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Determining the Effects of Sodium Bisulfate in Low Acid Binding Capacity-4 (ABC-4) Diets on Nursery Pig Performance and Fecal Dry Matter

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Summary

A total of 360 pigs (DNA 241 × 600, initial BW 12.3 ± 0.03 lb) were used in a 42-d growth study to determine the effects of sodium bisulfate compared with formic acid in low acid binding capacity-4 (ABC-4) diets on nursery pig growth performance and fecal dry matter (DM). At weaning, pigs were randomly allotted within three body weight blocks to one of six dietary treatments in a generalized randomized block design. There were 12 replicate pens per treatment and five pigs per pen. The experimental diets were fed in three dietary phases and were corn-soybean meal-based formulated using a low ABC-4 strategy including crystalline lactose, microbial enhanced soybean meal, and fumaric acid in the first two phases. Dietary treatments consisted of five increasing levels of sodium bisulfate (0, 0.40, 0.50, 0.60, and 0.70%) and a treatment with 0.70% formic acid to directly compare to the 0.70% sodium bisulfate treatment. Fecal samples were collected on d 10 and 24 of the experiment from the same three pigs per pen for analysis of fecal DM. From d 0 to 10 and d 10 to 24 (phases 1 and 2), there were no differences in growth performance between dietary treatments. From d 24 to 42 (phase 3), ADFI and F/G decreased and then increased (quadratic, $P \leq 0.013$) as sodium bisulfate increased in the diet with pigs fed 0.40% sodium bisulfate having the lowest ADFI and F/G. A similar tendency was observed for ADG and d 42 BW (quadratic, $P \leq 0.070$). Additionally, in phase 3, formic acid inclusion improved ($P = 0.009$) F/G compared with pigs fed 0.70% sodium bisulfate. Overall (d 0 to 42), sodium bisulfate decreased and then increased (quadratic, $P \leq 0.048$) ADFI and F/G as its inclusion level increased, with a similar tendency (quadratic, $P = 0.060$) observed for ADG. Also, the diet containing formic acid improved ($P = 0.005$) F/G compared with pigs fed 0.70% sodium bisulfate. For fecal DM, there were no observed differences on d 10, but on d 24, fecal DM decreased and then increased (quadratic, $P = 0.013$) with increasing sodium bisulfate inclusion with pigs fed 0.40% sodium bisulfate having the lowest fecal DM. In conclusion, neither sodium bisulfate nor formic acid influenced growth performance or fecal DM during the early nursery period in a low ABC-4 diet formulation strategy. During the late nursery period, when ingredients such as fumaric

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acid associated with a low ABC-4 formulation strategy were removed from the diet along with zinc oxide, sodium bisulfate had a quadratic effect on growth performance and fecal DM with lower inclusion levels reducing performance but then performance increased with higher levels reverting back to similar levels as the control. Furthermore, formic acid at similar inclusion levels to sodium bisulfate improved F/G, translating into overall improvements in feed efficiency during the nursery period.

Introduction

In addition to post-weaning stress, pigs do not begin producing sufficient quantities of hydrochloric acid (HCl) to lower their stomach pH until approximately 7 to 8 wk of age[3]. Acid binding capacity-4 (ABC-4) is defined as the amount of acid required to lower an ingredient to a pH of 4.0. Formulating diets to a low ABC-4 has been shown to be useful in improving the performance and fecal dry matter (DM) of newly weaned pigs[4]. Common strategies to reduce the ABC-4 value of diets include the use of crystalline lactose, reduction of $CaCO_3$, and the inclusion of specialty soy products having lower ABC-4 values. Crystalline lactose is the preferred lactose source because its lower mineral content results in a lower ABC-4 value compared with dried whey and whey permeate[4]. Minerals, such as Ca or Zn, have high ABC-4 values; therefore, high inclusion rates in diets can greatly increase ABC-4. Specialty soy products, specifically fermented products, often have a reduced ABC-4 compared with soybean meal, so moderate substitution in the diet may not only lower ABC-4, but also reduce the antinutritional factors associated with soybean meal. Previous research has investigated these strategies in combination with acidifiers and found improvements in growth performance and fecal DM in pigs not fed pharmacological levels of Zn[5].

As mentioned above, commercially available acidifiers are often added to diets to reduce ABC-4 and to aid newly weaned pigs with nutrient digestion. A recent study found the combination of fumaric and formic acid maintained growth performance in nursery pigs compared with pigs fed pharmacological levels of Zn[5]. The combination of these two acidifiers is frequently used as they demonstrate the lowest ABC-4 values of commercially available acidifiers commonly used in swine diets (fumaric acid: - 10,873 meq/kg; formic acid: - 8,287 meq/kg). Despite its low ABC-4, formic acid is often difficult to include in swine diets as it comes in a liquid form, potentially creating challenges at the feed mill. Furthermore, the combination of both formic and fumaric acid has been demonstrated to decrease feed intake when included at high levels in the diet[6]. A newer acidifier to the swine industry, sodium bisulfate, has a similar ABC-4 value (- 8,080 meq/kg) while potentially mitigating some of the negatives seen with formic acid. Sodium bisulfate, a granular acid salt, has historically been used

[3] Xu, R. J., and P. D. Cranwell. 1990. Development of gastric acid secretion in pigs from birth to thirty six days of age: the response to pentagastrin. J. Dev. Physiol. 13:315–326.

[4] Lee, J., D. Luise, F. Correa, M. D. Tokach, J. M. DeRouchey, and P. Trevisi. 2026. Feeding nursery pigs with low acid-binding capacity-4 diets: systematic review of growth performance, gut health, digestibility, and diarrhoea. Ital. J. Anim. Sci. 25:248–273. doi:10.1080/1828051X.2026.2627714.

[5] Stas, E. B., M. D. Tokach, J. C. Woodworth, J. M. DeRouchey, R. D. Goodband, and J. T. Gebhardt. 2025. Effects of dietary acidifiers and other low acid-binding capacity formulation strategies on weanling pig growth performance and fecal dry matter. Transl. Anim. Sci. 9:txaf104. doi:10.1093/tas/txaf104.

[6] Stas, E. B., M. D. Tokach, J. C. Woodworth, J. M. DeRouchey, R. D. Goodband, and J. T. Gebhardt. 2025. Evaluation of dietary acid-binding capacity level on nursery pig growth performance and fecal dry matter. J. Anim. Sci. 103:skaf039. doi:10.1093/jas/skaf039.

in the poultry industry to reduce the pH and ammonia in litter; however, it has also been shown to improve growth performance when fed to broilers[7]. To the authors' knowledge, there are currently no published studies investigating the effects of sodium bisulfate when used as a dietary acidifier in swine nutrition. Therefore, the objective of this study was to evaluate the effects of sodium bisulfate inclusion in low ABC-4 diets on nursery pig growth performance and fecal DM.

Procedures

The protocol used in this experiment was approved by the Kansas State University Institutional Animal Care and Use Committee. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. Each pen contained a 4-hole, dry self-feeder and nipple waterer for ad libitum access to feed and water.

Animals and diets

A total of 360 nursery pigs (DNA 241 × 600, initial BW 12.3 ± 0.03 lb) were used in a 42-d growth experiment with five pigs per pen and 12 replications per treatment. Pigs were weaned at approximately 18 d of age and divided into three BW categories: light, medium, or heavy. Pigs were randomly assigned to pens and pens were assigned to one of six dietary treatments within their respective BW categories. Dietary treatments consisted of five increasing levels of sodium bisulfate (0, 0.40, 0.50, 0.60, and 0.70%) and a treatment with 0.70% formic acid to compare to the 0.70% sodium bisulfate treatment. Treatment diets were formulated in three phases and fed in pellet form with phase 1 from d 0 to 10, phase 2 from d 10 to 24, and phase 3 from d 24 to 42 (Tables 1 and 2). A low ABC-4 strategy was utilized in diet formulation across all six treatments, including fumaric acid at 0.38%, microbial enhanced soybean meal in partial replacement of soybean meal, and crystalline lactose in replacement of dried whey and whey permeate in phases 1 and 2. To further reduce ABC-4, inclusion of calcium carbonate was limited, leading to a Ca:P ratio of 0.98 in phase 1 and 1.0 in phase 2 across all dietary treatments. Despite formulating using an ABC-4 concept, pharmacological levels of Zn from ZnO were used with 2,990 ppm added Zn in phase 1 and 1,910 ppm added Zn in phase 2. The ABC-4 value of the control diet in phase 1 had a calculated value of 334 meq/kg, and decreased with added inclusions of the acidifiers, with 0.70% inclusion of either sodium bisulfate or formic acid having an approximate value of 277 meq/kg. Similar trends were observed in phases 2 and 3 diets. All diets were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center in Manhattan, KS. Feed samples from manufacturing were retained from each diet and phase to be later used for analyzing ABC-4 and pellet durability.

Pigs and feeders were weighed on d 10, 17, 24, 31, and 42 to determine ADG, ADFI, and F/G. Fecal samples were collected via rectal palpation from the same three pigs per pen on d 10 and 24 of the study. Samples were stored at 39.2°F

[7] Turner, B. J., J. C. Jespersen, J. C. Suarez, and C. D. Coufal. 2025. Effects of sodium bisulfate or sodium sesquicarbonate as a sodium source in broiler chicken diets with or without a coccidiosis challenge. Poultry Sci. 104:104680. doi:10.1016/j.psj.2024.104680.

(4°C) until fecal DM analysis. The samples were dried in a forced-air oven for 48 h at 131°F (55°C) and loss of weight was used to determine percentage DM.

Each pelleted diet sample was analyzed in duplicate for pellet durability using the Holmen NHP100 (Tekpro Limited, North Walsham, Norfolk, UK) machine. To accomplish this, each diet sample was rifle divided and sifted using a #6 screen to remove any broken-down pellet fragments or fines (Fairfield, 2005, Appendix F, Table 2). A 100-g sample of sifted pellet was weighed, placed into the chamber, and air agitated for 60 s at 70 mbar of pressure. After agitation, the sample was then removed and sifted using the #6 screen to remove pellet fragments or fines and weighed. The pellet durability index (PDI) values were calculated using the following equation: PDI (%) = (recovered pellet weight / initial pellet weight) × 100.

Statistical analysis

Data were analyzed as a generalized randomized block design. The lm function was used from the lme4 package in RStudio [Version 4.0.2 (2020-06-22), R Core Team, R Foundation for Statistical Computing, Vienna, Austria] with pen serving as the experimental unit. For performance data, the model used treatment and block as fixed effects. For fecal DM, data were analyzed as repeated measures, considering the two sampling days, in addition to the parameters previously mentioned. The model also incorporated pen as a random effect to account for subsampling. Linear and quadratic contrasts were used to test for increasing levels of sodium bisulfate. Additionally, a contrast was used to compare the 0.70% sodium bisulfate and 0.70% formic acid treatments. All results were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

Acid binding capacity-4 of complete diets was analyzed and followed the expected trends with ABC-4 values decreasing as increasing levels of sodium bisulfate were added to the diet. Across all diets and phases, analyzed values were lower than calculated, which is consistent with previous research. Pellet durability was also analyzed on each complete diet and although there were slight numerical differences between treatments, the inclusion of either sodium bisulfate or formic acid did not appear to influence pellet quality. There was an observed numerical drop in durability from phase 1 and 2 diets compared with phase 3 diets.

For phases 1 (d 0 to 10) and 2 (d 10 to 24), there were no differences in growth performance due to dietary treatment. In phase 3 (d 24 to 42), ADFI and F/G decreased and then increased (quadratic, $P \leq 0.013$) as sodium bisulfate increased in the diet with pigs fed 0.40% sodium bisulfate having the lowest ADFI and F/G. A similar tendency was observed for ADG and d 42 BW (quadratic, $P \leq 0.070$). Additionally, in phase 3, formic acid inclusion improved ($P = 0.009$) F/G compared with pigs fed 0.70% sodium bisulfate.

Overall (d 0 to 42), sodium bisulfate decreased and then increased (quadratic, $P \leq 0.048$) ADFI and F/G, with a similar tendency (quadratic, $P = 0.060$) observed in ADG. Inclusion of formic acid improved ($P = 0.005$) overall F/G compared with pigs fed 0.70% sodium bisulfate, largely driven by the improvements observed in the third phase.

There were no differences observed in fecal DM on d 10. However, on d 24, there was a similar response (quadratic, $P = 0.013$) to that in the growth performance with fecal DM decreasing and then increasing with added levels of sodium bisulfate. There were no differences observed between treatments with either 0.70% sodium bisulfate or formic acid.

In conclusion, increasing levels of sodium bisulfate or the addition of 0.70% formic acid did not affect growth performance in the early nursery period. Additionally, there were no differences between the addition of 0.70% formic acid or 0.70% sodium bisulfate. These results suggest that sodium bisulfate may represent a practical alternative to liquid formic acid during the early nursery period when formulating using a low ABC-4 strategy. However, in the late nursery period, sodium bisulfate had a quadratic effect on growth performance and fecal DM with lower inclusion levels reducing performance but then increasing with higher levels reverting back to similar levels as observed in the control. Furthermore, formic acid improved feed efficiency when compared with a similar level of sodium bisulfate in the diet. The responses seen during the later nursery period may be partially driven by the shift in diet formulation from an ABC-4 formulation strategy utilizing crystalline lactose, microbial enhanced soybean meal, and fumaric acid in phases 1 and 2 to a more simplistic diet without the addition of fumaric acid or ZnO in phase 3.

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Table 1. Diet composition of phase 1 and 2 diets (as-fed basis)[1]

	Phase 1						Phase 2					
Sodium bisulfate or formic acid, %	0.00	0.40	0.50	0.60	0.70	0.70	0.00	0.40	0.50	0.60	0.70	0.70
Ingredient, %												
Corn	51.18	50.94	50.88	50.83	50.75	50.43	56.75	56.51	56.46	56.40	56.32	56.00
Soybean meal, 47.7% CP	15.55	15.57	15.57	15.57	15.58	15.60	23.83	23.85	23.85	23.86	23.86	23.89
Blood plasma	2.50	2.50	2.50	2.50	2.50	2.50	---	---	---	---	---	---
Microbial enhanced soybean meal[2]	9.00	9.00	9.00	9.00	9.00	9.00	6.25	6.25	6.25	6.25	6.25	6.25
Crystalline lactose	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50	7.50	7.50	7.50	7.50
Soybean oil	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00
Calcium carbonate	0.43	0.43	0.43	0.43	0.43	0.43	0.49	0.49	0.49	0.49	0.49	0.49
Monocalcium phosphate, 21.5% P	1.10	1.10	1.10	1.10	1.10	1.10	1.15	1.15	1.15	1.15	1.15	1.15
Sodium chloride	0.90	0.73	0.68	0.63	0.60	0.90	0.80	0.63	0.58	0.53	0.50	0.80
L-Lys-HCl	0.48	0.48	0.48	0.48	0.48	0.48	0.50	0.50	0.50	0.50	0.50	0.50
DL-Met	0.28	0.28	0.28	0.28	0.28	0.28	0.26	0.26	0.26	0.26	0.26	0.26
L-Thr	0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22
L-Trp	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
L-Val	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Zinc oxide	0.40	0.40	0.40	0.40	0.40	0.40	0.25	0.25	0.25	0.25	0.25	0.25
Fumaric acid	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Sodium bisulfate[3]	---	0.40	0.50	0.60	0.70	---	---	0.40	0.50	0.60	0.70	---
Formic acid[4]	---	---	---	---	---	0.70	---	---	---	---	---	0.70
Phytase[5]	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Total	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis												
SID AA, %												
Lys	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Ile:Lys	56	56	56	56	56	56	58	58	58	58	58	58
Leu:Lys	114	114	114	114	114	113	115	115	115	114	114	114
Met:Lys	40	40	40	40	40	40	40	40	40	40	40	40
Met and Cys:Lys	57	57	57	57	57	57	57	57	57	57	57	57

Thr:Lys	64	64	64	64	64	64	64	64	64	64	64	64
Trp:Lys	20	20	20	20	20	20	20	20	20	20	20	20
Val:Lys	70	70	70	70	70	70	70	70	70	70	70	70
SID Lys:NE, g/Mcal	5.23	5.24	5.24	5.24	5.25	5.27	5.43	5.44	5.44	5.45	5.45	5.47
NE, kcal/lb	1,172	1,169	1,168	1,168	1,167	1,163	1,128	1,126	1,125	1,124	1,123	1,120
CP, %	20.8	20.8	20.8	20.8	20.8	20.8	21.4	21.4	21.3	21.3	21.3	21.3
Ca, %	0.53	0.53	0.53	0.53	0.53	0.53	0.59	0.58	0.58	0.58	0.58	0.59
STTD P, %	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
ABC-4, meq/kg	334	302	294	286	277	276	343	311	303	295	287	285
Analyzed composition												
Pellet durability index, %	89.1	88.8	86.2	88.7	85.1	88.4	87.8	88.3	86.5	88.9	88.8	87.3
Na, %[6]	0.42	0.45	0.42	0.41	0.44	0.46	0.33	0.34	0.34	0.33	0.36	0.38
Cl, %[6]	0.61	0.59	0.56	0.57	0.88	0.64	0.62	0.51	0.50	0.46	0.34	0.59
Analyzed ABC-4, meq/kg	227	193	183	177	137	140	283	250	237	203	183	190

[1] Phase 1 diets were fed from d 0 to 10, with phase 2 diets fed from d 10 to 24.

[2] ME-PRO, Prairie Aquatech, Brookings, SD.

[3] AFG; Jones-Hamilton Co., Maumee, OH.

[4] pHormasil; Hawkins Inc., Roseville, MN.

[5] HiPhorius 2400 (Novonesis, Kongens Lyngby, Denmark) included at 1,800 FYT/kg provided an estimated release of 0.12% STTD P.

[6] Sodium and chloride levels were analyzed by Servi-Tech Laboratories, Dodge City, KS.

Table 2. Diet composition of phase 3 diets (as-fed basis)[1]

	Phase 3					
Sodium bisulfate or formic acid, %	0.00	0.40	0.50	0.60	0.70	0.70
Ingredient, %						
Corn	66.92	66.68	66.60	66.54	66.49	66.17
Soybean meal, 47.7% CP	28.20	28.21	28.22	28.22	28.23	28.25
Soybean oil	1.00	1.00	1.00	1.00	1.00	1.00
Calcium carbonate	0.75	0.75	0.75	0.75	0.75	0.75
Monocalcium phosphate, 21.5% P	0.85	0.85	0.85	0.85	0.85	0.85
Sodium chloride	0.60	0.43	0.40	0.35	0.30	0.60
L-Lys-HCl	0.55	0.55	0.55	0.55	0.55	0.55
DL-Met	0.21	0.21	0.21	0.21	0.21	0.21
L-Thr	0.23	0.23	0.23	0.23	0.23	0.23
L-Trp	0.06	0.06	0.06	0.06	0.06	0.06
L-Val	0.16	0.16	0.16	0.16	0.16	0.16
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25
Sodium bisulfate[2]	---	0.40	0.50	0.60	0.70	---
Formic acid[3]	---	---	---	---	---	0.70
Phytase[4]	0.08	0.08	0.08	0.08	0.08	0.08
Total	100	100	100	100	100	100
Calculated analysis						
SID AA, %						
Lys	1.30	1.30	1.30	1.30	1.30	1.30
Ile:Lys	53	53	53	53	53	53
Leu:Lys	112	112	112	112	112	112
Met:Lys	37	37	37	37	37	37
Met and Cys:Lys	57	57	57	57	57	57
Thr:Lys	63	63	63	63	63	63
Trp:Lys	20	20	20	20	20	20
Val:Lys	70	70	70	70	70	70
SID Lys:NE, g/Mcal	5.21	5.22	5.23	5.23	5.23	5.25
NE, kcal/lb	1,132	1,129	1,128	1,128	1,127	1,123
CP, %	19.9	19.9	19.9	19.9	19.9	19.9
Ca, %	0.64	0.64	0.64	0.64	0.64	0.64
STTD P, %	0.44	0.44	0.44	0.44	0.44	0.44
ABC-4, meq/kg	405	372	364	356	348	346
Analyzed composition						
Pellet durability index, %	65.4	61.3	62.6	60.4	55.1	56.2
Na, %[5]	0.25	0.26	0.26	0.29	0.27	0.31

Cl, %[5]	0.49	0.41	0.39	0.37	0.50	0.52
Analyzed ABC-4, meq/kg	310	297	273	263	243	247

[1] Phase 3 diets were fed from d 24 to 42.

[2] AFG; Jones-Hamilton Co., Maumee, OH.

[3] pHormasil; Hawkins Inc., Roseville, MN.

[4] HiPhorius 2400 (Novonesis, Kongens Lyngby, Denmark) included at 1,800 FYT/kg provided an estimated release of 0.12% STTD P.

[5] Sodium and chloride levels were analyzed by Servi-Tech Laboratories, Dodge City, KS.

Table 3. Effects of sodium bisulfate inclusion in low acid binding capacity-4 (ABC-4) diets on nursery pig performance and fecal dry matter[1]

	Sodium bisulfate, %[2]				Formic acid, %[3]		P =[4]		
Item	0	0.40	0.50	0.60	0.70	0.70	SEM	Linear	Quadratic	Sodium bisulfate vs. formic acid
BW, lb										
d 0	12.3	12.3	12.3	12.3	12.3	12.3	0.03	0.920	0.997	0.932
d 10	14.4	14.5	14.2	14.3	14.3	14.4	0.16	0.451	0.816	0.662
d 24	26.2	26.0	25.8	25.4	26.3	26.8	0.45	0.611	0.445	0.406
d 42	47.6	45.7	45.8	45.3	47.3	48.7	0.89	0.289	0.070	0.253
d 0 to 10 (phase 1)										
ADG, lb	0.21	0.22	0.20	0.20	0.20	0.21	0.017	0.465	0.816	0.675
ADFI, lb	0.33	0.31	0.28	0.31	0.31	0.29	0.015	0.111	0.212	0.544
F/G	1.61	1.49	1.47	1.60	1.52	1.40	0.096	0.619	0.219	0.224
d 10 to 24 (phase 2)										
ADG, lb	0.82	0.82	0.81	0.78	0.86	0.89	0.027	0.909	0.283	0.420
ADFI, lb	1.05	1.02	1.03	0.99	1.04	1.06	0.026	0.435	0.482	0.597
F/G	1.27	1.25	1.29	1.27	1.21	1.20	0.023	0.176	0.301	0.495
d 24 to 42 (phase 3)										
ADG, lb	1.19	1.10	1.12	1.11	1.17	1.22	0.038	0.294	0.062	0.344
ADFI, lb	1.64	1.47	1.53	1.56	1.65	1.63	0.044	0.711	0.001	0.772
F/G	1.37	1.35	1.37	1.41	1.42	1.35	0.019	0.085	0.013	0.009
d 0 to 42 (Overall)										
ADG, lb	0.83	0.79	0.79	0.78	0.83	0.87	0.022	0.489	0.060	0.259
ADFI, lb	1.12	1.04	1.06	1.07	1.13	1.12	0.026	0.569	0.004	0.911
F/G	1.35	1.31	1.34	1.37	1.35	1.29	0.015	0.680	0.048	0.005
Fecal DM, %[5]										
d 10	20.0	20.8	24.2	23.1	21.5	23.5	1.35	0.111	0.359	0.272
d 24	23.4	20.1	21.7	24.1	22.5	23.6	0.87	0.787	0.013	0.333

[1] A total of 360 pigs (initial BW = 12.3 ± 0.03 lb) were used in a growth performance study with five pigs per pen and 12 replications per treatment. Inclusion levels of sodium bisulfate and formic acid were maintained throughout the 42-d experiment.

[2] AFG; Jones-Hamilton Co., Maumee, OH.

[3] pHormasil; Hawkins Inc., Roseville, MN.

[4] Linear and quadratic contrasts were constructed to analyze increasing concentration of sodium bisulfate in the diet. The sodium bisulfate vs. formic acid contrast compares the two acidifiers included at 0.70% in the diet.

[5] Feces from three pigs from each pen were weighed and dried to measure fecal dry matter. Treatment × day: Linear, $P = 0.090$; Quadratic, $P = 0.015$; Treatment, $P = 0.074$; Day, $P = 0.447$.