EXTRUSION OF SORGHUM, SOYBEAN MEAL, AND WHOLE SOYBEANS IMPROVES GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY IN FINISHING PIGS

J. D. Hancock, R. H. Hines, and T. L. Gugle

Summary

One hundred forty-four finishing pigs (124 lb avg initial wt) were used to determine the effects of extruding sorghum, soybean meal (SBM), and whole soybeans on growth performance and nutrient digestibility. Treatments were: 1) control diet with ground sorghum, SBM, and soybean oil; 2) diet 1 with the ground sorghum, SBM, and soybean oil blended and extruded; 3) sorghum and whole soybeans extruded separately and blended; and 4) sorghum and extruded soybeans blended and extruded together. Extrusion was in an Insta-Pro® extruder. All diets were formulated to be equal in concentrations of metabolizable energy (ME) and lysine. Pigs fed diets with extruded ingredients had improved F/G. Extrusion of sorghum and extruded soybeans together was of greater benefit than extruding those ingredients separately. Diets with extruded ingredients had greater digestibilities of DM and N, but fat thickness at the last rib was not affected by treatment. Overall, optimum nutrient digestibility was achieved by feeding extruded diet ingredients, and efficiency of gain was maximized by feeding an extruded blend of sorghum and whole soybeans.

(Key Words: GF, Process, Sorghum, Soybeans, Performance, Digestibility.)

Introduction

Extrusion processing is not a new technology; extruders have been used to process human foodstuffs for more than 50 yr. Since those early applications, the high cost of equipment and considerable expertise needed to operate and maintain extruders has restricted their use largely to preparation of human foodstuffs and pet foods. However, there is currently a resurgence of interest in extrusion processing of ingredients and(or) whole diets for swine feeding, largely because of the advent of low-cost extrusion equipment and recognition of specific applications for preparation of specialty protein and starch products (e.g., extruded whole soybeans, soy flour, and soy protein concentrates for baby pig diets.)

In last year's KSU Swine Day Report (page 76), we reported marked improvements in efficiency of growth and nutrient digestibility (5 to 20%) when whole soybeans and sorghum grain were extruded separately and blended into diets for finishing pigs versus feeding ground sorghum-soybean meal-soybean oil-based diets. Reported herein are the results of a second experiment with objectives to determine: 1) if extrusion of a ground sorghum-soybean meal-soybean oil-based diet improves its utilization by finishing pigs and 2) if the positive response to extrusion processing of sorghum and whole soybeans is the same when they are blended and then extruded versus extruded and then blended.

Procedures

One hundred forty-four finishing pigs, with an avg weight of 124 lb, were allotted to one of four dietary treatments based on initial weight, sex, and ancestry. There were nine pigs per pen and four pens per treatment. The pigs were housed in a modified open-front building, with 50% solid concrete and 50%

concrete slat flooring. Each pen (6 × 16 ft) had a two-hole self-feeder and nipple waterer.

Treatments were: 1) control diet with ground sorghum, SBM, and soybean oil; 2) diet 1 with the ground sorghum, SBM, and soybean oil blended and then extruded; 3) sorghum and whole soybeans extruded separately and blended; and 4) sorghum and extruded soybeans blended and extruded together. Barrel temperatures during extrusion were 160°F for the sorghum-SBM-soybean oil mixture in diet 2, 140°F for the sorghum and 290°F for the whole soybeans in diet 3, and 150°F for the blend of sorghum and extruded soybeans in diet 4. The sorghum and sorghum-soy mixtures were tempered to 18% moisture before extrusion. Extrusion was in an Insta-Pro® extruder. All diets were formulated to be equal in concentrations of ME and lysine (Table 1), using published values from the NRC, 1988.

Three weeks after initiation of the experiment, chromic oxide was added to the diets (.25%) as an indigestible marker. After a 4-d adjustment period, fecal samples were collected from eight pigs per treatment. The samples were dried, ground, and analyzed for Cr, DM, and N concentrations, so that apparent digestibilities of DM and N could be calculated. Feeding continued until pigs in one pen of a wt block averaged at least 230 lb, at which time all pigs in that wt block were scanned for fat depth at the last rib and removed from the experiment. Final wt was used as a covariate in analyses of the fat depth measurements.

Results and Discussion

Average daily gain was not affected by dietary treatment (Table 2). However, pigs fed diets with extruded ingredients were 14% more efficient (F/G of 3.11 vs 3.61) than pigs fed the ground sorghum-SBM-soybean oil control diet. Although extrusion of the sorghum, SBM, and soybean oil reduced F/G from 3.61 to 3.19, pigs fed that diet were still less efficient than pigs fed diets with extruded sorghum and extruded whole soybeans, especially when sorghum and extruded soybeans were blended and then extruded. All diets were formulated to be in excess of the lysine requirement for finishing pigs and to have the same ME concentration and lysine/ME ratio. Thus, improved feed efficiency for pigs fed extruded sorghum and soybeans indicates that the ME value of sorghum grain is dependent on processing method, and the NRC value for ME of heat processed soybeans is probably too low, at least for dry-extruded whole soybeans.

Apparent digestibilities indicated that extrusion processing of diet ingredients increased DM digestibility by 6% (from 84.1 to 89.5%) and N digestibility by 14% (from 72.3 to 82.3%). Digestibilities of DM and N in diets with the different extrusion treatments were not different ($P > .70$). Last rib fat thickness was not affected by treatment.

In conclusion, results from this experiment support data reported last year, i.e., extrusion of sorghum and whole soybeans improves growth performance and nutrient digestibility in finishing pigs compared to feeding ground sorghum-SBM-soybean oil-based diets. Furthermore, these differences in energy value of extruded sorghum vs ground sorghum and extruded whole soybeans vs SBM and soybean oil warrant re-evaluation of published ME values (such as those found in the NRC for swine) and ME values used in least-cost diet formulation programs.

Table 1. Composition of Diets[a]

Ingredient, %	Control (with SBM)	Extruded soybean diet
Sorghum[b]	80.70	76.09
Soybean meal (48% CP)	14.90	—
Extruded soybeans	—	21.09
Soybean oil	1.50	—
Vit/Min/Antibiotics[c]	2.90	2.82

[a]All diets were formulated to supply .65% lysine, .65% Ca, .55% P, 1.48 Mcal ME/lb of diet, and 2.0 g lysine/Mcal ME (calculated analysis).
[b]Extruded sorghum replaced ground sorghum on a lb for lb basis.
[c]Antibiotic supplied 100 g chlortetracycline per ton of diet.

Table 2. Effect of Extrusion Processing on Nutritional Value of Sorghum, Soybeans, and Soybean Meal for Finishing Pigs

		Extrusion treatment			
Item	Control	Blended sorghum, SBM, soy oil	Sorghum and soybeans	Blended sorghum and soybeans	CV
Growth performance[a]					
ADG, lb[b]	1.97	2.00	1.94	1.99	4.7
ADFI, lb[c]	7.09	6.38	6.17	5.93	5.0
F/G[def]	3.61	3.19	3.18	2.97	2.6
Apparent digestibility					
DM, %[d]	84.1	89.6	89.5	89.5	1.6
N, %[d]	72.3	82.5	81.9	82.5	3.6
Last rib fat thickness, in[b]	1.03	1.05	1.00	1.04	18.5

[a]A total of 144 finishing pigs, avg initial wt of 124 lb, avg final wt of 224 lb. There were nine pigs per pen and four pens per treatment.
[b]No treatment effect ($P > .32$).
[cd]Control vs extrusion treatments ($P < .01$, $P < .001$, respectively).
[e]Extruded sorghum-SBM-soy oil vs extruded sorghum and whole soybean treatments ($P < .08$).
[f]Sorghum and whole soybeans extruded separately vs sorghum and whole soybeans extruded together ($P < .02$).