SPRAY DRIED PLASMA PROTEIN AS A PROTEIN SOURCE FOR EARLY WEANED PIGS

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Story in Brief

A study involving 144 pigs (72 pigs in each of two trials) weaned at approximately 24 days of age (20-28 days), was conducted to determine the effect of replacing dried skim milk in complex prestarter diets with plasma protein (AP-820) or spray-dried fresh whole blood (AP-300) on performance of early weaned pigs. Treatments were: 1) a control complex prestarter diet containing 10% dried skim milk; 2) and 3) dried skim milk was replaced on an equal lysine basis with 4% AP-820 or 2.75% AP-300, respectively. All diets were formulated to contain 1.4% lysine and 20% dried whey. Treatments were applied 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. Gain and efficiency were measured weekly. During week 1, week 2 and for the overall-2 week period, pigs fed AP-820 or AP-300 grew faster and consumed more feed than those fed dried skim milk. Pigs fed AP-820 had higher average daily gain and average daily feed intake than those fed AP-300. Feed efficiency during Period 1 was not affected by dietary treatments. Pigs fed AP-820 or AP-300 continued to have improved gain and efficiency during a subsequent 3-week period when pigs from all treatments were fed a common starter diet. These results suggest that spray dried plasma proteins are effective alternatives to dried skim milk in a complex prestarter diet for early weaned pigs and improve performance when compared to dried skim milk.

(**Key Words:** Swine, Nutrition, Weaning, Plasma Protein, Spray Dried Whole Blood.)

Introduction

Milk proteins have been used in the prestarter diet to minimize the effect of the 5 to 10 day postweaning lag period and their contribution to

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improved performance has been reported (Wilson and Leibholz, 1981; Walker et al., 1986). Recently, however, four papers (Dietz et al., 1988; Sohn et al., 1990 a,b; Geurin et al., 1988) indicate that some sources of refined soy protein will support performance similar to that observed in pigs fed milk proteins in complex prestarter diets.

Recently, Gatnau and Zimmerman (1990) indicated that spray dried porcine plasma as a protein source supported performance better than isolated soy protein or dried skim milk diets. Hansen et al. (1990) produced similar results with spray dried plasma protein replacing dried skim milk in a high nutrient dense diet with lactose maintained constant. Drew et al. (1990) found that either porcine or bovine immunoglobulins provided adequate local immune protection in the intestine when included in the diet of neonatal pigs.

Blood meal made from blood of pigs and cattle collected at slaughter is high in protein and lysine. Its lack of use in swine diets is due primarily to the poor avalability of lysine as a result of the extended high temperatures used during the batch drying process or lack of quality control prior to processing. Blood meal that has been flash dried by the ring or drum process has been shown to have a high available lysine. Miller and Parsons (1981) reported the bioavailable lysine in ring-dried pig and cattle blood and steam-drum dried cattle blood to be 6.5 to 7.0% on an as fed basis. Blood meal produced from blood refrigerated immediately after collection and spray dried using a low temperature drying process has not been tested.

This study was conducted to determine the effect of replacing dried skim milk in complex prestarter diets with plasma proteins or blood meal in 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 weaned at approximately 24 days of age (actual age 20-28 days). 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 postweaning (Period 1) consisted of the following (Table 1: TRT 1) a control complex prestarter diet containing 10% dried skim milk (DSM) and devoid of soybean meal; TRT 2) and 3) dried skim milk was replaced with 4% AP-820 and 2.75% AP-300, respectively. Substitutions were made on an equal lysine basis and diets were formulated to contain a constant lactose level. AP-820 is one of nature's unique proteins, composed of active albumin and

globulin proteins. AP-300 is the fresh whole blood produced from bovine and swine processing plants by spray drying at low temperatures. All diets were formulated to contain 1.4% lysine and 20% of an edible grade of dried whey. Treatments were applied for 2 weeks (Period 1) and 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 diets fed during Period 1. Pigs had ad libitum access to both feed and water during Period 1 and Period 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 maintained during the first week of the experiment and was decreased 2°F per week for the remainder of the trial.

The data for each response criteria were analyzed by least squares analysis of variance. The models for average daily gain, average daily feed intake and feed efficiency included the main effects of trial, treatment, litter within trial and appropriate 2-way interactions. 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

No block x treatment interactions ($P > .2$) were observed indicating that the response of both weight groups to dietary treatment was similar. Therefore, data from both blocks were combined in the results.

During the first week postweaning, pigs fed AP-820 or AP-300 grew faster ($P<.05$) than those fed dried skim milk (Table 2). The magnitude of response ranged from a 32.6% increase in average daily gain in pigs fed the AP-820 diet to a 19.5% increase in average daily gain in pigs fed the AP-300 when compared to gain of pigs fed the dried skim milk control diet (DSM). During the second week, pigs fed AP-820 or AP-300 continued to grow faster ($P<.05$) than those fed DSM. During the entire 14-day period, average daily gain was higher ($P<.05$) in pigs fed AP-820 or AP-300 when compared to pigs fed DSM. During the first week, the second week and for the entire 14-day period, pigs fed AP-820 grew faster than those fed AP-300.

Average daily feed intake during the first week was lower ($P<.05$) in pigs fed DSM compared to pigs fed AP-820 or AP-300 (Table 2). The largest difference in feed intake was observed during week 1 when pigs fed AP-820 and AP-300 consumed 28.3% and 15.2% more feed per day, respectively. During the second week on trial and for the entire 2-week

Table 1. Composition of Experimental Diets.

	Diets[ab]			
	Period 1			Period 2
Ingredient	DSM	AP-820	AP-300	
AP-820[c]	-	4.0	-	-
AP-300[d]	-	-	2.75	-
Dried skim milk	10.0	-	-	-
Whey, dehydrate	20.0	20.0	20.0	-
Steam rolled oats	26.9	26.9	26.9	-
Provesteen[e]	8.0	8.0	8.0	-
Pro-88[f]	5.0	5.0	5.0	-
Lactose	-	5.26	5.26	-
Corn, yellow	16.575	16.795	18.007	66.65
Soybean oil	6.0	6.0	6.0	-
Lysine, HCl	.35	.35	.35	.15
Soybean meal,44%	-	-	-	28.5
Fishmeal, menhaden	3.0	3.0	3.0	-
Ethoxyquin	.025	.025	.025	-
FOA 390[g]	1.0	1.0	1.0	1.0
Flavor, berry	.1	.1	.1	-
Novasil[h]	.5	.5	.5	-
Coli-mix[i]	.5	.5	.5	-
Copper sulfate	.1	.1	.1	.075
Dicalcium phosphate-	.53	.52	1.95	
Calcium carbonate	1.05	1.02	1.02	.90
DL-Methionine	.16	.18	.228	-
Vit. min. premix[j]	.74	.74	.74	.375
Salt	-	-	-	.40
Calculate analysis, %				
ME (Kcal/lb)	1585	1574	1574	1453
Crude protein	20.37	19.60	19.43	18.32
Calcium	.96	.96	.96	.88
Phosphorus	.87	.87	.87	.74
Lysine	1.40	1.40	1.40	1.11
Threonine	.86	.87	.82	.72
Tryptophan	.23	.24	.23	.24
Met+Cys	.76	.76	.76	.61

(Table 1 continued on next page)

Table 1. (Continued).

[a] As fed basis.
[b] DSM: dried skim milk diet; AP-820: active albumin and globulin protein diet; AP-300: fresh whole blood protein diet.
[c] AP-820, American Protein Corporation, Ames, Iowa.
[d] AP-300, American Protein Corporation, Ames, Iowa.
[e] Provesteen, Provesta Corporation, Bartlesville, OK.
[f] Pro-88, Morgan, Mfg. Co., Inc. Paris, IL.
[g] Contained 10g Furazolidone, 5g Oxytetracycline, 4.5g Arsanilic acid per lb of diet.
[h] Novasil, Engelhard Corporation, St. Charles, IL.
[i] Coli-mix, Central Biologics, Inc, Raleigh, NC.
[j] Supplied 4,160 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, .6 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, .01 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 mg selenium, .02 g manganese, .07 g zinc, .07 g iron, .07 g copper, .17 mg iodine, per lb of feed in Period 2.

period, average daily feed intake was higher ($P<.05$) in pigs fed AP-820 or AP-300 when compared to pigs fed DSM.

Feed efficiency (G:F) during the first week, the second week and for the overall 14- day period was not affected by dietary treatments.

Average daily gain and average daily feed intake during Period 2 continued to be higher ($P<.1$) in pigs previously fed AP-820 or AP-300 in Period 1 when compared to pigs previously fed DSM, even though pigs from all treatment groups were fed a common corn-soybean meal diet in Period 2. Feed efficiency, however, was similar among pigs fed the three dietary treatments (Table 2) during the subsequent 3-week period (Period 2). Average daily gain and average daily feed intake in Period 2 of pigs previously fed AP-820 as the supplemental protein source were similar to those of pigs previously fed AP-300.

Table 2. The effect of plasma protein on performance of early weaned pigs[a].

Item	Diet			SE
	DSM	AP-820	AP-300	
Average daily gain, lb				
Week 1	.46[b]	.61[c]	.55[d]	.02
Week 2	.77[b]	.97[c]	.88[d]	.02
Period 1	.62[b]	.79[c]	.72[d]	.02
Period 2	1.16[e]	1.21[f]	1.25[f]	.02
Average daily feed intake, lb				
Week 1	.46[b]	.59[c]	.53[d]	.02
Week 2	.97[e]	1.21[f]	1.08[g]	.02
Period 1	.72[e]	.90[f]	.81[g]	.02
Period 2	2.09[e]	2.17[f]	2.19[f]	.02
Feed efficiency (G:F)				
Week 1	.97	1.02	1.08	.06
Week 2	.86	.83	.84	.02
Period 1	.89	.90	.91	.02
Period 2	.56	.56	.57	.01

[a] Least squares means.
[b,c,d] Means in the same row with different superscript differ ($P < .05$).
[e,f] Means in the same row with different superscript differ ($P < .1$).

Initial pig weight (Table 3) averaged 15.90, 15.90 and 15.87 lb for pigs fed DSM, AP-820 and AP-300, respectively. After week 1, due to inferior gains by pigs fed dried skim milk, dietary protein source affected pig weight ($P < .05$) and by the end of week 2, pigs fed DSM weighed 9.7 and 4.9% less than pigs fed the AP-820 and AP-300, respectively. Differences in pig weight continued throughout the 3-week carryover period when pigs were fed a common starter diet.

It should be noted that the substantial improved performance in pigs fed plasma proteins was exhibited even though performance of pigs fed the

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

Item	Diet			SE
	DSM	AP-820	AP-300	
No of pigs	24	24	24	
Initial wt	15.90	15.90	15.87	
Week 1	19.14[b]	20.17[c]	19.72[d]	.15
Week 2	24.64[b]	27.02[c]	25.86[d]	.33
Week 3	31.15[b]	33.88[c]	33.15[c]	.55
Week 4	39.27[b]	42.11[c]	41.56[c]	.57
Week 5	49.06[b]	52.43[c]	52.05[c]	.59

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

complex control diet devoid of soybean meal was excellent and considerably better than performance during week 1 and week 2 of similar trials conducted in our facilities (Coffey et al., 1990, Sohn et al, 1990a). This study suggests that the plasma proteins offer a unique dietary protein source for pigs immediately after weaning.

Literature Cited

Coffey, R.D. et al. 1990. The effect of isolated soy protein substitution for milk proteins with and without maintaining constant lactose on performance of early weaned pigs. J. Anim. Sci. 68(Suppl.1):350(Abstr.).

Dietz, G.N. et al. 1988. Effect of protein source on performance of early weaned pigs. J. Anim. Sci. 66(Suppl. 1):314(Abstr.).

Drew, M.D. et al. 1990. Artificial rearing of colostrum-deprived piglets using iron chelators: in vitro and in vivo comparisions of EDDHA and HBED with and without porcine immunoglobulins. Can. J. Anim. Sci. 70:647.

Gatnau, R and D.R. Zimmerman. 1990. Spray dried plasma (SDPP) as a source of protein for weanling pigs. J. Anim. Sci. 68(Suppl. 1):374(Abstr.).

Geurin, H.B. et al. 1988. Effect of isolated soy protein and whey on replacing dried skim milk in a prestarter for weaned baby pigs. J. Anim. Sci. 66(Suppl.1):320(Abstr.).

Hansen, J.A. et al. 1990. Effect of substituting spray-dried plasma protein for milk products in starter pig diets. Proc. Kansas State Univ, Swine Day. p 30.

Leibholz, J. 1982. Utilization of casein, fishmeal, and soybean proteins in dry diets for pigs between 7 and 28 days of age. Anim. Prod. 34:9.

Miller, E.R and M.J. Parsons. 1981. Flash dried blood meal as an ingredient for pig diets. Pig News and Information 2(4):407.

Sohn, K.S. et al. 1990a. Effect of source of dietary protein on performance and amino acid availability in early weaned pigs. J. Anim. Sci. 68(Suppl.1):356(Abstr.).

Sohn, K.S. et al. 1990b. Effect of dietary protein source on ileal amino acid availability in early weaned pigs. J. Anim. Sci. 68(Suppl. 1):390(Abstr.).

Walker, W.R. et al. 1986. Milk versus soybean protein sources for pigs: I. Effect of performance and digestibility. J. Anim. Sci. 63:505.

Wilson, R.H. and J. Leibholz. 1981. Digestion in the pig between 7 and 35 d of age. 1. The performance of pigs given milk and soya-bean proteins. Brit. J. Nutr. 45:301.