EFFECTS OF DRIED DISTILLERS GRAINS WITH SOLUBLES ON SOW CARCASS FAT QUALITY

T. A. Houser, J. M. DeRouchey, A. N. Gipe, B. L. Goehring, S. L. Hillyard, A. W. Duttlinger, S. S. Dritz[1], M. D. Tokach, R. D. Goodband, and J. L. Nelssen

Summary

A pilot experiment was conducted to determine the effects of feeding nonpregnant (open) sows a diet containing 50% dried distillers grains with solubles (DDGS) on growth and carcass fat quality. A total of 8 open sows were allotted to 1 of 2 diets by parity and BW. One diet was a standard corn-soybean meal-based gestation diet; the second diet was a corn-soybean meal-based diet that contained 50% DDGS. All sows were fed 5 lb/d of feed in a single feeding for 92 d. All sows were harvested on d 92 at the Kansas State University Meat Laboratory for determination of carcass fat quality. As expected, no differences in BW or backfat change were found ($P > 0.62$) for the feeding period. Additionally, no differences ($P > 0.23$) in lipid oxidation as measured by 2-thiobarbituric acid reactive substances (TBARS) assay were reported either initially or after 5 d of retail display for sows fed 50% DDGS compared with controls. Lipid oxidation increased ($P < 0.003$) as measured by TBARS assay for both treatments from d 1 to 5 as expected. Jowl fatty acid analysis revealed an increase in linoleic acid ($P < 0.01$), total polyunsaturated fatty acids ($P < 0.01$), and the ratio of polyunsaturated fatty acids to saturated fatty acids ($P < 0.03$). Also, there was a trend for increased jowl iodine value ($P < 0.08$) for sows fed 50% DDGS compared with the controls. In summary, feeding 50% DDGS to open sows for 92 d did not significantly affect BW, backfat, and lipid oxidation compared with controls. However, feeding 50% DDGS increased the concentration of linoleic acid and total polyunsaturated fatty acids and tended to increase jowl iodine value compared with controls.

Key words: carcass fat quality, dried distillers grains with solubles, lipid oxidation, sow

Introduction

With the increase in biofuel production, the availability of feed coproducts from ethanol manufacturing has greatly increased. Dried distillers grains with solubles (DDGS) is the product that remains after the ethanol is removed from the fermented corn mash and contains high levels of nutrients compared with corn. One such nutrient is fat, which is approximately 3 times higher in DDGS than in corn (10.7 vs. 3.9%). Because of the high level of unsaturated fatty acids present in DDGS, carcass fat of

[1] Food Animal Health and Management Center, College of Veterinary Medicine, Kansas State University.

finishing pigs fed DDGS has been shown to decrease in firmness and percentage of saturated fat. When using iodine value (IV) as the fat firmness measurement, for every 10% DDGS fed to finishing pigs, the IV increases approximately 2 g/100 g. This increase has been documented in grow-finish pigs fed ad libitum while body fat levels increase during the finishing period. However, research has not evaluated whether the same results will occur at all or at the same rate of change in limit-fed sows that have less change in body fat accumulation than finishing pigs. Additionally, most cull sows in the United States are harvested and processed into fresh sausage products. As a result, the stability of the fat from cull sow trimmings is very important to retail shelf life and consumer acceptance of fresh sausage products. Therefore, the objective of this study was to determine in a pilot project the effects of feeding open sows a diet containing 50% DDGS on carcass fat quality and stability.

Procedures

The Kansas State University (KSU) Institutional Animal Care and Use Committee approved protocols used in this experiment. Sows were housed at the KSU Swine Teaching and Research farm.

Eight nonpregnant sows were used in a 92-d study. Sows were allotted in a randomized design to 1 of 2 diets by parity and BW. One diet was a standard corn-soybean meal-based gestation diet; the second diet was a corn-soybean meal-based diet that contained 50% DDGS (Table 1). All sows were fed 5 lb/d of feed in a single feeding. Each sow was maintained in a gestation stall and had ad libitum access to water via a nipple waterer. Sow BW and and backfat thickness (taken 1 to 2 in. from the midline over the last rib (P2)) were measured on d 0 and 92.

On d 92, sows were transported to the KSU Meat Laboratory for harvesting. After slaughter, all carcasses were chilled for 48 h, fabricated into lean trimmings, ground, packaged in oxygen permeable overwrap, and placed into simulated retail display. At the time of fabrication, the jowl was removed from each carcass for fatty acid analysis. Lipid oxidation, a measurement of oxidative rancidity, was measured on all the samples on d 1 (the day of grinding) and after 5 d of retail display. Lipid oxidation was measured by using the 2-thiobarbituric acid reactive substances (TBARS) assay, which measures milligrams of malonaldehyde and other lipid degradation products per kilogram of sample. TBARS values over 1.0 mg/kg are considered rancid.

Fatty acids from each of the fat samples were expressed as a percentage of the total fatty acids. Iodine value was calculated by using the fatty acid profile of each sample according to the following equation (AOCS, 1998).

C16:1 (0.95) + C18:1 (0.86) + C18:2 (1.732) + C18:3 (2.616) + C20:1 (0.785) + C22:1 (0.723).

Data were analyzed as a randomized design with sow as the experimental unit. Sows were blocked based on parity and initial weight at the beginning of the trial.

Results and Discussion

As expected, no differences in sow BW and P2 backfat existed at the start or end of the experiment between sows fed the 2 dietary treatments (Table 2; $P > 0.62$).

There were no differences in TBARS values as a result of treatment (Table 3; $P > 0.23$), which indicates that the amount of lipid oxidation was not significantly higher in sows fed 50% DDGS compared with controls. In addition, the rate of lipid oxidation was similar between the two treatment groups over the 5-d display period. As expected, TBARS values increased *(P* < 0.003) regardless of treatment from d 1 to d 5. It is well known that lipid oxidation increases with increased storage time.

The results of fatty acid analysis for jowl samples are reported in Table 4. Feeding 50% DDGS for 92 d increased ($P < 0.01$) linoleic acid and total polyunsaturated fatty acids , and increased ($P < 0.03$) the ratio of polyunsaturated fatty acids to saturated fatty acids. These changes may be a result of the increased crude fat level of the diet for sows fed DDGS. Because the oil content of DDGS is high in unsaturated fatty acids, this appears to have resulted in fat composition changes for sows fed DDGS. Thus, in the changes in fatty acid composition, a trend for an increased IV ($P < 0.08$) was observed for sows fed 50% DDGS compared with control sows. The magnitude of change in IV for sows fed DDGS on a limit-fed basis was not as great as previously observed in finishing pigs fed diets containing DDGS ad libitum. In fact, we found a change of only approximately 3.1 g/100 g increase with a 50% inclusion; finishing pigs typically have an increase of approximately 2 g/100 g for every 10% DDGS in the diet fed ad libitum. This may be due to sows not gaining weight or backfat rather than to sows being fed at maintenance. In conclusion, feeding 50% DDGS to open sows increased the concentration of linoleic acid and total polyunsaturated fatty acids and tended to increase jowl IV compared with control sows.

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

Ingredient, %	Control	DDGS[2]
Corn	80.92	37.11
Soybean meal (46.5% CP)	14.93	9.26
DDGS	---	50.00
Monocalcium phosphate (21% P)	1.70	0.55
Limestone	1.20	1.83
Salt	0.50	0.50
Vitamin premix	0.25	0.25
Trace mineral premix	0.15	0.15
Sow add pack	0.25	0.25
Phytase 600[3]	0.10	0.10
Total	100.00	100.00
Calculated analysis		
Standardized ileal digestible lysine, %	0.57	0.57
CP, %	13.8	21.1
Crude fat, %	3.4	6.9
ME, kcal/lb	1,484	1,493
Ca, %	0.85	0.85
P, %	0.69	0.64
Available P, %[4]	0.52	0.52

[1] Diets fed for 92 d with all sows receiving 5 lb/d in a single feeding.
[2] Dried distillers grains with solubles.
[3] Provided per pound of diet: 227 phytase unit (FTU) of phytase.
[4] Includes expected P release of 0.12% from added phytase.

Table 2. BW and backfat of sows[1]

Item	Control	50% DDGS	SE	Probability *P* <
BW, lb				
Initial	468.0	480.8	34.6	0.80
Final	466.5	482.0	21.3	0.62
Change	- 1.5	1.2	18.9	0.92
P2 backfat, mm[2]				
Initial	12.5	13.3	1.7	0.76
Final	13.3	13.3	0.8	0.99
Change	0.8	0.0	1.1	0.64

[1] A total of 8 nonpregnant sows (4 per treatment) fed for 92 d.
[2] P2 backfat is measured approximately 1 to 2 in. from the midline over the last rib.

Table 3. Lipid oxidation values for cull sow trim[1]

	Control	50% DDGS	Probability $P <$ [2]
TBARS, mg/kg			
d 1	0.128	0.171	0.335
d 5	0.249	0.283	0.452
Probability $P <$	0.0163	0.0249	
SE = 0.0307			

[1] A total of 8 nonpregnant sows (4 per treatment).
[2] Day effect, $P < 0.003$.

Table 4. Effects of dried distillers grains with solubles (DDGS) on sow jowl fat quality[1]

Item	Control	50% DDGS	SE	Probability, $P <$
Myristic acid (14:0), %	1.41	1.36	0.03	0.32
Palmitic acid (16:0), %	21.08	20.54	0.33	0.30
Palmitoleic acid (16:1), %	3.01	2.79	0.09	0.12
Margaric acid (17:0), %	0.28	0.33	0.03	0.26
Stearic acid (18:0), %	8.62	8.27	0.51	0.64
Oleic acid (18:1c9), %	43.90	41.93	0.81	0.13
Vaccenic acid (18:1n7), %	4.16	3.92	0.09	0.12
Linoleic acid (18:2n6), %	12.66	15.58	0.53	0.01
α-linolenic acid (18:3n3), %	0.56	0.58	0.05	0.81
Arachidic acid (20:0), %	0.33	0.37	0.03	0.42
Eicosadienoic acid (20:2), %	0.93	1.12	0.03	0.01
Arachidonic acid (20:4n6), %	0.13	0.13	0.01	0.51
Other fatty acids, %	15.60	18.66	0.59	0.01
Total SFA, %[2]	32.03	31.20	0.84	0.51
Total MUFA, %[3]	53.03	50.69	0.80	0.08
Total PUFA, %[4]	14.94	18.12	0.65	0.01
Total *trans* fatty acids, %[5]	0.37	0.49	0.10	0.44
UFA:SFA ratio[6]	2.13	2.21	0.08	0.49
PUFA:SFA ratio[7]	0.47	0.58	0.03	0.03
Iodine value, g/100 g[8]	69.33	72.38	1.03	0.08

[1] Total of 8 sows with 4 sows per treatment.
[2] Total saturated fatty acids = {[C8:0] + [C10:0] + [C12:0] + [C14:0] + [C16:0] + [C17:0] + [C18:0] + [C20:0] + [C22:0] + [C24:0]}; brackets indicate concentration.
[3] Total monounsaturated fatty acids = {[C14:1] + [C16:1] + [C18:1c9] + [C18:1n7] + [C20:1] + [C24:1]}; brackets indicate concentration.
[4] Total polyunsaturated fatty acids = {[C18:2n6] + [C18:3n3] + [C18:3n6] + [C20:2] + [C20:4n6]}; brackets indicate concentration.
[5] Total *trans* fatty acids = {[C18:1t] + [C18:2t] + [C18:3t]}; brackets indicate concentration.
[6] UFA:SFA ratio = [Total MUFA + Total PUFA] / Total SFA.
[7] PUFA:SFA ratio = Total PUFA / Total SFA.
[8] Calculated as IV=[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 (AOCS, 1998).