® group than for the CTR one (+7%, $P < 0.05$). These results demonstrated that the supplementation of the diet with the lipid micro-encapsulated blend can improve productivity of weaners during the first weeks after weaning, thus improving the growth rate during the 7–30 kg body weight interval.

Key Words: Piglets, Microencapsulation, Organic Acids

T156 The effect phytase on growth performance, metatarsal and 10th rib bone characteristics, and tissue phosphorus levels in growing pigs. T. C. Tsai*, C. R. Dove, and M. J. Azain, *University of Georgia, Athens.*

The primary objective of this study was to determine the effect of phytase on phosphorus balance in various tissues. Barrows ($n=24$ barrows, 7-wk, average weight 18.50 kg) were randomly assigned to one of six diets. Diets 1 to 4 contained 0.13% available phosphorus (aP), and were supplemented with 0 (negative control), 500, 2500, and 12,500 U/kg phytase (Quantum, *E. coli* Phytase). Diets 5 (positive control) and 6 contained 0.35% aP, and 0 or 12,500 U/kg phytase. All diets met or exceeded NRC requirements except for phosphorus level in diets 1-4. Diets and water were ad libitum for 18 d. Phytase addition to the low aP diets improved ADG over that in the unsupplemented diet. Body weight and ADG were normalized in pigs fed high levels of phytase (2500, 12500 U/kg) relative to the positive control. Metatarsal bone ash and percent bone ash were increased by phytase addition. Similarly, phytase supplementation improved 10th rib bone weight, dry matter, and ash weight significantly. There were no phytase or dietary phosphorous effects on phosphorous concentration of heart, kidney, liver, muscle, and spleen. Phytase supplementation in the low aP diets improved growth performance, metatarsal and rib bone characteristics. Addition of a high level of phytase to a diet that is adequate in aP also resulted in improved performance and increased bone strength and ash. These results suggest that the phosphorus released by phytase is absorbed and contributes to improved bone growth and strength, which allows for greater rates of tissue accretion and increased body weight, but does not change tissue P concentrations.

Table 1. Effect of Phytase on Growth Performance and Bones Characteristics.

Diet	1	2	3	4	5	6	SEM	P Value
Gain, kg								
Day 0-18	8.32 ^a	9.6 ^{ab}	11.11 ^{bc}	11.09 ^{bc}	12.08 ^c	12.9 ^c	0.68	0.0037
Metatarsal								
Bone								
Ash, g	1.41 ^a	1.76 ^b	1.85 ^b	1.98 ^{bc}	1.92 ^b	2.18 ^c	0.07	<0.0001
Ash, %	28.3 ^a	32.9 ^b	34 ^b	34.5 ^{bc}	35.6 ^{bc}	37.4 ^c	1.08	0.001
Strength, kgf	42.3	54.6	67.1	69.4	69.1	61.4	6.3	0.0658
10th Rib								
Bone								
Ash, g	1.28 ^a	1.61 ^{ac}	1.78 ^b	1.95 ^b	1.92 ^b	2.36 ^c	0.15	0.0061
Ash, %	45.1	50.4	47.9	50.5	50	51.6	1.53	0.1159

Means within a row lacking a common superscript letter differ ($P < 0.05$).

Key Words: Phytase, Metatarsal and Rib Bone, Tissue

T157 Copra meal supplementation with mannanase on growth performance, pork quality and nutrient digestibility in growing-finishing pigs. D. H. Kim*, J. H. Yoon, W. S. Ju, Y. K. Hong, and Y. Y. Kim, *Seoul National University, Seoul, South Korea.*

This experiment was conducted to evaluate the effects of copra meal supplementation with mannanase on growth performance, pork quality and nutrient digestibility in growing-finishing pigs. Treatments were: 1) A: Negative control (basal diet), 2) B: Positive control (0% copra meal + 0.1% mannanase 800 IU), 3) C: (6% copra meal + 0.1% mannanase 800 IU), 4) D: (12% copra meal + 0.1% mannanase 800 IU), 5) E: (18% copra meal + 0.1% mannanase 800 IU). A total of 80 crossbred pigs ([Landrace x Yorkshire] x Duroc) with an average body weight of 27.2 kg (SE:0.720) were allotted to 5 treatments and 4 replicates with 4 pigs per pen in a randomized complete block design. Although copra meal contains high level of mannan which can not be digested by endogenous enzyme of the pig, it is very cheap and good source of energy like corn or sorghum. Mannan digestive enzyme, mannanase, was invented and manufactured commercially by CTCbio Ltd in Korea. During the experimental period, average daily gain (ADG) in treatment E (848 g) tended to be lower ($P > 0.09$) than treatment A (883 g), B (909 g), C (930 g) and treatment D (911 g). And feed:gain ratio (F:G ratio) of treatment E (2.93) was also higher ($P < 0.05$) than other treatments (A:2.75, B:2.59, C:2.69, D:2.79). During growing phase, the nutrient digestibility of crude protein in treatment E (79.7%) was lower ($P < 0.05$) than treatment A (89.8%), B (93.8%), C (88.9%) and treatment D (90.1%) which support the results of growth performance. Thiobarbituric acid reactive substance (TBARS) values of C (0.154), D (0.201) and E treatments (0.172) were higher ($P < 0.05$) than control treatment (A:0.141, B:0.128) which represented less saturated fatty-acid was accumulated when pigs were fed copra meal. These results suggest that 12% of copra meal can be supplemented in swine diet at the expense of corn and soy-bean meal resulted in reducing feed production cost.

Key Words: Copra Meal, Mannanase, Growing Pig

T158 Effects of virginiamycin on microbial ecology in ileal digesta and feces of growing pigs. M. Song*¹, L. L. Stewart¹, J. Barnes¹, B. R. Gramm², R. D. Nimmo², H. H. Stein¹, and J. E. Pettigrew¹, ¹University of Illinois, Urbana, ²Phibro Animal Health Co., Ridgefield Park, NJ.

A study was conducted to evaluate effects of virginiamycin on microbial ecology in ileal digesta and feces of growing pigs. Pigs ($n=15$, 35.0±2.7 kg BW) were surgically equipped with a T-cannula in the distal ileum. Pigs were assigned randomly to one of 3 dietary treatments: 1) a corn-soybean meal diet (CON), 2) CON + 11 mg/kg virginiamycin (V11), and 3) CON + 22 mg/kg virginiamycin (V22). During a 6-wk experiment, all pigs were fed the CON diet during wk 1, 5, and 6 and their respective treatment diets during wk 2, 3, and 4. Pigs were allowed *ad libitum* access to feed and water. Ileal digesta and fecal samples were collected on d 6 and 7 of each period to measure the number of bacterial cells by Gram's method and to use denaturing gradient gel electrophoresis (DGGE) to estimate the species diversity of the bacterial population (the number of bands) and quantitative measures of the similarity of population structures (banding pattern expressed by Sorenson's pairwise similarity coefficients (C_s)) among pigs within and between treatments. Virginiamycin treatments reduced ($P < 0.05$) the number of bacterial cells in ileal digesta for V22 (10.45 vs. 10.56 (CON), log (/g digesta), overall) and in feces for V11 and V22 (11.36 and 11.19 vs. 12.00 (CON), log (/g digesta), wk 4; 11.73 and 11.72 vs. 11.90 (CON), log (/g digesta),

overall) when virginiamycin treatments were imposed. Pigs fed V22 had fewer (22.13 vs. 26.83; $P < 0.05$) bands in ileal digesta than pigs fed CON over the entire experiment. There was no virginiamycin effect for the number of band in feces. In a few cases, specific bands were present in most pigs fed CON, but absent from most pigs fed virginiamycin treatments. There were no virginiamycin effects on intratreatment or intertreatment C_s values. In conclusion, virginiamycin reduces the number of total bacteria in ileal digesta and feces and eliminates some species of bacteria.

Key Words: Virginiamycin, Microbial Ecology, Growing Pigs

T159 Quantitative in vitro assay to evaluate yeast products concerning their binding activity of enteropathogenic bacteria. A. Ganner*, L. Fink, and G. Schatzmayr, *BioMin Research Center, Tulln, Lower Austria, Austria.*

Certain yeast products play an important role in protecting animals by displaying alternative adhesion sites to enteropathogenic bacteria. In the gastrointestinal tract those pathogens preferentially bind to the yeast cell wall and therefore animals are protected against infectious diseases. According to literature Mannan oligosaccharides (MOS) are the substances in the yeast cell wall which are responsible for binding of pathogens. Thus they have been discussed as antibiotic replacements in the past years.

In some publications it is questioned if the amount of MOS in the yeast cell wall is the substance responsible for immobilizing the enteric pathogens. Some test procedures are available to investigate the binding capacity of yeast products, however, there is no test assay described that aims on a quantitative measurement of the bacterial adhesion. Therefore we developed an in vitro microplate-based assay to determine the quantitative adhesion between enteric bacteria such as *E. coli* F4 and various yeast products by measuring the growth of the adhering bacteria by its optical density. The exponential phase of the adhering bacteria was determined and compared with the CFU/ml on the agar plate. A linear regression is compiled and the bacterial number bound to the yeast product is determined.

Different commercially available yeast cell wall, nucleotide and beta-glucan products have been tested for their ability to bind *E. coli* F4 quantitatively. The different cell wall products bound variably amount of *E. coli* F4, however binding capacity was not dependent on the amount of MOS. One cell wall product with 25% MOS bound 102 CFU/ml while another cell wall product with only 8% MOS bound 105 CFU/ml. In contrast, beta-glucan did not bind any bacteria. The nucleotide product bound 103 CFU/ml, suggesting that there is still a certain amount of cell wall fractions in that product. We believe that the cell wall structure plays an important role in pathogen immobilization, rather than just the total amount of MOS.

Key Words: *E. coli* Adhesion, Yeast, Bacterial Growth

T160 Exopolysaccharide produced by *Enterobacter cloacae* Z0206 improves the humoral and cellular responses of immunologically intact and immunocompromised mice. C. Xu, Y. Wang*, M. Jin, X. Yang, and Z. Xu, *Zhejiang University, Hangzhou, Zhejiang, P. R. China.*

The objective of the present study was to investigate the immunomodulatory activity of an exopolysaccharide produced by *Enterobacter cloacae* Z0206 (ECZ-EPS-1) on cellular and humoral immunity. The immunosuppressed mice were induced by cyclophosphamide (CP). 192 ICR male mice (18±2g) were randomly divided into 6 groups, each of which was designed 4 replicates with 8 mice in one cage per replicate. Three immunosuppressed groups were treated per os with ECZ-EPS-1 (0 mg/kg, 200 mg/kg and 400 mg/kg body weight (B.W.)) for 14 days, and CP was given intraperitoneally in a single dose of 50 mg/kg B.W. on the 12th day. Two immunologically intact groups were treated per os with ECZ-EPS-1 (200 mg/kg and 400 mg/kg B.W.) for 14 days. The dose volume was 0.4 mL. Control animals received same volume of normal saline. Indexes of immune organs, plaque forming cell (PFC) assay, quantitative hemolysis of sheep red blood cell (SRBC) (QHS), splenic lymphocytes proliferation, levels of subset of T lymphocyte, NK cell, IL-2 and TNF- α were studied in these animals. CP showed suppressive effects on immune organs weight and cellularity and other parameters of humoral immunity ($p < 0.01$) compared to control. ECZ-EPS-1 treatment (400 mg/kg B.W.) significantly ($p < 0.01$) increased PFC response in CP-treated animals compared to CP-treated animals alone. In QHS assay, ECZ-EPS-1 showed protection in CP-treated animals. ECZ-EPS-1 (400 mg/kg B.W.) can relieve immunodepression and significantly ($p < 0.01$) increase the spleen and thymus index, decrease CD8+ cells and stimulate the proliferation of T and B lymphocytes compared to CP-treated animals alone. ECZ-EPS-1 treatment itself produced no toxicity. The administration of ECZ-EPS-1 to CP-exposed animals resulted in improved humoral and cellular responses. ECZ-EPS-1 may be developed into a new kind of immunomodulation agent.

Key Words: Exopolysaccharide, Cyclophosphamide, Immunosuppressed Mice

T161 Feeding an encapsulated nutritional blend in combination with ractopamine improves feed conversion and loin depth in finishing pigs. J. W. Frank*¹, C. V. Maxwell¹, Z. B. Johnson¹, S. A. Hansen², and R. E. Musser³, ¹University of Arkansas, Fayetteville, ²Ridley Inc., Mankato, MN, ³SODA Feed Ingredients LLC, Mankato, MN.

Finishing pigs (GPK35 × EBX; n = 180, BW = 100 ± 0.7 kg) were allotted to 4 dietary treatments arranged as a 2 × 2 factorial (9 replicates/treatment) to evaluate the effects of feeding an Encapsulated Blend (EB) using Micropearls™ encapsulation technology fed at 2.27 kg/ton in combination with ractopamine (RAC; 4.5 g/ton) on growth performance and carcass measurements. The EB contained: fumaric, malic, citric, phosphoric, and lactic acids, L-carnitine, chromium picolinate, inulin, d-pantothenic acid, and niacin. All pigs were fed typical corn-soy diets with 0.05% L-lysine-HCl and 3% added fat. The control (CON) and EB blend diets were formulated to 0.7% total lysine and RAC and RAC+EB diets were formulated to 0.86% total lysine. There was no effect of feeding the EB or RAC on ADG or ADFI. RAC improved G:F compared to pigs fed diets without RAC ($P = 0.04$) and the EB improved G:F compared to pigs fed diets without EB ($P = 0.04$), however the interaction was not significant. Over the 24 d period, G:F for CON, EB, RAC, and RAC+EB treatments were 0.265, 0.296, 0.295, and 0.322, respectively. The final BW of CON, EB, RAC, and RAC+EB pigs were 123.1, 124.1, 124.1, and 125.9 kg. Feeding RAC increased the percentage carcass lean and ham lean, as well as, loin depth compared to pigs fed diets without RAC ($P < 0.02$). Feeding EB increased loin

depth (61.3 vs. 58.9 mm, $P = 0.04$) compared to pigs fed diets with no EB. Feeding EB also improved carcass lean (53.4 vs 53.0%) and ham weight (11.4 vs 11.1 kg) but these differences were not significant. The percentage carcass lean of CON, EB, RAC, and RAC+EB pigs were 52.5, 53.1, 53.4, and 53.7%. RAC and EB did not significantly increase ADG, ADFI, or final BW. However, RAC and EB significantly improved G:F and loin depth in an additive manner. This study demonstrates that RAC and EB can improve production parameters which are economically beneficial for swine production.

Key Words: Pigs, Encapsulated, Conversion

T162 Comparison of two encapsulated nutritional blends in combination with ractopamine on growth performance and carcass characteristics in finishing pigs. J. W. Frank^{*1}, C. V. Maxwell¹, Z. B. Johnson¹, S. A. Hansen², S. L. Johnston², M. De La Llata², and R. E. Musser³, ¹University of Arkansas, Fayetteville, ²Ridley Inc., Mankato, MN, ³SODA Feed Ingredients LLC, Mankato, MN.

Finishing pigs (GPK35 × EBU; $n = 208$, BW = 72.7 ± 0.6 kg) were allotted to 4 dietary treatments (9 replicates/treatment) to evaluate the effects of feeding two Encapsulated Blends (EB) using Micropearls™ technology in combination with ractopamine (RCT) on growth and carcass measurements. The first EB (EB1: 2.27 kg/ton) contained a blend of encapsulated fumaric, malic, citric, phosphoric, and lactic acids, added to L-carnitine, chromium picolinate, inulin, d-pantothenic acid, and niacin; while the second EB (EB2: 0.91 kg/ton) contained a blend where organic acids, L-carnitine, inulin, d-pantothenic acid, and niacin were encapsulated together. Phase 1 (d 0 – 18) diets were CON (0.8% Lys), RAC (0.8% Lys + 0 g/ton RCT), EB1 (0.8% Lys + EB1), and EB2 (0.8% Lys + EB2). Phase 2 (d 18 – 47) diets were CON (0.8% Lys), RAC (1.05% Lys + 4.5 g/ton RCT), EB1 (0.85% Lys + EB1 + 4.5 g/ton RCT), and EB2 (0.85% Lys + EB2 + 4.5 g/ton RCT). There was no effect of dietary treatment on ADG or ADFI during the study. Although G:F was lower in CON compared to RAC, EB1, or EB2 (0.282, 0.293, 0.296, or 0.297; respectively) these differences were not significant ($P = 0.15$). The final BW of the CON, RAC, EB1, and EB2 pigs were 124.0, 124.3, 125.6, and 126.2 kg, respectively ($P = 0.30$). Hot carcass weights were lower in CON compared to RAC, EB1, and EB2 fed pigs (92.8, 93.9, 94.1, and 95.2 kg; respectively), but these differences were not significant ($P = 0.34$). Carcass lean was lower ($P = 0.02$) in CON (52.4%) vs. RAC (53.5%) and EB1 (53.4%) pigs, with EB2 pigs being intermediate (53.0%). This research demonstrates that encapsulated blends fed to pigs with lower dietary lysine levels will provide equal or more efficient performance compared to ractopamine alone. In conclusion, feeding ractopamine and EB in combination provides improvement in traits economically beneficial to swine producers.

Key Words: Pigs, Encapsulated, Growth

T163 Effects of mannan oligosaccharide on growth performance and serum cytokines of weaned pigs. M. T. Che^{*}, R. W. Johnson, K. W. Kelley, and J. E. Pettigrew, University of Illinois, Urbana.

The experiment was conducted to determine responses of growth performance and serum cytokines to the dietary supplementation with mannan oligosaccharide (MOS) for weaned pigs. Weaned pigs ($n=160$, 6.5 kg,

20 days old) were randomly assigned to one of five dietary treatment groups on basis of body weight, gender, and origin of litter. There were 8 pens (replicates)/treatment and 4 pigs/pen. The 5 treatments were 1) 0% MOS (control); 2) 0.2% MOS fed for 2 weeks; 3) 0.2% MOS fed for 4 weeks; 4) 0.4% MOS fed for 2 weeks; and 5) 0.4% MOS fed for 4 weeks. Pigs were fed a 3-phase diet (1, 1, & 2 weeks per phase) with declining diet complexity. For the first 2 weeks, data from treatments 2 & 3 were pooled as 0.2% MOS, and 4 & 5 as 0.4% MOS because they had the same dietary level of MOS. Blood samples from each treatment ($n=8$, one/replicate) were collected weekly for determination of pro-inflammatory (TNF- α) and anti-inflammatory (IL-10) cytokines by ELISA. Over a 4-week study, there were no significant differences in average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G/F) among the treatment diets. Similarly, no treatment effects ($P>0.05$) on the serum levels of TNF- α and IL-10 were seen. Interestingly, serum levels of TNF- α were high at Day 7 and declined at Day 14 whereas serum levels of IL-10 were low at Day 7 and increased at Day 14 (Table 1). In conclusions, addition of MOS to nursery diets showed no improvement in growth performance and seemed not to affect serum levels of cytokines in weaned pigs.

Table 1. Growth performance and serum cytokines of nursery pigs fed different dietary levels of MOS (means ± SEM)

Items	Dietary levels of MOS (%)			P
	0 ^a	0.2 ^b	0.4 ^b	
Days 0-14				
ADG, g	274±18	247±12	260±10	0.38
ADFI, g	327±24	284±11	292±9	0.10
G/F, g/kg	852±15	870±19	887±15	0.44
TNF- α , pg/mL				
Day 7	150.1±53.2	207.7±44.6	158.9±37.4	0.61
Day 14	33.4±2.4	34.3±4.1	32.0±3.4	0.90
IL-10, pg/mL				
Day 7	28.9±1.7	29.1±1.1	30.5±1.1	0.59
Day 14	56.9±9.7	81.9±13.0	126.0±35.8	0.23

^a $n = 8$, ^b $n = 16$.

Key Words: MOS, Nursery Pigs, Serum Cytokines

T164 Fecal-oral transmission from sow to piglet of a *Bacillus* based direct-fed microbial (Adsero™) and its effect on clostridial shedding. A. Baker^{*1}, E. Davis¹, J. D. Spencer², R. Moser², and T. Rehberger¹, ¹Agtech Products, Inc., Waukesha, WI, ²JBS United, Inc., Sheridan, IN.

Two studies were conducted to determine the effect of a *Bacillus* based direct-fed microbial (Adsero™) on clostridial shedding in the sow and pig and transfer of Adsero™ spores from the sow to pig by fecal-oral transmission. In Exp. 1, 36 sows were divided into 4 treatments: control and Adsero™ (3.75 × 10⁵ cfu/g feed) fed for 2, 4, and 6 weeks prior to and throughout lactation. Fecal samples were collected to determine clostridial counts from 5 sows/treatment before Adsero™ supplementation, on d -1 prior to farrowing (d 0), and on d 3 and d 14 after farrowing. Pig fecal clostridial counts were also determined on d 14. Samples were also plated for the presence of Adsero™ on d -1 from 5 sows/treatment, on d 3 and d 5 from 3 piglet litters/treatment and on d 14 from sows and their respective litters. Clostridial counts in fecal samples did not differ

between control and treated sows ($P > 0.97$) or pigs ($P > 0.52$). Adsero™ was detected in the fecal samples of treated sows on d -1 and d 14 and in litters from treated sows on d 5 and d 14, documenting the fecal-oral transfer of Adsero™ from sow to pig. In Exp. 2, Adsero™ and control diets were fed 6 weeks prior to farrowing and throughout lactation to 30 sows. Gastrointestinal (GI) tracts from 15 pigs were collected on d 3 and d 10 of lactation for a total of 30 pigs/treatment. *Clostridium* was evaluated in the ileum and distal colon. *Clostridium* was reduced ($P = 0.07$) in the GI tract of pigs from treated litters on d 3. Pig GI tracts were plated for the presence of Adsero™ on d 3 but were not detected suggesting the reduction of *Clostridium* in the pig GI tracts resulted from clostridia reduction in the sow and environment. These data demonstrate the fecal-oral transmission of Adsero™ from sow to pig and indicate that pigs from sows fed Adsero™ harbor less *Clostridium* than those from unsupplemented sows. Although reduced clostridial shedding could not be demonstrated from fecal sampling, decreased *Clostridium* in the GI tract due to Adsero™ indicates GI tract measurements provide a more accurate assessment of clostridial populations.

Key Words: *Bacillus*, Swine, *Clostridium*

T165 Effect of carbohydrase enzyme supplementation on the performance and nutrient digestibility in growing pigs fed barley-wheat distillers dried grains with solubles based diet. I. A. Emiola*, B. A. Slominski, and C. M. Nyachoti, *University of Manitoba, Winnipeg, MB, Canada.*

An experiment was conducted to determine the growth performance and nutrient utilization in growing pigs fed barley-wheat distillers dried grains with soluble (DDGS) based diet supplemented with carbohydrase enzymes. Forty-eight growing pigs, housed 2 per pen, were randomly to 4 experimental diets (6 pens/treatment) on the basis of sex and BW. Treatments consisted of four diets; a positive control (PC) formulated to meet NRC (1998) nutrient requirement of growing pigs; a negative control (NC) formulated with energy and lysine reduced by 4 and 5% respectively, from the PC; NC supplemented with enzyme preparation A; and NC supplemented with enzyme preparation B. Enzyme A contained 2,600 units of xylanase, 1,200 units of glucanase, and 1,300 units of cellulase per kg of feed; Enzyme B contained 5,200 units of xylanase, 2,400 units of glucanase, and 2,600 units of cellulase per kg of diet. Chromic oxide was used as an indigestible marker and diets were fed as mash. The ADG was higher ($P < 0.05$) in the PC diet compared with the NC diet. Supplementing NC diet with enzyme preparations improved ADG ($P < 0.01$). Pigs fed enzyme supplemented diets had similar ADG compared with those fed with the PC diet. The ADFI was not influenced by the dietary treatments. Feed:gain ratio was higher ($P < 0.05$) in pigs fed the PC diet compared with those fed the NC diet, but not different from pigs fed the NC diets supplemented with enzyme. Addition of enzyme to the NC diet tended ($P < 0.10$) to improve F:G ratio. Compared with the NC diet, addition of enzyme preparations to NC diet improved ($P < 0.05$) ATTD of nitrogen, ADF, and crude fats and tended ($P < 0.10$) to improve NSP digestibility. The result indicates growing pigs can effectively utilize wheat DDGS at 30% inclusion level provided appropriate enzyme combination is included in the diet.

Key Words: Enzyme Supplementation, Pigs, Wheat Distillers Dried Grains with Solubles

T166 Pooled-analysis of data demonstrating the performance benefits of including mannan oligosaccharides in swine nursery diets. B. Corrigan*, D. Koehler, and G. Grinstead, *Vita Plus Corporation, Madison, WI.*

Data sets from seven separate trials having similar protocols were pooled for the purpose of strengthening the evidence concerning the effects of the addition of Mannan Oligosaccharides (MOS) to swine nursery diets. MOS are derived from yeast cell walls and are believed to bind and suppress enteric pathogens in the gut and have been shown to increase piglet ADG. Seven separate trials were conducted to evaluate the effect of the addition of MOS (Bio-MOS; Alltech, Nicholasville, KY) to nursery diets on piglet performance for the first 42 days post-weaning. The data represents performance from a total of 1,092 weaned pigs, 156 pigs/trial, with a pooled starting weight of 5.90 kg (17 to 22 days old). For each trial, pigs were randomly blocked by body weight to one of two treatments in a 30-pen nursery facility (13 pigs per pen) resulting in a pooled total of 36 reps. A typical four-phase nursery diet containing antibiotics was used as the **Control**, while the **MOS** treatment included 0.20, 0.10, and 0.05% MOS in diet phases I, II and III, respectively. Diet phases I,II,III and IV were fed from approximately d 0 to 7, 7 to 14, 14 to 28 and 28 to 42, respectively. Pig BW and feed disappearance were measured on approximately d 0, 7, 14, 21, 28 and 42 days post-weaning. ADG, ADFI, and G/F were calculated for all trials. The data were then pooled and analyzed to include the main effects of trial, rep and trt using the Proc Mix procedure of SPSS. Pigs consuming MOS were heavier on d 28 ($P < 0.01$; 15.34 vs. 15.01kg) and d 42 ($P = 0.07$; 24.93 vs. 24.57kg) than pigs fed the Control. ADFI was significantly ($P < 0.05$) increased by MOS from d 0 to 28 (0.432 vs. 0.419kg) and for the period from d 0 to 42 (0.623 vs. 0.609kg). Pigs fed MOS had greater ADG ($P < 0.05$) from d 0 to 28 (0.337 vs. 0.326kg) and d 0 to 42 (0.434 vs. 0.426kg). However, ADG was similar ($P > 0.05$) between trts from d 28 to 42 (0.604 vs. 0.605kg, respectively). F/G was similar ($P > 0.05$) between Control and MOS throughout the trial period. The pooled data demonstrate that the addition of MOS to nursery diets increases ADFI and ADG of piglets.

Key Words: Pigs, MOS

T167 Development and validation of a mastication simulator. A. Woda*¹, A. Mishellany¹, J. P. Meunier², O. François¹, M. Alric², and M. A. Peyron¹, ¹*Faculty of Odontology, Clermont Fd, France*, ²*Faculty of Pharmacy, Clermont Fd, France.*

The feed bolus obtained after mastication and the corresponding feed disruption process could be an important parameter to be studied for a better understanding of feed intake. However, the feed bolus collected before swallowing does not represent the whole feed bolus being swallowed. Therefore, a simulator of mastication was developed which allows collecting the whole amount of feedstuff.

The first aim of this study was to complete a simulator of mastication reproducing human masticatory behavior and producing a food bolus with similar texture than an in vivo food bolus. The second aim was to validate the simulator by comparing the food boluses obtained in vitro and in vivo.

Food boluses were obtained from both the simulator and 30 young (23.7 ± 2.2 years old) healthy and full dentate subjects chewing pea-

nuts and carrots. The food boluses were characterized by the particle size distribution. The boluses were cleaned in a 0.1 mm aperture sieve, dried and scanned. The photos were analysed with a specific software (PowderShape®, IST-Ag, Vickers, Switzerland). The average particle size (D50) was chosen as the dependent variable. Simulator calibration was realized by adjusting the different parameters (number of masticatory cycles, rotation and translation amplitudes of the mandibular piston head, masticatory force, temperature of the chamber, addition of artificial saliva).

Number of cycles and applied force were the predominant parameters in determining the in vitro particle size (D50). Setting the number of cycles at the mean value observed in vivo and choosing the force of the simulator allowed to obtain agreement between in vitro and in vivo values for each food. Addition of artificial saliva and control of the temperature only marginally influenced the D50 values.

The food boluses obtained in vitro with the simulator displayed the same D50 values that the food boluses produced in vivo. This apparatus could be an interesting tool to simulate the mastication of numerous animal species.

Key Words: Mastication, Simulator, In Vitro

T168 Effect of supplying mannan oligosaccharide (MOS) to pig diets on response to an immune challenge. I. F. Hung*¹, M. D. Lindemann¹, G. L. Cromwell¹, B. G. Kim¹, and M. G. Holt², ¹University of Kentucky, Lexington, ²VI-COR, Mason City, IA.

A modified yeast culture feed additive (Celmanax®; Vi-COR, Mason City IA) containing MOS, was used to evaluate the effects of supple-

mental MOS on responses in pigs challenged with lipopolysaccharide (LPS). Weaned pigs (BW: 6.0 ± 0.96 kg) were assigned to 3 treatments with 3 pigs/pen. The treatments included: 1) control basal diet [n = 24], 2) basal + low level MOS diet [0.02%, 0.01% for Wk 1-2 and 3-4, respectively; n = 12], and 3) basal + high level MOS diet [0.04%, 0.02%; n = 12]. After 4 wk, 32 pigs (2 pigs/pen; BW: 16.8 ± 0.62 kg) continued on test to examine the response to LPS injection. At 0 h (0600 on d 29), each pig received an i.p. injection of phosphate buffered saline (PBS; for half of Trt 1 pigs) or LPS (for all other pigs). At 2 h post-injection, the control pigs challenged with LPS lost weight compared with PBS-injected pigs (-145 vs. 341 g; P < 0.01) and had lower cumulative feed intake (CFI; 43 vs. 181 g; P = 0.01). Cumulative weight gain (CWG) or CFI differences were not detectable (P > 0.20) at 48 h post-injection. MOS supplementation had no effect on CWG or CFI. Respiratory rate of LPS-injected control pigs was higher than PBS-injected pigs at 3 h post-injection (83 vs. 38 breaths/min; P < 0.01) and was linearly decreased as MOS inclusion was increased in LPS-injected pigs (83, 68, and 64 breaths/min, respectively; P < 0.01). Rectal temperature was higher in the LPS-injected control pigs than in the PBS-injected pigs at 2 h (40.2 vs. 39.4°C; P < 0.01) and at 4 h (40.2 vs. 39.5°C; P < 0.01); MOS fed pigs had a lower rectal temperature than the LPS-controls at 2 h post-injection (40.2 vs. 39.9°C; P = 0.03). Serum cortisol values were higher in the LPS-injected control pigs than in the PBS-injected pigs at 2 h (16.3 vs. 10.0 mcg/dL; P = 0.03) and at 4 h (22.8 vs. 8.9 mcg/dL; P < 0.01) but were not moderated by MOS supplementation. The results showed that LPS challenge affects CWG, CFI, rectal temperature, respiratory rate, and cortisol levels and that dietary MOS supplementation reduced LPS-induced effects on respiratory rate and rectal temperature, but not on CWG, CFI or cortisol levels.

Key Words: Immune Stress, Mannan Oligosaccharide, Pigs