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Evaluation of Dietary Acidifiers on Growth Performance of Nursery Pigs[1]

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Summary

Three 28-d experiments were conducted to determine the effects of dietary acidifiers on the growth performance of nursery pigs housed under both university and field conditions. All diets were corn-soybean meal–based and fed in meal form. Each experiment consisted of a 2-phase diet series with decreasing nutrient concentrations in the second phase. The same 4 dietary treatments were evaluated in all 3 experiments, including a control with (1) no acidifier, (2) 0.5% Vevovitall (DSM Nutritional Products, Parsippany, NJ), (3) 0.2% Kem-Gest (Kemin Americas, Des Moines, IA), or (4) 0.05% Buti-Pearl (Kemin Americas). In Exp. 1, 280 weanling pigs (PIC 327 × 1050, initially 16.1 lb, 3 d postweaning) were used with 7 pigs per pen and 10 pens per treatment. From d 0 to 14, pigs fed the Kem-Gest diet tended to have increased ($P < 0.07$) ADG compared with pigs fed the other 3 treatments. From d 14 to 28 and for the overall data (d 0 to 28), no differences ($P > 0.64$) were observed in ADG, ADFI, or F/G among treatments. In Exp. 2, 1,728 nursery pigs (PIC 327 × 1050, initially 12.8 lb, 10 d postweaning) were used with 48 pigs per feeder (24 pigs per pen) and 9 feeders per treatment. Treatment diets were fed from d 0 to 14, and a common diet was fed from d 14 to 28. From d 0 to 14, pigs fed the control diet had decreased ($P < 0.001$) ADG and poorer ($P < 0.001$) F/G compared with pigs fed diets with acidifiers. From d 14 to 28, when a common diet was fed, there were no differences ($P > 0.60$) in ADG, ADFI, or F/G among treatments. Overall (d 0 to 28), there were no differences in ADG, ADFI, or F/G ($P > 0.11$), but pigs fed diets containing acidifiers were approximately 2 lb heavier at the conclusion of the trial. In Exp. 3, 1,800 nursery pigs (PIC 327 × 1050, initially 16.3 lb, 13 d postweaning) were used with 50 pigs per feeder (25 pigs per pen) and 9 feeders per treatment. Treatment diets were fed throughout the entire trial (d 0 to 28), but there were no differences ($P > 0.12$) in ADG, ADFI, or F/G among pigs fed the different dietary treatments from d 0 to 14, d 14 to 28, or for the overall trial.

Overall, the responses to dietary acidification were inconsistent across experiments, but the reasons are unclear. Pigs fed acidifiers had improved growth performance in Exp. 2, but not Exp. 1 and 3. Further research is needed to determine the reason for the inconsistent responses so dietary acidifiers can be used effectively to improve the performance of nursery pigs.

Key words: acidifiers, benzoic acid, butyric acid, nursery pig

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[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[3] DSM Nutritional Products (Parsippany, NJ).

Introduction

With decreasing use of antibiotics in swine diets, potential alternatives are a growing area of interest. Among these alternatives are various types of acidifiers that are increasingly being incorporated in nursery pig diets, both in Europe and North America. Acidifiers have resulted in improved performance in some trials, but not in others. Explanations for the varying responses have been proposed but are not fully understood.

Many sources of acidifiers are available, and they often vary in pH and potency depending on the form of acid. Kem-Gest (phosphoric, fumaric, lactic, and citric acid blend; Kemin Americas, Des Moines, IA) and ButiPearl (encapsulated butyric acid; Kemin Americas) are 2 common sources of acidifiers that are currently available in the U.S. Vevovitall (DSM Nutritional Products Parsippany, NJ) is a source of benzoic acid that may become available to the North American swine industry and has been shown to provide growth and health benefits for swine in experiments from other countries. Previous experiments at K-State have shown no improvements in growth performance when Vevovitall was fed, regardless of diet complexity or antibiotic inclusion; however, previous trials were conducted in a university research nursery where pigs often maintain a higher health status and improved growth rate. With increasing interest in feeding dietary acidifiers, the objective of these trials was to determine the effect of 3 commercial acidifiers (Vevovitall, Kem-Gest, and Butipearl) on growth performance of nursery pigs housed in both university and field facilities.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the K-State Swine Teaching and Research Center in Manhattan, KS.

Experiment 1

A total of 280 weanling pigs (PIC 327 × 1050, initially 16.1 lb, 3 d postweaning) were used in a 28-d trial to evaluate the effects of Vevovitall, Kem-Gest, and ButiPearl on growth performance in a university research nursery. Pigs were weaned at approximately 21 d of age and allotted to pens by initial BW to achieve the same average pen weight for all pens. Pigs were fed a common, pelleted, transition diet for 3 d. On d 3 postweaning, pens were allotted to 1 of 4 dietary treatments; thus, d 3 after weaning was d 0 of the experiment. There were 7 pigs per pen and 10 pens per treatment. Each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. Pigs and feeders were weighed on d 0, 7, 14, 21, and 28 to calculate ADG, ADFI, and F/G. A 2-phase diet series was used, with decreasing nutrient concentrations in the second phase. All diets were corn-soybean meal–based. From d 0 to 14, all diets contained 10% dried whey, 1.25% select menhaden fish meal, 1.25% spray-dried blood cells, and 2,000 ppm of zinc oxide (Table 1). From d 14 to 28, no specialty protein sources or additional zinc oxide were included in any diets. There were 4 dietary treatments, including a control with (1) no acidifier, (2) 0.5% Vevovitall, (3) 0.2% Kem-Gest, or (4) 0.05% ButiPearl. Inclusion rates were based on the recommendations of the manufacturer. All experimental diets were in meal form and were prepared at the K-State Animal Science Feed Mill.

Experiments 2 and 3

In Exp. 2 and 3, a total of 1,728 and 1,800 nursery pigs (PIC 327 × 1050) were used, respectively, in 28-d trials conducted at a commercial research nursery facility. Each feeder was available to 2 adjacent pens (1 barrow and 1 gilt pen per feeder), resulting in 48 pigs per feeder (24 pigs per pen) for Exp. 2 and 50 pigs per feeder (25 pigs per pen) in Exp. 3. There were 9 replicate feeders per treatment. Treatment diets were fed starting on d 10 (Exp. 2) or d 13 (Exp. 3) after weaning, and these days were considered d 0 of the experiments. The 4 dietary treatments were the same as in Exp. 1 and included a control with (1) no acidifier, (2) 0.5% Vevovitall, (3) 0.2% Kem-Gest, or (4) 0.05% ButiPearl. A 2-phase diet series was used in each trial, with decreasing nutrient concentrations in the second phase. All diets were corn-soybean meal–based. Treatment diets were identical from d 0 to 14 for both experiments and were formulated to 1.35% standardized ileal digestible (SID) lysine (Table 2). In Exp. 2, a common diet with no acidifiers was fed from d 14 to 28 to monitor subsequent performance and was formulated to 1.30% SID lysine. In Exp. 3, instead of a common diet, a second phase of treatment diets (Control, 0.5% Vevovitall, 0.2% Kem-Gest, or 0.05% ButiPearl) was fed from d 14 to 28 and was formulated to 1.30% SID lysine. Pigs and feed disappearance were measured on d 0, 7, 14, 21, and 28 to calculate ADG, ADFI, and F/G. All experimental diets were in meal form and were manufactured at a commercial feed mill.

Statistical analysis

At the conclusion of the experiment, data were analyzed as a completely randomized design with pen (Exp. 1) or feeder (Exp. 2 and 3) as the experimental unit. Analysis of variance was performed using the PROC MIXED option of SAS (SAS Institute, Inc., Cary, NC). Differences between treatments were determined using the PDIFF statement in SAS, with differences declared at $P < 0.05$ and trends declared at $P < 0.10$.

Results and Discussion

Experiment 1

From d 0 to 14, pigs fed the Kem-Gest diet had a tendency for increased ($P < 0.07$) ADG compared with pigs fed the other 3 treatments (Table 3). No differences were observed ($P > 0.33$) in ADFI or F/G among pigs fed any of the treatment diets. From d 14 to 28 and for the overall period (d 0 to 28), no differences were observed ($P > 0.64$) in ADG, ADFI, or F/G among treatments; therefore, feeding acidifiers did not influence growth performance in a university research setting.

Experiments 2 and 3

For Exp. 2, when the treatment diets were fed from d 0 to 14, pigs fed the control diet had decreased ($P < 0.001$) ADG and poorer ($P < 0.001$) F/G compared with pigs fed all diets with acidifiers (Table 4), and ADFI did not differ ($P > 0.29$) among treatments. When a common diet was fed from d 14 to 28, there were no differences ($P > 0.60$) in ADG, ADFI, or F/G among treatments. These results indicate that no compensatory growth occurred when pigs were taken off diets containing acidifiers. Because growth was similar from d 14 to 28, there were no differences in overall (d 0 to 28) ADG, ADFI, or F/G ($P > 0.11$). Although no differences were found in growth for the overall data, pigs fed diets containing any of the 3 acidifiers were approximately 2 to 2.5 lb heavier in BW on d 14 compared with pigs fed the control diet. This difference was

maintained to d 28, resulting in a 2-lb heaver nursery pig at the end of the trial for pigs fed acidifiers.

Unlike in Exp. 2, no differences were observed ($P > 0.12$) in ADG, ADFI, or F/G in Exp. 3 among pigs fed the different dietary treatments from d 0 to 14, d 14 to 28, or for the overall trial (Table 5).

In conclusion, the responses to dietary acidifiers varied among experiments. In Exp. 1, including acidifiers in the diets had no beneficial effects on growth performance, which agrees with previous experiments conducted under university research conditions. Pigs fed acidifiers in Exp. 2 (a commercial nursery), however, had improved ADG and F/G, but only numerical differences were found in Exp. 3. The reason for the inconsistent responses among trials is unclear, but results may be influenced by health status, age, or starting weight of pigs. Pigs housed in university research facilities are often considered to have a higher health status than those in a commercial facility, which may mitigate any potential antimicrobial effects of the acids. This does not, however, fully explain the varying responses between Exp. 2 and Exp. 3, which were conducted in the same facility. Due to the inconsistent responses among trials, further investigation is needed to effectively incorporate acidifiers in diets for nursery pigs.

Table 1. Diet composition, Exp. 1 (as-fed basis)[1]

	Control	
Item	Phase 1[2]	Phase 2[3]
Ingredient, %[4]		
Corn	59.93	64.50
Soybean meal (46.5% CP)	26.39	32.15
Select menhaden fish meal	1.25	---
Spray-dried blood cells	1.25	---
Spray-dried whey	10.0	---
Monocalcium phosphate (21% P)	0.85	1.05
Limestone	0.80	1.00
Salt	0.30	0.35
Zinc oxide	0.25	---
Trace mineral premix	0.15	0.15
Vitamin premix	0.25	0.25
L-lysine HCl	0.295	0.325
DL-methionine	0.140	0.100
L-threonine	0.125	0.110
Phytase[5]	0.019	0.019
Diatomacious earth	1.00	---
Total	100.0	100.0

continued

Table 1. Diet composition, Exp. 1 (as-fed basis)[1]

	Control	
Item	Phase 1[2]	Phase 2[3]
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lysine	1.30	1.26
Isoleucine:lysine	56	62
Leucine:lysine	129	130
Methionine:lysine	33	31
Met & Cys:lysine	56	56
Threonine:lysine	62	62
Tryptophan:lysine	17.0	17.5
Valine:lysine	69	68
Total lysine, %	1.43	1.39
ME, kcal/lb	1,480	1,504
SID lysine:ME, g/Mcal	3.99	3.80
CP, %	20.7	20.9
Ca, %	0.71	0.70
P, %	0.63	0.62
Available P, %	0.47	0.41

[1] In addition to the control diet, pigs were fed 0.5% Vevovitall (DSM Nutritional Products, Parsippany, NJ), 0.2% Kem-Gest (Kemin Americas, Des Moines, IA), or 0.05% ButiPearl (Kemin Americas) for both phases.
[2] Phase 1 diets were fed from d 0 to 14.
[3] Phase 2 diets were fed from d 14 to 28.
[4] Vevovitall was used as a source of benzoic acid; Kem-Gest was used as a source of phosphoric, fumaric, lactic, and citric acid blend; and ButiPearl was used as a source of encapsulated butyric acid.
[5] Ronozyme P-CT (10,000) (International Nutrition, Omaha, NE), providing 840 phytase units (FTU)/lb and an estimated release of 0.10% available P.

Table 2. Diet composition, Exp. 2 and 3 (as-fed basis)[1]

	Control	
Item	Phase 1[2]	Phase 2[3]
Ingredient, %[4]		
Corn	42.29	51.34
Soybean meal (46.5% CP)	27.55	29.54
Dried distillers grains with solubles	15.00	15.00
Spray-dried blood cells	1.00	---
Spray-dried whey	10.0	---
Dicalcium phosphate (18.5% P)	0.75	1.13
Limestone	1.45	1.50
Salt	0.35	0.50
Zinc oxide	0.25	---
Vitamin-trace mineral premix	0.30	0.30
L-lysine HCl	0.400	0.450
DL-methionine	0.160	0.135
L-threonine	0.125	0.115
Denagard 10	0.175	---
CTC-100	0.200	---
Total	100.0	100.0
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lysine	1.35	1.30
Isoleucine:lysine	59	61
Leucine:lysine	137	136
Methionine:lysine	35	35
Met & Cys:lysine	58	58
Threonine:lysine	63	61
Tryptophan:lysine	17.4	17.2
Valine:lysine	70	68
Total lysine, %	1.53	1.48
ME, kcal/lb	1,462	1,474
SID lysine:ME, g/Mcal	4.19	4.00
Ca, %	0.90	0.93
P, %	0.60	0.64
Available P, %	0.46	0.46

[1] In addition to the control diet, pigs were fed 0.5% Vevovitall (DSM Nutritional Products, Parsippany, NJ), 0.2% Kem-Gest (Kemin Americas, Des Moines, IA), or 0.05% ButiPearl (Kemin Americas).
[2] Phase 1 diets were fed from d 0 to 14.
[3] Phase 2 diets were fed from d 14 to 28. For Phase 2, only the control diet was fed in Exp. 1, and all 4 treatment diets were fed in Exp. 2.
[4] Vevovitall was used as a source of benzoic acid; Kem-Gest was used as a source of phosphoric, fumaric, lactic, and citric acid blend; and ButiPearl was used as a source of encapsulated butyric acid.

Table 3. Effects of acidifiers on growth performance of nursery pigs under university research conditions, Exp. 1[1]

		Acidifier[2]				
	Control	Vevovitall	Kem-Gest	Butipearl	SEM	Probability, *P* <
d 0 to 14						
ADG, lb	0.54	0.52	0.58	0.53	0.017	0.07
ADFI, lb	0.76	0.74	0.81	0.77	0.026	0.33
F/G	1.41	1.43	1.39	1.45	0.035	0.61
d 14 to 28						
ADG, lb	1.06	1.05	1.02	1.05	0.024	0.68
ADFI, lb	1.70	1.71	1.67	1.66	0.039	0.81
F/G	1.60	1.63	1.64	1.59	0.032	0.64
d 0 to 28						
ADG, lb	0.82	0.80	0.82	0.81	0.017	0.90
ADFI, lb	1.26	1.26	1.27	1.25	0.029	0.97
F/G	1.54	1.57	1.55	1.54	0.024	0.87
BW, lb						
d 0	15.2	15.2	15.2	15.2	0.126	0.99
d 14	22.3	21.9	22.8	22.1	0.277	0.47
d 28	38.3	37.7	38.1	37.8	0.506	0.81

[1] A total of 280 weanling pigs were used with 7 pigs per pen and 10 pens per treatment. Treatment diets were fed starting on d 3 after weaning.
[2] Acidifiers were fed from d 0 to 28.

Table 4. Effects of acidifiers on growth performance of nursery pigs fed under field conditions, Exp. 2[1]

		Acidifier[2]				
	Control	Vevovitall	Kem-Gest	Butipearl	SEM	Probability, $P <$
d 0 to 14						
ADG, lb	0.66[a]	0.81[b]	0.78[b]	0.80[b]	0.026	0.001
ADFI, lb	0.90	1.00	0.96	0.97	0.036	0.29
F/G	1.36[a]	1.23[b]	1.22[b]	1.21[b]	0.015	< 0.001
d 14 to 28						
ADG, lb	1.03	1.04	1.03	1.02	0.026	0.97
ADFI, lb	1.25	1.29	1.30	1.29	0.029	0.64
F/G	1.22	1.26	1.27	1.27	0.027	0.60
d 0 to 28						
ADG, lb	0.84	0.92	0.91	0.91	0.023	0.10
ADFI, lb	1.07	1.14	1.13	1.13	0.028	0.37
F/G	1.28	1.24	1.24	1.24	0.016	0.35
BW, lb						
d 0	12.8	12.9	12.8	12.9	0.263	0.99
d 14	22.3[a]	24.7[b]	24.3[b]	24.4[b]	0.543	0.01
d 28	36.7	39.3	38.8	38.8	0.817	0.15

[ab] Within a row, means without a common superscript differ ($P < 0.05$).

[1] A total of 1,728 nursery pigs (PIC 327 × 1050) were used. Each number represents the mean of 9 feeders. Each feeder was accessible by 2 adjacent pens (1 barrow and 1 gilt pen per feeder). There were 24 pigs per pen. Treatment diets were fed starting on d 10 after weaning.

[2] Treatment diets were fed from d 0 to 14 of the trial. A common diet with no acidifiers was fed from d 14 to 28 to determine any effects on subsequent performance.

Table 5. Effects of acidifiers on growth performance of nursery pigs fed under field conditions, Exp. 3[1]

		Acidifier[2]				
	Control	Vevovitall	Kem-Gest	Butipearl	SEM	Probability, $P <$
d 0 to 14						
ADG, lb	0.79	0.80	0.80	0.76	0.017	0.18
ADFI, lb	1.20	1.18	1.15	1.12	0.030	0.32
F/G	1.52	1.47	1.44	1.48	0.022	0.14
d 14 to 28						
ADG, lb	0.98	0.97	0.93	0.99	0.023	0.25
ADFI, lb	1.65	1.65	1.53	1.61	0.047	0.27
F/G	1.68	1.69	1.65	1.63	0.022	0.28
d 0 to 28						
ADG, lb	0.89	0.89	0.86	0.87	0.016	0.65
ADFI, lb	1.42	1.41	1.34	1.37	0.031	0.23
F/G	1.61	1.59	1.55	1.57	0.016	0.12
BW, lb						
d 0	16.3	16.3	16.3	16.4	0.261	0.99
d 14	27.6	27.7	27.5	26.9	0.450	0.64
d 28	41.6	41.4	40.9	40.8	0.606	0.78

[1] A total of 1,800 nursery pigs (PIC 327 × 1050) were used. Each number represents the mean of 9 feeders. Each feeder was accessible by 2 adjacent pens (1 barrow and 1 gilt pen per feeder). There were 25 pigs per pen. Treatment diets were fed starting on d 13 after weaning.
[2] Acidifiers were fed from d 0 to 28.