EFFECT OF SOURCE OF DIETARY PROTEIN ON PERFORMANCE OF EARLY WEANED PIGS

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Story in Brief

Seventy-two Yorkshire pigs weaned at 21 days of age were allotted to one of seven treatments with different protein sources serving as the primary lysine source at the expense of dried skim milk. All diets were formulated to contain 18% crude protein, 1.5% lysine and 40% whey. Trial length was 14 days with gain and efficiency of gain estimates obtained weekly. Average daily gain and efficiency of gain was higher in pigs fed the dried skim milk diet, the two isolated soy protein diets or the three soy protein concentrate diets when compared to pigs fed the soybean meal diet during week 1, week 2 or for the 2-week period. Average daily feed intake during the first week was lowest in pigs fed the soybean meal diet. During the second week on trial and for the 2-week period, average daily feed intake among the dietary treatments was similar. Performance of pigs fed either isolated soy protein or soy protein concentrate as the supplemental protein source was equal to the performance of those fed the dried skim milk diet. During the subsequent 3-week period there was no treatment effect. Either isolated soy protein or soy protein concentrate can be used with whey to replace dried skim milk as the protein source for pigs from three to five weeks of age.

(Key Words: Swine, Early Weaned Pigs, Isolated Soy Protein, Soy Protein Concentrate.)

Introduction

Weaning of pigs as early as three weeks is commonly followed by a decrease in growth rate and feed intake. In addition, diarrhea is a frequent problem. Weaning as early as 18 days is considered essential in order to shorten the breeding cycle and maximize reproductive efficiency.

It has been very well documented that growth rate and efficiency of feed utilization of early weaned pigs are much better with milk protein than with soy

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protein. Milk proteins have been used in the prestarter diet to minimize the effect of the 5- to 10-day postweaning lag period.

Due to the high cost of milk proteins, soybean flakes have been supplemented with essential amino acids and/or digestive enzymes as well as treated with alkali or acid to improve performance and efficiency of utilization. Recently two studies (Dietz et al., 1988; Geurin et al., 1988) indicate that some sources of refined soy protein will support performance similar to that observed in pigs fed milk proteins. The ability to utilize the soy protein from soy protein concentrate or isolated soy protein could be a means of reducing the inclusion rate of more expensive milk proteins in the diet of early weaned pigs. This study was conducted to determine the effect of source of protein and method of processing of soy protein upon gain, efficiency of gain and feed intake for pigs weaned at 21 days of age.

Materials and Methods

Seventy-two Yorkshire pigs were used to study the effect of dietary protein source on performance of early weaned pigs. Thirty-six pigs in each of two replicates were allotted by sex, litter and weight to one of seven dietary treatments providing a total of 10 pigs per treatment with a mean initial weight of 11 lb. Pigs began the trial after being weaned at approximately 21 days of age. During the first 14 days (Period 1), one milk and six soy protein sources were used to formulate experimental diets (Table 1) which met NRC (1988) requirements for the 11- to 22-lb pig. Protein sources were dried skim milk (DSM), two isolated soy proteins, three soy protein concentrates (SPC) and 50% crude protein solvent extracted soybean meal. The two isolated soy proteins were selected to include a soluble (ISP I) and an insoluble (ISP II) isolated soy protein. The three soy protein concentrates represent three different methods for insolubilizing the major proteins while the low molecular weight components were removed. Pigs were individually housed in metabolism crates measuring 1.54 x 2.49 feet in an environmentally controlled feeding room. Temperature was maintained at 88°F during the first week and was decreased 3.6°F per week for the remainder of the experiment. Pigs had ad libitum access to feed and water throughout the trial and remained on trial for a 35-day period with pig weight and feed intake recorded weekly. In the subsequent 21-day period, all pigs were fed a common 18% crude protein starter diet (Table 2) to determine the effect of previous diet on subsequent performance. The data for each response criteria were analyzed by least squares analysis of variance.

Table 1. Composition (%) of experimental diets fed during Period 1 (2 weeks).

Ingredient	Diets[a,b]						
	DSM	ISP I	ISP II	SPC I	SPC II	SPC III	SBM
Soybean meal, 50% CP							24.12
Soy protein concentrate I[c]				25.09			
Soy Protein concentrate II[d]					25.09		
Soy protein concentrate III[e]						25.09	
Isolated soy protein I[f]		20.29					
Isolated soy protein II[g]			20.29				
Dried skim milk	40.00						
Whey, dried whole	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Lactose		20.62	20.62	20.62	20.62	20.62	20.62
Cerelose	7.31	4.77	4.77				.27
Soybean oil	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Lysine, HCl	.19.			.04	.04	.04	.44
DL-Methionine	.16	.30	.30	.24	.24	.24	.35
Tryptophan							.03
Threonine							.09
Lecithin	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Apralan[h]	.10	.10	.10	.10	.10	.10	.10
Calcium carbonate		.53	.53	.50	.50	.50	.39
Dicalcium phosphate		1.15	1.15	1.17	1.17	1.17	1.35
Vit. TM premix[i]	.94	.94	.94	.94	.94	.94.	.94

Table 1. (Continued).

Salt	.30	.30	.30	.30	.30	.30	.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[a] As fed basis.
[b] DSM: dried skim milk diet; ISP I: isolated soy protein (soluble) diet, ISP II: isolated soy protein (insoluble) diet; SPC I, II AND III: Soy protein concentrate diet; SBM: soybean meal diet.
[c] Promocon-plus, Central Soya, Fort Wayne, IN.
[d] Promine, Central Soya, Fort Wayne, IN.
[e] Promocaf, Central Soya, Fort Wayne, IN.
[f] PP-620, Protein Technologies International, St Louis, MO.
[g] PP-HD-90, Protein Technologies International, St Louis, MO.
[h] Contained 75 g Apramycine per lb.
[i] Supplied 8,800 IU vitamin A, 880 IU vitamin D, 37 IU vitamin E, 44mg pantothenic acid, 59 mg niacin, 8.8 mg riboflavin, 7.3 mg menadione sodium bisulfate, .04 mg vitamin B_{12}, 3 mg biotin, 6 mg pyridoxine, 2 mg folic acid, 10 mg thiamin, 880 mg choline chloride, .2 mg selenium, .06 g manganese, .2 g zinc, .2 g iron, .2 g copper, .2 g magnesium, 1.0 g potassium and .4 mg iodine, per kg of feed.

Table 2. Composition of experimental diets fed during Period 2 (3 weeks).

Ingredients	% of diet[a]
Yellow corn	67.30
Soybean meal (44% CP)	28.50
Dicalcium phosphate	1.95
Calcium carbonate	.90
Vitamin TM premix[b]	.37
Lysine, HCl	.15
Salt	.40
Copper sulfate	.07
Banmith (pyrantel tartrate - 48 g/lb)	.10
Mecadox - 10 (Carbadox - 10 g/lb)	.25
	100.00
Calculated composition of diet	
ME (Kcal/lb)	1429
Lysine, %	1.1
Crude protein, %	18.5
Threonine, %	.75
Tryptophan, %	.22
Met + Cys, %	.61
Calcium, %	.85
Phosphorus,%	.70
Actual analysis	
Crude protein (N X 6.25)	20.6

[a] As fed basis.

[b] Supplied 8,800 IU vitamin A, 880 IU vitamin D, 37 IU vitamin E, 44 mg pantothenic acid, 50 mg niacin, 8.8 mg riboflavin, 7.3 mg menadione sodium bisulfate, .04 mg vitamin B12, 880 mg choline chloride, .2 mg selenium, .06 g manganese, .2 g zinc, .2 g iron, .2 g copper, .4 mg iodine.

Results and Discussion

During the first week postweaning, pigs fed the dried skim milk, isolated soy protein and soy protein concentrate diets grew faster (P<.01) than those fed soybean meal (Table 3). The magnitude of response ranged from a 110% increase in average daily gain in pigs fed the ISP I diet to a 70% increase in average daily gain in pigs fed the SPC III diet when compared to gain of pigs fed the soybean meal diet. Average daily gain was similar between pigs fed the two isolated soy protein diets or among pigs fed the three soy protein concentrate diets. During the second week, pigs fed the soybean meal diet continued to grow more slowly (P<.01) than those fed either of the two isolated soy protein diets or the three soy protein concentrate diets, however, average daily gain in pigs fed the dried skim milk or soybean meal diet was similar. During the entire 14-day period, average daily gain of pigs fed the soybean meal diet was lower (P<.05) than that of pigs fed any other dietary treatments.

Average daily feed intake during the first week was lowest (P<.01) in pigs fed the soybean meal diet when compared to pigs fed the dried skim milk, the two isolated soy protein or the three soy protein concentrate diets. Average daily feed intake was similar among pigs fed the dried skim milk diet, the two isolated soy protein diets and the three soy protein concentrate diets. The largest difference in feed intake was observed during week 1 where pigs fed the dried skim milk diet, the two isolated soy proteins and the three soy protein concentrate diets during the first week consumed 40, 38 and 32% more feed per day, respectively, than those fed the soybean meal diet. During the second week on trial and for the entire 2-week period, average daily feed intake among the dietary treatments was similar.

The effect of dietary protein source on efficiency of feed utilization was similar to that observed for average daily gain. Pigs fed the dried skim milk diet, the two isolated soy protein diets and the three soy protein concentrate diets had a higher (P<.05) gain to feed ratio during the first and the second weeks and for the entire 14-day experimental period than those fed the soybean meal diet. No significant differences were observed, however, among the dried skim milk, the two isolated soy protein and the three soy protein concentrate diets. Average daily gain, average daily feed intake and feed efficiency were similar (P>.74) among pigs fed the seven dietary treatments (Table 4) during the subsequent three weeks.

Initial pig weight (Table 5) averaged 11.0, 11.0, 10.9, 11.0, 10,9, 10.9 and 10.9 lb for pigs fed the DSM, ISP I, ISP II, SPC I, SPC II, SPC III and SBM diets, respectively. After week 1, due to inferior gains by pigs fed soybean meal diet, dietary protein source affected pig weight (P<.05) and by the end of week 2, pigs fed the SBM diet weighed 13, 15 and 12% less than pigs fed the DSM diet, the two ISP diets and the three SPC diets, respectively. Differences in pig weight continued throughout the 3-week carryover period when pigs were given

Table 3. The effect of protein source on performance of weaned pigs in Period 1[a].

Days	Diet[b]							
	DSM	ISP I	ISP II	SPC I	SPC II	SPC III	SBM	SE
				Average daily gain, lb				
0 - 7	.44[c]	.46[c]	.44[c]	.42[c]	.40[c]	.37[c]	.22[d]	.08
7 - 14	.68[cd]	.77[c]	.86[c]	.81[c]	.79[c]	.79[c]	.64[d]	.11
0 - 14	.27[e]	.62[e]	.64[e]	.62[e]	.60[e]	.57[e]	.42[f]	.08
				Average daily intake, lb				
0 - 7	.55[e]	.53[e]	.53[e]	.48[e]	.51[e]	.48[e]	.33[f]	.08
7 - 14	1.01	.99	1.06	1.06	1.01	1.01	.95	.13
0 - 14	.79	.77	.79	.77	.77	.75	.64	.18
				Feed efficiency, lb gain/lb feed				
0 - 7	1.87[e]	1.89[e]	1.89[e]	1.83[e]	1.74[e]	1.74[e]	1.45[f]	.18
7 - 14	1.65[e]	1.74[e]	1.83[e]	1.74[e]	1.74[e]	1.72[e]	1.45[f]	.11
0 - 14	1.76[e]	1.83[e]	1.87[e]	1.78[e]	1.74[e]	1.74[e]	1.45[f]	.18

[a] Least squares means.
[b] See Table 1 for explanation of diet code names.
[c,d] Means in the same row with different superscripts differ (P<.01).
[e,f] Means in the same row with different superscripts differ (P<.05).

Table 4. The effect of protein source on performance of weaned pigs in Period 2[a].

	Diet[b]							
Days	DSM	ISP I	ISP II	SPC I	SPC II	SPC III	SBM	SE
				Average daily gain, lb				
14 - 35	.99	1.02	1.05	1.02	1.05	1.06	1.07	.09
				Average daily intake, lb				
14 -35	1.63	1.71	1.72	1.68	1.75	1.78	1.69	.26
				Feed efficiency, lb gain/lb feed				
14 -35	1.34	1.37	1.38	1.37	1.39	1.38[c]	1.40	.24

[a] Least squares means.
[b] See Table 1 for explanation of diet code names.

Table 5. The effect of protein source on pig weight (lb)[a].

	Diet[b]							
Item	DSM	ISP I	ISP II	SPC I	SPC II	SPC III	SBM	SE
No. of pigs	10	10	10	10	10	10	11	
Initial weight	11	11	10.9	11.0	10.9	10.9	10.9	
Week 1	14.1[c]	14.2[c]	14.1[c]	13.9[c]	13.7[c]	13.5[c]	12.4[d]	.70
Week 2	19.4[c]	19.7[c]	20.1[c]	19.7[c]	19.3[c]	19.2[c]	16.9[d]	.99
Week 3	25.1	25.2	26.4	25.7	25.5	25.5	23.6	1.37
Week 4	33.8	35.1	35.4	34.9	34.7	34.8	34.8	2.62
Week 5	43.7	45.2	45.2	45.1	44.7	44.8	42.3	2.60

[a] Least squares means.
[b] See Table 1 for explanation of diet code names.
[c,d] Means in the same row with different superscripts differ (P<.05)

a common diet. Pigs fed the SBM diet weighed 4 to 7% less at the completion of the trial when compared to the other dietary treatments although these differences were not significant.

Due to diminishing dairy surpluses, changing milk processing technology and demand in the human food sector, the cost of milk proteins continues to accelerate. It has become necessary to seek alternative protein sources for early weaned pigs. The present results suggest that selected isolated soy protein or soy protein concentrate can be used to replace dried skim milk in a complex starter diet without affecting performance. These sources of protein should be considered when economic circumstances allow.

Literature Cited

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