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EVALUATION OF PORCINE BLOOD MEAL AND PLASMA, BOVINE PLASMA, AND MEAT EXTRACT AS REPLACEMENT PROTEIN SOURCES FOR DRIED SKIM MILK IN STARTER SWINE DIETS[1]

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Summary

One-hundred fifty pigs averaging 21 ± 2 d of age were utilized in a 35 d growth assay to determine the efficacy of replacing the dried skim milk portion of a high nutrient-dense diet with four commercially available animal blood or meat co-products. Pigs were blocked by weight and allotted by ancestry and sex to provide six pens (five pigs/pen) per dietary treatment. Diets were randomly assigned within blocks to provide six replicate pens per treatment. The basal diet was formulated using a corn-soybean meal mixture with 20% dried skim milk and 20% dried whey to contain 1.40% lysine, 1.0% calcium, and .90% phosphorus. Spray-dried porcine plasma protein, porcine blood meal, bovine plasma protein, and extracted meat protein were substituted on a lysine basis for dried skim milk; lactose was added to maintain 24.4% lactose. During wk 1, pigs consuming the diet with porcine plasma had 25% and 28% higher daily gain and ADFI, respectively, than those fed the skim milk based diet. There were no differences in growth observed between pigs fed diets containing dried skim milk, porcine blood meal, or bovine plasma. Maximum performance was achieved during the Phase I period by feeding porcine plasma protein. Pigs fed the meat extract diet demonstrated significantly poorer performance than pigs fed the other diets, indicating that it is not an effective replacement for skim milk based on our substitution rates. When pigs were fed a common diet during Phase II, there was a propensity for pigs consuming porcine blood during Phase I to have higher ADFI and ADG, indicating a possible diet interaction between the two phases. During the overall trial (0 to 35 d), differences were detected only between the porcine blood meal and meat extract diets. In conclusion, porcine plasma appeared to offer the potential for greatest performance during Phase I, although there may have been a protein source interaction between Phase I and Phase II diets, indicating that more research is needed to alleviate stall-out during Phase II.

(Key Words: Starter, Performance, DSM, Milk, By-product, BM.)

Introduction

Previous research at this station has indicated that improvements of up to 40% can be observed in ADG and ADFI by replacing the dried skim milk portion of a high nutrient-dense diet with porcine plasma protein. Furthermore, these differences were maintained throughout the Phase II period in which pigs were fed a common corn-soybean meal diet containing 20% dried whey. At present, no data are available concerning the feeding value of high quality spray-dried porcine blood meal on spray-dried bovine plasma, and data are limited for soluble meat protein. Because these products are commercially available, the objective of this study was to examine their feeding value based as replacements for the dried skim

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milk portion of the high nutrient-dense, Phase I starter diet.

Procedures

One-hundred twenty pigs averaging 21 ± 2 d of age were utilized in a 35 d growth assay. Pigs (11.7 lb initially) were blocked by weight and allotted by ancestry and sex to provide five pens within each block (five pigs/pen). The five dietary treatments were randomly assigned within blocks, providing six replicate pens per treatment. The diets (Table 1) were formulated to contain 1.40% lysine, 1.0% Ca, and .90% P. The basal diet was formulated using a corn-soybean meal mixture with 20% dried skim milk and 20% dried whey. The porcine plasma, porcine blood meal, bovine plasma, and meat extract are commercially available (American Protein Corporation, Ames, IA) products and were substituted on a lysine basis for dried skim milk. All diets were formulated to contain at least .91% Na, .76% isoleucine, and .39% methionine (content of basal diet) or .68% methionine plus cystine. During Phase II (14 to 35 d), a common corn-soybean meal diet containing 10% dried whey and 4% menhaden fish meal was fed. It was formulated to contain 1.25% lysine, .90% calcium, and .80% phosphorus.

Digestibility of dry matter (DM) and nitrogen (N) were calculated from fecal samples obtained on d 14 using Cr_2O_3 as an indigestible marker. Pigs and feeders were weighed weekly for calculation of average daily gain (ADG), average daily feed intake (ADFI), and feed/gain (F/G). Data for the Phase I and overall trial were analyzed as a randomized block design. Phase II data were subjected to covariate analysis of variance with Phase I ADG as the covariate and diet x Phase I ADG as an interaction term. Means were separated using the Bonferroni paired t-test.

Results and Discussion

Phase I. During wk 1, pigs fed porcine plasma had 25% and 28% higher ($P<.05$) ADG and ADFI, respectively, than pigs fed porcine blood (Table 2). This difference in growth rate can be attributed to improved feed intake for pigs fed porcine plasma, because no differences were observed for feed utilization. No differences in ADG or ADFI were detected between pigs fed the porcine plasma, bovine plasma, or skim milk-based diets, indicating that all three protein sources are of similar nutritional value in Phase I starter diets. Pigs fed the meat extract diet had the poorest F/G ratio ($P<.05$), 35% poorer than those fed skim milk, and the slowest growth rates ($P<.05$).

During Phase I (0 to 14 d), pigs fed porcine plasma had 15% higher ($P < .05$) ADG than pigs on the skim milk or bovine plasma diets and 44% higher ADG ($P < .05$) than pigs fed meat extract. Similarly, the highest ADFI was observed for pigs fed porcine plasma; it was 18% higher than that of pigs fed bovine plasma, the second highest. Pigs fed porcine blood had similar ADFI to those fed the skim milk and bovine plasma diets, but growth rates were similar to those of pigs fed porcine plasma. The N in the porcine plasma diet may be less available (4% lower digestibility) to the pig than that in the porcine blood diet. Combined with the numerically better F/G, this indicates that the amino acids could have been utilized more efficiently, thus, explaining the similarity in ADG between the two diets.

The meat extract diet had the highest availability of N; however, this difference may have been due to the higher total N in the diet. Although neither urinary N nor blood urea nitrogen were measured, the biological value of the meat extract protein probably is low compared to skim milk or the blood protein products.

Phase II. Pigs were fed a common diet during Phase II to examine the effects of Phase I diet on subsequent performance. Covariate analysis of Phase II performance indicated that no interactions were observed for the entire Phase II period, although pigs fed porcine plasma tended to have poorer performance during wks 3 and 4. This may indicate a diet interaction between Phase I and II, because pigs fed porcine blood meal during Phase I had the highest growth rates and greatest ADFI ($P<.05$) during Phase II.

Overall Performance. Viewing the overall performance of pigs during the trial shows that performance during Phase II had the greatest impact on statistical comparisons because of the amount of gain and feed consumption achieved by the pigs. Pigs fed the porcine blood diet in Phase I consumed from 8 to 14% more feed than pigs fed the other diets. Also, pigs fed the meat extract diet had 13% lower ($P<.05$) ADFI overall than pigs fed the porcine blood diet. These observations suggest that pigs fed porcine plasma during Phase I went through a stall-out phase during weeks 3 and 4, resulting in the interaction between Phase I and Phase II diets.

Conclusions

Our data indicate that maximal performance can be obtained during wk 1 and Phase I by feeding porcine plasma. Spray-dried porcine blood meal and bovine plasma can effectively replace skim milk in Phase I starter diets; however, extracted meat protein does not appear to be an effective replacement based on the present substitution rate and amino acid additions. Comparing Phase I and Phase II performance indicates an apparent interaction between protein sources in each phase. The results of this trial clearly indicate that more research is needed on Phase II to alleviate the diet interactions limiting performance during that period.

Table 1. Composition of Diets

	Phase I					
Ingredient	Skim Milk	Porcine Plasma	Porcine Blood	Meat Extract	Bovine Plasma	Common Phase II
Corn	33.44	33.13	35.72	26.93	35.51	55.86
Soybean meal, 48%	16.10	16.10	16.10	16.10	16.10	22.71
Dried whey	20.00	20.00	20.00	20.00	20.00	10.00
Test protein	20.00	10.28	6.62	15.71	6.96	-
Select menhaden fish meal, 62%	-	-	-	-	-	4.00
Lactose	-	10.00	10.00	10.00	10.00	-
Soybean oil	6.00	6.00	6.00	6.00	6.00	4.00
Monocalcium phosphate, 21% P	-	2.57	.03	.48	.26	1.46
Monosodium phosphate	1.59	-	2.38	1.93	2.21	-
Limestone	1.27	.65	1.80	1.67	1.75	.55
Salt	.30	-	-	-	-	.25
L-lysine HCl, 98%	.15	-	-	-	-	.15
DL-methionine, 99%	-	.13	.11	.04	.08	-
L-isoleucine	-	-	.09	-	-	-
CSP-250[a]	.50	.50	.50	.50	.50	.50
Copper sulfate	.10	.10	.10	.10	.10	.08
Chromium oxide	.10	.10	.10	.10	.10	-
Selenium premix[b]	.05	.05	.05	.05	.05	.05
KSU vitamin premix	.25	.25	.25	.25	.25	.25
KSU trace minerals	.15	.15	.15	.15	.15	.15
Total	100.00	100.00	100.00	100.00	100.00	100.00

Table 1. Composition of Diets (Cont.)

	Phase I					
Ingredient	Skim Milk	Porcine Plasma	Porcine Blood	Meat Extract	Bovine Plasma	Common Phase II
Calculated analysis, %						
Crude protein[c]	19.45	19.35	18.73	26.73	18.00	18.56
Lysine	1.40	1.40	1.40	1.40	1.40	1.25
Methionine	.39	.39	.39	.42	.39	.35
Methionine plus cystine	.73	.87	.71	.68	.72	.69
Tryptophane	.25	.30	.28	.22	.22	.23
Isoleucine	1.05	.82	.76	.86	.65	.87
Threonine	.92	1.03	.90	.96	1.02	.82
Calcium	1.01	.99	.99	.99	.99	.90
Phosphorus	.90	.90	.90	.90	.90	.80
Sodium	.91	.91	.91	.91	.91	.25
Lactose	24.40	24.40	24.40	24.40	24.40	7.20

[a]Provided 5 g chlortetracycline, 5 g sulfathiazole, and 2.5 g penicillin per lb complete diet.
[b]Provided .3 ppm Se in complete diet.
[c]Analyzed content.

Table 2. Effect of Protein Source on Pig Performance[a]

Item	Skim Milk	Porcine Plasma	Porcine Blood	Meat Extract	Bovine Plasma	SEM[b]
Week 1 (0 to 7 d)						
ADG, lb	.71[cd]	.79[c]	.63[d]	.49[e]	.69[cd]	.02
ADFI, lb	.68[cd]	.83[c]	.65[d]	.64[d]	.72[cd]	.03
Feed/gain	.96[c]	1.05[c]	1.02[c]	1.30[d]	1.04[c]	.03
Phase I (0 to 14 d)						
ADG, lb	.72[c]	.83[d]	.75[cd]	.58[e]	.72[c]	.02
ADFI, lb	.86[c]	1.10[d]	.89[c]	.90[c]	.93[c]	.04
Feed/gain	1.19[c]	1.32[cd]	1.19[c]	1.56[d]	1.29[cd]	.07
Digestibility (d 14), %						
DM	73.78	72.65	71.70	71.00	72.31	1.19
N	78.28[cd]	74.92[c]	78.89[cd]	81.29[d]	76.16[cd]	1.39
Phase II (14 to 35 d)						
ADG, lb	1.08	1.06	1.22	1.12	1.14	.04
ADFI, lb	1.88[c]	1.86[c]	2.21[d]	1.96[c]	1.98[c]	.05
Feed/gain	1.75	1.75	1.81	1.74	1.74	.04
Overall (0 to 35 d)						
ADG, lb	.94[cd]	.97[cd]	1.03[c]	.91[d]	.97[cd]	.03
ADFI, lb	1.47[c]	1.55[cd]	1.68[d]	1.53[cd]	1.56[cd]	.03
Feed/gain	1.58	1.60	1.63	1.70	1.61	.04

[a]Values are means of six replicate pens containing five pigs each (initially 11.63 lb; 35 d trial).
[b]Pooled standard error of the pen means.
[cde]Means in the same row with different superscripts are different ($P < .05$).