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Effects of dried distillers grains with solubles and increasing dietary wheat middlings on growth performance, carcass characteristics, and fat quality in growing-finishing pigs

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Effects of dried distillers grains with solubles and increasing dietary wheat middlings on growth performance, carcass characteristics, and fat quality in growing-finishing pigs

Abstract

A total of 288 pigs (PIC TR4 x 1050, initially 100 lb) were used in an 84-d growth trial to evaluate the effects of dietary wheat middlings and dried distillers grain with solubles (DDGS) on growing-finishing pig growth performance, carcass characteristics, and carcass fat quality. Pens of pigs were balanced by initial weight and gender and were randomly allotted to 1 of 4 dietary treatments with 8 pigs per pen (4 barrows and 4 gilts) and 9 replications per treatment. Dietary treatments included a corn-soybean meal-based diet, a diet with 30% DDGS, or the diet with 30% DDGS with 10% or 20% wheat middlings. Treatment diets were formulated to constant standardized ileal digestible lysine:ME ratios within each phase. All treatments were fed in 4 phases. Overall (d 0 to 84), pigs fed increasing wheat middlings had decreased (linear; $P \leq 0.02$) ADG and poorer (linear; $P \leq 0.01$) F/G. There were no differences ($P = 0.12$) among treatments for ADFI. For carcass characteristics, increasing wheat middlings decreased (linear; $P < 0.01$) percentage yield and HCW and tended to decrease (linear; $P < 0.06$) loin depth. Pigs fed wheat middlings also had decreased (quadratic; $P < 0.02$) back fat and increased (quadratic; $P < 0.01$) percentage lean. Increasing DDGS from 0 to 30% decreased ($P < 0.03$) carcass yield and backfat depth ($P < 0.01$), while increasing percentage lean ($P < 0.03$) and jowl iodine value ($P < 0.001$). Increasing wheat middlings in the diet decreased (linear; $P < 0.006$) feed cost per pig and feed cost per lb gain but also decreased (linear; $P < 0.008$) total revenue. Similarly, feeding DDGS decreased ($P < 0.001$) feed cost per pig and feed cost per lb gain; however, because total revenue was not decreased as greatly by DDGS, feeding 30% DDGS increased ($P < 0.001$) income over feed costs (IOFC). In conclusion, alternative ingredients, such as DDGS and wheat middlings, can reduce feed cost; however, the full impact on growth performance and carcass value must be known to truly understand whether they influence net profitability.; Swine Day, Manhattan, KS, November 18, 2010

Keywords

Swine Day, 2010; Kansas Agricultural Experiment Station contribution; no. 11-016-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1038; Swine; Dried distillers grains with solubles; Iodine value; Wheat middlings

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Effects of Dried Distillers Grains with Solubles and Increasing Dietary Wheat Middlings on Growth Performance, Carcass Characteristics, and Fat Quality in Growing-Finishing Pigs

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Summary

A total of 288 pigs (PIC TR4 × 1050, initially 100 lb) were used in an 84-d growth trial to evaluate the effects of dietary wheat middlings and dried distillers grain with solubles (DDGS) on growing-finishing pig growth performance, carcass characteristics, and carcass fat quality. Pens of pigs were balanced by initial weight and gender and were randomly allotted to 1 of 4 dietary treatments with 8 pigs per pen (4 barrows and 4 gilts) and 9 replications per treatment. Dietary treatments included a corn-soybean meal-based diet, a diet with 30% DDGS, or the diet with 30% DDGS with 10% or 20% wheat middlings. Treatment diets were formulated to constant standardized ileal digestible lysine:ME ratios within each phase. All treatments were fed in 4 phases. Overall (d 0 to 84), pigs fed increasing wheat middlings had decreased (linear; $P \le 0.02$) ADG and poorer (linear; $P \le 0.01$) F/G. There were no differences ($P = 0.12$) among treatments for ADFI. For carcass characteristics, increasing wheat middlings decreased (linear; $P < 0.01$) percentage yield and HCW and tended to decrease (linear; $P < 0.06$) loin depth. Pigs fed wheat middlings also had decreased (quadratic; $P < 0.02$) back fat and increased (quadratic; $P < 0.01$) percentage lean. Increasing DDGS from 0 to 30% decreased ($P < 0.03$) carcass yield and backfat depth ($P < 0.01$), while increasing percentage lean ($P < 0.03$) and jowl iodine value ($P < 0.001$).

Increasing wheat middlings in the diet decreased (linear; $P < 0.006$) feed cost per pig and feed cost per lb gain but also decreased (linear; $P < 0.008$) total revenue. Similarly, feeding DDGS decreased ($P < 0.001$) feed cost per pig and feed cost per lb gain; however, because total revenue was not decreased as greatly by DDGS, feeding 30% DDGS increased ($P < 0.001$) income over feed costs (IOFC). In conclusion, alternative ingredients, such as DDGS and wheat middlings, can reduce feed cost; however, the full impact on growth performance and carcass value must be known to truly understand whether they influence net profitability.

Key words: dried distillers grains with solubles, iodine value, wheat middlings

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 affect performance and carcass characteristics to predict their

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economic value. Two alternative ingredients available for use in swine diets are dried distillers grains with solubles (DDGS) and wheat middlings.

Dried distillers grains with solubles are corn by-products from ethanol production. They have approximately 3 times the crude fat, protein, and fiber of corn, with a similar energy value. Also, DDGS are known to have higher bioavailability of phosphorus when compared to corn.

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

Limited research is available using DDGS and wheat midds together in swine diets. Therefore, more research is needed to fully evaluate the effects on performance of those ingredients. Thus, the objective of this experiment was to evaluate the effects of dietary wheat middlings and DDGS on growing-finishing pig growth performance, carcass characteristics, and carcass fat quality to determine whether reduced diet costs make DDGS and wheat middlings viable options for grow-finish diets.

Procedures

The Kansas State University (K-State) Institutional Animal Care and Use Committee approved the 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. It had 2 identical rooms containing 40 pens (8 × 10 ft) with adjustable gates facing the alleyway, allowing for 10 sq ft/pig. Each pen was equipped with a Farmweld (Teutopolis, IL), single-sided, dry self-feeder with 2 eating spaces 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 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 pigs (PIC TR4 × 1050), averaging 102.6 lb were used in this study. Initial weight and gender were balanced, and pens were randomly allotted to 1 of 4 dietary treatments with 8 pigs per pen (4 barrows and 4 gilts) and 9 replications per treatment. Dietary treatments included a corn-soybean meal-based diet, a diet with 30% DDGS, or that diet with 10 or 20% wheat middlings added (Tables 1 and 2). All treatments were fed in 4 phases in meal form. Pigs and feeders were weighed on d 0, 20, 36, 52, and 84 to determine ADG, ADFI, and F/G. Treatment diets were formulated to constant standardized ileal digestible (SID) lysine ME ratios within each phase. Diets were formulated to meet all requirements recommended by NRC (1998[2]). Samples of DDGS and wheat middlings were collected and analyzed for nutrient content and amino acid concentration (Table 3) at University of Missouri Agricultural Experiment Station Chemical Laboratories.

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

At the end of the 84-d trial, pigs were weighed and transported to Triumph Foods Inc. (St. Joseph, Missouri). Pigs had been individually tattooed according to pen number to allow for data retrieval by pen and carcass data collection at the packing plant. Hot carcass weights were measured immediately after evisceration, and each carcass was evaluated for percentage yield, backfat, loin depth, and percentage lean. Also, jowl samples were collected and analyzed by Near Infrared Spectroscopy (NIR) for iodine value. Because there were differences in HCW, it was used as a covariant for backfat, loin depth, and percentage lean. Percentage yield was calculated by dividing HCW by live weight obtained before transport to the packing plant.

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. Linear and quadratic polynomial contrasts were conducted to determine effects of increasing dietary wheat middlings. A single degree of freedom contrast was used for comparing pigs fed the control diet to pigs fed the diet containing 30% DDGS without wheat middlings.

Results and Discussion

Overall (d 0 to 84), pigs fed increasing wheat middlings had decreased (linear; $P \leq 0.02$) ADG and poorer (linear; $P < 0.01$) F/G. There were no differences ($P = 0.12$) among treatments for ADFI. There was a tendency for decreased (linear; $P < 0.07$) final weight as dietary wheat middlings increased. Pigs fed up to 20% wheat middlings may have experienced increased gut fill due to the high fiber content, and were therefore unable to offset the lower dietary energy from wheat middlings and gained less when compared to the pigs fed diets without wheat middlings (Table 4).

For carcass characteristics, increasing wheat middlings decreased (linear; $P < 0.01$) percentage yield and HCW and tended to decrease (linear; $P < 0.06$) loin depth. Pigs fed wheat middlings also had decreased (quadratic; $P < 0.02$) backfat and increased (quadratic; $P < 0.01$) percentage lean. Increasing DDGS from 0 to 30% decreased ($P < 0.03$) carcass yield and backfat depth ($P < 0.01$), while increasing percentage lean ($P < 0.03$) and jowl iodine value ($P < 0.001$). Past research has also shown that feeding DDGS increases carcass fat iodine value by causing it to become less saturated.

Increasing wheat middlings in the diet decreased (linear; $P < 0.006$) feed cost per pig and feed cost per lb gain, but also decreased (linear; $P < 0.008$) total revenue. Similarly, feeding DDGS decreased ($P < 0.001$) feed cost per pig and feed cost per lb gain. Because total revenue was not decreased as greatly by DDGS, feeding 30% DDGS increased ($P < 0.001$) income over feed costs (IOFC).

In conclusion, these data indicate that DDGS and wheat middlings are viable alternatives in swine diets. However, an understanding of their effect on performance and their value when considering income over feed cost is needed before deciding to use the ingredients. Also, valuing the ingredients on an IOFC basis is important to understand the value of these ingredients in diets for finishing pigs. For example, in this study DDGS reduced feed cost per lb of gain and increased IOFC. In contrast, although wheat midds reduced feed cost per lb of gain, their addition reduced IOFC.

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

	Phase 1				Phase 2			
DDGS, % :	0	30	30	30	0	30	30	30
Ingredient, % — Wheat middlings, %:	0	0	10	20	0	0	10	20
Corn	80.0	55.6	48.3	41.0	83.4	58.9	51.7	44.2
Soybean meal, (46.5% CP)	17.43	12.12	9.34	6.57	14.29	8.95	6.17	3.48
DDGS	---	30.00	30.00	30.00	---	30.00	30.00	30.00
Wheat middlings	---	---	10.00	20.00	---	---	10.00	20.00
Monocalcium phosphate, (21% P)	0.50	-	-	-	0.35	---	---	---
Limestone	0.98	1.28	1.28	1.30	0.95	1.18	1.18	1.30
Salt	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	0.13	0.13	0.13	0.13
Trace mineral premix	0.15	0.15	0.15	0.15	0.13	0.13	0.13	0.13
Lysine HCl	0.29	0.35	0.39	0.43	0.26	0.32	0.36	0.40
DL-methionine	0.02	---	---	---	0.01	---	---	---
L-threonine	0.06	---	---	---	0.04	---	---	---
Phyzyme 600[2]	0.13	0.05	0.03	0.02	0.13	0.03	0.01	---
TOTAL	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, 2]

	Phase 1				Phase 2			
DDGS, % :	0	30	30	30	0	30	30	30
Ingredient, % — Wheat middlings, %:	0	0	10	20	0	0	10	20
Calculate analysis								
Standardized ileal digestible amino acid %								
Lysine	0.86	0.87	0.86	0.85	0.76	0.76	0.75	0.74
Isoleucine:lysine	62	69	67	65	63	71	69	67
Leucine:lysine	151	196	191	187	161	213	207	202
Methionine:lysine	28	34	34	34	29	37	37	37
Met & Cys:lysine	57	69	69	70	59	75	75	75
Threonine:lysine	61	64	63	61	61	67	65	64
Tryptophan:lysine	17	17	17	17	17	17	16	17
Valine:lysine	72	85	84	84	75	89	89	88
Total lysine, %	0.96	1.02	1.01	0.99	0.85	0.91	0.90	0.88
ME, kcal/lb	1,515	1,520	1,503	1,486	1,518	1,523	1,506	1,487
SID Lysine:ME,g/Mcal	2.58	2.58	2.58	2.58	2.27	2.27	2.27	2.27
CP, %	15.2	18.9	18.6	18.3	14.0	17.6	17.4	17.1
Ca, %	0.55	0.55	0.55	0.56	0.50	0.50	0.50	0.55
P, %	0.45	0.45	0.51	0.56	0.41	0.44	0.49	0.55
Available P, %	0.28	0.28	0.28	0.28	0.24	0.24	0.24	0.26

[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.)

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

	Phase 3				Phase 4			
DDGS, % :	0	30	30	30	0	30	30	30
Ingredient, % Wheat middlings, %:	0	0	10	20	0	0	10	20
Corn	86.06	61.55	54.29	46.78	88.05	63.61	56.19	47.89
Soybean meal, 46.5%	11.80	6.46	3.68	1.00	9.95	4.53	1.84	0.00
DDGS	---	30.00	30.00	30.00	---	30.00	30.00	30.00
Wheat middlings	---	---	10.00	20.00	---	---	10.00	20.00
Monocalcium phosphate, 21% P	0.23	---	---	---	0.18	---	---	---
Limestone	0.98	1.13	1.14	1.29	0.95	1.08	1.15	1.28
Salt	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	0.08	0.08	0.08	0.08
Trace mineral premix	0.10	0.10	0.10	0.10	0.08	0.08	0.08	0.08
Lysine HCl	0.24	0.30	0.34	0.38	0.22	0.29	0.32	0.33
DL-methionine	---	---	---	---	---	---	---	---
L-threonine	0.03	---	---	---	0.03	---	---	---
Phytase 600[2]	0.13	0.02	---	---	0.13	---	---	---
TOTAL	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, 2]

		Phase 3				Phase 4			
	DDGS, % :	0	30	30	30	0	30	30	30
Ingredient, %	Wheat middlings, %:	0	0	10	20	0	0	10	20
Calculate analysis									
Standardized ileal digestible amino acid %									
Lysine		0.68	0.68	0.67	0.67	0.62	0.62	0.61	0.61
Isoleucine:lysine		64	74	71	69	65	76	73	73
Leucine:lysine		172	229	223	218	182	244	238	235
Methionine:lysine		30	39	39	39	32	42	42	42
Met & Cys:lysine		62	80	80	81	65	85	85	87
Threonine:lysine		62	70	68	66	64	72	71	71
Tryptophan:lysine		17	17	16	16	17	16	17	17
Valine:lysine		78	94	93	92	80	98	97	99
Total lysine, %		0.76	0.82	0.81	0.80	0.70	0.76	0.75	0.74
ME, kcal/lb		1,521	1,525	1,508	1,488	1,523	1,527	1,509	1,489
SID lysine:ME,g/Mcal		2.03	2.03	2.03	2.03	1.85	1.85	1.85	1.85
CP, %		13.0	16.7	16.4	16.1	12.3	15.9	15.7	15.7
Ca, %		0.48	0.48	0.48	0.54	0.45	0.45	0.48	0.53
P, %		0.37	0.43	0.48	0.54	0.35	0.42	0.48	0.53
Available P, %		0.21	0.21	0.23	0.26	0.20	0.20	0.23	0.26

[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.)

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

Item	DDGS[1]	Wheat middlings
Nutrient,%		
DM	90.98	89.72
CP	27.0 (27.7)[2]	14.7 (15.9)
Fat (oil)	11.00	3.8
Crude fiber	9.7 (7.3)	8.2 (7.0)
ADF	12.80	11.4
NDF	24.10	32.0
Ca	0.32 (0.20)	0.32 (0.12)
P	0.78 (0.77)	1.09 (0.93)
Amino acids, %		
Arginine	1.24	1.11
Histidine	0.80	0.45
Isoleucine	1.08 (1.03)	0.53 (0.53)
Leucine	3.26 (2.57)	1.03 (1.06)
Lysine	0.84 (0.62)	0.72 (0.57)
Methionine	0.53 (0.50)	0.24 (0.26)
Phenylalanine	1.38	0.64
Threonine	1.03 (0.94)	0.53 (0.51)
Tryptophan	0.21 (0.25)	0.20 (0.20)
Valine	1.47 (1.30)	0.77 (0.75)

[1] Dried distillers grains with solubles from Hawkeye Gold, Menlo, IA.
[2] Values in parentheses indicate those used in diet formulation.

Table 4. Effects of wheat middlings and DDGS in finishing diets on growth performance and carcass characteristics[1, 2]

						Probability, *P* <		
							Wheat middlings	
DDGS, %:	0	30	30	30				
Wheat middlings, %:	0	0	10	20	SEM	DDGS[3]	Linear	Quadratic
Initial wt, lb	102.6	102.7	102.7	102.6	1.33	0.97	0.96	1.00
d 0 to 84								
ADG, lb	2.32	2.29	2.22	2.19	0.03	0.51	0.02	0.57
ADFI, lb	7.09	6.86	6.84	6.80	0.102	0.12	0.68	0.95
F/G	3.06	3.00	3.09	3.11	0.026	0.11	0.01	0.35
Final wt, lb	297.4	294.9	288.8	286.2	3.300	0.61	0.07	0.65
Carcass measurements[2]								
Carcass yield, %[4]	74.2	73.4	72.7	72.1	0.27	0.03	0.003	0.94
HCW, lb	220.7	216.3	210	206.4	2.48	0.22	0.01	0.65
Lean, %[5]	51.0	51.7	51.0	51.7	0.002	0.03	0.92	0.01
Backfat depth, in[5]	0.98	0.90	0.94	0.86	0.02	0.01	0.24	0.02
Loin depth, in[5]	2.41	2.42	2.36	2.36	0.02	0.73	0.06	0.17
Jowl iodine value	70.6	76.5	76.0	77.4	0.56	<0.001	0.29	0.19
Economics[6]								
Feed cost/pig, $	69.76	62.35	59.9	57.03	0.924	<0.001	<0.001	0.85
Feed cost/lb gain, $	0.268	0.243	0.238	0.231	0.002	<0.001	0.006	0.85
Total revenue, $/pig[7]	165.55	162.25	157.5	154.82	1.857	0.22	0.008	0.65
IOFC, $[8]	95.79	99.90	97.60	97.97	1.836	0.02	0.22	0.40

[1] A total of 288 pigs (TR4 × 1050) were used in this 84-d trial with 8 pigs per pen and 9 replications per diet.
[2] Includes pigs that died, were culled, and were pulled off test during the experiment.
[3] Contrast control vs 30% DDGS.
[4] Percentage yield was calculated by dividing HCW by live weight obtained prior to transport to the packing plant.
[5] Carcass characteristics were adjusted using HCW as a covariate.
[6] 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.
[7] Value was determined based on carcass price of $75.00/ cwt.
[8] Income over feed cost = value of pig - feed costs during trial period.