EXTRUSION OF SORGHUM GRAIN AND SOYBEANS FOR LACTATING SOWS

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Summary

One hundred-seventeen primiparous sows were used to determine the effects of extruded sorghum grain and soybeans in lactation diets on sow and litter performance. The sows were fed a sorghum-soybean-based diet with the sorghum and soybeans extruded either singly or together. Treatments were: 1) ground sorghum-soybean meal (SBM)-soy oil-based control; 2) extruded sorghum-SBM-soy oil; 3) ground sorghum-extruded soybeans; and 4) sorghum and extruded soybeans blended then extruded together (extruded blend). All diets were formulated to .80% lysine, .90% Ca, .80% P, and 1.47 Mcal ME/lb. Sows fed diets with extruded ingredients tended to wean more pigs with greater survivability and greater litter weight gains compared to sows fed the ground sorghum-SBM-based control diet. No differences occurred in sow weight or sow backfat loss. Sows fed extruded soybeans had decreased sow weight loss (14.6 vs 29.7 lb) compared with those fed extruded sorghum. Overall, improvements in litter weight gain were 6, 7, and 10% for extruded sorghum, extruded soybeans, and the extruded blend, respectively, when compared to the ground sorghum-SBM-soy oil-based control. In conclusion, our data indicate that extrusion of ingredients for lactation diets improves sow and litter performance, and the greatest improvements were obtained by extrusion of blended soybeans and sorghum grain.

(Key Words: Process, Extrusion, Sorghum, Sows, Lactation.)

Introduction

The process of extrusion involves heat, pressure, and shear. Extruders are screw type augers in which high temperatures result from friction and pressure as the product is augured to the outlet. Extruders are capable of reaching temperatures up to 360°F, which is more than adequate to destroy trypsin inhibitors and other anti-nutritional factors present in soybeans. Extrusion also ruptures the oil cells of soybeans, allowing the oil to be reabsorbed onto the product and, thus, increasing digestibility. Extrusion affects cereal grains as well, by rupturing the semi-crystalline structure of starch granules, which causes gelatinization and, thus, enhances utilization by animals.

In the 1990 and 1991 KSU Swine Day Reports (Reports of Progress No. 610, page 76 and 641, page 92, respectively), it was reported that extrusion of sorghum and soybeans improved growth performance and nutrient digestibility by 5 to 20% in finishing pigs compared to feeding a ground sorghum-SBM-soy oil-based control. In the 1992 KSU Swine Day Report (Report of Progress No. 667, pages 65, 69, and 130), it was reported that the nutritional values of corn, sorghum, wheat, and barley were improved by extrusion of diets for finishing pigs. However, the use of extruded cereal grains in lactating sow diets has not been investigated. Therefore, an experiment was designed to determine the effects of extruded sorghum and(or) soybeans in lactation diets on sow and litter performance.

Procedures

On d 110 of gestation, 117 primiparous sows were randomly assigned to one of four experimental treatments (Table 1). The treatments were: 1) a ground sorghum-soybean meal (SBM)- soy oil-based control; 2) extruded sorghum-SBM-soy oil; 3) ground sorghum-extruded soybeans; and 4) sorghum and extruded soybeans blended then extruded together (extruded blend). Ingredients were extruded with an Insta-Pro Model 2000R dry extruder. The screw assembly consisted of four single-flight screws and seven double-flight screws (screw diameter of 5.25"). The screws were placed in series with the four single-flight screws at the inlet, followed by the seven double-flight screws. Spacer washers and steamlocks were placed between the screws as needed. The head assembly consisted of ribbed heads separated by wearsleeves. The same screw and head assembly was used to extrude all ingredients with the exception that the 5/16" nose cone was replaced by a "spaghetti" cutter head for extrusion of the sorghum grain. The sorghum was ground in a hammermill, and water was added to bring the sorghum to 18% moisture pre-extrusion. The extruded sorghum contained 2,350 lb of sorghum and 114 lb of water. Extrusion was at 1,240 lb/h with a final exit temperature of 256°F. The soybeans were ground through a roller mill before extrusion and extruded at 1,700 lb/hr with a final exit temperature of 300°F. The extruded blend was 2,096 lb sorghum, 904 lb extruded soybeans, and 146 lb water, with a final exit temperature of 172.6°F. Each diet was mixed in a 3,000 lb batch.

Sows were weighed and scanned ultrasonically for last rib fat depth at farrowing and at d 21 of lactation to determine weight and backfat loss. Piglet weights were recorded at farrowing and at d 21 to determine litter weight gain. Sow weight loss and backfat loss and litter weight gain were adjusted to a standard 21-d lactation. The sows were allowed ad libitum access to feed and water, and feed intake was recorded weekly. Response criteria were changes in sow weight and backfat during lactation, average daily feed intake (ADFI), and litter performance. All data were analyzed with sow as the experimental unit and initial litter size as a covariate.

Results and Discussion

No differences occurred in sow weight or backfat losses ($P>.50$) when the mean of extruded diets was compared to the sorghum-SBM-based control diet (Table 2). However, sows fed the extruded diets ate less feed ($P<.01$) than those fed the control diet. Sows fed the extruded blend had less weight loss ($P<.05$) than sows fed sorghum or soybeans extruded singly, and sows fed the extruded soybeans had greater ADFI ($P<.05$) and less weight loss ($P<.001$) than those fed extruded sorghum. The decreased ADFI for the extruded sorghum diet probably resulted from its flour-like consistency that reduced palatability, with the greatest decrease in feed intake occurring in the first week of lactation. Once the sows were acclimated to the extruded sorghum, their feed intakes were similar to those of sows fed the other diets.

Sows fed diets with extruded ingredients tended to wean more pigs ($P<.10$) because of the trend for greater piglet survivability during lactation ($P<.15$). Sows fed diets with extruded ingredients also tended to have heavier final litter weights and greater litter weight gain ($P<.10$). There were advantages of 4.4, 4.6, and 6.7 lb/litter for sows fed the extruded sorghum, extruded soybeans, and extruded blend, respectively, compared with sows fed the ground sorghum-SBM-soy oil-based control. These responses possibly resulted from the nutrients of extruded ingredients being more digestible. Improved digestibility of nutrients for extruded ingredients has been reported in previous KSU Swine Day Reports for both nursery and finishing pigs. However, we have yet to determine what the actual change in nutrient digestibility was in this experiment.

In conclusion, sows fed diets with extruded ingredients tended to have greater

piglet survival and heavier litters, with decreased ADFI compared to those fed the control diet. Among sows fed diets with extruded ingredients, those fed the extruded blend has less weight loss during lactation than sows fed extruded sorghum or soybeans. However, cost of extrusion must be taken into consideration. In a commercial feed processing plant, a producer can expect to pay approximately $40/ton of extruded ingredient, although the actual cost of processing can be as low as $20/ton, depending on location, electricity costs, labor, and depreciation. Using the $40/ton value, our diet costs were $115/ton for the control, $141/ton for the diet with extruded sorghum, $126/ton for the diet with extruded soybeans, and $153/ton for the diet with the extruded blend of sorghum and soybeans. Therefore, extrusion will increase diet costs, which will negate some of the economic benefits of increased litter weight gains for sows fed the extruded ingredients. Thus, the economic feasibility of extruding ingredients for lactation diets will depend on the case-by-case cost of extrusion and the value a producer places on increased litter weaning weights and reduced weight loss of sows during lactation.

Table 1. Diet Composition[a]

Item, %	Sorg-SBM	Extruded Sorghum	Extruded Soybeans	Extruded Sorg-SBM Blend
Sorghum	73.21	--	66.67	--
Extruded sorghum[b]	--	73.21	--	66.67
Soybean meal (48% CP)	20.24	20.24	--	--
Extruded soybeans	--	--	28.74	28.74
Soybean oil	1.96	1.96	--	--
Monocalcium phosphate (21% P)	2.23	2.23	2.23	2.23
Limestone	.96	.96	.96	.96
Salt	.50	.50	.50	.50
Trace mineral premix[c]	.15	.15	.15	.15
Sow add pack[c]	.25	.25	.25	.25
Vitamin premix[c]	.25	.25	.25	.25
Chromic oxide	.25	.25	.25	.25
Total	100.00	100.00	100.00	100.00

[a]All diets were formulated to .80% lysine, .90% Ca, .80% P, and 1.47 Mcal ME/lb of diet.
[b]Extruded sorghum replaced ground sorghum on an equal weight basis.
[c]KSU vitamin and mineral premixes.

Table 2. Effect of Extruded Sorghum and Soybeans on Sow Performance[a]

Item	Extrusion Treatment				
	Sorg-SBM[b]	Extruded Sorghum	Extruded Soybeans	Extruded Sorg-SBM Blend	CV
Sow wt postfarrowing, lb	387.3	371.5	389.4	387.0	--
Sow wt d 21, lb[efh]	370.3	341.8	374.8	374.4	5.7
Lactation wt loss, lb[gh]	17.0	29.7	14.6	12.6	99.5
Fat depth postfarrowing, in	.90	.90	.92	.95	--
Fat depth d 21, in[d]	.86	.88	.91	.92	13.1
Lactation fat loss, in	.04	.02	.01	.03	273.7
ADFI, lb[ci]	12.6	9.9	11.6	10.9	23.0

[a]A total of 117 primiparous sows (31 to 34 sows/treatment).
[b]SBM = soybean meal.
[cde]Sorghum-SBM vs extruded ingredients (P<.01, P<.10, P<.15, respectively).
[fg]Extruded blend vs extruded sorghum or soybeans (P<.01, P<.05, respectively).
[hi]Extruded sorghum vs extruded soybeans (P<.001, P<.05, respectively)

Table 3. Effect of Extruded Sorghum and Soybeans on Litter Performance[a]

Item	Extrusion Treatment				
	Sorg-SBM[b]	Extruded Sorghum	Extruded Soybeans	Extruded Sorg-SBM Blend	CV
Initial litter size	9.6	10.1	9.5	9.5	13.9
Pigs weaned[c]	8.9	9.2	9.3	9.0	9.7
Survivability, %[d]	91.4	94.4	95.0	93.0	8.4
Initial litter wt, lb	27.2	27.9	27.9	27.0	14.7
Final litter wt, lb[c]	96.4	101.4	101.6	102.8	14.3
Litter wt gain, lb[c]	69.2	73.5	73.7	75.8	16.9

[a]A total of 117 primiparous sows (31 to 34 sows/treatment).
[b]SBM = soybean meal.
[cd]Control vs extruded ingredients (P<.10, P<.15, respectively).