

Nonruminant Nutrition: Weanling Pig

M172 Effects of freeze-dried *Lactobacillus reuteri* on growth performance, serum indices, and intestinal microflora of weaned pigs. D. Y. Zhang, H. F. Ji,* J. Wang, S. X. Wang, H. Liu, and Y. M. Wang, *Institute of Animal Husbandry and Veterinary Medicine, Beijing Academy of Agriculture and Forestry Sciences, Beijing, China.*

The objective of this study was to evaluate the effect of supplementation of freeze-dried *Lactobacillus reuteri* on growth performance, serum indices, and intestinal microflora of weaned piglets compared with antibiotic. The strain was isolated from the cecum mucosa of healthy weanling pigs in our laboratory. Sixty 4 crossbred (Duroc × Landrace × Large White) weaned pigs with 9.02 ± 1.01 kg BW were randomly distributed to 4 groups comprised of an antibiotic-containing control (Zinc Bacitracin; 1 g/kg) and 3 dietary inclusion levels of *L. reuteri* (5.6×10^6 , 2.4×10^7 and 1.5×10^8 cfu/g of diet). The experiment lasted 30 d. Live weight gain and feed consumption of the weaned pigs were recorded weekly. Blood and fecal samples were collected at the end of the experiment. Viable bacterial counts were estimated by a standard plate counting method. *L. reuteri* supplementation had the same effect on ADG, ADFI, and FCR compared with the antibiotic control. Supplementation of *L. reuteri* decreased ($P < 0.05$) the serum urea nitrogen concentration and increased ($P < 0.01$) the IFN- γ concentration compared with the antibiotic control. Overall, supplementation with 2.4×10^7 cfu of *L. reuteri*/g produced the greatest improvements ($P < 0.05$) in serum indices among the 3 different probiotic levels. The number of *Lactobacilli* in the feces was increased ($P < 0.01$) by the supplementation of *L. reuteri* compared with control (2.74×10^8 , 3.00×10^8 , 5.35×10^8 vs. 1.25×10^8 cfu/g). The 2.4×10^7 and 1.5×10^8 cfu/g *L. reuteri* supplementation showed lower ($P < 0.01$) *Escherichia coli* in the feces compared with control group (4.65×10^6 , 6.75×10^6 vs. 4.35×10^7 cfu/g), and 2.4×10^7 cfu/g supplementation had lower ($P < 0.01$) *Escherichia coli* than 1.5×10^8 cfu/g. This experiment indicated that *L. reuteri* at 2.4×10^7 cfu/g may be the most appropriate and feasible level with regard to enhance the growth performance, promote the serum indices, and improve the intestinal bacteria of weaned pigs.

Key Words: *Lactobacillus reuteri*, weaned pigs

M173 Effects of two kinds of lactic acid bacteria on productive performance and intestinal microflora of weaned piglets. H. Liu, H. F. Ji,* S. X. Wang, J. Wang, D. Y. Zhang, and Y. M. Wang, *Institute of Animal Husbandry and Veterinary Medicine, Beijing Academy of Agriculture and Forestry Sciences, Beijing, China.*

The objective of this study was to evaluate the effects of 2 kinds of lactic acid bacteria (*Lactobacillus plantarum* and *Enterococcus faecalis*, isolated from small intestinal mucosa of healthy piglets) on the productive performance and intestinal microflora of weaned piglets. Ninety weaned piglets (Duroc × Large Yorkshire × Landrace) at 35 ± 2 d were randomly assigned to 3 groups and each group had 3 replicates with 10 piglets per replicates on the basis of body weights. Group A was fed basal diet, group B was fed basal diet with *Lactobacillus plantarum* (1.0×10^7 cfu/g diet), and group C was fed basal diet with *Enterococcus faecalis* (3.6×10^6 cfu/g diet). The concentrations of 2 bacterium were based on the previously study in our lab and were the optimal additional level. The experiment lasted 30 d. All piglets were free access to feed and water. The liveweight gains and feed consumption of the piglets were recorded weekly and fecal samples were collected at the end of the experiment. Data were analyzed using the ANOVA procedures of SPSS 18.0.

Supplementation of *Lactobacillus plantarum* and *Enterococcus faecalis* significantly improved ADG (by 7.37% and 8.79% respectively; $P < 0.05$) and FCR (by 7.28% and 8.05% respectively; $P < 0.05$) compared with control group. Pigs supplemented with *Lactobacillus plantarum* and *Enterococcus faecalis* had lower diarrhea incidence compared with pigs fed basal diet (1.44%, 1.33%, vs. 2.56%, $P < 0.05$). The result also showed that, compared with basal diet group, there was increase in lactobacillus counts (by 4.18% and 3.96%, $P < 0.05$) and decrease in *E. coli* counts (by 9.31% and 10.08%, $P > 0.05$) in the fecal samples of weaned pigs fed *Lactobacillus plantarum* and *Enterococcus faecalis*. There was no significant difference between group B and C on ADG, FCR, diarrhea incidence, and fecal bacterium. This experiment indicated that supplying 2 kinds of lactic acid bacteria had the same beneficial effect on enhancing growth performance, reducing diarrhea incidence, and improving the intestinal health of weaned piglets.

Key Words: lactic acid bacteria, weaned piglet, intestinal microflora

M174 Assessment of probiotic properties of *Enterococcus faecalis* isolated from gastrointestinal tract of piglet and its effect on growth performance of weaned pigs. J. Wang, H. F. Ji,* F. M. Wang, S. X. Wang, D. Y. Zhang, H. Liu, and Y. M. Wang, *Institute of Animal Husbandry and Veterinary Medicine, Beijing Academy of Agriculture and Forestry Sciences, Beijing, China.*

The objective of this study was to evaluate the probiotic characteristics of *Enterococcus faecalis* isolated from gastrointestinal tract of healthy piglet and its effects on growth performance of weaned pigs. Acid tolerance of *Enterococcus faecalis* was estimated by the survival rate when it cultured in simulated gastric fluid with pH of 2.0 and 3.0 after 2 h. Bile salt resistance of this strain was examined in MRS broth containing pig bile salt concentration from 0.1% to 0.3%. The sizes of the inhibitory zone of *Enterococcus faecalis* against *S. aureus*, *E. coli*, and *S. choleraesuis* were also determined to estimate the inhibition of this strain on pathogenic bacteria. Sixty-four piglets weaned at 28 d of age (8.05 ± 0.47 kg BW), were divided into 4 groups comprising of control with zinc bacitracin at 60 mg/kg, 3 treatments of different *Enterococcus faecalis* concentration (1.8×10^6 , 6.2×10^7 , 3.1×10^8 cfu/g diet). The experiment lasted 4 weeks. Data were analyzed using the ANOVA procedures of SAS. The results showed that *Enterococcus faecalis* had high tolerance to simulated gastric fluid at pH 2.0 and 3.0 with survival rates were 86.1% and 91.3%, respectively. The viable count of *Enterococcus faecalis* achieved 10^7 cfu/mL when it cultured in 0.2% pig bile salt medium of MRS 6 h, while the viable count achieved 10^6 cfu/mL cultured in 0.3% medium. Furthermore, *Enterococcus faecalis* performed well in inhibitory activity to 3 selected pathogens. The feeding trial results exhibited that *Enterococcus faecalis* supplementation enhanced average daily gain (490, 508, 471 vs. 466 g/d; $P < 0.05$) and feed conversation ratio (1.59, 1.60, 1.65 vs. 1.76; $P < 0.05$) in weaned pigs compared with control. The incidence of diarrhea was significantly decreased along with the increase of *Enterococcus faecalis* concentration in the diet compared with antibiotic control (13.1, 10.4, 9.0 vs. 15.2). It was also showed that there was increase in *Lactobacillus* counts and a numerical decrease in *E. coli* counts in the fecal samples of weaned pigs fed *Enterococcus faecalis*, especially with 6.2×10^7 cfu/g of feed. It was concluded from this study that the strain *Enterococcus faecalis* could be considered as a potential probiotic for weaned pigs.

Key Words: *Enterococcus faecalis*, probiotic, growth performance

M175 Digestibility of feed containing energy and protein ingredients to substitute dried whey and lactose for weanling pigs. L. V. C. Girão^{*1}, F. G. Luiggi¹, G. Mello¹, A. C. Stradiotti¹, C. C. E. J. Villela¹, N. B. Athayde¹, V. S. Cantarelli², R. Fasanaro¹, and D. A. Berto¹, ¹São Paulo State University, Faculty of Veterinary Medicine and Animal Science, Botucatu Campus, Botucatu, SP, Brazil, ²University Federal of Lavras, Lavras, MG, Brazil.

This experiment was carried out with the aim of evaluating apparent digestibility of pre-initial (PI) and initial (I) diets for weanling pigs containing a combination of energetic and protein ingredients to substitute dried whey and lactose. A total of 108 crossbred pigs (Landrace × Large White) weaned at 21 ± 2 d of age with an average of 6.02 kg BW were used in a 4-wk experiment. Piglets were blocked by weight and distributed in a randomized complete block design of 4 treatments and 3 animals per pen: 1) control with dried whey and lactose; 2) whey protein concentrate, maltodextrin and an energetic blend containing maltodextrin and corn oil; 3) gluten meal 60% CP, maltodextrin and energetic blend containing maltodextrin and corn oil; and 4) protein energetic blend containing maltodextrin, corn steep liquor and corn oil. The blends used were obtained by spray dryer. Two digestibility trials were performed with diets containing 0.1% chromium (III) oxide as a digestibility marker starting on the 7th and 19th day of the experiment. Pooled fecal samples were collected from an experimental unit (3 animals per pen) during the 2 periods (12th to 17th and 24th and 29th day post-weaning), and digestibility parameters evaluated included: dry matter (DCDM), ether extract (DCEE), crude protein (DCCP), and gross energy (DCGE); digestible values for dry matter (DMD), protein (PD), ether extract (EED), and energy (ED). Data was statistically analyzed using the GLM models of SAS. Differences were found just for I diet in DCEE was higher ($P = 0.007$) for piglets fed diets 3) and 4) (71.19 and 69.38%, respectively), PD was higher ($P = 0.002$) for piglets fed diets 1) and 4) (12.35 and 12.03%, respectively), and EED was higher ($P < 0.001$) for piglets fed diet 3) (4.27%). The ingredient blends tested in this experiment, whether associated or not with vegetable or animal protein sources, were feasible substitutes for dried whey and lactose in PI and I diets. They did not interfere in the digestibility coefficient of dry matter, crude protein and gross energy of weanling pigs aged from 21 to 50 d old.

Key Words: blend, maltodextrin, microencapsulated

M176 Dietary clay does not negatively affect growth performance, nitrogen and iron status, or diarrhea score of weanling pigs. M. Song^{*1}, B. G. Kim², O. Osuna³, and H. H. Stein¹, ¹University of Illinois, Urbana, ²Konkuk University, Seoul, Korea, ³Milwhite Inc., Brownsville, TX.

Clay may be included in diets fed to weanling pigs as mycotoxin binders, but it has been speculated that dietary clay may bind nutrients in the intestinal tract of pigs and increase diarrhea among pigs. The objective of this experiment was, therefore, to test the hypothesis that dietary clay does not negatively influence growth performance, serum nitrogen, serum iron parameters, and diarrhea score (DS) of weanling pigs. A total of 256 weanling pigs (initial BW: 6.49 ± 0.97 kg) were randomly allotted to 8 diets, 8 replicate pens per diet, and 4 pigs per pen in a randomized complete block design. A conventional control diet was formulated. Seven additional diets that were similar to the control diet with the exception that 0.3% clay was added to each diet were also formulated. The 7 clay treatments included 0.3% smectite (SM), 0.3% kaolinite (KL), 0.3% zeolite (ZL), 0.15% SM + 0.15% KL, 0.15% SM + 0.15% ZL, 0.15% KL + 0.15% ZL, and 0.10% SM + 0.10% KL + 0.10% ZL. No antibiotics were included in the diets. Pigs were allowed

ad libitum intake of the diets throughout the 29 d experiment, and blood was collected from 2 pigs per pen on the last day of the experiment. For the overall experimental period, no differences in ADG, ADFI, or G:F were observed among treatments (Table 1). Serum urea nitrogen (SUN), red blood cells (RBC), hemoglobin (HGB), hematocrit (HCT), and DS were also not different among treatments indicating that dietary clay did not impair N and Fe absorption. In conclusion, dietary clay does not negatively affect growth performance, nitrogen and iron status, serum values measured, or diarrhea score of weanling pigs.

Table 1. Effects of dietary clay on growth performance and N and Fe status of weanling pigs¹

Item	Control	SM	KL	ZL	SM +				SEM
					KL	SM + ZL	KL + ZL	KL + SM + ZL	
ADG, g/d	247	276	261	264	267	245	249	276	10
ADFI, g/d	382	413	403	407	392	377	381	411	15
G:F, g/kg	649	672	650	649	679	653	657	671	15
SUN, mg/dL	10.4	10.0	10.0	9.0	9.3	10.1	9.7	9.9	0.5
RBC, M/μL	5.9	5.8	5.9	5.9	5.8	5.9	5.9	5.9	0.1
HGB, g/dL	10.6	10.7	10.6	10.6	10.5	10.7	10.5	11.1	0.2
HCT, %	31.2	32.0	31.6	31.4	31.6	31.8	31.5	33.0	0.5
DS	1.5	1.6	1.5	1.5	1.4	1.5	1.5	1.6	0.1

¹SM = smectite; KL = kaolinite; ZL = zeolite.

Key Words: clay, growth performance, weanling pigs

M177 Effects of dry matter content of milk replacer on intake and growth in suckling pigs. S. M. Mendoza^{*1}, E. van Heugten¹, P. Hock², D. McKilligan³, and R. D. Boyd², ¹Department of Animal Science, North Carolina State University, Raleigh, ²Hanor Company Inc., Franklin, KY, ³TechMix Inc., Stewart, MN.

This study was designed to determine the effect of dry matter (DM) content of milk replacer (MR) on intake and growth in suckling pigs. Data were collected from one hundred litters in a 2,600-sow commercial research unit. Litters (10 ± 1.0 pigs) were randomly assigned to treatments consisting of a control without MR and supplementation with MR having 15, 20, 25, 30, 35, or 40% DM. Litters were adapted from d 10 to 12 of age to MR with a 20% DM content. At d 13, litters were weighed (43.8 ± 0.8 kg) and fresh MR was provided in enclosed, gravity dispensed containers on a daily basis according to disappearance. Milk consumption was measured daily by the difference of MR addition minus refusal. At weaning (20.3 ± 2.0 d) litter weights (63.8 ± 1.2 kg) were recorded. Milk replacer linearly increased ($P = 0.007$) total litter gain (19.5, 18.5, 20.1, 20.4, 23.7, and 21.9 kg for 15, 20, 25, 30, 35, and 40% DM, respectively) and tended ($P < 0.10$) to increase gain per pig (2.03, 1.81, 1.95, 2.00, 2.16, and 2.08 kg), and ADG (244, 231, 239, 256, 279, and 263 g/d) with increasing DM. Supplementation with MR tended to improve ($P = 0.06$) gain per pig compared with non-supplemented pigs (2.00 vs. 1.86 kg). Litter gain (23.7 vs. 19.6 kg) and gain per pig (2.16 vs. 1.86 kg) were greater for litters receiving MR having 35% DM compared with non-supplemented control pigs. Milk consumption was similar, regardless of DM content (140 g/pig/d; $P = 0.70$). Consequently, DM intake increased linearly ($P < 0.001$) with increasing DM content (20, 30, 34, 49, 46, and 50 g/pig/d). Conversion efficiency of DM (gain:DM intake) improved linearly ($P = 0.009$) with increasing DM (16.4, 10.7, 9.1, 6.9, 8.8, 5.9). These results demonstrate that nutrient intake in nursing pigs can be greatly increased by increasing the DM content of milk above that typical for sow milk, and that litter growth was moderately improved. Additional studies may help us

understand how to take advantage of the increase in nutrient intake to promote growth recovery, especially in litters composed of small pigs, the target of this technology.

Key Words: milk replacer, litter, growth

M178 The protein-to-energy ratio is a main driver of growth performance in piglets. S. A. Guzmán-Pino, D. Solà-Oriol, J. Figueroa,* and J. F. Pérez, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

It is well accepted that there is an optimal dietary protein-to-energy ratio for young pigs. However, there is not a final recommendation and doubts may arise about how to reach this ratio through changes on the dietary levels. The aim of the present study was to determine how a difference in the dietary protein or energy content and their corresponding protein-to-energy ratio affect growth performance in post-weaned piglets. A total of 480 weanling piglets (28d-old, initial BW 7.17 ± 0.01 kg) were distributed according to their BW into 48 pens (10 pigs/pen), and were randomly allotted to 1 of 4 experimental diets formulated to have different protein-to-energy ratios: a high protein (HP, 204 g CP/kg as-fed) and a low protein diet (LP, 142 g CP/kg) with similar DE content (3.60 Mcal/kg), and a low energy (LE, 3.35 Mcal DE/kg) and high energy diet (HE, 3.90 Mcal DE/kg) with similar CP content (190 g/kg). The protein-to-energy ratios were 56.6 and 56.7 g CP/Mcal DE for HP and LE, and 39.4 and 48.7 g CP/Mcal DE for LP and HE. Performance was measured on d 8 and 18 post-weaning. Up to d 8, HP diet promoted a higher ADFI than LP and HE diets ($P < 0.05$), and a higher ADG and BW than LP, HE and LE diets ($P < 0.01$). Feed:gain ratio also was more efficient for HP piglets in this period. On d 18, LE diet promoted the highest ADFI and ADG during period 8–18d ($P < 0.001$). Piglets fed the LE diet had a statistical approach to the highest piglet BW in comparison with piglets fed the HP diet (11.89 vs. 11.42 kg; $P = 0.09$), however, both treatments were higher than piglets fed the HE diet (10.84 ± 0.13 kg) and piglets fed the LP diet (9.16 ± 0.13 kg), that were the lightest ($P < 0.05$). Feed:gain ratio of latter piglets was higher than the rest of the experimental diets for this period. Growth results are in accordance with dietary protein-to-energy ratio offered. It is concluded that independently of the nature of the nutrient promoting imbalance, dietary protein-to-energy ratio may determine post-weaning piglet performance.

Key Words: protein-to-energy ratio, protein, energy

M179 Nucleotides in weanling pig diets. C. Andrade*¹, V. V. Almeida¹, M. Sbardella¹, D. P. Perina¹, F. L. Silva¹, P. L. Y. C. Chang², B. Berenchein³, L. B. Costa⁴, and V. S. Miyada¹, ¹USP/ESALQ, Piracicaba, SP, Brazil, ²University of North Carolina, Raleigh, ³USP/CENA, Piracicaba, SP, Brazil, ⁴UESC, Ilhéus, BA, Brazil.

Nucleotides have been supplemented in weanling pig diets due to their beneficial effects on maintenance of animal health, performance, immune response and on intestinal histology. The purpose of this study was to evaluate the effects of dietary nucleotide levels on performance, diarrhea occurrence, and intestinal histology of weanling pigs fed complex diet based on corn, soybean, dried milk and dried plasma. One hundred and 60 weaned pigs, averaging 6.43 ± 0.71 kg initial BW, were used in a randomized complete block design experiment with 5 treatments, 8 replications per treatment and 4 animals per pen (experimental unit). The treatments were: basal diet with 120 ppm of chloro-hydroxyquinoline (antimicrobial treatment) and basal diet with 0 (control), 100, 150 and 200 ppm of nucleotides. At the end of

the experimental period (34th d), an animal per experimental unit was slaughtered for analysis of intestinal histology (villus height and crypt depth) of the duodenum and jejunum. Data were analyzed using the GLM procedure of SAS. For 1–14 d of the experimental period, performance was not affected ($P > 0.05$) by treatments. For the total experimental period (1–34 d), linear effects of dietary levels of nucleotides on final BW ($P = 0.005$; 23.08, 24.13, 24.18 and 24.23 kg) and on ADG ($P = 0.008$; 0.491, 0.520, 0.523 and 0.523 kg) were observed, but not ($P > 0.05$) on ADFI and G:F. Pigs fed nucleotides had higher ($P = 0.0002$) diarrhea occurrence (0.89, 1.78, 1.78, 3.57 and 5.36%) from 1 to 14 d than those of control and antimicrobial treatments. However, for the total experimental period (1–34 d), dietary nucleotide levels did not affect ($P > 0.05$) diarrhea occurrence and intestinal histology. Therefore, added nucleotides up to 200 ppm in weanling pig complex diets showed beneficial effect on growth performance, but not on intestinal histology and diarrhea occurrence.

Key Words: feed additives, growth promoter, swine

M180 Time-related changes of serum amino acids in weanling piglets. Y. Xiao,* T. Wu, A. Chen, L. Yang, and C. Yang, *College of Animal Sciences, Zhejiang University, Hangzhou, Zhejiang, China.*

The time-course of serum amino acids following response to early weaning was investigated over a 30 d period in weanling piglets using amino acid analyzer. Eight healthy piglets were selected from 4 litters (one male and one female per litter). The piglets were weaned at 21 d of age and their blood samples were collected on d 0, 1, 3, 5, 7, 10, 15, and 30 post-weaning. Serum concentrations of arginine and its immediate precursors (citrulline and ornithine) decreased ($P < 0.05$) from d 0 to 5 post-weaning, and increased from d 7 to 30 post-weaning. Serum concentrations of leucine, proline, tyrosine, and taurine decreased ($P < 0.05$) on d 1 and 3 post-weaning, and increased to the level of d 0 post-weaning on d 30. Serum concentrations of isoleucine, lysine, glycine, and serine were lowest on d 5 post-weaning; histidine, phenylalanine, valine, aspartic acid, and serine were lowest on d 10 post-weaning, which then increased thereafter. Methionine concentration changed slightly ($P > 0.05$) from d 0 to 3 post-weaning, while it increased by 43.51% ($P < 0.05$) and 41.11% ($P < 0.05$) on d 5 compared with that on d 1 and 3 post-weaning, and kept constant thereafter. Serum concentration of threonine increased by 31.67% ($P < 0.05$) and 79.06% ($P < 0.05$) on d 3 post-weaning compared with that on d 0 and 1, and then decreased on d 15 and 30 post-weaning. Serum concentration of glutamic acid was relatively higher ($P < 0.05$) from d 3 to 30 than that on d 0 and 1 post-weaning. These findings indicate that the serum levels of amino acids are robustly altered in weaning piglets and the critical phase are from d 3 to 10 post-weaning.

Key Words: amino acids, weaning, piglets

M181 Comparing different copper sources at pharmacological levels in nursery pigs. J. Zhao*¹, G. Allee², M. Vazquez-Anon¹, and R. J. Harrell¹, ¹Novus International Inc., St. Charles, MO, ²University of Missouri, Columbia.

Pharmaceutical CuSO_4 is widely used in nursery pigs to promote growth when included beyond Cu requirements as defined by NRC (1998). However, high dietary Cu antagonizes other minerals (Zn and Fe) and nutrient utilization in monogastric animals. The objective of this research was to compare different Cu sources at pharmacological levels in nursery pigs. A total of 616 crossbred piglets (PIC, 20 d of age, 5.0 ± 0.3 kg) were randomly allocated to one of 4 treatments with 7

replicates per treatment and 22 piglets per pen. The treatments included an inorganic negative control (CuSO₄) at NRC level (6 mg/kg), and a pharmaceutical level (150 mg/kg) of Cu supplemented using CuSO₄, tri-basic copper chloride (Cu₂[OH]₃Cl), or Cu(HMTBa)₂. The Cu(HMTBa)₂ (Mintrex, Novus International Inc., St. Charles, MO) is a chelate of one Cu molecule with 2 molecules of 2-hydroxy-4-methylthio butanoic acid (HMTBa). Pigs were fed typical commercial nursery diets for 21 d. At the completion of 21 d, one median pig per pen was harvested for liver mineral analyses. Pigs fed CuSO₄ and Cu(HMTBa)₂ exhibited 8% and 10% improvements ($P = 0.02$) in feed efficiency, respectively, compared with pigs fed the negative control. Weight gain tended to be improved by both CuSO₄ and Cu(HMTBa)₂ ($P = 0.07$). Pigs fed Cu₂[OH]₃Cl were intermediate but were not differ from the negative control. No ADFI differences were observed among treatments ($P = 0.75$). For liver mineral concentration (dry weight basis), pigs fed Cu(HMTBa)₂ had the highest liver Cu concentration, which was significantly higher than pigs fed (Cu₂[OH]₃Cl) and the negative control (71% improvement, $P = 0.02$). Pigs fed CuSO₄ were intermediate with 39.8, 48.8, 52.1, and 68.2 mg liver Cu per kg dry weight for the negative control, Cu₂[OH]₃Cl, CuSO₄, and Cu(HMTBa)₂, respectively. No differences were observed for liver Fe, Mn, or Zn concentration ($P > 0.28$). In conclusion, pigs fed Cu(HMTBa)₂ at a pharmacological levels performed the best based on feed efficiency and liver copper concentrations, followed by CuSO₄. No benefits of Cu₂[OH]₃Cl was observed on performance or liver Cu concentration in this trial.

Key Words: Mintrex, copper, swine

M182 Effects of steam-processed rice, natural vitamin E, and glutamine in diets for weaning piglets. G. J. M. Lima^{*1}, M. Kutschenko², and E. T. Nogueira², ¹Embrapa, Concordia, SC, Brazil, ²Ajinomoto, Sao Paulo, SP, Brazil.

Expanded rice (R) obtained by heat steam processing, glutamine (Gln) and natural vitamin E sources (E) improve performance of young piglets. An experiment was conducted to compare these 3 ingredients using 400

barrows and gilts from the same genotype. Pigs were weaned at 21 d of age (6.90 ± 0.35 kg average initial BW) and allotted to 5 treatments according to a randomized block design, with 8 replicates/treatment and 10 pigs/pen (5 per sex). A 3-phase feeding program was used with free access to feed and water until the end of the trial (63 d of age). Treatments were: T1- control diet (corn, SBM, lactose sources, fish meal, soybean oil, amino acids, minerals, vitamins and a growth promoter); T2 – similar to T1, with the inclusion of 20% ground R in partial replacement of corn; T3 – similar to T1, with the addition of 0.8% and 0.6% of AminoGut (Gln source) in dietary phases 1 and 2, respectively, and no supplementation in phase 3; T4 – similar to T1, with the inclusion of 3% mechanically extracted rice oil (166.79 mg total E/100 g and 37.47 mg α-tocopherol/100 g) in replacement of soybean oil; T5 – similar to T2, with Gln and E addition at the same levels used in T3 and T4. Treatment diets had the same nutrient levels in each phase. Diarrhea occurrence throughout the trial did not differ among treatments (X^2 test, $P > 0.05$). Pigs fed control diet (T1) showed lower average final wt ($P < 0.06$) and daily gain (ADG, $P < 0.05$) compared with all treatments, except T4 ($P = 0.70$). There were no differences in average daily feed consumption ($P = 0.28$) or feed:gain ratio ($P = 0.40$) among treatments. Expanded rice (T2) or Gln (T3) supplementation alone or in combination (T5) improved pig BW gain, but no additive effects were observed. In conclusion, partial replacement of corn by expanded rice and Gln supplementation improved piglet performance in the nursery phase.

Table 1. Effects of expanded rice, glutamine, and natural vitamin E in diets for weaning pigs

Variable	T1	T2	T3	T4	T5	SEM	P-value
Final wt, kg	27.60 ^b	28.51 ^a	28.80 ^a	27.77 ^b	28.76 ^a	0.39	0.02
ADG, g/d	493 ^b	514 ^a	521 ^a	497 ^b	521 ^a	9	0.02
ADFC, g/d	712	746	745	723	711	18	0.28
Feed:gain	1.45	1.46	1.43	1.46	1.37	0.03	0.40

^{a,b}Means with different letters in the same line differ ($P < 0.05$).

Key Words: AminoGut, rice oil, swine