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Effects of alternative soy sources on growth performance in early-weaned pigs

Abstract

A total of 144 pigs (initial body wt of 10.4 lb) was used in a 56-d growth assay to determine the effects of different soybean preparations on growth performance and cost of gain in nursery pigs. Experimental diets were fed in three phases from d 0 to 35 postweaning (Le., d 0 to 7, 7 to 21, and 21 to 35). Treatments were a soybean meal-based regimen; a dry-extruded whole soybeans (mill-run) regimen; and a specially processed soy products regimen (Le., soy isolate in Phase I, soy concentrate in Phase 11, and extruded soy flour in Phase Ill). All diets were formulated to 1. 55, 1. 25, and 1.15% lysine for Phases I, 11, and III, respectively. Fat additions to the soybean meal and specialty soy product treatments were 2, 2, and 3%, for Phases I, 11, and III, respectively. The diets with extruded soybeans had more total fat (2.5, 3.8, and 4.8% greater percentage ether extract in Phases I, 11, and III, respectively) than the soybean meal-based control. On d 35 postweaning, the pigs were switched to the same soybean meal-based grower diet (.9% lysine) for a period of 3 wk. During Phase I (d 0 to 7 postweaning), pigs fed soybean meal gained 25% less and were 22% less efficient than those fed extruded soybeans and the specially processed soy products. Average daily feed intake was not affected by dietary treatment; however, pigs fed the specially processed soy product had the greatest ADG of any treatment, and numerically, the best efficiencies of gain. No statistical differences were found for ADG, ADFI, or F/G among treatments from d 7 to 21, 21 to 35, or 35 to 56 of the experiment. Thus, overall (from d 0 to 56 postweaning), pigs fed the various soybean protein sources had similar growth performance. However, overall costs per pound of gain were $.33, $.34, and $.42 for pigs fed extruded soybeans, soybean meal, and the specialty soy products, respectively. In conclusion, although the specially processed soy products regimen (Le., soy isolate) supported the greatest growth performance immediately after weaning (d 0 to 7), the best cost of gain was achieved by feeding extruded soybeans. However, the additional fat provided by extruded soybeans did not influence pig performance in this experiment.; Swine Day, Manhattan, KS, November 17, 1994

Keywords

Swine day, 1994; Kansas Agricultural Experiment Station contribution; no. 95-175-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 717; Swine; Pigs; Soybeans; Extrusion; Growth; Cost of gain

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EFFECTS OF ALTERNATIVE SOY SOURCES ON GROWTH PERFORMANCE IN EARLY-WEANED PIGS

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Summary

A total of 144 pigs (initial body wt of 10.4 lb) was used in a 56-d growth assay to determine the effects of different soybean preparations on growth performance and cost of gain in nursery pigs. Experimental diets were fed in three phases from d 0 to 35 postweaning (i.e., d 0 to 7, 7 to 21, and 21 to 35). Treatments were a soybean meal-based regimen; a dry-extruded whole soybeans (mill-run) regimen; and a specially processed soy products regimen (i.e., soy isolate in Phase I, soy concentrate in Phase II, and extruded soy flour in Phase III). All diets were formulated to 1.55, 1.25, and 1.15% lysine for Phases I, II, and III, respectively. Fat additions to the soybean meal and specialty soy product treatments were 2, 2, and 3%, for Phases I, II, and III, respectively. The diets with extruded soybeans had more total fat (2.5, 3.8, and 4.8% greater percentage ether extract in Phases I, II, and III, respectively) than the soybean meal-based control. On d 35 postweaning, the pigs were switched to the same soybean meal-based grower diet (.9% lysine) for a period of 3 wk. During Phase I (d 0 to 7 postweaning), pigs fed soybean meal gained 25% less and were 22% less efficient than those fed extruded soybeans and the specially processed soy products. Average daily feed intake was not affected by dietary treatment; however, pigs fed the specially processed soy product had the greatest ADG of any treatment, and numerically, the best efficiencies of gain. No statistical differences were found for ADG, ADFI, or F/G among treatments from d 7 to 21, 21 to 35, or 35 to 56 of the experiment. Thus, overall (from d 0 to 56 postweaning), pigs fed the various soybean protein sources had similar growth performance. However, overall costs per pound of gain were $.33, $.34, and $.42 for pigs fed extruded soybeans, soybean meal, and the specialty soy products, respectively. In conclusion, although the specially processed soy products regimen (i.e., soy isolate) supported the greatest growth performance immediately after weaning (d 0 to 7), the best cost of gain was achieved by feeding extruded soybeans. However, the additional fat provided by extruded soybeans did not influence pig performance in this experiment.

(Key Words: Pigs, Soybeans, Extrusion, Growth, Cost of Gain.)

Introduction

To avoid the high costs of milk products and the antinutritional factors found in soybean meal, many nutritionists and livestock feeders have elected to use specially processed soybean products in diets for weanling pigs and calves. In the past few years at Kansas State University, several research projects have been conducted to identify the soybean source that gives the best performance in newly weaned pigs. Jones et al. (p 54, 1989 KSU Swine Day) reported that specially processed soy protein isolate was of similar nutritional value, with a much lower cost, compared to the proteins from dried skim milk and dried whey. More recently, Hancock et al. (p 40, 1991 KSU Swine Day) observed equal or greater growth performance (depending on soybean genotype) when soybean meal and soy oil in a nursery diet were replaced with dry-extruded whole soybeans. However, use of extruded whole soybeans to replace soybean meal adds considerably more fat than we currently recommend (i.e., 2 to 3% added fat) for nursery diets, and previous research at KSU (p 77, 1989 KSU Swine Day) indicated no benefit from high-fat nursery diets fed immediately after weaning. Therefore, the objective of this experiment was to evaluate the nutritional value of highly refined soybean products, extruded whole soybeans, and soybean meal and to determine the consequences of these soybean products on cost of gain during the nursery phase.

Procedures

A total of 144 pigs (initial body wt of 10.4 lb) was used in a 56-d growth assay. The pigs were blocked by weight and assigned to three treatments based on sex and ancestry. There were six pigs per pen and eight pens per treatment. The experimental diets were fed in three phases (d 0 to 7, 7 to 21, and 21 to 35) from d 0 to 35 postweaning. Treatments were a soybean meal-based regimen; a dry-extruded whole soybeans regimen; and a specially processed soy products regimen (i.e., soy isolate in Phase I, soy concentrate in Phase II, and extruded soy flour in Phase III). The extruded soybeans were mill-run and prepared with dry extrusion using an Instra-Pro® extruder. Barrell temperature during extrusion was 297.7°F. Phase I diets (Table 1) were formulated to 1.55% lysine and .44% methionine with 20% dried whey, 10% lactose, 2% spray-dried blood meal, and 8% porcine plasma protein. Phase II diets (Table 2) were formulated to 1.25% lysine and .35% methionine with 20% dried whey and 2% spray-dried blood meal. Phase III diets (Table 3) were formulated to 1.15% lysine and .32% methionine. Fat additions to the soybean meal and specialty soy product treatments were 2, 2, and 3% for Phases I, II, and III. These are the fat additions we normally recommend. The diets with extruded soybeans had more total fat (2.5, 3.8, and 4.8% greater percentages ether extract in Phases I, II, and III, respectively) than the soybean meal-based control diet, but these had surprisingly small effects on calculated metabolizable energy (ME) concentrations of the diets (Tables 1, 2, and 3). Thus, one of our objectives was to determine if the extra fat from practical diets with extruded soybeans would affect growth performance. The diets for all three phases were fed in pelleted form. On d 35 postweaning, the pigs were switched to the same soybean meal-based grower diet (Table 3) for a period of 3 wk. The grower diet was formulated to .9% lysine, .7% Ca, and .6% P and was fed in meal form.

The pigs were housed in an environmentally controlled nursery room for the nursery experiment and transferred to a grower facility for the growing phase. The temperature was maintained at approximately 90°F for the first week of the experiment and reduced by 5°F per week thereafter. The pigs had ad libitum access to feed and water. Weight gain and feed disappearance were recorded on d 7, 21, 35, and 56 of the experiment to allow calculation of ADG, ADFI, and F/G.

Results and Discussion

During Phase I (d 0 to 7 postweaning), pigs fed soybean meal gained 25% less and were 22% less efficient than those fed extruded soybeans and the specially processed soy products ($P<.001$). Average daily feed intake was not affected by dietary treatment; however, pigs fed the specially processed soy product had the greatest ADG of any treatment ($P<.001$) and, numerically, the best efficiency of gain (improvements of 35 and 26% for ADG and F/G, respectively, compared to the soybean meal-based control).

No differences were found among treatments ($P>.2$) for ADG, ADFI, or F/G from d 7 to 21, 21 to 35, or 35 to 56 of the experiment. Thus, overall (from d 0 to 56 postweaning), pigs fed the various soybean protein sources had similar growth performance. However, cost of gain was different. The average cost of nursery diets with extruded soybeans was 2 and 26% less than that of diets with soybean meal and specially processed soy products (using ingredient costs of \$235.20/ton for soybean meal, \$213.67/ton for soybeans, \$20/ton for extrusion cost, \$770/ton for soy protein isolate, \$580/ton for soy protein concentrate, $290/ton for soy flour, and $35.60/cwt for soybean oil). For d 0 to 7, cost per pound of gain was lowest for pigs fed extruded soybeans, but for d 0 to 35, cost of gain was identical for pigs fed extruded soybeans and soybean meal. Pigs fed the specially processed soy products had relatively high cost of gain for d 7 to 21 and 21 to 35, resulting in the greatest cost of gain for the overall nursery phase (i.e., d 0 to 35). For d 0 to 56, cost of gain for pigs fed extruded whole soybeans was 3% less than that for pigs fed soybean meal and 27% less than that for pigs fed the specially processed soy products. We should note, however, that the overall advantage in cost of gain for pigs fed extruded soybeans compared to soybean meal resulted from differences for d 35 to 56 while the animals were fed the same diet. Whether this was a carryover effect from d 0 to 35 or simply a chance effect will require further investigation.

In conclusion, the best cost of gain was achieved by feeding extruded soybeans, although the greater fat concentration in these diets did not greatly increase calculated ME or improve efficiency of gain as one might expect. Feeding the specially processed soy products (i.e., soy isolate) during Phase I did improve growth performance of weanling pigs, but for the overall nursery period, the specially processed soy products had the greatest cost of gain. Thus, decisions on which soy product(s) to include in nursery diets should be made by considering the value of differences in early growth performance and the cost of the various soy products at any particular time.

Table 1. Diets for Phase I, %[a]

Item	Soybean meal	Extruded soybeans	Specialty products[b]
Corn	35.08	27.78	43.32
Dried whey	20.00	20.00	20.00
Soybean meal	18.56	--	--
Extruded soybeans	--	27.86	--
Soy isolate	--	--	10.10
Lactose	10.00	10.00	10.00
Porcine plasma protein	8.00	8.00	8.00
Soybean oil	2.00	--	2.00
Blood meal	2.00	2.00	2.00
Monocalcium phosphate	1.97	1.83	2.05
Limestone	.65	.78	.82
Vitamins and minerals premix[c]	.40	.40	.40
L-lysine HCl	.10	.10	.10
DL-methionine	.16	.17	.13
Copper sulfate	.08	.08	.08
Antibiotic[d]	1.00	1.00	1.00
Calculated analysis			
CP, %	21.5	21.7	22.1
Ether extract, %	3.9	6.4	4.1
ME, kcal/lb	1,463	1,479	1,480

[a]Phase I diets were formulated to 1.55% lysine, .44% methionine, .9% Ca, and .8% P.
[b]Specialty products were soy isolate for Phase I, soy concentrate for Phase II, and soy flour for Phase III.
[c]KSU vitamin and mineral premixes.
[d]Provided 150 g/ton of apramycin.

Table 2. Diets for Phase II, %[a]

Item	Soybean meal	Extruded soybeans	Specialty products
Corn	48.12	38.84	54.63
Dried whey	20.00	20.00	20.00
Soybean meal	23.72	--	--
Extruded soybeans	--	35.00	--
Soy concentrate	--	--	16.58
Soybean oil	2.00	--	2.00
Blood meal	2.00	2.00	2.00
Monocalcium phosphate	1.68	1.52	2.32
Limestone	.74	.89	.74
Vitamin and mineral premix	.40	.40	.40
L-lysine HCl	.10	.10	.10
DL-methionine	.06	.07	.05
Copper sulfate	.08	.08	.08
Salt	.10	.10	.10
Antibiotic[b]	1.00	1.00	1.00
Calculated analysis			
CP, %	19.3	19.5	19.7
Ether extract, %	4.3	8.1	4.4
ME, kcal/lb	1,478	1,509	1,503

[a]Phase II diets were formulated to 1.25% lysine, .35% methionine, .9% Ca, and .8% P.
[b]Provided 50g/ton of carbadox.

Table 3. Diets for Phase III and the Common Grower Diet, %[a]

Item	Soybean meal	Extruded soybeans	Specialty products	Grower
Corn	64.49	54.52	66.11	67.91
Soybean meal	28.62	--	--	24.26
Extruded soybeans	--	41.56	--	--
Extruded soy flour	--	--	26.80	--
Soybean oil	3.00	--	3.00	5.00
Monocalcium phosphate	1.59	1.43	1.69	1.20
Limestone	.90	1.08	1.02	.88
Vitamin and mineral premix	.40	.40	.40	.40
L-lysine HCl	.10	.10	.10	--
DL-methionine	.02	.03	--	--
Copper sulfate	.08	.08	.08	--
Salt	.30	.30	.30	.30
Antibiotic	.50[b]	.50[b]	.50[b]	.05[c]
Calculated analysis				
CP, %	19.6	20.0	19.8	17.1
Ether extract, %	5.7	10.5	5.7	7.8
ME, kcal/lb	1,539	1,576	1,500	1,590

[a]Phase III diets were formulated to 1.15% lysine, .32% methionine, .8% Ca, and .7% P. The common grower diet was formulated to .9% lysine, .7% Ca, and .6% P.
[b]Provided 100, 100, and 50 g/ton of chlortetracycline, sulfathiazole, and penicillin, respectively.
[c]Provided 40 g/ton of tylosin.

Table 4. Effects of Soy Sources on Growth Performance of Early-Weaned Pigs[a]

Item	Soybean meal	Extruded soybeans	Specialty products	CV
d 0 to 7				
ADG, lb[b,c]	.46	.53	.62	10.7
ADFI, lb	1.03	.97	1.03	12.1
F/G[b]	2.23	1.83	1.66	19.0
d 7 to 21				
ADG, lb	.70	.70	.65	14.0
ADFI, lb	1.38	1.53	1.41	7.0
F/G	1.97	2.18	2.17	21.5
d 21 to 35				
ADG, lb	1.16	1.08	1.08	10.9
ADFI, lb	2.27	2.13	2.38	15.9
F/G	1.82	1.97	2.20	15.1
d 0 to 35				
ADG, lb	.77	.77	.78	9.9
ADFI, lb	1.56	1.47	1.60	9.4
F/G	2.03	1.91	2.05	12.2
d 35 to 56				
ADG, lb	1.31	1.37	1.35	9.4
ADFI, lb	3.58	3.66	3.63	6.6
F/G	2.73	2.67	2.69	10.4
d 0 to 56				
ADG, lb	.91	.92	.93	7.3
ADFI, lb	2.06	2.08	2.11	3.5
F/G	2.26	2.26	2.27	6.8
Diet cost/ton, $				
Phase I	752.40	745.49	872.34	--
Phase II	416.80	409.95	558.72	--
Phase III	287.60	275.51	373.84	--
Grower	195.72	195.72	195.72	--
Cost/lb of gain, $				
d 0 to 7[d]	.84	.68	.72	17.6
d 7 to 21[e,f]	.41	.45	.61	24.2
d 21 to 35[e,f]	.26	.27	.41	22.4
d 0 to 35[f]	.39	.39	.52	13.8
d 35 to 56	.27	.26	.26	15.0
d 0 to 56[d,f]	.34	.33	.42	12.8

[a]One hundred and forty four weanling pigs were used (initial body wt of 10.4 lb) with six pigs per pen and eight pens per treatment.
[b,d,e]Soybean meal vs others ($P<.001$, .01, and .05, respectively).
[c,f]Extruded soybeans vs specialty products ($P<.001$ and .05, respectively).