THE EFFECT OF ISOLATED SOY PROTEIN SUBSTITUTION FOR MILK PROTEINS WITH AND WITHOUT MAINTAINING CONSTANT LACTOSE ON PERFORMANCE OF EARLY WEANED PIGS

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Story In Brief

Two hundred fifty two pigs (84 pigs in each of 3 Trials) weaned at approximately 23 days of age were used to determine the effect of isolated soy protein substitution for milk proteins, with and without constant lactose. Treatments were: 1) a basal pre-starter diet containing 10% dried skim milk and 20% whey; 2) and 3) 50 and 100% substitution, respectively, of both dried skim milk and whey with isolated soybean protein with constant lactose; 4) and 5) 50 and 100% replacement, respectively, of dried skim milk and whey with isolated soybean protein without lactose; 6) a corn-soybean meal diet with lactose; and 7) a corn-SBM diet without lactose. Trial duration was 2 weeks (Period 1) with gain and efficiency of gain obtained weekly. All pigs were fed a common 18.5% crude protein starter diet for an additional 3-week period (Period 2). During week 1, a quadratic response in average daily gain was observed in pigs fed increasing levels of isolated soy protein with lactose while no differences in gain were observed in pigs fed isolated soy protein without lactose. Pigs fed the corn-soybean meal diet without lactose had lower gains than those fed the basal pre-starter diet (Treatment 1). Gain:feed ratio in week 1 followed a similar pattern to that observed for gain. Treatment differences in gain and efficiency of gain during week 2 and for Period 1 were not significant. Performance during Period 2 was not affected by previous treatment. This study suggests that the lactose component of milk products may explain part of the response to milk protein observed in early weaned pigs.

(Key Words: Swine, Nutrition, Weaning, Protein Source, Lactose.)

Introduction

It has been well documented that growth rate and efficiency of feed utilization of early weaned pigs are superior with milk protein diets when

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compared to soybean protein diets (Hays et al., 1959; Coalson et al., 1972; Sheery et al., 1978; Wilson and Leibholz, 1981; Leibholz, 1982). Recently, however, two studies (Dietz et al., 1988; Geurin et al., 1988) indicate that sources of refined soybean protein offer a suitable replacement for milk protein in diets of early weaned pigs. It has also been reported that pigs fed isolated soy protein diets with added lactose had improved gain and efficiency of gain when compared to those receiving isolated soy protein diets without added lactose (Sewell and West, 1965; Giesting et al., 1985; Dietz et al., 1988).

The objective of this study was to evaluate the effect on performance of 50 and 100% substitution of dried skim milk (DSM) and whey with isolated soy protein, with and without maintaining constant lactose. The lactose effect on pigs fed a corn-soybean meal (SBM) diet was also investigated. All pigs were fed a common starter diet for an additional 3-week period to determine the effect of diet fed for the initial 2-week period on subsequent performance.

Materials and Methods

Two hundred fifty two Yorkshire, Hampshire and Yorkshire x Hampshire crossbred pigs (84 pigs in each of three replicates) were weaned at approximately 23 days of age (actual age 21 to 27 days). Pigs within replicate were blocked into two age groups with blocks consisting of seven pens. Forty two pigs per block (six pigs per pen) were stratified by sex, litter and weight to pens, and pens were randomly allotted to one of seven treatments.

Dietary treatments fed during the first 14 days (Period 1) consisted of the following (Table 1): 1) a basal pre-starter diet containing 10% dried skim milk and 20% of an edible grade of dried whey with limited use of 50% soybean meal; 2) and 3) 50 and 100% substitution, respectively, of dried skim milk and whey on an equal weight basis with isolated soy protein[4] with lactose maintained at the level present in the basal diet, 4) and 5) 50 and 100% substitution, respectively, of DSM and whey with isolated soy protein (Nurish 3000[5] replaced protein from Nurish 2000 on an equal crude protein basis) with no correction for differences in lactose; 6) a corn-SBM based diet with lactose maintained at the level present in the basal diet; and 7) the corn-SBM based diet of treatment 6 without lactose. All diets fed during Period 1 were formulated to contain 1.30% lysine, .90% Ca and .70% P. In the subsequent 21-day period (Period 2) all pigs were fed a common 18.5% crude protein corn-soybean meal starter diet (Table 2) to evaluate any carry-over effects on

[4]Nurish 2000; Protein Technologies International, St. Louis, MO
[5]Protein Technologies International, St. Louis, MO

Table 1. Composition of diets fed during Period 1 (2 Weeks)

	Treatment[a]						
Ingredient	1	2	3	4	5	6	7
Corn, US No 2	44.825	49.075	53.225	70.445	70.645	38.845	61.515
Soybean meal, 50%	13.80	7.00	.30	7.00	3.60	27.90	26.00
Casein	---	---	---	1.48	---	---	---
Nurish 2000[b]	---	15.00	30.00	---	---	---	---
Nurish 3000[b]	---	---	---	6.64	13.28	---	---
Dried skim milk	10.00	5.00	---	---	---	---	---
Whey protein isol.	---	---	---	1.89	---	---	---
Whey, dried isol.	20.00	10.00	---	---	---	---	---
Lactose, 97%	---	2.57	5.14	---	---	20.61	---
Fishmeal, Menhaden	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Soybean oil	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Lysine, HCL	.10	.10	.10	.10	.10	.10	.10
Ethoxyquin	.025	.025	.025	.025	.025	.025	.025
Methionine	---	---	---	---	---	.10	.05
Apraland[c]	.10	.10	.10	.10	.10	.10	.10
Calcium carbonate	.40	.37	.30	.75	.86	.61	.75
Dicalcium phosphate	.51	.52	.55	1.32	1.15	1.47	1.22
Vit. TM premix[d]	.94	.94	.94	.94	.94	.94	.94
Salt	.30	.30	.30	.30	.30	.30	.30
Tryptophan	---	---	.02	---	---	---	---

Table 1. (Continued).

Calculated composition of diet:

ME, kcal/kg	3,454.61	3,456.81	3,461.22	3,452.40	3,448.00	3,452.40	[illegible]
Lactose, %	19.99	19.99	19.99	.00	.00	19.99	.00
Lysine, %	1.30	1.30	1.30	1.30	1.30	1.30	[illegible].30
Crude protein, %	19.90	19.73	19.64	21.49	22.68	20.07	[illegible].08
Threonine, %	.89	.83	.77	.89	.89	.80	.84
Tryptophan, %	.25	.24	.26	.26	.28	.25	.26
Met + Cys, %	.72	.74	.77	.83	.89	.76	.78
Calcium, %	.90	.90	.90	.90	.90	.90	.90
Phosphorus, %	.70	.70	.70	.70	.70	.70	.70

[a] As fed basis.
[b] Protein Technologies International, St. Louis, MO.
[c] Contains 150 g Apramycin per ton of complete feed.
[d] Supplies 8.800 IU vitamin A, 880 IU vitamin D, 37 IU vitamin E, 44 mg pantothenic acid, 59 mg niacin, 8[illegible] mg riboflavin, 7.3 mg menadione sodium bisulfate, .04 mg vitamin B12, 3 mg biotin, 6 mg pyridoxine, 2 mg f[illegible]ic acid, 10 mg thiamine, 880 mg choline chloride, .2 mg selenium, .06 g manganese, .2 g zinc, .2 g iron, .02 [illegible] copper, .2 g magnesium, 1 g potassium, and .4 mg iodine per kg of feed.

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

Ingredient	% of Diet[a]
Yellow Corn	67.55
Soybean Meal	28.50
Dicalcium Phosphate	1.95
Calcium Carbonate	.90
Vit. TM Premix[b]	.375
Lysine	.15
Salt	.40
Copper Sulfate	.075
Apralan[c]	.10
Calculated Composition of Diet:	
ME, kcal/kg	3,150.62
Lysine, %	1.10
Crude Protein, %	18.48
Threonine, %	.75
Tryptophan, %	.22
Met + Cys, %	.61
Calcium, %	.85
Phosphorus, %	.70

[a] As fed basis.
[b] Supplies 6,600 IU vitamin A, 660 IU vitamin D, 28 IU vitamin E, 6.6 mg riboflavin, 33 mg pantothenic acid, 44 mg niacin, .03 mg vitamin B12, 5.5 mg menadione sodium bisulfate, 45 mg manganese, 150 mg iron, .15 mg selenium, .30 mg iodine, 15 mg copper, and 150 mg zinc per kg of feed.
[c] Contains 150 g Apramycin per ton of complete feed.

performance from diets fed during Period 1. Pigs had ad libitum access to both feed and water during Period 1 and Period 2.

The 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 84-86°F was maintained during the first week of the experiment and was decreased 2°F per week for the remainder of the trial.

Individual pig weights and pen feed intake was measured weekly, and pen feed efficiency was evaluated. Pen was used as the experimental unit to evaluate average daily gain, gain:feed ratio and average daily feed intake.

Results and Discussion

Results for average daily gain, gain:feed ratio and average daily feed intake are presented in Table 3. During week 1, a quadratic response ($P<.08$) in average daily gain was observed in pigs receiving increasing levels of isolated soy protein with lactose such that pigs fed diets containing 50% isolated soy protein substituted for milk proteins with lactose had improved average daily gain, followed by a decline in average daily gain in pigs fed the 100% isolated soy protein diet with lactose. A similar trend in gain:feed was observed for pigs receiving these diets. Pigs fed diets in which 50 and 100% of the dried skim milk and whey was replaced by isolated soy protein without lactose had similar gains, however, a linear decrease ($P<.05$) in gain:feed was observed during week 1. Gains of pigs fed the corn-soybean meal diet with lactose were similar to those fed the basal diet, while those fed the corn-soybean meal diet without lactose had lower ($P<.05$) gains than those receiving the basal diet. Efficiency of feed utilization for pigs fed the corn-soybean meal diets, with and without lactose, followed the same trend as average daily gain, however, these differences were not significant.

During week 2 similar gains were observed in pigs fed the basal diet and the isolated soy protein diet with lactose, while gain:feed was more variable as noted by a trial by treatment interaction ($P<.05$). A linear and quadratic response ($P<.05$) in gain:feed was observed in Trial 2 and Trial 3, respectively, during week 2 for pigs fed increasing levels of isolated soy protein with lactose. Pigs receiving the basal diet and the isolated soy protein diets without lactose had similar gain. A treatment by trial interaction ($P<.05$) was observed in gain:feed for pigs fed the isolated soy protein diets without lactose, but neither the linear nor the quadratic effects were significant. Average daily gain and gain:feed for pigs receiving the corn-soybean meal diets, with and without lactose, were similar to those observed in week 1, however, the differences during week 2 were not significant.

Average daily gain and gain:feed for Period 1, regardless of treatment, were not significant. However, a treatment by trial interaction ($P<.05$) for gain:feed was observed.

During Period 2 no differences in average daily gain or gain:feed due to previous treatment were observed. Average daily feed intake during week 1, week 2, Period 1 and Period 2 was not affected by treatment.

The results of this study support the findings of Dietz et al. (1988) and Geurin et al. (1988) who reported that pigs fed isolated soy protein diets had gains and efficiency of feed utilization that was equal to the performance of pigs fed milk protein based diets. Also, the performance of pigs fed lactose supplemented diets in this study supports the results of Sewell and West (1965), Giesting et al. (1985) and Dietz et al. (1988) who reported increased

Table 3. Effect of protein source and level of lactose on ADG (lb/d, feed efficiency (g:f) and average daily feed intake (lb/d).

Item	Time of Trial		(1) Basal Diet	(2) 50% ISP +LAC	(3) 100% ISP +LAC	(4) 50% ISP -LAC	(5) 100% ISP -LAC	(6) C-SBM +LAC	(7) C-SBM -LAC
ADG	Week 1[ab]		.34[h]	.38	.28	.35	.31	.31[h]	.23[i]
	Week 2		.45	.42	.52	.46	.39	.44	.43
	Period 1		.39	.40	.40	.40	.35	.37	.33
	Period 2		1.22	1.20	1.21	1.18	1.21	1.11	1.15
G:F	Week 1[c]		.80	.84	.63	.78	.62	.73	.48
	Week 2[de]	(Tr 1)	.33	.33	.32	.44	.29	.54	.44
		(Tr 2)[f]	.64	.74	.87	.79	.72	.72	.77
		(Tr 3)[g]	.38	.34	.46	.13	.27	.27	.17
	Period 1[de]	(Tr 1)	.44	.47	.35	.50	.37	.64	.45
		(Tr 2)	.69	.75	.81	.79	.66	.66	.64
		(Tr 3)	.58	.61	.59	.44	.52	.50	.42
	Period 2[de]	(Tr 1)	.61	.64	.65	.62	.61	.65	.61
		(Tr 2)	.62	.59	.61	.60	.63	.56	.54
		(Tr 3)	.58	.63	.55	.65	.61	.55	.63

Table 3. (Continued).

ADFI	Week 1	.42	.44	.43	.45	.47	.40	.40
	Week 2	.96	.87	.93	.94	.90	.85	.91
	Period 1	.69	.66	.68	.69	.68	.62	.66
	Period 2	2.04	1.95	2.02	1.90	1.96	1.89	1.93

[a] Treatment effect ($P < .05$).
[b] Quadratic response in ADG with increasing level of ISP with lactose ($P < .08$).
[c] Linear decrease in G:F with increasing level of ISP without lactose ($P < .05$).
[d] Treatment by trial interaction ($P < .05$).
[e] Trial effect ($P < .05$).
[f] Linear increase in G:F with increasing level of ISP with lactose ($P < .05$).
[g] Quadratic increase in G:F with increasing level of ISP with lactose ($P < .05$).
[h,i] Means in same row with different superscripts differ ($P < .05$).

average daily gain and improved feed efficiency in pigs fed lactose supplemented diets when compared to those consuming diets without lactose.

The greatest response to the lactose supplemented diets was observed in week 1 of the experiment. This is consistent with the results observed by Ekstrom et al. (1975) which indicate that the lactase activity in the small intestine of baby pigs increase from a low at 1 day of age to a maximum at 15 days of age before falling to a plateau level of 75% of maximum by 28 days of age. Furthermore, results by Turlington et al. (1989) indicate that improved performance in early weaned pigs fed lactose supplemented diets may be due to greater energy and nutrient digestibilities and reduced digesta flow rate.

For Period 1 of this experiment, average daily gain and gain:feed of pigs fed the diet where 50% of the milk proteins were substituted with isolated soy protein without lactose (Treatment 4) were lower than those reported by Decuypere et al. (1981) and Dietz et al. (1988). However, performance of pigs fed the diet in which 100% of the dried skim milk and whey was replaced with isolated soy protein without lactose (Treatment 5) was similar to that observed by Geurin et al. (1988), but was lower than values reported by Dietz et al. (1988). Higher average daily gain and gain:feed have been obtained by Mateo and Veum (1980) for pigs fed isolated soy protein diets with lactose than those reported here. Pigs consuming the corn-soybean meal diet with lactose (Treatment 6) and the corn-soybean meal diet without lactose in this study had lower average daily gain and gain:feed than those obtained by Dietz et al. (1988) and Wilson and Leibholz (1981), respectively.

The results of this study indicate that the lactose component of milk products may explain part of the response to milk protein observed in early weaned pigs, and that partial or total replacement of milk proteins with isolated soy protein with lactose addition will produce performance equivalent to that observed with milk protein.

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