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A COMPARISON OF RAW SOYBEANS AND SOYBEAN OIL AS ENERGY SOURCES FOR FINISHING PIGS

R.D. Goodband, R.H. Hines,
and R.C. Thaler

Summary

Two hundred and seventy pigs averaging 125 lbs were utilized in two growth trials to determine the effects of raw soybeans or soybean oil on finishing pig performance. In each trial, raw soybeans or soybean oil were substituted for milo to provide 2 or 3% added fat. Pigs fed these diets were compared to pigs fed a milo-soybean meal diet (control). In Experiment 1, raw soybeans or soybean oil were added in place of milo in a 15% crude protein, .7% lysine diet. Increasing levels of raw soybeans resulted in greater trypsin inhibitor content compared to the control or soybean oil diets. Pigs fed diets containing soybean oil showed a slight tendency ($P<.15$) for improved average daily gain (ADG) compared to pigs fed raw soybeans. Pigs fed raw soybeans also had poorer feed efficiency (F/G) compared to those fed soybean oil ($P<.01$) and the control diet ($P<.05$). Plasma urea concentrations measured on day 21 of the trial were lower for pigs fed the soybean oil diets than for pigs fed the control ($P<.10$) and raw soybean ($P<.01$) diets. In Experiment 2, control pigs were fed a low protein, lysine-fortified diet (11.2% crude protein, .60% lysine). Pigs fed the control diet tended to have higher ADG ($P<.12$) and average daily feed intake (ADFI) than pigs fed diets containing raw soybeans or soybean oil. Feed efficiency was not influenced by dietary treatment. Plasma urea concentrations were highest ($P<.01$) for pigs fed diets containing raw soybeans. These results indicate that, in a typical finishing diet (15% crude protein, .7% lysine), the addition of raw soybeans as an energy source reduced pig performance compared to diets containing 2 or 3% soybean oil. Additions of raw soybeans also resulted in poorer F/G for pigs compared to the diet without added fat. However, when low protein diets were fed, fat additions from either soybean oil or raw soybeans resulted in slightly poorer pig performance compared to the control diet.

Introduction

Numerous studies have been conducted to determine the effects of raw soybeans as a protein source in swine diets. The anti-nutritional factors contained in raw soybeans have resulted in inferior performance of starter and finishing pigs. However, additions of raw soybeans to gestation diets do not adversely affect performance. Therefore, the age of the pig may affect its ability to efficiently utilize raw soybeans in the diet. Fat additions to swine diets have been shown to have beneficial effects on pig performance, provided a constant calorie/protein ratio was maintained. Therefore, two trials were conducted to compare raw soybeans and soybean oil as energy sources for finishing pigs.

Experimental Procedure

Two hundred and seventy, crossbred, finishing pigs averaging 125.1 lbs were utilized in two 63-day growth trials. Pigs were allotted to one of five dietary treatments on the basis of weight, ancestry, and sex in a randomized complete block design. Pigs were housed in 6 x 15 ft pens with half slotted and half solid concrete flooring in a modified open-front finishing facility. Each pen was equipped with a two-hole feeder and a nipple waterer. Feed and water were available ad libitum. Pigs were weighed at 21-day intervals, and feed intake and efficiency were determined. On day 21 of each trial, pigs were bled, and serum was collected for determination of plasma urea concentrations. Feed samples were obtained for trypsin inhibitor analysis according to the American Association of Cereal Chemists. Orthogonal contrasts were used to compare differences between treatment means.

Experiment 1

Experiment 1 utilized 120 pigs averaging 121.7 lbs with eight pigs per pen and three pens per treatment. Dietary treatments included a milo-soybean meal diet (control; 15% crude protein, .7% lysine) and diets containing 2 or 3% added fat from either raw soybeans or soybean oil (table 1). Soy oil or raw soybean additions were made at the expense of milo.

Experiment 2

Experiment 2 utilized 150 pigs averaging 128.5 lbs with 10 pigs per pen and three pens per treatment. Because of the protein supplied by the raw soybeans, a low protein, lysine-fortified control diet (11.4% crude protein, .6% lysine) was used (table 2) to avoid excessive protein levels in the diet.

Results and Discussion

Increasing levels of raw soybeans in the diet resulted in an increase in the trypsin inhibitor content of diets in Experiments 1 and 2 (table 1 and 2, respectively). Trypsin inhibitor, as well as several other anti-nutritional factors present in raw soybeans, have been shown to reduce protein digestibility and decrease pig performance. In Experiment 1, pigs fed diets containing 2 or 3% soybean oil had slightly higher ($P < .15$) average daily gain (ADG) than pigs fed diets containing raw soybeans. Pigs fed the control diet were not different in ADG from pigs fed either added soy oil or raw soybeans. Average daily feed intake was not affected by dietary treatment. Pigs fed raw soybeans had poorer feed efficiency (F/G) compared to pigs fed soy oil ($P < .01$) or control ($P < .05$) diets. Although not significantly different ($P > .18$), pigs fed soy oil containing diets were 5% more efficient than pigs fed the control diet. Plasma urea concentrations of pigs fed the added soy oil diets were lower than those of pigs fed the control ($P < .10$) and raw soybean ($P < .05$) diets. These data indicate that raw soybeans did not adversely affect ADG, but was slightly inferior to added soy oil. Pigs fed raw soybeans had the poorest F/G, possibly as a result of the trypsin inhibitors impairing digestive enzymes. The lower plasma urea concentrations of pigs fed the soy oil diets suggest that with the increased energy level of the diet, less dietary protein was

deaminated, resulting in more efficient protein utilization. However, the high plasma urea concentrations of pigs fed raw soybeans indicated that some of the extra protein provided by raw soybeans was absorbed, but not efficiently utilized.

Dietary fat additions from either soybean oil or raw soybeans in low protein diets resulted in a tendency for decreased ADG ($P<.10$) and average daily feed intake (ADFI) ($P<.12$) compared to control pigs (table 4). Feed efficiency was not affected by dietary treatment. Plasma urea concentrations were not different between pigs fed the control or added soy oil diets; however, both were lower ($P<.01$) than those of pigs fed diets containing raw soybeans. Soybean oil additions resulted in decreased ADG because of decreased ADFI and subsequently lowered intake of lysine and other amino acids. However, the lysine and other amino acids provided by the raw soybeans were not utilized, as indicated by the similar ADG and high plasma urea concentrations compared to those of pigs fed soy oil diets. As in Experiment 1, the high plasma urea levels of pigs fed raw soybeans indicated some absorption but poor protein utilization.

These data indicate that addition of raw soybeans as an energy source in finishing diets resulted in poorer F/G and a tendency for lower ADG in pigs compared to diets containing soybean oil. These results may have been caused by the anti-nutritional factors contained in raw soybeans. However, in low protein diets, addition of soybean oil reduced ADG by lowering daily intake of lysine, other essential amino acids, vitamins, and minerals.



Dr. Bob Hines prepares a report on a completed research project.

Table 1. Composition of Diets, Trial 1.

Ingredient, %	Control	Soy oil		Raw soybeans	
		2%	3%	2%	3%
Milo, ground	79.35	77.35	76.35	68.15	62.55
Soybean meal	18.25	18.25	18.25	18.25	18.25
Soy oil	----	2.0	3.0	----	----
Raw soybeans	----	----	----	11.2	16.8
Monocalcium phosphate	1.00	1.00	1.00	1.00	1.00
Limestone	.80	.80	.80	.80	.80
Salt	.40	.40	.40	.40	.40
Trace mineral premix	.05	.05	.05	.05	.05
Vitamin premix	.15	.15	.15	.15	.15

Calculated Analysis:					
Crude protein, %	15.1	15.0	14.9	18.3	19.9
Lysine, %	.69	.69	.69	.94	1.06
Ca, %	.60	.60	.60	.63	.64
P, %	.56	.55	.55	.59	.61
Me, Kcal/lb	1421	1463	1483	1437	1445

Trypsin inhibitor, units/mg	17.0	11.0	18.5	50.5	75.0

Table 2. Composition of Diets, Trial 2

Ingredient, %	Control	Soy oil		Raw soybeans	
		2%	3%	2%	3%
Milo, ground	89.85	87.85	86.85	78.65	73.05
Soybean meal	7.50	7.50	7.50	7.50	7.50
Soy oil	----	2.0	3.0	----	----
Raw soybeans	----	----	----	11.2	16.8
L-Lysine HCL	.25	.25	.25	.25	.25
Monocalcium phosphate	1.00	1.00	1.00	1.00	1.00
Limestone	.80	.80	.80	.80	.80
Salt	.40	.40	.40	.40	.40
Trace mineral premix	.05	.05	.05	.05	.05
Vitamin premix	.15	.15	.15	.15	.15

Calculated Analysis:					
Crude protein, %	11.4	11.2	11.1	14.5	16.1
Lysine, %	.61	.60	.60	.85	.97
Ca, %	.55	.55	.55	.58	.59
P, %	.52	.52	.52	.56	.57
Me, Kcal/lb	1426	1466	1487	1441	1449

Trypsin inhibitor, units/mg	10.5	15.5	15.0	54.5	67.5

Table 3. Effects of Soy Oil and Raw Soybean Additions in Finishing Diets, Experiment 1^a

Item	Control	Treatments			
		Soy oil		Raw soybeans	
		2%	3%	2%	3%
Average daily gain, lbs ^b	1.83	1.77	1.92	1.74	1.74
Average daily feed intake, lbs	7.05	6.54	7.01	7.20	6.96
Feed efficiency ^{cd}	3.86	3.71	3.65	4.14	4.22
Plasma urea, mg/dl ^{ce}	22.8	20.2	17.6	24.7	26.7

^aA total of 120 finishing pigs, 8 pigs/pen with 3 pens/treatment, average initial wt. 121.7 lbs., average final wt. 234.4, trial duration 63 days.

^bSoy oil vs raw soybeans (P<.15).

^cSoy oil vs raw soybeans (P<.01).

^dControl vs raw soybeans (P<.05).

^eControl vs soy oil (P<.10).

Table 4. Effects of Soy Oil and Raw Soybean Additons to Finishing Diets, Experiment 2^a

Item	Treatments				
	Control	Soy oil		Raw soybeans	
		2%	3%	2%	3%
Average daily gain, lbs ^b	1.73	1.64	1.66	1.64	1.65
Average daily feed intake, lbs ^c	6.51	6.01	6.12	6.28	6.11
Feed efficiency	3.77	3.71	3.68	3.83	3.71
Plasma urea, mg/dl ^{de}	13.5	14.0	14.0	18.5	19.8

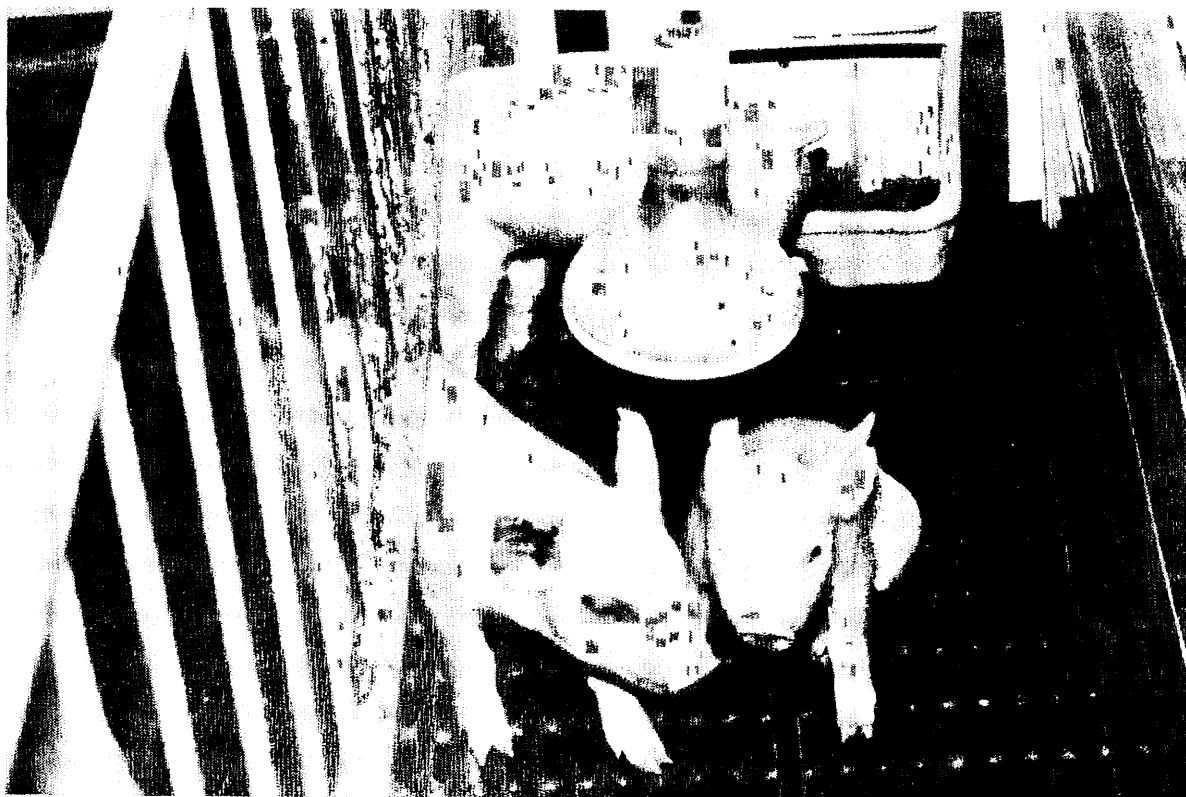
^aA total of 150 finishing pigs, 10 pigs/pen with 3 pens/treatment, average initial wt. 128.5, average final wt. 223.5, trial duration 63 days.

^bControl vs soy oil and raw soybeans ($P < .10$).

^cControl vs soy oil and raw soybeans ($P < .12$).

^dSoy oil vs raw soybeans ($P < .01$).

^eControl vs raw soybeans ($P < .01$).



Pigs in the KSU farrowing house.