

870 Effects of phytobiotics on nursery pig performance. R. C. Sulabo^{*1}, J. Y. Jacela¹, J. M. DeRouchey¹, M. D. Tokach¹, F. Neher², R. D. Goodband¹, S. S. Dritz¹, and J. L. Nelssen¹, ¹Kansas State University, Manhattan, ²Biomim Inc., San Antonio, TX.

A total of 192 weanling pigs (initially weighing 5.85 kg and 22 ± 2 d of age, PIC) were used in a 42-d growth assay to determine the effects of phytobiotics (Biomim[®] P.E.P. 125 and 125T) on post-weaning growth performance. Pigs were blocked by initial weight and randomly allotted to one of four treatments: 1) negative control (feed containing no antibiotic or phytobiotic); 2) negative control + phytobiotic 1 (125 g/ton of Biomim[®] P.E.P. 125); 2) negative control + phytobiotic 2 (125 g/ton of Biomim[®] P.E.P. 125T), and 4) positive control (feed containing 140 g/ton of neomycin sulfate and 140 g/ton of oxytetracycline HCl; Neo/OTC). Each treatment had six pigs per pen and eight replications (pens). Phase 1 and 2 diets were fed from d 0 to 14 and d 14 to 42, respectively. Overall (d 0 to 42), ADG (g), ADFI (g), and G:F was 453, 642, and 0.71 for pigs fed the negative control; 481, 658, and 0.73 for pigs fed phytobiotic 1; 477, 649, and 0.74 for pigs fed phytobiotic 2; and 502, 705, and 0.71 for pigs fed the positive control. Pigs fed Neo/OTC had greater (P<0.03) ADG and ADFI than pigs fed the negative control diet and pigs fed diets with phytobiotics. Addition of phytobiotics to the nursery diet also increased (P<0.03) ADG and G:F compared to pigs fed diets without antibiotics and improved (P<0.01) G:F compared to pigs fed the positive control diet. No differences (P>0.38) were observed in ADFI between pigs fed the negative control diet and pigs fed either phytobiotic. Pigs fed diets with Neo/OTC had similar (P>0.28) G:F compared to pigs fed diets without antibiotics. No differences (P>0.52) were observed in ADG, ADFI, and G:F between pigs fed diets with phytobiotic 1 and 2. In conclusion, phytobiotics in nursery diets improved post-weaning growth performance when added to diets without antibiotics. Further research is needed to elucidate specific modes of action that caused positive effects in post-weaning growth and efficiency.

Key Words: Phytobiotics, Antibiotics, Nursery Pig

871 Dietary supplementation with *Acanthopanax Senticosus* extracts enhances the digestion and absorption of dietary protein and amino acids in weaned pigs. F. G. Yin^{*1}, X. F. Kong¹, Y. L. Yin¹, H. J. Liu¹, F. F. Xing¹, Q. H. He¹, T. J. Li¹, R. L. Huang¹, P. Zhang¹, and G. Y. Wu^{1,2}, ¹Institute of Subtropical Agriculture, The Chinese Academy of Sciences, Changsha, Hunan, China, ²Texas A&M University, College Station.

This study was conducted to determine the effects of dietary supplementation with *Acanthopanax senticosus* extracts (ASE) on the digestion and absorption of protein and amino acids in weaned pigs. Sixty piglets weaned at 21 d of age were randomly assigned to one of the three treatment groups, representing supplementation with 0 (control) or 0.1% ASE or 0.02% colistin (an antibiotic) to a corn- and soybean meal-based diets for 28 d (n=20 pigs/group). On d 0, 7, 14 and 28 post the initiation of ASE supplementation, venous blood samples were obtained from 5 pigs per group and sera were analyzed for amino acids. On d 28, pigs were euthanized to obtain digesta from the terminal ileum for determining total amino acids. The results indicated that serum concentrations of total amino acids in all groups of pigs were gradually increased (P<0.05) with increasing age. On d 28, serum concentrations of His and Lys in ASE-supplemented pigs were higher (P<0.05) than those in the other two groups, whereas serum concentrations of Thr in ASE-supplemented pigs were higher (P<0.05) than those in colistin-supplemented pigs. Serum concentrations of Phe, Tyr, Leu, Ile and Ala in ASE-supplemented pigs were higher (P<0.05) than those in the control group. Concentrations of Phe, Tyr, Leu, Ile, Ala, Gly, Asp, Glu, His, Lys and Ser in the digesta of in ASE-supplemented pigs were lower (P<0.05) than those in the other two groups. Further, concentrations of Val, Arg and Thr Ser were lower (P<0.05) in ASE-supplemented pigs than those in colistin-treated pigs. Collectively, these findings suggest that dietary supplementation with ASE enhances the digestion and absorption of protein or amino acids in weaned pigs.

Key Words: Herbal Extracts, Amino Acids, Weaned Pigs

Nonruminant Nutrition: Weanling Pig Nutrition

872 Effect of organic acids and antibiotic growth promoters on growth performance, gastrointestinal pH, intestinal microbial populations and immune responses of weaned pigs. Z. Li¹, D. Li¹, G. Yi^{*2}, J. Yin¹, and P. Sun¹, ¹China Agricultural University, Beijing, P.R. China, ²DaChan NorthEast Asia Corp, Beijing, P. R. China.

Two experiments compared the effects of feeding organic acids and antibiotic growth promoters (AGP) in weaned pigs. Nursery pigs (N=96, 7.80 ± 0.07 kg) were allotted to a control or supplemented with AGP (200 ppm chlortetracycline plus 60 ppm Lincospectin), 0.5% potassium diformate, or 0.5% dry organic acid blend ACTIVATE Starter DA. During 4 weeks postweaning, pigs fed AGP or ACTIVATE had better ADG (P<0.03) and GF (P<0.04) than controls. On d 14 postweaning, control pigs had the lowest fecal lactobacilli counts among all treatments (P<0.02), whereas pigs fed AGP or ACTIVATE tended to have lower fecal E. coli counts compared to the controls (P<0.08). Serum IGF-1 levels of pigs fed AGP was greater than control pigs (P<0.03). Weaned pigs (N=24, 5.94 ± 0.33 kg) were used

to evaluate AGP and ACTIVATE on performance, gastrointestinal measurements, and immune response of E. coli K88+ challenged pigs. Pigs were fed a control, or supplemented with AGP (100 ppm colistin sulfate, 50 ppm Kitasamycin plus 60 ppm Olaquinox), 0.5, or 1% ACTIVATE. During d 5 to 14 after E. coli K88+ challenge, pigs fed AGP, 0.5, or 1% ACTIVATE had higher gain than controls (P<0.01). Furthermore, control pigs had the worst GF among all treatments (P<0.03). On d 14, compared to the control pigs, pigs fed 0.5% ACTIVATE had higher lactobacilli in the duodenum, and pigs fed AGP and 1% ACTIVATE tended to have higher lactobacilli in the ileum (P<0.08). Pigs fed AGP, 0.5% or 1% ACTIVATE diets tended to have lower ileal E. coli counts compared to the controls (P<0.08). Serum interleukin-6, cortisol, or digesta pH values were not affected by treatment (P=0.11). These results indicate that AGP and organic acid blend ACTIVATE can improve growth performance of weaned pigs, mainly via modulating intestinal microflora populations or somatotrophic axis.

Key Words: Antibiotics, Growth Performance, Organic Acid

873 Dietary supplementation with glycyrrhetic acid (GA) increases endogenous arginine provision and growth performance in milk-fed piglets. Z. S. He¹, Y. L. Hu², Y. L. Yin^{*1,3}, R. L. Huang¹, X. F. Kong¹, T. J. Li¹, F. W. Li¹, and G. Y. Wu^{1,3}, ¹*Institute of Subtropical Agriculture, The Chinese Academy of Sciences, Changsha, Hunan, China*, ²*Nanjing Agricultural University, Nanjing, Jiangsu, China*, ³*Texas A&M University, College Station*.

Physiological levels of cortisol stimulate intestinal arginine synthesis in piglets. Interestingly, some herbal extracts contain GA (a pentacyclic triterpenoid derivative of the β -type amyrin), which has a chemical structure similar to cortisol. This study was conducted to test the hypothesis that dietary GA supplementation may increase arginine availability and growth performance in young pigs. In Experiment 1, 20 piglets (Landrace x Yorkshire) with similar BW (2.92 ± 0.10 kg) were obtained from 5 sows (4 piglets/sow) and weaned at 7 d of age to a liquid milk-replacer diet. After a 2-d period of adaptation, piglets were assigned randomly to one of the 4 treatments, representing supplementation with 0, 0.01, 0.02 or 0.04% GA to the milk powder for 12 d (1 piglet/pen; 5 pigs/treatment). Dietary supplementation with 0.02% GA resulted in highest ADG among all the treatment groups ($P < 0.05$). Experiment 2 was conducted as Experiment 1, except that 9-d-old pigs were fed a liquid milk diet supplemented with 0 or 0.02% GA for 12 d ($n = 15$ pigs/group). On d 0, 5, and 12, BW was measured and venous blood samples were obtained for the analysis of hematology and amino acids. Compared with the control, dietary supplementation with 0.02% GA increased feed intake by 27%, ADG by 47%, and the gain:feed ratio by 17%, while reducing scour frequency by 40% ($P < 0.05$); increased the ratio of lymphocytes to leukocytes by 12-13% and reduced the ratio of neutrophils to leukocytes by 20-27%, while elevating mean corpuscular hemoglobin concentrations by 5% ($P < 0.05$); and increased plasma arginine concentrations by 25% ($P < 0.05$). These results suggest that GA enhances the endogenous provision of arginine and growth performance of milk-fed piglets.

Key Words: Glycyrrhetic Acid, Pigs, Arginine

874 Dietary arginine supplementation enhances the immune status of piglets. B. E. Tan¹, Y. L. Yin^{*1}, X. F. Kong¹, T. J. Li¹, R. L. Huang¹, P. Zhang¹, F. G. Yin¹, I. Shinzato², S. W. Kim^{3,4}, and G. Y. Wu^{1,4}, ¹*Institute of Subtropical Agriculture, The Chinese Academy of Sciences, Changsha, Hunan, China*, ²*Ajinomoto, Tokyo, Japan*, ³*Texas Tech University, Lubbock*, ⁴*Texas A&M University, College Station*.

The study was conducted to determine effects of dietary L-arginine (Arg) supplementation on the immune status of 7- to 21-d-old pigs fed a milk replacer diet, which consisted of 60% dried whey, 26% dried skim milk, 6.2% a-casein, 3.6% lactose, 1.65% glucose, 1% calcium lactate, 1% dihydrocalcium phosphate, 0.1% vitamin premix, 0.2% mineral premix, 0.1% lysine, 0.1% methionine, and 0.05% antibiotic. Seventy piglets (Landrace x Yorkshire) were weaned at 7 d of age and assigned randomly to one of the five treatments (14 piglets/treatment), representing supplementation with 0% (control), 0.2%, 0.4%, 0.6% or 0.8% Arg to the milk replacer powder. Milk powder was dissolved in water to obtain 18% DM, and the resultant liquid milk was fed to piglets every 4 h for 14 d. On d 7, the ratio of spleen weight to BW and serum concentrations of immunoglobulin (Ig) M were higher and serum concentrations of interleukin (IL)-8 were lower in Arg-supplemented piglets compared with control piglets ($P < 0.05$). On d 14, the ratio of thymus weight to BW in piglets supplemented with 0.6% dietary Arg

and the numbers of white blood cells (WBC) and blood lymphocytes in piglets supplemented with 0.8% dietary Arg were higher than those in control piglets ($P < 0.05$). On d 14, the numbers of WBC and blood granulocytes as well as serum concentrations of IL-1 β and IL-2 were higher in piglets supplemented with 0.4% dietary Arg, compared with control piglets ($P < 0.05$). Dietary supplementation with 0.6% and 0.8% Arg enhanced lymphocyte proliferation in response to phytohaemagglutinin and increased serum concentrations of IgG and tumor necrosis factor, compared with control piglets ($P < 0.05$). Collectively, these findings suggest that dietary Arg supplementation is beneficial for improving immune function in piglets.

Key Words: Arginine, Immune-function, Piglets

875 Evaluation of different additives in weaned pigs raised in a commercial setting. K. J. Touchette¹, M. D. Newcomb¹, J. A. Cuaron², G. Lanz-Arias², and D. W. Giesting^{*1}, ¹*Cargill Animal Nutrition, Elk River, MN*, ²*INIFIAP/PAIPEME, Queretaro, Qro., Mexico*.

A trial was conducted with 244 weaned pigs (19.6 d, $6.15 \pm .34$ kg) to evaluate the effect of additives alone or in combination with antibiotics on nursery performance. The pigs were weaned and assigned to one of 6 treatments in a 2x3 factorial arrangement in a RCBD with 2 levels of antibiotics (AB, none or added) and 3 levels of additives (none, ADD3, or ADD4). The antibiotic used in this study was carbadox fed at 55 mg/kg. The additives used in this study were combinations of enzymes, sweetener, a *Bacillus* DFM, and a plant extract. The ADD3 trt contained the first 3 additives, and the ADD4 trt contained all 4 additives. Pigs were fed a 3-phase, 28 d nursery program with diet changes on d 7 and 21. For phase 1, there were no effects of treatment on animal performance. For phase 2, treatment did not affect feed intake, while pigs fed either ADD3 or ADD4 had improved ADG ($p < 0.001$) and G/F ($p < 0.004$) versus the diets with no additives, while AB did not affect ADG or G/F. For phase 3, AB improved ADFI ($p < 0.02$) compared to no AB, and both ADD3 and ADD4 treatments improved ADFI ($p < 0.04$) compared to the diet with no additives. For both ADG and G/F, there were AB x additive interactions ($p < 0.03$), with no effect of either additive when in diets without, but an improvement in ADG in diets with AB. Adding additives to diets without AB decreased G/F, while adding additives to diets with AB increased G/F. For the entire 28 d trial, AB improved ADFI ($p < 0.04$), while there were interactions for ADG and G/F ($p < 0.003$). Both additives had no effect on ADG or G/F in diets without AB, while they improved ADG and G/F in diets with AB. This study demonstrates that both additives and antibiotics improved nursery performance.

Key Words: Swine, Antibiotics, Additives

876 The interaction of dietary energy and an *E. coli* phytase enzyme on the performance of weanling pigs. A. D. Beaulieu^{*1}, J. F. Patience¹, T. M. Parr², C. L. Wyatt², and M. R. Bedford², ¹*Prairie Swine Centre, Inc., Saskatoon, SK, Canada*, ²*Syngenta Animal Nutrition, RTP, NC*.

Supplementation of swine diets with phytase enzyme improves the digestibility and retention of phytate-bound P. Phytate complexes other nutrients; however, the data demonstrating an improvement in the utilization of these nutrients is equivocal. The objective of this experiment was to examine the interaction of dietary energy and an

E. coli derived phytase (Quantum™) on weanling pig performance. A total of 406 pigs (9.30 ± 0.51 kg) were utilized in a 42-d experiment. Pelleted phase 1 and 2 diets were fed for 2 and 4 wks, respectively. Treatments consisted of a positive control (PC: 3.48 and 3.52 Mcal DE/kg in phases 1 and 2, respectively) and 6 additional treatments arranged as a 3 x 2 factorial (3 DE levels [HI: 3.45 and 3.49, MED: 3.41 and 3.45, LO: 3.37 and 3.40 Mcal DE/kg for phases 1 and 2, respectively]; 0, 500 FTU phytase/kg). The PC contained 0.32 and 0.23% aP and 0.70 and 0.60% Ca in phases 1 and 2, respectively. Treatment diets contained 0.18 and 0.09% aP and 0.58 and 0.48% Ca in phases 1 and 2. To exploit the factorial arrangement, the initial statistical analysis excluded the PC. Overall ADG improved from 500 to 560 g/d (P<0.001), ADFI from 900 to 950 g/d (P<0.01) and FCE from 0.58 to 0.62 (P<0.05) with 500 FTU/kg phytase. Phytase by energy interactions were non-significant (P>0.05); thus, the analysis examining the effect of energy also excluded the phytase treatments. Increasing DE improved ADG, FCE (linear, P<0.02) and ADFI (quadratic, P<0.05). The ADG and FCE of the PC were similar to HI (P>0.15) regardless of phytase supplementation, but similar to MED and LO only when 500 FTU/kg phytase was included (P>0.20). The ADG and FCE of the PC were improved (P<0.02) relative to the MED and LO treatments when no enzyme was added. Regardless of the diet DE content, phytase improved ADG and FCE in weanling pigs. Based on ADG and FCE, 500 FTU/kg of an *E. coli* derived phytase provided approximately 100 kcal DE/kg when added to the diets of weanling pigs.

Key Words: Weanling Pigs, Phytase, Dietary Energy

877 Bioavailability of iron in an organic iron source for young pigs. G. L. Cromwell*, M. D. Lindemann, and H. J. Monegue, *University of Kentucky, Lexington.*

An experiment involving 96 pigs was conducted to determine the bioavailability of Fe in an organic Fe source (Bioplex®Fe, Alltech, Nicholasville, KY) (OrgFe) relative to the bioavailability of Fe in an inorganic Fe source (FeSO₄•H₂O) (FeSul). Pigs not injected with Fe at birth were weaned at 17-22 d of age and fed a low-Fe diet for 4-5 d, resulting in low hemoglobin (Hb, 4.1 g/dl) and hematocrit (Hct, 17.9%) levels. The pigs (n=84, initial BW=5.5 kg) were allotted to 7 treatments with 6 replications of 2 pigs/pen. Treatments were a low-Fe basal diet (35 ppm Fe) and the basal with 14, 28, or 42 ppm added Fe from OrgFe or the basal with 14, 28, or 42 ppm added Fe from FeSul. An 8th treatment consisted of 12 positive control (PC) pigs injected with 150 mg Fe at birth and fed the basal diet with 150 ppm added Fe as FeSul during the study. These pigs had initial Hb of 10.4 g/dl and Hct of 36.8%. Diets were fed on an ad libitum basis and pigs were on plastic coated floors. At the end of the 28-d study, 4 pigs/treatment were killed and liver, heart, spleen, and kidneys were collected for Fe determination. Increasing the Fe level from either Fe source resulted in linear (P<0.001) increases in ADG (257, 339, 430, 438, 372, 424, 452 g for treatments 1 to 7, respectively). ADG for the PC pigs was 565 g. Hb and Hct also responded to added Fe from the 2 sources (4.82, 6.51, 7.28, 8.73, 7.14, 8.00, 9.95 g/dl; 20.8, 24.9, 28.3, 31.1, 27.1, 29.5, 35.2%). Levels of Hb and Hct for the PC pigs were 12.33 g/dl and 40.5%. Liver Fe (ppm of DM) was 15.3, 18.8, 25.5, 29.0, 28.8, 31.3, 43.5, 99.0 and total liver Fe was 1.31, 1.77, 2.93, 3.65, 3.16, 3.37, 4.97, 14.13 mg for the 8 treatments. Hb, Hct, and liver Fe responded linearly (P<0.001) to added Fe from either source, and the responses were greater for FeSul than for OrgFe (P<0.001). Hb, Hct, and liver Fe

were regressed on Fe intake for each Fe source with the basal included in both regressions. Based on slope ratios, the bioavailability of Fe in the organic Fe source was 80 to 85% of the bioavailability of Fe in FeSul. Based on this study, the Fe in Bioplex®Fe seems to be less available to pigs than the Fe in FeSO₄•H₂O.

Key Words: Pigs, Iron, Bioavailability

878 A comparison of water delivered direct fed microbials or organic acids with in-feed antibiotics on weanling pig growth performance, intestinal morphology, gut microbiota and immune status following a *Salmonella typhimurium* challenge. M. C. Walsh*¹, D. M. Sholly¹, K. L. Saddoris¹, B. E. Aldridge¹, A. L. Sutton¹, M. H. Rostagno², B. T. Richert¹, and J. S. Radcliffe¹, ¹*Purdue University, West Lafayette, IN*, ²*USDA Livestock Behaviour Unit, West Lafayette, IN.*

Pigs (n=88) weaned at ~19 d of age were used in a 14 d experiment to compare the effects of water delivered direct fed microbials (DFM) or a propionic acid based blend with in-feed antibiotics on growth performance, intestinal morphology, gut microbiota and immune status following a *Salmonella typhimurium* challenge. Treatments were: 1) negative control (NC), 2) Trt. 1 + water supplied DFM (*Enterococcus faecium*, *Bacillus subtilis*, *Bacillus licheniformis*, Chr Hansen, Inc.), 3) Trt. 1 + water supplied propionic acid based blend (PA blend, 2.58 mL/L; Kem San®) and 4) Trt. 1 + in feed antibiotics (carbadox, 55 ppm). Pigs were challenged intra-nasally with *Salmonella typhimurium* on d 6 post-weaning, and harvested (22 pigs/d) on d 6 (prior to challenge), 8, 10 and 14 post-weaning. Water delivered DFM or PA blend or in feed antibiotics improved ADG (P<0.05) on d 2-4 post-challenge compared to NC pigs. Water supplied DFM tended (P<0.10) to increase G:F from d 0-5 pre-challenge compared to NC pigs. Water supplied DFM increased (P<0.05) duodenal villus height on d 4 post-challenge compared to pigs receiving carbadox or NC pigs. Water delivered PA blend tended (P<0.10) to decrease Enterobacteriaceae counts in the cecum on d 0 and 2 post-challenge compared to the DFM treatment. *Salmonella* presence in the ileum, cecum and mesenteric lymph nodes was not different among treatments at any time point post-challenge. However, the proportion of pigs shedding salmonella in the feces was decreased 100 and 50% by DFM and PA blend treatments, respectively, on d 5 post-challenge. There were no treatment differences in TNFα concentrations in serum, duodenal, jejunal, or ileal tissue at any time point post-challenge. However, serum TNFα linearly increased (P<0.04) through d 4 post-challenge for all treatments. Treatments had no effect on microbial presence and/or concentrations in the gastrointestinal tract, but did improve growth performance and intestinal morphology following a salmonella challenge.

Key Words: Pig, Direct Fed Microbials, Water Acidification

879 Influence of diet and manure management on growth performance and carcass characteristics of wean-finish pigs. D. M. Sholly*, R. B. Hinson, K. L. Saddoris, M. C. Walsh, A. L. Sutton, B. T. Richert, and J. S. Radcliffe, *Purdue University, West Lafayette, IN.*

A total of 1,920 pigs (initial BW=5.8 kg) were used in a 2 x 2 factorial, 153 d wean-finish experiment to determine the effects of diet (CTL or LNE) and manure management (deep pit, DP vs. monthly pull

plug-recharge, PP) on growth performance, live ultrasound scans, and carcass characteristics. The CTL and LNE diets were corn-SBM based and had equal Lys:calorie. The LNE diets had reduced CP and P, increased synthetic amino acids, contained a non-sulfur trace mineral premix and added fat. Pigs were housed in a 12 room environmental building, with 30 barrows and 30 gilts per room. Split-sex and phase feeding (9 phases) were used to meet or exceed the nutrient requirements of pigs (NRC, 1998) at different stages of growth. Nursery ADFI was greater for pigs fed the CTL diet compared to LNE fed pigs (1.00 vs. 0.96 kg/d; $P<0.05$), but ADG and d 56 BW (avg BW=37.0 kg) were not different ($P>0.05$). The LNE diet tended to improve nursery G:F over the CTL diet (0.45 vs. 0.42; $P=0.06$). Grow-finish ADG, G:F, and market BW were greater (0.97 vs. 0.94 kg/d, 0.39 vs. 0.35, and 130.1 vs. 125.4 kg, respectively; $P<0.05$) for LNE fed pigs compared to CTL fed pigs. Market BW pigs fed LNE diets had a greater loin eye area (LEA) and backfat compared to CTL fed pigs (40.7 vs. 38.9 cm² and 20.9 vs. 17.9 mm, respectively; $P<0.05$). Pigs housed under the DP manure management had greater market BW live scan LEA (40.3 vs. 39.3 cm²; $P<0.05$) compared to PP manure management. Pigs fed the CTL diet had greater ($P<0.05$) carcass % lean, however LNE fed pigs had greater carcass % yield, fat depth, and hot carcass wt ($P<0.05$). Deep pit manure management increased carcass yield (74.83 vs. 73.82%; $P<0.05$) compared to PP manure strategy. All other carcass characteristics and nursery and grow-finish growth performance were unaffected by manure management. Diet formulation can impact pig performance to a greater extent than either a deep pit or pull plug-recharge manure management system.

Key Words: Pigs, Diet Manipulation, Manure Management

880 Relationship of isoprostanes, biomarker of oxidative stress, and pig productivity. T. S. Stahl*, J. B. Zamzow, D. Wang, and A. E. Atwood, *Iowa State University, Ames.*

Variation in a urinary isoprostanes, a biomarker of systemic oxidative stress status, was determined in pigs and its relationship to pig productivity was quantified. An imbalance between oxidative and antioxidative processes within cells results in excess production of reactive oxidative species which in turn create oxidized lipids and potential cell dysfunction. These cell dysfunctions include a greater loss of cellular energy and a potential redirection of energetic pathways. Four female pigs from each of 27 litters were selected from a single sow strain and herd and reared in a common environment. Pigs were individually penned, self-fed a nutritionally adequate diet and weighed weekly from weaning to 126 kg BW. Freshly voided urine was collected and the isoprostane/creatinine (IC, ng/mg) content determined at BW (± 3) of 6, 18, 54, 90 and 126 kg. Urinary IC varied ($P<0.01$) among litters and stage of growth. Urinary IC were elevated in young pigs and declined as the pigs grew, averaging 28.8, 18.3, 5.1, 2.9 and 1.6 ng/mg at 6, 18, 54, 90 and 126 kg BW, respectively. Urinary IC was elevated in small birth weight pigs initially (at 6, 18 kg BW) but not at later stages of growth. Urinary IC at 54 and 90 kg BW was negatively associated ($P<0.02$) with efficiency of feed utilization from BW of 36-72 and 72-108 kg, respectively, but not daily BW gain. Each 1 ng increase in urinary IC at 54 and 90 kg BW was associated with an additional .02 and .04 kg of feed per unit BW gain. From the last 75 pigs to reach 126 kg BW, pigs (11 pigs/group) with mean urinary IC at 54-90 kg BW in the highest and lowest 15% of the sample population were killed at 135 kg BW and their carcass traits evaluated.

The high urinary IC pigs possessed greater subcutaneous backfat (20.8 vs. 16.6 mm, tenth rib) and leaf fat (1.94 vs. 1.31 kg). Based on these data, greater oxidative stress in pigs is associated with less efficient feed utilization and the accumulation of body fat.

Key Words: Isoprostanes, Energetic Efficiency, Pigs

881 The impact of coating on thermostability and bioefficacy of phytase in weaned pigs fed corn-soybean meal based diets.

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A study evaluated the effects of a new coating on thermal tolerance and bioefficacy of a bacteria-derived, phytase product Phyzyme XP (6-phytase, EC 3.1.3.26; U-phytase) against the same phytase with a thermo-protective coating (Phyzyme XP-TPT; C-phytase) in weaned pigs fed corn-soybean meal-based diets. Individually-housed 28-day-old pigs weaned at 21 d with average initial BW of 8.20 kg (8 pigs per treatment) were randomly allotted to 7 dietary treatments based on corn-soybean meal for a 21 d. The treatments were: 1, Positive Control (PC) mash; 2, Negative Control (NC) mash; 3, NC pelleted at 90°C; 4, NC + 500 U/kg U-phytase; 5, NC + 500 U/kg C-phytase; 6, NC + 500 U/kg C-phytase pelleted at 80°C; and 7, NC + 500 U/kg C-phytase pelleted at 90°C. The PC and NC diets were formulated to be isocaloric and isonitrogenous. Calcium content was 1.01 and 0.83% and available P content was 0.40 and 0.22% in the PC and NC diets, respectively. Pig BW and feed intake were measured on d 7, 14, and 21. Data were analyzed as a CRD using ANOVA. Pigs fed the PC performed better than those fed the NC ($P<0.05$). Both the U-phytase and C-phytase increased ADG and improved G:F ($P<0.05$) but not ADFI in mash diets compared with the negative control. Compared to NC diets pelleted at 90°C, G:F for C-phytase diet pelleted at 90°C improved ($P<0.05$) by 16%. Other performance variables were not significantly different ($P>0.05$) in pigs fed C-phytase in mash diets or diets pelleted at 80 and 90°C diets compared with U-phytase diet. In conclusion, in diets limiting in Ca and P, a coated phytase product in mash or diets pelleted at 90°C improved performance of weaner pigs indicating that phytase bioefficacy remained intact.

Key Words: Phytase, Pelleting, Weaned pig

882 Enzymatic comparisons of *Aspergillus niger* PhyA and *Escherichia coli* AppA2 phytases.

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Both *Aspergillus niger* PhyA and bacterial *Escherichia coli* AppA2 have been used to increase phosphorus bioavailability and decrease excreta phosphorus content in simple-stomached animals. Although different feeding efficiencies have been observed with these two phytases, it remains unclear whether or not this difference is due to inherent enzymatic properties of these proteins. The objective of our study was to compare the kinetic properties of these two enzymes at the commonly observed stomach pH 3.5. Both PhyA and AppA2 were expressed in the same *Pichia pastoris* host using a constitutive expression system, and purified to >95% homogeneity using two steps of ion-exchange chromatography. While AppA2 had a lower affinity

to phytate with a higher K_m (74 vs. 34 μM , $P < 0.01$) than PhyA, this bacterial enzyme displayed a greater ($P < 0.01$) V_{max} (1,070 vs. 120 $\mu\text{mol min}^{-1} \text{mg}^{-1}$), k_{cat} (840 vs. 170 sec^{-1}) and k_{cat}/K_m (1.1×10^7 vs. $0.5 \times 10^7 \text{ M}^{-1} \text{sec}^{-1}$) than that of PhyA. PhyA and AppA2 had optimal temperatures of 65°C (pH 5.0) and 58°C (pH 3.5), respectively. Both enzymes had two pH optima at 37°C: PhyA with a peak at 2.0 and a greater peak at 5.5, while AppA2 had a peak at 3.4 and a greater peak at 5.0. PhyA was nearly twenty times more resistant to competitive inhibition by myo-inositol hexasulfate than AppA2 ($K_i = 3.9$ vs. 0.2 μM). Likewise, 4 times more (1.4 vs. 0.3 M) guanidine hydrochloride was required to produce the same 50% inhibition of enzyme activity for PhyA than AppA2. Overall, AppA2 possesses superior kinetic properties compared to PhyA at pH 3.5, which helps in catalyzing phytate hydrolysis at commonly observed gastric conditions of simple-stomached animals.

Key Words: Phytase, Kinetics, Enzymology

883 Effects of dietary electrolyte balance and molasses in diets with corn-based distillers dried grains with solubles on growth performance in nursery and finishing pigs. C. Feoli*¹, J. D. Hancock¹, S. M. Williams¹, T. L. Gugle¹, S. D. Carter², and N. A. Cole³, ¹Kansas State University, Manhattan, ²Oklahoma State University, Stillwater, ³USDA/ARS, Bushland, TX.

Two assays were conducted to determine the effects of dietary electrolyte balance (dEB) and molasses in diets with corn-based

distillers dried grains with solubles (DDGS, Sioux River Ethanol, Hudson, SD) on growth performance of nursery and finishing pigs. For the first experiment, 126 nursery pigs (35 d old and avg BW of 10.2 kg) were assigned with six pigs/pen and seven pens/treatment. Treatments were a corn-soybean meal-based control and diets with DDGS as 30% of the formula without and with 0.93% sodium bicarbonate to bring dEB to 64 meq/kg $[(\text{Na} + \text{K}) \times (\text{Cl} + \text{S})]$ as in the control. Diets were formulated to 1.4% Lys, 0.75% Ca, and 0.35% available P. Pigs fed the control diet had greater ADG ($P < 0.03$) and ADFI ($P < 0.08$) but did not differ in G:F ($P > 0.6$) compared to those fed diets with DDGS. Addition of sodium bicarbonate did not improve growth performance ($P > 0.3$). For the second experiment, a total of 70 gilts (avg BW of 60.5 kg) were assigned with two pigs/pen and five pens/treatment. The pigs were fed the experimental diets for 26 d, fed a common diet for 6 d, and then reassigned to a different treatment for an additional 26-d assay. The end result was 10 pens per treatment. Treatments were a corn-soybean meal-based control and diets with DDGS as 40% of the formula without and with 5% molasses and sodium bicarbonate (none, 1, and 2%) arranged as a 2 x 3 factorial plus control. Diets were formulated to 0.9% Lys, 0.6% Ca, and 0.22% available P. Pigs fed the control diet had greater ADG and ADFI ($P < 0.001$) but did not differ in G:F ($P > 0.4$) compared to those fed diets with DDGS. Adding molasses and(or) sodium bicarbonate did not affect ADG ($P > 0.5$) or ADFI ($P > 0.14$) and adding molasses actually decreased ($P < 0.03$) G:F. In conclusion, adding sodium bicarbonate and(or) molasses to diets with DDGS did not improve growth performance in nursery or finishing pigs.

Key Words: Distillers Dried Grains, dEB, Pig

Physiology & Endocrinology - Livestock and Poultry: Reproductive Physiology

884 Emerging concepts regarding the integration of neuroendocrine signals that regulate gonadotropin secretion in domestic livestock. C. A. Lents*¹ and C. R. Barb², ¹The University of Georgia, Athens, ²USDA-ARS, Russell Research Center, Athens, GA.

The pulsatile discharge of GnRH from hypothalamic neurons is obligatory for the synthesis and release of the pituitary gonadotropins. Many conditions have been characterized that reduce gonadotropin secretion and result in anovulatory states which contribute to inefficiencies in livestock production. Nutrient intake, body energy reserves, suckling, and season are all major regulators of gonadotropin secretion in mammals. Lack of adequate gonadotropin secretion during the pre-pubertal and postpartum periods adversely impact the reproductive efficiency of domestic herds and flocks. These various anovulatory states typically have one fundamental similarity; a lack of hypothalamic release of GnRH. For the most part, pituitary function remains intact, as indicated by the release of gonadotropin from the anterior pituitary gland in response to exogenous GnRH. Identifying the hormonal and metabolic factors that mediate the central effects of these factors on the GnRH neuronal network in the brain has been an intensely studied area. Additionally, season and metabolic status seems to enhance the central mechanism of estradiol negative feedback on LH secretion. Despite much progress, identifying the mechanisms that directly mediate these actions on GnRH neurons in a consistent and well regulated fashion has proven difficult. For example, GnRH neurons appear to lack estrogen receptors, suggesting that feedback effects of estrogen are mediated through interneuronal systems. A role

for the peptide hormone kisspeptin as a major regulator of gonadotropin secretion has recently emerged. Recent reports have demonstrated a potential role of kisspeptin in regulating the onset of puberty as well as mediating metabolic and photoperiodic control of reproduction in rodents. The purpose of this review is to summarize what is currently known regarding kisspeptin in domestic livestock and postulate the role it may have in regulating reproductive function of these larger mammalian species.

Key Words: Kisspeptin, Gonadotropin, Reproduction

885 Effects of human chorionic gonadotropin (hCG) and gonadotropin releasing hormone (GnRH) on follicle and corpus luteum dynamics and concentrations of progesterone in pre-pubertal Angus heifers. C. R. Dahlen*², J. E. Larson¹, G. Marquezini¹, and G. C. Lamb¹, ¹North Central Research and Outreach Center, University of Minnesota, Grand Rapids, ²Northwest Research and Outreach Center, University of Minnesota, Crookston.

We determined the effects of administering human chorionic gonadotropin (hCG) on subsequent follicle and corpus luteum dynamics and concentrations of progesterone in pre-pubertal heifers. Forty-seven purebred, pre-pubertal Angus heifers were stratified by age and weight and assigned randomly to one of three treatments: 1) heifers received a 100 μg injection of GnRH (GnRH; $n = 16$); 2) heifers received a 1,000 IU injection of hCG (H1000; $n = 16$); and 3) heifers received a 500 IU