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Abstract

A total of 280 weanling pigs (PIC 327 Ã— 1050, initially 15.4 lb, 3 d postweaning) were used in a 28-d trial to evaluate the effects of benzoic acid and diet complexity on growth performance. Treatments were arranged as a 2 Ã— 2 factorial with 2 diet complexities and 2 benzoic acid levels (0 vs. 0.5%) fed for the first 14 d. Diet complexity treatments were either a simple diet that did not contain any lactose, zinc oxide, or specialty protein sources or a complex diet that contained 10% dried whey, 1.25% select menhaden fish meal, 1.25% spray-dried blood cells, and 0.25% zinc oxide. From d 14 to 28, pigs were fed a common diet with and without 0.5% benzoic acid, with pigs continuing to receive benzoic acid if they received it from d 0 to 14. No growth performance interactions ($P > 0.33$) were detected between diet complexity and benzoic acid. From d 0 to 14, when different diet complexities were fed, pigs fed simple diets had decreased ($P < 0.001$) ADG and ADFI and poorer ($P < 0.001$) F/G compared with pigs fed complex diets. From d 14 to 28, pigs previously fed simple diets showed compensatory growth and tended to have increased ($P < 0.06$) ADG and improved ($P < 0.003$) F/G compared with pigs previously fed the complex diets. Overall (d 0 to 28), pigs fed simple diets during Phase 1 had decreased ($P < 0.001$) ADG and ADFI from d 0 to 28 compared with pigs fed complex diets. For the main effect of benzoic acid, no differences ($P > 0.10$) were observed in ADG, ADFI, or F/G. In conclusion, as expected, early nursery pig growth performance was reduced when pigs were fed simple diets. Benzoic acid had no impact on pig growth performance regardless of diet complexity.; Swine Day, Manhattan, KS, November 21, 2013

Keywords

Swine day, 2013; Kansas Agricultural Experiment Station contribution; no. 14-044-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1092; Benzoic acid; Diet complexity; Nursery pig

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Evaluation of Diet Complexity and Benzoic Acid on Growth Performance of Nursery Pigs[1]

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Summary

A total of 280 weanling pigs (PIC 327 × 1050, initially 15.4 lb, 3 d postweaning) were used in a 28-d trial to evaluate the effects of benzoic acid and diet complexity on growth performance. Treatments were arranged as a 2 × 2 factorial with 2 diet complexities and 2 benzoic acid levels (0 vs. 0.5%) fed for the first 14 d. Diet complexity treatments were either a simple diet that did not contain any lactose, zinc oxide, or specialty protein sources or a complex diet that contained 10% dried whey, 1.25% select menhaden fish meal, 1.25% spray-dried blood cells, and 0.25% zinc oxide. From d 14 to 28, pigs were fed a common diet with and without 0.5% benzoic acid, with pigs continuing to receive benzoic acid if they received it from d 0 to 14.

No growth performance interactions ($P > 0.33$) were detected between diet complexity and benzoic acid. From d 0 to 14, when different diet complexities were fed, pigs fed simple diets had decreased ($P < 0.001$) ADG and ADFI and poorer ($P < 0.001$) F/G compared with pigs fed complex diets. From d 14 to 28, pigs previously fed simple diets showed compensatory growth and tended to have increased ($P < 0.06$) ADG and improved ($P < 0.003$) F/G compared with pigs previously fed the complex diets. Overall (d 0 to 28), pigs fed simple diets during Phase 1 had decreased ($P < 0.001$) ADG and ADFI from d 0 to 28 compared with pigs fed complex diets. For the main effect of benzoic acid, no differences ($P > 0.10$) were observed in ADG, ADFI, or F/G. In conclusion, as expected, early nursery pig growth performance was reduced when pigs were fed simple diets. Benzoic acid had no impact on pig growth performance regardless of diet complexity.

Key words: benzoic acid, diet complexity, nursery pig

Introduction

Benzoic acid is an acidifier that is most commonly utilized in nursery pig diets. Vevovitall is a source of benzoic acid that may become available to the North American swine industry; however, it has been used by European swine nutritionists for a number of years. Data from European trials indicate that adding Vevovitall to the nursery pig diet may improve growth performance, but little research has been conducted with the product in typical U.S. diet formulations, which are corn and soybean meal–based and often contain pharmacological levels of zinc oxide. The possible introduction of Vevovitall to the North American market justifies the need for research to demonstrate its efficacy using typical U.S. diet formulation techniques and to determine whether the

[1] Appreciation is expressed to DSM Nutritional Products (Parsippany, NJ), for providing the benzoic acid (Vevovitall) utilized in this study and for partial financial support.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.
[3] DSM Nutritional Products (Parsippany, NJ).

response is influenced by diet complexity. Thus, the objective of this experiment was to determine the effects of diet complexity and Vevovitall (as a source of benzoic acid) on growth performance of nursery pigs.

Procedures

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

A total of 280 weanling pigs (PIC 327 × 1050, initially 15.4 lb, 3 d postweaning) were used in a 28-d trial. 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 after weaning before the beginning of the study. On d 3 postweaning, pens were allotted to 1 of 4 dietary treatments, arranged as a 2 × 2 factorial with 7 pigs per pen and 7 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.

Diets were formulated and fed in 2 phases with decreasing nutrient concentrations in the second phase (Table 1). The first phase was fed from d 0 to 14, and the experimental treatments were organized in a 2 × 2 factorial with main effects of diet complexity (simple vs. complex) and benzoic acid (Vevovitall; DSM Nutritional Products, Parsippany, NJ; 0 vs. 0.5%). All diets were corn-soybean meal–based, with the simple diets containing no lactose, zinc oxide, or specialty protein sources. The complex diets contained 10% dried whey, 1.25% select menhaden fish meal, 1.25% spray-dried blood cells, and 0.25% zinc oxide. Phase 2 was fed from d 14 to 28, and the 2 treatment diets were corn-soybean meal–based with no specialty protein sources, either with or without 0.5% benzoic acid. All pigs fed benzoic acid from d 0 to 14 were also fed benzoic acid from d 14 to 28, regardless of diet complexity during Phase 1. Similarly, pigs fed diets without benzoic acid during Phase 1 were fed diets without benzoic acid during Phase 2. All experimental diets were in meal form and were prepared at the K-State Animal Science Feed Mill.

Experimental data were analyzed as a completely randomized design using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Treatments were arranged as a 2 × 2 factorial with 2 diet complexities and 2 benzoic acid levels. Differences between treatments were determined using the PDIFF option of SAS. Significant differences were declared at $P < 0.05$ and trends at $P < 0.10$.

Results and Discussion

No interactions ($P > 0.33$) were detected between diet complexity and benzoic acid on growth performance (Table 2).

From d 0 to 14, when different diet complexities were fed, pigs fed simple diets had decreased ($P < 0.001$) ADG and ADFI, and poorer ($P < 0.001$) F/G compared with pigs fed complex diets (Table 3). This response was expected because the simple diet did not contain any lactose, animal protein, or zinc oxide. From d 0 to 14, benzoic acid did not affect ($P > 0.26$) ADG, ADFI, or F/G.

From d 14 to 28, pigs previously fed simple diets tended to have increased ($P < 0.06$) ADG and improved ($P < 0.003$) F/G compared with pigs previously fed the complex diets. These differences appear to be a compensatory growth response from the pigs previously fed simple diets. When benzoic acid was added to the diet, there were no differences ($P > 0.13$) in ADG or F/G. Pigs fed diets containing benzoic acid in Phase 2 had a tendency for increased ($P < 0.10$) ADFI.

Decreased growth during the first phase in pigs fed simple diets carried over into the overall data, causing decreased ($P < 0.001$) ADG and ADFI from d 0 to 28 compared with pigs fed complex diets. Because of the differences in overall ADG, feeding complex diets from d 0 to 14 resulted in a 2-lb heavier ($P < 0.001$) nursery pig at the end of the trial. Overall, F/G did not differ ($P > 0.31$) between pigs fed different diet complexities because of the compensatory F/G exhibited by pigs from d 14 to 28 after they were fed the simple diet from d 0 to 14. From d 0 to 28, there were no differences ($P > 0.28$) in ADG, ADFI, or F/G when benzoic acid was added to the diet.

In conclusion, the current experiment confirmed that feeding simple, corn-soybean meal–based diets did not allow for optimal growth of early nursery pigs. Although compensatory growth did occur during Phase 2, it was inadequate to compensate for the poorer ADG and ADFI exhibited in Phase 1. Contrary to previous European data, our study suggests that there were no improvements in growth or efficiency when benzoic acid was included in the diet, regardless of diet complexity.

Table 1. Diet composition (as-fed basis)

	Phase 1[1]		
Item	Complex	Simple	Phase 2[2]
Ingredient, %			
Corn	59.93	63.17	64.50
Soybean meal (46.5% CP)	26.39	32.27	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	1.30	1.05
Limestone	0.80	0.90	1.00
Salt	0.30	0.30	0.35
Zinc oxide	0.25	---	---
Trace mineral premix	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25
L-lysine HCl	0.295	0.375	0.325
DL-methionine	0.140	0.125	0.100
L-threonine	0.125	0.140	0.110
Phytase[3]	0.019	0.019	0.019
Diatomacious earth[4]	1.00	1.00	---
Benzoic acid	---	---	---
Total	100.00	100.00	100.00

continued

Table 1. Diet composition (as-fed basis)

	Phase 1[1]		
Item	Complex	Simple	Phase 2[2]
Calculated analysis			
Standardized ileal digestible amino acids (SID), %			
Lysine	1.30	1.30	1.26
Isoleucine:lysine	56	60	62
Leucine:lysine	129	125	130
Methionine:lysine	33	32	31
Met & Cys:lysine	56	56	56
Threonine:lysine	62	62	62
Tryptophan:lysine	17.0	17.0	18
Valine:lysine	69	66	68
Total lysine, %	1.43	1.43	1.39
ME, kcal/lb	1,480	1,488	1,504
SID lysine:ME, g/Mcal	3.99	3.96	3.80
CP, %	20.7	20.9	20.9
Ca, %	0.71	0.71	0.70
P, %	0.63	0.67	0.62
Available P, %	0.47	0.46	0.41

[1] Pigs were fed complex or simple diets from d 0 to 14. Within each diet complexity, pigs were fed diets either without or with 0.5% benzoic acid. Vevovitall was used as a source of benzoic acid (DSM Nutritional Products, Parsippany, NJ).
[2] From d 14 to 28, 2 treatment diets were fed, without or with 0.5% benzoic acid.
[3] Ronozyme P CT (10,000) (International Nutrition, Omaha, NE), providing 840 phytase units (FTU)/lb and an estimated release of 0.10% available P.
[4] Indigestible marker (Perma-Guard, Inc., Corrales, NM).

Table 2. Effect of diet complexity and benzoic acid on growth performance of nursery pigs[1]

Complexity:[2]	Complex	Simple	Complex	Simple		Probability, $P <$		
Benzoic acid:[3]	0	0	0.5%	0.5%	SEM	Complexity × benzoic acid	Complexity	Benzoic acid
d 0 to 14								
ADG, lb	0.60	0.41	0.62	0.42	0.023	0.78	0.001	0.55
ADFI, lb	0.84	0.67	0.84	0.66	0.028	0.82	0.001	0.96
F/G	1.41	1.65	1.37	1.61	0.037	0.95	0.001	0.26
d 14 to 28								
ADG, lb	1.25	1.27	1.25	1.31	0.021	0.33	0.06	0.37
ADFI, lb	1.88	1.86	1.95	1.93	0.041	0.88	0.57	0.10
F/G	1.51	1.46	1.57	1.48	0.021	0.39	0.003	0.13
d 0 to 28								
ADG, lb	0.92	0.84	0.93	0.86	0.019	0.72	0.001	0.40
ADFI, lb	1.36	1.26	1.39	1.30	0.031	0.99	0.003	0.28
F/G	1.48	1.51	1.50	1.51	0.019	0.56	0.31	0.62
Weight, lb								
d 0	15.4	15.4	15.4	15.4	0.178	0.95	0.97	0.99
d 14	23.7	21.1	24.1	21.2	0.378	0.72	0.001	0.54
d 28	41.2	38.9	41.5	39.5	0.592	0.80	0.001	0.40

[1] A total of 280 weanling pigs (PIC 327 × 1050, initially 15.4 lb and 3 d postweaning) were used with 7 pigs per pen and 10 pens per treatment.
[2] Pigs were fed complex or simple diets from d 0 to 14. From d 14 to 28, pigs were fed the same basal diet formulation with or without benzoic acid.
[3] Pigs were fed diets without or with benzoic acid from d 0 to 28. Vevovitall (DSM Nutritional Products, Parsippany, NJ) was used as the source of benzoic acid.

Table 3. Main effects of diet complexity and benzoic acid on growth performance of nursery pigs[1]

	Complexity[2]			Benzoic acid[3]			Probability, $P <$	
	Complex	Simple	SEM	0	0.5%	SEM	Complexity	Benzoic acid
d 0 to 14								
ADG, lb	0.61	0.41	0.013	0.51	0.52	0.013	0.001	0.55
ADFI, lb	0.84	0.67	0.019	0.76	0.75	0.019	0.001	0.96
F/G	1.39	1.63	0.024	1.53	1.49	0.024	0.001	0.26
d 14 to 28								
ADG, lb	1.25	1.29	0.011	1.26	1.28	0.011	0.06	0.37
ADFI, lb	1.92	1.90	0.030	1.87	1.94	0.030	0.57	0.10
F/G	1.54	1.47	0.011	1.49	1.53	0.011	0.003	0.13
d 0 to 28								
ADG, lb	0.92	0.85	0.010	0.88	0.90	0.010	0.001	0.40
ADFI, lb	1.38	1.28	0.023	1.31	1.35	0.023	0.003	0.28
F/G	1.49	1.51	0.010	1.50	1.51	0.010	0.31	0.62
Weight, lb								
d 0	15.4	15.4	0.120	15.4	15.4	0.120	0.97	0.99
d 14	23.9	21.1	0.239	22.4	22.7	0.239	0.001	0.54
d 28	41.4	39.2	0.391	40.1	40.5	0.391	0.001	0.40

[1] A total of 280 weanling pigs (PIC 327 × 1050, initially 15.4 lb) were used with 7 pigs per pen and 20 pens per diet complexity main effect.
[2] Pigs were fed complex or simple diets from d 0 to 14. From d 14 to 28, a common diet was fed that did not differ in complexity.
[3] Pigs were fed diets without or with 0.5% Vevovitall from d 0 to 28.