

The Effect of Phytogenic and Acidifying Feed Additives on Growth Performance and Carcass Characteristics of Grow-Finish Pigs

A.S. Leaflet R3346

Leigh A. Ruckman, Graduate Research Assistant;
John F. Patience, Professor, Department of Animal
Science, Iowa State University

Summary and Implications

The objective of this experiment was to determine the effects of phytogenic compounds and acidifiers on the growth and carcass characteristics of grow-finish pigs. Two hundred ninety-eight pigs were blocked by initial BW (28.3 ± 0.6 kg) and sex and allotted to 1 of 4 dietary treatments with 5 pigs per pen and 15 pens per treatment. The dietary treatments were fed over 4 phases and consisted of: a negative control with no additives (NC), the NC with a blend of phytogenic compounds (PC), the NC with oregano essential oils (OEE), and the NC with blends of phytogenic compounds and acidifiers (PCA). Individual pig weights and feed disappearance were measured on d 0, 21, 48, 68, and prior to each of the 3 market cuts (d 103, 110, and 119). Data were analyzed using PROC MIXED of SAS (9.4) with pen as the experimental unit and treatment \times sex \times time and block as fixed effects. Hot carcass weight (HCW) was used as a covariate for carcass data. Overall, there were no differences among treatments for final BW, ADG, ADFI, and feed efficiency ($P > 0.10$). As expected, there was a difference in growth between sex, as barrows had greater final BW, ADG, and ADFI, but decreased feed efficiency compared to gilts ($P < 0.05$). Treatment did not affect HCW, dressing percentage (DP), backfat depth (BD), loin depth (LD), or lean percent (LP) ($P > 0.10$). Barrows had greater HCW and BD, with decreased LD and LP compared to gilts ($P < 0.05$). In conclusion, the experimental treatments (PC, OEE, and PCA) did not affect growth performance or carcass characteristics of grow-finish pigs.

Introduction

In response to concerns about antibiotic-resistant bacteria in human and animal medicine, the FDA has introduced the Veterinary Feed Directive (VFD) to eliminate the sub-therapeutic use of antibiotics of value in human medicine as growth promoters (AGP) in food-animal production. Several types of non-antibiotic feed additives have been developed as growth promoters in the pig, but research on their efficacy is still ongoing. Phytogenic compounds, a relatively new class of additives, can be defined as plant-derived compounds utilized in the form of essential oils or plant or herbal extracts. These substances,

sometimes used in conjunction with acidifiers, have garnered interest in the swine and poultry industries because they are thought to have beneficial health and growth effects. The exact mode of action of these additives is unknown. In addition, there are few and inconsistent results about the effectiveness of phytogenic compounds as growth promoters in grow-finish pigs. Therefore, the objective of this experiment was to test the hypothesis that the addition of phytogenic compounds and acidifiers added to the feed would improve the rate and efficiency of growth and the carcass composition of finisher pigs.

Materials and Methods

All procedures were approved by the Iowa State University Institutional Animal Care and Use Committee. This experiment was conducted at the Iowa State University Swine Nutrition Farm (Ames, IA). A total of 298 crossbred pigs (Genetiporc 6.0 \times F25; PIC, Hendersonville, TN) were assigned to 15 blocks on the basis of initial BW (28.3 ± 0.6 kg) and sex and allotted to 1 of 4 dietary treatments. There was a total of 60 pens including 8 blocks of barrows and 7 blocks of gilts per treatment. Pigs were housed 5 pigs per pen (1.00 m²/pig). Each pen was equipped with a half-slatted concrete floor, a two-space dry self-feeder, and a nipple waterer in a power-ventilated building. The pigs had ad libitum access to feed and water for the duration of the 119-d trial.

The dietary treatments consisted of a negative control containing no feed additives (NC), the NC with a mixture of microencapsulated phytogenic compounds (including carvacrol, thymol, capsaicin, and cinnamaldehyde; PC), NC with added essential oils from the oregano plant combined with emulsifiers (OEE), and NC with blends of phytogenic compounds and acidifiers (PCA), all added at the expense of corn. Dietary treatments were fed in 4 phases and phase changes corresponded with each weigh day (d 21, 48, and 68).

Pigs were individually weighed on d 0, 21, 48, 68, and prior to each of the 3 marketing cuts. Feeders were weighed on d 0 to determine empty weight and at each phase change to measure feed disappearance. These data were used to determine ADG, ADFI and G:F overall. The CV for initial BW and final BW was calculated on a pen basis using the average BW of each pen on d 0 and 103, which was the last day that all of the pigs on trial were present prior to harvest.

Pigs were harvested in 3 cuts - on d 103, 110, and 119 and transported to Tyson Fresh Meats (Perry, IA). The number of pigs per treatment was similar within and across

cuts to avoid the risk of confounding carcass data arising from differing harvest dates. Backfat depth and LD were determined on all carcasses using ultrasound scanning at the 10th rib (BioQscan, Biotronics Inc., Ames, IA). Lean percent was calculated using BD and LD measurements based on Tyson Fresh Meat's proprietary equation. Dressing percentage was calculated by dividing HCW by final live BW and multiplying by 100 ($DP = (HCW \div \text{Final BW}) \times 100$).

All data were analyzed using the PROC MIXED procedure of SAS (SAS 9.4, SAS Inst. Inc., Cary, NC). The PROC UNIVARIATE procedure of SAS was used to test data for normality and homogenous variance; outliers outside of three standard deviations beyond the mean were removed. The experimental unit was pen and pig was the observational unit for growth and carcass data. Treatment \times sex \times time and block were used as fixed effects. For carcass data, treatment \times sex and block were used as fixed effects and HCW was used as a covariate for BD, LD, and LP parameters. Effects were considered significant if $P < 0.05$, and trends if $P > 0.05$ or < 0.10 .

Results and Discussion

The inclusion of phytogetic feed additives and acidifiers showed no beneficial impact on growth performance in this study (Table 3). The experimental treatments had no effect on final BW ($P > 0.10$). There was no effect of diet on ADG, ADFI or gain:feed among treatments ($P > 0.10$).

Overall, there was a significant sex effect for final BW ($P < 0.0001$; Table 3), ADG ($P < 0.0001$), ADFI ($P < 0.0001$), and feed efficiency ($P = 0.005$). As expected, the barrows grew faster and had a greater feed intake than gilts but were not as feed efficient.

This experiment showed no effect of treatment on carcass characteristics ($P > 0.10$; Table 4). The gilts had increased LD ($P = 0.007$) with decreased BD ($P < 0.0001$) and HCW ($P < 0.0001$) compared to the barrows, and therefore, an increased LP ($P < 0.0001$).

In conclusion, the addition of these particular phytogetic compounds and acidifiers had no effect on growth performance or carcass characteristics of grow-finish pigs. The hypothesis, that these products would increase growth and improve feed efficiency in finisher pigs, was not supported. Further research is still needed to develop growth promoting products or solutions that will allow for the reduced use of antibiotics in pork production, or to better understand the mode of action of these products to increase their usefulness in pork production.

Acknowledgements

The authors would like to thank EW Nutrition and the State of Iowa for their financial support of this project and the staff of the ISU Swine Nutrition Farm for their assistance with this project.

Iowa State University Animal Industry Report 2019

Table 1. Ingredient and nutrient composition of experimental diets (as-fed basis): phase 1 and 2¹.

Phase	Phase 1				Phase 2			
Treatment ²	NC	PC	OEE	PCA	NC	PC	OEE	PCA
Ingredients, %								
Corn	56.96	56.93	56.86	56.86	57.89	57.87	57.79	57.79
Soybean meal	21.87	21.87	21.87	21.87	16.73	16.73	16.73	16.73
Corn DDGS	15.00	15.00	15.00	15.00	20.00	20.00	20.00	20.00
Soybean oil	3.00	3.00	3.00	3.00	2.50	2.50	2.50	2.50
L-lysine HCl	0.40	0.40	0.40	0.40	0.36	0.36	0.36	0.36
DL-methionine	0.06	0.06	0.06	0.06	-	-	-	-
L-threonine	0.08	0.08	0.08	0.08	0.04	0.04	0.04	0.04
L-tryptophan	-	-	-	-	0.003	0.003	0.003	0.003
Monocalcium phosphate	0.38	0.38	0.38	0.38	0.31	0.31	0.31	0.31
Limestone	1.40	1.40	1.40	1.40	1.31	1.31	1.31	1.31
Sodium chloride	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix ³	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Trace mineral premix ⁴	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Phytase ⁵	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
PC	-	0.025	-	-	-	0.025	-	-
OEE	-	-	0.10	-	-	-	0.10	-
PCA	-	-	-	0.10	-	-	-	0.10
Nutrients, calculated								
Crude protein, %	19.24	19.24	19.24	19.24	18.23	18.23	18.23	18.23
Calcium, %	0.70	0.70	0.70	0.70	0.64	0.64	0.64	0.64
STTD P, % ⁶	0.33	0.33	0.33	0.33	0.32	0.32	0.32	0.32
SID Lys, %	1.08	1.08	1.08	1.08	0.94	0.94	0.94	0.94
SID TSAA:Lys	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56
SID Trp:Lys	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
SID Thr:Lys	0.60	0.60	0.60	0.60	0.61	0.61	0.61	0.61
ME, Mcal/kg	3.42	3.42	3.42	3.42	3.41	3.41	3.41	3.41
NE, Mcal/kg	2.56	2.56	2.56	2.56	2.55	2.55	2.55	2.55

¹ Phase 1 was formulated for 20-40 kg BW and was fed from d 0-21. Phase 2 was formulated for 40-65 kg BW and was fed from d 21-48.

² NC: negative control, containing no feed additive; PC: NC with phytogenic compounds; OEE: NC with oregano essential oil; PCA: NC with phytogenic compounds and acidifiers.

³ Vitamin premix provided per kg of complete diet: 6,125 IU vitamin A, 700 IU vitamin D₃, 50 IU vitamin E, 3 mg vitamin K, 11 mg riboflavin, 50 µg vitamin B₁₂, 56 mg niacin, and 27 mg pantothenic acid.

⁴ Trace mineral premix provided per kg of complete diet: 165 ppm Fe as FeSO₄, 165 ppm Zn as ZnSO₄, 39 ppm Mn as MnSO₄, 16.5 ppm Cu as CuSO₄, 0.3 ppm I as C₂H₁₀I₂N₂ or KIO₃, and 0.3 ppm Se as Na₂SeO₄ or Na₂SeO₃.

⁵ Quantum Blue 5 G (AB Vista Feed Ingredients, Marlborough, Wiltshire, UK) was added at 0.005% for 250 FTU/kg.

⁶ STTD P = standardized total tract digestible P

Iowa State University Animal Industry Report 2019

Table 2. Ingredient and nutrient composition of experimental diets (as-fed basis): phase 3 and 4¹.

Phase	Phase 3				Phase 4			
Treatment ²	NC	PC	OEE	PCA	NC	PC	OEE	PCA
Ingredients, %								
Corn	61.96	61.93	61.86	61.86	73.94	73.92	73.84	73.84
Soybean meal	13.63	13.63	13.63	13.63	11.74	11.74	11.74	11.74
Corn DDGS	20.00	20.00	20.00	20.00	10.00	10.00	10.00	10.00
Soybean oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
L-lysine HCl	0.30	0.30	0.30	0.30	0.24	0.24	0.24	0.24
L-threonine	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
L-tryptophan	0.01	0.01	0.01	0.01	0.005	0.005	0.005	0.005
Monocalcium phosphate	0.08	0.08	0.08	0.08	0.16	0.16	0.16	0.16
Limestone	1.20	1.20	1.20	1.20	1.07	1.07	1.07	1.07
Sodium chloride	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix ³	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral premix ⁴	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Phytase ⁵	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
PC	-	0.025	-	-	-	0.025	-	-
OEE	-	-	0.10	-	-	-	0.10	-
PCA	-	-	-	0.10	-	-	-	0.10
Nutrients, calculated								
Crude protein, %	17.09	17.09	17.09	17.09	14.44	14.44	14.44	14.44
Calcium, %	0.55	0.55	0.55	0.55	0.50	0.50	0.50	0.50
STTD P, % ⁶	0.27	0.27	0.27	0.27	0.25	0.25	0.25	0.25
SID Lys, %	0.82	0.82	0.82	0.82	0.69	0.69	0.69	0.69
SID TSAA:Lys	0.62	0.62	0.62	0.62	0.64	0.64	0.64	0.64
SID Trp:Lys	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SID Thr:Lys	0.62	0.62	0.62	0.62	0.66	0.66	0.66	0.66
ME, Mcal/kg	3.40	3.40	3.40	3.40	3.41	3.41	3.41	3.41
NE, Mcal/kg	2.56	2.56	2.56	2.56	2.61	2.61	2.61	2.61

¹ Phase 3 was formulated for 65-90 kg BW and was fed from d 48-68. Phase 4 was formulated for 90-130 kg BW and was fed from d 68 to the end of the experiment.

² NC: negative control, containing no feed additive; PC: NC with phytogetic compounds; OEE: NC with oregano essential oil; PCA: NC with phytogetic compounds and acidifiers.

³ Vitamin premix provided per kg of complete diet: 4,594 IU vitamin A, 525 IU vitamin D3, 38 IU vitamin E, 2 mg vitamin K, 8 mg riboflavin, 38 µg vitamin B12, 42 mg niacin, and 20 mg pantothenic acid.

⁴ Trace mineral premix provided per kg of complete diet: 165 ppm Fe as FeSO4, 165 ppm Zn as ZnSO4, 39 ppm Mn as MnSO4, 16.5 ppm Cu as CuSO4, 0.3 ppm I as C2H10I2N2 or KIO3, and 0.3 ppm Se as Na2SeO4 or Na2SeO3.

⁵ Quantum Blue 5 G (AB Vista Feed Ingredients, Marlborough, Wiltshire, UK) was added at 0.005% for 250 FTU/kg.

⁶ STTD P = standardized total tract digestible P

Iowa State University Animal Industry Report 2019

Table 3. Overall growth performance of pigs¹.

Item	Treatment ²				Sex		SEM	P-value ³	
	NC	PC	OEE	PCA	Barrow	Gilt		Treatment	Sex
Initial BW, kg	28.4	28.5	27.9	28.4	28.6	28.0	0.61	0.527	0.096
Final BW, kg ⁴	135.3	136.5	134.8	135.9	138.9	132.4	1.92	0.604	<0.0001
CV initial BW, % ⁵	7.7	6.7	6.9	7.5	7.3	7.1	0.02	0.854	0.856
CV final BW, % ⁵	7.6	7.3	6.9	6.3	7.0	7.0	0.02	0.752	0.977
ADG, kg	0.97	0.97	0.97	0.97	1.02	0.92	0.02	0.991	<0.0001
ADFI, kg	2.54	2.60	2.57	2.61	2.75	2.41	0.07	0.531	<0.0001
Gain:Feed ratio	0.38	0.38	0.38	0.37	0.37	0.38	0.01	0.377	0.003

¹ Data are least square means; n = 15 pens per treatment with 5 pigs per pen, totaling 298 pigs; sexes were split with 8 pens of barrows and 7 pens of gilts per treatment. Performance calculations included pig days to account for mortality.

² NC: negative control, containing no feed additive; PC: NC with phytogetic compounds; OEE: NC with oregano essential oil; PCA: NC with phytogetic compounds and acidifiers.

³ There were no significant treatment × sex interactions.

⁴ Pigs were harvested in 3 cuts; pigs were marketed based on individual BW rather than average pen BW; final live BW of pigs was averaged for pens.

⁵ CV of initial and final BW was calculated on pen basis; CV final BW was calculated using pig weights from d 103, the last day all of the pigs were present in the trial.

Iowa State University Animal Industry Report 2019

Table 4. Carcass characteristics of pigs¹.

Item	Treatment ²				Sex		SEM	P-value ^{3,4}	
	NC	PC	OEE	PCA	Barrow	Gilt		Treatment	Sex
Live BW, kg ⁵	135.3	136.5	134.8	135.9	138.9	132.4	1.92	0.604	0.083
HCW, kg	99.4	100.1	99.6	99.7	102.1	97.3	1.18	0.951	<0.0001
Dressing, % ⁶	73.5	73.3	73.3	73.4	73.5	73.3	0.54	0.962	0.457
Backfat Depth, cm	1.3	1.4	1.4	1.4	1.5	1.3	0.07	0.430	<0.0001
Loin Depth, cm	7.5	7.4	7.5	7.5	7.4	7.6	0.11	0.644	0.007
Lean, % ⁷	57.6	57.3	57.4	57.4	56.9	57.9	0.27	0.616	<0.0001

¹Data are least square means; n = 15 pens per treatment with 5 pigs per pen, totaling 298 pigs; sexes were split with 8 pens of barrows and 7 pens of gilts per treatment.

²NC: negative control, containing no feed additive; PC: NC with phytogetic compounds; OEE: NC with oregano essential oil; PCA: NC with phytogetic compounds and acidifiers.

³HCW was used as a covariate for backfat depth, loin depth, and lean percent.

⁴There were no significant treatment × sex interactions.

⁵Pigs were harvested in 3 cuts; pigs were marketed based on individual BW rather than average pen BW; final live BW of pigs was averaged for pens.

⁶Dressing percentage = $(\text{HCW} \div \text{live BW}) \times 100$

⁷Lean percent was calculated using backfat depth and loin depth measurements based on Tyson Fresh Meat's (Perry, IA) proprietary equation.