

Evaluation of Dietary Phytochemicals on Growth Performance and Carcass Characteristics of Pigs During the Growing- Finishing Phase

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Summary

A total of 317 pigs (DNA 600 × 241, initially 108.6 lb) were used in a 87-d trial to determine the effects of two essential oil mixtures tested individually and in combination on growth performance and carcass characteristics of growing-finishing pigs from 108 to 285 lb. Pens of 9 or 10 mixed-gender pigs were allotted by BW and randomly assigned to 1 of 4 dietary treatments with 8 replications per treatment. Pigs were fed a nutritional program with 4 dietary phases with the same treatments fed in all 4 phases. Experimental treatments included a control diet with no feed additives or the control with 0.02% essential oil mixture 1 (EOM 1) containing caraway, garlic, thyme, and cinnamon; 0.013% essential oil mixture 2 (EOM 2) containing oregano, citrus, and anise; and the combination of 0.02% EOM 1 and 0.013% EOM 2 (EOM 1+2). At d 87, pigs were transported to a packing plant for processing and carcass data collection. There was no evidence for treatment differences for overall ADG, ADFI, or F/G. Similarly, there was no evidence for treatment differences in HCW, carcass yield, backfat, loin depth or percentage lean. In summary, the inclusion of these phytochemical feed additives did not influence growth or carcass performance.

Introduction

Phytochemical feed additives are compounds derived from plant extracts that are incorporated into animal feed with the goal of improving animal health and performance. While the exact mode of action and physiological effects are not fully understood, most are associated with antimicrobial benefits, increased antioxidant activity, stimulation of digestive enzymes, and overall improvement of gut function.^{2,3} Furthermore, phytochemical

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² J. Jacela, J. DeRouchey, M. Tokach, R. Goodband, J. Nelssen, D. Renter and S. Dritz. 2010. Feed additives for swine: Fact sheets – prebiotics and probiotics, and phytochemicals. *J. Swine Health Prod.* 2010; 18(3): 132-136.

³ L. Yan, Q.W. Meng, and I.H. Kim. 2012. Effect of an herb extract mixture on growth performance, nutrient, digestibility, blood characteristics, and fecal microbial shedding in weanling pigs. *Livest. Sci.* 145:189-195.

ics potentially can improve diet palatability, which could lead to greater growth rate.^{4,5} Research with phytochemicals in swine diets has yielded inconsistent results with more research needed to determine the correct blend or timing of use, as well as to identify the greatest opportunities to yield economic benefits.^{3,6} Previous research with the use of phytochemicals during the growing-finishing phase suggested that the combination of two essential oil mixtures (EOM), EOM 1 (containing caraway, garlic, thyme, and cinnamon) and EOM 2 (containing oregano, citrus, and anise), would improve pigs ADFI, HCW, and carcass ADG compared to a control regimen without the use of any additives.⁷ In that study, EOM 2 was not tested by itself; therefore, it was not possible to determine whether the observed responses were elicited because of its action alone or if it needs to be combined with EOM 1 in order to yield the benefit. Therefore, the objective of the present study was to determine the effects of two essential oil mixtures tested individually and in combination during the growing-finishing phase on the growth performance and carcass characteristics of pigs from 108 to 285 lb.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. This study was conducted at the Kansas State University Swine Teaching and Research Center, Manhattan, KS. The facility was totally enclosed and environmentally regulated, containing 32 pens. Each pen was equipped with a dry, single-sided feeder (Farmweld, Teutopolis, IL) and a 1-cup waterer. Pens were located over a completely slatted concrete floor with a 4-ft pit underneath for manure storage. A robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) was used to deliver and record daily feed additions to each individual pen.

A total of 317 pigs (DNA 600 × 241, initially 108.6 lb) were used in an 87-d trial. There were 9 or 10 mixed-gender pigs per pen at a floor space of 7.83 ft² per pig. Pigs were allotted by BW to pens and pens were randomly assigned within weight blocks to 1 of 4 dietary treatments in a completely randomized block design with 8 replications per treatment. Pigs were fed a conventional nutritional program with four dietary phases; from d 0 to 14, 14 to 32, 32 to 59, and 59 to 87 for phases 1, 2, 3, and 4, respectively (Table 1). Experimental treatments included a control diet with no feed additives or the control with 0.02% essential oil mixture 1 (EOM 1) containing caraway, garlic, thyme, and cinnamon; 0.013% essential oil mixture 2 (EOM 2) containing oregano, citrus, and anise; or the combination of 0.02% EOM 1 and 0.013% EOM 2 (EOM 1+2).

Pigs were weighed on d 0, 14, 32, 59, and 87 to determine ADG, ADFI, and F/G. At d 87, pigs were individually ear tagged with a unique radio frequency identification devices (RFID) number to allow for carcass measurements to be recorded on a pig basis.

⁴ W. Windisch, K. Schedle, C. Plitzner and A. Kroismayr. 2007. Use of phytochemical products as feed additives for swine and poultry. *J. Anim. Sci.* 86:140-148.

⁵ K. Karaskova, P. Suchy and E. Strakova. 2015. Current use of phytochemical feed additives in animal nutrition: a review. *Czech J. Anim. Sci.* 60:521-530.

⁶ Thacker, P. 2013. Alternatives to antibiotics as growth promoters for use in swine productions: a review. *J. Anim. Sci. Biotechnol.* 4(1):1-12.

⁷ J. A. Soto, M. D. Tokach, G. R. Murugesan, S. S. Dritz, J. C. Woodworth, J. M. DeRouche and R. D. Goodband. 2017. Evaluation of dietary phytochemicals on growth performance, carcass characteristics, and economics of grow-finish pigs housed under commercial conditions. *J. Anim. Sci.* Vol. 95, Suppl. 2 83-83/J. Dairy Sci. Vol. 100, Suppl. 1. doi:10.2527/asasmw.2017.12.175.

On d 87, final pen weights and individual weights were taken, and pigs were transported to a commercial packing plant (Triumph, St. Joseph, MO) for processing and carcass collection. Many RFID tags were dislodged and lost during the dehairing process. Thus, the recovery of carcass data from the processing plant was limited to 65, 66, 71, and 63% of the pigs for control, EOM 1, EOM 2, and EOM 1+2, respectively.

Diet samples from each dietary phase were taken from 6 feeders per dietary treatment 3 d after the beginning and 3 d before the end of each dietary phase and stored at -20°C until they were homogenized, subsampled, and submitted to Cumberland Valley Analytical Service (Hagerstown, MD) for analysis of DM, CP, Ca, P, ether extract, and ash (Tables 2 and 3).

Data were analyzed using the GLIMMIX procedure of SAS version 9.4 (SAS Institute, Inc., Cary, NC) in a randomized complete block design with pen serving as the experimental unit and initial BW serving as the blocking factor. Main effects of EOM 1 and EOM 2 as well as their interaction were tested. Random effects of block and treatment \times block were included in the model for growth performance and carcass characteristics response variables, respectively. Hot carcass weight served as a covariate for the analysis of backfat, loin depth, and lean percentage. Results from the experiment were considered significant at $P < 0.05$ and marginally significant between $P > 0.05$ and $P \leq 0.10$.

Results

The analyzed DM, CP, Ca, P, ether extract, and ash contents of experimental diets (Tables 2 and 3) agreed closely with formulated estimates.

During phase 1 (d 0 to 14), there was no evidence for treatment differences for ADG, ADFI, or F/G (Table 4). During phase 2 (d 14 to 32), ADFI increased ($P < 0.05$) for pigs fed EOM 2 and F/G worsened ($P < 0.05$) for pigs fed the EOM 1. During phase 3 (d 32 to 59), ADFI was increased ($P < 0.05$) in pigs fed EOM 2, which marginally improved ($P < 0.10$) ADG. During phase 4 (d 59 to 87), there was no evidence for treatment differences for ADG, ADFI, or F/G. For overall growth performance, there was no evidence for treatment differences for ADG, ADFI, or F/G. Similarly, there was no evidence for treatment differences in HCW, carcass yield, backfat, loin depth, or percentage lean.

In summary, the inclusion of these phytogetic feed additives did not provide any benefits in overall growth or carcass performance. This is in contrast with our previous research where we observed that the combination of these same EOM 1 and EOM 2 improved ADFI, HCW, and carcass ADG in comparison with pigs fed a control diet.⁷ Research with phytoGENICS in swine diets has yielded inconsistent results. More research is needed to determine the correct blend or timing of use as well as to identify the greatest opportunities to yield economic benefits.

Table 1. Diet composition from phase 1 to 5 (as-fed basis)^{1,2,3,4}

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredient, %				
Corn	58.48	66.45	73.64	87.90
Soybean meal, (46.5% CP)	23.93	16.09	9.06	9.83
DDGS ³	15.00	15.00	15.00	---
Monocalcium P, (21% P)	0.25	0.20	0.15	0.35
Limestone	1.08	1.05	1.00	1.00
Salt	0.35	0.35	0.35	0.35
L-Lys-HCl	0.41	0.42	0.44	0.29
DL-Met	0.08	0.05	0.02	0.02
L-Thr	0.10	0.10	0.09	0.08
L-Trp	0.02	0.03	0.04	0.02
Trace mineral premix	0.15	0.13	0.10	0.08
Vitamin premix	0.15	0.13	0.10	0.08
Phytase ⁵	0.02	0.02	0.02	0.02
Total	100.0	100.0	100.0	100.0
Calculated analysis				
Standardized ileal digestible (SID) AA, %				
Lys	1.14	0.96	0.80	0.65
Ile:Lys	62	60	58	60
Leu:Lys	146	154	164	161
Met:Lys	33	33	32	32
Met and Cys:Lys	58	58	58	62
Thr:Lys	62	62	62	65
Trp:Lys	18	18	18	18
Val:Lys	70	70	70	71
SID Lys: ME, g/Mcal	3.44	2.95	2.40	1.95
ME, kcal/lb	1,501	1,507	1,512	1,509
CP, %	20.9	17.8	15.0	12.3
Ca, %	0.56	0.51	0.46	0.48
P, %	0.47	0.42	0.38	0.37
Available P, %	0.28	0.26	0.24	0.22
Standardized digestible P, %	0.33	0.30	0.27	0.27

¹ Phase 1, 2, 3, and 4 diets were fed from d 0 to 14, d 14 to 32, d 32 to 59, and d 59 to 87, which correspond to 108 to 138, 138 to 168, 168 to 227, and 227 to 285 lb BW, respectively.

² EOM 1 (EOM = essential oil mixture) was included at 0.020% of the diet at the expense of corn in all dietary phases.

³ EOM 2 was included at 0.013% of the diet at the expense of corn in all dietary phases. DDGS = dried distillers grains with solubles.

⁴ A combination of EOM 1 at 0.020% and EOM 2 at 0.013% of the diet was included at the expense of corn in all dietary phases.

⁵ Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Inc, Parsippany, NJ). Provided 181.8 phytase units (FYT) per lb of diet with a release of 0.10% available P.

Table 2. Chemical analysis of experimental diets (as-fed basis)^{1,2}

Feed additive:	Phase 1				Phase 2			
	Control	EOM 1 ³	EOM 2 ⁴	EOM 1+2 ⁵	Control	EOM 1	EOM 2	EOM 1+2
Item, %								
DM	87.0	86.8	86.7	86.4	86.9	86.9	86.8	86.9
CP	20.8	20.3	20.0	20.0	17.6	17.5	16.9	17.2
Ca	0.70	0.72	0.63	0.72	0.64	0.65	0.63	0.63
P	0.50	0.46	0.48	0.45	0.45	0.46	0.46	0.43
Ether extract	2.8	2.7	3.3	2.5	3.6	3.7	3.3	3.5
Ash	4.7	4.4	3.7	4.2	3.7	4.1	4.1	4.2

¹ Multiple diet samples were collected from each diet throughout the study, homogenized, and then subsampled for analysis (Cumberland Laboratories, Inc. Kearney, NE).

² Phase 1 and 2 were fed from 108 to 138 and 138 to 138 to 168 lb BW, respectively.

³ EOM 1 (EOM = essential oil mixture) was included at 0.020% of the diet at the expense of corn in all dietary phases.

⁴ EOM 2 was included at 0.013% of the diet at the expense of corn in all dietary phases.

⁵ A combination of EOM 1 at 0.020% and EOM 2 at 0.013% of the diet were included at the expense of corn in all dietary phases.

Table 3. Chemical analysis of experimental diets (as-fed basis)^{1,2}

Feed additive:	Phase 3				Phase 4			
	Control	EOM 1 ³	EOM 2 ⁴	EOM 1+2 ⁵	Control	EOM 1	EOM 2	EOM 1+2
Item, %								
DM	87.2	87.4	87.4	87.3	86.4	86.4	86.4	86.4
CP	15.0	14.8	14.1	14.3	11.9	12.4	12.4	12.0
Ca	0.66	0.59	0.59	0.58	0.69	0.67	0.64	0.58
P	0.39	0.39	0.37	0.38	0.35	0.35	0.36	0.36
Ether extract	3.9	4.1	3.7	3.7	2.7	2.7	3.0	2.7
Ash	3.0	3.7	3.3	3.1	3.6	3.1	3.5	3.2

¹ Multiple diet samples were collected from each diet throughout the study, homogenized, and then subsampled for analysis (Cumberland Laboratories, Inc. Kearney, NE).

² Phase 3 and 4 were fed from 168 to 227 and 227 to 285 lb BW, respectively.

³ EOM 1 (EOM = essential oil mixture) was included at 0.020% of the diet at the expense of corn in all dietary phases.

⁴ EOM 2 was included at 0.013% of the diet at the expense of corn in all dietary phases.

⁵ A combination of EOM 1 at 0.020% and EOM 2 at 0.013% of the diet was included at the expense of corn in all dietary phases.

Table 4. Evaluation of dietary phytonics on the growth performance and carcass characteristics of pigs from 110 to 285 lb¹

Item	Feed additive				SEM	Probability, $P <$		
	Control	EOM 1 ²	EOM 2 ³	EOM 1+2 ⁴		EOM 1	EOM 2	E1 × E2 ⁵
BW, lb								
d 0	108.6	108.6	108.7	108.6	1.76	0.862	0.960	0.890
d 14	138.6	138.7	138.4	138.1	2.29	0.918	0.678	0.830
d 32	167.6	167.4	168.0	166.6	2.41	0.441	0.833	0.581
d 59	225.5	225.6	227.9	225.9	2.53	0.484	0.322	0.438
d 87	285.4	283.2	286.0	284.5	2.22	0.244	0.520	0.818
d 0 to 14								
ADG, lb	2.15	2.15	2.11	2.11	0.054	0.928	0.407	0.969
ADFI, lb	4.57	4.57	4.43	4.51	0.154	0.738	0.416	0.708
F/G	2.12	2.12	2.11	2.14	0.042	0.632	0.990	0.608
d 14 to 32								
ADG, lb	2.05	1.99	2.13	2.04	0.051	0.153	0.205	0.723
ADFI, lb	5.55	5.70	5.88	5.89	0.110	0.393	0.010	0.437
F/G	2.71	2.87	2.77	2.89	0.056	0.018	0.475	0.766
d 32 to 59								
ADG, lb	2.00	2.04	2.08	2.11	0.037	0.287	0.057	0.855
ADFI, lb	6.68	6.53	6.85	6.96	0.108	0.849	0.004	0.193
F/G	3.35	3.20	3.31	3.30	0.069	0.312	0.669	0.271
d 59 to 87								
ADG, lb	1.73	1.73	1.67	1.72	0.052	0.626	0.484	0.609
ADFI, lb	6.92	6.61	6.74	6.77	0.100	0.176	0.887	0.101
F/G	4.02	3.84	4.08	3.94	0.107	0.140	0.435	0.848
d 0 to 87								
ADG, lb	2.01	2.00	2.02	2.01	0.015	0.467	0.518	0.935
ADFI, lb	6.25	6.14	6.24	6.26	0.076	0.570	0.419	0.336
F/G	3.11	3.07	3.08	3.12	0.032	0.946	0.610	0.184
Carcass characteristics								
HCW, lb	222.7	220.1	222.7	223.3	1.84	0.463	0.230	0.251
Carcass yield, %	74.8	75.0	74.8	74.9	0.31	0.594	0.881	0.948
Backfat, in. ⁶	0.64	0.68	0.66	0.66	0.015	0.429	0.966	0.478
Loin depth, in. ⁶	2.49	2.51	2.52	2.54	0.021	0.482	0.229	0.184
Lean, % ⁶	53.8	53.6	53.8	53.9	0.18	0.934	0.847	0.890

¹ A total of 317 pigs (DNA 600 × 241; initially 108.6 lb) were used in a 87-d experiment with 9 or 10 pigs per pen and 8 replications per treatment.

² EOM 1 (EOM = essential oil mixture) was included at 0.020% of the diet in all dietary phases.

³ EOM 2 was included at 0.013% of the diet in all dietary phases.

⁴ A combination of EOM 1 at 0.020% and EOM 2 at 0.013% of the diet were included in all dietary phases.

⁵ Interaction between EOM 1 and EOM 2.

⁶ Adjusted using HCW as a covariate.