ALTERNATIVE PROTEIN SOURCES FOR MILK PROTEIN IN EARLY WEANED PIG DIETS

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Story in Brief

A study involving 144 pigs weaned at approximately 24 days of age, was conducted to determine the effect of two dried skim milk substitutes on performance. Treatments were: 1) a control complex prestarter diet containing 10% dried skim milk; 2) and 3) dried skim milk was replaced with a cheese by-product or an isolated soy protein based dried skim milk substitute, respectively. Trial duration was for a 2 week period (Period 1) followed by a 3 week period (Period 2) when all pigs were fed a common 18% crude protein starter diet. During week 1 and Period 1, average daily gain in pigs fed either the cheese by-product or isolated soy protein diet was similar to that observed in pigs fed the dried skim milk diet. During week 2, average daily gain was similar in Trial 1 among the treatments but pigs fed the control diet had lower average daily gain in Trial 2 when compared to pigs fed the isolated soy protein diet (Trial x treatment interaction). During week 1 and Period 1, average daily feed intake was higher in pigs fed the isolated soy protein diet than in those fed the other diets. Feed efficiency during Period 1 was not affected by dietary treatments although a trial x treatment interaction was observed in week 2 and Period 1. Performance during Period 2 was not affected by dietary treatments. These results suggest that a selected cheese by-product and an isolated soy protein based dried skim milk substitute can be used to effectively replace dried skim milk in a complex prestarter diet for early weaned pigs.

(Key Words: Swine, Nutrition, Weaning, Cheese By-product, Isolated Soy Protein.)

Introduction

It has become commonplace for swine producers to wean pigs at early ages. Weaning as early as three weeks has been accomplished by the use of

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diets containing high levels of milk products, especially dried skim milk and dried whey. Although performance of pigs fed these milk based diets is superior to that observed in pigs fed simple corn-soybean meal diets, the milk product diets are more expensive. Thus, other feed ingredients need to be evaluated as replacements for all or part of the dried skim milk. The ability of utilizing the protein from isolated soy protein or cheese by-product could reduce the inclusion rate of more expensive milk protein in the diet of early weaned pigs. The feasibillity of the protein from a cheese by-product in early weaned pig diets as an alternative protein source for milk protein has not been tested. Recently, two studies (Sohn et al., 1990a,b; Coffey et al., 1990) indicated that isolated soy protein adequately replaces the proteins of dried skim milk for three week old weaned pigs, however, a product containing whey and isolated soy protein developed to replace dried skim milk had not been tested. This study was conducted to determine the effect of two dried skim milk substitutes on performance of early weaned pigs.

Materials and Methods

One hundred forty four Yorkshire, Hampshire and Yorkshire x Hampshire crossbred pigs (72 pigs in each of two trials) were used in this experiment. Pigs were weaned at approximately 24 days of age (actual age 20-28 day). Pigs within trial were blocked by weight into two groups with blocks consisting of six pens. Thirty six pigs per block (six pigs per pen) were stratified by litter and weight to six pens, and two pens within each block were randomly allotted to one of three experimental diets. Dietary treatments (TRT) during the first 14 days (Period 1) consisted of the following (Table 1): 1) a control complex prestarter diet containing 10% dried skim milk (DSM); TRT 2) and 3) DSM was replaced with PRO-88 or NURISH-2000, respectively. PRO-88 (cheese by-product) was made from the rejected cheese from the human retail sector with several varieties of cheese used in the manufacturing process. NURISH-2000 (isolated soy protein based milk protein substitute) was developed to provide a protein source that is very similar in nutrient composition to dried skim milk and is a mixture of isolated soy protein, dried skim milk and dried whey. All diets were formulated to contain 1.4% lysine and 20% of an edible grade of dried whey. Trial duration was 2 weeks (Period 1) with weekly gain and efficiency estimates obtained. All pigs were fed a common 18% crude protein starter diet (Table 1) for an additional 3 week period (Period 2) to evaluate any carry-over effects on performance from the diet fed during Period 1. Pigs had ad libitum access to both feed and water during Periods 1 and 2. Pigs were housed in an environmentally controlled nursery in pens measuring 3.8 by 5.0 feet on a raised, woven wire floor. A temperature of 84 to 86°F was

Table 1. Composition of experimental diets.

	Diets[a,b]			
	Period 1			Period 2
Ingredient	DSM	PRO-88	NURISH-2000	
Isol. soy protein	3.0	3.0	3.0	-
Dried skim milk	10.0	-	-	-
Whey, dehydrate	20.0	20.0	20.0	-
Steam rolled oats	26.9	26.9	26.9	-
Provesteen[c]	8.0	8.0	8.0	-
Pro-88[d]	-	10.0	-	-
Nurish-2000[e]	-	-	10.0	-
Corn, yellow	11.52	13.63	11.33	66.65
Soybean oil	8.0	5.7	8.0	-
Lysine, HCl	.24	.32	.32	.15
Soybean meal,44%	-	-	-	28.5
Fishmeal, menhaden	3.0	3.0	3.0	-
Ethoxyquin	.025	.025	.025	-
Pment Sugar[f]	5.0	5.0	5.0	-
FOA 390[g]	1.0	1.0	1.0	1.0
Flavor 792[h]	.1	.1	.1	-
Novasil[i]	.5	.5	.5	-
Coli-mix[j]	.5	.5	.5	-
Copper sulfate	.1	.1	.1	.075
Dicalcium phosphate	-	-	-	1.95
Calcium carbonate	1.0	1.1	1.1	.90
DL-Methionine	.075	0.085	.085	-
Vit. min. premix[k]	.74	.74	.74	.375
Salt	.30	.30	.30	.40
Calculated analysis				
ME (Kcal/lb)	1595	1593	1596	1453
Crude protein, %	20.71	20.87	20.59	18.32
Calcium, %	.90	.91	.91	.88
Phosphorus, %	.81	.86	.82	.74
Lysine, %	1.40	1.40	1.40	1.11
Threonine, %	.87	.87	.86	.72
Tryptophan, %	.24	.25	.25	.24
Met+Cys, %	.64	.64	.65	.61

Table 1. (Continued).

[a] As fed basis.
[b] DSM: dried skim milk diet; PRO-88: cheese by-product diet; NURISH-2000: isolated soy protein based dried skim milk substitute diet.
[c] Provesteen, Provesta Corporation, Bartlesville, OK.
[d] Pro-88, Morgan Mfg. Co., Inc, Paris, IL.
[e] Nurish-2000, Protein Technologies International, St Louis, MO.
[f] Pment sugar, Bob's Candy Co., Albany, GA.
[g] Contained 10g Furazolidone, 5g Oxytetracycline, 4.5 g Arsanilic acid per lb of diet.
[h] Flavor 792, Flavor Hut Corp. St. Charles, IL.
[i] Novasil, Engelhard Corp. Cleveland, OH.
[j] Coli-mix, Central Biologics, Inc. Raleigh, NC.
[k] Supplied 4160 IU vitamin A, 416 IU vitamin D, 18 IU vitamin E, 20 mg pantothenic acid, 28 mg niacin, 4.0 mg riboflavin, .02 mg vitamin B_{12}, 1.3 mg biotin, 2.7 mg pyridoxine, .9 mg folic acid, 3.9 mg thiamin, 267 mg choline, .1 mg selenium, .03 g manganese, .1 g zinc, .1 g iron, .1 g copper, .43 g potassium and .2 mg iodine, per lb of feed in Period 1 and 3,000 IU vitamin A, 300 IU vitamin D, 12.8 IU vitamin E, 15 mg pantothenic acid, 20.3 mg niacin, 3.0 mg riboflavin, .01 mg vitamin B_{12}, 193 mg choline, .07 g selenium, .02 g manganese, .07 g zinc, .07 g iron, .07 g copper, .17 mg iodine, per lb of feed in Period 2.

maintained during the first week of the experiment and was decreased 2°F per week for the remainder of the trial. Individual pig weight and pen feed intake were measured weekly to determine average daily gain, average daily feed intake and gain to feed ratio. Pen was used as the experimental unit.

Results and Discussion

During the first week and Period 1, average daily gain in pigs fed either the cheese by-product (PRO-88) or the isolated soy based dried skim milk substitute (NURISH-2000) was similar to that observed in pigs fed the control diet (Table 2). During the second week average daily gain was similar in Trial 1 among the treatments but pigs fed the control diet had

Table 2. The effect of protein source on average daily gain, average daily feed intake and feed efficiency of young pigs in period 1[a].

Item	Diet[b]			SE
	DSM	PRO-88	NURISH-2000	
	Average daily gain, lb/day			
Week 1	.48	.53	.55	.02
Week 2[e] (Trial 1)	.95	.79	.86	.02
(Trial 2)	.81[c]	.88[cd]	.97[d]	.02
Mean	.88	.84	.92	.02
Period 1	.68	.68	.73	.02
Period 2	1.23	1.25	1.28	.02
	Average daily feed intake, lb/day			
Week 1	.51[c]	.51[c]	.57[d]	.02
Week 2	1.03	1.03	1.12	.02
Period 1	.77[c]	.77[c]	.85[d]	.02
Period 2	2.11	2.16	2.18	.07
	Gain:feed ratio			
Week 1	.94	1.01	.95	.03
Week 2[e] (Trial 1)	.83[c]	.70[d]	.72[d]	.02
(Trial 2)	.87	.91	.92	.02
Mean	.85	.81	.82	.02
Period 1[e] (Trial 1)	.88[c]	.84[cd]	.82[d]	.01
(Trial 2)	.87	.91	.91	.01
Mean	.87	.87	.86	.01
Period2	.58	.58	.59	.01

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

lower ($P<.05$) gain in Trial 2 when compared to pigs fed the isolated soy based dried skim milk substitute (trial x treatment interaction, $P<.05$). Performance of pigs fed PRO-88 was intermediate. Average daily feed intake during the first week was highest ($P<.05$) in pigs fed NURISH-2000 when compared to pigs fed PRO-88 or the control diet. During the first week pigs fed the NURISH-2000 diet consumed 11.5% more feed per day than those fed the PRO-88 or the control diet. During the second week on trial, average daily feed intake among the dietary treatments was similar. During the overall two week period, average daily feed intake was higher ($P<.05$) in pigs fed NURISH-2000 than in those fed the other diets. The effect of dietary protein source on feed efficiency was similar to that observed for average daily gain. Treatment differences in feed efficiency in week 1 were not significant. During the second week, pigs fed the control diet had improved feed efficiency ($P<.05$) in Trial 1 and similar feed efficiency in Trial 2 when compared to pigs fed NURISH-2000 or PRO-88 resulting in a trial x treatment interaction ($P<.05$). No significant differences were observed, however, in efficiency between pigs fed NURISH-2000 or PRO-88. Average dailly gain, average daily feed intake and feed efficiency were similar among pigs fed the three dietary treatments during the subsequent 3 week period (Table 2). These results are similar to the findings of Sohn et al. (1990a,b) who reported that pigs fed an isolated soy protein diet in individual pens had gains and feed efficiency that were similar to those observed in pigs fed a dried skim milk based diet. This study confirms the efficiency of isolated soy proteins in a pen feeding system which more closely simulates eommercial production systems.

Initial pig weight (Table 3) averaged 14.76, 14.76 and 14.78 lb for pigs fed the control, PRO-88 and NURISH-2000 diets, respectively. Pigs fed the control diet had lower weights ($P<.05$) at the end of weeks 3 and 4 postweaning when compared to pigs fed NURISH-2000. A similar trend was evident at the completion of the trial (week 5) although differences were not significant. Geurin et al. (1988) and Coffey et al. (1990) reported that pigs fed an isolated soy protein diet had a similar average daily gain and feed efficiency when compared to those fed a milk protein diet. Also, Dietz et al .(1988) and Decuypere et al. (1981) suggested that partial or total replacement of milk proteins with isolated soy protein could produce performance equivalent to that observed in pigs fed dried skim milk.

When whole milk is used for cheese manufacture, a starter culture and enzyme preparation are added to the heated whole milk. The bacteria cultures and enzymes react with the lactose and casein, respectively, and produce lactic acid and casein is precipitated as a curd. The curd is then separated from the whey and pressed into cheese. Thus, PRO-88, which contains casein should be a highly digestible protein source for baby pigs. Kies et al. (1983) suggested that when lactic casein is manufactured under

Table 3. The effect of protein source on pig weight (lb)[a].

Item	Diet			
	DSM	PRO-88	NURISH-2000	SE
No of pigs	48	48	48	
Initial wt	14.76	14.76	14.78	
Week 1	18.15[b]	18.48[bc]	18.63[c]	.13
Week 2	24.44	24.42	25.12	.22
Week 3	32.41[b]	32.87[bc]	33.68[c]	.31
Week 4	40.63[b]	41.43[bc]	42.44[c]	.46
Week 5	50.34	51.08	51.99	.64

[a] Least squares menas.
[b,c] Means in the same row with different superscript differ ($P < .05$).

controlled conditions, its protein or in particular the essential amino acid component, is virtually completely digested and absorbed at the terminal ileum of the growing pigs. Mclaughlin et al. (1983) reported that addition of cheese flavor improved feed intake and weight gain relative to those obtained with pigs fed a diet containing a commercial flavor; during week 1 pigs fed diets containing a cheese flavor ate more (.42 lb vs .30 lb/day) and gained more (.18 lb vs .06 lb/day) than pigs fed a diets containing no flavor. Our results suggest that a selected cheese by-product (PRO-88) and an isolated soy protein based dried skim milk substitute (NURISH-2000) can be used to effectively replace dried skim milk in a complex prestarter diet for early weaned pigs.

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