improvement of gut barrier function. The aim of this study was to assess the impact of a mixture of organic acids and botanicals on the intestinal barrier function using a cell culture model. Caco-2 cells were seeded on transwell inserts, cultured in a high glucose DMEM+10% FBS (basal medium, BM) in 5% CO_2at 37°C and allowed to grow until stable. Then cells were cultured for 15 d in BM (control group), or BM added with a mixture of citric acid, sorbic acid, thymol, and vanillin at 0.2 or 1 g/L. Trans-epithelial electrical resistance (TER) was measured every other day using a voltohmmeter. At d7 and d15 since the addition of the experimental media, the paracellular permeability was measured with FITC-dextran flux and at d15 cells were harvested to assess mRNA expression of tight junction markers by qPCR. Data were analyzed with 1-way ANOVA (FITC-dextran flux and mRNA expression) or ANOVA repeated measures (TER), and the treatments had 5 independent replicates ($n = 5$). Compared to control, the blend of organic acids and botanicals at 0.2 g/L significantly improved the TER starting at 4 d since the beginning of the experiment (+13%, $P < 0.001$) and the increase remained significant throughout the experiment (on average +12%, $P < 0.05$). At d15 both treatments improved the TER in a dose-dependent way compared to control (+16% for 0.2 g/L, $P < 0.05$; +27% for 1 g/L, $P < 0.001$). FITC-dextran flux was not affected by the treatments. Tight junction mRNA expression was generally improved by the treatments: while claudin-1 was not affected, occludin tended to be improved at 1 g/L ($P < 0.2$) and zonula occludens-1 was increased in a dose-dependent manner ($P < 0.01$), as shown in Table 207. In conclusion, the mixture of organic acids and botanicals improved Caco-2 epithelial barrier integrity by increasing the TER and improving the tight junction expression and this could validate the “gut barrier-improving” mechanism of action of these additives in animal nutrition.

Key Words: Caco-2 cells, intestinal barrier function, organic acids and botanicals
doi: 10.2527/asasmw.2017.12.207

Table 207. Tight junction markers mRNA relative expression*

	CTR	0.2 g/L	1 g/L	Pooled SEM	*P*-value
Claudin-1	1.02	1.17	1.12	0.10	0.53
Occludin	1.02	1.07	1.31	0.12	0.19
Zonula occludens-1	1.02	1.35	1.61	0.10	0.004

*Normalized on 2 housekeeping genes (GAPDH and RPLP0) and calculated relative to the control group.

208 The interactive effects of a matrix coated organic acids blend and antibiotic supplementation in growing pigs.

M. M. Hossain[1,*], B. Jayaraman[1], S. C. Kim[2], K. Y. Lee[3], I. H. Kim[2], C. M. Nyachoti[1], *[1]Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada, [2]Department of Animal Resource, and Science, Dankook University, Cheonan, South Korea, [3]Morningbio Co. Ltd, Cheonan, South Korea.*

Dietary addition of organic acids can promote nutrient digestibility, growth performance, and gut health outcomes in pigs. Thus, we investigated the effect of supplementing a matrix coated organic acids blend (MCOA) without or with antimicrobial growth promoters (AGP) in growing pig diets on growth performance, hematological profiles, diarrhea score, and in vitro fecal noxious gas emission. Ninety-six growing pigs [(Yorkshire × Landrace) × Duroc] with an average BW of 47.71 ± 1.15 kg (mean ± SD) were used in a 6-wk experiment. Based on initial BW and gender, pigs were randomly blocked and allocated to 1 of 4 experimental treatments each with 12 replicates and 2 pigs per pen. Pigs were allotted to diets containing 0 or 0.2% MCOA, and 0 or 0.25% AGP (aureomycin, Aureo S-P 250 G) according to a 2 × 2 factorial arrangement of treatments. For hematology and serum urea N (SUN) measurements, 1 pig from each pen was randomly selected, and blood samples (10 mL per pig) were collected via jugular vein puncture on d 41. The occurrence and severity of diarrhea were monitored and assessed during the whole experiment. All data were statistically analyzed using the PROC MIXED procedure of SAS. Pigs fed the diet supplemented with MCOA had higher feed efficiency (G:F) than those fed the diets without MCOA (0.38 vs. 0.36; $P = 0.030$). Moreover, AGP × MCOA supplementation tended to have higher G:F ($P = 0.083$). However, pigs fed AGP × MCOA diet had reduced SUN ($P = 0.024$). Diarrhea score was not affected ($P > 0.10$) by dietary AGP or MCOA. Pigs fed diet supplemented with AGP had reduced fecal ammonia (NH_3) gas emission compared to those fed without AGP (8.49 vs. 8.80 ppm; $P = 0.037$). Moreover, pigs fed diet supplemented with MCOA had reduced fecal NH_3 and acetic acid gas emission compared to those fed without MCOA (8.36 vs. 8.93 ppm, and 1.73 vs. 2.79 ppm; $P < 0.001$, and $P = 0.048$, respectively). In conclusion, growing pigs fed diets supplemented with MCOA had improved G:F and similar beneficial responses as those fed diets with AGP in terms of reducing serum urea N, and in vitro noxious gas emission. This suggests that supplementation of MOCA can promote G:F of growing pigs in antibiotic-free-feeding regimens.

Key Words: growing pigs, matrix coated organic acid blends, performance
doi: 10.2527/asasmw.2017.12.208

209 Effect of enzymatically fermented soybean meal and *Lactobacillus plantarum* on nursery pig performance.

A. M. Jones*, J. C. Woodworth, S. S. Dritz, M. D. Tokach, R. D. Goodband, *Kansas State University, Manhattan.*

A total of 360 pigs (PIC C-29 × 359, initial BW 5.52 kg) were used in a 45-d trial to determine the effects of enzymatically fermented soybean meal (EFS) and *Lactobacillus plantarum* (LP1) on nursery pig performance. Pigs were weaned at approximately 18 to 20 d of age and allotted to pens blocked by BW within sex. Pens were randomly assigned to 1 of 4 dietary treatments with 10 pigs/pen and 9 replications/treatment. Dietary treatments were arranged in a 2 × 2 factorial with main effects of added EFS (0 vs. 8% replacing soybean meal) and LP1 (0 vs. 0.1%). Experimental diets were fed in 2 phases (Phase 1: d 0-14 and Phase 2: d 14-24) with a common diet fed to all pigs from d 24-45 post-weaning. From d 0-24, pigs fed the diet containing EFS tended to have decreased ($P = 0.088$) ADFI compared to pigs fed diets without EFS; however, no evidence for differences were observed for ADG and G:F. Also, pigs fed diets containing LP1 tended to have improved ($P = 0.053$) G:F compared to pigs fed diets without LP1, with no evidence of differences observed for ADG or ADFI. Overall (d 0-45), a LP1×EFS interaction was detected for G:F ($P = 0.021$) where LP1 and EFS individually improved G:F, but the effects were not additive when combined. In conclusion, the addition of LP1 and EFS in nursery diets had variable responses when fed independently, but when combined, no benefit was evident.

Key Words: enzymatically fermented soybean meal, *Lactobacillus plantarum*, nursery pig,
doi: 10.2527/asasmw.2017.12.209

210 Effect of diet complexity and specialty protein source on nursery pig performance. A. M. Jones[1,*], J. C. Woodworth[1], J. M. DeRouchey[1], G. E. Fitzner[2], M. D. Tokach[1], S. S. Dritz[1], R. D. Goodband[1], *[1]Kansas State University, Manhattan, [2]Hamlet Protein, Findlay, OH.*

Seven hundred twenty nursery pigs (PIC C-29 × 359, initial BW 5.83 kg and 18-20 d of age) with 10 pigs/pen and 12 replications/treatment were used in a 42-d growth study evaluating diet type (DT; complex vs. simple) and protein source (PS; fish meal, HP300, or HP800) on growth performance. Complex diets contained 20 and 10% lactose, while simple diets contained 12 and 5% lactose in Phases 1 and 2, respectively. Complex diets contained 10% oat meal in both phases, while all diets contained 2% plasma in Phase 1 only. Soybean meal and SID Lys levels were equal within phase by adjusting fish meal, HP300, and HP800. Pens were allotted to 6 treatments in a 2 × 3 factorial arrangement with main effects of DT and PS. Dietary treatments were the fixed effect and block and room served as the random effect. Phase 1 was budgeted at 2.27 kg/pig and Phase 2 was fed thereafter until d-21. A common diet was fed from d 21-42. For the overall treatment period (d 0-21), pigs fed complex had improved G:F ($P = 0.040$) compared to pigs fed simple diets, but ADG and ADFI were not affected. Overall (d 0–42), no differences in growth were observed among treatments. In summary, the 3 specialty protein sources used resulted in similar growth. The complex diet had small positive benefits on growth during the first 21d; however, the benefits were not evident at the end of the common diet period. The general lack of responses to DT or PS could be related to health, a common ingredient quality issue or lower than expected performance from this facility.

Key Words: diet complexity, nursery pig, protein sources
doi: 10.2527/asasmw.2017.12.210

211 Evaluation of berberine as an alternative to antibiotics in nursery pig diets. E. E. Scholtz*, *South Dakota State University, Brookings.*

A study was conducted to determine the effects of berberine (plant extract) on growth performance, electrophysiological properties of small intestine mounted in Ussing chambers, and small intestinal histomorphology of weaned pigs. Twenty-four 3 wk-old weaned pigs (average initial BW = 6.35 kg) were obtained in 2 batches of 12 pigs each, and assigned to 3 experimental diets within batch (4 pigs/diet/batch). The diets included a basal diet without or with antibiotics or 3% berberine. The experiment lasted for 7 d, and at the end, body weight gain and feed consumption were determined. The pigs were then euthanized to determine duodenal, jejunal, and ileal trans-epithelial resistance (TER) and small intestinal histomorphology. Data were analyzed using Mixed procedure of SAS with batch as block and pig as experimental unit. There was no effect of

Table 209.

BW, kg	CTRL	LP1	EFS	LP1 + EFS	SEM	Probability, $P <$		
						LP1 × EFS	LP1	EFS
d 0	5.52	5.51	5.52	5.53	0.012	0.301	0.892	0.392
d 24	10.86	11.04	10.84	10.98	0.136	0.890	0.247	0.751
d 45	22.78	23.42	23.07	23.29	0.276	0.459	0.130	0.782
d 0 to 24								
ADG, g	222	231	222	226	5.8	0.709	0.294	0.662
ADFI, g	303	298	290	292	5.4	0.544	0.789	0.088
G:F	0.734	0.774	0.765	0.773	0.0122	0.210	0.053	0.244
d 0 to 45								
ADG, g	383	398	390	393	6.2	0.332	0.142	0.832
ADFI, g	539	549	534	547	8.5	0.881	0.178	0.658
G:F	0.710[a]	0.723[b]	0.732[b]	0.721[ab]	0.0050	0.021	0.826	0.055