EFFECTS OF VARIOUS FRACTIONS OF SPRAY-DRIED PLASMA PROTEIN ON PERFORMANCE OF EARLY-WEANED PIGS[1]

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Summary

Two experiments were conducted to determine the individual protein fraction (IgG, low molecular weight peptides and albumin) contained in spray-dried plasma protein responsible for stimulating feed intake. In Exp. 1, pigs (21 d of age) fed a diet containing the IgG protein fraction had similar performance to pigs fed a plasma protein diet. In Exp. 2, two fractions of spray-dried porcine plasma, IgG and albumin, were evaluated with pigs (10 d of age). Pigs fed either fraction had performance similar to pigs fed plasma protein.

(Key Words: Starter, Performance, Plasma Protein.)

Introduction

Previous research at Kansas State University has shown that including spray-dried plasma protein in the phase I high nutrient dense diet will stimulate feed intake and, thus, improve growth performance of pigs weaned at 21 d of age. However, little research has attempted to determine the reason(s) why early-weaned pigs respond to the inclusion of spray-dried plasma protein in the diet. Thus, our objective was to determine whether one of three fractions of spray-dried plasma protein is responsible for these positive responses of early-weaned pigs.

Procedures

Two experiments were conducted to determine the influence of various fractions of spray-dried plasma protein on performance of the early-weaned pig. A total of 216 pigs (initially 9.9 lb and 21-d of age) was used in Exp. 1. Pigs were blocked by weight, sex, and litter and allotted to one of five dietary treatments. Pigs were housed (six pigs/pen and six pens/ treatment) in an environmentally controlled nursery in 5 × 7 ft pens with metal flooring and allowed ad libitum access to feed and water.

Dietary treatments were based on different fractions of spray-dried plasma protein added to the phase I diet (d 0 to 14 postweaning). The different spray-dried plasma protein fractions evaluated were immunoglobulin (IgG), low molecular weight peptides (< 10,000 MW), and albumin. A positive control diet (1.5% lysine and .42% methionine) was formulated to contain 7.5% SDPP, 1.75% spray-dried blood meal, and 25% dried whey (Table 1.). Fractionation of SDPP was conducted by American Protein Inc. A negative control diet was formulated without added SDPP. The three other dietary treatments were formulated replacing dried skim milk in the negative control diet with one of the three plasma fractions on an equal lysine basis. Spray-dried plasma fractions were added to represent the same amount as provided in SDPP. A common diet was fed during phase II (d 14 to 35

[1]We would like to thank American Protein Inc., Ames, IA, for partial financial support and for providing the plasma fractions used in Exp. 1 and 2.

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postweaning); it was corn-soybean meal based (1.25% lysine) and contained 2.5% spray-dried blood meal and 10% dried whey (Table 3).

Experiment 2 used a total of 168 pigs (initially 7.0 lb) weaned at approximately 10 d of age. Pigs were blocked by weight and allotted to one of four dietary treatments (Table 2.). There were six pigs/pen and seven pens/treatment. Dietary treatments were based on two different fractions of SDPP (IgG and albumin) and fed to pigs from d 0 to 21 postweaning. The albumin fraction contained 70% crude protein and was 58.5% pure albumin with less than 5% IgG. The IgG fraction contained 80% crude protein and was 48.3% pure IgG with 16% albumin. These analyses were performed on the albumin and IgG fractions used just in Exp. 2 (which were different from lots used in Exp. 1.). A positive control diet (1.7% lysine and .46% methionine) was formulated to contain 25% dried whey, 12% lactose, 10% SDPP, and 6% select menhaden fish meal. The three other dietary treatments were obtained by replacing dried skim milk in a negative control diet with one of the two plasma fractions on an equal lysine basis. A common diet was fed from d 21 to 35 postweaning (Table 3).

For both experiments, pigs and feeders were weighed on d 7, 14, 21, 28, and 35 postweaning to determine ADG, ADFI and feed efficiency (F/G). Both trials were analyzed as randomized complete block designs using nonorthogonal contrasts to separate means.

Results and Discussion

Experiment 1. From d 0 to 14 postweaning, pigs fed the diet containing IgG had higher ADG ($P<.07$) than pigs fed the negative control or diets containing the low molecular weight or albumin fractions, but were similar to pigs fed the diet containing plasma protein (Table 3.). However, pigs fed the plasma-based diet had the poorest F/G compared to pigs fed the other dietary treatments ($P<.10$). From d 14 to 35 (when pigs were fed a common diet) and d 0 to 35, no differences were noted for any of the response criteria.

Experiment 2. From d 0 to 21 postweaning, pigs fed either of the two plasma (IgG or albumin) fractions had similar performance compared to pigs fed the positive control diet, but superior performance compared to pigs fed the negative control diet ($P<.08$; Table 4.). When pigs were switched to a common phase II diet (d 21 to 35 postweaning), no differences in ADG or ADFI occurred among any experimental treatments. However, pigs fed the albumen-based diet during phase I had better F/G compared to pigs fed the IgG fraction ($P<.10$).

Overall (d 0 to 35 postweaning), pigs fed either the IgG- or albumin-based diets had similar ADG and ADFI compared to pigs fed the positive control diet, but superior performance compared to pigs fed the milk-based diet ($P<.08$). However, feed efficiency was not effected for the entire nursery period.

Data from Exp. 1 (using pigs weaned at 21 d of age) indicate that pigs fed the IgG fraction had similar performance compared to pigs fed the plasma protein diet. However, in Exp. 2 (using pigs weaned at 10 d of age), pigs fed either IgG or albumin had performance similar to that of pigs fed plasma protein. The use of two different lots of plasma protein to obtain the plasma fractions for Exp. 1 and 2 may explain the differences in results. This research indicates that both the albumin and IgG fractions of SDPP are important in explaining the beneficial response in the early-weaned pig. However, further research is required on the fractionation process to develop purified protein fractions before a specific fraction can be denoted as the cause of the stimulated feed intake observed when SDPP is fed.

Table 1. Composition of Diets (Exp. 1)[a]

Item	Neg. control	Plasma protein	Plasma fraction LMW	Plasma fraction IgG	Plasma fraction Albumin	Phase II
Corn	31.33	31.78	29.33	31.51	32.17	58.76
Spray-dried plasma fraction		7.50	2.0	3.84	3.75	
Dried whey	25.00	25.00	25.00	25.00	25.00	10.00
Skim milk	18.00		18.00	8.90	7.60	
Soybean meal, 48.5%	15.03	15.03	15.03	15.03	15.03	21.26
Lactose		9.00		4.55	5.20	
Spray-dried blood meal						2.50
Soybean oil	5.00	5.00	5.00	5.00	5.00	3.00
Fish meal	3.00	3.00	3.00	3.00	3.00	
Antibiotic[b]	1.00	1.00	1.00	1.00	1.00	1.00
Monocalcium phosphate	.736	1.56	.736	1.18	1.23	1.97
Vitamin/mineral premix	.40	.40	.40	.40	.40	.40
Limestone	.21	.384	.21	.30	.32	.83
L-lysine	.15	.15	.15	.15	.15	.15
Copper sulfate	.075	.075	.075	.075	.075	.075
Cystine	.067		.067	.029	.006	
Methionine		.12		.041	.072	.05

[a]All phase I diets were formulated to contain 1.5% lysine, .42% methionine, .90% Ca, and .80% P. The common phase II diet was formulated to contain 1.25% lysine, .35% methionine, .90% Ca, and .80% P.
[b]Provided 150 g/ton of apramycin, in phase I and 50 g/ton of carbadox in phase II.

Table 2. Composition of Diets (Exp. 2)[a]

Item	Neg. control	Plasma protein	Plasma fraction IgG	Plasma fraction Albumin
Corn	25.147	25.71	25.30	26.22
Spray-dried plasma fraction		10.00	4.00	5.00
Dried whey	25.00	25.00	25.00	25.00
Skim milk	24.00		14.50	10.14
Soybean meal, 46.5%	12.96	13.00	13.00	13.00
Lactose		12.00	4.75	6.93
Soybean oil	5.00	5.00	5.00	5.00
Fish meal	6.00	6.00	6.00	6.00
Antibiotic[b]	1.00	1.00	1.00	1.00
Monocalcium phosphate	.18	1.28	.638	.838
Vitamin/mineral premix	.40	.40	.40	.40
Limestone	.028	.27	.125	.174
L-lysine	.15	.15	.15	.15
Copper sulfate	.08	.08	.08	.08
Cystine	.07		.053	.011
Methionine		.13	.014	.068

[a]All segregated early-weaned diets were formulated to contain 1.7% lysine, at least .46% methionine, .95% Ca, and .80% P. The common phase II diet was identical to that listed in Table 1.
[b]Provided 150 g/ton of apramycin in phase I and 50 g/ton of carbadox in phase II.

Table 3. The Effect of Various Plasma Fractions on Growth Performance of the Early-Weaned Pig (Exp. 1.)[a]

			Plasma fraction			
Item	Neg. control	Plasma protein	Low MW	IgG	Albumin	CV
d 0 to 14						
ADG, lb	.52[b]	.61[c,d]	.55[b]	.66[c]	.58[b,d]	10.0
ADFI, lb	.54[b]	.70[c]	.56[b]	.70[c]	.62[d]	8.9
F/G	1.03[b]	1.15[e]	1.01[b]	1.06[b,c]	1.09[c,d]	4.9
d 14 to 35						
ADG, lb	1.04	1.00	1.00	.99	1.00	7.1
ADFI, lb	1.74	1.65	1.66	1.70	1.66	6.9
F/G	1.67	1.66	1.66	1.71	1.66	4.8
d 0 to 35						
ADG, lb	.83	.84	.82	.86	.83	6.6
ADFI, lb	1.26	1.27	1.22	1.30	1.24	6.8
F/G	1.51	1.51	1.48	1.51	1.50	3.8

[a]Two hundred and sixteen weanling pigs were used (initially 9.9 lbs and 21 d of age), 6 pigs/pen with 6 pens per treatment.
[bcde]Rows with different superscript differ (P<.10).

Table 4. The Effect of Various Plasma Fractions on Growth Performance of the Early-Weaned Pig (Exp. 2.)[a]

			Plasma fraction		
Item	Neg. control	Plasma protein	IgG	Albumin	CV
d 0 to 21					
ADG, lb	.45[b]	.50[b,c]	.56[c]	.51[b,c]	13.3
ADFI, lb	.54[b]	.61[b,c]	.63[c]	.58[b,c]	12.9
F/G	1.23	1.19	1.13	1.15	10.9
d 21 to 35					
ADG, lb	.84	.83	.82	.88	12.2
ADFI, lb	1.34	1.37	1.39	1.37	8.7
F/G	1.60[b,c]	1.65[b,c]	1.72[b]	1.56[c]	9.3
d 0 to 35					
ADG, lb	.60[b]	.63[b,c]	.67[c]	.65[c]	7.6
ADFI, lb	.86[b]	.91[b,c]	.94[c]	.90[b,c]	7.8
F/G	1.42	1.44	1.41	1.37	5.4

[a]One hundred and sixty eight weanling pigs were used (initially 7.0 lbs and 10 d of age), 6 pigs/pen with 7 pens per treatment.
[bc]Rows with different superscript differ (P<.10).