The Effects of Medium-Oil Dried Distillers Grains with Solubles on Growth Performance and Carcass Traits in Finishing Pigs[1]

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Summary

An experiment was conducted to determine the effects of increasing medium-oil dried distillers grains with solubles (DDGS; 7.4% fat, 28.1% CP, 10.8% ADF, and 25.6% NDF) on growth performance and carcass traits in finishing pigs. A total of 288 pigs (PIC 327 × 1050; initially 151.8 lb) were allotted to 1 of 4 dietary treatments. Treatments consisted of a corn-soybean meal control diet or the control diet with 15, 30, or 45% medium-oil DDGS, with 8 pigs per pen and 8 replications per treatment. Increasing medium-oil DDGS decreased (linear, $P < 0.01$) ADG and worsened (linear, $P < 0.02$) F/G. In addition, final BW, HCW, carcass yield, and loin-eye depth decreased (linear, $P < 0.03$), and jowl iodine value (IV) increased (linear, $P < 0.001$) with increasing medium-oil DDGS. When pigs are fed traditional DDGS containing >10.5% fat, each 10% DDGS added to the diet increases jowl IV approximately 2 mg/g; however, feeding increasing medium-oil DDGS increased jowl IV only about 1.4 units per each 10% DDGS. In conclusion, swine producers must be aware of the negative ramifications on growth performance of using medium-oil DDGS in swine diets.

Key words: DDGS, finishing pig, iodine value, medium-oil DDGS

Introduction

Dried distillers grains with solubles are a by-product of the ethanol industry that are commonly used in the United States to lower diet costs. Research suggests that growth performance will remain unchanged if traditional (>10.5% oil) DDGS are fed at up to 30% of the diet (Stein and Shurson, 2009[3]), but carcass characteristics such as yield and jowl IV are adversely affected with feeding DDGS. Jowl IV is a measure of the unsaturated fat content, and as IV increases, pork fat becomes softer and less desirable.

Many ethanol plants have begun to remove a portion of the oil from DDGS, thus altering its chemical composition. A concern is that the new, medium-oil DDGS may negatively affect ADG and F/G because of its low energy content; however, the medium-oil DDGS may not have as negative of an effect on fat IV and carcass traits as traditional DDGS. The objective of this trial was to determine the effects of increasing medium-oil

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

[3] Stein, H. H., and G. C. Shurson. 2009. Board-Invited Review: The use and application of distillers dried grains with solubles (DDGS) in swine diets. J. Anim. Sci. 87:1292–1303.

DDGS on growth performance, carcass characteristics, and carcass fat quality of growing-finishing pigs.

Procedures

The protocol for this experiment was approved by the Kansas State University Institutional Animal Care and Use Committee. The experiment was conducted at the K-State Swine Teaching and Research Center in Manhattan, KS.

A total of 288 finishing pigs (PIC 327 × 1050, initially 151.8 lb) were used in a 67-d study. Pens of pigs were allotted to 1 of 4 dietary treatments with 8 pigs per pen and 8 replications per treatment. The facility was a totally enclosed, environmentally controlled, mechanically ventilated barn containing 36 pens. The pens (8 ft × 10 ft) had adjustable gates facing the alleyway that allowed for 10 ft^2/pig. Each pen was equipped with a cup waterer and a Farmweld (Teutopolis, IL) single-sided, dry self-feeder with 2 eating spaces located 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 single batch of medium-oil DDGS was used in this study and analyzed for chemical composition (Table 1). The DDGS contained 7.4% fat, 28.1% CP, 10.8% ADF, and 25.6% NDF. Fatty acid analysis was conducted of the medium-oil DDGS at the K-State Analytical Lab (Manhattan, KS; Table 2). At the time of diet formulation, the 2012 NRC publication was not available; therefore, Stein et al. (2007[4]) values for amino acids were used in diet formulation. Pigs were fed corn-soybean meal–based diets containing 0, 15, 30, or 45% medium-oil DDGS. Diets were fed in 2 phases from approximately 150 to 220 and 220 to 280 lb (Tables 3 and 4). All pigs and feeders were weighed on d 0, 33, and 67 to determine ADG, ADFI, and F/G.

On d 67, all pigs were weighed and transported approximately 2.5 h (160 miles) to Triumph Foods LLC, 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 carcass yield, backfat, loin depth, and percentage lean. Because HCW differed, 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 carcass yield was calculated by dividing HCW at the plant by live weight at the farm before transport to the plant.

Data were analyzed in a completely randomized design with pen as the experimental unit. Analysis of variance was used with the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC). Linear and quadratic contrasts were used to determine the effects of increasing medium-oil DDGS.

[4] Stein, H. H. 2007. Feeding distillers dried grains with solubles (DDGS) to swine. Swine Focus #001. University of Illinois Extension publication.

Results and Discussion

Traditional DDGS contains approximately 10.5% oil or greater. After the oil is removed from DDGS by the process of centrifugation, the chemical composition of medium-oil DDGS (approximately 7% oil) is different than that of traditional DDGS (Table 1). Traditional DDGS are lower in crude fiber and starch content than medium-oil DDGS, whereas NDF is lower in medium-oil DDGS than in traditional DDGS[5]. Lysine in medium-oil DDGS is greater (0.90% vs. 0.77%) than in traditional DDGS, but other amino acids remain consistent. The analyzed amino acid levels in the DDGS were greater than those used in diet formulation, so diets containing DDGS contained slightly higher lysine and other amino acids than calculated in diet formulation. The lower amount of fat/energy in medium-oil DDGS compared with traditional DDGS is the reason for concern for growth performance in finishing pigs. Because energy content of DDGS is the most important factor determining its value relative to corn, a reduction in energy content of the DDGS significantly reduces its feeding value.

In this experiment, pigs fed increasing medium-oil DDGS had decreased (linear, $P < 0.01$) ADG and poorer (linear, $P < 0.02$) F/G (Table 5). As a result, pigs fed DDGS had lighter (linear, $P < 0.03$) final BW than those fed the corn-soybean meal–based diet. Pigs fed increasing medium-oil DDGS had decreased (linear, $P < 0.01$) HCW, backfat, and loin-eye depth. Increasing medium-oil DDGS also increased jowl IV (linear, $P < 0.001$.

When feeding traditional DDGS (>10.5% oil), growth performance typically remains unchanged with an inclusion rate up to 30%, but jowl IV increases because of the unsaturated fat. Typically, for every 10% traditional DDGS added to the diet, jowl IV increases approximately 2 mg/g; however, in this study with the medium-oil DDGS, IV increased only 1.4 mg/g for every 10% inclusion. Thus, the IV increase for medium-oil DDGS is approximately 70% of the increase with high-oil DDGS. This difference was expected because the oil content in the medium-oil DDGS (7.4%) is approximately 70% of the oil content in high-oil DDGS (10.5%).

In conclusion, increasing medium-oil DDGS in finishing pig diets reduced growth performance such that it needs to be discounted in value relative to regular DDGS when adding to swine diets.

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

Table 1. Comparison of dried distillers grains with solubles (DDGS) sources

		NRC 2012[1]		
Item	Medium-oil DDGS[2]	Low-oil DDGS[3]	Medium-oil DDGS[4]	Traditional DDGS[5]
Nutrient, %				
DM	89.9	89.25	89.35	89.31
CP	28.1	27.86	27.36	27.33
Crude fiber	7.14	6.19	8.92	7.06
Ether extract (Fat)	7.4	3.57	8.9	10.43
Ash	4.35	4.64	4.04	4.11
Starch	7.6	10.0	9.6	6.7
NDF	25.60	33.75	30.46	32.50
ADF	10.8	16.91	12.02	11.75
Amino acids, %				
Cysteine	---	0.51	0.44	0.51
Isoleucine	1.11	1.02	1.06	1.02
Leucine	3.38	3.64	3.25	3.13
Lysine	0.92	0.68	0.90	0.77
Methionine	0.53	0.50	0.57	0.55
Threonine	1.03	0.97	0.99	0.99
Tryptophan	0.23	0.18	0.20	0.21
Valine	1.46	1.34	1.39	1.35
Energy, kcal/kg				
GE	---	2,317	2,141	2,204
DE	---	1,496	1,628	1,645
ME	---	1,410	1,544	1,561
NE	---	913	1,065	1,084

[1] NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington DC.
[2] Values represent the mean of 1 composite sample analyzed in triplicate.
[3] Defined as corn DDGS, <4% oil.
[4] Defined as corn DDGS, >6 and <9% oil.
[5] Defined as corn DDGS, >10% oil.

Table 2. Fatty acid analysis of medium-oil dried distillers grains with solubles (DDGS)

Item	Medium-oil DDGS
Myristic acid (C14:0), %	0.08
Palmitic acid (C16:0), %	13.69
Palmitoleic acid (C16:1), %	0.15
Margaric acid (C17:0), %	0.11
Stearic acid (C18:0), %	1.86
Oleic acid (C18:1 cis-9), %	22.50
Vaccenic acid (C18:1n-7), %	1.25
Linoleic acid (C18:2n-6), %	56.75
α-Linoleic acid (C18:3n-3), %	1.80
Arachidic acid (C20:0), %	0.41
Gadoleic acid (C20:1), %	0.24
Eicosadienoic acid (C20:2), %	0.08
Arachidonic acid (C20:4n-6), %	0.05
Other fatty acids, %	1.00
Total SFA, %[1]	16.15
Total MUFA, %[2]	24.19
Total PUFA, %[3]	58.70
Total trans fatty acids, %[4]	0.15
UFA:SFA ratio[5]	5.13
PUFA:SFA ratio[6]	3.63
Iodine value,g/100g[7]	122.7

[1] Total SFA = ([C8:0] + [C10:0] + [C12:0] + [C14:0] + [C16:0] + [C17:0] + [C18:0] +[C20:0] + [C22:0] + [C24:0]); brackets indicate concentration.
[2] Total MUFA = ([C14:1] + [C16:1] + [C18:1 cis-9] + [C18:1n-7] + [C20:1] + [C24:1]); brackets indicate concentration.
[3] Total PUFA = ([C18:2n-6] + [C18:3n-3] + [C18:3n-6] + [C20:2] + [C20:4n-6]); brackets indicate concentration.
[4] Total *trans* fatty acids = ([C18:1 trans] + [C18:2 trans] + [C18:3 trans]); brackets indicate concentration.
[5] UFA:SFA = (total MUFA + total PUFA)/total SFA.
[6] PUFA:SFA = total PUFA/total SFA.
[7] Calculated as iodine value = [C16:1] × 0.95 + [C18:1] × 0.86 + [C18:2] × 1.732 + [C18:3] × 2.616 + [C20:1] × 0.785 + [C22:1] × 0.723; brackets indicate concentration.

Table 3. Composition of diets from d 0 to 33 (as-fed basis)[1]

	Medium-oil dried distillers grains with solubles (DDGS), %			
Item	0	15	30	45
Ingredient, %				
Corn	79.00	66.83	54.80	42.45
Soybean meal, 46.5% CP	18.48	15.84	13.04	10.41
Medium-oil DDGS[2]		15.00	30.00	45.00
Monocalcium P, 21% P	0.90	0.55	0.20	
Limestone	0.89	1.03	1.17	1.32
Salt	0.35	0.35	0.35	0.35
Vitamin premix	0.10	0.10	0.10	0.10
Trace mineral premix	0.10	0.10	0.10	0.10
L-lysine HCl	0.18	0.21	0.24	0.27
L-threonine	0.01			
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible amino acids, %				
Lysine	0.80	0.80	0.80	0.80
Isoleucine:lysine	68	73	77	81
Leucine:lysine	165	190	215	239
Methionine:lysine	29	34	38	43
Met & Cys:lysine	60	65	70	76
Threonine:lysine	61	66	71	76
Tryptophan:lysine	18	19	18	19
Valine:lysine	80	87	93	101
Total lysine, %	0.90	0.93	0.96	0.99
CP, %	15.48	17.32	19.11	20.95
Ca, %	0.59	0.57	0.55	0.56
P, %	0.54	0.52	0.50	0.51
Available P, %	0.25	0.25	0.25	0.28

[1] Diets were fed from approximately 152 to 220 lb.
[2] Amino acid values used in diet formulation for the medium-oil DDGS were derived from Stein et al. (2007) for values of traditional DDGS.

Table 4. Composition of diets from d 33 to 72 (as-fed basis)[1]

	Medium-oil dried distillers grains with solubles (DDGS), %			
Item	0	15	30	45
Ingredient, %				
Corn	82.71	70.55	58.52	45.99
Soybean meal, 46.5% CP	14.96	12.31	9.52	6.90
Medium-oil DDGS[2]		15.00	30.00	45.00
Monocalcium P, 21% P	0.75	0.40	0.05	
Limestone	0.87	1.00	1.14	1.30
Salt	0.35	0.35	0.35	0.35
Vitamin premix	0.10	0.10	0.10	0.10
Trace mineral premix	0.10	0.10	0.10	0.10
L-lysine HCl	0.16	0.19	0.23	0.26
L-threonine	0.01			
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible amino acids, %				
Lysine	0.70	0.70	0.70	0.70
Isoleucine:lysine	70	75	79	84
Leucine:lysine	177	206	234	262
Methionine:lysine	31	36	41	47
Met & Cys:lysine	64	70	76	82
Threonine:lysine	64	68	74	80
Tryptophan:lysine	18	19	18	19
Valine:lysine	83	91	99	107
Total lysine, %	0.79	0.82	0.85	0.88
CP, %	14.15	15.98	17.77	19.60
Ca, %	0.54	0.52	0.50	0.54
P, %	0.49	0.47	0.45	0.50
Available P, %	0.21	0.21	0.21	0.27

[1] Diets were fed from approximately 220 to 275 lb.

[2] Amino acid values used in diet formulation for the medium-oil DDGS were derived from Stein et al. (2007) for values of traditional DDGS.

Table 5. Effects of increasing medium-oil dried distillers grains with solubles (DDGS) on growth performance and carcass characteristics of finishing pigs[1]

	Medium-oil DDGS, %					Probability, *P*<	
Item	0	15	30	45	SEM	Linear	Quadratic
d 0 to 67							
ADG, lb	1.93	1.87	1.85	1.80	0.02	0.01	0.77
ADFI, lb	6.03	5.97	5.91	5.87	0.07	0.10	0.84
F/G	3.13	3.19	3.20	3.26	0.04	0.02	0.99
BW, lb							
Initial	151.8	151.8	151.8	151.8	1.91	0.99	0.99
Final	280.4	277.0	275.7	273.1	2.35	0.03	0.87
Carcass yield, %[2]	73.98	73.16	72.36	71.84	0.16	0.001	0.35
HCW, lb	205.7	201.4	198.5	195.0	1.82	0.001	0.82
Backfat depth, mm[3]	19.4	19.8	19.4	18.7	0.40	0.17	0.15
Loin depth, mm[3]	61.0	60.0	59.7	57.9	0.81	0.01	0.58
Lean, %[3]	53.1	52.8	52.8	52.7	0.23	0.32	0.65
Jowl iodine value	70.2	71.1	73.7	76.3	0.27	.001	0.01

[1] A total of 288 pigs (PIC 327 × 1050, initially 151.8 lb BW) were used in this 67-d study with 8 pigs per pen and 8 pens per treatment.
[2] Percentage yield was calculated by dividing HCW by live weight obtained at the farm before transport to the packing plant.
[3] Adjusted by using HCW as a covariate.