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The Effects of Feeding Benzoic Acid and Essential Oils on Sows and Litter Performance[1]

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Summary

A total of 48 sows (DNA Line 200 × 400) and their progeny were used in this study to determine if feeding sows and/or piglets benzoic acid (VevoVitall, DSM Nutritional Products, Parsippany, NJ) paired with an essential oil blend (CRINA, DSM Nutritional Products, Parsippany, NJ) enhances sow and pig performance during lactation, piglet weight gain in the nursery, and survivability to market. For sow and preweaned piglet performance in the farrowing house, adding benzoic acid and an essential oil blend to the maternal diet did not affect ($P > 0.05$) litter performance or weaning weight of the piglets. Fecal swabbing litters the day before weaning showed the pigs did not eat the creep feed. Nursery pigs weighed on d 12 or d 45 postweaning were not heavier ($P > 0.05$) due to the maternal diet or the presence/absence of creep feed in the farrowing crate. Also, survivability of pigs from weaning to market did not increase due to maternal diet ($P > 0.05$). From this study, it appears that benzoic acid paired with an essential oil blend does not affect sow and pig performance or survivability to market.

Introduction

Many nursery pigs are challenged at weaning with considerable enteric diseases caused by various bacteria. Unfortunately, the use of feed ingredients with growth promoting properties are limited for use in the nursery phase. One such alternative being studied is essential oils. Essential oils are extracted from plants, or synthetically made to be "naturally identical," and are known to sometimes have beneficial properties, including flavoring, stimulation of enzyme secretion, antioxidant, and/or microbiome-altering activities.[4] In poultry, Weber et al.[4] fed diets with a blend of essential oils and found a significant improvement ($P < 0.05$) in body weight on d 21 and 42. They also expressed

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[4] Weber, G. M., M. Michalczuk, G. Huyghebaert, H. Juin, C. Kwakernaak, and M. I. Gracia. 2012. Effects of a blend of essential oil compounds and benzoic acid on performance of broiler chickens as revealed by a meta analysis of 4 growth trials in various locations. Poult Sci. 91:2820-2828. doi:10.3382/ps.2012-02243.

a significant increase ($P = 0.02$) in ADG for the entire poultry starter and grower trial period.

Another alternative being studied is benzoic acid for acidification of the intestines to lessen the impact of pathogenic disease harming the pig. In a study completed at Sichuan Agricultural University in China, Chen et al.[5] investigated the effects of benzoic acid on growth performance and intestinal development and barrier function of 90 weaned pigs. They found significant increases ($P < 0.05$) in body weight, daily growth, and feed efficiency for the entire trial period for the study (d 1 to 42).

Sulabo et al.[6] looked at the effects of lactation feed intake and creep feeding on sow and piglet performance. They suggested that the lack of postweaning performance differences between litters offered creep-feed or not offered creep-feed may be due to the assumption that every piglet consumed the creep-feed offered. To further investigate this suggestion, Sulabo et al. categorized individual piglets as eaters, non-eaters, and non-creep-fed pigs. The "eaters" had statistically greater ($P < 0.05$) overall postweaning ADG and total body weight gain from d 0 to 28 than the non-eaters or non-creep-fed pigs.

The objective of this study was to determine if feeding sows and/or piglets benzoic acid paired with an essential oil blend can enhance sow and pig performance during lactation, piglet weight gain in the nursery, and survivability to market.

Procedures

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

A total of 48 sows (DNA Line 200 × 400) and their progeny over 2 consecutive farrowing groups were used in this study to determine if feeding sows and/or piglets benzoic acid (VevoVitall, DSM Nutritional Products, Parsippany, NJ) paired with an essential oil blend (CRINA, DSM Nutritional Products, Parsippany, NJ) will enhance sow and pig performance during lactation. Sows were fed diets 5 to 7 days before farrowing and throughout lactation. Sows and their litters were randomly allotted to the initial lactation treatment based on parity and BW. The lactation dietary treatments include a control lactation diet and a diet with benzoic acid and an essential oil blend (VevoVitall and CRINA Piglets AF, DSM Nutritional Products, Parsippany, NJ) at an inclusion level of 10.00 lb/ton and 0.20 lb/ton, respectively. At 7 d before scheduled weaning, whole litters of piglets were assigned to a creep treatment or no creep was offered. The creep treatments include a control creep diet and a diet with benzoic acid and an essential oil blend (VevoVitall and CRINA Piglets AF, DSM Nutritional Products,

[5] Chen, J. L., P. Zheng, C. Zhang, B. Yu, J. He, J. Yu, J. Q. Luo, X. B. Mao, Z. Q. Huang, and D. W. Chen. 2016. Benzoic acid beneficially affects growth performance of weaned pigs which was associated with changes in gut bacterial populations, morphology indices and growth factor gene expression. J Anim Physiol Anim Nutr (Berl). doi: 10.111/jpn.12627

[6] Sulabo, R. C., J. Y. Jacela, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. M. DeRouchey, and J. L. Nelssen. 2010. Effects of lactation feed intake and creep feeding on sow and piglet performance. J. Anim. Sci. 88:3145-3153. doi:10.2527/jas.2009-2131.

Parsippany, NJ) at an inclusion level of 4.50 lb/ton and 0.20 lb/ton, respectively. Both creep diets contained 1% added chromic oxide as an indigestible marker. All diets were formulated to meet or exceed the Swine NRC dietary requirements.[7] All diets were prepared and sampled at the K-State O.H. Kruse Feed Technology Innovation Center, Manhattan, KS. Samples were pooled, subsampled, and stored at -20°C. Diet compositions and calculated analysis can be found in Tables 1 and 2.

In the farrowing house, sows were housed in individual farrowing crates and fed 4 times a day using an electronic feeding system (Gestal Solo; JYGA Technologies, St-Lambert-de-Lauzon, Quebec, Canada). Sows were fed their dietary treatments at 6 lb/d as soon as they entered the farrowing house. Once the sows gave birth, they were placed on a feeding curve determined by their parity. Feed consumption in lactation was recorded by feed disappearance. Individual piglet weights were recorded within 24 hours of birth and at weaning. Piglets were fecal swabbed the day before weaning to visually detect the chromic oxide present or not present in the feces to determine if the piglets consumed the creep feed. A total of 549 pigs from the 48 sows were weighed on d 12 and 45 in the nursery. All pigs were monitored for survivability from weaning to market.

Both sow performance data and nursery data were analyzed as 1-way ANOVA using the GLIMMIX procedure in Statistical Analysis Software (SAS) version 9.4 (SAS Institute, Inc., Cary, NC). The 1-way factor was either the sow diet or the presence of creep feed. The experiment was a completely randomized design. Sows were randomly assigned a dietary treatment based on d 107 weight and parity. Response data as counts of piglets were analyzed in Poisson distribution with log link function, and data as percentages were analyzed in Beta distribution with logit link function. The rest were analyzed in normal distribution with identity link function. The survivability data from weaning to market were analyzed using the Fisher's exact test to test the relationship between survivability and feed categorical variables. Statistical significance of above analyses were determined at $P < 0.05$ and trends at $P < 0.10$.

Results and Discussion

For sow and preweaned piglet performance in the farrowing house, adding benzoic acid and an essential oil blend to the maternal diet had no effect ($P > 0.05$) on litter performance or litter weaning weight. Fecal swabbing of litters the day before weaning to detect chromic oxide in the feces showed the pigs did not eat the creep feed or not enough time had passed since ingesting the feed for it to be shown in the feces.

There were no differences in nursery pig weights on d 12 and 45 ($P > 0.05$) due to the maternal diet or the presence/absence of creep feed in the farrowing crate. Also, survivability of pigs from weaning to market was not affected by maternal diet ($P > 0.05$).

In conclusion, adding benzoic acid and an essential oil blend to diets fed to the sows and/or piglets did not enhance sow and pig performance during lactation. It also did not affect nursery pig performance or survivability to market.

[7] NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington DC.

Table 1. Sow lactation diet composition (as-fed basis)[1]

Ingredient	%
Corn	63.285
Soybean meal	30.20
Monocalcium P (21% P)	1.475
Limestone	1.05
Salt	0.50
L-Lys-HCL	0.20
DL-Met	0.05
L-Thr	0.075
Choice white grease	2.50
Trace mineral premix	0.15
Vitamin premix	0.25
Sow add pack	0.25
Phytase[2]	0.015
Benzoic acid[3]	---
Essential oil blend[4]	---
Total	100.00
Calculated analysis[5]	
SID lysine, %	1.07
NE NRC, kcal/lb	1,139
CP, %	19.90
Ca, %	0.77
Available P, %	0.48
Standardized digestible P, %	0.52

[1] Diets were fed 5 to 7 days before parturition and throughout lactation.

[2] Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Parsippany, NJ), with a release of 0.10% available P.

[3] VevoVitall (DSM Nutritional Products, Parsippany, NJ) is an ultra-pure source of benzoic acid added at 10 lb/ton.

[4] CRINA Piglets AF (DSM Nutritional Products, Parsippany, NJ) is a blend of essential oils added at 0.20 lb/ton.

[5] NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington DC.

Table 2. Piglet creep diet composition (as-fed basis)[1]

Ingredient	%
Corn	8.84
Soybean meal	2.32
Spray-dried whey	25.00
Fine ground oat groats (steamed)	30.00
HP 300	10.00
Spray-dried animal plasma	6.00
Select menhaden fish meal	6.00
Lactose	5.00
Choice white grease	4.00
Monocalcium P, 21% P	0.35
Limestone	0.40
Salt	0.30
L-Lysine HCl	0.15
DL-methionine	0.15
Trace mineral premix	0.15
Vitamin premix	0.25
Phytase[2]	0.04
Vitamin E, 20,000 IU	0.05
Chromic oxide	1.00
Benzoic acid[3]	---
Essential oil blend[4]	---
Total	100.00
Calculated analysis[5]	
SID lysine, %	1.40
NE NRC, kcal/lb	1247
CP, %	23.20
Ca, %	0.70
Available P, %	0.66
Standardized digestible P, %	0.66

[1] Diets were fed 7 days before weaning.

[2] Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Parsippany, NJ), with a release of 0.10% available P.

[3] VevoVitall (DSM Nutritional Products, Parsippany, NJ) is an ultra-pure source of benzoic acid added at 6.0 lb/ton.

[4] CRINA Piglets AF (DSM Nutritional Products, Parsippany, NJ) is a blend of essential oils added at 0.20 lb/ton.

[5] NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington DC.

Table 3. Effects of feeding benzoic acid and an essential oil blend on sow and preweaned piglet performance[1]

	Diet[2]			
	Control	Benzoic acid[3] and essential oil blend[4]	SEM	Probability, $P <$
Sows, *n*	24	24	---	---
Parity	2.42	2.29	---	---
Lactation ADFI, lb	12.80	12.63	0.293	0.6889
Sow BW, lb				
Gestation				
d 107	536.4	532.3	12.579	0.8213
Lactation				
d 0	505.0	498.9	12.559	0.7300
d 21	484.2	478.3	11.765	0.7238
BW loss, lb	-20.9	-20.6	3.728	0.9624
Litter characteristics				
Total born, *n*	17.13	16.29	0.845	0.4837
Born alive, %	91.22	90.70	0.015	0.8877
Stillborn, %	7.34	7.95	0.015	0.8868
Mummies, %	1.43	1.35	0.007	0.9971
Number nursed	15.13	14.46	0.794	0.5512
Number weaned	13.83	13.25	0.759	0.5856
Survivability, %	92.06	92.09	0.015	0.9372
Piglet BW, lb				
Birth	3.13	3.27	0.094	0.2873
Weaning	12.67	12.67	0.280	0.9917

[1] A total of 48 sows (DNA Line 200 × 400) and their progeny over 2 consecutive farrowing groups were used in this study.

[2] Diets were fed 5 to 7 days before parturition and throughout lactation.

[3] VevoVitall (DSM Nutritional Products, Parsippany, NJ) is an ultra-pure source of benzoic acid added at 10 lb/ton.

[4] CRINA Piglets AF (DSM Nutritional Products, Parsippany, NJ) is a blend of essential oils added at 0.20 lb/ton.

Table 4. Effects of feeding benzoic acid and an essential oil blend on nursery pig performance[1]

	Maternal diet			
	Control	Benzoic acid[2] and essential oil blend[3]	SEM	Probability, $P <$
Survivability, %[4]	96.69	97.81	---	0.4761
BW, lb				
d 12	15.14	14.79	0.197	0.2064
d 45	56.77	56.53	0.594	0.7674
	Creep fed[5]			
	No	Yes		
BW, lb				
d 12	14.83	15.03	0.241	0.5113
d 45	56.04	56.95	0.725	0.3035

[1] A total of 549 nursery pigs (DNA Line 200 × 400) were followed through the nursery.

[2] VevoVitall (DSM Nutritional Products, Parsippany, NJ) is an ultra-pure source of benzoic acid added at 10 lb/ton.

[3] CRINA Piglets AF (DSM Nutritional Products, Parsippany, NJ) is a blend of essential oils added at 0.20 lb/ton.

[4] The survivability data from weaning to market were analyzed using the Fisher's exact test to test the relationship between survivability and feed categorical variables.

[5] At 7 d before scheduled weaning, whole litters of piglets were assigned to a creep treatment or no creep was offered. The two creep treatments were combined in this table in the "yes" category.