

**NONRUMINANT NUTRITION:
FEED ADDITIVES, ENZYMES,
AND DIETARY SUPPLEMENTS**

0474 Effects of a blend of essential oil compounds, feed-grade antibiotics, and their combination on the growth performance of nursery pigs.

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A total of 72 pigs (initial wt. of 6.2 kg) were utilized in a 35-d study to evaluate the effects of feeding a blend of essential oils (EO, Crina Piglet, DSM Nutritional Products, Parsippany, NJ), a feed-grade antibiotic (AB, Mecadox, Phibro, Teaneck, NJ), and their combination (EO + AB) on the growth performance of nursery pigs. Weaned pigs (3 wks of age) were placed into 24 pens containing 3 pigs per pen and allotted to 1 of 4 dietary treatments for a total of 6 replicate pens per treatment. Gender was balanced within pens in a weight block. Treatments were arranged as a 2 × 2 factorial arrangement to evaluate possible EO × AB interactions. Treatments consisted of (1) Control without EO or AB, (2) EO (200 mg/kg), (3) AB (50 mg/kg), and (4) EO + AB. All pigs were fed the same 3-phase nursery program with the exception of the added treatments, which replaced corn when added. Diet phases were 0 to 7 d, 7 to 21 d, and 21 to 35 d. Diets were formulated to meet or exceed all nutrient requirements based on NRC (2012). Overall, there were no EO × AB interactions ($P \leq 0.05$) for any parameters measured. The EO significantly improved G:F ($P \leq 0.05$) for the d 0 to 35 period as compared with pigs fed no EO, while AB significantly improved final body weight, ADG, and ADFI compared with pigs not fed AB ($P \leq 0.05$) during the d 0 to 35 period. In summary, it appears that dietary addition of both AB and EO can improve the growth performance of nursery pigs.

Key Words: essential oils, performance, pigs

Table 0474. Main effects of essential oils and antibiotics on nursery pig performance

Treatment	-	+	SEM	P-value	% Change
Essential oils					
BW, d 35	22.43	23.18	0.37	0.17	3.3
ADG, g (d 0–35)	464	485	10	0.17	4.5
ADFI, g (d 0–35)	659	661	14	NS	–
G:F (d 0–35)	0.703 ^a	0.734 ^b	0.007	0.006	4.4
Antibiotic					
BW, d 35	22.01 ^a	23.59 ^b	0.37	0.01	7.2
ADG, g (d 0–35)	452 ^a	497 ^b	11	0.01	10.0
ADFI, g (d 0–35)	637 ^a	683 ^b	15	0.05	7.2
G:F (d 0–35)	0.710	0.727	0.007	0.08	2.4

^{a-b} Means within a row with different superscripts differ ($P < 0.05$).

0475 Impact of zinc and arginine dietary supplements on antioxidant capacity and oxidative status in weanling piglets under conditions of commercial production.

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The effects of high levels of Zn and arginine (Arg) supplementation on the antioxidant capacity and oxidative status of weanling piglets raised under commercial conditions were examined. Weanling piglets aged 21 d were fed for 15 d a diet supplemented or not with 2500 mg kg⁻¹ of Zn and 1% Arg. They were distributed among the 4 treatments in a randomized complete block design based on initial body weight, 6 pens per treatment, 13 animals per pen. Access to feed was ad libitum. Data were analyzed as a 2 × 2 factorial experiment using the SAS MIXED procedure (SAS Inst. Inc., Cary, NC), with Zn and Arg supplementation as the main independent variables. Blood sampling day was included as a third factor. Blood was collected from the same 2 piglets in each pen before the morning feeding on d 8 and 15. The Zn supplement increased average daily gain (ADG) from d 0 to 7 (0.194 vs. 0.140 g d⁻¹), d 7 to 15 (0.368 vs. 0.280 g d⁻¹) and for the entire experimental period (0.289 vs. 0.217 g d⁻¹), average daily feed intake (ADFI) from d 0 to 7 (0.197 vs. 0.182 g d⁻¹), d 7 to 15 (0.454 vs. 0.358 g d⁻¹) and for the entire experimental period (0.338 vs. 0.279 g d⁻¹) and ADG:ADFI ratio from d 0 to 7 (0.991 vs. 0.760), and for the entire experimental period (0.860 vs. 0.777; $P < 0.001$). Both supplements decreased the malondialdehyde concentration significantly (Zn:4.37 vs. 3.91, $P < 0.005$; Arg:4.38 vs. 3.89 μmol L⁻¹, $P < 0.002$). Total antioxidant capacity increased from d 8 to 15 (0.953 vs. 1.391 μmol equivalent Trolox L⁻¹), regardless of the dietary treatment ($P < 0.05$). The reduced glutathione concentration also was higher on d 15 than on Day 8 (3.37 vs. 2.22 μmol L⁻¹), regardless of the dietary treatment ($P < 0.001$). On d 8, the concentrations of total and oxidized glutathione were increased when Arg and Zn supplements were combined (Zn2500Arg1:5.42 and 1.20; Zn0Arg0: 4.19 and 1.04 μmol L⁻¹), but decreased in the presence of either supplement alone (Zn2500Arg0:2.57 and 0.41; Zn0Arg1:3.42 and 0.67 μmol L⁻¹; $P < 0.001$). Piglets fed Zn-supplemented diets had a lower haptoglobin serum concentration than those fed a nonsupplemented diet (509.5 vs. 1417.6 mg L⁻¹; $P < 0.001$). In conclusion, although a high level of Zn improved piglet growth performance, the results do not indicate any clear association between performance and oxidative status. Arginine supplementation had a limited effect on growth performance and oxidative status under these commercial conditions.

Key Words: piglets, zinc, arginine

0476 Effect of a 6-phytase derived from *Buttiauxella* spp. expressed in *Trichoderma reesei* on apparent total tract digestibility of Ca and P, bone ash, and growth performance in weaning piglets.

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Two studies evaluated the effect of a 6-phytase derived from *Buttiauxella* spp. expressed in *Trichoderma reesei* (PHY) on apparent total tract digestibility (ATTD) of Ca and P, bone ash and growth performance in piglets. Five dietary treatments were tested, including a positive control (PC) based on corn-SBM-canola meal adequate in available P and Ca, a negative control (NC) with low available P and Ca and NC supplemented with PHY at 250, 500, and 1000 FTU/kg feed with low available P (-0.2%) and Ca (-0.17%). Experiment 1 used 232 male piglets (Initial BW = 9.62 ± 1.36 kg) with 10 replicates per treatment; 3 to 4 piglets/replicate. Experiment 2 used 160 piglets (Initial BW = 8.99 ± 0.16 kg) with 8 replicates/treatment; 4 piglets/replicate. Experimental diets were fed in mash form ad libitum in 2 phases for 6 wk in Exp. 1 and from 9 to 22 kg BW in Exp. 2. Fecal samples were collected from 1 pig/pen at the end of Exp. 1 and in the last 4 d of feeding in Exp. 2; samples were measured for ATTD using a TiO₂ marker. Femurs from both forelegs were collected for bone analysis. Linear and quadratic responses were determined using the Fit Model platform of JMP; trial was used as a random effect. In both experiments, NC reduced all growth and digestibility parameters compared with PC (Table 0476). PHY supplementation resulted in linear/quadratic improvement in BWG, G:F, digestible Ca and P, as well as bone ash. In conclusion, 1000 FTU/kg 6-phytase derived from *Buttiauxella* spp., expressed in *Trichoderma reesei*, can replace 0.2% available P in weaning piglet diets, based on BWG and bone ash data.

Key Words: phytase, swine, performance

0477 Effect of supplementation of nonstarch polysaccharide-degrading enzymes on nutrient digestibility of wheat and wheat millrun based diets in growing pigs.

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Nutrient digestibility of wheat millrun (WMR) is limited by nonstarch polysaccharides (NSP) such as arabinoxylans. Supplementation of NSP-degrading enzymes may increase nutrient digestibility of WMR. Effects of supplementation of 2 endo-xylanases, fed with or without 2 arabinofuranosidases, on nutrient digestibility of a wheat and WMR-based diet were evaluated in a 6 × 6 Latin square. Six ileal-cannulated barrows were fed 5 test diets and 1 N-free diet in six 9-d periods. Five test diets contained 56.2% wheat, 40% WMR, and added enzymes as follows: (1) control (Diet C), without enzyme; (2) 10 mg enzyme protein (EP)/kg of xylanase Ronozyme WX (Diet X1); (3) 10 mg EP/kg of xylanase GH11 (Diet X2); (4) 10 mg EP/kg of xylanase Ronozyme WX + 5 mg EP/kg of arabinofuranosidase GH43 + 5 mg EP/kg of arabinofuranosidase GH51 (Diet X1A); and (5) 10 mg EP/kg of xylanase GH11 + 5 mg EP/kg of arabinofuranosidase GH43 + 5 mg EP/kg of arabinofuranosidase GH51 (Diet X2A). Feces and ileal digesta were collected sequentially for 2 d. Data were analyzed using MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Wheat and WMR contained 12.2 and 21.2% total NSP, respectively. Insoluble NSP were greater than soluble NSP, respectively, in wheat (10.8 vs. 1.4%), WMR (18.8 vs. 2.4%), and diets (14.6 vs. 5.1%). Digesta viscosity (resistance to flow) was greatest for Diet C. Compared with Diet C (377 Pa·s), digesta viscosity was reduced by 15.1% (*P* < 0.05) for Diet X2A (320 Pa·s), while viscosity was not affected for Diets X1 (362 Pa·s), X2 (354 Pa·s), and X1A (348 Pa·s). Apparent total tract digestibility (ATTD) of GE and CP were greater (*P* < 0.05) for Diets X2 and X2A than for Diet C. Specifically, ATTD of GE was 79.7, 80.3, 81.0, 80.3, and 81.3% and ATTD of CP was 81.9, 82.1, 83.3, 83.1, and 83.7%, respectively, for Diets C, X1, X2, X1A, and X2A. Diets X1A and X2A increased (*P* < 0.05) apparent ileal digestibility (AID) of NSP compared with Diets C, X1, and X2. Compared with control, Diets X1A and X2A

Table 0476. Effect of phytase supplementation on growth parameters, Ca and P digestibility, and bone ash percentage¹

	PC	NC	Phytase dose, FTU			SEM	Linear	Quadratic
			250	500	1,000			
Body weight gain, g/d	566.8	377.1	466.2	484.3	536.3	11.84	< 0.0001	0.110
Feed intake, g/d	942.6	774.1	896.0	910.9	954.3	18.19	< 0.001	0.116
G:F	0.61	0.49	0.53	0.54	0.57	0.01	0.002	0.504
Phosphorous ATTD, %	28.52	6.08	23.04	43.32	47.89	1.09	0.023	0.372
Calcium ATTD, %	54.51	38.00	40.99	67.04	56.21	2.23	< 0.0001	< 0.001
Bone ash, %	46.45	36.82	41.06	42.45	43.67	2.15	< 0.0001	< 0.0001

¹Assessment of linear and quadratic responses excluded positive control treatments.

increased ($P < 0.05$) AID of insoluble and total NSP, insoluble and total arabinose, insoluble and total xylose by 52, 42, 86, 80, 85, and 84%, respectively. In conclusion, combined application of xylanase and arabinofuranosidase was more effective than single application of xylanase to increase the nutritional value of diets based on wheat and WMR.

Key Words: wheat co-product, xylanase, arabinofuranosidases

0478 Efficacy of novel 6-phytase derived from *Buttiauxella* spp. expressed in *Trichoderma reesei* on ileal and total tract nutrient digestibility in growing pigs fed a corn-soy based diet. D. E. Velayudhan*¹, J. M. Heo¹, Y. Dersjant-Li², A. Owusu-Asiedu², and C. M. Nyachoti¹, ¹University of Manitoba, Winnipeg, Canada, ²Danisco Animal Nutrition, DuPont Industrial Biosciences, Marlborough, UK.

The current study evaluated the effect of different levels of a 6-phytase derived from *Buttiauxella* spp. expressed in *Trichoderma reesei* on ileal and total tract nutrient digestibility in growing pigs. Twelve ileal cannulated pigs (initial BW = 25 kg) were randomly assigned to 1 of 6 treatments in a 6 × 6 Latin square design to give 12 observations per treatment. The experimental diets consisted of corn soybean meal based control diet (NC), NC supplemented with 4 levels of phytase (i.e., 250, 500, 1000, and 2000 FTU/kg) and a low-protein diet (5% casein) used to quantify endogenous AA losses. All diets contained titanium dioxide as indigestible marker. Pigs were given their daily feed allowance at a rate of 4.5% of BW determined at the beginning of each experimental period. Each period lasted for 9 d, with 5 d of adaptation to the assigned experimental diet followed by 2 d fecal and 2 d ileal digesta collections. Data were analyzed using the mixed model procedures of SAS (SAS Inst. Inc., Cary, NC). The final model had treatment as the main effect since pen and period effects were nonsignificant. Increasing levels of 6-phytase supplementation linearly increased apparent ileal digestibility (AID) of DM, CP and GE ($P < 0.01$). Compared with NC, AID of Ca and P respectively increased ($P < 0.05$) by 5.9, 11.7, 9.0, and 12.3% and 12.7, 46.6, 49.1, and 77.4% with 250, 500, 1000, and 2000 FTU/kg of phytase. Mean AID of dispensable and indispensable AA improved ($P < 0.05$) by 2.5, 2.0, and 1.0% and 2.0, 1.3, and 1.2%, respectively, for diets containing 500, 1000, and 2000 FTU/kg of phytase. Mean standard ileal digestibility (SID) of dispensable and non dispensable AA improved ($P < 0.05$) by 1.7, 1.2, and 2.8% and 1.0, 0.2, and 3.4% respectively, for diets with 500, 1000, and 2000 FTU/kg of phytase. Apparent total tract digestibility (ATTD) of DM, CP, and GE responded linearly ($P < 0.01$) to increasing levels of phytase. The ATTD of Ca and P respectively increased ($P < 0.05$) by 18.2, 30.4, 24.5, and 33.8% and 46.8, 98.4, 99.7, and 124.3% for diets supplemented with 250, 500, 1000, and 2000 FTU/kg of the 6-phytase. In conclusion, supplementation with

a 6-phytase from *Buttiauxella* spp. expressed in *Trichoderma reesei* significantly enhanced the AID and ATTP of Ca, P, and other nutrients in pigs, in dose-dependent manner.

Key Words: amino acid, calcium, phosphorus, phytase, ileal digestibility, pig

0479 Nutrient digestibility of growing pigs fed phytase- and xylanase-supplemented wheat-based diets with low, medium, or high lysine level. T. A. Woyengo*¹, A. Owusu-Asiedu², and R. T. Zijlstra¹, ¹University of Alberta, Edmonton, Canada, ²DuPont Industrial Biosciences–Danisco Animal Nutrition, Marlborough, Wiltshire, UK.

An experiment was conducted to determine the effect of adding xylanase to phytase-supplemented wheat-based diets containing low, medium, or high Lys on apparent ileal digestibility (AID) and apparent total tract digestibility (ATTD) of nutrients in growing pigs. Six ileal-cannulated barrows (initial BW = 39.1 ± 1.6 kg) were fed 6 diets in a 6 × 6 Latin square design. The 6 diets were a phytase-supplemented (500 FTU/kg) wheat-soybean meal-based basal diet with a standardized ileal digestible Lys content of 0.81% (low), 0.91% (medium), or 1.01% (high) and xylanase at 0 or 2000 XU/kg in a 3 × 2 factorial arrangement. The diets were similar in NE (1.79 Mcal/kg) and CP (25%); and the dietary AA levels were based on ideal AA ratio. The diets only differed in wheat and crystalline AA; the dietary level of AA was increased by increasing the dietary level of crystalline AA at the expense of wheat. All 6 diets contained 0.5% Cr₂O₃ as an indigestible marker. Dietary Lys level and xylanase interacted ($P < 0.05$) for AID of energy and all AA except Lys and Trp such that xylanase supplementation increased ($P < 0.05$) the AID of energy by 11%, and of the AA on average by 9% when the basal diet was low in Lys, but not when the basal diet was medium or high in Lys. Also, dietary Lys level and xylanase tended to interact ($P = 0.054$) on AID of Lys such that xylanase supplementation increased the AID of Lys only when the basal diet was low in Lys. Xylanase supplementation increased ($P < 0.05$) AID of Trp from 77.6 to 79.3%, and ATTD of energy from 79.1 to 80.2% regardless of dietary Lys level. In summary, an addition of xylanase to phytase-supplemented wheat-based basal diet for growing pigs can increase the AID and ATTD of energy but also AID of AA for diets limiting in Lys. In conclusion, the results from the present study indicate that diets could be formulated with reduced AA levels to optimize the benefits of xylanase supplementation to increase nutrient and energy digestibility in growing pigs.

Key Words: lysine, pig, xylanase

0480 The effects of β -mannanase (Hemicell HT) supplementation to nursery pig diets on nutrient digestibility and retention. C. Vonderohe*¹,

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Three groups of 18 barrows with an initial BW of 10 ± 2.95 kg were blocked by BW and randomly assigned to diets containing 0, 32, or 48 kU/kg of β -mannanase (Hemicell HT, ChemGen Corp., Gaithersburg, MD) to investigate energy and N digestibility and retention. Pigs were individually housed in pens (0.35 m²) and provided ad libitum access to feed and water for 7d. Following this 7d adaptation period, 12 pigs (4 pigs/diet in each group, 12 pigs/diet in total) were selected and moved to metabolic pens (0.84 m²) where they remained for the final 7 d of the experiment. In the metabolic pens, feed was supplied at 9% of metabolic BW (BW^{0.75}) split evenly in 2 daily feedings and water was supplied ad libitum. A total collection of feces and urine was conducted for the final 4 d in the metabolism pens for subsequent determination of nutrient digestibility and retention. There was no effect of β -mannanase supplementation on growth ($P = 0.23$), feed efficiency ($P = 0.84$), or feed intake ($P = 0.27$) in either the adjustment period (d 0 to 7) or the collection period (d 7 to 14). Supplementing nursery pig diets with β -mannanase resulted in increased digestible ($P < 0.001$) and metabolizable ($P < 0.001$) energy and improved DM digestibility ($P < 0.001$) and N retention ($P < 0.02$). These responses to β -mannanase were greatest when β -mannanase was supplemented at 32 kU/kg. Feeding β -mannanase at 48 kU/kg resulted in DE, ME, and DM digestibility and N retention values that tended ($P < 0.10$) to be greater than control fed pigs, but were not significantly different from pigs fed 32 kU/kg β -mannanase. The results of this experiment indicate that β -mannanase supplementation improves energy digestibility and retention and DM digestibility and N retention in nursery pigs.

Key Words: pig, digestibility, β -mannanase

Table 0480.

β -mannanase, kU/kg:	0	32	48	MSE	P-value
DE, kcal/kg	3300 ^{a,x}	3462 ^{b,y}	3385 ^{a,b,y}	96.14	< 0.001
ME, kcal/kg	3249 ^{a,x}	3429 ^{b,y}	3351 ^{a,b,y}	94.96	< 0.001
N digestibility, %	91.2	91.4	91.8	0.88	0.18
N retention, %	72.2 ^x	77.2 ^y	74.9 ^{x,y}	4.49	0.02
DM digestibility, %	83.5 ^{a,x}	87.2 ^{b,z}	85.6 ^{b,y}	2.40	< 0.001

^{a,b} Values in a row are different at $\alpha = 0.05$.

^{x,y,z} Values in a row are different at $\alpha = 0.10$.

0481 Nucleotide supplementation in the diet of farrowing sows and its effect on milk quality, litter weight gain, and mortality. L. A. Vitagliano*¹, M. A. Bonato², R. L. D. C. Barbalho², G. D. Santos², and L. F. Araújo¹, ¹Universidade de São Paulo, Pirassununga, Brazil, ²ICC Brazil, São Paulo, Brazil.

It is not yet understood whether increased nucleotides in sow milk are a response to a requirement of piglets or are part of the composition of milk, as it naturally occurs during lactation. However, exogenous nucleotide supplementation is able to further increase these levels. The objective of this study was to evaluate effects of nucleotide supplementation in farrowing sows diets on performance, RNA concentration in milk, and piglet litter performance. The nucleotides were derived from a yeast source containing hydrolyzed RNA (free nucleotides/nucleosides). The trial was conducted with 80 sows (Agroceres PIC) distributed in a completely randomized design (by parity order, avg. 3.7/treatment), with 4 treatments (0, 4, 8, and 12kg/MT of yeast or 0, 0.24, 0.48 and 0.72kg/MT of free nucleotides/nucleosides) and 20 replications of 1 sow in each. The sows were fed experimental diets starting 3 d before farrowing, until weaning of piglets at 21 d of age. The number of piglets per sow (10.48 ± 0.26) and piglet weight (1.70 ± 0.04 kg) was equalized at birth. The sow parameters were weight after farrowing (WF, kg), weight after weaning (WW, kg), weight loss (WL, %), and feed intake (FI,kg). The number of weaned piglets (NWP), piglet weight at weaning (PWW,kg), litter weight at weaning (LWW, kg), litter weight gain (LWG, kg), mortality (MORT, %), and milk production (MP, kg; 1kg of piglet weight = 4 kg of milk) were measured. Samples of colostrum and milk (11, 20 d of lactation) were collected for laboratory analysis of RNA (mg/mL milk). The data were analyzed using the GLM (SAS Inst. Inc., Cary, NC), and means were compared by Tukey's test ($P = 0.10$). Nucleotide supplementation in the diet of farrowing sows resulted in no difference ($P > 0.10$) in WF, WW, WL, or FI. The piglets from sows fed diets supplemented with nucleotides had improved ($P < 0.10$) NWP, LWW, LWG, MORT, and MP compared with unsupplemented diets. There were no differences ($P > 0.10$) between treatments in PWW. In general, the 8 kg/MT and 12 kg/MT levels showed best piglet performance results (6 and 4.5% higher LWG than control group) and lower MORT (41.7 and 53.5% lower than control group). Nucleotide supplementation gave no significant response ($P > 0.10$) in total RNA in colostrums, but the amount of RNA present in milk at 11 and 20 d of lactation significantly increased ($P < 0.10$). This study demonstrated that supplementation of nucleotides to farrowing sows had a positive carryover effect on milk quality which, consequently, increased the litter weight gain and the number of weaned piglets (+3.5%).

Key Words: piglet, performance, RNA

0482 Evaluation of the efficacy of *Bacillus licheniformis* or sodium butyrate in front of a *Salmonella* Typhimurium oral challenge in piglets.

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The objective of the study was to evaluate the efficacy of *Bacillus licheniformis* (PROPORC, NOREL S.A.) or sodium butyrate (GUSTOR BP70, NOREL S.A.) in weanling pigs orally challenged with *Salmonella* Typhimurium. Seventy-two piglets (28 d old, 8.21 ± 0.79 kg) were divided into 24 pens allocated to 3 experimental diets: (1) CTR, base diet without additives; (2) PRO, base diet supplemented with 1 kg/t of PROPORC (equivalent to 10⁹ CFU/kg of feed of *Bacillus licheniformis*); and (3) BUT, base diet supplemented with 3kg/t of GUSTOR BP70 (containing 70% sodium butyrate protected with vegetable fat). The base diet was multicereal (corn, wheat, and barley) with selected protein sources (soybean meal 44, fishmeal, and bovine sweet whey), without antibiotics and met NRC 2012 requirements. Consumption and weight gain of the animals were monitored during the trial (16 d). After a week of adaptation, the animals were orally inoculated with *Salmonella* Typhimurium (1 × 10⁸ CFU). Parameters evaluated after the oral challenge were fecal consistency, rectal temperature (24 and 72 h postinoculation, PI) and fecal shedding of *Salmonella* (d 0, 1, and 7 PI). Moreover, on d 4 and 8 PI, 1 animal in each pen was euthanized to evaluate the serological inflammatory response (TNFα and Pig-Map), the microscopic ileal morphology, and the presence of *Salmonella* in the colon. No significant differences between treatments were seen on performance, fecal consistency, rectal temperature, or inflammatory markers ($P > 0.05$). However, a trend to reduction was observed in *Salmonella* prevalence in feces on d 7 PI (100, 75, and 75, $P = 0.074$) and significant reduction in colon on d 8 PI (88, 50, and 63, $P = 0.043$), for CTR, PRO, and BUT, respectively. Besides, on d 4 PI crypt depth showed a tendency to increase with the 2 supplemented diets (203, 239, and 251 203 μm, SEM ± 15.9, $P = 0.107$), for CTR, PRO, and BUT, respectively. The results obtained demonstrate that the administration of *Bacillus licheniformis* (10⁹ CFU/kg) or sodium butyrate (3kg/mT) could improve intestinal morphology and reduce the colonization and fecal shedding of *Salmonella* Typhimurium in piglets.

Key Words: *Salmonella*, probiotic, sodium butyrate

0483 Effects of dietary supplementation of direct fed microbial on growth performance, nutrient digestibility, blood profiles, fecal microflora, and noxious gas emission in nursery pigs.

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A total of 128 weanling pigs [(Yorkshire × Landrace) × Duroc] with an average BW of 6.75 ± 0.59 were used in a 42-d experiment to investigate the efficacy of *Bacillus* spp. direct-fed microbial (DFM) on growth performance, indices of gut health and nutrient utilization in piglets. Pigs were allotted to experimental diets based on BW in a completely randomized block design. There were 2 dietary treatments: NC, basal diet (corn-soybean meal based diet); DFM, NC + DFM (1.5 × 10⁵ cfu/g of feed). The DFM product was based on 1 strain of *B. subtilis* and 2 strains of *B. amyloliquefaciens* specifically selected and optimized for high enzyme production (Danisco Animal Nutrition, Marlborough, Wiltshire, UK). The diets were fed during the experiment in 2 phases: d 0 to 14, and 15 to 42. All diets, in pelleted form, were formulated to meet or exceed the nutrient requirements (NRC, 1998) for weanling pigs. Feed intake and BW were monitored weekly. We used 0.20% chromium oxide as indigestible marker and fecal samples were collected via rectal massage. Incidences of diarrhea were monitored in phase using a fecal scoring system (1 hard to 5 watery). At the end of each phase, 2 pigs/pen were bled for serum and fresh fecal samples were collected. At the end of the experiment, 1 pig/pen was killed to obtain small intestinal tissues for histomorphology and large intestinal digesta for select microbial counts. In the overall (d 0 to 42), pigs fed DFM had better G:F (0.694 vs. 0.680, $P = 0.04$) and tended to have a higher ADG (425 vs. 417 g/d, $P = 0.08$) compared with the NC fed pigs. Pigs fed DFM showed lower incidences of diarrhea ($P = 0.01$) than NC fed pigs on d 4. Duodenum and jejunum villi length of pigs fed DFM diets were longer ($P < 0.01$) than for pigs fed NC diet. Cecal digesta *Lactobacillus* counts tended to be higher ($P = 0.06$) in pigs fed DFM compared with the NC pigs; however, *Lactobacillus* and *Escherichia coli* counts in the colon digesta were unaffected by the dietary treatments. Pigs fed DFM tended ($P < 0.09$) to have higher apparent total tract digestibility of crude protein and lower fecal ammonia release coinciding with low blood urea N concentration than the NC fed pigs. In conclusion, DFM supplementation improved growth performance and efficiency in nursery pigs linked to improved nutrients utilization and indices of gut health and function.

Key Words: weanling pigs, growth performance, gut health

0484 Tributyrin, a source of butyric acid, modulates the intestinal health of weaning pigs.

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Aim of this study was to evaluate the intestinal architecture and expression of inflammatory and tight junction markers in piglets fed with tributyrin as dietary source of butyric acid. Twenty-one weaned pigs ($n = 7$), received a basal diet (control) or the diet supplemented with tributyrin or its encapsulated form at 1750 mg/kg (TB and m-TB, respectively), both providing 960 mg/kg of butyric acid equivalents. After 21 d, pigs were euthanized to collect duodenum, jejunum, ileum, and colon samples for histo-morphology, and cytokines and tight junction markers m-RNA analysis. Data were analyzed with 1-way ANOVA. Compared with control, m-TB induced deeper crypts in the duodenum ($P = 0.09$) and significantly reduced villi: crypts in the ileum ($P = 0.04$); goblet cells tended to be reduced by TB in duodenal villi (2.4-fold, $P = 0.09$), by both TB and m-TB in ileal villi (1.8- to 2.2-fold, respectively; $P = 0.06$), and by m-TB in colonic crypts ($P = 0.08$). Compared with control, TB tended to have higher TNF- α expression in the duodenum and ileum ($P = 0.06$ and $P = 0.10$), and higher IFN- γ level in the jejunum ($P = 0.04$), whereas in the colon m-TB downregulated IFN- γ and IL-1 β level (2.2-fold and 1.7-fold; $P = 0.06$). Jejunal claudin-1 mRNA was reduced in m-TB compared with control (2.4-fold; $P = 0.05$). Similarly, in the colon claudin-1 mRNA was numerically lower in m-TB (2.1-fold) than in control group. Ileal occludin mRNA was reduced in both groups receiving tributyrin compared with control (1.6–2.2-fold for TB and m-TB; $P < 0.01$). In the colon occludin mRNA was downregulated in m-TB compared with control (1.4-fold; $P < 0.05$). The supplementation of tributyrin in the diet reduced the mucous-secreting goblet cells in a tract specific manner, tributyrin affecting the upper intestine while the microencapsulated form acting in the lower gut. The differential expression of cytokines in the upper and lower intestine by TB and m-TB, would suggest a differential modulation of cellular turnover and epithelial differentiation that would reflect differences in the anatomy and functionality of the gut segments. Nevertheless, the reduced expression of proinflammatory cytokines observed in the colon of m-TB indicate a reduced inflammation by butyric acid released via microencapsulated tributyrin. This beneficial effect mediated by m-TB would be substantiated by the parallel reduction of tight junction proteins gene expression in the hindgut probably indicating, by a mechanism of negative feed-back, a relatively higher abundance of these proteins and a tighter intestinal epithelium.

Key Words: tributyrin, microencapsulation, weaning piglet

0485 Effects of salmonella inhibitors on growth performance, relative organ weight, meat quality, salmonella populations, fecal gas emission, and blood profiles in broilers. A. Hosseindoust*, H. L. Li, and I. H. Kim, *Department of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 768 male and female ROSS308 broiler chicks [1 d old, BW = 37 ± 0.08 g] were used in this 5-wk trial (6 treatments with 8 replications/treatment and 16 chicks/pen) to evaluate the effect of salmonella inhibitors on growth performance, relative organ weight, meat quality, salmonella populations, fecal gas emission and blood profiles in broilers. A corn-soybean meal-based diet was formulated as a control diet and dietary treatments were as follows: (i) NC, basal diet (without antibiotics and *Bacillus subtilis*); (ii) PC, NC + 0.1% antibiotics (virginiamycin); (iii) A, NC + 0.1% *B. subtilis* 1.0×10^{10} cfu/kg; (iv) B, NC + 0.1% *B. subtilis* RX7 1.0×10^{10} cfu/kg; (v) C, NC + 0.1% *B. subtilis* B2A 1.0×10^{10} cfu/kg; (vi) D, NC + 0.1% *B. subtilis* RX7 1.0×10^9 cfu/kg. Broilers were weighed and feed intake were recorded on d 14 and 35 for calculating BW gain (BWG), feed intake (FI), and feed conversion ratio (FCR). At d 35, 2 birds were randomly selected from each replication (16 broilers/treatment) and slaughtered by cervical dislocation for meat quality. During d 1 to 14, BWG was higher (393, 390 vs. 375 g; $P < 0.05$) in B and C treatments than NC treatment; moreover, NC treatment got higher (1.52 vs. 1.45; $P < 0.05$) FCR than B treatment. During d 15 to 35, NC treatment group had higher FCR (1.81 vs. 1.72; $P < 0.05$) than C treatment fed broilers. Overall, chickens fed with C diet had higher (1648 vs. 1569 g; $P < 0.05$) BWG and lower (1.65 vs. 1.74; $P < 0.05$) FCR than those fed with NC diet. No significant difference ($P > 0.05$) was observed in meat quality, relative organ weight, gas emission and blood profiles among treatments. However, the salmonella populations of chickens fed with NC diet was higher (2.94 vs. 2.50, 2.47, 2.51, 2.51 \log_{10} cfu/g; $P < 0.05$) compared with those fed with PC, B, C, and D diets in large intestine, moreover, the salmonella populations of NC treatment was higher (2.81 vs. 2.56, 2.48, 2.48, 2.55, 2.47 \log_{10} cfu/g; $P < 0.05$) compared with other 5 treatments in small intestine. In conclusion, salmonella inhibitors partially improved BWG, FCR, while decreasing salmonella populations in intestine without any adverse effect on meat quality, relative organ weight, gas emission, and blood profiles in broilers.

Key Words: blood profiles, broilers, growth performance, meat quality, salmonella inhibitors, salmonella populations