FATS AND PROTEINS RESEARCH FOUNDATION, INC.

Director's Digest

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INTRODUCTION:

The below article appeared in the February 1992 issue of FEED MANAGEMENT magazine. We are observing increased utilization of blood meal in swine diets and in the past two years spray dried blood plasma in pig starter rations is receiving increased interest. These new developments offer some of our members an opportunity to sell value added products.

F.D.B.

BLOOD PRODUCTS ARE NOT CREATED EQUAL

By
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Starter pig nutrition has undergone dramatic changes during the past two years. Feed manufacturers have directed their attention to finding cost effective alternatives to milk products as protein sources in swine starter diets. Typically, dried skim milk or casein is used in early-weaned pig diets to help the young pig make the transition to a dry diet. Low-antigenicity milk products can replace a portion of the highly antigenic soybean meal in starter swine diets. This can reduce much of the immunological stresses that contribute to post-weaning lag (Li et al., 1990). However, milk products in particular casein and dried skim milk, increase the cost of starter pig diets, especially when fed for extended periods of time. Also, nutrients in milk products are susceptible to destruction during pelleting.

The introduction of several blood products, derived from improved processing methods, have altered the feeding program of many commercial feed producers as well as swine producers who mix feed on the farm. These products are highly digestible and the amino acids appear to be highly available when processed properly. However, the feed manufacturer must be aware of the order of limiting amino acids in blood products. Deficiencies of certain amino acid, such as methionine and isoleucine, may occur with high concentrations of blood products.

A carryover effect appears to be associated with the feeding blood products to pigs. Performance has been increased when blood products were added to the diets of growing pigs. These improvements continued during the subsequent phases of pig growth. Starter pigs may find spray-dried blood meal to be unpalatable initially, but maintain greater growth rates during the subsequent phases of growth.

EXPLORING NEW TOOLS IN PIG FEEDING

Within the last two years, spray-dried blood plasma has become commercially available for use by feed manufacturers.

Iowa STate University researchers conducted two experiments to evaluate porcine plasma protein in the diets of starter pigs (Gatnau and Zimmerman, 1990b). In the first experiment, the researchers incorporated alternative protein sources casein, meat extract, isolated soybean protein, and spray-dried porcine plasma into corn-soybean meal diet containing 20% dried whey. The protein sources were added at 10% of the diet.

Compared to the other protein sources tested, the spray-dried porcine plasma increased average daily feed intake during the first two weeks post-weaning (Gaynau and Zimmerman, 1990b). Similarly, pigs fed the porcine plasma and casein diets had higher daily gains (P .05) than pigs fed either the meat extract or isolated soybean protein diets. Because the researchers substituted each protein source at a rate of 10%, there is great potential for imbalances of amino acids in the diets examined. A methionine deficiency may occur when porcine plasma is incorporated in starter pig diets at 10%. When a diet containing porcine plasma was supplemented with methionine, pig performance was superior to pigs on a milk-based diet (Hansen et al, 1990).

Gatnau and Zimmerman (1990B) reported only slight advantages to using spray-dried porcine plasma in pig diets. Also, Hansen et al (1990) observed no difference in average daily gain, feed intake, or feed efficiency when porcine plasma and lactose simply replaced dried skim milk in starter pig diets.

Hansen et al. (1990) evaluated the efficacy of combining porcine plasma with various ingredients (lactose and starch) to replace 20% dried skim milk and 20% dried whey in 21-day old starter pig diets. The diets were fed for 14 days post-weaning. Pigs were subsequently fed a common corn-soybean meal based diet with 4% select menhaden fish meal and 20% dried whey to 35 days post-weaning. The data obtained from this study are presented in Table 1. Overall, pig fed diets containing plasma protein performed better than pigs fed the corn-soybean meal-skim milk control diet. However, pigs fed the diet containing porcine plasma and whey and either lactose or starch had the greatest average daily body weight gains and feed intakes. With the exception of slightly higher performance and a more pronounced response to porcine plasma, these data are in agreement with those of Gatnau and Zimmerman (1990b). Hansen et al. (1990) also indicated that maximal performance was observed when only dried skim milk was replaced by porcine plasma, with the concomitant addition of lactose. Furthermore, the improvement in growth rate paralleled the increases in daily feed intake, suggesting that the response was related to the inclusion of plasma protein and not differences in feed utilization.

Questions have arisen regarding the optimal inclusion rate of plasma protein. Gatnau et al. (1990) observed quadratic changes in growth rate and feed intake (Figure 1) as the inclusion rate of porcine plasma increased from 0-8% of the diet. Diets were formulated to contain 1.20% lysine and the methionine concentration was allowed to vary. The estimated methionine requirement for a 14 lb. pig fed a 1.20% lysine diet is .29 to .30%. This was the calculated content of diet containing 4% porcine plasma. A linear relation existed between performance and porcine plasma inclusion, when the diets contained between 0 and 6% porcine plasma. However, when the concentration of porcine plasma exceeded 6%, performance was reduced. This was possibly due to a limitation in total methionine content.

When comparing the two concentrations of porcine plasma inclusion used by Hansen et al., (1990), it is unclear whether the slightly lower performance observed when replacing both dried skim milk and dried whey was due to an amino acid imbalance or some interactive effect of ingredients. Thus, from the present data, it is impossible to determine an optimal rate of inclusion of porcine plasma. But, diets containing up to 10% porcine plasma may require supplementation with methionine if satisfactory pig performance is desired.

Plasma protein can be obtained from swine or beef blood. However, little research has been conducted evaluating the effects of blood meal obtained from different species on animal performance. Hansen et al. (1991) replaced 20% of dried skim milk in early-weaned starter pig diets with: 1) spray-dried porcine plasma, 2) spray=dried porcine blood meal, 3) spray-dried bovine plasma, and 4) commercial meat extract. Diets were formulated to contain 1.40% lysine and at least .39% methionine. All diets had the same concentration of lactose (24.4%).

According to the data presented in Table 2, when used in pig starter diets, porcine plasma offers an advantage over bovine plasma. Pigs fed either bovine plasma, dried skim milk, or porcine blood meal appeared to perform at similar levels during the first two weeks post-weaning. The difference observed between the swine and bovine plasma proteins was not expected, and at present are only supported by the work of Parsons et al. (1985) who found slightly lower available lysine contents for rig-flash-dried bovine blood compared to a similarly processed swine blood.

When utilizing diets with plasma protein, a producer or feed manufacturer may question whether the use of milk products is necessary to maintain a similar lactose concentration. When replacing the milk protein fraction, Hansen et al. (1990) found that lactose inclusion was needed to maximize both feed intake and gains. The young pigs' digestive capabilities may be limiting performance. This idea is supported by the reports of several other researchers (Newton and Mahan, 1990; Mahan, 1991; Radke et al. 1991) who found that lactose was readily utilized and necessary for optimal growth of the young pig. Therefore, when replacing milk products with blood products in starter swine diets, it is necessary to maintain the same lactose concentration.

REEXAMINING AN OLD STANDBY

Miller and Parsons (1981) published recommendations for use of blood meal in swine diets based on research that they conducted at Michigan State University. Research demonstrated that up to 6% ring-dried blood meal could be utilized in starter pig diets (Miller et al., 1976). Miller et al., (1976), further stated that concentrations of 4 and 3% ring-dried blood meal could be effectively utilized in grower and finishing pig diets, respectively. The dietary concentrations for blood meal set forth by Miller and Parsons (1981) were limited to 5% inclusion of flash-dried blood meal in all phases of production.

Hansen et al (1991) demonstrated that blood meal of porcine origin could effectively replace dried skim milk in starter pig diets fed during Phase 1 of the experiment-from 0-14 days post-weaning (Table 2). Average daily body weight gain, feed intake, and feed efficiency was the same for pigs fed diets containing either the skim milk or porcine blood. Feed intake was slightly reduced during the first week post-weaning. However, those pigs fed porcine blood meal appeared to have increased appetite during the subsequent 14-35 days post-weaning period (Phase I). When viewing growth rate plotted over time, one can see an interaction between Phase 1 protein source feeding and subsequent performance in Phase II (Figure 2).

This observation is supported by the work of Tokach et al. (1991), who fed pigs a common diet containing porcine plasma for the first seven days post-weaning (Phase 1) and then imposed six different feeding regimes for the 7-28 day post-weaning period (Phase II), Pigs consuming spray-dried porcine blood meal during the Phase II period had similar gains to those fed spray-dried porcine plasma. However, the performance obtained with the porcine plasma and blood meal was greater than that obtained with either the amino acid supplemented, fish meal, or extruded or unextruded soybean protein concentrate diets. Also, subsequent growth rates during the grower period (28-56 days post-weaning) were significantly (P .03) higher for pigs fed the blood meal compared to all other treatments.

Because both Hansen et al. (1991) and Tokach et al. (1991) found that spray-dried blood meal caused improvements in subsequent growth patterns, the question arises concerning the inclusion of both blood meal and plasma in the starter pig diet.

Gatnau and Zimmerman (1990a) fed diets containing porcine plasma and blood meal, alone and in combination, to nursery pigs. Their results, presented in Table 4, are similar to those of Hansen et al. (1991) in which pigs consumed less feed when blood meal was incorporated in the diet. However, Gatnau and Zimmerman (1990a) did not observe improvements during the subsequent growth phase, nor did they observe maximal performance with the diet containing both products.

The feed manufacturer must be aware of the order of limiting amino acids in each product. The performance observed by Gatnau and Zimmerman (1990a) may have been influenced by the concentration of essential amino acids in the diet. It is important to note that blood meal is extremely low in the essential amino acid isoleucine, and may be limiting in methionine when included at high concentration. Based on their inclusion rates of blood meal, it is suspected that isoleucine may have been limiting performance if they did not supplement it in the diet. It is apparent from these data that more information is needed regarding feed ingredient interaction, and subsequent performance.

Inclusion of blood products into starter pig diets will depend upon the cost of gain, changes in post-feeding growth patterns, and possible changes in nursery mortality.

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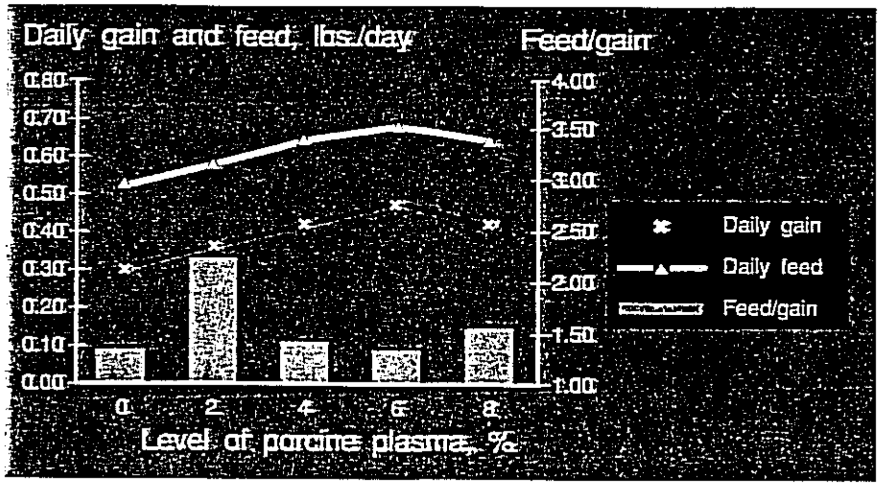

Figure 1. Influence of porcine plasma inclusion rate on starter pig performance. Source: Gatnau *et al.*, 1990.

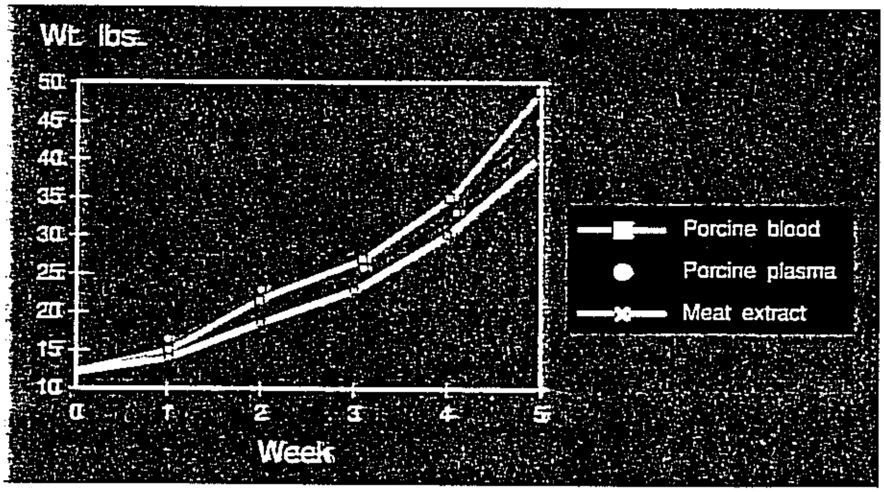

Figure 2. Effect of 0-14 day post-weaning protein source on subsequent starter pig growth pattern. Note: Pigs fed porcine blood meal and meat extract had near linear growth during the study, but the levels of performance were substantially different. Pigs fed the meat extract exhibited no compensatory growth when fed the same diet 14-35 days post-weaning. Performance was reduced in pigs fed porcine plasma when switched to the common diet at 14 days post-weaning. Source: Hansen *et al.*, 1991.

Table 1.

Effect of substituting plasma protein and lactose or starch for milk products in starter pig diets—Trial 2.

	Days	CON[1]	PLW[1]	PSW[1]	PL[1]	PS[1]	CV[2]
Ave. daily gain, lbs.	0-14[abc]	.69	.98	.93	.91	.83	8.9
	14-35	1.30	1.34	1.30	1.34	1.33	6.4
Ave. daily feed intake, lbs.	0-14[abc]	.86	1.18	1.07	1.06	.96	8.2
	14-35[c]	2.30	2.48	2.43	2.53	2.54	6.3
Feed/gain	0-14[c]	1.24	1.21	1.16	1.17	1.15	4.7
	14-35[c]	1.77	1.86	1.88	1.90	1.90	4.3

[1]Diets were formulated to contain 1.40% lysine using the following ingredients: CON=control (corn, soybean meal, 20% dried skim milk, 20% whey); PLW=same as CON but 10.3% porcine plasma and 10% lactose replaced skim milk; PSW=PLW but corn starch replaced lactose; PL=CON but 13.4% porcine plasma and 24.4% lactose replaced skim milk and dried whey; PS=PL but corn starch replaced lactose. A common diet was fed during 14-35 day period.

[2]CV=Coefficient of variation, %.

[a]Main effect of lactose (P<.10).

[b]Main effect of plasma protein concentration (P<.05).

[c]Plasma protein versus control (P<.05).

Source: Hansen *et al.*, 1990.

Table 2.

Influence of protein source on starter pig performance.

	Days	Skim milk	Porcine plasma	Porcine blood	Bovine plasma	Meat extract	SEM[2]
		Protein source[1]					
Ave. daily gain, lbs.	0-14	.72[b]	.83[c]	.75[bc]	.72[b]	.58[a]	.02
	14-35	1.08	1.06	1.22	1.14	1.12	.04
Ave. daily feed intake, lbs.	0-14	.86[a]	1.10[b]	.89[a]	.93[a]	.90[a]	.04
	14-35	1.88[a]	1.86[a]	2.21[b]	1.98[a]	1.96[a]	.05
Feed/gain	0-14	1.19[a]	1.32[ab]	1.19[a]	1.29[ab]	1.56[b]	.07
	14-35	1.75	1.75	1.81	1.74	1.74	.04

[1]Values are means of six replicate pens containing five pigs each. Initial pig weight was 11.7 lbs. A common corn-soybean meal diet with 10% added dried whey and 4% select menhaden fish meal was fed from 14 to 35 days.
[2]Pooled standard error of the pen means.
[abc]Means in same row differ with different superscripts ($P < .05$).
Source: Hansen *et al*, 1991.

Table 3.

Effect of Phase II (7-28 day) protein source on swine growth.

	Days	AA	MFM	SDPP	SDBM	SPC	ESPC	CV[2]
		Protein source[1]						
Ave. daily gain, lbs.	7-28[a]	.87	.87	.94	.92	.87	.89	7.4
	28-56[b]	1.21	1.20	1.23	1.33	1.25	1.22	7.0
Pig weight, lbs.	28[a]	36.3	36.4	37.8	37.4	36.3	36.8	3.8
	56[a]	70.1	70.3	72.4	74.7	71.3	71.0	3.5
Ave. daily feed intake, lbs.	7-28	1.39	1.32	1.41	1.40	1.35	1.36	6.3
Feed/gain	7-28[c]	1.61	1.52	1.51	1.53	1.56	1.53	4.4

[1]All pigs were fed a common diet from 0-7 days. Experimental diets were formulated to contain 1.18% lysine using the following supplemental protein sources: AA=amino acids replacing fish meal; MFM=5% select menhaden fish meal; SDPP=spray dried porcine plasma replacing fish meal (lysine basis); SDBM=spray-dried blood meal replacing fish meal on a lysine basis; SPC=soybean protein concentrate replacing fish meal on a lysine basis; ESPC=same as SPC except that the soybean protein concentrate was extruded.
[2]CV=coefficient of variation.
[a]Blood products versus others ($P<.06$).
[b]SDBM versus others ($P<.03$).
[c]AA versus others ($P<.02$).
Source: Tokach *et al*, 1991.

Table 4.

Effect of blood meal and porcine plasma combinations on starter pig feed.

	Weeks	CON	SDPP	SDPP-BM	BM	CV[2]
		Protein source[1]				
Ave. daily gain, lbs.	0-2	.14[bc]	.28[a]	.21[ab]	.13[a]	20
	0-4	.53	.59	.54	.52	9
Ave. daily feed intake, lbs.	0-2	.26[a]	.46[a]	.36[b]	.29[bc]	14
	0-4	.73[b]	.90[a]	.77[ab]	.75[ab]	10
Feed/gain	0-2	1.85[ab]	1.65[a]	1.66[a]	2.37[b]	15
	0-4	1.39	1.53	1.41	1.46	5

[1]Diets were formulated to contain 1.20% lysine using the following ingredients: CON=control (corn-soybean meal-dried whey); SDPP=10% porcine plasma replaced corn and soybean meal; SDPP-BM=5% porcine plasma and 3.8% blood meal replaced corn and soybean meal; BM=7.5% blood meal replaced corn and soybean meal.
[2]CV=coefficient of variation, %
[abc]Means within the same row with different superscripts are different ($P<.05$).
Source: Gatnau and Zimmerman, 1990a.