The Effects of Corn- or Sorghum-Based Diets with or without Sorghum Dried Distillers Grains with Solubles on Lactating Sow and Litter Performance

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Summary

A total of 140 sows (PIC 1050) and their litters were used to determine the effects of corn- or sorghum-based diets with or without 20% sorghum dried distillers grains with solubles (DDGS) on lactating sow and litter performance. On d 110 of gestation, sows were allotted to 1 of 4 dietary treatments arranged in a 2 × 2 factorial with main effects of grain source (corn vs. sorghum) and sorghum DDGS (0 vs. 20%; 32.1% CP and 9.2% crude fat as-fed). All diets were formulated to 0.97% standardized ileal digestible lysine but were not balanced for energy. Litters were equalized to at least 12 pigs per sow after farrowing. Two sows and one sow were removed from the study for the sorghum and sorghum-DDGS treatments, respectively, because of initial feed refusal.

Overall (d 0 to 21), a tendency ($P < 0.08$) for a DDGS × grain source interaction was observed as ADFI increased in corn-based diets when DDGS were added, but this tendency decreased in sorghum-based diets. Sows fed the sorghum-based diets had decreased ($P < 0.04$) lactation BW loss compared with those fed corn-based diets. Litter weaning weights tended to be lower ($P < 0.06$) for sows fed the diets containing DDGS compared with those fed the diets without DDGS. Sows fed the sorghum-based diet with 20% sorghum DDGS had the lightest litter weaning weight at 155 lb, with weaning weights averaging 161 to 162 lb for the other dietary treatments. Following this trend, litter weight gain tended ($P < 0.09$) to decrease when sorghum DDGS were added to corn- or sorghum-based diets. No differences were observed in piglet survivability among dietary treatments. Overall, feeding sows corn- vs. sorghum-based diets (without DDGS) in lactation did not affect litter performance; however, the 5% decrease in litter weaning weight of sows fed sorghum with 20% sorghum DDGS needs to be taken into account when selecting ingredients for lactating sows.

Key words: lactation, sorghum, sorghum DDGS, sow

Introduction

Sorghum grain is grown in the Great Plains region of the United States due to its resilience in drought conditions. Sorghum DDGS are often available to swine producers due to the large acreage of sorghum in the area and its use in ethanol production.

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Grain sorghum is a suitable replacement for corn in nursery and finishing diets (Sotak et al., 2011[2]; Benz et al., 2011[3]). Previous research has found that gestating sow performance is not affected by corn DDGS inclusion rates from 40 to 80% (Monegue and Cromwell, 1995[4]) and that lactating sow performance is not affected by corn DDGS at an inclusion rate of 30% (Greiner et al., 2008[5]). Louis et al. (1991[6]) observed no differences for lactation weight loss among sows fed corn- or sorghum-based diets; however, a reduction in litter weaning weights was observed for sows fed the sorghum-based diet.

Research has been conducted on lactating sows fed corn DDGS, but more research needs to be conducted to determine the feeding value of grain sorghum and sorghum DDGS for lactating sows.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved all practices and procedures used in these experiments. This study was conducted at the K-State Swine Teaching and Research Center in Manhattan. The facility is a totally enclosed, environmentally controlled, mechanically ventilated barn. The barn contains 29 farrowing crates that are each equipped with a single feeder and nipple waterer.

The sorghum, corn, and sorghum DDGS were analyzed for DM, CP, crude fat, crude fiber, and ash at the K-State Analytical Laboratory (Manhattan, KS). Standard ileal digestibility values for the sorghum DDGS were derived from Urriola et al. (2009[7]) and used in diet formulation (Table 1). The sorghum grain used in this study was a red pericarp variety, and the corn grain used was #2 yellow dent. The corn DDGS used were golden brown, and the sorghum DDGS were slightly darker than the corn DDGS in visual color.

A total of 140 sows (PIC 1050) and their litters were used. Sows were randomly allotted to 1 of 4 experimental diets throughout 5 farrowing groups using farrowing group as the blocking criteria. Each farrowing group had 7 sows per treatment with 4 replications. During gestation, all sows were fed a corn-based diet with 20% corn DDGS. Feed amounts in gestation were assigned based on sow body condition.

Treatments were arranged in a 2 × 2 factorial with main effects of grain source (corn vs. sorghum) and sorghum DDGS (0 vs. 20%; Table 2). Sows had ad libitum access to water throughout the study. Sows were switched to their experimental diets on d 110 of gestation, corresponding to their move to the farrowing house. Sows had restricted

[2] Sotak et al., Swine Day 2011, Report of Progress 1056, pp. 118–128.
[3] Benz, J. M., M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouchey, R. C. Sulabo, and R. D. Goodband. 2011. Effects of increasing choice white grease in corn- and sorghum-based diets on growth performance, carcass characteristics, and fat quality characteristics of finishing pigs. J. Anim. Sci. 89:773–782.
[4] Monegue, J. J., and G. L. Cromwell. 1995. High dietary levels of corn by-products for gestating sows. J. Anim. Sci. 73(Suppl. 1):86(Abstr.).
[5] Greiner, L. L., X. Wang, G. Allee, and J. Conner. 2008. The feeding of dry distillers grains with solubles to lactating sows. J. Anim. Sci. 86(Suppl. 2):63 (Abstr.).
[6] Louis, G. F., A. J. Lewis, and E. R. Peo Jr. 1991. Feeding value of grain sorghum for the lactating sow. J. Anim. Sci. 69:223–229.
[7] Urriola, P. E., D. Hoehler, C. Pederson, H. H. Stein, and G. C. Shurson. 2009. Amino acid digestibility of distillers dried grains with solubles produced from sorghum- and sorghum-corn blend, and corn fed to pigs. J. Anim. Sci. 87:2574–2580.

access to feed from d 110 until farrowing (4.5 lb). Sows were fed 6.0, 8.0, and 12.0 lb on d 0 of farrowing and subsequent 2 d, respectively. Sows had ad libitum access to feed for the remainder of the lactation period.

Average daily feed intake was determined by measuring total feed disappearance to d 0, 7, 14, and 21 (weaning). Sow weights were measured as the sows were placed in the farrowing house on d 110 of gestation, within 24 h postfarrowing, and at weaning.

After birth, pigs were weighed and processed, then distributed among treatments with at least 12 pigs per sow. Mummified and stillborn pigs were also recorded to calculate total born and live born piglets. Pigs were cross-fostered within 24 h after farrowing to standardize litter size within dietary treatments. Pigs were weighed after fostering to measure fostered litter weight, and litters were weighed at weaning to determine litter weight gain and survivability.

Data were analyzed as a randomized complete block design with sow as the experimental unit and farrowing group as the blocking criteria. The study was analyzed using the MIXED procedure in SAS (SAS Institute, Inc., Cary, NC). Contrasts were used to compare the main effects of grain source, added DDGS, and their interactions. Differences among treatments were considered significant at $P \leq 0.05$ and trends at $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

We observed a tendency for a DDGS × grain source interaction for ADFI from d 0 to 7 ($P = 0.06$) and overall ($P = 0.08$; Table 3). Sows fed the basal corn diet consumed less feed than those fed the corn diet with 20% sorghum DDGS, but sows fed the basal sorghum diet consumed more feed than those fed the sorghum diet with 20% sorghum DDGS (Table 4). The decrease in feed consumption the first 7 d of the study observed for sows fed the sorghum-based diet with 20% sorghum DDGS appeared to be due to the transition from the corn-based diet with 20% corn DDGS in gestation. This result is similar to Wilson et al. (2003[8]), who reported a decrease in feed intake during the first 7 d when DDGS were not fed during gestation. No differences were observed in sow ADFI from d 7 to 14 or d 14 to weaning. For overall (d 0 to 21) ADFI, a tendency ($P < 0.08$) was observed for a DDGS × grain source interaction, with consumption mirroring the trend on d 7. Two sows were removed from the study for the sorghum-based diet and 1 sow from the sorghum-based diet with 20% sorghum-DDGS treatments because of feed refusals. An additional 1 and 2 sows were removed from the study for the sorghum and sorghum-DDGS treatments, respectively, because of illness. When 20% sorghum DDGS were included in the corn- or sorghum-based diets, bulk density of the dietary treatment decreased (Table 2).

No differences were observed among the sows fed the corn- or sorghum-based diets with no DDGS compared with those fed the corn- or sorghum-based diets with 20% sorghum DDGS for sow weaning weight, lactation weight change, or lactation BF

[8] Wilson, J. A., M. H. Whitney, G. C. Shurson, and S. K. Baidoo. 2003. Effects of adding distiller's grains with solubles (DDGS) to gestation and lactation diets on reproductive performance and nutrient balance in sows. J. Anim. Sci. 81(Suppl. 2):47–48. (Abstr.).

change. A decrease ($P < 0.04$) in lactation weight change was found for sows fed diets containing sorghum compared with those fed the corn-based diets.

No differences were observed in the number of pigs weaned or in pig survivability among the dietary treatment groups. Additionally, no differences were observed for litter weaning weight; however, a numerical decrease was observed for sows fed 20% sorghum DDGS. A tendency ($P < 0.06$) for decreased (0.70 lb) individual pig weaning weight was observed for sows fed the diets containing 20% sorghum DDGS. Furthermore, a tendency ($P < 0.09$) for decreased litter weaning weight gain was observed for sows fed diets with 20% sorghum DDGS. The litter weaning weight gain reduction was numerically greater for sows fed the sorghum-based diet with 20% sorghum DDGS than for those fed the corn-based diet with 20% sorghum DDGS.

In conclusion, feeding sows corn- vs. sorghum-based diets (without DDGS) in lactation did not affect litter performance, but the 5% decrease in litter weaning weight of sows fed sorghum with 20% sorghum DDGS needs to be taken into account when selecting ingredients for lactating sows.

Table 1. Ingredient analysis (as-fed basis)[1]

Item, %	Sorghum	Corn	Sorghum dried distillers grains with solubles
DM	88.47	88.05	92.53
CP	8.10	8.61	32.05
Crude fat	2.96	2.72	9.23
Crude fiber	1.36	1.31	7.03
Ash	1.40	1.42	4.19

[1] Values represent the mean of one composite sample of each ingredient.

Table 2. Bulk densities of experimental diets by farrowing group (as-fed basis)[1]

	Grain source			
	Corn		Sorghum	
	DDGS[2] source and level, %			
Item	None 0	Sorghum 20	None 0	Sorghum 20
Bulk density, lb/bushel				
Group 1	57.6	51.7	60.7	52.7
Group 2	53.4	51.4	57.1	52.0
Group 3	52.2	48.2	58.4	50.4
Groups 4 and 5	59.0	51.7	62.2	53.5

[1] Bulk densities represent the mass per unit volume.
[2] Dried distillers grains with solubles.

Table 3. Diet composition (as-fed basis)[1]

	Grain source			
	Corn		Sorghum	
Ingredient, %	None	DDGS[2]	None	DDGS
Corn	66.20	51.85	---	---
Sorghum	---	---	67.05	52.80
Soybean meal (46.5% CP)	30.00	24.50	29.10	23.45
Sorghum DDGS	---	20.00	---	20.00
Monocalcium P (21% P)	1.10	0.60	1.05	0.60
Limestone	1.40	1.66	1.44	1.68
Salt	0.50	0.50	0.50	0.50
Vitamin premix	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15
Sow add pack	0.25	0.25	0.25	0.25
L-lysine HCl	0.03	0.13	0.08	0.18
Phytase[3]	0.14	0.14	0.14	0.14
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible amino acids, %				
Lysine	0.97	0.97	0.97	0.97
Isoleucine:lysine	76	79	80	81
Methionine:lysine	29	30	29	30
Met & Cys:lysine	60	61	58	59
Threonine:lysine	66	66	66	66
Tryptophan:lysine	22	21	23	22
Valine:lysine	85	90	88	91
Total lysine, %	1.10	1.13	1.08	1.12
CP, %	19.6	21.5	19.8	21.5
ME, kcal/kg	1,487	1,445	1,463	1,426
Ca, %	0.86	0.86	0.86	0.86
P, %	0.62	0.59	0.62	0.59
Available P, %[4]	0.43	0.43	0.43	0.43

[1] Diets were fed in meal form beginning on d 3 before farrowing.
[2] Dried distillers grains with solubles.
[3] Natuphos classic (BASF Corp.) provided (per kilogram of complete diet): 300 phytase units (FTU) of phytase.
[4] Phytase provided 0.08% available P to the diet.

Table 4. Effects of grain source and sorghum dried distillers grains with solubles (DDGS) on lactating sow and litter performance[1,2]

	Grain source					Probability, *P*<		
	Corn		Sorghum					
	DDGS, %							
	None 0	Sorghum 20	None 0	Sorghum 20	SED	DDGS × grain source	Control vs. DDGS[3]	Corn vs. Sorghum
Sows, n	35	35	32	32				
ADFI, lb								
d 0 to 7	11.43	11.97	12.97	11.70	0.68	0.06	0.44	0.18
d 7 to 14	13.32	13.52	14.19	13.28	0.58	0.17	0.37	0.43
d 14 to weaning	13.47	13.82	14.19	13.28	0.62	0.30	0.81	0.13
d 0 to weaning	12.70	13.08	13.89	12.97	0.53	0.08	0.46	0.15
Sow backfat, mm								
Entry	16.4	15.8	15.7	15.9	0.76	0.80	0.95	0.46
Weaning	14.2	14.3	13.9	13.7	0.87	0.49	0.43	0.06
Change	-1.4	-1.3	-1.7	-2.2	0.62	0.39	0.65	0.15
Sow BW, lb								
Postfarrowing	546.9	537.5	530.9	538.4	14.53	0.40	0.93	0.46
Weaning	515.3	506.9	506.8	517.0	14.21	0.35	0.93	0.93
Change	-31.5	-30.6	-24.2	-21.5	5.84	0.83	0.62	0.04
Piglets								
Litter size, n								
Fostered	12.6	12.7	12.5	12.8	0.24	0.69	0.28	0.75
Weaned	11.8	12.1	11.8	11.8	0.29	0.38	0.48	0.58
Piglet BW, lb								
Fostered litter	43.5	44.5	45.7	43.6	0.24	0.76	0.28	0.62
Pig weaning	13.8	13.3	13.8	13.1	0.44	0.74	0.06	0.72
Litter weaning gain	118.8	116.3	116.1	111.2	5.68	0.76	0.35	0.32
Survivability, %[4]	93.3	95.3	94.8	92.8	1.84	0.11	1.00	0.70

[1] A total of 140 sows (PIC 1050) and their litters were used to determine the effects of sorghum DDGS on lactating sow and litter performance. Two and one sows were removed from the sorghum-based basal diet because of feed refusal and illness, respectively. One and two sows were removed from the sorghum-based diet with 20% sorghum DDGS due to feed refusal and illness, respectively.

[2] Farrowing group was used as a blocking factor.

[3] Basal diets vs. diets with 20% sorghum DDGS.

[4] Survivability was calculated by dividing the weaned litter size by the fostered litter size.

Table 5. Main effects of grain source and sorghum dried distillers grains with solubles (DDGS) on lactating sow and litter performance[1,2]

	Grain source			DDGS, %			Probability, *P*<	
Item	Corn	Sorghum	SED	0	20	SED	Grain source	0 vs. 20% DDGS
Sows								
ADFI, lb								
d 0 to 7	11.7	12.3	0.47	12.2	11.8	0.47	0.18	0.44
d 7 to 14	13.4	13.7	0.40	13.8	13.4	0.40	0.43	0.37
d 14 to weaning	13.6	14.3	0.43	14.0	13.9	0.43	0.13	0.81
d 0 to weaning	12.9	13.4	0.37	13.3	13.0	0.37	0.15	0.46
Sow backfat, mm								
Entry	16.1	15.8	0.43	16.0	15.9	0.43	0.49	0.72
Weaning	14.8	13.8	0.50	14.5	14.1	0.50	0.06	0.43
Change	-1.3	-2.0	0.43	-1.6	-1.8	0.43	0.15	0.65
Sow BW, lb								
Postfarrowing	542.2	534.7	10.1	538.9	538.0	10.1	0.46	0.95
Weaning	511.1	511.9	9.83	511.1	512.0	9.83	0.93	0.93
Change	-31.1	-22.8	4.04	-27.9	-26.0	4.04	0.04	0.65
Piglets								
Litter size, n								
Fostered	12.7	12.6	0.17	12.6	12.7	0.17	0.75	0.28
Weaned	11.9	11.8	0.20	11.8	11.9	0.20	0.58	0.48
Piglet BW, lb								
Foster	44.0	44.6	1.28	44.6	44.1	1.28	0.62	0.68
Litter weaning	161.5	158.3	4.43	162.0	157.8	4.43	0.32	0.34
Pig weaning	13.6	13.5	0.31	13.8	13.2	0.31	0.72	0.06
Litter weaning gain	117.5	113.6	3.93	117.4	113.8	3.93	0.20	0.09
Survivability, %[3]	94.3	93.8	1.27	94.1	94.1	1.27	0.70	1.00

[1] A total of 140 sows (PIC 1050) and their litters were used to determine the effects of sorghum DDGS on lactating sow and litter performance. Two and one sows were removed from the sorghum-based basal diet because of feed refusal and illness, respectively. One and two sows were removed from the sorghum-based diet with 20% sorghum DDGS due to feed refusal and illness, respectively.

[2] Farrowing group was used as the blocking factor.

[3] Survivability was calculated by dividing the weaned litter size by the fostered litter size.