EFFECT OF SOYBEAN PROCESSING ON STARTER PIG PERFORMANCE AND NUTRIENT DIGESTIBILITY

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Summary

One hundred sixty-eight pigs were used to evaluate the effect of soybean processing on starter pig performance and nutrient digestibility. Soybean products tested were commercial soybean meal, full-fat roasted soybeans from either a Roast-A-Tron or Rickles Roaster, extruded soybeans, and steam-flaked soybeans. Pigs fed soybeans from the Rickles Roaster had lower average daily gain, average daily feed intake, and feed efficiency than pigs fed the other soybean products. Rickles soybeans had lower apparent digestibility of nitrogen, dry matter, total fat, and long chain fatty acids than the other treatments. Pigs fed steam-flaked soybeans had the second lowest growth rate. These results indicate that soybeans processed through a Rickles Roaster are not suitable for starter pigs. Based on the results of this experiment, we conclude that processing method may be a major factor influencing soybean utilization by the early weaned pig.

(Key Words: Soybeans, Pig, Performance, Digestibility, Roasting, Steam Flaking, Extruding.)

Introduction

A number of heating processes have been developed to prepare full-fat soybeans, such as toasting, flaking, and extruding. With dry heat, the anti-nutritional factors are destroyed, but the loss of available lysine can be considerable. Therefore, the objective of the present study was to investigate the effects of different methods of full-fat soybean processing on starter pig performance and nutrient digestibilities.

Experimental Procedures

A growth trial utilizing 168 pigs was conducted to evaluate the method of processing soybeans on starter pig performance and nutrient digestibility. Pigs were weaned at 21 d with an average initial weight of 11.6 lb. Pigs were allotted by litter, sex, and weight to one of six dietary treatments. Five replications per treatment were used with six pigs per pen. Soybean products tested were commercial soybean meal (SBM), SBM plus 5 % soybean oil, soybeans roasted in a Roast-A-Tron® (ROA-A) or Rickles Roaster® (ROA-RC), extruded soybeans (EXTRU), and steam-flaked soybeans (STEAMF). Pigs were housed in a temperature-controlled nursery. Feed and water were supplied ad libitum. Feed intake and body weight were recorded weekly. At 2 wk postweaning, fecal samples were collected from pigs by rectal massage and frozen until analyzed. Apparent digestibilities of dry matter, nitrogen, total fat, and fatty acids were calculated using chromic oxide (.3%) as an indigestible marker.

Composition of the experimental diets is shown on Table 1. A constant calorie:lysine ratio (250 calories/g lysine) was maintained across the six treatments.

Table 1. Diet Composition

Ingredient, %	Control	Control + soy oil	ROA-A	ROA-RC	EXTRU	STEAMF
Corn	58.88	50.49	50.68	31.48	31.48	31.48
Soybean product	26.50	28.80	34.70	34.70	34.70	34.70
Dried whey	10.00	10.00	10.00	10.00	10.00	10.00
Soybean oil	.00	10.00	--	--	--	--
Lysine	.18	.25	.25	.32	.32	.32
Salt	.30	.30	.30	.30	.30	.30
Trace minerals[a]	.10	.10	.10	.10	.10	.10
Vitamins[b]	.25	.25	.25	.25	.25	.25
Copper sulfate	.10	.10	.10	.10	.10	.10
Selenium[c]	.05	.05	.05	.05	.05	.05
Antibiotic[d]	.50	.50	.50	.50	.50	.50
Dical(21% P, 18.5%Ca)	1.84	1.89	1.76	1.76	1.76	1.76
Limestone (38%)	1.00	.97	1.01	1.01	1.01	1.01
Chromic oxide	.30	.30	.30	.30	.30	.30
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated composition, %						
DM	89.30	90.10	91.50	90.80	90.80	91.50
CP	18.56	17.69	19.56	19.50	20.06	19.56
Lysine	1.15	1.25	1.25	1.25	1.25	1.25
Ca	0.90	0.90	0.90	0.90	0.90	0.90
P	0.80	0.80	0.80	0.80	0.80	0.80
Total fat	3.70	8.80	9.90	8.70	9.40	9.70

[a]Trace mineral premix contained 10% Mn, 10% Fe, 10% Zn, 4% Ca, 1% Cu, 0.4% K, 0.3% I, 0.2% Na, and 0.1% Co.

[b]Each lb of premix contained: Vitamin A, 1,000,000 IU; vitamin D_3, 100,000 IU; vitamin E, 4000 IU; menadione, 400 mg; riboflavin 1,000 mg; pantothenic acid, 2,500 mg; niacin, 5,500 mg; choline, 100,000 mg; and vitamin B_{12}, 5 mg.

[c]Each lb of selenium premix contained 272.4 mg Se.

[d]Each lb of antibiotics contained 10 g chlortetracycline, 10 g sulfathiazole, and 5 g penicillin.

Results and Discussion

Growth rate (ADG) of pigs fed the ROA-RC soybeans (Table 2) was poorer (P<.01) than ADG of pigs fed the other treatments. Average daily feed intake (ADFI) was depressed for pigs fed diet containing the ROA-RC soybeans. Pigs fed the diet containing ROA-RC soybeans were less efficient (P<.01) than pigs fed the other treatments. The ROA-RC soybeans were darker than Roast-A-Tron, extruded, or steam flaked soybeans. The product appeared to be overcooked, and that may have contributed to the low ADFI, ADG, and poorer efficiency of gain (F/G). Yet, ROA-RC soybeans had a high urease activity (.35 pH raise), indicating that they were not heated equally, which resulted in some of the soybeans being burned and some of them not being heated adequately. The remaining antinutritional factors in ROA-RC soybeans could have caused the lowered growth performance. The lowered growth rate of pigs fed STEAMF soybeans corresponds with the urease value, which indicated they were under-cooked. Pigs fed the control diet with 5% soybean oil had higher ADG (P<.05) than those fed either ROA-A, EXTRU, or SBM, indicating that extruded or steamflaked soybeans also may have been cooked under improper conditions.

Table 2. Effects of Soybean Processing Methods on Starter Pig Performance

Item	Control	Control + soy oil	ROA-A	ROA-RC	EXTRU	STEAMF	SE
0-2 wk							
ADG, lb	.34[b]	.36[b]	.33[b]	.25[a]	.33[b]	.30[b]	.12
AFI, lb	.49[b]	.47[b]	.46[b]	.43[a]	.43[a]	.42[a]	.08
F/G	2.01[b]	1.72[b]	1.59[a]	2.46[c]	1.38[a]	1.54[a]	1.62
2-5 wk							
ADG, lb	1.11[b]	1.13[b]	1.02[b]	.79[a]	1.01[b]	.92[b]	.23
AFI, lb	1.66[b]	1.75[b]	1.62[b]	1.49[c]	1.53[b]	1.40[a]	.21
F/G	1.53[b]	1.59[b]	1.64[b]	2.39[a]	1.58[b]	1.68[b]	.91
0-5 wk							
ADG, lb	.80[c]	.82[c]	.74[b]	.57[a]	.74[b]	.67[d]	.16
AFI, lb	1.19[b]	1.24[b]	1.16[b]	1.07[a]	1.09[a]	1.01[a]	.15
F/G	1.53[b]	1.53[b]	1.62[b]	2.36[a]	1.54[b]	1.62[b]	.93

[abcd]Means with unlike superscripts differ (P<.05). Five pens per treatment with six pigs per pen.

ROA-RC soybeans showed lower (P<.01) digestibilities for dry matter, nitrogen, total fat and long chain fatty acids (Table 3). These data coincide with the poor growth performance of pigs fed ROA-RC soybeans. Digestibility of stearic acid (C 18:0) over the total tract showed negative values except for extruded soybeans, suggesting that microflora in the large intestine may contribute a large amount of C 18:0 to the fecal samples.

Table 3. Effects of Soybean Processing Methods on Nutrient Digestibility for Young Pigs

Item	Control	Control + oil	ROA-A	ROA-RC	EXTRU	STEAMF	SE
DM	80.4[b]	82.7[b]	81.1[b]	75.9[a]	81.6[b]	83.8[b]	1.97
N	75.9[b]	77.6[b]	74.8[b]	59.6[a]	81.1[b]	77.6[b]	4.23
Total fat	70.5[b]	85.2[a]	73.4[b]	63.2[b]	87.3[a]	82.7[a]	2.13
C16	60.8[b]	75.9[a]	65.4	55.2[b]	78.4[a]	74.8[a]	3.14
C18	-124.9	-6.4	-95.6	-114.4	7.2	-52.8	49.70
C18-1	61.9[b]	82.3[a]	63.3[b]	49.5[c]	83.5[a]	79.7	5.46
C18-2	69.1[b]	77.5[a]	74.7	66.8[b]	78.3[a]	79.5[a]	2.53
C18-3	81.8	94.2[a]	86.1	79.1[b]	94.1[a]	93.3[a]	2.50
Urease pH	0.14	0.14	0.22	0.35	0.22	0.44	

[abc]Means with unlike superscripts differ (P<.05). Each mean represents six observations.

Based on the results from this experiment, full-fat soybeans processed with the Rickles Roaster may be undesirable for use in starter pig diets. The soybeans processed on the Rickles Roaster for this study were made on an experimental prototype. It is understood that later versions may have been substantially improved. Also, soybeans processed in different ways do not have the same nutritional values for starter pigs.