Effects of PepSoyGen Processing Method on Nursery Pig Growth Performance[1]

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Summary

A total of 292 weanling pigs (PIC 327 × 1050; 13.3 ± 2.4 lb BW and 21 d of age) were used in a 31-d experiment evaluating the effects of alternative PepSoyGen processing methods for nursery pig diets. There were 11 replicate pens per treatment and 6 or 7 pigs per pen. At weaning, pigs were allotted to pens by initial weight to 1 of 4 treatments in a completely randomized design. A 3-phase diet series was used with treatment diets fed during Phase 1 (d 0 to 7) and Phase 2 (d 7 to 21), with a common diet fed from d 21 to 31. Diets were: (1) negative control (corn, soybean meal, and dried whey), (2) positive control (4% DPS 50 + 1% PepSoyGen), (3) PepSoyGen processing method 1 (PSG1; 5%), and (4) PepSoyGen processing method 2 (PSG2; 5%). The alternative PepSoyGen processing methods incorporated increasing levels of a proprietary additive post-fermentation (PSG2 > PSG1) aimed at further breakdown of anti-nutritional factors associated with soybean meal. Nutrient analyses generally matched formulated levels for negative and positive control diets, but for both PSG1 and PSG2, CP and amino acid concentrations were lower than formulated, with PSG1 generally 10% lower than PSG2.

In Phase 1, pigs fed the positive control diet had improved ($P < 0.01$) ADG and feed efficiency compared with pigs fed the negative control, whereas pigs fed PSG1 and PSG2 diets were intermediate for feed efficiency but tended ($P < 0.07$) to have increased ADG compared with those fed the negative control. For Phase 2, there were no significant differences in growth performance between treatment diets. For the overall experimental period (d 0 to 21), pigs fed the positive control diet and PSG2 diet had improved ADG ($P < 0.05$), whereas pigs fed the positive control, PSG1, and PSG2 diets had improved feed efficiency ($P < 0.05$) compared with pigs fed the negative control diet. Also, pigs fed PSG1 tended ($P < 0.06$) to have lower ADG compared with pigs fed the positive control diet. During the Phase 3 common period, no difference in growth performance was observed. Overall (d 0 to 31), ADG was greater ($P < 0.01$) for pigs fed the positive control diet and tended to be greater ($P < 0.07$) for pigs fed diets containing PSG2 than the negative control diet, with pigs fed PSG1 intermediate.

In conclusion, pigs fed the PSG1 or PSG2 diets had similar performance to pigs fed the positive control diet. Numerically, the PSG2 diet elicited greater performance than the PSG1 diet, but it is unclear whether this response is reflective of the reduced CP and amino acid content in the PSG1 diet or if the differences in processing method affected growth response.

Keywords: dried porcine solubles, fermented soybean meal, growth, nursery pig, protein sources

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Introduction

Short amino acid chains, also known as peptides, comprise two-thirds of dietary amino acids digested by the newly weaned pig. These peptides are more easily absorbed than intact proteins. Consequently, highly digestible soy protein products containing high levels of peptides continue to receive more attention as an ingredient in postweaning nursery pig diets. Research has indicated that pigs fed fermented rather than solvent-extracted soybean meal have improved nutrient digestibility. The fermentation process is thought to reduce trypsin inhibitors and some oligosaccharides that may decrease pig performance; however, most research has indicated that soy proteins cannot fully replace animal protein sources postweaning and maintain equal pig growth performance.

PepSoyGen (Nutraferma Company, North Sioux City, SD) is a commercially available fermented soybean meal product that is intended for use in weanling pig diets. Initial research showed that PepSoyGen could elicit performance similar to that observed from pigs when menhaden fish meal was included in the diets, and performance could be improved further when dried porcine solubles (DPS 50; Nutra-Flo, Sioux City, IA) were added with the PepSoyGen. Optimization of the PepSoyGen manufacturing process has yielded two next-generation products that are designed to further improve the performance of pigs fed diets containing PepSoyGen, but they have not yet been tested in weanling pig diets. Therefore, the objective of this experiment was to compare the effects of two alternative PepSoyGen processing methods on nursery pig growth performance.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The trial was conducted at the K-State Swine Teaching and Research Center in Manhattan, KS.

A total of 292 mixed-sex weanling pigs (PIC 327 × 1050; 13.3 ± 2.4 lb BW and 21 d of age) were used in a 31-d experiment. There were 11 replicate pens per treatment and 6 or 7 pigs in each pen. At weaning, pigs were allotted to pens by initial weight to 1 of 4 treatments in a completely randomized design. Each pen contained a 4-hole, dry self-feeder (4 ft × 5 ft) and a nipple waterer to provide ad libitum access to feed and water.

A 3-phase diet series was used with treatment diets fed during Phase 1 (d 0 to 7) and Phase 2 (d 7 to 21), with a common diet fed from d 21 to 31 (Table 1). All diets were manufactured at the O. H. Kruse Feed Mill in Manhattan, KS. Phase 1 was fed in pelleted form, whereas Phase 2 and the common diet were provided in meal form. Experimental protein sources were provided by Nutraferma (North Sioux City, SD) and shipped to Kansas State University prior to diet manufacturing. The nutrient values used for diet formulation for PSG1 and PSG2 were assumed to be similar to the regular PepSoyGen that was provided by Nutraferma. After diet manufacturing, the products were analyzed for amino acid profile (Table 2) and proximate analysis at the University of Missouri Agricultural Experiment Station Chemical Laboratories (Columbia, MO). The 4 dietary treatments were: (1) negative control (no specialty protein source); (2) positive control (4% DPS 50 + 1% PepSoyGen), with PepSoyGen manufactured according to the standard process; (3) PepSoyGen processing method 1 (PSG1; 5%);

and (4) PepSoyGen processing method 2 (PSG2; 5%). Spray-dried whey was added to all diets at 25 and 10% for Phases 1 and 2, respectively. The soybean meal level for the negative control diet was 38.5 and 40.9%, whereas diets 2 to 4 contained 28.5 and 30.9% for Phases 1 and 2, respectively. The alternative PepSoyGen processing methods incorporated a proprietary additive included post-fermentation at increasing levels (PSG2 > PSG1) aimed at further breakdown of anti-nutritional factors associated with soybean meal. Average daily gain, ADFI, and F/G were calculated by weighing pigs and determining feed disappearance on d 0, 7, 14, 21, and 31 (Table 3).

Results were analyzed as a completely randomized design. Treatment means were analyzed using the LSMEANS statement of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Least squares means were calculated for each independent variable, and means were considered significant at $P < 0.05$ and tendencies at $0.05 < P < 0.10$.

Results and Discussion

For nutrient analyses, the positive control diet with DPS 50/PepSoyGen combined in a 4:1 ratio generally matched formulated concentrations; however, crude protein and crude fat levels in PSG1 and PSG2 were lower and Ca was higher than formulated levels. Matching the lower analyzed CP content, lysine, methionine, and threonine levels in PSG1 and PSG2 were lower than formulated, but other amino acids generally matched formulated concentrations. Between the two processing methods, amino acid levels were generally 10% lower in PSG1 than in PSG 2.

During Phase 1 (d 0 to 7), pigs fed positive control diets had improved ($P < 0.01$) ADG and feed efficiency compared with pigs fed the negative control. Pigs fed PSG1 and PSG2 were intermediate for feed efficiency but tended ($P < 0.07$) to have increased ADG compared with pigs fed the negative control diet. There were no differences in ADFI. For Phase 2 (d 7 to 21), there were no significant differences for ADG, ADFI, or feed efficiency among treatment diets. For the period when experimental diets were fed (d 0 to 21), pigs fed the positive control diet and PSG2 diets had improved ADG ($P < 0.05$), whereas pigs fed the positive control, PSG1, and PSG2 had improved feed efficiency ($P < 0.05$) compared with pigs fed the negative control diet. Also, pigs fed PSG1 tended ($P < 0.06$) to have lower ADG compared with pigs fed the positive control diet. Feed intake was not affected by dietary treatment during the experimental diet period. During the Phase 3 common period (d 21 to 31), no difference in growth performance was reported.

Overall (d 0 to 31), ADG was greater ($P < 0.01$) for pigs fed the positive control diet and tended to be greater ($P < 0.07$) for pigs fed diets containing PSG2 compared with the negative control diet, with pigs fed PSG1 intermediate. There were no treatment differences in ADFI or feed efficiency. Pig BW differences generally matched observed ADG responses, with pigs fed the positive control diet heavier ($P < 0.02$) on d 7 and 21, whereas pigs fed PSG1 and PSG2 tended to be heavier ($P < 0.07$) on d 7 than negative controls. The weight differences were maintained through the end of the experiment, but pig BW differences were not found to be significant on d 35.

Altogether, the observed growth differences indicate that pigs fed diets containing PSG2 had greater performance than those fed the negative control diets, which did not include specialty protein sources, and performance similar to the positive control diets containing PepSoyGen and DPS 50. Numerically, pigs fed the PSG1 diet performed at a lower level than those fed the PSG2 diet but still exhibited better performance than pigs fed the negative control diet. It is unclear whether the lower CP and amino acid content in PSG1 may have contributed to its diminished growth response compared with pigs fed diets containing PSG2 or whether this result is a reflection of the difference in processing method. More research is needed to fully define the growth performance differences between pigs fed diets containing PSG1 and PSG2.

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

	Phase 1			Phase 2			Phase 3
Item	NC[2]	PC[3]	PSG[4]	NC	PC	PSG	Common
Ingredient, %							
Corn	30.1	34.8	34.8	42.3	47.0	46.9	60.9
Soybean meal, 46.5%	38.5	28.5	28.5	40.9	30.9	30.9	34.2
Spray-dried whey	25.0	25.0	25.0	10.0	10.0	10.0	-
Choice white grease	3.0	3.0	3.0	3.0	3.0	3.0	1.0
Monocalcium phosphate, 21% P	1.2	1.1	1.3	1.6	1.4	1.6	1.5
Limestone, ground	0.9	1.0	0.9	0.9	1.1	1.0	1.1
Sodium chloride	0.3	0.3	0.3	0.4	0.4	0.4	0.4
L-lysine HCl	0.1	0.2	0.2	0.1	0.3	0.3	0.3
DL-methionine	0.1	0.2	0.2	0.1	0.2	0.2	0.1
L-threonine	-	0.1	0.1	0.1	0.1	0.1	0.1
Trace mineral premix	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Vitamin premix	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Zinc oxide	0.4	0.4	0.4	0.3	0.3	0.3	0.0
DPS 50	-	4.0	-	-	4.0	-	-
PepSoyGen	-	1.0	5.0	-	1.0	5.0	-
Total	100	100	100	100	100	100	100
Calculated composition							
Standardized ileal digestible (SID) amino acids, %							
Lysine	1.35	1.35	1.35	1.35	1.35	1.35	1.25
Isoleucine:lysine	71	63	65	69	62	63	63
Leucine:lysine	130	121	126	131	122	128	128
Methionine:lysine	33	34	35	33	35	35	34
Met & Cys:lysine	58	58	58	58	58	58	58
Threonine:lysine	64	64	64	64	64	64	64
Tryptophan:lysine	21.8	18.8	19.1	21.1	18.2	18.5	18.8
Valine:lysine	73	70	70	73	70	70	68
Total lysine, %	1.50	1.50	1.50	1.51	1.51	1.51	1.40
ME, kcal/lb	1,542	1,544	1,552	1,535	1,547	1,545	1,496
SID lysine:ME, g/Mcal	3.97	3.94	3.95	3.99	3.96	3.96	3.97
CP, %	23.9	22.3	22.5	24.4	22.8	23.0	21.8
Ca, %	0.80	0.80	0.80	0.80	0.80	0.80	0.78
P, %	0.79	0.76	0.78	0.80	0.78	0.79	0.72
Available P, %	0.50	0.50	0.50	0.48	0.48	0.48	0.40

[1] Treatment diets were fed in two phases with a common Phase 3 diet. Phase 1 (d 0 to 7) diets were fed in pelleted form, and Phase 2 (d 7 to 21) and Phase 3 (d 21 to 31) diets were fed in meal form.
[2] Negative control (NC) diet formulated without fermented soybean meal.
[3] Positive control (PC) diet formulated with 4% DPS 50 (dried porcine solubles; Nutra-Flo, Sioux City, IA) and 1% PepSoyGen (Nutraferma, North Sioux City, SD).
[4] Fermented soybean meal (PSG) produced using 1 of 2 proprietary processing methods.

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

Item	DPS 50/PepSoyGen[2]	PSG1[3]	PSG2[3]
Crude protein, %	53.00 (50.81)[4]	50.56 (54.07)	52.96 (54.07)
Crude fat, %	7.81 (8.06)	0.92 (2.30)	0.92 (2.30)
Ca, %	0.19 (0.11)	0.52 (0.37)	0.52 (0.37)
P, %	0.79 (1.28)	0.66 (0.78)	0.70 (0.78)
Amino acid content, %			
Lysine	3.66 (3.12)	2.91 (3.20)	3.14 (3.20)
Isoleucine	2.29 (1.88)	2.31 (2.21)	2.52 (2.21)
Leucine	4.09 (3.80)	3.88 (5.42)	4.17 (5.42)
Methionine	0.97 (0.86)	0.71 (0.71)	0.78 (0.71)
Cysteine	0.74 (0.87)	0.72 (0.97)	0.76 (0.97)
Threonine	2.09 (2.03)	1.85 (2.15)	2.03 (2.15)
Tryptophan	0.34 (0.38)	0.67 (0.49)	0.72 (0.49)
Valine	2.63 (2.38)	2.42 (2.32)	2.62 (2.32)

[1] Samples were analyzed at the University of Missouri Agricultural Experiment Station Chemical Laboratories in Columbia, MO.
[2] Provided at a ratio of 4 parts dried porcine solubles (DPS 50; Nutra-Flo, Sioux City, IA) to 1 part fermented soybean meal (PepSoyGen; Nutraferma, North Sioux City, SD).
[3] PSG (PepSoyGen; Nutraferma, North Sioux City, SD) produced using 1 of 2 proprietary processing methods.
[4] Values in parentheses indicate values used in diet formulation.

Table 3. Effects of PepSoyGen (PSG) processing method in diets on nursery pig growth performance[1,2]

Item	Negative control	Positive control (DPS 50 + PSG)[3]	PSG1[4]	PSG2[4]	SEM	*P* <
d 0 to 7						
ADG, lb	0.18[a,x]	0.27[b]	0.23[ab,y]	0.24[ab,y]	0.021	0.023
ADFI, lb	0.30	0.32	0.35	0.32	0.024	0.409
F/G	1.89[b]	1.14[a]	1.52[ab]	1.55[ab]	0.240	0.060
d 7 to 21						
ADG, lb	0.66	0.72	0.67	0.70	0.022	0.166
ADFI, lb	0.98	1.00	0.95	0.97	0.025	0.478
F/G	1.49	1.41	1.42	1.39	0.032	0.120
d 0 to 21						
ADG, lb	0.50[a]	0.57[b,y]	0.52[ab,x]	0.55[b]	0.018	0.029
ADFI, lb	0.75	0.78	0.75	0.76	0.021	0.749
F/G	1.51[b]	1.36[a]	1.43[a]	1.38[a]	0.038	0.002
d 21 to 31						
ADG, lb	1.04	1.10	1.09	1.07	0.058	0.428
ADFI, lb	1.67	1.82	1.79	1.74	0.065	0.157
F/G	1.60	1.65	1.64	1.62	0.043	0.588
Overall (d 0 to 31)						
ADG, lb	0.68[a,x]	0.75[b]	0.71[ab]	0.72[ab,y]	0.018	0.053
ADFI, lb	1.05	1.12	1.09	1.08	0.026	0.316
F/G	1.55	1.50	1.53	1.49	0.020	0.106
BW, lb						
d 0	13.3	13.3	13.3	13.3	0.03	0.909
d 7	14.5[a,x]	15.2[b]	14.9[ab,y]	14.9[ab,y]	0.15	0.027
d 21	23.9[a,x]	25.2[b]	24.4[ab]	24.8[ab,y]	0.37	0.091
d 31	34.5	36.3	35.4	35.7	0.63	0.144

[1] A total of 292 weanling pigs (initially 13.3 ± 2.4 lb BW) were used with 11 replicate pens per treatment and 6 or 7 pigs per pen.
[2] Treatment diets were fed in two phases with a common Phase 3 diet. Phase 1 (d 0 to 7) diets were fed in pelleted form, and Phase 2 (d 7 to 21) and Phase 3 (d 21 to 31) diets were fed in meal form.
[3] Positive control diets contained 4% dried porcine solubles (DPS 50, Nutra-Flo, Sioux City, IA) and 1% PepSoyGen (PSG; Nutra-ferma, North Sioux City, SD) during Phase 1 and 2.
[4] PSG1 and PSG2 diets contained fermented soybean meal processed using alternative methods compared with PepSoyGen. Both PSG1 and PSG2 were incorporated at 5% into Phase 1 and 2 diets.
[a,b] Within a row, means without a common superscript differ, $P < 0.05$.
[x,y] Within a row, means without a common superscript differ, $0.05 < P < 0.10$.