

Swine Species: Weanling Pigs

TH411 Mitochondrially targeted antioxidants as a strategy to reduce oxidative stress in pigs. M. R. O'Neil^{*1}, G. A. Kraus², N. K. Gabler¹, S. M. Lonergan¹, and D. C. Beitz¹, ¹*Department of Animal Science, Iowa State University, Ames*, ²*Department of Chemistry, Iowa State University, Ames*.

Free radical production by the mitochondria and subsequent oxidative cellular damage is a potential target for management of oxidative stress in animals. Targeting antioxidant compounds to the mitochondria may increase the efficiency with which antioxidants decrease oxidative stress. Thirty weaned barrows (68.9 ± 7.4 kg) were used in a completely randomized design to test the effect of dietary tertiary butylhydroquinone (TBHQ) and the triphenylphosphonium derivatized mitochondrially targeted TBHQ (mitoTBHQ) on measures of oxidative stress and growth. Each barrow was assigned randomly to one of 3 treatment diets—control, TBHQ (control plus 8.546 mg/kg TBHQ per day), and mitoTBHQ (control plus 30 mg/kg mitoTBHQ per day). Barrows were penned individually and fed for 6 weeks. Barrows were weighed and urine was collected weekly, and serum and plasma were collected every 2 weeks. All barrows were evaluated for loin eye area and backfat thickness via ultrasound at the initiation of treatments and before harvest. Barrows did not differ in lean tissue accretion ($P = 0.152$) with control, TBHQ, and mitoTBHQ barrows gaining 12.41, 12.79, and 14.54 kg of lean tissue, respectively. Similarly backfat thickness was unaffected ($P = 0.184$) by treatment with control, TBHQ, and mitoTBHQ barrows having backfat thicknesses of 0.65, 0.69, and 0.63 inches, respectively.

Key Words: oxidative stress, antioxidant, tertiary butylhydroquinone

TH412 Effect of neonatal Ca nutrition on growth, bone development and differentiation of mesenchymal stem cell in pigs. Y. Li^{*}, B. Seabolt, and C. Stahl, *North Carolina State University, Raleigh*.

Dietary Ca content plays an important role in animal growth, bone integrity and behavior of mesenchymal stem cells, especially in the neonatal period. To fully characterize the effects of neonatal Ca nutrition, we conducted a Ca dose response feeding trial for 14 d with 24 piglets (28 ± 6 h of age). Pigs were allotted into deficient, adequate, or excessive Ca treatments, fed with 0.6, 0.9 or 1.3% Ca on a DM basis, respectively. Blood was collected at d7 and d14 to monitor Ca status. Urine and bones were collected at the end of the study for determining Ca metabolism. Also bone marrow derived MSCs were isolated. In vivo MSC proliferation was determined by an oral dose of BrdU 12h before tissue collection. Twenty individual colonies were obtained from each pig, and the most and least osteogenic (O⁺/O⁻) and the most and least adipogenic (A⁺/A⁻) clones were selected based on functional staining. The results show that the ADG and ADFI were depressed by Ca deficiency, but not improved by excessive Ca. Bone mineral content ($P < 0.05$) was dose dependent on dietary Ca concentration. With increased dietary Ca, urinary Ca excretion increased ($P < 0.05$) and blood PTH level decreased ($P < 0.05$), while the sera Ca and P levels were stable. Proliferation rate of MSC was increased ($P < 0.05$) by excessive Ca. Bone-forming ability was depressed in MSC from Ca deficient pigs. However, both Ca deficient ($P < 0.1$) and Ca excess ($P < 0.05$) groups improved the fat-forming ability of MSC. There is no treatment effect on differentiation ability in A⁺/A⁻ or O⁺/O⁻. The data suggest that neonatal Ca nutrition affects bone development by changing the programming potential of MSC.

Key Words: neonatal pig, calcium

TH413 Immunological and growth response in pre-weanling piglets administered an oral gavage of alligator blood. S. Means^{*}, B. Chung, T. Shields, and F. LeMieux, *McNeese State University, Lake Charles, LA*.

The objective of this study was to evaluate the effects of alligator blood administered over a 3 d period on pre and post-weaning growth of pigs. A total of 18 crossbred pigs (Yorkshire × Landrace × Duroc) from 2 litters were randomly allocated to a control (tap water) or treatment alligator blood (AB). Pigs were administered 5 mL of an oral gavage twice daily for a total of 3 d before weaning. Pig weights were recorded at d -3, 0, 3, 7, and 14 to determine average daily gain. Additionally pigs were bled at d -3 and 0 in relation to weaning to evaluate blood chemistry (glucose, blood urea nitrogen, creatinine, phosphorus, total protein, albumin, and globulin) and ELISA testing was conducted to determine immunoglobulin levels (IgG, IgA, and IgM). Treatment did not affect ($P > 0.10$) growth of pigs. Pigs on control treatment had increased levels of glucose, phosphorus, total protein, albumin, and globulin over the 3 d treatment period. Over the 3 d treatment period pigs receiving AB had a 12.02% decrease in blood glucose compared with an increase of 2.7% for the control pigs. Globulin levels decreased 13.23% in pigs administered AB versus a decrease of 19.24% in the control pigs. After 3d of treatment, serum immunoglobulin levels of IgG were lower ($P < 0.05$) in pigs receiving AB treatment. There was no difference ($P > 0.10$) in IgM levels. Immunoglobulin G levels in pigs receiving alligator blood decreased 32% in a 3 d period. This was double the 14% decrease in pigs receiving control treatments. Immunoglobulin A levels were also lower ($P < 0.05$) in pigs receiving the AB gavage. These results suggest that alligator blood may be a beneficial additive for nursing and weanling pigs.

Key Words: oral gavage, pre-weanling pig, alligator blood

TH414 Effect of in-feed enzymes on ileal and cecal microbial populations of nursery pigs. G. M. Preis², M. H. Rostagno^{*1}, B. T. Richert², and J. E. Ferrel³, ¹*USDA-ARS, West Lafayette, IN*, ²*Purdue University, West Lafayette, IN*, ³*Elanco Animal Health, Greenfield, IN*.

Exogenous enzymes are increasingly being used as feed additives in swine production to promote growth performance and efficiency of nutrient utilization. However, there is a lack of knowledge on their potential effects on the intestinal microbial populations. A total of 48 pigs (37 d of age; 8.35 ± 0.10 kg of BW) were used to evaluate the effect of 2 strains of β -mannanase enzymes, normal (HC) and heat tolerant (HT), the combination of HC with β -glucanase (HC+G), and alkaline phosphatase (AP) on growth performance and intestinal microbial ecology during a 16 d period. Pigs were allocated in a randomized incomplete block design into individual pens, stratified by litter and initial BW, to 5 treatments, with 9 or 10 pigs/treatment. Dietary treatment enzyme concentrations were: Negative Control (NC; no enzymes); HC, 0.10 MU/kg mannanase; HT, 0.06 MU/kg mannanase; HC+G, 0.10 MU/kg HC mannanase + 0.077 MU/kg glucanase; AP, 0.066 MU/kg. Final BW were similar among treatments (16.73 kg; $P > 0.05$). However, ADG of HC+G pigs tended to be greater than HC ($P < 0.10$), and numerically greater ADG (9.2%) and ADFI (11.9%, $P < 0.10$) than NC pigs. All other treatments were intermediate with no significant feed efficiency difference. Ileal anaerobes, coliforms, and lactobacilli were not affected by the dietary supplementation of enzymes. However, HT increased ileal aerobes ($P < 0.05$), whereas HC increased Bifidobacterium spp. and

Enterococcus spp. ($P < 0.05$). Moreover, HC+G and AP reduced ileal concentrations of *E. coli*, and increased Bifidobacterium spp. ($P < 0.05$). In the cecum, no effects were observed on aerobes, anaerobes, lactobacilli, and Bifidobacterium spp. However, HC increased concentrations of Enterococcus spp. ($P < 0.05$), whereas AP reduced concentrations of coliforms and *E. coli* ($P < 0.05$) in the cecum. It is concluded that the use of exogenous enzymes can affect the intestinal microbial ecology, and therefore, may provide an interesting alternative to manipulate bacterial populations of interest in nursery pigs.

Key Words: enzyme, microbial ecology, swine

TH415 Evaluating postweaning macromineral and organic trace mineral supplementation on performance and tissue mineral status of nursery pigs. R. S. Samuel^{*1}, J. S. Jolliff², and D. C. Mahan², ¹Alltech Inc., Nicholasville, KY, ²The Ohio State University, Columbus.

Pigs may be weaned onto diets with greater concentrations of minerals than recommended to attempt to maximize performance. Due to mineral antagonisms, it is important to provide minerals in the appropriate form and balance. The objective of the experiment was to investigate the effects of reduced dietary mineral inclusion in diets fed to newly weaned pigs on growth performance and bone and plasma mineral status. Pigs ($n = 180$) were weaned onto 1 of 7 dietary treatments as pens of 5 pigs. Pigs were fed diets formulated to contain Normal (0.80% Ca), Mid (0.52% Ca), or Low (0.27% Ca) and available P (2:1 ratio) according to recommendations of NRC (1998). The Mid and Low diets were fed for 0 to 7, 0 to 14, or 0 to 21 d before feeding the Normal diet until 35 d postweaning. All diets were formulated to contain organic trace minerals (Bioplex, Alltech, Inc.) providing Cu, Fe, and Mn at 25% of NRC levels and Bioplex Zn and Sel-Plex (Alltech, Inc.) providing 100% of NRC levels. The ADG of piglets fed the Mid Ca and P diet for 21 d postweaning was numerically greater ($P = 0.14$) from d 21 to 35 than pigs fed only the Normal diet. The ADFI of pigs fed only the Normal diet was greater ($P = 0.03$) from d 7 to 21 compared with the pigs fed the Ca and P restricted diets. Feed efficiency of pigs fed Ca and P restricted diets for 21 d postweaning was greater ($P = 0.05$) than for pigs fed only the Normal diet, indicating compensatory gain after extended mineral restriction. Percent bone ash in the femur was lower ($P = 0.01$) in pigs fed the Low Ca and P diet for 21 d postweaning compared with the other treatments. The resulting significant ($P = 0.01$) treatment x week interaction indicated that the percent bone ash of the femur from pigs fed the Mid diets was not affected by moderately reduced dietary Ca and P. Macro- (Ca, P, Mg, S) and trace mineral (Cu, Fe, Zn, Mn, Se) concentrations in the femur, liver and plasma were not affected by dietary treatment. These results indicate that moderately reduced dietary Ca and P and organic trace minerals at 25% of NRC recommendations was not detrimental to animal performance or tissue mineral status.

Key Words: minerals, weaning, Bioplex

TH416 Zinc source and level on nursery pig growth performance. R. S. Samuel^{*1}, J. S. Jolliff², B. W. James³, and D. C. Mahan², ¹Alltech Inc., Nicholasville, KY, ²The Ohio State University, Columbus, ³Kalmbach Feeds Inc., Upper Sandusky, OH.

Zinc (Zn) is routinely added to swine diets to prevent disease and improve growth performance. The current recommended dietary inclusion of Zn is 100 ppm and 80 ppm for growing swine up to 11 kg and 25 kg, respectively. Dietary inclusion of ZnO has been demonstrated

to reduce postweaning diarrhea and improve weight gain of piglets. The objective of this experiment was to investigate the effects of dietary organic (Bioplex Zn) and inorganic (Zn sulfate) Zn sources and interactions with ZnO on growth performance. Pigs ($n = 900$) were fed diets in a 3×5 factorial arrangement of 3 ZnO levels (0, 1500, or 3000 ppm) and 5 Zn additions (0, 75 or 100 ppm Bioplex Zn or Zn sulfate). Pigs were provided free access to feed and water in a commercial research facility. Diets based on corn and soybean meal were formulated to provide all nutrients, except Zn, at the recommended levels in 3 dietary phases (0 to 7, 7 to 21, and 21 to 42 d). All diets contained a commercially available phytase source. Compared with no added Zn, the addition of at least 75 ppm Zn, from Bioplex Zn or as Zn sulfate, increased ($P < 0.01$) ADG and improved ($P < 0.05$) feed efficiency from 21 to 42 d and overall ($P < 0.01$; 0 to 42 d). The addition of 100 ppm Zn, from Bioplex Zn or as Zn sulfate, increased ($P < 0.05$) ADFI and improved ($P = 0.03$) feed efficiency from 21 to 42 d, compared with no added Zn. Positive effects of Bioplex Zn or Zn sulfate additions on ADG were detected after ZnO was removed from the diets. This observation contradicts observations from a previous experiment performed in this facility in which pigs previously fed ZnO had a decrease in performance after ZnO was removed from the diets. In this experiment, there were no significant interactions of Zn source and ZnO on measured parameters. In conclusion, 75 ppm Zn from Bioplex Zn or Zn sulfate was sufficient to meet the requirement for Zn in conventional nursery diets containing phytase and there were no negative effects on performance due to the removal of ZnO from the diets.

Key Words: zinc oxide, Bioplex, weaning

TH417 Probiotics and enzymes on swine feed: Post-weaning to growing phase effects. L. G. M. Amaral, H. Silveira, F. M. Carvalho Jr., C. A. P. Garbosa, and V. S. Cantarelli^{*}, Federal University of Lavras, Lavras, Minas Gerais, Brazil.

The aim of this study was to evaluate the effects of an enzyme pool associated with probiotics on performance, intestinal morphology and incidence of diarrhea in pigs from 24 to 129 d old. The study was conducted at the Swine Experimental Center (SEC), at Federal University of Lavras. Eighty pigs (females and castrated males), weaned at 24 d of age, with initial average weight of 6.04 ± 0.18 kg were used. The experiment was a randomized block design and lasted 105 d. Treatments were: PB - *Bacillus subtilis*; PB + E - Probiotics + Enzymes; ATB - antibiotics; CTR - control (5 rep/trt). Pigs were distributed according to the weaning weight and housed in groups of 4 animals per pen (experimental plot). The data were subjected to ANOVA by SNK test (5%) and the diarrhea incidence to the Kruskal-Wallis analysis. Intestinal morphology was not affected by diet ($P > 0.05$). The ADG, feed conversion and final BW was greater ($P < 0.05$) for ATB pigs compared with PB and PB+E trt from 24 to 66 d. However, the use of PB + E resulted in the same BW at 129 d as pigs supplemented with ATB, while consuming less feed ($P < 0.05$). All treatments had high incidences of diarrhea in the first 2 wk of experiment. Animals supplemented with antibiotics had high incidences of diarrhea during the exchange diets (45 to 52 d) and at the time of relocation (66 to 70 d). Despite the high percentage of diarrhea in the first week, animals supplemented with *B. subtilis* showed lower ($P < 0.05$) incidence of diarrhea during the changing in the feed. The additives tested are not as effective as antibiotics at immediately post-weaning, but beneficial effects during the growing phase on performance and frequency of diarrhea were observed.

Key Words: swine, feed additive, weaning

TH418 Dose response assessment of a whey and yeast-derived additive for nursery pigs. J. S. Monegue¹, M. D. Lindemann¹, H. J. Monegue¹, M. Thomas¹, and S. Jalukar², ¹University of Kentucky, Lexington, ²Varied Industries Corporation, Mason City, IA.

The use of products containing whey and/or yeast-metabolites as dietary supplements has often demonstrated improved feed efficiency and reduction of scours in nursery pigs. A total of 96 crossbred pigs (mean initial BW, 6.92 ± 0.95 kg) were used to evaluate a novel product (called CAP-110) on nursery pig performance and gastrointestinal health. This product contained a proprietary blend of whey fermentation derived sugars, organic acids, and yeast metabolites. Pigs were blocked at weaning into groups based on sex and bodyweight. Pigs were randomly allotted within blocks to 4 dietary treatments and housed 4 pigs/pen (2 barrows and 2 gilts) for a total of 6 replicates. Pens were left somewhat dirty from the previous nursery group to put greater environmental pressure on the newly weaned pigs (simulating a dirty nursery) with the intent of inducing more diarrhea. The 4 dietary treatments were a control diet and 3 levels (0.025, 0.050, 0.10%; or 0.25, 0.50, and 1.00 kg/metric ton [MT]) of the test ingredient. The study was conducted over a 5-week period with 3 diet phases. Phases 1, 2, and 3 diets were fed for 1, 2, and 2 weeks respectively. Performance measures of ADG, ADFI, and Feed/Gain were determined weekly. Pigs receiving Diet 2 (0.025% test ingredient) were 3.4, 1.5, and 5.9% heavier at the end of the study than those fed Diets 1, 3, and 4, respectively. For the total study period, pigs fed Diet 2 had 4.7% greater ADG (505, 528, 517, 488 g/d; $P = 0.093$; quadratic $P = 0.055$), 3.0% greater ADFI (809, 834, 822, 821 g/d; $P = 0.94$), and 1.4% lower Feed:Gain (1.600, 1.578, 1.588, 1.683; $P = 0.28$) compared with pigs fed the control diet. While the P -values varied, observations of all responses across all phases were visually quadratic in nature. Routine fecal scoring of the pigs and pens was conducted on d 1, 3, 7, 10, 14, 21, 28, and 35. There was no diarrhea observed in the study so questions about potential efficacy of the product when diarrhea is present cannot be answered. This new product has potential to improve performance and, because of the responses observed, lower inclusion rates should be examined to determine the optimal inclusion rate.

Key Words: growth, pig, yeast metabolite

TH419 Evaluation of Celmanax SCP supplementation in sow diets on piglet performance at weaning. M. Peng¹, C. Guozhu², and S. Jalukar³, ¹Anyou Animal Nutrition R&D Co. Ltd., Huanggang City, Hubei Province, China, ²All Vectors Biotechnology Co. Ltd., Wuhan, China, ³Vi-COR, Mason City, IA.

A highly concentrated form of enzymatically hydrolyzed yeast and yeast culture was evaluated for its potential to improve sow reproductive performance at a private research farm affiliated to a commercial feed company in Hubei Province, China. Twenty-seven Landrace × Yorkshire × Duroc crossbred sows were allotted to 3 treatments in a completely randomized block design with 9 replicates/treatment. Sow allotment was equalized by parity. Treatments were supplemented 14 d before farrowing and for 21 d post-farrowing during lactation phase. The treatments were: No additive, Celmanax SCP (Vi-COR, Mason City, IA) 100 g/MT and Celmanax SCP 200 g/MT. Feed was available ad libitum during lactation. Feed intake, litter size, litter weight at birth and weaning, mortality and scouring in baby pigs was recorded. Piglets

were weighed individually at birth and at weaning. Experimental data was analyzed by SPSS 17.0 software and DuSCPan for comparison. A dose dependent response in improving piglet birth and weaning weights, decreasing scours, and mortality was noted with Celmanax SCP 200g/MT inclusion resulting in the best performance. Feed intake and litter size was not affected by the additives. Piglet mortality at birth was also not affected by the treatments. Individual piglet and litter weight at birth was not affected by the additives. However, when Celmanax SCP was supplemented at 200g/MT, piglet weaning weight was 5.48 kg vs. 5.03 kg ($P < 0.01$) and litter weaning weight was 55.93 kg vs. 46.05 kg ($P < 0.05$) compared with control. Scouring score decreased from 8.13% in control to 4.51% ($P < 0.05$) with Celmanax SCP 200 g/MT inclusion rate. Mortality decreased from 16.15% in control to 5.51% ($P > 0.05$) with Celmanax SCP 200 g/MT treatment. In conclusion, supplementation of Celmanax SCP 2 weeks before farrowing and during lactation clearly increased piglet body weight, reduced mortality and improved piglet health at weaning.

Key Words: sows yeast, reproductive performance

TH420 Eating patterns of newly weaned piglets. T. van Kempen^{1,2} and J.-W. Resink¹, ¹Nutreco, Boxmeer, the Netherlands, ²North Carolina State University, Raleigh.

Weaning imposes stress which affects health and thus performance. The prime problem appears to be their adaptation to eating solid feed. To better understand how pigs start eating, 96 piglets were weaned at 25 d of age at 1000 h. Pigs were placed into 8 pens equipped with feeding stations with a measuring accuracy of 1 g. Visits and cumulative feed disappearance were recorded for each piglet: the first 10 g was considered their first meal, and the 2nd 10 g their 2nd meal. Light was on continuously the first 24 h and afterward a 16h light 8h dark pattern was introduced; feeders, however, were permanently lit. Ninety-three piglets visited the feeder on the day of weaning; the remaining 3 the next morning. Seventy-eight piglets consumed their first meal the day of weaning, 9 the next day, and the remaining 9 the 2nd day. The day of weaning the average feed disappearance was 2.6g and the largest feed disappearance recorded was 22g. Despite 24 h light, there were nearly no feeder visits between 2000 and 0400 h the first night (38, compared with 1932 before 2000 h). The next day a clear day-night pattern was discernable as well but there were approximately 10× more feeder visits during night time. 77 piglets finished both their first and 2nd meal the first day. Interestingly, the 2nd meal occurred 50% later than the first meal ($r^2 = 0.98$). Piglets that did not finish their 2nd meal before 20:00 waited with finishing their 2nd meal till the next morning (after 6:00) where again a linear relationship was observed between the time till the first meal and the 2nd meal. Pigs that waited till the 2nd day for their first meal only ate their 2nd meal at the end of the 2nd day or the third day: none of these pigs ate a meal at night. The data show that pigs immediately upon weaning change to a day-night feed intake pattern despite 24 h light in the nursery. Pigs that were hesitant to start eating did so carefully; the lag time between the first 10 g and second 10 g feed disappearance was 50% of the time it took to the first 10 g feed disappearance. The time of day that piglets are weaned may thus well affect their transition time to solid feed.

Key Words: piglet, weaning, feed intake pattern