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Evaluation of Bovine Plasma Source and a Dried Milk Product on Nursery Pig Growth in a Commercial Environment[1]

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Summary

A total of 360 barrows and gilts (PIC 359 × C29; initially 13.7 ± 3.1 lb and 19 d of age) were used in a 24-d experiment evaluating the effect of different specialty ingredients on nursery pig growth performance. This experiment was conducted in a commercial research nursery (Cooperative Research Farm Nursery; Sycamore, OH). At weaning, pigs were allotted to pens by initial BW and to one of four dietary treatments in a completely randomized design. There were 9 pens per treatment with 10 pigs per pen. Experimental diets were fed from d 0 to 10, with a common diet fed from d 10 to 24. Experimental diets were: 1) Negative control (NC); 2) NC + 5% bovine Plasma A (AP920, APC Inc.; Ankeny, IA); 3) NC + 5% bovine Plasma B (Promax; Protena S.A., Nicaragua); and 4) NC + 5% dried milk (Nutrigold; International Ingredients Corporation Inc., St. Louis, MO). All diets contained 5% fishmeal and were balanced for SID lysine, lactose, and salt. Diets were fed in pellet form. From d 0 to 10, pigs fed either Plasma A or B had greater ($P < 0.01$) ADG and ADFI than pigs fed the NC or Nutrigold diets. Pigs fed Nutrigold had increased ($P < 0.01$) ADG compared to pigs fed the NC diet. Also, F/G was improved ($P < 0.001$) for pigs fed either Plasma A or B and Nutrigold diets compared to those fed the NC. During the common period (d 10 to 24), there were no differences for ADG or ADFI, although the pigs previously fed NC had improved (1.24 vs. 1.31; $P < 0.01$) F/G compared to those previously fed Plasma A. Overall (d 0 to 24), pigs fed Plasma A and B had greater ($P < 0.02$) ADG and ADFI than NC pigs. Pigs fed Plasma B had increased ($P < 0.04$) ADG relative to pigs fed Nutrigold. In summary, both plasma sources increased feed intake and growth with no differences among sources. Nutrigold also improved performance compared to the NC.

Key words: dried milk, growth, nursery pig, spray-dried bovine plasma

[1] Appreciation is expressed to International Ingredient Corporation Inc. (St. Louis, MO) for providing the bovine plasma sources and whole milk product used in this experiment and for partial financial support.
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Introduction

Supplying sources of milk and animal-based proteins in early nursery diets has become standard practice to help the newly weaned pig begin the rapid transition from a milk-based liquid diet to a plant-based solid diet. These specialty protein sources are more digestible and stimulate feed intake, which is directly correlated to a pig's lifetime performance potential[4]. Nevertheless, incorporating these ingredients adds significant cost to nursery diets, so newly available products must be evaluated regularly to determine their value. This study was designed to evaluate two newly available ingredients, a bovine plasma source (ProMAX; Protena S.A., Nicaragua) and a dried whole milk product (Nutrigold; International Ingredient Corporation, St. Louis, MO). ProMAX is spray-dried bovine plasma that is both food and feed grade. This plasma is collected immediately from the animal during exsanguination in an effort as to reduce any possible contaminants. Nutrigold is a milk product made by drum-drying fresh milk that has been returned from retail grocery stores. All milk used in this product is collected before the expiration date and kept chilled throughout the handling process until drying. The milk sources used vary (e.g., 2%, skim, chocolate, whole) and, accordingly, are blended to make a consistent product with 17% fat, which is lower than that of whole dried milk (26% fat).

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Cooperative Research Farm's Swine Research Nursery (Sycamore, OH), which is owned and managed by Kalmbach Feeds, Inc.

A total of 360 pigs (PIC 359 × C29: initially 13.7±3.1 lb) were used in a 24-d growth trial. Pens of 10 pigs (5 barrows and 5 gilts) were balanced by initial BW and randomly allotted to treatments with 9 replications (pens) per treatment. Each pen had slatted metal floors and was equipped with a 4-hole stainless steel feeder and one cup waterer for ad libitum access to feed and water.

Facilities were intentionally not cleaned between groups for 2 turns before trial onset to provide an unsanitary environment and potentially increase disease-challenge level to aid in differentiating responses to dietary treatments. Pigs were weaned and started on experimental Phase 1 diets that were fed from d 0 to 10. A common Phase 2 diet was fed from d 10 to 24. All experimental diets were processed and manufactured at Kalmbach Feeds, Inc., and were fed in pelleted form. All Phase 1 diets contained 5% fishmeal and were formulated to be equivalent in standardized ileal digestible (SID) lysine, lactose, and salt. The four dietary treatments were: 1) negative control (NC; no special protein source); 2) Plasma A (5% APC 920 bovine plasma; APC, Ankeny, IA); 3) Plasma B (5% ProMAX bovine plasma); and 4) dried milk (Nutrigold; 5%). Phase 2 diets contained no specialty protein sources. The SBM level for the negative control diet was 34.0%, and diets 2, 3, and 4 contained 25.8% SBM. Pig weights and feed disappearance were measured on d 0, 5, 10, 17, and 24 to determine ADG, ADFI, and F/G.

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[4] Tokach, M.D., R.D. Goodband, J.L. Nelssen, and D.R. Keesecker. 1992. Influence of weaning weight and growth during the first week postweaning on subsequent pig performance. Proc. Amer. Assoc. Swine Practitioners. pp. 409 (Abstr.).

Results were analyzed as a completely randomized design using PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Least squares means were calculated for each independent variable. Significance was set at $P < 0.05$, and pairwise comparisons between treatments were made if overall means were significant.

Results and Discussion

The analyzed AA content of the specialty proteins used generally matched formulated levels. However, the proximate analysis of experimental diets revealed greater Ca and P levels in NC diets than formulated, which resulted in a Ca:P ratio of 1.80 compared to a formulated ratio of 1.06 (Table 3).

For growth performance during the experimental period (d 0 to 10), as expected, pigs fed the NC diet had decreased ($P < 0.01$) ADG and poorer feed efficiency versus all other treatments (Table 4). In addition, the NC pigs had decreased ($P < 0.01$) ADFI compared to pigs fed bovine plasma, regardless of source. Pigs fed diets containing Nutrigold had increased ($P < 0.05$) ADG versus the NC, driven by improved ($P < 0.01$) feed efficiency. Both Plasma A and B increased ($P < 0.01$) ADG and ADFI compared to pigs fed Nutrigold or the NC, but there were no differences among bovine plasma sources. Pigs fed Plasma A or Plasma B were heavier ($P < 0.01$) than pigs fed Nutrigold or the NC, but pigs fed Nutrigold were also heavier ($P < 0.01$) at d 10 compared to NC pigs.

The improved feed efficiency for Nutrigold versus the NC might be attributed to the newly weaned pig's ability to more efficiently digest protein and AAs originating from dried milk compared to plant-based protein sources. Also, the absence of a growth benefit for Plasma B versus Plasma A indicates that differences in collection and processing methods did not significantly alter growth responses observed between bovine plasma sources.

When the Phase 2 common diet was fed (d 10 to 24), no differences were observed for ADG or ADFI across treatments. However, pigs previously fed NC had improved ($P < 0.01$) feed efficiency compared to pigs previously fed Plasma A, with the feed efficiency of pigs fed Plasma B and Nutrigold intermediate. The improvement in F/G for NC pigs during the common diet may be associated with an easier transition to the Phase 2 diet, which contained less specialty animal proteins. Nevertheless, this improvement in feed efficiency did not result in an improvement in ADG.

Overall (d 0 to 24), pigs fed the NC had decreased ($P < 0.05$) ADG, ADFI, and final BW compared to either source of bovine plasma, but growth performance of NC pigs was similar to those fed the Nutrigold dried milk product. While the addition of bovine plasma elicited similar growth regardless of source, both plasma sources increased ($P < 0.05$) ADFI compared to Nutrigold, and pigs fed Plasma B had increased ($P < 0.05$) ADG and were heavier in BW at d 24 versus pigs fed Nutrigold.

In summary, both plasma sources used in this study equally increased feed intake and growth performance. This growth benefit was maintained during the common diet period, and pigs fed bovine plasma remained heavier at d 24 post-weaning. Nutrigold also improved performance compared to the NC during the experimental period, but after a 14-d common period no growth differences were detected. Overall, Plasma B appears to elicit a similar response compared to Plasma A and can likely be substituted in nursery pig diets without negative impact. The present study indicates that the Nutrigold dried milk product cannot be used to fully replace bovine plasma in starter nursery pig diets. Nevertheless, Nutrigold appears to offer benefit compared to Phase 1 diets with limited specialty proteins.

Table 1. Formulated diet composition (as-fed basis)[1]

	Phase 1				Phase 2
Item	Negative control	Plasma A[2]	Plasma B[3]	Nutrigold[4]	Common diet
Ingredient, %					
Corn	31.27	35.01	35.03	37.26	45.20
Soybean meal, 46.5%	34.01	25.75	25.75	25.75	26.95
APC bovine plasma[2]	---	5.00	---	---	---
ProMAX bovine plasma[3]	---	---	5.00	---	---
Nutrigold dried milk[4]	---	---	---	5.00	---
Lactose	22.50	22.50	22.50	20.31	12.50
Select menhaden fishmeal	5.00	5.00	5.00	5.00	2.00
Monocalcium phosphate, 21% P	0.27	0.15	0.46	0.36	1.48
Corn DDGS	2.50	2.50	2.50	2.50	5.00
Beef tallow	2.34	2.31	2.22	1.40	3.50
Limestone, ground	0.63	0.73	0.61	0.59	0.75
Zinc oxide	0.40	0.40	0.40	0.40	0.26
Sodium chloride	0.45	0.33	0.20	0.38	0.30
L-Lysine HCl	0.16	---	0.05	0.34	0.40
DL-methionine	0.11	0.07	0.05	0.16	0.26
L-tryptophan	0.03	---	---	0.06	0.02
L-threonine	0.13	0.03	0.01	0.23	0.19
L-valine	---	---	---	0.06	---
Trace mineral premix	0.09	0.09	0.09	0.08	0.09
Vitamin premix	0.05	0.05	0.05	0.05	0.05
Vitamin E, 20,000 IU	0.06	0.06	0.06	0.05	0.06
Selenium, 0.06%	0.02	0.02	0.02	0.02	0.02
Choline chloride, 70%	---	---	---	---	0.05
Copper sulfate	---	---	---	---	0.10
Lignosulfate	---	---	---	---	0.75
Biotin	---	---	---	---	0.08
Total	100	100	100	100	100

continued

Table 1. Formulated diet composition (as-fed basis)[1]

	Phase 1				Phase 2
Item	Negative control	Plasma A[2]	Plasma B[3]	Nutrigold[4]	Common diet
Calculated composition					
Standardized ileal digestible (SID) amino acids, %					
Lys	1.35	1.35	1.35	1.35	1.24
Met:lys	34	30	29	37	0.54
Met & cys:lys	58	58	58	58	44
Thr:lys	64	64	64	64	62
Trp:lys	21	21	21	21	18
Val:lys	70	74	75	70	64
Total Lys, %	1.51	1.51	1.51	1.51	1.40
ME, kcal/lb	1,557	1,575	1,558	1,558	1,543
SID Lys:ME, g/Mcal	3.93	3.89	3.93	3.93	3.63
CP, %	23.7	23.7	23.5	21.5	20.1
Ca, %	0.80	0.80	0.80	0.80	0.85
P, %	0.75	0.75	0.75	0.75	0.84
Available P, %	0.42	0.45	0.46	0.46	0.45
NaCl, %	1.21	1.21	1.21	1.21	0.74
Lactose, %	18.0	18.0	18.0	18.0	10.0

[1] Treatment diets were fed during Phase 1 from d 0 to 10, with a common Phase 2 diet fed from d 10 to 21. All diets were fed in pelleted form.
[2] Spray-dried bovine plasma (APC 920; APC, Inc., Ankeny, IA).
[3] Spray-dried bovine plasma (ProMAX; Protena S.A., Nicaragua).
[4] Drum-dried food grade milk (Nutrigold; International Ingredients Corporation Inc., St. Louis, MO).

Table 2. Nutrient analysis of specialty protein ingredients (as-fed basis)[1]

Item	Plasma A[2]	Plasma B[3]	Nutrigold[4]
Crude protein, %	77.60 (78.00)	76.46 (72.00)	28.10 (25.00)
Amino acid content, %			
Lysine	6.82 (7.14)	6.43 (6.36)	1.67 (1.69)
Valine	5.38 (4.70)	5.15 (5.36)	1.75 (1.69)
Threonine	5.10 (4.7)	5.21 (5.29)	1.18 (1.02)
Cysteine	2.33 (2.55)	2.21 (2.63)	0.21 (0.19)
Tryptophan	1.65 (1.50)	1.74 (1.61)	0.45 (0.40)
Methionine	0.89(0.62)	0.82 (0.75)	0.61 (0.62)

[1] Samples were analyzed at the University of Missouri Agricultural Experiment Station Chemical Laboratories, Columbia, MO. Numbers in parentheses indicate formulated levels.
[2] Spray-dried bovine plasma (APC 920; APC, Inc., Ankeny, IA).
[3] Spray-dried bovine plasma (ProMAX; Protena S.A., Nicaragua).
[4] Drum-dried food grade milk (Nutrigold; International Ingredients Corporation Inc., St. Louis, MO).

Table 3. Nutrient analysis of experimental diets (as-fed basis)[1]

	Phase 1			
Ingredient, %	Negative control	Plasma A[2]	Plasma B[3]	Nutrigold[4]
CP	22.60	24.20	23.70	22.20
Ca	1.67	0.96	0.88	0.81
P	0.93	0.73	0.69	0.67
Ash	10.49	8.02	7.64	7.43
Starch	19.20	22.70	22.50	23.90
Ether extract	5.30	5.00	5.00	5.00

[1] Samples were analyzed at Ward Laboratories (Kearney, NE).
[2] Spray-dried bovine plasma (APC 920; APC Inc., Ankeny, IA).
[3] Spray-dried bovine plasma (ProMAX; Protena S.A., Nicaragua).
[4] Drum-dried food grade milk (Nutrigold; International Ingredients Corporation Inc., St. Louis, MO).

Table 4. Effects of bovine plasma source and whole dried milk in nursery pig diets on growth performance[1, 2]

Item	Negative control[3]	Plasma A[3,4]	Plasma B[3,5]	Nutrigold[3,6]	SEM	Probability, P <
d 0 to 10						
ADG, lb	0.18[a]	0.29[c]	0.28[c]	0.22[b]	0.011	<0.0001
ADFI, lb	0.27[a]	0.34[b]	0.31[b]	0.27[a]	0.007	<0.0001
F/G	1.54[b]	1.21[a]	1.14[a]	1.23[a]	0.052	<0.0001
d 10 to 24						
ADG, lb	0.76	0.75	0.77	0.76	0.016	0.73
ADFI, lb	0.93	0.98	0.99	0.95	0.019	0.18
F/G	1.24[a]	1.31[b]	1.28[ab]	1.26[ab]	0.018	0.04
d 0 to 24						
ADG, lb	0.52[a]	0.56[b]	0.57[bc]	0.53[ab]	0.010	<0.01
ADFI, lb	0.66[a]	0.71[b]	0.71[b]	0.67[a]	0.012	<0.01
F/G	1.28	1.29	1.25	1.25	0.014	0.19
Pig BW, lb						
d 0	13.72	13.73	13.73	13.73	0.022	0.86
d 10	15.54[a]	16.54[c]	16.49[c]	16.08[b]	0.110	<0.0001
d 24	26.11[a]	27.07[bc]	27.32[c]	26.56[ab]	0.252	<0.01

[1] A total of 360 barrows and gilts (PIC 359 × C29; initially 13.7 ± 3.1 lb and 19 d of age) were used with 9 replicate pens per treatment and 10 pigs per pen. Research was conducted at Cooperative Research Farm's Swine Research Nursery (Sycamore, OH).
[2] Experimental diets were fed from d 0 to 10, followed by a common diet from d 10 to 24.
[3] Specialty ingredients were added at 5%.
[4] APC 920 spray-dried bovine plasma (APC Inc., Ankeny, IA).
[5] ProMAX spray-dried bovine plasma (Protena S. A., Nicaragua).
[6] Drum-dried whole milk (International Ingredients Corporation Inc., St. Louis, MO).
[a,b,c] Means without a common superscript differ $P < 0.05$.