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EFFECTS OF ADDING SATURATED FAT TO DIETS WITH SORGHUM-BASED DRIED DISTILLERS GRAINS WITH SOLUBLES ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS IN FINISHING PIGS

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Summary

Two experiments were conducted to determine the effects of adding sources of saturated fat to diets with sorghum-based dried distillers grains with solubles (DDGS). For Exp. 1, 112 barrows (initially 140 lb) were used in a 69-d growth assay with 7 pigs per pen and 4 pens per treatment. Treatments were a corn-soybean meal-based control and diets having 40% sorghum-based DDGS (U.S. Energy Partners, Russell, KS) without and with 5% added tallow or palm oil. Feed and water were consumed on an ad libitum basis until pigs were slaughtered (average BW 283 lb) to allow collection of carcass data and jowl samples. Fatty acid composition of jowl samples was used to calculate iodine value (IV) as an indicator of carcass fat firmness. Overall (d 0 to 69), the corn-soybean control supported greater ADG and ADFI ($P < 0.001$) with no difference in F/G ($P > 0.9$) compared with the DDGS treatments. Adding 5% beef tallow and palm oil to diets with DDGS improved overall F/G ($P < 0.02$). Pigs fed the control diet had greater ($P < 0.04$) HCW and dressing percentage than pigs fed the DDGS treatments. Adding fat to DDGS diets tended to improve dressing percentage ($P < 0.07$), but there were no effects of fat source on carcass measurements ($P > 0.14$). Changes in IV indicated softer fat in pigs fed DDGS ($P < 0.001$) than in pigs fed the control diet even when sources of saturated fatty acids were added to the diets. For Exp. 2, 112 barrows (initially 150 lb) were used in a 67-d growth assay with 7 pigs per pen and 4 pens per treatment. Treatments were the same as in Exp. 1, but fat sources were stearic acid and coconut oil. At slaughter (average BW 270 lb), in addition to collection of carcass data and jowl samples, belly firmness was determined by using a subjective scoring system and by measuring the distance from tip to tip of the belly after it was drooped over a 1-in.[2] bar for 5 min. The corn-soybean control tended to support greater overall ADG ($P < 0.09$) with no difference in ADFI and F/G ($P > 0.14$) compared with DDGS treatments. Adding fat sources to diets with DDGS tended to improve ($P < 0.06$) overall F/G, and coconut oil improved F/G compared with stearic acid ($P < 0.001$). Pigs fed the control diet had greater ($P < 0.05$) HCW than pigs fed the DDGS treatments. Pigs fed the control diet had lower IV and greater firmness score than pigs fed diets with added DDGS ($P < 0.02$). Adding fat sources to diets with DDGS improved these estimates of carcass firmness and tip to tip distance for suspended bellies ($P < 0.001$); coconut oil had a much greater effect than stearic acid ($P < 0.001$). In conclusion, adding beef tallow, palm oil, and coconut oil to diets with 40% DDGS improved efficiency of gain in finishing pigs. However, only coconut oil restored carcass firmness to levels at or above a corn-soybean diet without DDGS.

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Key words: carcass firmness, coconut oil, dried distillers grains with solubles, palm oil

Introduction

With conversion of starch to ethanol, other proximate components in cereal grain (e.g., protein, fiber, and fat) are concentrated by about three times in dried distillers grains with solubles (DDGS). Existing data suggest negative effects of the vegetable oil in DDGS on firmness of pork carcasses. Work at North Carolina State University demonstrated that hydrogenated choice white grease added to corn-soybean diets increased carcass firmness in pigs. However, we reported in the 2007 Swine Day Report of Progress (Feoli et al., page 122) that increasing tallow (a source of saturated fatty acids) from 0 to 5% of the diet did not improve iodine value (IV) of jowl fat (an indicator of carcass firmness) in finishing pigs fed diets with DDGS. Beef tallow is only 50% saturated and mainly long-chain fatty acids, which seems to not be saturated enough to compensate for the negative effects of DDGS on firmness of carcass fat. Therefore, the objective of the present experiments was to determine the effects of adding various sources of saturated fat (beef tallow, palm oil, stearic acid, and coconut oil) to diets with sorghum-based DDGS.

Procedures

In Exp. 1, 112 barrows (initially 140 lb) were used in a 69-d growth assay. The pigs were sorted by ancestry, blocked by weight, and assigned to pens. There were 7 pigs per pen and 4 pens per treatment. The pigs were housed in a finishing facility having 6-ft × 16-ft pens with half solid and half slatted concrete flooring. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water.

Treatments were a corn-soybean meal-based control and diets having 40% sorghum-based DDGS (U.S. Energy Partners, Russell, KS) without and with 5% added tallow or palm oil (Table 1). The control diet and first DDGS treatment were formulated to 0.90% lysine, 0.60% Ca, and 0.50% total P for d 0 to 36 and 0.70% lysine, 0.55% Ca, and 0.45% total P for d 36 to 69. However, nutrient:calorie ratios were kept constant for diets with added fat.

Pigs and feeders were weighed at d 0, 36, and 69 to allow calculation of ADG, ADFI, and F/G, and the pigs were slaughtered (average BW 283 lb). Carcass data were collected, and samples of jowl fat were collected, their fatty acid profile was determined, and their IV was calculated following AOCS (1998) procedures.

All data were analyzed as a randomized complete block design by using the MIXED procedure of SAS with HCW as a covariate for carcass measurements. Orthogonal contrasts were used to separate treatment means with comparisons between control vs. DDGS treatments, DDGS without vs. with added fat, and tallow vs. palm oil.

In Exp. 2, 112 barrows (initially 150 lb) were used in a 67-d growth assay. The pigs were sorted by ancestry, blocked by weight, and assigned to pens. There were 7 pigs per pen and 4 pens per treatment. The pigs were housed in the same finishing facility as in Exp. 1. Treatments were a corn-soybean meal-based control and diets having 40% DDGS without and with 5% added stearic acid and coconut oil (Table 1). The diets were formulated to the same nutrient specifications as used in Exp. 1.

Pigs and feeders were weighed on d 0, 30, and 67 to allow calculation of ADG, ADFI, and F/G, and the pigs were slaughtered (average BW 270 lb). Carcass data were collected, and samples of jowl fat were collected, their fatty acid profile was determined, and their IV was calculated. In addition, belly firmness was determined by using a subjective scoring

system (scale of 1 = very soft to 10 = very firm) and by measuring the distance from tip to tip of the belly after it was drooped over a 1-in.^{2} bar for 5 min.

All data were analyzed as a randomized complete block design by using the MIXED procedure of SAS with HCW as a covariate for carcass measurements. Orthogonal contrasts were used to separate treatment means with comparisons between control vs. DDGS treatments, DDGS without vs. with added fat, and stearic acid vs. coconut oil.

Results and Discussion

Analyses of the DDGS (Table 2) indicated that its fat was mainly long-chain and unsaturated (e.g., C18:2) as is expected for the oil in cereal grains. Fatty acid composition of the other fat sources was similar to expected compositions; tallow and palm oil were about 50% saturated, and the stearic acid and coconut oil products were more than 90% saturated.

In the first growth assay (Exp. 1), the corn-soybean control supported greater overall ADG and ADFI ($P < 0.001$) with no difference in F/G ($P > 0.9$) compared with the DDGS treatments (Table 3). Adding 5% beef tallow or palm oil to diets with DDGS improved overall F/G by 6.5% ($P < 0.02$), but there was no difference ($P > 0.12$) in growth performance between pigs fed tallow vs. palm oil. For carcass data, pigs fed the control diet had greater ($P < 0.04$) HCW and dressing percentage than pigs fed the DDGS treatments. Adding fat to the DDGS diets tended to improve dressing percentage ($P < 0.07$), but there were no effects of fat source on carcass measurements ($P > 0.14$). Changes in IV indicated softer fat in pigs fed DDGS ($P < 0.001$) than in pigs fed the control diet even when the sources of saturated fatty acids (tallow and palm oil) were added to the diets.

In Exp. 2, the corn-soybean control tended to support greater overall ADG ($P < 0.09$) with no difference in ADFI and F/G ($P > 0.14$) compared with the DDGS treatments (Table 4). Adding fat sources to diets with DDGS tended to improve ($P < 0.06$) overall F/G, and coconut oil improved F/G compared with stearic acid ($P < 0.001$). For carcass data, pigs fed the control diet had greater ($P < 0.05$) HCW than pigs fed the DDGS treatments. However, dressing percentage, percentage carcass lean, backfat thickness, and loin depth were not affected by adding DDGS or fat to the diets ($P > 0.18$). Pigs fed the control diet had lower IV and greater firmness scores compared with pigs fed diets with added DDGS ($P < 0.02$). Adding fat sources to diets with DDGS improved these estimates of carcass firmness and the tip to tip distance for suspended bellies ($P < 0.001$); coconut oil had a much greater effect than stearic acid ($P < 0.001$).

In conclusion, the use of 40% DDGS in diets for finishing pigs tended to reduce ADG and indicators of carcass firmness. Adding tallow, palm oil, or coconut oil to diets with DDGS improved feed efficiency, but only coconut oil restored indicators of carcass firmness to levels as good as or better than those achieved with the corn-soybean meal-based control treatment.

Table 1. Composition of diets

	Phase 1			Phase 2		
Ingredient, %	Control	DDGS	DDGS + fat	Control	DDGS	DDGS + fat
Corn	79.90	53.10	49.32	84.96	58.10	54.56
DDGS[1]	---	40.00	40.00	---	40.00	40.00
Fat	---	---	5.00	---	---	5.00
Soybean meal (47.5% CP)	17.70	4.80	6.00	12.90	---	1.00
Limestone	1.09	1.35	1.34	1.07	1.27	1.31
Monocalcium phosphate (21% P)	0.73	0.04	0.13	0.59	---	---
Salt	0.23	0.10	0.10	0.23	0.10	0.10
L-lysine HCl	0.20	0.47	0.47	0.12	0.39	0.39
L-threonine	0.03	---	---	---	---	---
Vitamin premix	0.04	0.04	0.04	0.04	0.04	0.04
Mineral premix	0.03	0.05	0.05	0.04	0.05	0.05
Antibiotic[2]	0.05	0.05	0.05	0.05	0.05	0.05
Calculated analysis, %[3]						
Lys	0.90	0.90	0.93	0.70	0.70	0.73
Ca	0.60	0.60	0.62	0.55	0.55	0.57
Total P	0.50	0.50	0.52	0.45	0.45	0.47

[1] Dried distillers grains with solubles.
[2] To provide 40 g/ton tylosin.
[3] Nutrient:calorie ratios were kept constant for diets with added fat.

Table 2. Fatty acid composition of dried distillers grains with solubles (DDGS) and fat sources

Fatty acid, %	DDGS	Beef tallow	Palm oil	Stearic acid	Coconut oil
C8:0	0.43	0.01	0.05	0.01	7.87
C10:0	0.00	0.10	0.05	0.06	6.02
C12:0	0.04	0.07	0.35	0.09	47.82
C14:0	0.11	3.16	1.09	2.65	17.53
C16:0	16.58	24.24	42.46	27.20	8.61
C16:1	0.50	2.15	0.07	0.40	0.06
C17:0	0.16	2.00	0.14	1.89	0.02
C18:0	1.96	20.25	4.45	65.34	3.24
C18:1	28.15	41.88	37.81	0.08	6.14
C18:2	48.30	3.04	11.68	0.27	2.08
C18:3	2.70	0.25	0.59	0.02	0.06
C20:0	0.30	0.15	0.37	1.25	0.09
Saturated fatty acids	19.88	50.62	49.14	98.97	91.31
Unsaturated fatty acids	80.12	49.38	50.86	1.03	8.69
Unsaturated/saturated	4.03	0.98	1.03	0.01	0.10
Iodine value	115.6	44.1	54.5	1.0	9.1

Table 3. Effects of adding beef tallow and palm oil to diets with sorghum-based dried distillers grains with solubles (DDGS) on growth performance and carcass characteristics in finishing pigs[1]

		40% DDGS				*P* value		
Item	Control	No added fat	Tallow	Palm oil	SE	Control vs. DDGS	Fat effect	Tallow vs. Palm
d 0 to 36								
ADG, lb	2.32	2.04	1.95	2.07	0.06	0.001	---[2]	0.13
ADFI, lb	6.72	6.18	5.75	5.83	0.14	0.002	0.06	---
F/G	2.90	3.03	2.95	2.82	0.06	---	0.09	0.15
d 0 to 69								
ADG, lb	2.27	2.04	1.96	2.06	0.04	0.001	---	0.13
ADFI, lb	7.37	6.91	6.34	6.40	0.13	0.001	0.006	---
F/G	3.25	3.39	3.23	3.11	0.05	---	0.02	0.15
HCW, lb	214.8	195.6	195.5	198.2	6.6	0.001	---	---
Dressing, %[3]	71.9	70.0	71.1	70.4	0.4	0.04	0.07	0.14
Carcass lean, %[3]	53.8	54.2	54.2	54.4	0.4	---	---	---
Backfat thickness, in.[3]	0.76	0.73	0.72	0.72	0.02	---	---	---
Loin depth, in.[3]	2.23	2.21	2.12	2.18	0.05	---	---	---
Iodine value[3,4]	67.9	72.1	73.1	73.2	0.6	0.001	---	---

[1] A total of 112 barrows (initially 140 lb) with 7 pigs per pen and 4 pens per treatment.
[2] Dashes indicate $P > 0.15$.
[3] HCW used as a covariate.
[4] As calculated from fatty acid profile of the jowls.

Table 4. Effects of adding stearic acid and coconut oil to diets with sorghum-based dried distillers grains with solubles (DDGS) on growth performance and carcass characteristics in finishing pigs[1]

		40% DDGS				*P* value		
Item	Control	No added fat	Stearic	Coconut	SE	Control vs. DDGS	Fat effect	Stearic vs. Coconut
d 0 to 30								
ADG, lb	1.71	1.53	1.53	1.67	0.03	0.009	0.12	0.02
ADFI, lb	6.45	6.05	6.17	5.87	0.19	0.02	---[2]	0.13
F/G	3.77	3.95	4.03	3.51	0.07	---	0.02	0.001
d 0 to 67								
ADG, lb	1.80	1.69	1.72	1.75	0.05	0.09	---	---
ADFI, lb	6.32	6.07	6.32	5.75	0.18	0.14	---	0.02
F/G	3.51	3.59	3.67	3.29	0.05	---	0.06	0.001
HCW, lb	197.5	188.0	189.5	194.2	5.1	0.05	---	---
Dressing, %[3]	71.7	70.8	70.5	71.4	0.6	---	---	---
Carcass lean, %[3]	55.4	55.7	55.7	55.0	0.3	---	---	0.09
Backfat thickness, in.[3]	0.67	0.64	0.64	0.69	0.02	---	---	0.06
Loin depth, in.[3]	2.25	2.18	2.22	2.27	0.04	---	---	---
Iodine value[3,4]	67.4	71.7	70.5	66.6	0.3	0.001	0.001	0.001
Belly firmness score[3,5]	5.8	4.7	4.9	6.1	0.3	0.02	0.001	0.001
Tip to tip distance, in.[3]	7.3	5.7	6.4	9.4	0.3	---	0.001	0.001

[1] A total of 112 barrows (initially 150 lb) with 7 pigs per pen and 4 pens per treatment.
[2] Dashes indicate $P > 0.15$.
[3] HCW used as a covariate.
[4] As calculated from fatty acid profile of the jowls.
[5] Scale of 1 = very soft to 10 = very firm.