PROCESSING PROCEDURES AND FEEDING SYSTEMS FOR SORGHUM-BASED DIETS GIVEN TO LACTATING SOWS

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Summary

One-hundred twenty nine primiparous sows were used to determine the effects of alternative processing procedures and feeding systems on the nutritional value of sorghum grain-based diets for lactating sows. Treatments were a ground sorghum control, steam- flaked sorghum and extruded sorghum fed in meal form, or the ground sorghum control given as pellets or gruel (1:1 ratio of water and feed on a volume:volume basis). Average daily feed intake was greater for sows fed pelleted and gruel forms compared to sow fed the diets with steam-flaked and extruded sorghum. However, no differences occurred in sow weight or backfat losses among the treatments. Number of pigs weaned and percentage survivability were similar among treatments, except that steam-flaked sorghum supported greater litter weight gains than extruded sorghum. Apparent digestibilities of DM, N, and GE in sows fed steam-flaked and extruded sorghum were greater than in sows fed pelleted or gruel diets. Sows fed extruded sorghum tended to have the greatest digestibilities of DM, N, and GE and lowest excretions of DM and N in the feces. Severity of ulceration was not affected significantly by treatments, but keratinization was greatest for sows fed extruded sorghum. In conclusion, the alternative processing methods (steam-flaking and extrusion) and feeding systems (pellets and gruel) had little effect on sow and litter performance. However, nutrient digestibilities were improved for all treatments that involved heating (steam flaking, extrusion, and pelleting), and, thus, these treatments resulted in less fecal excretion of DM and N.

(Key Words: Sow, Sorghum, Steam-Flake, Extrusion, Pellet, Gruel, Digestibility.)

Introduction

Mash diets with ground cereal grains are the most prevalent feeding system for swine. In ruminants, however, alternative methods of processing sorghum grain consistently give improved energy utilization compared to grinding. Limited information is available concerning the effects of alternative methods of processing and the resulting feeding value of sorghum in swine diets. Therefore, an experiment was designed to determine the effects of alternative processing procedures of sorghum grain on sow and litter performance, nutrient digestibility, nutrient intake and excretion, and changes in stomach morphology of primiparous sows.

Procedures

Mill-run sorghum was ground through a 3/16" hammermill screen for the control diet. For steam flaking, the sorghum grain was steamed at atmospheric pressure (steam chest set at 221°F) for approximately 30 min. The flaked sorghum (19% moisture) was allowed to air-dry at 140°F prior to mixing into the diet (final moisture concentration of 10%). To prepare the extruded sorghum, an Insta-Pro® (Model 2000R) dry extruder was used. The sorghum was ground in a hammermill,

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and water was added to bring the sorghum to 18% moisture before extrusion. The extrusion conditions were those deemed usual for sorghum processing (i.e., a throughput of approximately 1,240 lb/h and an average barrel temperature of 256°F). Pelleting was done in a Master Model California Pellet Mill®. The diet was preconditioned to 131°F and pelleted through a 1.5" thick die with 3/16" diameter holes. Average production rate was 3,550 lb/h with an average exit temperature of 144°F.

A total of 129 primiparous sows was used in the 21-d lactation experiment. On d 110 of gestation, the sows were allotted randomly to treatments and given 5 lb/d of the experimental diets to allow for adjustment to the diets before parturition. Treatments were a ground sorghum control, steam-flaked and extruded sorghum fed in meal form, and the ground sorghum control given as pellets or gruel (1:1 ratio of water and feed on a volume:volume basis). The lactation diets were formulated to .85% lysine, .9% Ca, .8% P, and 1.46 Mcal ME/lb (Table 1).

The sows were penned individually in 2 ft × 7 ft farrowing crates. All litters were standardized at nine or more piglets within 24 h of parturition. Sow and litter weight and sow backfat measurements were taken at farrowing and on d 21 of lactation. Backfat thickness was measured at the first rib, last rib, and last lumbar vertebra. Final weight and backfat thickness of sows weaned prior to d 21 were adjusted by multiplying their daily weight and backfat losses by 21. The sows were allowed ad libitum access to feed and water. On d 18, grab samples of feces were collected from each sow, dried, and ground. Concentrations of Cr, DM, N, and GE in the feces and diets were determined to allow calculation of apparent digestibilities of DM, N, and GE using the indirect ratio method. Intake of digestible DM, N, and GE were calculated by multiplying nutrient intake by their respective apparent digestibilities. The portion of nutrient intake not digested was reported as fecal excretion. After weaning, the sows were fed 4 lb/d of the lactation diet for 10 d and slaughtered. Stomachs were collected and scored for severity of esophagogastric ulcers and keratinization. The scoring system used for ulcers was 0 = normal, 1 = erosions, 2 = esophagogastric ulcers, and 3 = severe esophagogastric ulcers. The scoring system used for keratinization was 0 = normal, 1 = mild parakeratosis, 2 = moderate parakeratosis, and 3 = severe parakeratosis. Because the stomach scores were categorical data, they were analyzed using the Cochran-Mantel-Haenszel procedure of SAS (an analysis of variance procedure designed for categorical data). Contrasts used to separate treatment means were: 1) ground sorghum vs other treatments; 2) mash treatments (steam-flaked and extruded sorghum) vs pelleted and gruel diet forms; 3) steam-flaked vs extruded; and 4) pelleted vs gruel.

Table 1. Diet Composition[a]

Ingredient	%
Sorghum	66.70
Extruded soybeans	28.70
Monocalcium phosphate	2.08
Limestone	1.11
Salt	.50
KSU vitamin premix	.25
KSU mineral premix	.15
KSU sow add pack	.25
Lysine-HCl	.06
Antibiotic[b]	.10
Chromic oxide[c]	.10
Total	100.00

[a]The lactation diet was formulated to .85% lysine, .9% Ca, .8% P, and 1.46 Mcal ME/lb of diet.
[b]Provided 100 g/ton of chlortetracycline.
[c]Used as an indigestible marker.

Results and Discussion

Average daily feed intake was greater for sows fed the pelleted and gruel diets than for sows fed the mash diets with steam-flaked and extruded sorghum (P<.05). This response was primarily because of the relatively low ADFI for sows fed extruded sorghum. However, no differences occurred in weight or backfat loss for sows fed the various treatments (P>.15).

Equalizing litters ensured no differences in number of pigs at initiation of the experiment (with an average of 10.1 live pigs/sow). Also, survivability and number of pigs weaned were similar (P>.20) among treatments. However, steam-flaked sorghum supported the greatest litter wt gains (P<.05).

Apparent digestibilities of DM, N, and GE were greater for sows fed steam-flaked sorghum and extruded sorghum than for sows fed the pelleted and gruel diets (P<.001). Sows fed the extruded sorghum tended to have the highest digestibilities of nutrients, with 13% greater intake of digestible N than sows fed the ground sorghum control. With increased digestibility of nutrients comes decreased excretion of nutrients. Excretion of DM was 22% less for sows fed the alternatively processed sorghums compared to the ground sorghum control (P<.001). However, this improvement in digestibility never translated into an improvement in litter weaning weight.

The number of stomachs given each score for ulceration and keratinization and a mean score for each treatment are provided in Table 4. Treatment had no effect on severity of ulceration (row mean scores differ test, P>.74). However, sows fed extruded sorghum had the greatest stomach keratinization scores (P<.001).

In conclusion, the alternative processing methods (steam-flaking and extrusion) and feeding systems (pellets and gruel) had little effect on sow and litter performance. However, nutrient digestibilities were improved for all treatments that involved heating (steam flaking, extrusion, and pelleting), and, thus, these treatments resulted in less fecal excretion of DM and N.

Table 2. Effects of Alternative Processing Procedures and Feeding Systems for Sorghum on Performance of Sows[a]

Item	Ground	Steam-flaked	Extruded	Pelleted	Gruel	CV
No. of sows	30	22	26	26	25	--
Sow wt, lb						
Postfarrowing	376.5	372.4	382.1	378.9	386.8	7.3
d 21 of lactation[b]	361.0	357.7	373.8	371.7	373.8	8.2
Change	-15.4	-14.7	-8.3	-7.3	-9.3	162.1
Sow backfat thickness, in						
Farrowing	.97	.91	.96	.99	.96	18.3
d 21 of lactation[d]	.93	.87	.93	.97	.97	20.0
Change	-.04	-.04	-.03	-.01	.01	513.9
ADFI, lb[be]	9.88	9.54	8.95	9.53	9.99	12.4
No. of pigs/litter						
Initial	10.3	10.0	9.9	10.1	10.3	15.1
Weaned	9.5	9.4	9.3	9.2	9.5	13.9
Survivability, %	93.1	94.8	94.0	91.4	93.0	9.0
Litter wt, lb						
Initial	28.5	28.6	28.5	28.5	28.5	15.1
d 21[c]	106.5	110.3	101.5	102.6	100.9	12.3
Gain[c]	78.0	81.7	73.0	74.1	72.4	17.0

[a]A total of 129 primiparous sows (22 to 30 sows/treatment).
[bc]Steam-flaked vs extruded (P<.10 and .05, respectively).
[de]Steam-flaked and extruded vs pelleted and gruel (P<.10 and .05, respectively).

Table 3. Effects of Alternative Processing Procedures and Feeding Systems for Sorghum on Apparent Digestibility, Intake, and Excretion of Nutrients[a]

Item	Ground	Steam-flaked	Extruded	Pelleted	Gruel	CV
Apparent digestibilities, %						
DM[bcdg]	77.2	81.8	84.3	81.2	79.1	4.2
N[bceg]	70.9	77.7	83.8	76.1	73.3	5.9
GE[bceh]	75.6	80.9	87.1	81.8	77.7	4.3
Digestible DM intake, g/d	3,073	3,205	3,132	3,112	3,213	10.5
Digestible N intake, g/d	80	83	90	83	83	12.6
DE intake, Mcal/d	12.9	13.5	13.9	13.5	13.5	11.2
DM excretion, g/d[bcg]	935	688	602	728	897	14.2
N excretion, g/d[bcf]	33	20	17	27	32	17.1

[a]A total of 129 primiparous sows (22 to 30 sows/treatment).
[b]Ground vs other treatments ($P<.001$).
[c]Steam-flaked and extruded vs pelleted and gruel ($P<.001$).
[de]Steam-flaked vs extruded ($P<.10$ and .001, respectively).
[fgh]Pelleted vs gruel ($P<.10$, .05, and .001, respectively).

Table 4. Effects of Alternative Processing Procedures and Feeding Systems on Stomach Morphology of Sows[a]

Item	Ground	Steam-flaked	Extruded	Pelleted	Gruel	CV
Stomach ulceration						
Total observations	30	22	25	26	25	--
Normal	15	13	15	10	12	--
Erosions	8	2	3	3	2	--
Ulcers	6	6	5	11	9	--
Severe ulcers	1	1	2	2	2	--
Mean score[bc]	.85	.84	.82	1.33	1.10	108.0
Stomach keratinization						
Total observations	30	22	25	26	25	--
Normal	5	6	0	1	3	--
Mild	8	8	6	10	3	--
Moderate	14	4	10	12	13	--
Severe	3	4	9	3	6	--
Mean score[de]	1.57	1.46	2.24	1.83	1.98	46.0

[a]A total of 128 primiparous sows (22 to 30 sows/treatment).
[b]Scoring system: 0 = normal; 1 = erosion; 2 = ulcer; and 3 = severe ulcer.
[c]Cochran-Mantel-Haenszel statistic, row mean scores differ test ($P>.74$).
[d]Scoring system: 0 = normal; 1 = mild; 2 = moderate; and 3 = severe.
[e]Cochran-Mantel-Haenszel statistic, row mean scores differ test ($P<.001$).