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Effects of 30% Dried Distillers Grains with Solubles and 5% Added Fat Prior to Slaughter on Growth Performance, Carcass Characteristics, and Economics of Finishing Pigs[1]

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Summary

Two groups of pigs (n = 1,258, initially 233.2 lb; group 1 PIC 337 × 1050; group 2 PIC 327 × 1050) were used in a 20-d experiment to determine the effects of 30% dried distillers grains with solubles (DDGS) and 5% added fat prior to slaughter on growth performance, carcass characteristics, and economics of finishing pigs. There were a total of 20 replications per treatment. All pigs were fed a common diet with 30% DDGS until 20 d prior to slaughter, at which point they were weighed and allotted to dietary treatments. The dietary treatments were arranged in a 2 × 2 factorial with 2 diet types, a corn-soybean meal–based diet with or without 30% DDGS and added fat of 0 or 5% (group 1 = tallow; group 2 = choice white grease). Diets were formulated on a standardized ileal digestible (SID) lysine basis and balanced on an SID lysine to NE ratio. There were no treatment × group interactions for any of the measured responses, so data for the two groups were combined for analysis. For the overall experiment, there was a tendency ($P < 0.10$) for a diet type × added fat interaction for ADG; this interaction was significant ($P < 0.05$) for F/G and caloric efficiency on an ME and NE basis. These were the result of pigs fed the diet with 30% DDGS having greater ADG and F/G improvements when fat was included compared with those fed the corn-soybean meal–based diet without DDGS. For the caloric efficiency interaction, pigs fed 30% DDGS had an improvement with added fat, whereas those fed the corn-soybean meal–based diet with added fat had worse caloric efficiency than pigs fed the corn-soy diet without added fat.

Although diet type did not affect final live weight, pigs fed the diet containing DDGS had reduced HCW ($P < 0.05$), which was the result of reduced carcass yield ($P < 0.05$). Adding 5% fat to the diet containing DDGS did not improve carcass yield. Jowl fat iodine value was increased by added fat ($P < 0.05$) and feeding DDGS ($P < 0.05$). For economics, there was a diet type × added fat interaction ($P < 0.05$) for cost per pound of gain, which was the result of a larger increase in cost for pigs fed added fat in the corn-soybean meal–based diet compared with the diet containing DDGS. Income over feed cost did not differ among dietary treatments. In conclusion, adding 5% fat to finishing pig diets containing 30% DDGS approximately 20 d prior to slaughter improved ADG and F/G but did not overcome the reduction in carcass yield from feeding DDGS.

Key words: finishing pig, fiber, fat, yield

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Introduction

Carcass yield is negatively influenced when diets containing high-fiber ingredients are fed during the late finishing period. The undigested fiber fraction remaining in the gastrointestinal tract causes an increase in gut fill, resulting in a lower carcass yield compared with pigs fed a lower fiber diet. Previous research has shown that when diets containing high-fiber ingredients, such as dried distillers grains with solubles (DDGS) and wheat middlings, are removed from finishing pig diets approximately 20 d prior to slaughter and replaced with a corn-soybean meal–based diet, carcass yield returns to normal levels (Asmus et al., 2012[3]; Coble et al., 2013[4]).

Asmus et al. (2012[3]) fed 3% choice white grease (CWG) in diets containing high-fiber ingredients during the last 19 days prior to marketing and improved ADG and F/G but did not alter carcass yield. The 3% added fat in high-fiber diets had no detectable impact on carcass yield, and research has not been completed at higher dietary fat levels that may have a more pronounced influence on carcass yield. Previous research has found that adding dietary fat to corn-soybean meal–based diets for the duration of the finishing period can improve carcass yield (Baudon et al., 2003[5]). Therefore, an experiment was conducted to determine the effects of 30% DDGS and 5% added fat prior to slaughter on growth performance, carcass characteristics, and economics of finishing pigs.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. One experiment was conducted involving two groups of pigs. Group 1 was housed in southwest Minnesota in a commercial research finisher, and group 2 was housed at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The barn that housed group 1 was naturally ventilated, double-curtain-sided, and equipped with a 4-hole stainless steel feeder that allowed ad libitum access to feed. The barn used for group 2 was mechanically ventilated and equipped with a 2-hole stainless steel feeder allowing for ad libitum access to feed. In both facilities, a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) was used to deliver and record daily feed additions to each individual pen. Pens in each facility were completely slatted and contained a bowl waterer that allowed for ad libitum access to water.

A total of 1,258 pigs (initially 233.2 lb; group 1 PIC 337 × 1050; group 2 PIC 327 × 1050) were used in a 20-d study. Prior to d 0, pigs were fed a common diet containing 30% DDGS. The common diet was fed to the pigs in group 1 for 21 d and 53 d in group 2. On d 0, 20 d prior to slaughter, pigs were weighed and allotted to dietary treatments. Dietary treatments were arranged in a 2 × 2 factorial with 2 diet types; a corn-soybean meal–based diet (corn-soy) or a corn-soybean meal–based diet with 30% DDGS (DDGS) and added fat; 0 or 5% (group 1 = tallow; group 2 = choice white grease (CWG). Diets were formulated on a standardized ileal digestible (SID) lysine basis and balanced on a SID lysine to NE ratio (Tables 1 and 2). Samples of the DDGS were obtained at the time of manufacturing the diets. Samples of each treatment diet

[3] Asmus et al., Swine Day 2012, Report of Progress 1074, pp. 204–217.
[4] Coble et al., Swine Day 2013, Report of Progress 1092, pp. 186–204.
[5] Baudon et al., Swine Day 2003, Report of Progress 920, pp. 155–158.

were obtained by taking samples from the feeders 2 d after the start of the trial and 2 d prior to completing the trial. These samples were combined for a composite sample for each treatment. Proximate analysis and bulk density were completed on each diet and each source of DDGS.

Pens of pigs were ranked by BW and randomly allotted to 1 of the 4 dietary treatments within BW block. For group 1, pens contained 20 to 23 pigs (similar number of barrows and gilts) with 11 replications per treatment. For group 2, pens contained 7 to 8 pigs (similar number of barrows and gilts) with 9 replications per treatment, making a total of 20 replications per treatment. Pens of pigs were weighed and feed disappearance determined on d 0 and 20 to calculate ADG, ADFI, F/G, and ME and NE caloric efficiency.

After final weights were taken on d 20, pigs were transported to a commercial packing plant for processing and data collection. Group 1 was transported to JBS Swift and Company (Worthington, MN), and group 2 was transported to Triumph Foods, LLC (St. Joseph, MO). Carcass measurements taken at the plant included HCW, loin depth, backfat, and percentage lean. Also, carcass yield was calculated by dividing the average pen HCW by the corresponding average pen final live weight at the farm. Near-infrared spectroscopy (NIR) was used to measured jowl iodine value (IV) at the plant for group 2. To calculate HCW ADG, the initial carcass weight on d 0 was calculated with the assumed yield of 75% of the live weight and subtracted from final HCW to determine HCW gain over the 20-d period. Then, HCW gain was divided by 20 (total d of experiment). Hot carcass weight F/G was calculated by dividing overall intake (ADFI × 20 d) by HCW gain on a pen basis.

An economic analysis was completed to determine the financial impact of 30% DDGS and 5% added fat prior to slaughter. The total feed cost per pig was calculated by multiplying the ADFI by the feed cost per pound and 20 d. Cost per pound of gain was calculated by dividing the total feed cost per pig by the total pounds gained overall. Value of the weight gained during the experiment (gain value) was calculated by multiplying the carcass gain by an assumed carcass value of $93.76/cwt. To calculate IOFC, total feed cost was subtracted from the value of the carcass gain.

Experimental data were analyzed in a randomized complete block design using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen serving as the experimental unit and initial BW serving as the blocking factor. Data from groups 1 and 2 were initially analyzed as a combined dataset with the random effect of block within group and the fixed effects of treatment, group, and treatment × group. No group × treatment interactions were observed for any of the measured responses, so this was subsequently removed from the initial model. Contrasts between pigs fed with and without added DDGS and fat were tested, as well as their interaction. Hot carcass weight served as a covariate for the analysis of backfat, loin depth, and lean percentage. Results from the experiment were considered significant at $P \leq 0.05$ and a tendency between $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

Proximate analysis of diets and DDGS demonstrated that the nutrient values used in diet formulation were similar to analyzed values (Tables 3 and 4). Importantly, the diets containing the DDGS had analyzed NDF levels approximately 3 to 5 percentage units greater than the corn-soy diets, and the diets containing 5% added fat had analyzed EE levels 4 to 5 percentage units higher than those not containing the added fat as expected.

Overall, there was a tendency ($P < 0.10$) for a diet type × added fat interaction for ADG, whereas this interaction was significant ($P < 0.05$) for F/G and caloric efficiency on an ME and NE basis (Table 5). The interactions were the result of pigs fed the diet with 30% DDGS having greater ADG and F/G improvements when added fat was included compared with those fed the corn-soybean meal–based diet without DDGS. For the caloric efficiency interaction, pigs fed 30% DDGS had an improvement with added fat, whereas those fed the corn-soybean meal–based diet with added fat had worse caloric efficiency than pigs fed the corn-soy diet without added fat. Assuming the corn and soybean values are accurate, this may have been the result of overvaluing the NE and ME content used in formulation for the fat and DDGS sources used in the experiment. For ADFI, pigs fed the corn-soy diet did have an increase ($P < 0.05$) in ADFI compared with those fed the diet containing 30% DDGS.

For carcass characteristics, there were no diet type × added fat interactions for any of the measured responses (Table 6); however, pigs fed the diet containing 30% DDGS had decreased HCW ($P < 0.05$), which was driven by lower percentage yield ($P < 0.05$). Adding 5% fat to the diet containing 30% DDGS did not improve carcass yield, which is consistent with Asmus et al. (2012), who showed that adding 3% fat to high-fiber diets did not improve carcass yield. As expected, pigs fed the diet containing DDGS had an increase in jowl IV ($P < 0.05$) resulting from the increase in unsaturated dietary fat from the DDGS. Furthermore, adding 5% fat to either diet increased ($P < 0.05$) jowl IV and tended to increase backfat ($P < 0.10$). Carcass ADG was reduced ($P < 0.05$) by 7.5% when pigs were fed the diet containing DDGS but improved by 6% ($P < 0.05$) when 5% fat was added to the diet. Carcass F/G was worse ($P < 0.05$) for pigs fed the diet containing DDGS compared with the corn-soy diet; however, carcass F/G improved ($P < 0.05$) when added fat was included in the diet.

For experiment economics, there was a diet type × added fat interaction ($P < 0.05$) for cost per pound of gain, which was the result of a larger increase for pigs fed added fat in the corn-soybean meal–based diet compared with the diet containing DDGS. Total feed cost, cost per pound of gain, and the value of the weight gained during the experiment (gain value) were all reduced ($P < 0.05$) for those fed the diet containing 30% DDGS compared with pigs fed the corn-soybean meal diet; however, income over feed cost (IOFC) did not differ between diet types. Adding fat to the diet increased ($P < 0.05$) total feed cost, cost per pound of gain, and gain value but did not increase IOFC.

In conclusion, adding 5% fat to finishing pig diets for 20 d prior to slaughter improved ADG and F/G but did so to a greater extent in diets with 30% DDGS; however, adding fat did not improve carcass yield for pigs fed either diet type. Pigs fed the corn-soybean

meal–based diet had the highest carcass yield, further validating that feeding a higher-fiber diet until slaughter reduces carcass yield.

Table 1. Group 1 diet composition (as-fed basis)[1]

Item	Diet type: Added fat, %:	DDGS[2] 0	DDGS[2] 5	Corn-soy 0	Corn-soy 5
Ingredient, %					
Corn		66.41	58.87	84.76	76.88
Soybean meal , 46.5% CP		1.41	3.94	13.20	16.06
DDGS		30.00	30.00	---	---
Beef tallow		---	5.00	---	5.00
Dicalcium P, 18.5%		---	---	0.35	0.35
Limestone		1.18	1.18	0.92	0.92
Salt		0.35	0.35	0.35	0.35
L-lysine HCl		0.45	0.45	0.23	0.22
DL-methionine		---	---	0.02	0.04
L-threonine		0.06	0.07	0.06	0.06
L-tryptophan		0.03	0.03	---	---
Phytase[3]		0.03	0.03	0.03	0.03
Vitamin premix		0.05	0.05	0.05	0.05
Trace mineral premix		0.05	0.05	0.05	0.05
Total		100.0	100.0	100.0	100.0
Calculated analysis					
Standard ileal digestible (SID) amino acids, %					
Lysine		0.65	0.70	0.66	0.71
Isoleucine:lysine		58	58	62	62
Leucine:lysine		199	187	154	147
Methionine:lysine		36	34	31	33
Met & Cys:lysine		66	63	60	60
Threonine:lysine		65	65	65	65
Tryptophan:lysine		18	18	18	19
Valine:lysine		73	72	70	70
SID lysine: NE, g/Mcal		2.57	2.57	2.57	2.57
ME, kcal/lb		1,516	1,616	1,508	1,608
NE, kcal/lb		1,145	1,234	1,157	1,245
Total lysine, %		0.79	0.84	0.75	0.80
CP, %		14.4	15.0	12.7	13.4
Ca, %		0.46	0.47	0.47	0.47
P, %		0.36	0.36	0.38	0.38
Available P, %		0.30	0.30	0.25	0.25
Crude fiber, %		4.0	4.0	2.2	2.1
Diet cost,[4] $/ton		182.03	207.17	206.51	233.28

[1] Diets were fed from approximately 236.2 to 278.5 lb.
[2] Dried distillers grains with solubles.
[3] Optiphos 2000 (Huvepharma, Peach Tree, GA) provided 568 phytase units (FTU)/lb, with a release of 0.10% available P.
[4] Cost of corn = $4.18/bushel; soybean meal = $420/ton; DDGS = $164/ton; beef tallow = $520/ton.

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

	Diet type:	DDGS[2]		Corn-soy	
Item	Added fat, %:	0	5	0	5
Ingredient, %					
Corn		66.26	58.60	84.63	76.41
Soybean meal , 46.5% CP		1.32	4.00	13.05	16.30
DDGS		30.00	30.00	---	---
Choice white grease		---	5.00	---	5.00
Monocalcium P, 18.5%		---	---	0.33	0.33
Limestone		1.28	1.25	1.07	1.05
Salt		0.35	0.35	0.35	0.35
L-lysine HCl		0.45	0.45	0.23	0.21
DL-methionine		---	---	0.03	0.05
L-threonine		0.07	0.07	0.06	0.07
L-tryptophan		0.03	0.03	0.01	---
Phytase[3]		0.10	0.10	0.10	0.10
Vitamin premix		0.08	0.08	0.08	0.08
Trace mineral premix		0.08	0.08	0.08	0.08
Total		100.0	100.0	100.0	100.0
Calculated analysis					
Standard ileal digestible (SID) amino acids, %					
Lysine		0.65	0.70	0.66	0.71
Isoleucine:lysine		58	58	61	62
Leucine:lysine		199	187	153	146
Methionine:lysine		36	34	33	34
Met & Cys:lysine		67	63	61	61
Threonine:lysine		66	66	66	66
Tryptophan:lysine		19	19	19	19
Valine:lysine		73	72	70	70
SID lysine: NE, g/Mcal		2.57	2.57	2.57	2.57
ME, kcal/lb		1,513	1,619	1,505	1,611
NE, kcal/lb		1,143	1,238	1,154	1,247
Total lysine, %		0.79	0.84	0.75	0.81
CP, %		14.3	15.0	12.6	13.5
Ca, %		0.50	0.50	0.50	0.50
P, %		0.36	0.36	0.38	0.38
Available P, %		0.28	0.28	0.23	0.23
Crude fiber, %		4.0	4.0	2.2	2.1
Diet cost,[4] $/ton		199.89	236.50	207.70	245.58

[1] Phase 1 diets were fed from approximately 229.5 to 274.2 lb.
[2] Dried distillers grains with solubles.
[3] Natuphos 600 (BASF Corporation; Florham Park, NJ) provided 136 phytase units (FTU)/lb, with a release of 0.11% available P.
[4] Cost of corn = $4.18/bushel; soybean meal = $420/ton; DDGS = $164/ton; choice white grease = $740/ton.

Table 3. Group 1 diet proximate analysis (as-fed basis)[1]

Diet type:	DDGS[2]		Corn-soy		
Item, % — Added fat,[3] %:	0	5	0	5	DDGS
Moisture	11.77	11.21	12.24	11.72	7.90
DM	88.23	88.79	87.76	88.28	92.10
CP	15.70	15.20	12.90	12.40	30.60
ADF	4.40	5.30	3.10	3.00	10.1
NDF	12.20	11.30	7.60	7.20	25.5
Crude fiber	2.90	2.90	1.80	1.80	8.00
Ca	0.64	0.71	0.51	0.56	0.07
P	0.36	0.39	0.31	0.35	0.74
Ether extract	4.40	8.50	2.80	7.50	9.20
Ash	3.69	3.90	3.19	3.17	4.08
Bulk density, lb/bushel	47.50	50.03	46.61	49.03	---

[1] Diets were sampled at the feeder 2 d after initiation and 2 d prior to termination of the experiment. Samples were combined in equal amounts to create composite samples for analysis.
[2] Dried distillers grains with solubles.
[3] Beef tallow served as the added fat source in diets for group 1.

Table 4. Group 2 diet proximate analysis (as-fed basis)[1]

Diet type:	DDGS		Corn-soy		
Item, % — Added fat,[2] %:	0	5	0	5	DDGS
Moisture	10.30	9.97	11.09	10.49	10.05
DM	89.70	90.03	88.91	89.51	89.95
CP	16.60	17.10	14.50	15.70	29.70
ADF	4.40	5.70	2.50	4.20	11.80
NDF	10.20	10.90	5.50	8.10	24.10
Crude fiber	2.10	3.00	1.30	2.10	7.10
Ca	0.68	0.63	0.62	0.63	0.08
P	0.46	0.47	0.35	0.47	0.87
Ether extract	3.70	8.70	2.40	6.90	6.90
Ash	3.96	3.92	3.64	3.69	4.17
Bulk density, lb/bushel	---	57.04	51.06	52.08	44.88

[1] Diets were sampled at the feeder 2 d after initiation and 2 d prior to termination of the experiment. Samples were combined in equal amounts to create composite samples for analysis.
[2] Choice white grease served as the added fat source in diets for group 2.

Table 5. Interactive effects of diet type and added fat fed 20 d prior to slaughter on growth, carcass traits, and economics of finishing pigs[1]

Diet type:	DDGS[2]		Corn-soy			Probability, P <		
Added fat,[3] %:	0	5	0	5	SEM	Diet type × fat	Diet type	Added fat
Weight, lb								
d 0	232.9	232.8	233.0	232.8	1.65	0.982	0.989	0.880
d 20	274.2	277.4	276.6	277.3	1.66	0.338	0.400	0.135
d 0 to 20								
ADG, lb	2.06	2.23	2.17	2.23	0.031	0.054	0.056	0.001
ADFI, lb	6.92	6.80	7.07	7.03	0.067	0.472	0.002	0.182
F/G	3.38	3.06	3.26	3.18	0.041	0.006	0.947	0.001
Caloric efficiency[4]								
ME, kcal/lb gain	5,112	4,952	4,912	5,120	63.9	0.006	0.809	0.709
NE, kcal/lb gain	3,861	3,783	3,768	3,964	49.1	0.007	0.376	0.232
Carcass traits								
HCW, lb	199.9	201.9	202.6	203.5	1.22	0.556	0.026	0.122
Yield, %	72.75	72.67	73.05	73.24	0.132	0.294	0.001	0.633
Loin depth,[5] in.	2.36	2.38	2.35	2.34	0.019	0.342	0.168	0.738
Backfat,[5] in.	0.76	0.79	0.78	0.80	0.011	0.522	0.190	0.061
Lean,[5] %	53.58	53.22	53.26	53.03	0.182	0.735	0.165	0.101
Iodine value,[6] g/100 g	73.02	73.48	71.49	72.28	0.210	0.423	0.001	0.006
Carcass performance								
HCW ADG,[7] lb	1.26	1.37	1.39	1.45	0.028	0.354	0.001	0.006
HCW F/G[8]	5.53	5.00	5.14	4.90	0.103	0.171	0.022	0.001
Economics, $/pig								
Feed cost	13.20	15.03	14.69	16.84	0.153	0.280	0.001	0.001
Cost/lb gain	0.322	0.338	0.339	0.381	0.005	0.011	0.001	0.001
Gain value[9]	23.64	25.63	26.10	27.10	0.531	0.354	0.001	0.006
IOFC[10]	10.44	10.60	11.41	10.26	0.498	0.191	0.529	0.323

[1] 1,258 pigs (initial 233.2 lb; Group 1 PIC 337 × 1050; Group 2 PIC 327 × 1050) were used in a 20-d experiment. Pens contained 20 to 23 pigs per pen with 11 replications per treatment in group 1 and 7 to 8 pigs per pen with 9 replications per treatment in group 2, for a total of 20 replications per treatment.
[2] Dried distillers grains with solubles.
[3] Beef tallow served as the added fat source in diets for group 1 and choice white grease for group 2.
[4] Caloric efficiencies were calculate by the following equation (ADFI × kcal) ÷ (ADG).
[5] Hot carcass weight was used as a covariate.
[6] Iodine value was measured only in pigs from group 2.
[7] HCW ADG = (HCW – (d 0 wt. ×75% yield)) ÷ 20 d.
[8] HCW F/G = (ADFI × 20) ÷ (HCW- (d 0 wt. × 75% yield)).
[9] Gain value was calculated using the following equation: (HCW × $0.9376)-(d 0 wt × 0.75 ×$0.9376).
[10] Income over feed cost = gain value – feed cost.