THE EFFECT OF MOIST AND DRY EXTRUSION PROCESSING ON GROWTH PERFORMANCE AND NITROGEN DIGESTIBILITY IN THE EARLY-WEANED PIG

K. G. Friesen, J. L. Nelssen, R. D. Goodband, K. C. Behnke[1], and L. J. Kats

Summary

One hundred pigs (initially 13.0 lb and 21 d of age) were used to assess the differences between moist and dry extruded soybean meal in diets for early-weaned pigs. Dietary treatments included: 1) corn+dried skim milk+dried whey+casein, 2) corn+soybean meal, 3) corn+dry extruded soybean meal, and 4) corn+moist extruded soybean meal. The diets were formulated to contain 1.4% lysine and 24.4% lactose. Soybean meal (with or without extrusion processing) replaced milk protein on an equal lysine basis. Experimental diets were fed for the entire 28 d experiment. On d 14, fecal samples were collected to determine apparent DM and N digestibilities by feeding chromic oxide as an undigestible marker. Average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (F/G) were improved ($P < .05$) in pigs fed the predominately milk diet from d 0 to 14 postweaning compared to pigs fed soybean meal with or without extrusion processing. For the entire trial (d 0 to 28), ADG was increased in pigs fed the milk based diet compared to pigs fed a soybean meal-based diet. Pigs fed moist extruded soybean meal had a similar ADG to pigs fed the milk diet and had an increased ADG compared to pigs fed dry extruded soybean meal. Average daily feed intake (d 0 to 28) was increased in pigs fed soybean meal (with or without moist extrusion) compared to pigs fed the milk based diet. Pigs fed the milk based diet had improved feed efficiency compared to pigs fed soybean meal with or without extrusion processing. Dry matter and N digestibilities were similar between dietary treatments. These data suggest that extrusion processing can be used to improve soybean meal quality for use in starter pig diets. Moist extrusion produces a superior product compared to dry extrusion for starter pig diets as indicated by increased ADG and improved feed efficiency.

(Key Words: Starter Pigs, Extrusion, Soybean Meal.)

Introduction

The postweaning "lag" frequently detected in the early-weaned pig has been attributed to an immune (allergic) response to soy protein. Previous research at Kansas State University suggests that moist extrusion processing can be used to process less refined soy products for inclusion in starter pig diets, decreasing the potential for a postweaning lag. Further research has also indicated that dry extrusion can be used to process soybean meal for complex starter diets. During extrusion, the protein structure of the soy product is altered, decreasing the antagonistic properties and increasing the surface area exposed for protein digestion. However, whether or not moist and dry extrusion processing can produce comparable products remains to be answered. Thus, the objective of this experiment was to assess the differences between soybean meal quality when processed by either moist or dry extrusion.

[1]Department of Grain Science and Industry.

Procedures

The experiment was designed as a randomized complete block using 100 pigs (initially 13.0 lb and 21 ± 1 d of age), randomly allotted to one of four treatments based upon weight, gender, and ancestry. Dietary treatments included: 1) corn+dried skim milk+dried whey+casein, 2) corn+soybean meal, 3) corn+dry extruded soybean meal, and 4) corn+moist extruded soybean meal. The diets (Table 1) were formulated to contain 1.4% lysine and 24.4% lactose. Soybean meal (with or without extrusion processing) replaced milk protein on an equal lysine basis. Experimental diets were fed for the entire 28 d experiment. On d 14, fecal samples were collected to determine apparent DM and N digestibilities by feeding chromic oxide as an undigestible marker.

Pigs were housed in an environmentally controlled nursery (five pigs/pen, five pens/treatment). Each pen (4 × 5 ft) contained a self feeder and a nipple waterer to provide *ad libitum* access to both feed and water. Weekly pig weights and feed consumption were collected to determine ADG, ADFI, and F/G ratio.

Soybean meal from the same lot was used in all diets. Soybean meal was moist extrusion with a single screw extruder (Wenger X-20, Wenger Mfg. Sebetha, KS) equipped with a high shear screw, barrel, and die arrangement. Steam and water were added to the extruder to facilitate processing and to prevent burning. The extruded product (approximately 30% moisture) was dried in a double pass, gas-fired dryer (Wenger Mfg. Sebetha, KS) to approximately 12% moisture. Dry extrusion was accomplished by utilizing a single screw extruder (Insta-Pro, Tripple F Feeds Inc., Des Moines, IA). Moisture was not added during this process. After extrusion, the dried product was ground through a Fitz Mill (Fitzpatrick Co., Elmhurst, IL) equipped with a 1/8 in. hammermill screen and mixed into the experimental diets.

Results and Discussion

Trypsin inhibitor concentrations were less than 1 mg/g in unprocessed soybean meal and soybean meal processed by either moist or dry extrusion (.43, .56, and .32 mg/g, respectively). These levels of trypsin inhibitor are below concentrations that typically reduce growth performance. Protein dispersibility index of soybean meal (27.37%) was decreased by using both moist and dry extrusion (15.02% and 15.89%, respectively), suggesting similar amounts of protein denaturization in both processing methods.

Moist and dry extrusion were compared to determine the superior processing method for soy products to be included in starter pig diets. Milk-fed pigs had the greatest ($P<.05$) ADG, ADFI, and F/G compared to pigs fed the soy-based diets (Table 2). Pigs fed extruded soybean meal (moist or dry extrusion) had improved ($P<.05$) ADG, ADFI, and F/G compared to pigs fed a corn-soybean meal diet from d 0 to 14. Nitrogen and DM digestibilities (d 14) were similar between pigs fed moist and dry extruded soybean meal, with pigs fed a milk diet having the greatest ($P<.05$) nutrient digestibilities.

Cumulative (d 0 to 28) ADG was similar between pigs fed a milk-based diet and pigs fed a moist extruded soybean meal diet, with pigs fed a dry extruded soybean meal diet having decreased ($P<.05$) ADG. Pigs fed a nonextruded soybean meal diet had the poorest ($P<.05$) ADG. Average daily feed intake was increased ($P<.05$) in pigs fed either a moist or dry extruded soybean meal diet compared to the nonextruded soybean meal diet from d 0 to 28 postweaning, with pigs fed a soybean meal based diet having the lowest ($P<.05$) ADFI. Feed efficiency was optimized ($P<.05$) in pigs fed a milk diet from d 0 to 28 compared to pigs fed soybean meal diets. Similar F/G was detected in pigs

fed either a moist or dry extruded soybean meal.

Both methods of extrusion processing improved growth performance and nutrient digestibility compared to nonextruded soybean meal. The product quality (trypsin inhibitor and protein dispersibility index) was similar for both moist and dry extrusion processing. Overall ADG was improved by 11.5%, and feed efficiency was improved by 7% in pigs fed moist extruded soybean meal compared to pigs fed dry extruded soybean meal. These data suggest that moist extrusion produces a superior soy product for starter pig diets. The difference between moist and dry extrusion can potentially be explained by differences in protein denaturization and degree of product burning. With moist extrusion of soybean meal, processing methods can be controlled more effectively, resulting in improved product quality.

Table 1. Diet Composition, %

Ingredient	Milk	Soybean meal
Corn	43.56	19.98
Soybean meal (48% CP)	-	45.00
Dried whey, edible grade	20.00	--
Dried skim milk	20.00	--
Casein	7.41	--
Lactose	--	24.40
L-Lysine-HCl	.15	--
Soybean oil	6.00	6.00
Monocalcium phosphate (21% P)	1.24	2.09
Limestone	.49	1.08
Vitamin premix	.25	.25
Trace mineral premix	.15	.15
Copper sulfate	.10	.10
Selenium premix	.05	.05
Salt	--	.30
Antibiotic[b]	.50	.50
Chromic oxide	.10	.10
Total	100.00	100.00

[a]Soybean meal, moist extruded soybean meal, or dry extruded soybean meal was substituted at equal concentration.
[b]CSP-250 provided the following per lb of complete diet (g): oxytetracycline, .11; sulfathiazole, .22; penicillin, .055.

Table 2. The Effect of Moist or Dry Extrusion of Soybean Meal on Weanling Pig Growth Performance and Nutrient Digestibility

Item	Milk	SBM	Dry Extruded SBM	Moist Extruded SBM	CV
d 0 to 14					
ADG, g[bc]	.70	.37	.47	.52	9.8
ADFI, g[bc]	.71	.56	.60	.64	9.5
F/G[bc]	1.01	1.51	1.28	1.23	10.0
d 0 to 28					
ADG, g[bcd]	.79	.40	.69	.78	6.5
ADFI, g[c]	.92	.80	.99	1.04	7.4
F/G[bc]	1.16	2.00	1.43	1.33	8.2
Digestibility					
DM, %	94.5	89.9	91.0	90.3	1.0
N, %	91.3	86.3	89.3	89.0	1.7

[a]A total of 100 pigs initial weight = 5.9 kg, 5 pigs/pen, 5 pens/treatment.
[b]Milk protein vs soy protein ($P<.05$).
[c]Milk protein vs extruded soy protein ($P<.05$).
[d]Moist vs dry extrusion ($P<.10$).

Rodger Anderson, farrowing house and nursery manager.