Effects of Wheat Middlings and Choice White Grease in Diets on the Growth Performance, Carcass Characteristics, and Carcass Fat Quality in Growing-Finishing Pigs

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Summary
A total of 288 pigs (PIC TR4 × 1050, initially 93.3 lb) were used in an 87-d study to determine the effects of wheat middlings and choice white grease (CWG) on growth performance, carcass characteristics, and carcass fat quality of growing-finishing pigs. Pens of pigs were randomly allotted by initial weight and gender (4 barrows and 4 gilts per pen) to 1 of 6 dietary treatments with 6 replications per treatment. Treatments were arranged in a 2 × 3 factorial arrangement with the main effects of added wheat middlings (0 or 20%) and CWG (0, 2.5, or 5%). Dietary treatments were corn-soybean meal-based diets with 15% dried distillers grains with solubles (DDGS) and fed in 4 phases. There were no CWG x wheat middlings interactions ($P \geq 0.12$) for any of the criteria evaluated. Overall, (d 0 to 87) adding 20% dietary wheat middlings decreased ($P < 0.001$) ADG and worsened ($P < 0.001$) F/G. Pigs fed diets with increased dietary CWG had increased (quadratic, $P < 0.03$) ADG and improved (linear, $P < 0.01$) F/G. Pigs fed diets containing 20% wheat middlings had decreased ($P < 0.01$) final BW; while there was a numerical increase in final BW ($P < 0.09$) as dietary fat was increased.

For carcass traits, pigs fed wheat middlings had decreased percentage yield ($P < 0.04$), HCW ($P < 0.003$), backfat depth ($P < 0.04$), and loin depth ($P < 0.001$), while jowl iodine value increased ($P < 0.001$). Additionally, pigs fed added fat had a tendency for increased backfat depth (linear; $P < 0.06$) and had a linear increase ($P < 0.01$) in jowl iodine value.

For economics, adding 20% wheat middlings to the diet decreased ($P < 0.001$) feed cost per pig and feed cost per lb gain; however, total revenue was also reduced ($P < 0.003$), resulting in a numeric decrease ($P = 0.13$) in income over feed cost (IOFC). Adding CWG increased (linear; $P < 0.001$) feed cost per pig and feed cost per lb gain, but only numerically increased ($P = 0.12$) total revenue, leading to a tendency for decreased IOFC (linear; $P < 0.09$), with increasing amounts of CWG.

Therefore, wheat middlings can be used as an alternative ingredient in swine diets to decrease feed cost and feed cost per lb of gain, but in this study the reduced performance resulted in less revenue and lower profitability.

Key words: energy, DDGS, wheat middlings

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Introduction

Feed ingredient alternatives to corn and soybean meal are often used in swine diets. While these ingredients are used with the intent of lowering feed costs, it is important to know how they can affect performance and carcass characteristics. Thus, determining the proper nutritional value and optimum utilization of alternative feedstuffs is critical to reducing diet costs. One such alternative ingredient is wheat middlings.

Wheat middlings are among the cereal by-products most commonly used in commercial pig feed. Often referred to as wheat midds, they are by-products from flour milling. Most U.S. wheat that is not exported is processed into flour, so milling by-products are widely available for use in the animal feed industry. Wheat middlings have higher crude protein and fiber but lower dietary energy than corn (corn ME = 1,551 kcal/lb; wheat middlings ME = 1,372 kcal/lb; NRC, 1998[2]).

Because of the lower ME content, producers can expect reduced gains and higher feed efficiency in finishing pigs fed wheat middlings. To mitigate this effect, dietary fat can be added to increase the diet energy level. However, limited data are available on the effects of combining wheat middlings with choice white grease (CWG) in diets for finishing pigs. Also, due to opportunities to reduce diet cost with wheat middlings, its effect on performance needs further investigation.

Therefore, the objective of this trial was to determine the effects of 20% wheat middlings and increasing levels of CWG in diets containing 15% DDGS on growth performance, carcass characteristics, and carcass fat quality of growing-finishing pigs.

Procedures

The Kansas State University (K-State) Institutional Animal Care and Use Committee approved procedures used in these experiments. These experiments were conducted in the growing-finishing research barn at the K-State Swine Teaching and Research Center. The facility was a totally enclosed, environmentally controlled, mechanically ventilated barn with 2 identical rooms, each containing 40 pens (8 × 10 ft). The pens had adjustable gates facing the alleyway that allowed for 10 sq ft/pig. Each pen was equipped with a Farmweld (Teutopolis, IL), single-sided, dry self-feeder with 2 eating spaces located in the fence line and a cup waterer. Pens were located over a completely slatted concrete floor with a 4-ft pit underneath for manure storage. The facility was also equipped with a computerized feeding system (FeedPro; Feedlogic Corp., Willmar, MN) that delivered and recorded diets as specified. The equipment provided pigs with ad libitum access to food and water.

A total of 288 (PIC TR4 × 1050, initially 93.3 lb) were used in an 87-d study. Pens of pigs (4 barrows and 4 gilts per pen) were randomly allotted by initial weight to 1 of 6 dietary treatments with 6 replications per treatment. Treatments were arranged in a 2 × 3 factorial arrangement with the main effects of added wheat middlings (0 or 20%) and CWG (0, 2.5, or 5%). Dietary treatments were corn-soybean meal-based diets with 15% DDGS and were fed in 4 phases (Tables 1 and 2). All diets were fed in meal form and balanced to a similar SID lysine:ME ratio within each phase. The ME values for

[2] NRC. 1998. Nutrient Requirements of Swine, 10th ed. Natl. Acad. Press, Washington DC.

dietary ingredients included: DDGS = 1,552 ME kcal per lb; wheat middlings = 1,375 ME kcal per lb; and CWG = 7,955 ME kcal per lb.

Wheat middling samples were collected at the time of feed manufacturing and a composite sample was analyzed (Table 3). Also, samples were collected from the top of each feeder and combined for a single composite sample by treatment for each phase to measure bulk density (Table 4). Bulk density of a material represents the mass per unit volume (lb per bushel).

Pigs and feeders were weighed approximately every 3 weeks to calculate ADG, ADFI, and F/G. On d 87, all pigs were weighed and transported to Triumph Foods Inc., St. Joseph, MO. Before slaughter, pigs were individually tattooed according to pen number to allow for carcass data collection at the packing plant and data retrieval by pen. Hot carcass weights were measured immediately after evisceration, and each carcass was evaluated for percentage yield, back fat, loin depth, and percentage lean. Because there were differences in HCW, it was used as a covariant for back fat, loin depth, and percentage lean. Also, jowl fat samples were collected and analyzed by Near Infrared Spectroscopy (NIR) at the plant for iodine value. Percentage yield was calculated by dividing HCW by live weight.

Data were analyzed as a completely randomized design using the PROC-MIXED procedure of the Statistical Analysis System (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. The main effects of the different treatment regimens of wheat middlings and added CWG, and their interaction were tested. Linear and quadratic contrasts were used to determine the effects of increasing dietary fat.

Results and Discussion

Bulk density tests showed that adding dietary wheat middlings decreased diet bulk density but adding CWG had no effect (Table 4).

There were no CWG x wheat middlings interactions ($P \geq 0.12$) for any of the criteria evaluated (Table 5 and 6). Overall, (d 0 to 87) adding 20% dietary wheat middlings to finishing pig diets decreased ($P < 0.001$) ADG and resulted in poorer ($P < 0.001$) F/G. Pigs fed diets with increased CWG had increased (linear; P < 0.004; quadratic; $P < 0.03$) ADG and improved (linear; $P < 0.01$) F/G. Feed intake was not affected by the addition of 20% dietary wheat middlings ($P > 0.40$) or added CWG ($P > 0.31$). Pigs fed diets containing 20% wheat middlings had decreased ($P < 0.01$) final BW; while there was a trend for increased (linear; $P < 0.09$) final BW as dietary fat was increased.

For carcass traits, feeding 20% dietary wheat middlings decreased percent yield ($P < 0.04$), HCW ($P < 0.003$), backfat depth (P < 0.04), and loin depth ($P < 0.001$). Furthermore, feeding 20% wheat middlings increased ($P < 0.001$) jowl iodine value. Additionally, pigs fed added fat had a tendency for increased backfat depth (linear; $P < 0.06$) and had a linear increase ($P < 0.01$) in jowl iodine value.

For economics, adding 20% wheat middlings to the diet decreased ($P < 0.001$) feed cost per pig and feed cost per lb gain; however the lower ADG also resulted in lighter carcasses and less (P < 0.003) total revenue and numerically lower (*P* = 0.12) IOFC of $3.82 per pig. Added CWG increased (linear; *P* < 0.001) feed cost per pig and feed cost per lb gain. Added CWG also numerically increased (*P* = 0.12) total revenue, but it wasn't a great enough increase to overcome the increased feed cost and resulted in a tendency for decreased IOFC (linear; *P* <0.09) with added CWG.

The decrease in growth rate and feed intake suggest that in addition to the lower energy content, some other factor associated with feeding of wheat middlings could affect growth rate. One factor of concern is diet bulk density. Diets with high levels of wheat middlings had decreased levels of bulk density, which could result in increased gut fill. Alternatively, the high NDF levels in diets containing both dried distillers grains with solubles and wheat middlings may have limited the pigs' ability to consume enough feed to overcome the lower energy level in the wheat middling diets. Feeding 20% wheat middlings worsened ADG and F/G by 6 and 7% respectively. Interestingly, adding 5% CWG to the diet containing 20% wheat middlings resulted in similar ADG and F/G to the diet without wheat middlings or added CWG. The ME level of the high-fat, 20% wheat middlings diet would suggest that this diet should have resulted in lower F/G, indicating that energy may have been overestimated in the wheat middling diets.

Therefore, these data indicate feeding wheat middling reduced feed cost by approximately $4.00 per pig. However, due to reduced performance, IOFC was reduced by approximately $3.80 per pig. Adding 5% CWG to a diet containing 20% wheat middlings resulted in equal growth performance but poorer IOFC compared to pigs fed no wheat middlings and 2.5% CWG, due to the relatively higher cost of energy from the CWG.

Table 1. Phase 1 and 2 diet composition (as-fed basis)[1]

	Phase 1						Phase 2					
Wheat midds,%:	0	0	0	20	20	20	0	0	0	20	20	20
Ingredient % Fat, %:	0	2.5	5	0	2.5	5	0	2.5	5	0	2.5	5
Corn	64.85	61.25	57.41	50.46	46.88	43.06	68.00	64.26	60.61	53.48	49.81	46.14
Soybean meal, 46.5%	17.73	18.81	20.13	12.17	13.25	14.57	14.76	16.00	17.16	9.28	10.52	11.68
DDGS	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Wheat middlings	---	---	---	20.00	20.00	20.00	---	---	---	20.00	20.00	20.00
Choice white grease	---	2.50	5.00	---	2.50	5.00	---	2.50	5.00	---	2.50	5.00
Monocalcium P, 21% P	0.30	0.30	0.30	---	---	---	0.30	0.30	0.30	---	---	---
Limestone	1.08	1.08	1.08	1.23	1.22	1.20	1.00	1.00	0.98	1.15	1.13	1.13
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.15	0.15	0.15	0.15	0.15	0.15	0.13	0.13	0.13	0.15	0.13	0.13
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.13	0.13	0.13	0.15	0.13	0.13
L-lysine HCl	0.31	0.32	0.33	0.39	0.40	0.40	0.29	0.30	0.30	0.37	0.37	0.38
L-threonine	0.03	0.03	0.05	0.05	0.06	0.06	0.01	0.01	0.03	0.04	0.04	0.05
Phyzyme 600[2]	0.06	0.06	0.06	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0.04
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

continued

Table 1. Phase 1 and 2 diet composition (as-fed basis)[1]

	Phase 1						Phase 2					
Wheat midds,%:	0	0	0	20	20	20	0	0	0	20	20	20
Ingredient % Fat, %:	0	2.5	5	0	2.5	5	0	2.5	5	0	2.5	5
SID amino acid %[3]												
Lysine	0.93	0.96	0.99	0.91	0.94	0.97	0.84	0.87	0.90	0.82	0.85	0.88
Isoleucine:lysine	66	65	65	62	62	61	67	66	66	63	63	62
Leucine:lysine	168	163	159	159	154	150	178	173	168	168	163	158
Methionine:lysine	30	29	28	29	29	28	31	30	30	31	30	29
Met & cys:lysine	61	59	58	61	59	58	64	62	61	64	63	61
Threonine:lysine	62	62	62	62	62	62	62	62	62	62	62	62
Tryptophan:lysine	17	17	17	17	17	17	17	17	17	17	17	17
Valine:lysine	78	76	75	77	75	74	81	79	78	79	78	77
SID Lysine:ME/Mcal	2.78	2.78	2.78	2.78	2.78	2.78	2.51	2.51	2.51	2.51	2.51	2.51
ME, kcal/lb	1,517	1,568	1,620	1,485	1,536	1,588	1,520	1,571	1,623	1,487	1,539	1,591
Total lysine, %	1.06	1.10	1.13	1.03	1.06	1.10	0.97	1.00	1.03	0.94	0.97	1.00
CP, %	18.15	18.36	18.66	17.61	17.82	18.12	17.01	17.27	17.52	16.50	16.77	17.01
Ca, %	0.55	0.55	0.55	0.55	0.55	0.55	0.51	0.51	0.51	0.51	0.51	0.51
P, %	0.47	0.47	0.47	0.52	0.52	0.51	0.46	0.46	0.46	0.51	0.50	0.50
Available P, %	0.28	0.28	0.28	0.28	0.28	0.28	0.25	0.25	0.25	0.25	0.25	0.25

[1] Phase 1 diets were fed from approximately 100 to 140 lb. Phase 2 diets were fed from 140 to 180 lb.
[2] Phyzyme 600 (Danisco Animal Nutrition, St Louis, MO.) provided per pound of diet: Phase 1 163.4 FTU/lb and 0.08 % available P released; Phase 2, 95.3 FTU/lb and 0.055 % available P released.
[3] Standardized ileal digestible.

Table 2. Phase 3 and 4 diet composition (as-fed basis)[1]

	Phase 3						Phase 4					
Wheat midds,%:	0	0	0	20	20	20	0	0	0	20	20	20
Ingredient % Fat, %:	0	2.5	5	0	2.5	5	0	2.5	5	0	2.5	5
Corn	70.82	67.30	63.74	56.42	52.94	49.30	73.61	70.20	66.77	59.10	55.66	52.11
Soybean meal, 46.5%	12.04	13.04	14.12	6.51	7.48	8.60	9.35	10.27	11.19	3.95	4.87	5.91
DDGS	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Wheat middlings	---	---	---	20.00	20.00	20.00	---	---	---	20.00	20.00	20.00
Choice white grease	---	2.50	5.00	---	2.50	5.00	---	2.50	5.00	---	2.50	5.00
Monocalcium P, 21% P	0.30	0.30	0.30	---	---	---	0.30	0.30	0.30	---	---	---
Limestone	1.00	1.00	0.98	1.13	1.13	1.13	0.98	0.95	0.95	1.10	1.10	1.10
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.10	0.10	0.10	0.10	0.10	0.10	0.08	0.08	0.08	0.08	0.08	0.08
Trace mineral premix	0.10	0.10	0.10	0.10	0.10	0.10	0.08	0.08	0.08	0.08	0.08	0.08
Lysine HCl	0.27	0.27	0.28	0.35	0.35	0.36	0.25	0.25	0.26	0.32	0.33	0.33
L-threonine	0.01	0.02	0.02	0.03	0.04	0.05	---	0.01	0.01	0.02	0.03	0.04
Phyzyme 600[2]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

continued

Table 2. Phase 3 and 4 diet composition (as-fed basis)[1]

	Phase 3						Phase 4					
Wheat midds,%:	0	0	0	20	20	20	0	0	0	20	20	20
Ingredient % Fat, %:	0	2.5	5	0	2.5	5	0	2.5	5	0	2.5	5
Caluclated analysis												
SID amino acids, %[3]												
Lysine	0.75	0.78	0.80	0.74	0.76	0.79	0.67	0.69	0.71	0.65	0.68	0.70
Isoleucine:lysine	69	68	67	64	64	63	71	70	69	66	65	65
Leucine:lysine	191	184	179	179	174	168	205	198	192	193	186	180
Methionine:lysine	33	32	31	33	32	31	35	34	33	35	34	33
Met & cys:lysine	68	66	64	68	66	65	73	71	69	74	71	69
Threonine:lysine	64	64	64	64	64	64	65	65	65	65	65	65
Tryptophan:lysine	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Valine:lysine	84	82	81	82	81	79	88	86	84	87	84	83
SID[3] Lysine:ME/Mcal	2.24	2.24	2.24	2.24	2.24	2.24	1.99	1.99	1.99	1.99	1.99	1.99
ME, kcal/lb	1,521	1,573	1,624	1,489	1,541	1,592	1,523	1,575	1,626	1,491	1,542	1,594
Total lysine, %	0.87	0.90	0.93	0.85	0.87	0.90	0.78	0.81	0.83	0.76	0.78	0.80
CP, %	15.96	16.14	16.34	15.44	15.60	15.82	14.92	15.07	15.21	14.44	14.59	14.78
Ca, %	0.50	0.50	0.50	0.50	0.50	0.50	0.48	0.48	0.48	0.48	0.48	0.48
P, %	0.45	0.45	0.45	0.50	0.49	0.49	0.44	0.44	0.43	0.49	0.48	0.48
Available P, %	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22

[1] Phase 3 diets were fed from approximately 180 to 220 lb; Phase 4 diets were fed from 220 to 270 lb.
[2] Phyzyme 600 (Danisco Animal Nutrition, St Louis, MO.) provided per pound of diet: Phase 3, 54.5 FTU/lb and 0.04 % available P released; Phase 4, 47.7 FTU/lb and 0.03 % available P released.
[3] Standardized ileal digestible.

Table 3. Analysis of dried distillers grains and wheat middlings (as-fed basis)

Item	DDGS	Wheat middlings
Nutrient, %		
DM	91.30	90.4
CP	27.7 (27.7)[1]	14.6 (15.9)
Fat (oil)	11.0	3.9
Crude fiber	9.5 (7.3)	8.4 (7.0)
ADF	11.0	10.2
NDF	27.1	34
Ca	0.15 (0.20)	0.14 (0.12)
P	0.8 (0.77)	1.0 (0.93)

[1] Values in parenthesis indicate those used in diet formulation.

Table 4. Bulk density of experimental diets (as-fed basis)[123]

	Treatments					
Wheat midds,%:	0	0	0	20	20	20
Bulk density, lb/bu[4] Fat,%:	0	2.5	5	0	2.5	5
Phase 1	48.0	46.5	46.5	42.5	40.5	40.1
Phase 2	47.7	46.2	46.2	39.4	39.1	38.8
Phase 3	47.9	47.9	47.9	38.8	38.2	38.0
Phase 4	48.4	48.2	48.2	40.7	40.1	40.5

[1] 288 pigs (TR4 × 1050, Initial BW= 93.3 lb) were used in this 84-d study with 8 pigs per pen and 6 pens per treatment.
[2] Bulk density of a material represents the mass per unit volume.
[3] Diet samples collected from the tops of each feeder during each phase.
[4] Phase 1 was d 0 to 21; Phase 2 was d 21 to 41; Phase 3 was d 41 to 60; Phase 4 was d 60 to 87.

Table 5. Interactions of wheat middlings and fat on finishing-pig growth performance and carcass characteristics[12]

	0% Wheat Midds			20% Wheat Midds				Probability, P <
Item	0% Fat	2.5% Fat	5% Fat	0% Fat	2.5% Fat	5% Fat	SEM	Fat × Midds
Initial wt, lb	93.2	93.4	93.3	93.2	93.3	93.3	2.87	1.00
D 0 to 87								
ADG, lb	2.32	2.31	2.39	2.18	2.17	2.30	0.029	0.63
ADFI, lb	6.75	6.67	6.70	6.77	6.54	6.61	0.102	0.75
F/G	2.91	2.89	2.80	3.11	3.02	2.88	0.034	0.24
Final wt, lb	295.1	298.0	301.7	282.7	284.2	292.8	4.75	0.90
Carcass characteristics[3]								
Carcass yield, %[4]	73.3	73.9	73.4	72.8	72.9	72.8	0.41	0.82
HCW, lb	216.2	220.2	221.5	205.8	207.2	213.1	3.96	0.84
Backfat depth, in[3]	0.84	0.90	0.88	0.79	0.80	0.86	0.03	0.35
Loin depth, in[3]	2.58	2.52	2.53	2.43	2.40	2.48	0.03	0.14
Lean, %[3]	52.8	51.9	52.0	53.0	52.7	52.2	0.34	0.70
Jowl iodine value	71.6	72.4	72.3	72.3	73.7	75.1	0.34	0.12
Economics[5]								
Feed cost/pig, $	48.62	53.61	58.56	43.91	50.61	53.95	0.704	0.41
Feed cost/lb gain, $	0.28	0.31	0.34	0.26	0.28	0.31	0.006	0.54
Total revenue, $/pig[6]	162.1	165.1	166.1	154.3	155.4	159.8	2.970	0.84
IOFC[7]	113.5	111.5	107.6	110.4	104.8	105.9	2.993	0.68

[1] 288 pigs (TR4 × 1050, initial BW= 93.3 lb) were used in an 84-d study.
[2] Includes pigs that died, were culled, and were pulled off test during the experiment.
[3] Carcass characteristics other than yield and iodine value were adjusted by using hot carcass weight as a covariate.
[4] Percentage yield was calculated by dividing HCW by live weight obtained before transport to the packing plant.
[5] Diet cost was based on corn at $3.50/bu; 46.5% soybean meal at $300/ton; DDGS at $120/ton; wheat middlings at $100/ton and CWG at $30.00/cwt.
[6] Value was determined by using a base carcass price of $75.00/cwt.
[7] Income over feed cost = value of pig - feed costs during trial period.

Table 6. Effects of dietary wheat middlings and fat on finishing pig growth performance and carcass characteristics[12]

	Wheat Midds, %		Fat, %					Probability, *P* <			
								Main effects		Added Fat	
Item	0	20	0	2.5	5	WM SEM	Fat SEM	Midds	Fat	Linear	Quadratic
Initial wt, lb	93.3	93.2	93.2	93.3	93.3	1.66	2.03	0.98	1.00	0.98	0.98
Day 0 to 87											
ADG, lb	2.34	2.21	2.25	2.24	2.34	0.029	0.020	<0.001	0.002	0.004	0.03
ADFI, lb	6.71	6.64	6.76	6.61	6.65	0.102	0.102	0.40	0.31	0.30	0.27
F/G	2.87	3.00	3.01	2.95	2.84	0.034	0.423	<0.001	<0.001	<0.001	0.36
Final wt, lb	298.3	286.6	288.9	291.1	297.2	3.36	4.75	0.01	0.21	0.09	0.64
Carcass characteristics[2]											
Carcass yield, %[3]	73.5	72.8	73.0	73.4	73.1	0.24	0.41	0.04	0.68	0.86	0.39
HCW, lb	219.3	208.7	211.0	213.7	217.3	3.96	0.24	0.003	0.29	0.12	0.89
Lean, %[4]	52.5	52.4	52.8	52.3	52.3	0.17	0.20	0.74	0.16	0.10	0.35
Back fat, in[4]	0.87	0.82	0.81	0.85	0.87	0.02	0.02	0.04	0.16	0.06	0.77
Loin depth, in[4]	2.54	2.44	2.50	2.46	2.51	0.02	0.47	<0.001	0.22	1.00	0.08
Jowl iodine value	72.1	74.2	72.7	73.1	73.7	0.02	0.24	<0.001	0.37	0.005	0.66
Economics[5]											
Feed cost/pig, $	53.60	49.49	46.26	52.11	56.25	0.406	0.498	<0.001	<0.001	<0.001	0.17
Feed cost/lb gain, $	0.31	0.28	0.27	0.30	0.32	0.003	0.004	<0.001	<0.001	<0.001	0.54
Total revenue, $/pig[6]	164.45	156.52	158.23	160.24	162.98	1.715	2.100	0.003	0.29	0.12	0.89
IOFC[7]	110.86	107.04	111.97	108.14	106.73	1.728	2.117	0.13	0.21	0.09	0.64

[1] 288 pigs (TR4 × 1050, initial BW= 93.3 lb) were used in an 84-d study.

[2] Includes pigs that died, were culled, and were pulled off test during the experiment.

[3] Percentage yield was calculated by dividing HCW by live weight obtained before transport to the packing plant.

[4] Carcass characteristics other than yield and iodine value were adjusted by using hot carcass weight as a covariate.

[5] Diet cost was based on corn at $3.50/bu; 46.5% soybean meal at $30.0/ton; DDGS at $120/ton; wheat middlings at $100/ton and CWG at $30.0/cwt.

[6] Value was determined by using a base carcass price of $75.00/cwt.

[7] Income over feed cost = value of pig - feed costs during trial period.