Kansas Agricultural Experiment Station Research Reports

Volume 1
Issue 7 *Swine Day*

Article 33

January 2015

Effect of Soy Protein Sources on Nursery Pig Performance

M. D. Tokach
Kansas State University, Manhattan, mtokach@k-state.edu

S. S. Dritz
Kansas State University, Manhattan, dritz@k-state.edu

J. M. DeRouchey
Kansas State University, Manhattan, jderouch@k-state.edu

See next page for additional authors

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Abstract

A total of 480 nursery pigs (PIC C-29 × 359, initially 12.9 lb) were used in a 38-d growth trial to determine the effects of soy protein sources on pig performance. There were 10 pigs per pen and 8 replications per treatment. The 6 dietary treatments were a negative control, corn-soybean meal-based diet (30.1% soybean meal), and diets containing five different specialty protein sources including: Nutrivance, HP 300, soy protein concentrate (SPC), or NF8 or fish meal replacing 10% of the soybean meal in the negative control diet. Experimental diets were fed in two phases (5 lb per pig on d 0 to approximately d 14 and d 14 to 24) with a common diet fed from d 24 to 38. Diets contained 25 and 10% dried whey in phases 1 and 2, respectively. From d 0 to 14, pigs fed diets containing Nutrivance or NF8 had greater ($P < 0.05$) ADG than pigs fed the negative control, high SBM diet. Also, pigs fed the NF8 diet had greater ($P < 0.05$) ADG than pigs fed diets containing SPC or fish meal. The growth response was a result of greater ($P < 0.05$) ADFI for pigs fed the Nutrivance diet and improved ($P < 0.05$) feed efficiency for the NF8 diet. From d 14 to 24, pigs fed the diets containing fish meal or HP 300 had greater ($P < 0.05$) ADG than pigs fed NF8, with pigs fed NF8 having poorer ($P < 0.05$) F/G compared with pigs fed all other treatments. From d 0 to 24, pigs fed the diet containing HP 300 had greater ($P < 0.05$) ADG than pigs fed the negative control, high SBM diet, with other treatments being intermediate. Pigs fed the diet containing HP 300 had improved ($P < 0.05$) F/G compared with pigs fed all other protein sources except fish meal. Pigs fed the fish meal diet also had improved ($P < 0.05$) F/G compared with pigs fed the diet containing NF8. The improvement in performance from d 0 to 14 for pigs fed the diet containing Nutrivance resulted in a 0.5 lb heavier ($P < 0.05$) pig on d 14 as compared to the negative control diet. The 0.5 lb advantage in BW over the negative control was maintained to the end of the trial (d 38) and was similar to the final BW of pigs fed the HP 300 diet; however, the weight advantage was no longer statistically significant.

Keywords

soy protein products, soybean meal, HP 300, nursery pigs

Authors

M. D. Tokach, S. S. Dritz, J. M. DeRouchey, J. C. Woodworth, and R. D. Goodband

K-STATE Research and Extension

SWINE DAY 2015

KANSAS STATE UNIVERSITY SWINE INDUSTRY DAY 2015

Effect of Soy Protein Sources on Nursery Pig Performance[1,2]

M. D. Tokach, S. S. Dritz, J. M. DeRouchey, J. C. Woodworth, and R. D. Goodband

Summary

A total of 480 nursery pigs (PIC C-29 × 359, initially 12.9 lb) were used in a 38-d growth trial to determine the effects of soy protein sources on pig performance. There were 10 pigs per pen and 8 replications per treatment. The 6 dietary treatments were a negative control, corn-soybean meal-based diet (30.1% soybean meal), and diets containing five different specialty protein sources including: Nutrivance, HP 300, soy protein concentrate (SPC), or NF8 or fish meal replacing 10% of the soybean meal in the negative control diet. Experimental diets were fed in two phases (5 lb per pig on d 0 to approximately d 14 and d 14 to 24) with a common diet fed from d 24 to 38. Diets contained 25 and 10% dried whey in phases 1 and 2, respectively. From d 0 to 14, pigs fed diets containing Nutrivance or NF8 had greater ($P < 0.05$) ADG than pigs fed the negative control, high SBM diet. Also, pigs fed the NF8 diet had greater ($P < 0.05$) ADG than pigs fed diets containing SPC or fish meal. The growth response was a result of greater ($P < 0.05$) ADFI for pigs fed the Nutrivance diet and improved ($P < 0.05$) feed efficiency for the NF8 diet. From d 14 to 24, pigs fed the diets containing fish meal or HP 300 had greater ($P < 0.05$) ADG than pigs fed NF8, with pigs fed NF8 having poorer ($P < 0.05$) F/G compared with pigs fed all other treatments. From d 0 to 24, pigs fed the diet containing HP 300 had greater ($P < 0.05$) ADG than pigs fed the negative control, high SBM diet, with other treatments being intermediate. Pigs fed the diet containing HP 300 had improved ($P < 0.05$) F/G compared with pigs fed all other protein sources except fish meal. Pigs fed the fish meal diet also had improved ($P < 0.05$) F/G compared with pigs fed the diet containing NF8. The improvement in performance from d 0 to 14 for pigs fed the diet containing Nutrivance resulted in a 0.5 lb heavier ($P < 0.05$) pig on d 14 as compared to the negative control diet. The 0.5 lb advantage in BW over the negative control was maintained to the end of the trial (d 38) and was similar to the final BW of pigs fed the HP 300 diet; however, the weight advantage was no longer statistically significant.

Key words: soy protein products, soybean meal, HP 300, nursery pigs

Introduction

Diets for nursery pigs require high levels of digestible amino acids to meet their requirements. Highly palatable ingredients are also needed to encourage feed intake as young pigs are in an energy deficient state during the nursery phase. The most economical

protein source for pigs is usually soybean meal; however, soybean meal contains anti-nutritional factors, such as trypsin inhibitors and oligosaccharides, which can reduce the performance of young pigs. These reductions in performance with soybean meal are particularly noted when pigs are exposed to more stressful, commercial nursery conditions. Thus, specialty protein sources are used in diets immediately after weaning to decrease the soybean meal inclusion rate in the diet.

In the past, the most common protein sources for these diets included spray-dried animal plasma, blood meal, and fish meal. Producer and nutritionist concerns with cost, availability, and inclusion limits for animal-based proteins have led to increased interest in further processed soy products to be used in young pig diets. Past research with soy protein concentrate has often shown that anti-nutritional factors can be reduced, but palatability and feed intake can remain an issue with some specialty soy products. The objective of this experiment was to determine the effect of different soy protein sources on performance of pigs from weaning to 25 lb under typical commercial nursery pig production conditions.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. A total of 480 pigs (PIC C-29 × 359, initially 12.9 lb) with 10 pigs per pen and 8 replications per treatment were used in the study, conducted in a commercial research nursery in Ohio (Kalmbach Feeds, Sandusky OH). Pigs were weaned at approximately 18 to 20 d of age and allotted to pen based on initial body weight in a randomized complete block design. Each pen had slatted metal floors and was equipped with a 4-hole stainless steel feeder and one nipple-cup waterer for ad libitum access to feed and water. Pens were 5 × 6 ft to allow for 3 ft^2 per pig. Nursery rooms were not power washed after the previous group of pigs to better evaluate the difference observed between protein sources.

Pigs and feeders were weighed on d 0, 14, 24, and 38 after weaning, and data were used to calculate the response criteria of ADG, ADFI, F/G, removal rate, and mortality.

There were 6 treatments tested in this trial (Tables 1 and 2). The negative control diet was a corn-soybean meal-based diet (30.1%; SBM). Approximately 10% soybean meal in the negative control diet was then replaced with four soy protein sources including Nutrivance (Midwest Ag Enterprises, Marshall, MN); HP 300 (Hamlet Protein, Findlay, OH); soy protein concentrate (SPC, Soycomil P; ADM, Decatur, IL); or NF 8 (Nutraferma, North Sioux City, SD), and fish meal. For the positive control diet, fish meal (Omega Proteins, Houston, TX) replaced the same amount of soybean meal in the negative control diet. All diets contained the same level of L-lysine HCl. Inclusion rates for the specialty protein sources were altered to maintain the same soybean meal levels and SID lysine levels in the test diets containing the specialty protein sources. Inclusion rates for the specialty sources were: 8% Nutrivance, 9% HP 300, 6.85% soy protein concentrate, 11% NF8, or 6.7% fish meal throughout the experimental diet test period.

Experimental diets were fed in two phases with the first diet provided at 5 lb/pig. The second diet was then fed until d 24 after weaning (approximately 24 lb BW). The initial diet contained 25% dried whey and 10% dried distillers grains with solubles (DDGS).

The phase 2 diet contained 10% dried whey and 10% DDGS. A common diet was fed from d 24 to 38 following the treatment diets (~24 to 41 lb).

Samples of the protein sources were collected at the feed mill during diet manufacturing. Complete diet samples were obtained from each of the dietary treatments each wk during the study. Composite samples were analyzed at a commercial laboratory (Ward Labs, Norfolk, NE; Table 3).

Data were analyzed using the PROC GLIMMIX procedure in SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Dietary treatments were the fixed effect, and block served as the random effect in analysis. Means are reported as least squares means with individual treatment difference used to determine differences between protein sources. Significant differences between treatments were determined by using ($P < 0.05$) and trends were declared at $P < 0.10$.

Results and Discussion

A total of 8 of the 480 pigs (1.7%) did not complete the study with 2 removed for humane reasons and 6 due to death. Of those removed, 3 pigs were on the control diet, 2 pigs were from the fish meal diet, and 1 pig from each of the Nutrivance, SPC, and NF8 diets.

From d 0 to 14, pigs fed diets containing Nutrivance or NF8 had greater ($P < 0.05$) ADG than pigs fed the negative control, high SBM diet (Table 4). Pigs fed the diet containing NF8 also had greater ($P < 0.05$) ADG than pigs fed diets containing SPC or fish meal. The growth response was a result of greater ($P < 0.05$) ADFI for pigs fed the Nutrivance diet and improved ($P < 0.05$) F/G for the NF8 diet. Pigs fed the diet containing Nutrivance or NF8 had greater ($P < 0.05$) BW on d 14 after weaning than pigs fed the negative control diet or diets containing SPC or fish meal.

From d 14 to 24, pigs fed the diets containing fish meal or HP 300 had greater ($P < 0.05$) ADG than pigs fed the diet containing NF8. Pigs fed NF8 had poorer ($P < 0.05$) F/G compared with pigs fed all other protein sources. There were no differences in ADFI.

For the entire period when the specialty protein sources were fed (d 0 to 24), pigs fed the diet containing HP 300 had greater (P < 0.05) ADG than pigs fed the negative control high-SBM diet, with the other treatments intermediate. Pigs fed the diet containing HP 300 had improved ($P < 0.05$) F/G compared with pigs fed all other protein sources except fish meal. Pigs fed the fish meal diet also had improved ($P < 0.05$) F/G compared with pigs fed the diet containing NF8.

There were no differences in subsequent performance from d 24 to 38 when pigs were fed a common diet. In addition, there were no differences detected in overall (d 0 to 38) performance among dietary treatments.

For pigs fed diets containing Nutrivance, the 0.5 lb advantage in BW over the negative control was maintained to the end of the trial on d 38; however, it was no longer statistically significant.

Table 1. Phase 1 diet composition[1]

Ingredient, %	Control	Nutrivance	HP 300	SPC	NF8	Fish meal
Corn	28.70	30.90	29.90	32.05	28.05	33.40
Soybean meal, 46.5% CP	30.10	19.85	19.85	19.85	19.85	19.85
Specialty protein source[2]	- - -	8.0	9.0	6.85	11.0	6.65
Corn DDGS[3]	10.00	10.00	10.00	10.00	10.00	10.00
Dried whey	25.00	25.00	25.00	25.00	25.00	25.00
Corn oil	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	1.00	1.05	1.05	1.05	0.90	0.70
Monocalcium P, 21% P	0.80	0.80	0.80	0.80	0.80	- - -
Sodium chloride	0.25	0.25	0.25	0.25	0.25	0.25
L-lysine HCl	0.30	0.30	0.30	0.30	0.30	0.30
DL-methionine	0.16	0.16	0.15	0.17	0.16	0.14
L-threonine	0.07	0.06	0.06	0.07	0.05	0.09
L-tryptophan	- - -	- - -	- - -	0.02	- - -	0.03
Phytase[4]	0.01	0.01	0.01	0.01	0.01	0.01
Zinc oxide	0.40	0.40	0.40	0.40	0.40	0.40
Trace mineral premix[5]	0.106	0.106	0.106	0.106	0.106	0.106
Vitamin premix[6]	0.13	0.13	0.13	0.13	0.13	0.13
Total	100	100	100	100	100	100
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lys	1.35	1.35	1.35	1.35	1.35	1.35
Ile:lys	65	66	66	65	67	61
Met:lys	35	35	34	35	35	37
Met & cys:lys	58	58	58	58	58	58
Thr:lys	62	62	63	62	62	62
Trp:lys	19.0	19.0	19.1	19.1	19.9	19.2
Val:lys	68	70	71	70	70	67
Total lys, %	1.51	1.51	1.50	1.50	1.53	1.52
ME, kcal/lb	1,559	1,569	1,578	1,577	1,563	1,586
NE NRC, kcal/lb	1,156	1,164	1,172	1,174	1,152	1,187
SID Lysine:ME, g/Mcal	3.93	3.90	3.88	3.88	3.92	3.86
CP, %	22.1	22.3	22.5	22.1	22.9	21.9
Ca, %	0.80	0.80	0.80	0.80	0.80	0.80
P, %	0.69	0.68	0.69	0.68	0.69	0.66
Available P, %	0.58	0.58	0.58	0.58	0.58	0.58

[1] Phase 1 diets were fed from weaning to approximately 15 lb BW (5 lb/pig).
[2] Corn dried distillers grains with solubles (8% oil).
[3] Specialty protein sources were: Nutrivance (Midwest Ag Enterprises, Marshall, MN); HP 300 (Hamlet Protein, Findlay, OH); soy protein concentrate (SPC, Soycomil P; ADM, Decatur, IL); NF 8 (Nutraferma, North Sioux City, SD), and fish meal (Omega Proteins, Houston, TX).
[4] Quantum Blue (AB-Vista Americas, Plantation, FL) provided 227 phytase units (FTU)/lb of diet, with a release of 0.13% available P.
[5] Provided in the final diet: 25 ppm Mn from manganese oxide, 88 ppm Fe from iron sulfate, 110 ppm Zn from zinc sulfate, 26 ppm Cu from copper sulfate, 1.36 ppm I from calcium iodate, and 0.30 ppm Se from sodium selenite.
[6] Provided per pound of the diet: 6,500 IU vitamin A; 1,000 IU vitamin D3; 35 IU vitamin E; 4 mg vitamin K; 3.5 mg riboflavin; 15 mg pantothenic acid; 25 mg niacin; and 0.18 mg vitamin B12.

Table 2. Phase 2 diet composition (as fed basis)[1]

Ingredient, %	Control	Nutrivance	HP 300	SPC	NF8	Fish meal
Corn	42.80	44.95	43.950	46.05	42.10	47.40
Soybean meal, 46.5% CP	32.00	21.85	21.85	21.85	21.85	21.85
Specialty protein source[2]	- - -	8.00	9.00	6.90	11.00	6.70
Corn DDGS[3]	10.00	10.00	10.00	10.00	10.00	10.00
Dried whey	10.00	10.00	10.00	10.00	10.00	10.00
Corn oil	2.00	2.00	2.00	2.00	2.00	2.00
Calcium carbonate	1.10	1.10	1.20	1.10	1.00	0.80
Monocalcium P, 21% P	0.80	0.80	0.80	0.80	0.80	- - -
Sodium chloride	0.30	0.30	0.30	0.30	0.30	0.30
L-lysine HCL	0.30	0.30	0.30	0.30	0.30	0.30
DL-methionine	0.13	0.13	0.12	0.13	0.12	0.11
L-threonine	0.08	0.06	0.06	0.08	0.06	0.09
L-tryptophan	- - -	- - -	- - -	0.02	- - -	0.03
Phytase[3]	0.01	0.01	0.01	0.01	0.01	0.01
Zinc oxide	0.27	0.27	0.27	0.27	0.27	0.27
Trace mineral premix[4]	0.106	0.106	0.106	0.106	0.106	0.106
Vitamin premix[4]	0.13	0.13	0.13	0.13	0.13	0.13
Total	100	100	100	100	100	100
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lys	1.30	1.30	1.30	1.30	1.30	1.30
Ile:lys	65	67	67	66	68	62
Met:lys	34	34	34	34	34	36
Met & cys:lys	58	58	58	58	58	58
Thr:lys	62	62	62	62	62	62
Trp:lys	19.0	18.9	19.0	19.0	19.9	19.2
Val:lys	71	73	73	72	73	70
Total lys, %	1.47	1.47	1.46	1.47	1.49	1.48
ME, kcal/lb	1,534	1,543	1,551	1,552	1,538	1,560
NE NRC, kcal/lb	1,127	1,135	1,141	1,145	1,123	1,158
SID Lysine:ME, g/Mcal	3.84	3.82	3.80	3.80	3.83	3.78
CP, %	22.3	22.5	22.7	22.3	23.1	22.2
Ca, %	0.75	0.75	0.75	0.75	0.75	0.75
P, %	0.64	0.63	0.64	0.63	0.64	0.63
Available P, %	0.48	0.48	0.48	0.48	0.48	0.48

[1] Phase 2 diets were fed from approximately 15 to 25 lb BW (d 14 to 24).
[2] Specialty protein sources were: Nutrivance (Midwest Ag Enterprises, Marshall, MN); HP 300 (Hamlet Protein, Findlay, OH); soy protein concentrate (SPC, Soycomil P; ADM, Decatur, IL); NF8 (Nutraferma, North Sioux City, SD), and fish meal (Omega Proteins, Houston, TX).
[3] Corn dried distillers grains with solubles (8% oil).
[4] Quantum Blue (AB-Vista Americas, Plantation, FL) provided 227 phytase units (FTU)/lb of diet, with a release of 0.13% available Phosphorus.
[5] Provided in the final diet: 25 ppm Mn from manganese oxide, 88 ppm Fe from iron sulfate, 110 pm Zn from zinc sulfate, 26 ppm Cu from copper sulfate, 1.36 ppm I from calcium iodate, and 0.30 ppm Se from sodium selenite.
[6] Provided per pound of the diet: 6,500 IU vitamin A; 1,000 IU vitamin D3; 35 IU vitamin E; 4 mg vitamin K; 3.5 mg riboflavin; 15 mg pantothenic acid; 25 mg niacin; and 0.18 mg vitamin B_{12}.

Table 3. Laboratory analysis of experimental diets

Item, %	SBM	Nutrivance	HP 300	SPC	NF8	Fish meal
Phase 1 diets[1]						
DM	92.57	92.32	92.48	92.42	92.4	92.29
CP	22.1	22.5	22.4	22.5	23.2	21.3
ADF	1.1	1.4	1.0	1.2	1.5	1.4
NDF	7.0	5.6	5.6	7.7	6.2	6.7
Crude fiber	2.4	2.4	2.2	2.3	2.4	2.1
Ca	0.95	0.96	0.89	0.89	0.82	0.89
P	0.71	0.72	0.74	0.74	0.71	0.71
Cl	0.63	0.64	0.63	0.62	0.62	0.69
Salt	1.04	1.06	1.04	1.02	1.02	1.13
Ether extract	5.0	5.0	5.2	5.1	5.1	5.6
Ash	6.9	6.6	6.7	6.5	6.8	6.9
Starch	23.0	20.9	20.5	21.9	18.5	22.2
Phase 2 diets[2]						
DM	91.6	91.3	91.9	91.3	91.6	91.0
CP	23.2	22.6	22.6	23.1	22.5	22.6
ADF	1.6	1.8	1.8	2.2	1.5	2.2
NDF	9.2	7.1	7.0	7.7	6.9	8.3
Crude fiber	2.6	2.6	2.6	2.6	2.5	2.4
Ca	0.81	0.8	0.88	0.83	1.14	0.89
P	0.65	0.66	0.67	0.64	0.63	0.6
Cl	0.45	0.46	0.45	0.45	0.62	0.51
Salt	0.75	0.76	0.74	0.74	1.02	0.84
Ether extract	4.5	4.5	4.6	4.0	4.3	4.7
Ash	5.8	5.3	5.8	5.4	7.4	5.9
Starch	27.9	29.4	28.1	29.5	27.0	31.1

[1] Phase 1 diets were fed from weaning to approximately 15 lb BW.
[2] Phase 2 diets were fed from approximately 15 to 25 lb BW.

Table 4. Influence of specialty protein source on nursery pig performance[1,2]

Item	SBM	Nutrivance	HP 300	SPC	NF8	Fish meal	SEM	TRT *P* <
d 0 to 14								
ADG, lb	0.25[a]	0.29[bc]	0.27[abc]	0.26[ab]	0.29[c]	0.26[ab]	0.02	0.06
ADFI, lb	0.35[a]	0.38[b]	0.34[a]	0.34[a]	0.35[ab]	0.34[a]	0.02	0.06
F/G	1.37[a]	1.31[abc]	1.27[bc]	1.35[ab]	1.23[c]	1.32[abc]	0.05	0.03
d 14 to 24								
ADG, lb	0.77[ab]	0.76[ab]	0.82[a]	0.77[ab]	0.72[b]	0.82[a]	0.03	0.01
ADFI, lb	1.09	1.10	1.13	1.10	1.12	1.13	0.02	0.56
F/G	1.41[a]	1.45[a]	1.38[a]	1.44[a]	1.55[b]	1.38[a]	0.04	<0.01
d 0 to 24								
ADG, lb	0.47[a]	0.49[ab]	0.50[b]	0.47[ab]	0.47[ab]	0.49[ab]	0.01	0.20
ADFI, lb	0.65	0.68	0.67	0.66	0.67	0.67	0.01	0.64
F/G	1.39[ab]	1.40[ab]	1.34[c]	1.40[ab]	1.43[a]	1.36[bc]	0.02	0.02
d 24 to 38								
ADG, lb	1.15	1.16	1.16	1.16	1.15	1.13	0.04	0.97
ADFI, lb	1.66	1.68	1.65	1.64	1.65	1.63	0.06	0.83
F/G	1.45	1.45	1.43	1.42	1.44	1.44	0.03	0.97
d 0 to 38								
ADG, lb	0.72	0.73	0.74	0.72	0.72	0.73	0.016	0.75
ADFI, lb	1.02	1.04	1.03	1.02	1.03	1.02	0.02	0.81
F/G	1.42	1.43	1.39	1.41	1.43	1.40	0.015	0.39
BW								
d 0	12.9	12.9	12.9	12.9	12.9	12.9	0.02	0.98
d 14	16.5[ab]	17.0[c]	16.7[abc]	16.6[ab]	17.0[c]	16.6[ab]	0.26	0.08
d 24	24.3	24.6	24.9	24.3	24.3	24.8	0.27	0.28
d 38	40.6	41.1	41.1	40.4	40.5	40.6	0.565	0.82

[abc] Means without common superscripts differ $P < 0.05$.

[1] A total of 480 pigs were used with 10 pigs per pen and 8 replications per treatment.

[2] Specialty protein sources were: Nutrivance (Midwest Ag Enterprises, Marshall, MN); HP 300 (Hamlet Protein, Findlay, OH); soy protein concentrate (SPC, Soycomil P; ADM, Decatur, IL); NF8 (Nutraferma, North Sioux City, SD); and fish meal (Omega Proteins, Houston, TX).