EFFECT OF DIETARY DISTILLERS DRIED GRAINS WITH SOLUBLES ON PERFORMANCE AND CARCASS CHARACTERISTICS IN FINISHING HOGS

L.S. Freitas, M.J. Azain, C.R. Dove, and T.D. Pringle

ABSTRACT

Seventy two pigs were used in a 2 x 3 factorial design with main effects of gender (barrows vs gilts) and dietary distillers dried grains with soluble (DDGS; 0, 10 and 20%) on performance and carcass characteristics, with 18 pens of 4 pigs each. Pigs were weighed and feed consumption was monitored weekly. Ultrasound measurements of the 10th rib fat thickness and longissimus muscle area were made initially and at 2 and 4 weeks. One pig per pen was slaughtered to collect leaf fat, belly fat, backfat and the longissimus (loin) muscle, for determination of lipid content. Carcass data was collected including first rib, 10th rib, last rib, and last lumbar fat depths and loin eye area. In addition, meat quality attributes was measured, including ultimate pH, visual color, marbling, and firmness scores. There were no differences ($P>0.05$) in ADFI, ADG and feed conversion rate (FCR) of the animals that received different inclusion levels of DDGS. However, gender affected the ADG ($P<0.05$) of the pigs, with the barrows having higher ADG than the gilts. No effects were observed ($P>0.05$) for DDGS inclusion level or gender on loin area or fat thickness. Loin color, firmness and color were not affected by diet ($P>0.05$). In contrast, the marbling was affected ($P<0.05$) by the inclusion of DDGS, with an increase in marbling score seen in pigs 20% of DDGS in the diet. Also, carcass pH at 24 h was lower in pigs fed 20% DDGS as compared to the pigs fed 0 and 10% DDGS. There was no effect ($P>0.05$) of DDGS or gender on the belly thickness or belly firmness, or lipid percentage and moisture of the loin. These results indicate that up to 20% DDGS can be fed to finishing pigs for the last 4 weeks prior to slaughter without a negative impact on performance or carcass characteristics.

INTRODUCTION

A significant portion of the US corn crop is currently being used for ethanol production. As a result of this, corn prices in the summer of 2008 were 2-3 times that previously seen. This has resulted in greater feed costs, causing producers to consider alternative feed ingredients. Distillers dried grains with solubles (DDGS) is a co-product of ethanol production from corn and has received considerable attention as an alternative feed ingredient for several species. It is essentially corn with the most starch removed through fermentation and thus, the protein, lipid and fiber are concentrated. The fermentation process also converts much of the phytin phosphorous in corn to a more readily available form. The use of DDGS will likely increase as an alternative to corn in swine diets. The primary concerns with its use, are the high fiber and lipid content relative to corn. The objective of this study was to determine the effect of including up to 20% DDGS in the diet on growth performance and carcass characteristics of finishing pigs.

EXPERIMENTAL PROCEDURE

The study was conducted in a 2 x 3 factorial arrangement of treatments, with main effects of gender (barrows vs gilts) and dietary DDGS (0, 10 and 20% DDGS). The effects of diet on growth performance and carcass characteristics were evaluated in a single replicate with 18 pens of 4 pigs each. Pigs were obtained from the UGA research herd and are PIC genetics. Barrows and gilts were penned separately. There were 3 pens of each gender on each diet. The trial was initiated at an average initial weight of 70.8 ± 6.7 kg and conducted for 4 weeks. Pigs were weighed, and feed consumption monitored weekly. Ultrasound measures at the 10^{th} rib were taken to determine fat thickness and loin area initially, and at 2 and 4 weeks. The pig in each pen with growth rate closest to the average was selected for processing at the University of Georgia Meat Science and Technology Center. This represents a total of 18 pigs with carcass information. Remaining pigs in each pen were taken to a commercial slaughter plant or local sale barn.

The control diet was based on corn and soybean meal and was formulated to meet or exceed the NRC (1998) recommendations and to contain 0.76% lysine and 3350 kcal/kg ME (Table 1). Threonine, tryptophan, and total sulfur amino acids were added to maintain an ideal pattern of these amino acids relative to lysine. The experimental diets with 10 or 20% DDGS were formulated to provide a similar concentration of nutrients as in the control diet. The nutrient content of the DDGS used in this research was determined and found to be similar to that reported in the literature (Stein and Shurson, 2009) (Table 2).

Upon completion of the feeding period, selected pigs were transported to The University of Georgia Meat Science and Technology Center and humanely harvested using standard industry practices. Perirenal (leaf) fat was removed, weighed and sampled for lipid content.

Following a 24-hour chill, carcass data were collected between the 10^{th} and 11^{th} ribs and first rib, last rib, last lumbar, and 10^{th} rib fat depths and loin eye area were obtained. In addition, meat quality attributes was measured, including ultimate pH, visual color, marbling, firmness scores and Hunter color (Widmer et al., 2008). Belly firmness was determined and a belly sample obtained for lipid analysis. Subcutaneous fat samples were removed and separated into inner and outer layers for fatty acid analysis. In addition, longissimus samples (near the 10^{th} rib) were removed for determination of lipid content.

Performance and carcass data was analyzed as a 3 x 2 factorial arrangement with main effects of diet and gender using the GLM procedure of SAS. Pen was considered the experimental unit for performance data and the animal was considered the experimental unit for carcass data. The initial weight was used as a covariate, and differences were considered to be significant at $P < 0.05$.

RESULTS AND DISCUSSION

There were no significant differences ($P>0.05$) in ADFI, ADWG and FCR of the animals that received different levels of DDGS (Table 3). The similar performance of pigs indicates that up to 20% DDGS can be added to the finishing diet without affecting performance. The expected differences in performance of barrows and gilts, such as greater ADG and ADFI in barrows, were observed (Cromwell et al, 1993). There were no effects of diet ($P>0.05$) or gender on SW, HCW or DP (Table 4). There were no diet x gender interactions ($P>0.05$) for these variables.

Loin eye area (LEA) and fat depth (FD) in the first, tenth and last ribs was not affected by the level of DDGS in the diet or the gender (Table 5, $P>0.05$). Loin color, firmness and color characteristics (Hunter L, a, b) were not affected by diet (Table 6, $P>0.05$). However, the loin marbling score was affected ($P<0.05$) by diet, with increased marbling observed in pigs fed diets with 20% DDGS. Also, 24 h pH of the loin was lower carcasses of pigs fed diets with 20% DDGS

relative to those fed 0 or 10% ($P < 0.05$). Belly thickness or firmness were not affected by diet or gender (data not shown, $P>0.05$). The lipid content and moisture of the loin, backfat inner and outer, belly and leaf fat of gilts and barrows were determined, but were not affected by treatment or gender (data not shown, $P > 0.05$). The lack of difference in loin lipid content is not consistent with the increase in marbling score noted for carcasses from pigs fed high DDGS. There were no differences in the fatty acid profile of the loin or belly fat. In general, the results of this study indicate that DDGS must be fed for a longer period of time or at a higher level in order to cause changes in carcass quality that have been noted in other studies.

CONCLUSION

These results suggest that feeding up to 20% DDGS in the diet the last 4 weeks prior to slaughter has no detrimental effect on growth performance or carcass characteristics. The observation of increased marbling, although not confirmed by chemical analysis is of interest and warrants further investigation.

LITERATURE CITED

Cromwell, G.L., T.R. Cline, J.D. Crenshaw, T.D. Crenshaw, R. C. Ewan, C. R. Hamilton, A. J. Lewis, D. C. Mahan, E. R. Miller, J. E. Pettigrew, L. F. Tribble, and T. L. Veum. 1993. The dietary protein and (or) lysine requirements of barrows and gilts. J. Anim. Sci. 71:1510-1519.

NRC. 1998. Nutrient Requirements of Swine. 10th rev ed. National Academy Press, Washington, DC.

Stein, H. H., and G. C. Shurson. 2009. BOARD-INVITED REVIEW: The use and application of distillers dried grains with solubles in swine diets. J. Anim. Sci. 87: 1292-1303.

Widmer, M. R., L. M. McGinnis, D. M. Wulf, and H. H. Stein. 2008. Effects of feeding distillers dried grains with solubles, high-protein distillers dried grains, and corn germ to growing-finishing pigs on pig performance, carcass quality, and the palatability of pork. J Anim Sci 86: 1819-1831.

Table 1. Composition of the experimental diets

DDGS inclusion (%)	0%	10%	20%
Ingredients (%)			
Corn	77.345	73.488	69.632
Soybean meal 48%	17.885	12.784	7.679
DDGS	0.000	10.000	20.000
Soybean oil	2.200	1.100	0.000
Dicalcium phosphate	1.049	0.780	0.522
Limestone	0.819	1.020	1.212
Salt	0.350	0.350	0.350
L-Lysine HCl (%)	0.052	0.148	0.244
L-Threonine (%)	-	0.012	0.025
L-Tryptophan (%)	-	0.018	0.036
Vitamins[a]	0.150	0.150	0.150
Minerals[b]	0.150	0.150	0.150
TOTAL	100.00	100.00	100.00
Calculated composition			
Metabolizable energy (kcal/Kg)	3350	3350	3350
Crude protein (%)	15.000	15.000	15.000
Total Lysine (%)	0.759	0.759	0.759
Total TSAA (%)	0.523	0.544	0.565
Total Threonine (%)	0.580	0.580	0.580
Total Tryptophan (%)	0.169	0.169	0.169
Digestible Lysine (%)	0.674	0.668	0.662
Digestible TSAA (%)	0.467	0.469	0.469
Digestible Threonine (%)	0.491	0.473	0.456
Digestible Tryptophan (%)	0.148	0.149	0.149
Total phosphorous (%)	0.496	0.470	0.446
Available phosphorus (%)	0.247	0.247	0.247
Ca (%)	0.650	0.650	0.650

[a]Supplied per kg of diet: vitamin A, 6,600 IU; vitamin D_3, 990 IU; vitamin E, 26.4 IU; menadione, 26.4 mg; riboflavin, 5.9 mg; niacin, 33 mg; panothenic acid, 19.8 mg; vitamin B12, 26.4 µg (Animal Science Products, Inc, Nacogdoches, TX).
[b] Supplied per kg of diet: iron 165 mg; copper, 16.5 mg; manganese, 40 mg; zinc, 165 mg; iodine, 0.3 mg; selenium, 0.3 mg (Animal Science Products, Inc, Nacogdoches, TX).

Table 2. Composition of Corn Grain and DDGS

	Corn Grain[a]	DDGS UGA (Stein and Shurson, 2009)[b]
Crude Protein	8.8	27.3 (30.9)
Fat	3.8	9.4 (10.9)
Fiber	2.2	8.0 (8.8)
Lysine	0.26	0.63 (0.91)
Methionine + Cystine	0.36	1.05 (1.30)
Threonine	0.29	0.95 (1.13)
Tyrptophan	0.06	0.18 (0.26)
Energy, kcal ME/kg	3420	3801[c] (3814)
Phosphorous, total	0.28	0.65 (0.89)
Phosphorous, available	0.10	- (0.80)

[a] Nutrient composition of corn grain from NRC, 1998.
[b] Nutrient profile of DDGS determined for the material used in the study and from that reported by Stein and Shurson, 2009.
[c] Metabolizable energy calculated based on NRC, 1998.

Table 3. Initial and final body weight, average daily feed intake (ADFI), average daily weight gain (ADWG) and feed conversion ratio (FCR) of gilts (F) and barrows (M) from 70 to 100 kg, fed with different inclusion levels of DDGS in the diets

	DDGS inclusion			Gender		P value			CV (%)
	0%	10%	20%	F	M	T	G	TxG	
Initial weight, kg	70.36	7.46	70.59	67.71	73.90				
Final weight, kg	99.77	99.83	97.68	93.11	105.07				
ADFI, kg	2.88	2.93	2.74	2.56	3.14	0.2559	0.0819	0.2747	6.05
ADG, kg	1.05	1.01	0.96	0.91 ^{x}	1.11 ^{y}	0.0573	0.0153	0.0335	6.03
FCR	2.79^{a}	2.94^{a}	2.95^{a}	2.93	2.86	0.0565	0.0887	0.0512	4.40

Mean values followed by different letters in the same line are statistically different by the Tukey test (P<0.05). **T**: treatment; **G**: gender; **TxG**: treatment and gender interaction.

Table 4. Slaughter weight (SW), hot carcass weight (HCW) and dressing percentage (DP) of gilts and barrows from 70 to 100 kg, fed with different inclusion levels of DDGS in the diets

	DDGS inclusion			Gender		P value			CV (%)
	0%	10%	20%	F	M	T	G	TxG	
SW, kg	103.09	106.06	100.08	98.62	107.53	0.2791	0.4330	0.2964	4.93
HCW, kg	69.97	71.48	67.93	66.55	73.03	0.3373	0.4463	0.8049	4.87
DP, %	73.13	72.65	73.14	72.75	73.20	0.9634	0.9643	0.2368	2.97

Mean values followed by different letters in the same line are statistically different by the Tukey test (P<0.05). **T**: treatment; **G**: gender; **TxG**: treatment and gender interaction.

Table 5. Loin Eye area (LEA) and fat depth (FD) in the first, tenth and last ribs of gilts and barrows from 70 to 100 kg, fed with different inclusion levels of DDGS in the diets

	DDGS inclusion			Gender		P value			CV (%)
	0%	10%	20%	F	M	T	G	TxG	
LEA, cm^2	33.51	33.92	34.56	33.68	34.31	0.9010	0.8120	0.8803	12.24
FD 1^{st} ,mm	32.17	30.83	33.33	29.33	34.89	0.6584	0.6032	0.6015	16.80
FD 10^{th} , mm	18.00	17.50	16.67	14.33	20.44	0.5352	0.7469	0.8780	9.36
FD last, mm	18.00	18.50	16.83	14.89	20.67	0.5303	0.8944	0.8229	13.18

Mean values followed by different letters in the same line are statistically different by the Tukey test (P<0.05). **T**: treatment; **G**: gender; **TxG**: treatment and gender interaction.

Table 6. Loin characteristics of gilts and barrows from 70 to 100 kg, fed with different inclusion levels of DDGS in the diets

	DDGS inclusion			Gender		P value			CV (%)
	0%	10%	20%	F	M	T	G	TxG	
Color	2.50	2.50	2.50	2.56	2.44	0.5267	0.1330	0.1554	21.19
Marbling	1.35^{b}	1.80^{ab}	2.18^{a}	1.79	1.77	0.0288	0.4052	0.1216	25.49
Firmness	2.83	3.33	3.00	3.11^{x}	3.00^{y}	0.0796	0.0249	0.2620	18.79
Hunter Color Score									
L*	56.47	55.98	55.45	54.07^{y}	57.86^{x}	0.1987	0.0200	0.0931	6.03
a*	9.99	9.71	9.52	9.98	9.50	0.8963	0.7801	0.5375	14.23
b*	17.60	17.20	17.28	17.11	17.62	0.3836	0.1668	0.9297	5.73
pH	5.48a	5.48a	5.42b	5.46	5.46	0.0045	0.6573	0.0045	0.50

Mean values followed by different letters in the same line are statistically different by the Tukey test (P<0.05). **T**: treatment; **G**: gender; **TxG**: treatment and gender interaction.