ALTERNATIVE PROTEIN SOURCES FOR THE EARLY WEANED PIG

G. N. Dietz[1], C. V. Maxwell[2], D. S. Buchanan[2] and W. G. Luce[3]

Story in Brief

Seventy two Yorkshire pigs weaned at 21 days of age were allotted to one of four treatments differing in the type of protein supplying the lysine source: an all milk protein based diet with dried skim milk as the primary lysine source, a diet with isolated soy protein (PP500E, Protein Technologies International) as the primary lysine source, a diet with dried skim milk and isolated soy protein providing equal amounts of lysine or a diet with 50% soybean meal as the primary lysine source. All diets were formulated to contain 1.50% lysine and 40% whey. Pigs were housed individually in an environmentally controlled room in elevated metal pens. Temperature was maintained at 92 and 90° F for weeks 1 and 2, respectively. Trials were 14 days in length. Gain and efficiency of gain estimates were obtained weekly. All pigs were fed a common 18% crude protein starter diet for an additional three-week period to evaluate post-treatment effects on gain and efficiency of gain. Performance of pigs fed isolated soy protein as the supplemental protein source was equal to or exceeded the performance of those fed dried skim milk. Average daily gain during the subsequent three-week period was not affected by treatment. These findings indicate that isolated soy protein 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.)

Introduction

Weaning pigs at 18 to 21 days of age is often economically advantageous to swine producers. This practice will shorten the reproductive cycle of the sow herd and allow placement of females back into productivity sooner with

---

[1]Graduate Assistant [2]Professor [3]Regents Professor

the expectation of rearing more pigs per sow per year, thus maximizing profit.

Subjecting a three week old pig to the distresses associated with weaning commonly results in a reduction of feed intake, little or no weight gain and diarrhea. It is also common to observe a longer postweaning growth depression and a higher incidence of mortality in early weaned pigs when compared to those weaned at an older age.

It has been well documented that young pigs' performance is greater when fed diets containing high levels of milk protein as compared to soybean protein. However, the use of the more complex diets has been questioned because of high cost and because pigs are capable of compensatory gain that results in little change in days to market weight.

The etiology of lower performance of young pigs fed soybean protein has not been determined clearly but possible explanations include: 1) lower amino acid availability in soybean protein than in milk protein; 2) substance or substances present in soybean protein may be detrimental to the health of the intestinal villi; and 3) protease or disaccharidase levels may be insufficient for optimal utilization of non-milk protein or energy.

The objective of this study was to compare gain, efficiency of gain and feed intake of early weaned pigs fed an all milk protein based diet using dried skim milk as the primary source of lysine compared to two sources of soybean protein. All pigs were fed a common starter diet for a three-week period after the trial to determine the effect of diet fed for a two-week period on subsequent performance.

Material and Methods

Seventy-two Yorkshire pigs were used to study the effect of dietary protein source on performance of early weaned pigs. Twenty-four pigs in each of three replicates were allotted by sex, litter and weight to one of four dietary treatments providing 18 pigs per treatment. Pigs began the trial after being weaned at approximately 21 days of age. These pigs were individually housed in metabolism crates measuring 1.54 ft by 2.49 ft in an environmentally controlled room at a temperature of 92^{O} to 82^{O} F for a period of 35 days. During the first 14 days (Period 1) the pigs were assigned to one of four dietary treatments (Table 1): dried skim milk as the primary lysine source (MP), a diet where isolated soy protein replaced dried skim milk as the primary lysine source (IS), a diet where dried skim milk and isolated soy protein provided equal amounts of lysine (MPIS), or a diet where 48% soybean meal served as the primary lysine source (SBM). Pigs had ad libitum access to feed and water. Calculated analysis of each diet is presented in Table 2.

Table 1. Composition of diets fed during period 1 (2 wk).

Ingredient	Diets[a,b] MP	IS	MPIS	SBM
Soybean meal	----	----	----	24.12
Isolated soy protein[c]	----	20.29	10.15	----
Dried skim milk	40.00	----	23.25	----
Whey, dried whole	40.00	40.00	40.00	40.00
Lactose	----	20.62	8.63	20.62
Cerelose	7.01	4.52	4.55	----
Soybean oil	10.00	10.00	10.00	10.00
Lysine, HCl	.21	----	----	.45
DL Methionine	.085	.115	.08	.17
Cystine	.085	.115	.08	.17
Tryptophan	----	----	----	.03
Threonine	----	----	----	.09
Lecithin	1.00	1.00	1.00	1.00
ASP 250	.25	.25	.25	.25
Calcium carbonate	.12	.70	.42	.49
Dicalcium phosphate	----	1.15	.35	1.37
Vit. TM premix[d]	.94	.94	.94	.94
Salt	.30	.30	.30	.30
	100.00	100.00	100.00	100.00

[a]As fed basis.
[b]MP: milk protein diet; IS: isolated soybean diet; MPIS: milk protein isolated soybean diet; SBM: soybean meal diet.
[c]Product PP500E, Protein Tech. Int., St. Louis, MO.
[d]Supplies 4,000 IU vitamin A, 400 IU vitamin D, 17 IU vitamin E, 20 mg panothenic acid, 27 mg niacin, 4 mg riboflavin, 3.3 mg menadione, .02 mg vitamin B_{12}, 400 mg choline chloride, .2 mg selenium, .06 g manganese, .2 g zinc, .1 g iron, .01 g copper, .2 mg iodine, per lb of feed.

Table 2. Calculated analysis of diets fed during period 1 (2 wk).

Ingredient	Diets[ab] MP	IS	MPIS	SBM
Lysine	1.50	1.50	1.50	1.50
Crude protein	20.09	23.46	22.81	17.91
Calcium	.90	.90	.90	.90
Phosphorus	.71	.70	.70	.71
M.E. (Kcal/kg)	1628.50	1611.10	1625.80	1603.30
Tryptophan	.25	.33	.30	.26
Threonine	.92	1.04	1.02	.90
Met + Cys	.88	.88	.89	.88

[a]As fed basis.
[b]MP: milk protein diet; IS: isolated soybean diet; MPIS: milk protein isolated soybean diet; SBM: soybean meal diet.

In the subsequent 21-day period all pigs were fed a common 18% crude protein starter diet to test for carry over effects from Period 1.

During the 5-week trial, individual pig weight was recorded weekly, feed intake was estimated, and feed efficiency (gain to feed ratio) was evaluated.

Results and Discussion

The effect of dietary protein source on average daily gain, average daily feed intake and feed efficiency during the 14-day experimental period is shown in Table 3. Pigs fed the IS diet grew 51 ($P<.01$) and 27% faster than those fed the SBM or MP diets, respectively. Similarly, pigs fed the MPIS diet grew 44 ($P<.01$) and 16% faster than those fed the SBM or MP diets, respectively. Differences observed in average daily gain were primarily the result of differences that occurred during week 1 of the trial when pigs fed the IS diet out performed those fed the SBM ($P<.01$) and MP diets by .34 and .14 lb/day, respectively. Pigs fed the MPIS diet during week 1 grew .31 ($P<.05$) and .11 lb/day faster than those fed the SBM and MP diets, respectively.

Table 3. The effect of protein source on piglet performance in period 1[a].

Item	Diet				
	MP	IS	MPIS	SBM	SEM
			Average daily gain, lb		
d 0 - 7	.27^{bc}	.41^{b}	.38^{b}	.07^{c}	.05
d 7 - 14	.88	.97	.92	.81	.07
d 0 - 14	.56^{bc}	.68^{b}	.65^{b}	.45^{c}	.05
			Feed efficiency lb gain/lb feed		
d 0-7	.40^{fg}	1.27^{f}	2.60^{f}	-9.83^{g}	4.93
d 7-14	.60	.99	1.16	.60	.34
d 0-14	.84	.93	1.09	.70	.16
			Average daily feed intake, lb		
d 0-7	.32de	.38^{d}	.38^{d}	.25^{e}	.05
d 7-14	.83^{c}	1.06^{b}	.92^{bc}	.72^{c}	.07
d 0-14	.58^{bc}	.72^{b}	.65^{b}	.47^{c}	.05

[a]Least squares means, MP: milk protein diet; IS: isolated soybean diet; MPIS: milk protein isolated soybean diet; SBM: soybean meal diet.

[b,c]Means in the same row with different superscripts differ ($P<.01$).

[d,e]Means in the same row with different superscripts differ ($P<.05$).

[f,g]Means in the same row with different superscripts differ ($P<.10$).

The effect of dietary protein source on the efficiency of feed utilization was similar to the effect on average daily gain. Pigs fed the IS and MPIS diets had a higher ($P<.10$) gain to feed ratio during the first week on trial than those fed the SBM diet. Also during week 1, pigs fed the SBM diet exhibited a negative gain to feed ratio even though feed intake and weight gain were positive. This may be explained as several pigs lost large amounts of body weight, largely due to dehydration, in proportion to the amount of feed consumed causing the average of the G:F ratios to be negative. Perhaps a more meaningful approach would be to use the ratio of the means which were .84, 1.08, 1.00 and .28 lb gain/lb feed for pigs fed the MP, IS, MPIS and SBM diets, respectively. The efficiency of feed utilization was similar ($P>.49$) among the dietary protein sources during the entire 14 day period even though pigs fed the MPIS diet gained 56% more per lb of feed than those fed the SBM diet.

Average daily feed intake during Period 1 was larger ($P<.01$) for pigs fed IS and MPIS diets than for those fed the SBM diet. The largest difference was observed during week 2. Pigs fed the IS diet consumed 15%, 28% and 47% more per day than those fed the MPIS, MP, and SBM ($P<.01$) diets, respectively.

Average daily gain was similar ($P>.30$) among all treatments (Table 4) during the subsequent 3 weeks although pigs fed the SBM and MP diets

Table 4. The effect of protein source on piglet performance in period 2[a].

Item	Diet MP	IS	MPIS	SBM	SEM
			Average daily gain, lb		
d 14-21	.97	.99	1.17	1.01	.09
d 14-35	1.26	1.31	1.35	1.26	.02
			Feed efficiency lb gain/lb feed		
d 14-21	.68[bc]	.61[c]	1.00[b]	.79[bc]	.10
d 14-35	.67[de]	.63[d]	.69[de]	.70[e]	.02
			Average daily feed intake, lb		
d 14-21	1.37[bc]	1.53[b]	1.49[bc]	1.28[c]	.07
d 14-35[f]	1.89[de]	2.05[d]	1.96[de]	1.80[e]	.05

[a]Least squares means, MP: milk protein diet; IS: isolated soybean diet; MPIS: milk protein isolated soybean diet; SBM: soybean meal diet.

[b,c]Means in the same row with different superscripts differ ($P<.05$).

[d,e]Means in the same row with different superscripts differ ($P<.01$).

[f]Means for MP and SBM treatments differ ($P<.05$).

during period 1 continued to show reduced gains when compared to pigs fed the IS and MPIS diets.

During week 3, pigs fed the MPIS diet exhibited a gain to feed ratio that was 64%, 47% and 27% higher than those fed the IS, MP and SBM diets, respectively. However, this difference was significant only for those fed the IS diet. During the combined 3-week period, the magnitude of the differences decreased and the gain to feed ratios for the MP, MPIS and SBM diets were only 6%, 9% and 10% higher than those observed in pigs fed the IS diet. During the subsequent twenty-one day period, pigs fed the IS diet ate more ($P<.01$) than those fed the SBM diet and the MP diet ($P<.05$) but was similar to pigs that received the MPIS diet.

Initial pig weights (Table 5) averaged 13.70, 13.84, 13.79 and 13.68 lb for MP, IS, MPIS and SBM treatments, respectively when placed on trial. After week 1, due to superior gains by pigs fed the IS and MPIS diets, dietary protein source affected pig weights ($P<.01$) and by the end of week 2, pigs fed the SBM diet weighed 8%, 15% and 14% less than pigs fed the MP, IS and MPIS diets, respectively. Less weight variation between treatments was evident during the 3 week carryover period although pigs previously fed the IS diet weighed more at the end of week 3 and 4 ($P<.05$) than those fed the SBM diet. Pigs fed the SBM diet weighed less at the completion of the trial when compared to other dietary treatments although differences tended to be significant ($P<.06$) only for those fed the IS diet.

Tight supplies of milk products combined with increasing demand usually cause higher prices for milk proteins and has resulted in a search for sources of protein that can nutritionally replace milk. The results of this study indicate that selected isolated soy protein will produce performance equivalent to that observed with milk protein and may be used to replace milk protein when economic circumstances allow.

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

Item	Diet				
	MP	IS	MPIS	SBM	SEM
Initial Wgt.	13.70	13.84	13.79	13.68	.38
Week 1	15.53^{bc}	16.72^{b}	16.50^{b}	14.22^{c}	.50
Week 2	21.75^{bc}	23.46^{b}	22.99^{b}	19.90^{c}	.74
Week 3	28.42^{de}	30.34^{d}	30.70^{d}	27.09^{e}	1.10
Week 4	36.70^{de}	39.40^{d}	38.21^{de}	35.39^{e}	1.33
Week 5	47.90	50.90	49.50	46.73	1.56

[a]Least squares means, MP: milk protein diet; IS: isolated soybean diet; MPIS: milk protein isolated soybean diet; SBM: soybean meal diet.

[b,c]Means in the same row with different superscripts differ ($P<.01$).

[d,e]Means in the same row with different superscripts differ ($P<.05$).