Kansas Agricultural Experiment Station Research Reports

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

Article 1248

2012

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M D. Asmus

Michael D. Tokach

Steven S. Dritz

See next page for additional authors

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Authors

M D. Asmus, Michael D. Tokach, Steven S. Dritz, Robert D. Goodband, Terry A. Houser, Joel M. DeRouchey, and Jim L. Nelssen

Effects of Lowering Dried Distillers Grains with Solubles and Wheat Middlings with or without the Addition of Choice White Grease Prior to Marketing on Finishing Pig Growth Performance, Carcass Characteristics, Carcass Fat Quality, and Intestinal Weights[1]

M. D. Asmus, J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, S. S. Dritz[2], R. D. Goodband, and T. A. Houser

Summary

A total of 225 pigs (PIC 327 × 1050, initially 100.1 lb) were used in a 92-d study to determine the effects of withdrawing high-fiber diets 19 d before market on growth performance, carcass characteristics, fat quality, and intestinal weights of finishing pigs. Pigs were allotted to 1 of 7 dietary treatments (5 or 6 pens/treatment). Treatments were arranged in a 2 × 3 factorial plus control with main effects of added choice white grease (CWG; 0 or 3%) during the withdrawal period (d 73 to 92) and fiber levels of low (corn-soybean meal diet), medium (9.5% wheat middlings [midds] and 15% dried distillers grains with solubles [DDGS]), or high (19% midds and 30% DDGS) during the withdrawal period. Pigs were fed high-fiber (19% midds and 30% DDGS) diets from d 0 to 73. Control pigs were fed low-fiber corn-soybean meal diets from d 0 to 92. No CWG × fiber interactions ($P > 0.13$) occurred except for jowl iodine value (IV), which increased (linear, $P < 0.03$) with increasing DDGS and midds only when CWG was added to the diet during the withdrawal period. Adding CWG during the withdrawal period (d 73 to 92) improved ($P < 0.02$) ADG (1.81 vs 1.94 lb/d) and F/G (3.46 vs 3.19), leading to an overall (d 0 to 92) improvement ($P < 0.02$) in F/G. Carcass yield and backfat depth increased (linear, $P < 0.05$) when low-fiber diets were fed from d 73 to 92. Pigs fed high levels of DDGS and midds had increased ($P < 0.001$) jowl IV, with a larger increase when CWG was added. Feeding low levels of DDGS and midds during the withdrawal period decreased (linear, $P < 0.01$) whole intestine weights, mainly due to the reduction ($P < 0.02$) in rinsed stomach and full large-intestine weights. Lowering dietary DDGS and midds during a 19-d withdrawal period increased yield through reduced large intestine weight and content and lowered jowl IV. The addition of CWG improved F/G but did not improve carcass characteristics.

Key words: DDGS, fiber, finishing pig, NDF, wheat middlings, withdrawal

[1] Appreciation is expressed to Triumph Foods LLC (St. Joseph, MO) for collecting jowl fat and conducting the iodine value analysis and to Jerry Lehenbauer, David Donovan, Derek Petry, and Brad Knadler for technical assistance.

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

Introduction

Feed ingredients such as wheat midds and DDGS are often used as alternatives to corn and soybean meal in swine diets. Although these ingredients are used to lower feed costs, they have been shown to affect performance and carcass characteristics negatively. Two areas of concern are the reduction in carcass yield with pigs fed high-fiber diets and the negative effect of DDGS on fat quality. Soft carcass fat with a high IV has been observed consistently in pigs fed high levels of DDGS. Reducing the level of DDGS in the diet prior to market has been successful in lowering IV and improving yield, but little is known about including CWG in the diet during withdrawal or its potential effects on yield, carcass characteristics, and carcass fat quality. More data are also required to determine why yield is reduced when feeding diets containing high-fiber ingredients such as DDGS or midds.

The objective of this trial was to determine the effects of decreasing or withdrawing fiber sources and including CWG prior to market on growth performance, carcass characteristics, and carcass fat quality of growing-finishing pigs.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the K-State Swine Teaching and Research Center in Manhattan, KS. The facility was a totally enclosed, environmentally regulated, mechanically ventilated barn containing 36 pens (8 ft × 10 ft). The pens had adjustable gates facing the alleyway, allowing 10 ft^2/pig. Each pen was equipped with a cup waterer and a single-sided, dry self-feeder (Farmweld, Teutopolis, IL) with 2 eating spaces in the fence line. 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 225 pigs (PIC 327 × 1050, initially 100.1 lb) were used in a 92-d trial. Pens of pigs (4 gilts and 2 barrows per pen or 4 gilts and 3 barrows per pen) were randomly allotted by initial weight to 1 of 7 dietary treatments with 5 or 6 replications per treatment. Treatments were arranged in a 2 × 3 factorial plus control with the main effects of added CWG (0 or 3%) during the withdrawal period (d 73 to 92) and fiber levels of low (corn-soybean meal diet), medium (9.5% midds and 15% DDGS), or high (19% midds and 30% DDGS) during the withdrawal period. Pigs were fed high-fiber (19% midds and 30% DDGS) diets from d 0 to 73. Control pigs were fed low-fiber corn-soybean meal diets from d 0 to 92. Dietary treatments were corn-soybean meal–based and fed in 4 phases (Tables 1 and 2). All diets were fed in meal form.

Midds and DDGS samples were collected at the time of feed manufacturing and a composite sample was analyzed (Table 3). Feed samples were collected from every feeder during each phase and combined for a single composite sample by treatment to measure bulk density (Table 4).

Pigs and feeders were weighed approximately every 3 wk to calculate ADG, ADFI, and F/G. On d 92, all pigs were weighed individually. The second heaviest gilt in each pen

(1 pig per pen, 5 pigs per treatment) was identified for harvest at the K-State Meats Lab (KSU); all others were then transported to Triumph Foods LLC, St. Joseph, MO. The pigs selected for harvest at KSU were blocked by treatment and randomly allotted to a harvest order to equalize the withdrawal time from feed before slaughter. Hot carcass weights were measured immediately after evisceration. Following evisceration, the entire pluck (heart, lungs, liver, kidneys, spleen, stomach, cecum, large intestine, small intestine, and reproductive tract) was weighed and then the individual organs were weighed. After full organ weights were recorded, the large intestine, stomach, and cecum were physically stripped of contents and reweighed, then flushed with water, physically stripped of contents, and weighed again. Pigs harvested at the commercial packing plant were individually and sequentially tattooed with a unique number to allow for carcass data collection at the packing plant and individual data retrieval. Hot carcass weights were measured immediately after evisceration, and each carcass was evaluated for percentage yield, backfat, loin depth, and percentage lean. Because HCW differed among treatments, it was used as a covariate for backfat, loin depth, and percentage lean. Also, jowl fat samples were collected and analyzed by Near Infrared Spectroscopy at the plant for IV. Percentage yield was calculated by dividing HCW at the plant by live weight at the farm before transport to the plant.

Data were analyzed as a completely randomized design using the PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. The main effects of fiber level and CWG prior to market were tested. Linear and quadratic contrasts were used to determine the effects of withdrawal fiber levels. Differences between treatments were determined by using least squares means. Results were considered significant at $P \leq 0.05$ and considered a trend at $P \leq 0.10$.

Results and Discussion

Bulk density tests showed that adding dietary fiber from midds and DDGS dramatically decreased diet bulk density (Table 4).

Overall, (d 0 to 92) the withdrawal treatments did not influence ($P > 0.39$) ADG; however, adding CWG to the diet during the withdrawal period (d 73 to 92) increased ($P < 0.02$) ADG and improved ($P < 0.006$) F/G, resulting in an overall (d 0 to 92) improvement ($P < 0.002$) in feed efficiency (Tables 5 and 6). Feeding high-fiber diets during the first 73 d had no impact ($P > 0.44$) on ADG; however, the pigs fed higher-fiber diets tended ($P < 0.10$) to have poorer feed efficiency than pigs fed the low-fiber (control) diet.

For carcass traits and fat quality, there were no CWG × fiber interactions ($P < 0.13$) except for jowl IV, which increased (linear, $P < 0.03$) with increasing DDGS and midds only when CWG was added to the diet during the withdrawal period (Tables 7 and 8). Carcass yield and backfat depth increased (linear, $P < 0.05$) when low-fiber diets were fed from d 73 to 92. Pigs fed high DDGS and midds had increased ($P < 0.001$) jowl IV, with a larger increase when CWG was added.

For intestinal measurements, the fiber level fed during the withdrawal period had minor effects on most organ weights except the digestive tract, which, as expected, was the most influenced by fiber levels. Feeding low levels of DDGS and midds during the with-

drawal period decreased (linear, $P < 0.01$) whole intestine weights whether calculated on a weight basis (Tables 9 and 10) or percentage of live weight basis (Tables 11 and 12). Cecum weights were not influenced ($P > 0.24$) by the addition of CWG during the withdrawal; however, minor ($P < 0.11$) reductions were observed in full cecum weights when the low-fiber diet was fed during the withdrawal period. These differences were not maintained in stripped or rinsed cecum weights, which indicates that the change was due to an increase in fill rather than an increase in actual organ weight. The greatest impact of withdrawal treatments was on large intestine weight and rinsed stomach weights with the similar response to the yield response. Reducing fiber level during the 19-d withdrawal reduced ($P < 0.01$) full large intestine weight, with a greater response when CWG was added to the diet, resulting in a tendency ($P > 0.09$) for an interactive effect. Similar to the cecum, the response in the large intestine was due to fill. After the large intestine was stripped and rinsed, the fiber level fed had no impact ($P > 0.21$) on the actual intestine weight. Although no significant differences ($P > 0.18$) were detected in full stomach weights, rinsed stomach weights tended ($P < 0.06$) to be reduced when calculated on a weight basis and were reduced ($P < 0.02$) when calculated as a percentage of BW when low-fiber diets were fed during the withdrawal, indicating a reduction in actual organ size.

In summary, withdrawing pigs from a high-fiber diet containing DDGS and midds during a 19-d withdrawal period increased carcass yield through reduced large intestine content and rinsed stomach weight and improved jowl IV. The addition of CWG improved F/G but worsened jowl IV and did not improve carcass characteristics.

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

	Phase 1		Phase 2		Phase 3	
NDF, %:	9.2	18.9	9.3	19.0	9.3	19.0
ADF, %:	3.3	6.7	3.2	6.6	3.1	6.5
Wheat midds, %:	0	19	0	19	0	19
Item DDGS, %:[2]	0	30	0	30	0	30
Ingredient, %						
Corn	73.70	34.90	78.95	40.00	82.65	43.55
Soybean meal (46.5% CP)	23.80	13.75	18.85	8.70	15.30	5.20
DDGS	---	30.00	---	30.00	---	30.00
Wheat midds	---	19.00	---	19.00	---	19.00
Monocalcium P, (21% P)	0.45	---	0.35	---	0.25	---
Limestone	1.05	1.30	1.00	1.28	0.98	1.29
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.15	0.15	0.13	0.13	0.10	0.10
Trace mineral premix	0.15	0.15	0.13	0.13	0.10	0.10
L-lysine HCl	0.17	0.31	0.15	0.29	0.14	0.28
DL-methionine	0.02	---	---	---	---	---
L-threonine	0.03	---	0.01	---	---	---
Phytase[3]	0.13	0.13	0.13	0.13	0.13	0.13
Total	100.0	100.0	100.0	100.0	100.0	100.0
Crude fiber, %	2.5	4.9	2.5	4.9	2.4	4.8
Standardized ileal digestible (SID) amino acids, %						
Lysine	0.93	0.93	0.79	0.79	0.69	0.69
Isoleucine:lysine	69	72	70	74	72	76
Leucine:lysine	156	188	169	206	181	224
Methionine:lysine	30	34	30	37	32	40
Met & Cys:lysine	59	70	62	77	66	83
Threonine:lysine	63	66	63	69	64	72
Tryptophan:lysine	19	19	19	19	19	19
Valine:lysine	78	88	81	94	85	99
SID lysine:ME/Mcal	2.79	2.84	2.36	2.41	2.06	2.10
ME, kcal/lb	1,513	1,484	1,516	1,486	1,520	1,487
Total lysine, %	1.04	1.09	0.89	0.94	0.78	0.83
CP, %	17.52	20.83	15.62	18.91	14.28	17.57
Ca, %	0.59	0.58	0.53	0.56	0.49	0.55
P, %	0.47	0.58	0.42	0.56	0.39	0.55
Available P, %	0.27	0.39	0.25	0.38	0.22	0.38

[1] Phase 1 diets were fed from approximately 100 to 130 lb; Phase 2 diets were fed from 130 to 180 lb; Phase 3 were fed from 180 to 230 lb.

[2] DDGS: dried distillers grain with solubles.

[3] Phyzyme 600 (Danisco Animal Nutrition, St Louis, MO) provided per pound of diet: 353.8 phytase units (FTU)/lb and 0.11% available P released.

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

	NDF, %:	9.3	9.3	14.2	19.0	9.0	14.0	18.7
	ADF, %:	3.1	3.1	4.8	6.4	3.0	4.7	6.4
	Wheat midds, %:	0	0	15	30	0	15	30
	DDGS, %:[2]	0	0	9.5	19	0	9.5	19
Item	Choice white grease, %:	0	0	0	0	3	3	3
Ingredient, %								
Corn		84.95	84.95	65.60	45.80	80.65	61.25	41.45
Soybean meal (46.5% CP)		13.15	13.15	8.05	3.05	14.45	9.35	4.35
DDGS		---	---	15.00	30.00	---	15.00	30.00
Wheat midds		---	---	9.50	19.00	---	9.50	19.00
Monocalcium P, (21% P)		0.20	0.20	---	---	0.20	---	---
Limestone		0.93	0.93	1.05	1.28	0.93	1.05	1.28
Salt		0.35	0.35	0.35	0.35	0.35	0.35	0.35
Choice white grease		---	---	---	---	3.00	3.00	3.00
Vitamin premix		0.08	0.08	0.08	0.08	0.08	0.08	0.08
Trace mineral premix		0.08	0.08	0.08	0.08	0.08	0.08	0.08
L-lysine HCl		0.13	0.13	0.20	0.27	0.13	0.20	0.27
Phytase[3]		0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0
Crude fiber, %		2.4	2.4	3.6	4.8	2.3	3.5	4.7
Standardized ileal digestible (SID) amino acids, %								
Lysine		0.63	0.63	0.63	0.63	0.66	0.66	0.66
Isoleucine:lysine		73	73	75	78	72	75	77
Leucine:lysine		191	191	214	238	184	206	228
Methionine:lysine		33	33	38	43	32	37	41
Met & Cys:lysine		69	69	78	88	66	76	85
Threonine:lysine		66	66	70	74	65	69	73
Tryptophan:lysine		19	19	19	19	19	19	19
Valine:lysine		87	87	95	103	86	93	100
SID lysine:ME/Mcal		1.88	1.88	1.90	1.92	1.88	1.90	1.92
ME, kcal/lb		1,522	1,522	1,508	1,488	1,584	1,569	1,550
Total lysine, %		0.72	0.72	0.74	0.77	0.75	0.77	0.79
CP, %		13.46	13.46	15.1	16.75	13.70	15.34	16.99
Ca, %		0.46	0.46	0.46	0.54	0.46	0.47	0.54
P, %		0.37	0.37	0.43	0.54	0.37	0.43	0.54
Available P, %		0.21	0.21	0.27	0.37	0.21	0.27	0.37

[1] Phase 4 diets were fed from approximately 230 to 280 lb.
[2] DDGS: dried distillers grain with solubles.
[3] Phyzyme 600 (Danisco Animal Nutrition, St Louis, MO) provided per pound of diet: 353.8 phytase units (FTU)/lb and 0.11% available P released.

Table 3. Chemical analysis of dried distillers grains with solubles (DDGS) and wheat middlings (midds), as-fed basis

Nutrient, %	DDGS	Midds
DM	90.97	89.39
CP	27.2 (27.2)[1]	15.5 (15.9)
Fat (oil)	11.5	3.3
Crude fiber	9.1 (7.7)	8.1 (7.0)
ADF	12.4 (9.9)	10.5 (10.7)
NDF	31.1 (25.3)	32.1 (35.6)
Ash	4.22	5.68

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

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

	Treatments						
NDF, %:	9.3	9.3	14.2	19.0	9.0	14.0	18.7
Wheat midds, %:	0	0	15	30	0	15	30
DDGS[1], %:	0	0	9.5	19	0	9.5	19
Bulk density, lb/bu[2,3] CWG,[4] %:	0	0	0	0	3	3	3
Phase 1	53.3	---	---	40.6	---	---	---
Phase 2	52.7	---	---	39.1	---	---	---
Phase 3	50.0	---	---	37.0	---	---	---
Phase 4	50.8	50.8	43.2	36.5	49.7	43.3	37.5

[1] DDGS: dried distillers grains with solubles.
[2] Diet samples collected from the top of each feeder during each phase.
[3] Phase 1 was d 0 to 23; Phase 2 was d 23 to 43; Phase 3 was d 43 to 73; Phase 4 was d 73 to 92.
[4] CWG: choice white grease.

Table 5. Effect of dietary NDF and added fat prior to marketing on growth performance[1]

Treatment:	1	2	3	4	5	6	7	
d 0 to 73:	Low[2]	High[3]	High	High	High	High	High	
					3% added fat			
d 73 to 90:	Low	Low	Med[4]	High	Low	Med	High	SEM
Weight, lb								
d 0	101.0	101.1	101.2	101.1	101.1	101.0	101.1	1.98
d 23	146.8	146.3	145.7	147.8	146.6	146.0	146.3	2.10
d 43	179.3	179.9	180.0	179.9	178.9	180.0	179.8	2.57
d 73	238.7	237.1	237.2	236.9	237.3	237.7	236.9	3.04
d 92	273.8	270.5	272.4	272.8	274.7	274.5	273.8	3.30
d 0 to 73								
ADG, lb	1.89	1.86	1.86	1.86	1.87	1.84	1.86	0.03
ADFI, lb	5.29	5.37	5.42	5.38	5.29	5.34	5.25	0.13
F/G	2.80	2.88	2.91	2.89	2.83	2.91	2.83	0.04
d 73 to 92								
ADG, lb	1.85	1.76	1.85	1.80	1.96	1.94	1.94	0.07
ADFI, lb	6.17	6.26	6.39	6.12	6.35	6.15	6.07	0.15
F/G	3.35	3.58	3.48	3.40	3.24	3.19	3.15	0.11
d 0 to 92								
ADG, lb	1.88	1.84	1.86	1.85	1.89	1.86	1.88	0.03
ADFI, lb	5.47	5.56	5.62	5.53	5.51	5.50	5.42	0.12
F/G	2.91	3.02	3.02	2.99	2.92	2.96	2.89	0.04

[1] A total of 225 pigs (PIC 327 × 1050, initial BW= 101.1 lb) were used in this 92-d study.
[2] Refers to diet with 0% dried distillers grains with solubles (DDGS) and 0% midds with NDF of 9.3%.
[3] Refers to diet with 30% DDGS and 19.0% midds with NDF of 19.0%.
[4] Refers to diet with 15% DDGS and 9.5% midds with NDF of 14.2%.

Table 6. Effect of dietary NDF and added fat prior to marketing on growth performance[1]

	Probability, *P*<								
		Fiber[3]		Interaction[4]		Fiber no fat[5]		Fiber with 3% fat[6]	
	Fat[2]	Linear	Quad	Linear	Quad	Linear	Quad	Linear	Quad
Weight, lb									
d 0	0.97	0.99	1.00	0.99	0.95	1.00	0.97	0.99	0.96
d 23	0.87	0.80	0.65	0.70	0.82	0.65	0.63	0.92	0.88
d 43	0.86	0.87	0.87	0.87	0.90	1.00	0.98	0.81	0.84
d 73	0.92	0.93	0.90	0.97	0.95	0.97	0.97	0.93	0.90
d 92	0.42	0.85	0.86	0.66	0.94	0.66	0.86	0.86	0.94
d 0 to 73									
ADG, lb	0.79	0.90	0.69	0.95	0.68	0.97	0.99	0.89	0.57
ADFI, lb	0.39	0.93	0.62	0.87	0.91	0.96	0.79	0.86	0.67
F/G	0.26	0.97	0.18	0.82	0.43	0.85	0.69	0.89	0.13
d 73 to 92									
ADG, lb	0.02	0.92	0.61	0.65	0.50	0.70	0.40	0.80	0.91
ADFI, lb	0.64	0.22	0.62	0.67	0.37	0.56	0.33	0.24	0.78
F/G	0.006	0.29	0.97	0.75	0.96	0.33	0.95	0.60	0.99
d 0 to 92									
ADG, lb	0.39	0.95	0.87	0.78	0.45	0.88	0.67	0.81	0.52
ADFI, lb	0.39	0.68	0.61	0.81	0.86	0.90	0.63	0.64	0.81
F/G	0.02	0.54	0.31	0.95	0.54	0.70	0.78	0.63	0.25

[1] A total of 225 pigs (PIC 327 × 1050, initial BW=101.1 lb) were used in a 92-d study.
[2] Main effect of fat regardless of fiber level (Treatments 2, 3, and 4 vs. 5, 6, and 7).
[3] Main effect of fiber regardless of fat inclusion (Treatments 2, 3, 4 and 5, 6, 7).
[4] Interaction effect of fat × fiber (Treatments 2, 3, 4 and 5, 6, 7).
[5] Effect of fiber level on diets without fat (Treatments 2, 3, 4).
[6] Effect of fiber level on diets with fat (Treatments 5, 6, 7).

Table 7. Effect of dietary NDF levels with or without the addition of fat prior to marketing on finishing pig intestinal and organ weights, %[1]

Treatment:	1	2	3	4	5	6	7	
d 0 to 73:	Low[2]	High[3]	High	High	High	High	High	
					3% added fat			
d 73 to 92:	Low	Low	Med[4]	High	Low	Med	High	SEM
Carcass yield[5]	72.6	72.6	71.8	71.9	73.0	72.3	71.5	0.31
HCW, lb	199.3	196.7	195.7	196.2	200.6	199.4	195.6	2.93
Backfat depth, in.[6]	0.75	0.69	0.67	0.67	0.73	0.70	0.65	0.02
Loin depth, in.[6]	2.29	2.21	2.24	2.27	2.32	2.16	2.23	0.04
Lean, %[6]	52.8	53.0	53.3	53.4	53.0	52.6	53.4	0.30
Jowl iodine value	69.4	77.8	78.5	79.2	77.3	78.6	81.2	0.50

[1] A total of 225 pigs (PIC 327 × 1050, initial BW = 101.1 lb) were used in a 92-d study.
[2] Refers to a diet with 0% dried distillers grains with solubles (DDGS) and 0% midds with NDF of 9.3%.
[3] Refers to a diet with 30% DDGS and 19.0% midds with NDF of 19.0%.
[4] Refers to a diet with 15% DDGS and 9.5% midds with NDF of 14.2%.
[5] Percentage yield was calculated by dividing HCW by live weight obtained at the farm before transport to the packing plant.
[6] Carcass characteristics other than yield and iodine value were adjusted by using HCW as a covariate.

Table 8. Effect of dietary NDF levels with or without the addition of fat prior to marketing on finishing pig carcass characteristics[1]

	Probability, *P*<								
	Fat[2]	Fiber[3]		Interaction[4]		Fiber no fat[5]		Fiber with fat[6]	
		Linear	Quad	Linear	Quad	Linear	Quad	Linear	Quad
Carcass yield, %[5]	0.50	0.003	0.53	0.23	0.44	0.16	0.32	0.003	0.91
HCW, lb	0.38	0.40	0.91	0.49	0.72	0.91	0.86	0.28	0.74
Backfat depth, in.[6]	0.40	0.05	0.92	0.22	0.73	0.59	0.75	0.03	0.86
Loin depth, in.[6]	0.91	0.74	0.13	0.15	0.16	0.42	0.94	0.21	0.04
Lean, %[6]	0.48	0.23	0.38	0.95	0.22	0.42	0.80	0.38	0.14
Jowl iodine value	0.24	< 0.001	0.54	0.03	0.46	0.09	0.93	< 0.001	0.35

[1] A total of 225 pigs (PIC 327 × 1050, initial BW=101.1 lb) were used in a 92-d study.
[2] Main effect of fat regardless of fiber level (Treatments 2, 3, and 4 vs. 5, 6, and 7).
[3] Main effect of fiber regardless of fat inclusion (Treatments 2, 3, 4 and 5, 6, 7).
[4] Interaction effect of fat × fiber (Treatments 2, 3, 4 and 5, 6, 7).
[5] Effect of fiber level on diets without fat (Treatments 2, 3, 4).
[6] Effect of fiber level on diets with fat (Treatments 5, 6, 7).

Table 9. Effect of dietary NDF levels with or without the addition of fat prior to marketing on finishing pig intestinal and organ weights, lb[1]

Treatment:	1	2	3	4	5	6	7	
d 0 to 73:	Low[2]	High[3]	High	High	High	High	High	
					3% added fat			
d 73 to 92	Low	Low	Med[4]	High	Low	Med	High	SEM
Full pluck	30.81	29.35	30.17	31.48	29.19	28.80	32.50	1.14
Whole intestine	19.73	18.01	19.07	19.98	17.62	18.39	21.36	0.93
Stomach								
Full	2.64	2.15	2.00	2.66	2.24	2.14	2.47	0.24
Stripped	1.51	1.44	1.51	1.60	1.53	1.50	1.66	0.07
Rinsed	1.52	1.40	1.49	1.54	1.52	1.47	1.65	0.06
Cecum								
Full	2.22	1.44	1.73	1.84	1.65	1.45	1.81	0.14
Stripped	0.68	0.59	0.60	0.63	0.68	0.60	0.65	0.03
Rinsed	0.63	0.56	0.57	0.59	0.65	0.58	0.59	0.04
Large intestine								
Full	7.71	7.74	8.55	8.48	7.14	8.38	10.46	0.65
Stripped	3.53	3.68	3.82	3.70	3.56	3.99	4.18	0.21
Rinsed	3.44	3.44	3.61	3.44	3.49	3.55	3.84	0.18
Small intestine								
Full	6.43	6.09	5.59	6.05	6.01	5.88	6.06	0.25
Heart	0.98	0.97	0.91	0.91	0.90	0.95	0.89	0.04
Lungs	2.17	2.22	2.18	2.29	2.12	2.25	2.22	0.09
Liver	4.53	4.60	4.55	4.50	4.35	4.17	4.46	0.16
Kidneys	0.89	0.88	0.91	0.85	0.88	0.83	0.87	0.04
Spleen	0.52	0.53	0.50	0.51	0.50	0.50	0.50	0.04
Reproductive tract	1.54	1.70	1.70	1.99	2.21	1.32	1.84	0.26

[1] A total of 225 pigs (PIC 327 × 1050, initial BW = 101.1 lb) were used in a 92-d study.
[2] Refers to a diet with 0% dried distillers grains with solubles (DDGS) and 0% midds with NDF of 9.3%.
[3] Refers to a diet with 30% DDGS and 19.0% midds with NDF of 19.0%.
[4] Refers to a diet with 15% DDGS and 9.5% midds with NDF of 14.2%.

Table 10. Effect of dietary NDF levels with or without the addition of fat prior to marketing on finishing pig intestinal and organ weights, lb[1]

	Probability, *P*<								
	Fat[2]	Fiber[3]		Interaction[4]		Fiber no fat[5]		Fiber with fat[6]	
		Linear	Quad	Linear	Quad	Linear	Quad	Linear	Quad
Full pluck	0.87	0.04	0.30	0.64	0.41	0.24	0.87	0.07	0.19
Whole intestine	0.90	0.01	0.57	0.39	0.51	0.18	0.95	0.01	0.39
Stomach									
Full	0.95	0.18	0.19	0.61	0.68	0.20	0.22	0.54	0.51
Stripped	0.44	0.06	0.41	0.84	0.50	0.15	0.91	0.21	0.29
Rinsed	0.22	0.06	0.43	0.94	0.27	0.16	0.81	0.19	0.18
Cecum									
Full	0.81	0.11	0.50	0.49	0.20	0.09	0.65	0.52	0.17
Stripped	0.24	0.90	0.26	0.36	0.41	0.46	0.83	0.58	0.17
Rinsed	0.30	0.70	0.51	0.25	0.60	0.59	0.92	0.28	0.40
Large intestine									
Full	0.51	0.01	0.99	0.09	0.51	0.50	0.65	0.003	0.63
Stripped	0.35	0.17	0.53	0.20	0.98	0.95	0.64	0.06	0.67
Rinsed	0.42	0.38	0.87	0.38	0.41	1.00	0.48	0.21	0.63
Small intestine									
Full	0.75	0.99	0.19	0.87	0.50	0.92	0.16	0.90	0.65
Heart	0.61	0.38	0.72	0.53	0.22	0.29	0.54	0.86	0.26
Lungs	0.69	0.40	0.98	0.88	0.38	0.63	0.55	0.49	0.52
Liver	0.14	0.98	0.46	0.56	0.46	0.70	1.00	0.67	0.30
Kidneys	0.62	0.69	1.00	0.84	0.30	0.67	0.46	0.89	0.46
Spleen	0.69	0.80	0.78	0.80	0.78	0.73	0.69	1.00	1.00
Reproductive tract	0.98	0.89	0.09	0.25	0.26	0.47	0.68	0.36	0.05

[1] A total of 225 pigs (PIC 327 × 1050, initial BW=101.1 lb) were used in a 92-d study.
[2] Main effect of fat regardless of fiber level (Treatments 2, 3, and 4 vs. 5, 6, and 7).
[3] Main effect of fiber regardless of fat inclusion (Treatments 2, 3, 4 and 5, 6, 7).
[4] Interaction effect of fat × fiber (Treatments 2, 3, 4 and 5, 6, 7).
[5] Effect of fiber level on diets without fat (Treatments 2, 3, 4).
[6] Effect of fiber level on diets with fat (Treatments 5, 6, 7).

Table 11. Effect of dietary NDF levels with or without the addition of fat prior to marketing on finishing pig intestinal and organ weights, %[1,2]

Treatment:	1	2	3	4	5	6	7	
d 0 to 73:	Low[3]	High[4]	High	High	High	High	High	
					3% added fat			
d 73to 92:	Low	Low	Med[5]	High	Low	Med	High	SEM
Full pluck	10.98	10.61	10.96	11.69	10.51	10.52	11.74	0.42
Whole intestine	7.03	6.51	6.93	7.42	6.35	6.72	7.73	0.35
Stomach								
Full	0.94	0.78	0.72	0.99	0.81	0.78	0.90	0.09
Stripped	0.54	0.52	0.55	0.59	0.55	0.55	0.60	0.02
Rinsed	0.54	0.51	0.54	0.57	0.55	0.54	0.60	0.02
Cecum								
Full	0.79	0.52	0.63	0.68	0.60	0.53	0.65	0.06
Stripped	0.24	0.21	0.22	0.23	0.24	0.22	0.23	0.01
Rinsed	0.22	0.20	0.21	0.22	0.23	0.21	0.21	0.01
Large intestine								
Full	2.75	2.80	3.21	3.12	2.58	3.06	3.79	0.25
Stripped	1.26	1.33	1.39	1.37	1.28	1.46	1.51	0.07
Rinsed	1.22	1.24	1.31	1.28	1.26	1.30	1.39	0.06
Small intestine								
Full	2.29	2.20	2.03	2.24	2.16	2.14	2.18	0.08
Heart	0.35	0.35	0.33	0.34	0.32	0.35	0.32	0.01
Lungs	0.77	0.80	0.79	0.85	0.77	0.82	0.80	0.04
Liver	1.61	1.66	1.65	1.67	1.57	1.52	1.61	0.06
Kidneys	0.32	0.32	0.33	0.32	0.32	0.30	0.31	0.01
Spleen	0.18	0.19	0.18	0.19	0.18	0.18	0.18	0.01
Reproductive tract	0.55	0.61	0.62	0.74	0.78	0.49	0.66	0.09

[1] A total of 225 pigs (PIC 327 × 1050, initial BW = 101.1 lb) were used in a 92-d study.
[2] All values are a percent of live weight (ex. (reproductive tract/live weight) × 100).
[3] Refers to a diet with 0% dried distillers grains with solubles (DDGS) and 0% midds with NDF of 9.3%.
[4] Refers to a diet with 30% DDGS and 19.0% midds with NDF of 19.0%.
[5] Refers to a diet with 15% DDGS and 9.5% midds with NDF of 14.2%.

Table 12. Effect of dietary NDF levels with or without the addition of fat prior to marketing on finishing pig intestinal and organ weights, %[1]

	Probability, *P*<								
		Fiber[3]		Interaction[4]		Fiber no fat[5]		Fiber with fat[6]	
	Fat[2]	Linear	Quad	Linear	Quad	Linear	Quad	Linear	Quad
Full pluck	0.66	0.02	0.32	0.87	0.61	0.11	0.73	0.07	0.29
Whole intestine	0.94	0.006	0.60	0.55	0.67	0.11	0.94	0.02	0.50
Stomach									
Full	0.98	0.15	0.19	0.56	0.58	0.16	0.19	0.51	0.59
Stripped	0.52	0.02	0.39	0.63	0.78	0.05	0.68	0.16	0.42
Rinsed	0.24	0.02	0.41	0.73	0.44	0.05	0.96	0.13	0.26
Cecum									
Full	0.73	0.12	0.57	0.40	0.28	0.08	0.70	0.62	0.25
Stripped	0.33	0.74	0.26	0.22	0.52	0.27	0.73	0.53	0.22
Rinsed	0.40	0.85	0.51	0.16	0.71	0.39	0.83	0.26	0.47
Large intestine									
Full	0.68	0.01	0.79	0.13	0.46	0.43	0.50	0.004	0.72
Stripped	0.43	0.10	0.50	0.25	0.84	0.71	0.74	0.05	0.54
Rinsed	0.53	0.25	0.81	0.49	0.55	0.74	0.56	0.19	0.80
Small intestine									
Full	0.97	0.71	0.13	0.91	0.26	0.73	0.07	0.86	0.77
Heart	0.38	0.46	0.64	0.69	0.06	0.42	0.30	0.81	0.09
Lungs	0.62	0.33	0.99	0.85	0.27	0.41	0.43	0.58	0.44
Liver	0.08	0.71	0.43	0.80	0.66	0.93	0.81	0.66	0.39
Kidneys	0.39	0.80	0.99	0.98	0.34	0.88	0.49	0.84	0.51
Spleen	0.63	0.91	0.74	0.95	0.66	0.90	0.58	0.97	0.94
Reproductive tract	0.86	1.00	0.11	0.22	0.31	0.39	0.67	0.39	0.07

[1] A total of 225 pigs (PIC 327 × 1050, initial BW=101.1 lb) were used in a 92-d study.
[2] Main effect of fat regardless of fiber level (Treatments 2, 3, and 4 vs. 5, 6, and 7).
[3] Main effect of fiber regardless of fat inclusion (Treatments 2, 3, 4 and 5, 6, 7).
[4] Interaction effect of fat × fiber (Treatments 2, 3, 4 and 5, 6, 7).
[5] Effect of fiber level on diets without fat (Treatments 2, 3, 4).
[6] Effect of fiber level on diets with fat (Treatments 5, 6, 7).