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Evaluating the Effects of Benzoic Acid on Finishing Pig Growth Performance

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Summary

A total of 2,106 pigs (PIC 337 × 1050; initially 73.5 ± 4.21 lb) were used in a 101-d growth study to evaluate the effects of dietary benzoic acid level on grow-finish pig growth performance and carcass characteristics. Pens of pigs (27 pigs per pen) were randomly assigned to 1 of 3 dietary treatments with 13 pens per treatment. Dietary treatments were corn-soybean meal-DDGS-based with an inclusion of none, 0.25, or 0.50% benzoic acid (VevoVital, DSM Nutritional Products, Parsippany, NJ). Diets were fed in 4 phases from 74 to 110, 110 to 165, 165 to 220, and 220 to 290 lb body weight. In the grower period (d 0 to 44), there was no evidence of differences ($P > 0.10$) for pigs fed increasing benzoic acid for any growth response criteria. For the finisher period (d 44 to 101) and overall (d 0 to 101), increasing benzoic acid tended to increase ADFI (linear, $P < 0.10$) and worsen F/G (linear, $P < 0.01$). There was no evidence of differences in ADG ($P > 0.10$) for the overall experimental period. For carcass characteristics, no evidence of differences ($P > 0.10$) were observed. In conclusion, these data suggest that feeding benzoic acid in the grow-finish period had no impact on ADG, but tended to increase ADFI and worsen F/G.

Introduction

Benzoic acid serves as an organic acidifier and is commonly used in nursery diets. This is due to its ability to reduce the pH of the feed which subsequently results in enhanced digestibility of nutrients and influences the microbial populations in the digestive tract. Additions of acidifiers such as benzoic acid have shown to be most effective around the time of post-weaning due to increased stress on the pig.³ In a previous study, we observed increases in ADG of pigs fed benzoic acid from weaning to the end of the nursery phase (approximately 50 lb).⁴ With such a positive response to diet acidification in the late nursery phase, we wanted to investigate if benzoic acid might have an effect

¹ The authors appreciate New Horizon Farms, Pipestone, MN, for providing technical assistance for these studies.

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

³ Tung, C. M., and J. E. Pettigrew. 2006. Critical review of acidifiers. National Pork Board. #05-169. Available at: <https://porkcheckoff.org/research/critical-review-of-acidifiers/>.

⁴ Gaffield, K. N., J. M. DeRouchey, M. D. Tokach, J. C. Woodworth, R. D. Goodband, and J. T. Gebhardt. 2022. Effect of benzoic acid feeding strategy on weanling pig growth performance and fecal dry matter. Kansas State University Swine Day. Kansas Agricultural Experiment Station Research Reports: Vol. 8, Issue 11. <https://newprairiepress.org/kaesrr/vol8/iss11/>.

in finishing pig diets. Therefore, the objective of this study was to investigate the effects of increasing levels of benzoic acid in grow-finish diets on growth performance and carcass characteristics.

Procedures

The protocol for this experiment was approved by the Kansas State University Institutional Animal Care and Use Committee. Two barns at a commercial research grow-finish site located in southwest Minnesota (New Horizon Farms, Pipestone, MN) were used in this experiment. Each barn had slatted concrete floors, deep manure storage, were naturally ventilated, and double-curtain-sided. Pens (10 × 18 ft) contained a cup waterer and a 5-hole stainless steel dry self-feeder (Thorp Equipment, Thorp, WI) to provide *ad libitum* access to feed and water. Feed was delivered and daily feed additions were recorded with a computerized feeding system (FeedPro; Feedlogic Corp., Willmar, MN).

Animals and diets

A 101-d growth trial was conducted using two groups of 1,053 pigs (2,106 total pigs; PIC 337 × 1050; initially 73.5 ± 4.21 lb). Pens of pigs (27 pigs per pen) were randomly assigned to 1 of 3 dietary treatments in a completely randomized design with 13 pens per treatment in each barn for a total of 26 replications. Dietary treatments were corn-soybean meal-DDGS-based with the addition of none, 0.25, or 0.50% benzoic acid (VevoVital, DSM Nutritional Products, Parsippany, NJ). Diets were fed in 4 phases from 74 to 110, 110 to 165, 165 to 220, and 220 to 290 lb body weight. All treatments were formulated to meet or exceed NRC⁵ requirements for growing-finishing pigs for their appropriate weight ranges (Table 1). All diets were manufactured at New Horizon Farms Feed Mill (Pipestone, MN).

Every two weeks, pens of pigs were weighed, and feed disappearance was measured to determine ADG, ADFI, and F/G. Three pigs per pen were weighed and marketed two weeks prior to the end of the experiment. At the completion of the experiment, the remaining pens of pigs were weighed and marketed. Pigs were transported to a U.S. Department of Agriculture-inspected packing plant (JSB Swift, Worthington, MN). Carcass data were collected including HCW, loin depth, and backfat. Percentage lean was calculated using a proprietary equation from the plant. Carcass yield was calculated using the pen average HCW divided by the pen average final live weight.

Statistical analysis

Data were analyzed as a completely randomized design with pen as the experimental unit and treatment as the fixed effect. Data were analyzed as a one-way ANOVA using the lmer function from the lme4 package in R (version 4.1.1 (2021-08-10), R Foundation for Statistical Computing, Vienna, Austria). Contrasts were used to test for the main effects of the different benzoic acid feeding levels (0, 0.25, and 0.50%). All results were considered significant at $P \leq 0.05$ and marginally significant at $0.05 > P \leq 0.10$. Similarly, contrasts were used to analyze carcass characteristics including backfat, loin depth, and percent lean with HCW serving as a covariate.

⁵ National Research Council. 2012. Nutrient Requirements of Swine: Eleventh Revised Edition. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13298>.

Results and Discussion

In the grower period (d 0 to 44), there was no evidence of differences ($P > 0.10$) due to increasing benzoic acid for any growth response criteria (Table 2). For the finisher period (d 44 to 101), feeding increasing benzoic acid tended to increase ADFI (linear, $P = 0.053$) and worsened F/G (linear, $P = 0.002$). However, there was no evidence for differences ($P > 0.10$) in ADG. Similarly, for the overall experimental period (d 0 to 101), pigs fed increasing benzoic acid had a tendency for increased ADFI (linear, $P = 0.083$) and poorer F/G (linear, $P = 0.011$). There was no evidence of difference in ADG ($P > 0.10$) for the overall experimental period. Furthermore, there was no evidence of differences ($P > 0.10$) in grower BW (d 44), or final BW (d 101).

For carcass characteristics, no evidence of differences ($P > 0.10$) were observed for any criteria including HCW, carcass yield, backfat, loin depth, or lean percentage due to increasing benzoic acid.

For economics, pigs fed 0.25 or 0.50% benzoic acid had increased (linear, $P \leq 0.001$) feed cost and feed cost per lb of gain in both low and high price ingredient scenarios. However, there was no evidence of difference ($P > 0.10$) in revenue when pigs were fed increasing levels of benzoic acid when using both low and high price scenarios. Due to the increased feed cost and no change in revenue, pigs fed increasing benzoic acid had lower (linear, $P < 0.001$) IOFC.

In conclusion, these data suggest that feeding benzoic acid in the grow-finish period had no impact on ADG, but tended to increase ADFI and worsen F/G. These data contradict past studies showing a positive⁶ or no response^{7,8} to benzoic acid supplementation in the growing-finishing period. The consistency of response to benzoic acid supplementation has proven to be more variable during the grow-finish production phase compared to the nursery period. Further research is warranted to better understand under what conditions a positive response might be observed.

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⁶ Zhai, H., W. Ren, S. Wang, J. Wu, P. Guggenbuhl, and A. Klueenter. 2017. Growth performance of nursery and grower-finisher pigs fed diets supplemented with benzoic acid. *Anim. Nutr.* 3:218-221. doi:10.1016/j.aninu.2017.05.001.

⁷ O'Meara, F. M., G. E. Gardiner, J. V. O'Doherty, and P. G. Lawlor. 2020. Effect of dietary inclusion of benzoic acid (VevoVital®) on the microbial quality of liquid feed and the growth and carcass quality of grow-finish pigs. *Livest. Sci.* 237. doi:10.1016/j.livsci.2020.104043.

⁸ Cho, J. H., S. I. Lee, and I. H. Kim. 2014. Effects of different levels of fibre and benzoic acid on growth performance, nutrient digestibility, reduction of noxious gases, serum metabolites and meat quality in finishing pigs. *J. Appl. Anim. Res.* 43:336-344. doi:10.1080/09712119.2014.978772.

Table 1. Composition of experimental diets (as-fed basis)¹

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredients, %				
Corn	61.09	67.61	71.90	82.91
Soybean meal (46.5% CP)	26.63	20.40	16.29	15.50
DDGS	10.00	10.00	10.00	---
Limestone, ground	1.08	1.00	1.00	0.80
Monocalcium P (21% P)	0.40	0.25	0.10	0.10
Salt	0.35	0.35	0.35	0.35
L-Lys-HCl	0.28	0.24	0.22	0.18
DL-Met	0.01	---	---	---
Thr ²	0.04	0.03	0.01	0.04
Vitamin-trace mineral premix	0.10	0.10	0.10	0.10
Phytase ³	0.03	0.03	0.03	0.03
Benzoic acid ⁴	+/-	+/-	+/-	+/-
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible (SID) amino acids, %				
Lys	1.08	0.90	0.78	0.70
Ile:Lys	67	69	71	69
Leu:Lys	151	165	178	169
Met:Lys	28	30	32	31
Met and Cys:Lys	55	59	63	62
Thr:Lys	61	62	63	65
Trp:Lys	19	19	19	19
Val:Lys	75	79	83	80
His:Lys	45	47	50	49
Total Lys, %	1.24	1.04	0.91	0.80
NE, kcal/lb	1,106	1,125	1,137	1,155
SID Lys:NE, g/Mcal	4.43	3.63	3.11	2.75
CP, %	20.9	18.4	16.7	14.4
Ca, %	0.56	0.49	0.45	0.37
STTD P, %	0.41	0.36	0.32	0.28

¹Phases 1, 2, 3, and 4 were fed from approximately 73 to 110 lb, 110 to 165 lb, 165 to 220 lb and 220 lb to market, respectively.

²Thr Pro; CJ America Bio, Downers Grove, IL.

³Optiphos (Huevepharma, Sofia, Bulgaria) was included at 340 FTU/lb providing an estimated release of 0.13% STTD P for all the diets.

⁴Benzoic acid (VevoVitall, DSM Nutritional Products, Parsippany, NJ) at 0.25 and 0.50% of the diet was included at the expense of corn.

Table 2. Effect of increasing benzoic acid on grow-finish pigs' growth performance and carcass characteristics¹

Item	Benzoic acid, % ²			SEM	P =	
	0	0.25	0.50		Linear	Quadratic
BW, lb						
Initial (d 0)	73.4	73.6	73.4	4.21	0.996	0.900
Grower (d 44)	155.1	155.1	156.5	3.94	0.574	0.774
Final (d 101)	276.4	277.0	277.5	2.51	0.707	0.977
Grower (d 0 to 44)						
ADG, lb	1.86	1.86	1.89	0.025	0.389	0.597
ADFI, lb	4.45	4.46	4.56	0.119	0.188	0.588
F/G	2.40	2.41	2.42	0.042	0.380	0.983
Finisher (d 44 to 101)						
ADG, lb	2.18	2.17	2.17	0.094	0.616	0.868
ADFI, lb	6.72	6.73	6.86	0.291	0.053	0.340
F/G	3.08	3.10	3.16	0.018	0.002	0.303
Overall						
ADG, lb	2.04	2.03	2.04	0.056	0.777	0.630
ADFI, lb	5.71	5.72	5.82	0.188	0.083	0.404
F/G	2.80	2.82	2.85	0.018	0.011	0.472
Carcass characteristics						
HCW, lb	203.0	204.0	205.2	1.60	0.254	0.956
Carcass yield, %	72.4	72.5	72.7	0.24	0.359	0.828
Backfat, in. ³	0.63	0.64	0.63	0.013	0.862	0.591
Loin depth, in. ³	2.44	2.42	2.41	0.014	0.134	0.487
Lean, % ³	56.5	56.4	56.4	0.242	0.745	0.490
Mortality and removals, %	4.99	5.84	6.70	4.902	0.793	0.992

continued

Table 2. Effect of increasing benzoic acid on grow-finish pigs' growth performance and carcass characteristics¹

Item	Benzoic acid, % ²			SEM	P =	
	0	0.25	0.50		Linear	Quadratic
Economics, \$/pig						
Low ingredients prices ⁴						
Feed cost	42.29	43.72	45.83	0.432	< 0.001	0.517
Feed cost/lb gain ⁵	0.214	0.223	0.234	0.001	< 0.001	0.408
Revenue ⁶	85.76	85.27	85.48	0.853	0.816	0.743
IOFC ⁷	43.46	41.56	39.64	0.589	< 0.001	0.998
High ingredients prices ⁸						
Feed cost	71.05	72.32	74.71	0.710	< 0.001	0.520
Feed cost/lb gain ⁵	0.360	0.369	0.382	0.002	< 0.001	0.419
Revenue ⁶	125.78	125.07	125.36	1.251	0.816	0.743
IOFC ⁷	54.73	52.75	50.65	0.827	< 0.001	0.950

¹A total of 2,106 pigs (initial BW of 73.5 lb) were used in two groups with 27 pigs per pen and 26 replicates per treatment.

² VevoVital, DSM Nutritional Products, Parsippany, NJ.

³Adjusted using HCW as covariate.

⁴Market price for the revenue calculation: corn = \$3.00/bushel (\$107.14/ton); soybean meal = \$300/ton; DDGS = \$140/ton; L-Lys HCl = \$0.65/lb; DL-Met = \$1.70/lb; Thr Pro = \$0.80/lb; Optiphos Plus 2500G = \$0.947/lb; VevoVital = \$1.15/lb)

⁵Feed cost/lb gain = total feed cost per pig ÷ total gain per pig.

⁶Revenue = (total gain × carcass yield) × carcass price. Revenue is based on a \$0.60/lb or \$0.88/lb carcass price for low- or high-priced scenarios, respectively.

⁷Income over feed cost = revenue – feed cost.

⁸ Market price for the revenue calculation: corn = \$6.00/bushel (\$214.29/ton); soybean meal = \$400/ton; DDGS = \$240/ton; L-Lys HCl = \$0.80/lb; DL-Met = \$2.50/lb; Thr Pro = \$0.80/lb; Optiphos Plus 2500G = \$0.947/lb; VevoVital = \$1.15/lb).