Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 1053

2014

Effects of wheat source and particle size in pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics

Jon A. De Jong

Joel M. DeRouchey

Michael D. Tokach

See next page for additional authors

Recommended Citation

De Jong, Jon A.; DeRouchey, Joel M.; Tokach, Michael D.; Goodband, Robert D.; Paulk, Chad B.; Woodworth, Jason C.; Jones, Cassandra K.; Stark, Charles R.; and Dritz, Steven S. (2014) "Effects of wheat source and particle size in pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.6893

Effects of wheat source and particle size in pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics

Authors

Jon A. De Jong, Joel M. DeRouchey, Michael D. Tokach, Robert D. Goodband, Chad B. Paulk, Jason C. Woodworth, Cassandra K. Jones, Charles R. Stark, and Steven S. Dritz

Effects of Wheat Source and Particle Size in Pelleted Diets on Finishing Pig Growth Performance, Caloric Efficiency, and Carcass Characteristics[1]

J.A. De Jong, J.M. DeRouchey, M.D. Tokach, R.D. Goodband, C.B. Paulk, J.C. Woodworth, C.K. Jones[2], C.R. Stark[2] and S.S. Dritz[3]

Summary

A total of 576 pigs (PIC 327 × 1050; initially 96 lb BW) from 2 consecutive finishing groups were used to determine the effects of wheat source and particle size of pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics. Pigs were allotted randomly to pens upon entry into the finisher. Pens of pigs were balanced by initial BW and randomly allotted to 1 of 6 dietary treatments with 12 replications per treatment and 8 pigs per pen in two groups of finisher pigs. The experimental diets all had the same wheat-soybean meal formulation, with the 6 treatments formed by including the wheat from 1 of 2 sources (hard red winter vs. soft white winter) that were processed to 1 of 3 mean particle sizes (200, 400, or 600 μ). All diets were fed in pelleted form.

Overall, feeding hard red winter wheat improved ($P < 0.05$) ADG, ADFI, and caloric efficiency on both an ME and NE basis compared with soft white winter wheat. There was a tendency ($P < 0.07$) for a quadratic particle size × wheat source interaction for ADG, ADFI, and both DM and GE digestibility because the lowest ADG, ADFI, and both DM and GE digestibility values were for 400-μ hard red winter wheat, and the highest were for 400-μ soft white winter wheat. No significant ($P > 0.10$) main effects were detected of particle size, or of particle size within wheat source. Finally, dietary treatments did not affect carcass characteristics.

In conclusion, decreasing wheat particle size from 600 to 200 μ in pelleted diets had no effect on growth performance. Feeding hard red winter wheat improved ADG and ADFI compared with feeding soft white winter wheat.

Key words: finishing pig, grinding, pelleting, wheat

Introduction

Reducing the particle size of cereal grains has been shown to improve the efficiency of gain in swine. Opinions vary regarding the optimum particle size of cereal grains for animal production and feed manufacturing economics. Most experiments exploring optimum particle size of grain have been conducted in meal diets. Previous research in

[1] Funding, wholly or in part, was provided by The National Pork Board.

[2] Department of Grain Science and Industry, College of Agriculture, Kansas State University.

[3] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

finishing pigs completed at Kansas State University in meal feed has shown improvements in ADG and F/G when hard red winter wheat was ground from 800 to 400 µ.

In addition to fine-grinding cereal grains, pelleting has been shown to consistently improve performance in finishing pigs through reduced intake and improved feed efficiency. Reducing particle size of cereal grains can improve pellet quality by increasing the surface area of the grains during the pelleting process and improving adhesion of the pellet. Murphy et al. (2009[4]) reported no differences in growth performance in growing pigs as wheat particle size of pelleted diets was reduced from 639 to 552 µ, but no research has focused on grinding wheat to finer particle sizes. Thus, the objective of our study was to determine the effects of wheat source and particle size in pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The barns were tunnel-ventilated with completely slatted flooring and deep pits. Each pen was equipped with a 2-hole stainless steel feeder and bowl waterer for ad libitum access to feed and water. Feed was delivered to each individual pen by a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN).

A total of 576 pigs (PIC 327 × 1050; initially 96 lb BW) from 2 consecutive finishing groups were used to determine the effects of wheat source and particle size of pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics. Pigs were allotted randomly to pens upon entry into the finisher and remained in the experiment for 75 and 89 d, respectively, for each group. Pens of pigs were balanced by initial BW and randomly allotted to 1 of 6 dietary treatments with 12 replications per treatment and 8 pigs per pen. The 6 basal diets consisted of the same wheat-soybean meal formulation. The experimental treatments were arranged as a 2 × 3 factorial with 2 wheat sources (hard red winter wheat or soft white winter wheat) and 3 particle sizes (200, 400, or 600 µ). All diets were fed in pelleted form.

Pigs and feeders were weighed approximately every 2 wk to determine ADG, ADFI, and F/G. Caloric efficiencies of pens were determined on both an ME and NE basis. Efficiencies were calculated by multiplying total feed intake × energy in the diet (kcal/lb) and dividing by total gain. Feed ingredients were assigned an ME and NE value taken from the NRC (2012[5]).

Composite samples of the wheat used in the diets were collected prior to feed manufacturing and analyzed for DM, CP, fat, NDF, ADF, ash, and amino acids (Table 1). Nutrient analyses were then used in diet formulation (Table 2). Feed samples were taken from each feeder during each phase, then combined within treatment and phase for analysis (Tables 3, 4, and 5). Bulk density, pellet durability index (PDI), and

[4] Murphy, A., C. Collins, A. Philpotts, A. Bunyan, and D. Henman. 2009. Influence of hammer mill screen size and grain source (wheat or sorghum) on the growth performance of male grower pigs. Co-op. Res. Cen. for an Inter. Comp. Pork Ind. Rep. QAF Meat Industries Pty Ltd., Corowa, NSW, Australia.
[5] NRC. 2012. Nutrient Requirements of Swine. 11th ed. Natl. Acad. Press, Washington DC.

percentage fines were determined for all diets (Table 6). Particle size, angle of repose, and bulk density was determined for each wheat source at the three different particle sizes. Particle sizes were determined using Tyler sieves, with numbers 6, 8, 10, 14, 20, 28, 35, 48, 65, 100, 150, 200, and 270 and a pan. A Ro-Tap shaker (W.S. Tyler, Mentor, OH) was used to sift the 100-g samples for 10 min. Particle size testing was conducted with and without a flow agent (amorphous silica powder, Gilson Company Inc., Middleton, WI) added at 0.5 g to 100 g of feed. Angle of repose was measured by allowing feed to flow freely over a flat circular platform of a known diameter. The diameter of the platform and height of the resulting pile were used to calculate the angle of repose.

Feed was manufactured at the K-State O.H. Kruse Feed Technology Innovation Center. Wheat was ground to three particle sizes (200, 400, and 600 µ targets) for each of the 2 wheat sources (hard red and soft white wheat). The 3 particle sizes of the hard red wheat were created using a hammer mill equipped with either a # 2, 10, or 16 screen (0.03, 0.16, 0.25 in., respectively). The hard red wheat ground to 245 µ was first ground through a roller mill to ensure a fine enough grind was achieved through the hammer mill. Soft white wheat was ground through a #4, 12, and 16 hammer-mill screen (0.06, 0.19, 0.25 in., respectively). During feed manufacturing, electrical consumption and throughput were measured (Table 7).

Fecal samples were collected on d 7 of Phase 3 (d 61 and 59, respectively, for group 1 and 2) from 2 pigs per pen. The Phase 3 diets contained 0.5% titanium dioxide as an inert digestibility marker. After collection, fecal samples were then dried in a 50°C forced-air drying oven, then ground for measurement of energy by bomb calorimetry and titanium concentration. The digestibility values were calculated using the indirect method.

Prior to marketing, all pigs were individually weighed and tattooed for carcass data collection and transported to Triumph Foods LLC (St. Joseph, MO). Standard carcass characteristics were measured, and jowl fat samples were collected and analyzed at the plant by near-infrared analysis for iodine value.

Data were analyzed as a completely randomized design using PROC MIXED in SAS (SAS Institute, Inc., Cary, NC) with pen serving as the experimental unit. Linear and quadratic contrasts were completed to determine the main effects of decreasing wheat particle size as well as the interaction with wheat source. The main effects of wheat source were also determined. Lastly, linear and quadratic contrasts within wheat source for particle size were also tested. Results were considered significant at $P \leq 0.05$ and tendencies between $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

Analysis of dietary treatments showed that all values were similar to those used in formulation. Bulk density and percentage fines were similar among treatments, but PDI was lower for the soft white wheat diets than for the hard red wheat. Decreasing the particle size of the wheat improved PDI as expected. Wheat particle sizes decreased for hard red winter wheat and soft white winter wheat as expected. Reductions in particle size led to increases in angle of repose for both wheat sources, which would suggest

decreased flowability; however, no issues with diet flowability in feed lines or feeders were observed during the trial. In addition, decreased wheat particle size decreased bulk density.

Grinding hard red winter wheat required more kilowatt hours (kWh) than grinding soft white winter wheat (Table 7). For both sources, fine-grinding increased kWh as expected. Pelleting soft white winter wheat diets increased electrical consumption compared with hard red winter wheat. Finely ground wheat increased electrical consumption for hard red wheat during pelleting but decreased electrical consumption for soft white wheat. Throughput during pelleting was improved by increasing wheat particle size as well as by pelleting soft white wheat compared with hard red wheat.

Overall, feeding hard red winter wheat improved ($P < 0.05$) ADG, ADFI, and caloric efficiency on both an ME and NE basis when compared with soft white winter wheat (Table 8). The improvement in caloric efficiency reflected source differences in the ME and NE values obtained from the NRC because there were no differences in F/G, which suggests the energy value for the wheat sources was similar. There was a tendency ($P < 0.07$) for a quadratic particle size × wheat source interaction for ADG, ADFI, and both DM and GE digestibility because the lowest ADG, ADFI, and both DM and GE digestibility values were for 400-µ hard red winter wheat, and the highest were for 400-µ soft white winter wheat. There were no main effects ($P > 0.10$) of particle size or particle size within wheat source (Table 9). Finally, dietary treatments did not affect ($P > 0.10$) carcass characteristics.

Results from this study suggest that reducing the particle size of either hard red or soft white winter wheat from 600 to 200 µ does not improve growth performance when diets are pelleted. This is in contrast to previous work done with meal diets but agrees with Nemechek et al. (2013[6]), who showed that corn-based diets had larger improvements to fine-grinding when diets were fed in meal form compared with similar diets fed in pelleted form. Less electrical consumption is needed to grind wheat to a particle size of 600 µ compared with 200 µ, and thus should result in diets that cost less to manufacture. Feeding hard red compared with soft white winter wheat improved growth rate and feed intake of pigs fed pelleted diets.

[6] Nemechek, J.E., M.D. Tokach, K.F. Coble, C.W. Hastad, J.M. DeRouchey, S.S. Dritz, and R.D. Goodband. Effects of corn particle size and diet form on finishing pig growth performance and carcass characteristics. J. Anim. Sci. 92:54 Supp 2.

Table 1. Chemical analysis of wheat sources (as-fed basis)[1]

Item	Hard red winter wheat	Soft white winter wheat
DM, %	90.86	91.80
CP, %	11.8	11.2
ADF, %	3.2	2.8
NDF, %	8.1	8.6
NFE, %	72.9	74.8
Ca, %	0.07	0.13
P, %	0.38	0.40
Fat, %	1.8	1.6
Ash, %	1.81	1.89
Starch, %	55.4	56.9

[1] A composite sample consisting of 6 subsamples was used for analysis.

Table 2. Diet composition (as-fed basis)[1]

Item	Source: Phase:	Hard red winter wheat 1	2	3	Soft white winter wheat 1	2	3
Ingredient, %							
Wheat		78.45	85.02	89.95	78.45	85.02	89.95
Soybean meal (46.5% CP)		17.31	11.19	6.33	17.31	11.19	6.33
Choice white grease		1.50	1.50	1.50	1.50	1.50	1.50
Monocalcium phosphate (21% P)		0.25	---	---	0.25	---	---
Limestone		1.38	1.28	1.25	1.38	1.28	1.25
Salt		0.35	0.35	0.35	0.35	0.35	0.35
L-lysine HCl		0.29	0.30	0.32	0.29	0.30	0.32
DL-methionine		0.05	0.05	0.01	0.05	0.05	0.01
L-threonine		0.09	0.08	0.10	0.09	0.08	0.10
Trace mineral premix		0.13	0.10	0.08	0.13	0.10	0.08
Vitamin premix		0.13	0.10	0.08	0.13	0.10	0.08
Phytase[2]		0.08	0.08	0.05	0.08	0.08	0.05
Titanium[3]		---	---	0.50	---	---	0.50
Total		100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis							
Standard ileal digestible (SID) amino acids, %							
Lysine		0.94	0.81	0.71	0.94	0.81	0.71
Isoleucine:lysine		66	65	63	68	67	67
Leucine:lysine		121	122	123	120	121	121
Methionine:lysine		31	30	30	30	30	30
Met & Cys:lysine		62	63	66	62	64	66
Threonine:lysine		63	63	66	62	63	66
Tryptophan:lysine		23.5	24.0	24.3	22.1	22.1	22.1
Valine:lysine		70	70	70	74	75	75
Total lysine, %		1.05	0.91	0.80	1.05	0.91	0.80
ME, kcal/lb[4]		1,467	1,470	1,470	1,491	1,497	1,498
NE kcal/lb[4]		1,099	1,114	1,123	1,143	1,161	1,174
SID lysine:ME, g/Mcal		2.91	2.50	2.19	2.86	2.45	2.15
CP, %		17.8	15.6	13.9	17.4	15.2	13.5
Crude fiber, %		2.7	2.6	2.6	0.7	0.4	0.2
Ca, %		0.65	0.55	0.53	0.65	0.55	0.53
P, %		0.48	0.41	0.40	0.48	0.41	0.40
Available P, %		0.28	0.23	0.22	0.28	0.23	0.22

[1] Treatment diets fed for 79 and 85 d for groups 1 and 2, respectively.

[2] Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO) provided 340.5 phytase units (FTU)/lb, with a release of 0.12% available P.

[3] Titanium was included in diets fed from day 7 to 14 in group 1 at a level of 0.5%, at the expense of corn.

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

Table 3. Chemical analysis of diets, Phase 1 (as-fed basis)[1,2]

Source:	Hard red winter wheat			Soft white winter wheat		
Particle size:	200	400	600	200	400	600
Item						
DM, %	89.68	89.69	90.19	91.16	91.73	91.48
CP, %	20.1	20.2	20.5	19.1	20.3	19.5
ADF, %	2.7	2.7	2.2	2.3	3.5	3.1
NDF, %	7.6	8.1	7.5	6.9	9.9	8.9
NFE, %	60.8	60.8	61.5	63.5	61.8	62.6
Ca, %	0.72	0.69	0.76	0.87	0.76	0.80
P, %	0.49	0.52	0.50	0.46	0.51	0.52
Fat, %	2.8	2.7	2.6	2.6	2.6	2.6
Ash, %	3.78	3.85	3.88	4.10	4.20	4.21
Starch, %	39.8	39.9	39.9	42.7	41.0	41.8

[1] A composite sample consisting of 3 subsamples was used for analysis.
[2] All values are averages of the 2 finishing groups' feed.

Table 4. Chemical analysis of diets, Phase 2 (as-fed basis)[1,2]

Source:	Hard red winter wheat			Soft white winter wheat		
Particle size:	200	400	600	200	400	600
Item						
DM, %	90.63	90.26	90.66	91.6	91.54	91.54
CP, %	18.5	18.0	18.4	18.2	17.0	17.4
ADF, %	2.2	2.9	1.9	3.0	2.9	2.9
NDF, %	7.4	8.3	6.2	8.1	7.4	9.7
NFE, %	64.4	63.9	64.8	64.5	66.1	65.5
Ca, %	0.66	0.72	0.67	0.69	0.64	0.67
P, %	0.45	0.44	0.41	0.39	0.44	0.42
Fat, %	2.5	2.7	2.6	2.7	2.6	2.7
Ash, %	3.47	3.44	3.32	3.76	3.50	3.62
Starch, %	45.1	44.4	46.6	45.3	45.0	43.9

[1] A composite sample consisting of 3 subsamples was used for analysis.
[2] All values are averages of the 2 finishing groups' feed.

Table 5. Chemical analysis of diets, Phase 3 (as-fed basis)[1,2]

Source:	Hard red winter wheat			Soft white winter wheat		
Particle size, µ:	200	400	600	200	400	600
Item						
DM, %	90.24	89.83	89.92	89.98	90.82	90.64
CP, %	15.7	15.8	16.5	16.8	14.2	15.1
ADF, %	2.0	1.7	1.9	2.3	1.4	2.9
NDF, %	7.3	6.9	6.6	7.7	6.5	8.7
NFE, %	67.3	68.3	66.1	65.6	69.5	67.2
Ca, %	0.63	0.63	0.61	0.62	0.65	0.62
P, %	0.43	0.46	0.45	0.46	0.35	0.42
Fat, %	2.4	2.4	2.4	2.2	2.5	2.5
Ash, %	4.16	3.61	3.45	3.54	3.63	3.57
Starch, %	48.4	47.9	46.1	46.6	53.7	47.6

[1] A composite sample consisting of 3 subsamples was used for analysis.
[2] All values are averages of the 2 finishing groups' feed.

Table 6. Physical analysis of diets and wheat[1,2]

Source:	Hard red winter wheat			Soft white winter wheat		
Item Particle size, µ:	200	400	600	200	400	600
Diet[3]						
Bulk density, lb/bu	68.0	66.8	67.5	68.6	68.0	66.3
Pellet durability index, %	88.5	81.2	74.2	54.5	50.9	48.7
Percentage fines, %	24.0	22.9	26.9	22.2	27.2	24.1
Wheat						
Particle size (no flow agent)[4], µ	245	465	693	258	402	710
Particle size (flow agent), µ	201	415	631	210	341	638
Angle of repose, °	50.8	49.5	45.8	58.1	58.2	43.6
Bulk density, lb/bu	56.6	55.0	54.3	59.4	56.5	56.1

[1] A composite sample consisting of 3 subsamples was used for analysis.
[2] All values are averages of samples taken from the 2 groups.
[3] Diet samples from phases were averaged; no differences existed between phases.
[4] Particle sizes were determined using Tyler sieves, with numbers 6, 8, 10, 14, 20, 28, 35, 48, 65, 100, 150, 200, and 270 and a pan. A Ro-Tap shaker (W.S. Tyler, Mentor, OH) was used to sift the 100-g samples for 10 min. Particle sizes were run with and without flow agent at an inclusion level of 0.5 g.

Table 7. Electrical consumption and throughput during feed manufacturing[1]

Source:	Hard red winter wheat			Soft white winter wheat		
Particle size, μ:	200	400	600	200	400	600
Item						
Wheat grinding						
Kilowatts, kW[2]	11.04	9.33	8.37	8.58	8.47	7.59
Kilowatt hours, kWh[3]	7.88	7.00	6.98	5.00	4.94	4.43
Cost/ton, $[4]	0.32	0.28	0.28	0.20	0.20	0.18
Pelleting						
Kilowatts, kW	20.64	20.57	20.99	22.56	22.80	22.68
Kilowatt hours, kWh	14.07	12.66	12.25	13.63	13.83	14.88
Cost/ton, $	2.25	2.03	1.96	2.18	2.21	2.38
Throughput, lb/hr	5,033	5,443	5,804	5,862	5,961	5,909

[1] Voltage was recorded during each manufacturing run, then averaged across the phases and between the groups.
[2] kW was calculated by the formula kW = amperage × voltage / 1000.
[3] kWh was calculated by the formula kWh = kW × hours used.
[4] Cost per kWh was $0.12.

Table 8. Interactive effects of wheat source and particle size of pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics[1]

	Wheat source and particle size, μ								
	Hard red winter			Soft white winter				Quadratic particle size × source[2]	Source main effect
Item	200	400	600	200	400	600	SEM		
ADG, lb	2.26	2.21	2.26	2.14	2.20	2.18	0.03	0.075	0.004
ADFI, lb	5.85	5.70	5.88	5.58	5.67	5.63	0.08	0.068	0.003
F/G	2.58	2.58	2.61	2.61	2.58	2.58	0.02	0.994	0.948
Initial wt, lb	95.6	95.6	95.6	95.6	95.5	95.6	8.3	0.983	0.978
Final wt, lb	281.9	276.8	280.5	271.5	277.1	276.1	7.03	0.289	0.129
Caloric efficiency[3]									
ME	3,796	3,783	3,829	3,903	3,851	3,859	28	0.985	0.041
NE	2,098	2,087	2,121	2,189	2,164	2,140	114	0.447	0.001
Digestibility									
DM, %	87.7	87.0	88.0	85.8	87.7	85.1	0.80	0.030	0.048
GE, %	68.3	64.5	66.3	62.3	67.5	64.9	1.94	0.053	0.360
Carcass traits									
Feed/carcass gain[4]	3.53	3.57	3.69	3.58	3.77	3.76	0.09	0.454	0.065
HCW, lb	201.4	199.1	202.3	197.1	200.8	199.3	3.2	0.331	0.479
Yield, %	73.0	72.8	72.9	73.0	73.1	73.1	73.1	0.241	0.167
BF, in.	0.77	0.76	0.75	0.75	0.77	0.78	0.02	0.945	0.466
Loin depth, in.	2.28	2.28	2.31	2.21	2.29	2.27	0.05	0.474	0.447
Fat-free lean, %	0.52	0.53	0.53	0.52	0.53	0.52	0.02	0.792	0.397
Jowl iodine value, mg/100 g	69.1	69.0	68.6	68.4	68.6	68.3	0.4	0.928	0.210

[1]A total of 576 pigs (PIC 327 × 1050; initially 96 lb BW) in 2 groups were used in a 75- and 89-d study with 8 pigs per pen and 12 replications per treatment.
[2]No source × particle size interactions, main effects of particle size, or linear or quadratic effects of particle size within wheat source.
[3]Caloric efficiency is expressed as kcal/lb of gain.
[4]Feed/carcass gain is expressed as total intake / lb carcass gain with an assumed initial yield of 75%.

Table 9. Main effects of wheat source and particle size of pelleted diets on finishing pig growth performance, caloric efficiency, and carcass characteristics[1]

	Wheat source		Particle size				Probability, $P <$	
Item	Hard red winter	Soft white winter	200	400	600	SEM	Source main effect	Particle size main effect
ADG, lb	2.24	2.18	2.20	2.21	2.22	0.02	0.004	0.510
ADFI, lb	5.81	5.63	5.71	5.69	5.76	0.06	0.003	0.566
F/G	2.59	2.59	2.60	2.58	2.59	0.01	0.948	0.845
Initial wt, lb	95.6	95.6	95.6	95.6	95.6	8.2	0.978	0.979
Final wt, lb	279.7	274.9	276.7	276.9	278.3	6.6	0.129	0.627
Caloric efficiency[2]								
ME	3,696	3,861	3,843	3,732	3,762	86	0.041	0.407
NE	2,102	2,165	2,143	2,126	2,131	114	0.001	0.463
Digestibility								
DM, %	87.84	86.22	86.73	87.37	86.55	0.57	0.048	0.818
GE, %	66.37	64.91	65.32	66.00	65.60	1.38	0.360	0.884
Carcass traits								
Feed/carcass gain[3]	3.63	3.73	3.66	3.68	3.71	0.04	0.065	0.431
HCW, lb	201.0	199.1	199.2	199.9	200.8	2.23	0.479	0.618
Yield, %	72.9	73.1	73.1	73.0	73.0	0.01	0.167	0.787
Backfat, in.	0.76	0.77	0.76	0.76	0.76	0.01	0.466	0.884
Loin depth, in.	2.29	2.26	2.25	2.28	2.29	0.03	0.447	0.469
Fat-free lean, %	52.6	52.4	52.5	52.6	52.6	0.01	0.397	0.609
Jowl iodine value, mg/100 g	68.9	68.4	68.7	68.8	68.4	0.31	0.210	0.475

[1] A total of 576 pigs (PIC 327 × 1050, initially 96 lb BW) in 2 groups were used in a 75- and 89-d study with 8 pigs per pen and 12 replications per treatment.

[2] Caloric efficiency is expressed as kcal/lb of gain.

[3] Feed/carcass gain is expressed as total intake/lb carcass gain with an assumed initial yield of 75%.