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Effects of pepsoygen and dried porcine solubles 50 in nursery pig diets

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EFFECTS OF PEP SOYGEN AND DRIED PORCINE SOLUBLES 50 IN NURSERY PIG DIETS¹

C. K. Jones, J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, S. S. Dritz², and R. D. Goodband

Summary

Two experiments were conducted to evaluate the effects of dietary specialty protein source on weanling pig growth performance. In Exp. 1, 350 pigs (initially 13.4 lb) were used in a 35-d growth trial to compare the effects of fish meal, PepSoyGen, and dried porcine solubles (DPS 50) on weanling pig performance. Seven dietary treatments were fed: (1) negative control, (2) 3% fish meal, (3) 6% fish meal, (4) 3.75% PepSoyGen, (5) 7.50% PepSoyGen, (6) 1.88% PepSoyGen and 1.88% DPS 50, and (7) 3.75% PepSoyGen and 3.75% DPS 50. From d 0 to 14, pigs fed increasing PepSoyGen and PepSoyGen in combination with DPS 50 had improved (quadratic, $P = 0.01$, linear, $P = 0.002$, respectively) F/G. Average daily gain and F/G were improved ($P = 0.05$ and $P = 0.03$, respectively) for pigs fed diets containing PepSoyGen and DPS 50 combinations compared with pigs fed diets containing fish meal. Also, feeding the combination of PepSoyGen and DPS 50 improved ADG and ADFI ($P = 0.01$ and $P = 0.02$, respectively) compared with feeding only PepSoyGen. Overall (d 0 to 35), pigs fed increasing PepSoyGen from d 0 to 14 had improved F/G (quadratic, $P = 0.03$).

In Exp. 2, 252 pigs (initially 15.0 lb) were used to evaluate the effects of fish meal, PepSoyGen, and DPS 50 on nursery pig performance. A common pelleted starter diet was fed from weaning until the start of the experiment (d 7). Six dietary treatments were fed: (1) negative control, (2) 5% fish meal, (3) 3.5% DPS 50, (4) 6.0% PepSoyGen, (5) 1.75% PepSoyGen and 1.75% DPS 50, and (6) 3.0% PepSoyGen and 2.5% fish meal. During the treatment period (d 0 to 14), pigs fed DPS 50 alone or in combination with PepSoyGen had improved ADG and F/G ($P < 0.05$) compared with pigs fed all other diets. Overall (d 0 to 28), pigs fed DPS 50 from d 0 to 14 had improved ADG and F/G ($P < 0.05$) compared with pigs fed the control diet. Additionally, pigs fed DPS 50 had improved F/G ($P < 0.05$) compared with pigs fed PepSoyGen and fish meal in combination.

In conclusion, pigs fed DPS 50 alone or in combination with PepSoyGen had improved performance compared with pigs fed the control diet.

Key words: growth, nursery pig, protein sources

¹ Appreciation is expressed to Nutra-Flo, Sioux City, IA, for providing the PepSoyGen and DPS 50 and for partial funding of the trials.

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Introduction

Nursery pigs have relatively immature digestive systems at weaning, which limits their ability to utilize plant protein sources. However, newly weaned pigs absorb nearly two-thirds of dietary amino acids as peptides, or short amino acid chains. These peptides are absorbed nearly twice as fast as free amino acids. Therefore, supplying weaned pigs with protein containing higher levels of peptides or more highly digestible soy proteins should improve growth performance.

Research has indicated that pigs fed fermented rather than solvent-extracted soybean meal have improved nutrient digestibility. The fermentation process is thought to eliminate trypsin inhibitors and some oligosaccharides that may decrease pig performance. PepSoyGen (Nutra-Flo Company, Sioux City, IA) is a commercially available fermented soybean meal product.

Another possible protein source for nursery diets is DPS 50 (Nutra-Flo Company, Sioux City, IA), a coproduct of the heparin (a human pharmaceutical product) industry. DPS 50 is made from porcine intestinal mucosa and is thought to contain a high level of easily digestible peptides and amino acids. This protein source has previously been shown to improve growth performance of nursery pigs, possibly because the product supplies a high level of small peptides to assist in gut development.

Although the positive effects of DPS have been demonstrated in nursery pigs, less information is available on fermented soy products or the combined use of these protein products. Therefore, the objective of these experiments was to evaluate the effects of fish meal, PepSoyGen, and DPS 50 on growth performance of weanling pigs.

Procedures

All experimental procedures were approved by the Kansas State University (KSU) Animal Care and Use Committee. Protein sources were collected and analyzed for DM, CP, amino acids, Ca, and P (Table 1).

Experiment 1. A total of 350 pigs (initially 13.4 lb) were used in a 35-d growth trial to evaluate the effects of fish meal, PepSoyGen, and DPS 50 on weanling pig performance. Pigs were blocked by weight and allotted to 1 of 7 dietary treatments. There were 5 pigs per pen and 10 pens per treatment. Each pen (5 × 5 ft) contained a 4-hole dry self-feeder and 1 cup waterer to provide ad libitum access to feed and water. The study was conducted at the KSU Segregated Early Weaning Facility.

A common pelleted starter diet was fed from weaning until the start of the experiment (d 7). The 7 dietary treatments were (1) negative control, (2) 3% fish meal, (3) 6% fish meal, (4) 3.75% PepSoyGen, (5) 7.50% PepSoyGen, (6) 1.88% PepSoyGen and 1.88% DPS 50, and (7) 3.75% PepSoyGen and 3.75% DPS 50 (Table 2). Treatment diets 2, 4, and 6 were each formulated with 35.7% soybean meal; diets 3, 5, and 7 each had 29.8% soybean meal. Treatment diets were fed for 14 d; then, all pigs received a common phase 3 diet for 21 d. All diets were in meal form. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 7, 14, 24, and 35 of the trial.

Experiment 2. A total of 252 pigs (initially 15.0 lb) were used in a 28-d growth trial to further evaluate the effects of fish meal, PepSoyGen, and DPS 50 on nursery pig performance. Pigs were blocked by weight and allotted to 1 of 6 dietary treatments. There were 6 pigs per pen and 7 pens per treatment.

Each pen contained 1 self-feeder and 1 nipple waterer to provide ad libitum access to feed and water. Pigs were housed in the KSU Swine Teaching and Research Center.

A common pelleted starter diet was fed from weaning until the start of the experiment. The 6 experimental treatments were (1) negative control, (2) 5% fish meal, (3) 3.5% DPS 50, (4) 6.0% PepSoyGen, (5) 1.75% PepSoyGen and 1.75% DPS 50, and (6) 3.0% PepSoyGen and 2.5% fish meal (Table 3). Treatments 2 through 6 were formulated to the same dietary soybean meal level (31.4%). Treatment diets were fed for 14 d; then, all pigs received a common phase 3 diet for 14 d. All diets were in meal form. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 7, 14, 21, and 28 of the trial.

Statistical Analysis. Data were analyzed as a randomized complete block design with pen as the experimental unit. Data were analyzed with an analysis of variance by using the MIXED procedure of SAS with the weight block as a random effect and treatments as a fixed effect. Contrasts were used to determine the effects of protein source compared with the control.

Results and Discussion

Crude protein and amino acid analysis of the protein sources were consistent with the values supplied by the manufacturer that were used in diet formulation (Table 1).

Experiment 1. From d 0 to 14, pigs fed diets containing the lower (3%) level of fish meal had improved ADFI (quadratic, $P = 0.05$; Tables 4 and 5), leading to a tendency for improved (quadratic, $P = 0.08$) ADG compared with pigs fed the control diet. Pigs fed diets containing either 3 or 6% fish meal

tended to have improved (linear, $P = 0.09$) F/G compared with pigs fed the control diet. Pigs fed diets containing 6% fish meal or PepSoyGen had ADG and ADFI similar ($P > 0.10$) to those of pigs fed the control diet. However, F/G was improved (quadratic, $P = 0.01$) for pigs fed diets containing PepSoyGen compared with pigs fed the control diet; the lower (3.75%) level of PepSoyGen was optimum. Pigs fed either diet with the combination of PepSoyGen and DPS 50 had improved F/G (linear, $P = 0.01$) and tended to have improved (linear, $P = 0.06$) ADG compared with pigs fed the control diet but had similar ($P > 0.10$) ADFI. Pigs fed diets containing PepSoyGen had ADF, ADFI, and F/G similar ($P > 0.10$) to those of pigs fed diets containing fish meal. Pigs fed diets containing the combination of PepSoyGen and DPS 50 had improved ADG and F/G ($P = 0.05$ and $P = 0.03$, respectively) compared with pigs fed diets containing fish meal but had similar ($P > 0.10$) ADFI. Pigs fed diets containing the combination of PepSoyGen and DPS 50 had improved ($P = 0.01$) ADG compared with pigs fed diets containing PepSoyGen without DPS 50, a direct result of improved ($P = 0.02$) ADFI. Thus, DPS 50 appears to stimulate feed intake and improve nursery pig growth rate compared with the other protein sources evaluated. There were no differences ($P > 0.10$) in F/G in pigs fed diets containing PepSoyGen alone or in combination with DPS 50.

During the common period (d 14 to 35), there were no changes ($P > 0.10$) in ADG, ADFI, or F/G for pigs previously fed fish meal, PepSoyGen, or the combination of PepSoyGen and DPS 50.

Overall (d 0 to 35), pigs fed diets containing PepSoyGen from d 0 to 14 had improved (quadratic, $P = 0.03$) F/G compared with pigs fed the control diet; feed efficiency was optimized at the lower (3.75%) level of

PepSoyGen. Moreover, pigs fed diets containing increasing amounts of PepSoyGen and DPS 50 in combination from d 0 to 14 tended to have improved F/G (linear, $P = 0.06$) compared with pigs fed the control diet. There were no other significant differences ($P > 0.10$) in ADG, ADFI, or F/G.

Experiment 2. During the treatment period (d 0 to 14), pigs fed diets containing DPS 50 alone or in combination with PepSoyGen had improved ($P < 0.05$) ADG and F/G compared with pigs fed all other diets (Table 6). Pigs fed diets containing fish meal, PepSoyGen, or the combination of PepSoyGen and fish meal had ADG similar ($P > 0.10$) to that of pigs fed the control diet. Pigs fed diets containing DPS 50 tended to have improved ($P < 0.10$) ADFI compared with pigs fed the control diet. No other differences in ADFI were seen ($P > 0.10$) among any other diets.

Overall (d 0 to 35), pigs fed diets containing DPS 50 from d 0 to 14 had improved ($P < 0.05$) ADG compared with pigs previously fed the control diet and tended to have improved ($P < 0.10$) ADG compared with pigs previously fed the diet containing PepSoyGen and fish meal in combination. There were no significant differences ($P > 0.10$) in ADFI. Pigs fed diets containing DPS 50 from d 0 to 14 had improved ($P < 0.05$) F/G from d 0 to 35 compared with pigs fed the control diet or the diet containing PepSoyGen and fish meal in combination from d 0 to 14. Pigs fed diets containing the combination of PepSoyGen and DPS 50 from d 0 to 14 tended to have improved ($P < 0.10$) overall F/G compared with pigs fed the control diet from d 0 to 14.

In conclusion, pigs fed DPS 50 alone or in combination with PepSoyGen had improved performance compared with those fed the control diet.

Table 1. Analyzed nutrient composition of ingredients (Exp. 1 & 2, as-fed basis)

Item	Fish meal		PepSoyGen ¹		DPS 50 ²	
	Formulated ^{3,4}	Analyzed ⁵	Formulated ⁶	Analyzed ⁵	Formulated ⁶	Analyzed ⁵
CP, %	62.90	65.34	54.25	56.37	50.00	51.01
Amino acids, %						
Arginine	---	3.74	---	3.92	---	2.72
Histidine	---	1.35	---	1.45	---	1.06
Isoleucine	2.57	2.53	1.80	2.69	1.80	2.06
Leucine	4.54	4.46	3.40	4.55	3.40	3.94
Lysine	4.81	4.74	3.20	3.46	3.10	3.81
Methionine	1.77	1.71	0.71	0.80	0.90	0.96
Phenylalanine	---	2.55	---	3.12	---	2.23
Threonine	2.64	2.52	2.15	2.22	2.00	2.10
Tryptophan	0.66	0.59	0.49	0.75	0.35	0.25
Valine	3.03	2.96	2.32	2.83	2.40	2.60
Alanine	---	4.06	---	2.57	---	2.95
Cysteine	0.57	0.47	0.97	0.78	0.85	0.78
Glycine	---	4.82	---	2.47	---	3.65
Hydroxylysine	---	0.20	---	0.08	---	0.16
Hydroxyproline	---	0.99	---	0.00	---	0.71
Ornithine	---	0.08	---	0.08	---	0.32
Proline	---	2.94	---	2.98	---	2.83
Serine	---	2.19	---	2.55	---	1.86
Taurine	---	0.47	---	0.03	---	0.20
Tyrosine	---	1.99	---	2.18	---	1.86

¹ PepSoyGen (Nutra-Flo, Sioux City, IA).² Dried porcine solubles 50 (Nutra-Flo, Sioux City, IA).³ Diets were prepared using formulated values.⁴ Nutrient values from NRC (1998).⁵ Mean value of 1 sample analyzed in duplicate.⁶ Nutrient values provided by the manufacturer.

Table 2. Composition of diets, Exp. 1 (as-fed basis)¹

Ingredient, %	Control	Fish meal		PepSoyGen ²		PepSoyGen + DPS 50 ³		Common diet
		3%	6%	3.75%	7.50%	1.88% + 1.88%	3.75% + 3.75%	
Corn	45.46	48.26	50.73	46.96	48.13	46.98	48.13	61.28
Soybean meal (46.5% CP)	40.01	34.76	29.87	34.65	29.66	34.70	29.76	33.85
Select menhaden fish meal	---	3.00	6.00	---	---	---	---	---
PepSoyGen	---	---	---	3.75	7.50	1.88	3.75	---
DPS 50	---	---	---	---	---	1.88	3.75	---
Spray dried whey	10.00	10	10.00	10.00	10.00	10.00	10.00	---
Soybean oil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Monocalcium P (21% P)	1.53	1.15	0.78	1.55	1.55	1.45	1.35	1.65
Limestone	0.98	0.80	0.60	1.00	1.03	1.05	1.13	0.95
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Lysine-HCl	0.15	0.15	0.15	0.19	0.23	0.19	0.23	0.30
DL-methionine	0.12	0.11	0.11	0.13	0.13	0.12	0.13	0.12
L-threonine	0.06	0.07	0.07	0.07	0.08	0.07	0.09	0.11
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis ⁴								
Total amino acids, %								
Lysine	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.42
Isoleucine:lysine ratio	69	67	66	67	66	67	65	64
Leucine:lysine ratio	132	131	129	134	136	132	131	130
Methionine:lysine ratio	31	32	34	31	31	31	32	31
Met & Cys:lysine ratio	58	58	58	58	58	58	58	57
Threonine:lysine ratio	65	65	65	65	65	65	66	64
Tryptophan:lysine ratio	20	19	18	19	18	19	18	18
Valine:lysine ratio	75	74	73	73	72	73	72	71
CP, %	23.9	23.6	23.4	23.7	23.5	23.6	23.4	21.4
ME kcal/lb	1,508	1,517	1,526	1,507	1,507	1,511	1,514	1,518
Total lysine:ME ratio, g/Mcal	4.61	4.57	4.55	4.61	4.60	4.58	4.58	4.23
Ca, %	0.88	0.88	0.88	0.89	0.89	0.88	0.88	0.80
P, %	0.80	0.78	0.77	0.80	0.80	0.79	0.78	0.75
Available P, %	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.42

¹ Pigs were fed experimental diets from d 0 to 14 of the trial and a common diet from d 15 to 35 of the trial.

² PepSoyGen (Nutra-Flo, Sioux City, IA).

³ Dried porcine solubles 50 (Nutra-Flo, Sioux City, IA).

⁴ Nutrient values from NRC (1998) were used for fish meal, and nutrient values for PepSoyGen and DPS were provided by the manufacturer.

Table 3. Composition of diets, Exp. 2 (as-fed basis)¹

Ingredient, %	Control	Fish meal 5.0%	DPS 50 ² 3.5%	PepSoyGen ³ 6.0%	PepSoyGen + DPS 50 1.75% + 1.75%	PepSoyGen + Fish meal 3.0% + 2.5%
Corn	45.46	49.98	50.31	47.94	50.25	48.97
Soybean meal (46.5% CP)	40.01	31.42	31.38	31.40	31.40	31.39
Select menhaden fish meal	---	5.00	---	---	---	2.50
PepSoyGen	---	---	---	6.00	1.75	3.00
DPS 50	---	---	3.50	---	1.75	---
Spray dried whey	10.00	10.00	10.00	10.00	10.00	10.00
Soybean oil	1.00	1.00	1.00	1.00	1.00	1.00
Monocalcium P (21% P)	1.53	0.90	1.38	1.55	1.45	1.23
Limestone	0.98	0.68	1.13	0.98	1.08	0.83
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Lysine-HCl	0.15	0.15	0.32	0.22	0.32	0.19
DL-methionine	0.12	0.11	0.16	0.14	0.17	0.13
L-threonine	0.06	0.07	0.13	0.08	0.13	0.08
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis ⁴						
Total amino acids, %						
Lysine	1.53	1.53	1.53	1.53	1.53	1.53
Isoleucine:lysine ratio	69	6	62	66	62	66
Leucine:lysine ratio	132	130	123	135	125	132
Methionine:lysine ratio	31	33	33	32	33	33
Met & Cys:lysine ratio	58	58	58	58	58	58
Threonine:lysine ratio	65	65	65	65	65	65
Tryptophan:lysine ratio	20	19	17	18	17	18
Valine:lysine ratio	75	73	69	72	69	72
CP, %	23.9	23.5	22.3	23.5	22.4	23.5
ME, kcal/lb	1,508	1,523	1,515	1,508	1,512	1,515
Total lysine:ME ratio, g/Mcal	4.61	4.55	4.58	4.60	4.59	4.59
Ca, %	0.88	0.88	0.88	0.88	0.88	0.88
P, %	0.80	0.77	0.77	0.80	0.77	0.78
Available P, %	0.47	0.47	0.47	0.47	0.47	0.47

¹ Pigs were fed experimental diets from d 0 to 14 of the trial and a common diet from d 15 to 28 of the trial.² Dried porcine solubles 50 (Nutra-Flo, Sioux City, IA).³ PepSoyGen (Nutra-Flo, Sioux City, IA).⁴ Nutrient values from NRC (1998) were used for fish meal, and nutrient values for PepSoyGen and DPS were provided by the manufacturer.

Table 4. Effects of fish meal, PepSoyGen, and DPS 50 on nursery pig performance (Exp. 1)¹

	Negative	Fish meal		PepSoyGen		PepSoyGen ² + DPS 50 ³	
Item	Control	3%	6%	3.75%	7.50%	1.88 + 1.88%	3.75% + 3.75%
d 0 to 14							
ADG, lb	0.58	0.63	0.56	0.57	0.58	0.65	0.65
ADFI, lb	0.76	0.79	0.69	0.70	0.73	0.77	0.78
F/G	1.33	1.26	1.26	1.21	1.27	1.20	1.20
d 14 to 35							
ADG, lb	1.29	1.31	1.28	1.28	1.31	1.26	1.32
ADFI, lb	1.91	1.94	1.87	1.85	1.93	1.89	1.93
F/G	1.48	1.48	1.47	1.45	1.48	1.50	1.47
d 0 to 35							
ADG, lb	1.00	1.04	0.98	0.99	1.01	1.01	1.05
ADFI, lb	1.45	1.48	1.39	1.39	1.44	1.44	1.47
F/G	1.44	1.43	1.42	1.39	1.43	1.43	1.40

¹ A total of 350 pigs (5 pigs per pen and 10 pens per treatment) with an initial BW of 13.1 lb. Pigs were fed a common diet from weaning until d 7 then fed experimental diets for 14 d.

² PepSoyGen (Nutra-Flo, Sioux City, IA).

³ Dried porcine solubles 50 (Nutra-Flo, Sioux City, IA).

Table 5. Probability values for pigs fed fish meal, PepSoyGen, and DPS 50 on nursery pig performance (Exp. 1)^{1,2,3}

Item	Probability, $P <$									SE
	Fish meal		PepSoyGen		Combination		Fish meal vs.		PepSoyGen vs.	
	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic	PepSoyGen	Combination ⁴	Combination	
d 0 to 14										
ADG, lb	0.71	0.08	1.00	0.89	0.06	0.32	0.45	0.05	0.01	0.042
ADFI, lb	0.08	0.05	0.39	0.14	0.69	0.90	0.24	0.24	0.02	0.049
F/G	0.09	0.37	0.16	0.01	0.01	0.06	0.47	0.03	0.13	0.030
d 14 to 35										
ADG, lb	0.74	0.45	0.77	0.52	0.60	0.24	0.84	0.78	0.93	0.055
ADFI, lb	0.52	0.38	0.83	0.17	0.77	0.53	0.63	0.94	0.58	0.082
F/G	0.70	0.77	0.99	0.19	0.70	0.16	0.55	0.49	0.20	0.019
d 0 to 35										
ADG, lb	0.58	0.17	0.91	0.73	0.24	0.70	0.73	0.46	0.28	0.049
ADFI, lb	0.22	0.14	0.86	0.19	0.67	0.67	0.55	0.56	0.24	0.069
F/G	0.29	0.83	0.55	0.03	0.06	0.82	0.15	0.26	0.86	0.016

¹ A total of 350 pigs (5 pigs per pen and 10 pens per treatment) with an initial BW of 13.1 lb. Pigs were fed a common diet from weaning until d 7 then fed experimental diets for 14 d.

² PepSoyGen (Nutra-Flo, Sioux City, IA).

³ Dried porcine solubles 50 (Nutra-Flo, Sioux City, IA).

⁴ 1.88% PepSoyGen + 1.88% DPS 50⁴ and 3.75% PepSoyGen + 3.75% DPS 50.

Table 6. Effects of fish meal, PepSoyGen, and DPS 50 on nursery pig performance (Exp. 2)^{1,2,3}

Item;	Negative Control	Fish meal 5.0%	DPS 50 3.5%	PepSoyGen 6.0%	PSG + DPS 50 1.75% + 1.75%	PSG + Fish meal 3.0% + 2.5%	SE
d 0 to 14							
ADG, lb	0.56 ^a	0.59 ^a	0.69 ^b	0.59 ^a	0.66 ^b	0.56 ^a	0.032
ADFI, lb	0.73 ^x	0.78 ^{xy}	0.81 ^y	0.76 ^{xy}	0.78 ^{xy}	0.74 ^{xy}	0.040
F/G	1.34 ^b	1.34 ^b	1.17 ^a	1.28 ^b	1.18 ^a	1.32 ^b	0.050
d 14 to 28							
ADG, lb	1.14 ^{abxy}	1.18 ^{abx}	1.17 ^{abxy}	1.20 ^{bxy}	1.10 ^{ay}	1.19 ^{bxy}	0.040
ADFI, lb	1.59	1.60	1.59	1.63	1.54	1.64	0.053
F/G	1.40	1.35	1.37	1.36	1.40	1.39	0.040
d 0 to 28							
ADG, lb	0.84 ^{ay}	0.89 ^{abxy}	0.93 ^{bx}	0.90 ^{abx}	0.88 ^{abxy}	0.87 ^{aby}	0.030
ADFI, lb	1.16	1.19	1.20	1.19	1.16	1.19	0.035
F/G	1.38 ^{bx}	1.35 ^{abxy}	1.29 ^{axy}	1.33 ^{abxy}	1.32 ^{aby}	1.36 ^{bxy}	0.032

^{ab} Treatments without a common superscript letter differ $P < 0.05$.

^{xy} Treatments without a common superscript letter differ $P < 0.10$.

¹ A total of 252 pigs (6 pigs per pen and 7 pens per treatment) with an initial BW of 15 lb. Pigs were fed a common diet from weaning until 15 lb then fed experimental diets for 14 d.

² Dried porcine solubles 50 (Nutra-Flo, Sioux City, IA).

³ PepSoyGen (Nutra-Flo, Sioux City, IA).