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Replacing Soybean Meal with Soy Protein Concentrate in Diets Containing 12% Crude Protein Does Not Maintain Performance in Finishing Pigs from 240 to 280 lb

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Replacing Soybean Meal with Soy Protein Concentrate in Diets Containing 12% Crude Protein Does Not Maintain Performance in Finishing Pigs from 240 to 280 lb

Abstract

A total of 252 pigs (DNA 600 × 241, initially 238.8 lb) were used in a 21-d trial to determine the effects of replacing soybean meal (SBM) with soy protein concentrate (SPC) in diets containing 12% crude protein (CP) on growth performance of finishing pigs from 240 to 280 lb. Pens of 7 or 8 pigs were allotted by body weight (BW) and randomly assigned to 1 of 4 dietary treatments with 8 replications per treatment. Treatments consisted of 3 levels of SBM (10.6, 5.3, and 0%) with 12% CP and a negative control treatment with 4.0% SBM and 10% CP. Soy protein concentrate was increased as SBM decreased to maintain 12% CP. For overall growth performance, decreasing SBM marginally decreased (linear, $P = 0.062$) average daily gain (ADG) and worsened (linear, $P = 0.061$) feed efficiency (F/G). In conclusion, regardless of the 12% CP level, reducing the concentration of SBM and replacing it with SPC worsened ADG and F/G.

Keywords

soybean meal, crude protein, finishing pigs

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Summary

A total of 252 pigs (DNA 600 × 241, initially 238.8 lb) were used in a 21-d trial to determine the effects of replacing soybean meal (SBM) with soy protein concentrate (SPC) in diets containing 12% crude protein (CP) on growth performance of finishing pigs from 240 to 280 lb. Pens of 7 or 8 pigs were allotted by body weight (BW) and randomly assigned to 1 of 4 dietary treatments with 8 replications per treatment. Treatments consisted of 3 levels of SBM (10.6, 5.3, and 0%) with 12% CP and a negative control treatment with 4.0% SBM and 10% CP. Soy protein concentrate was increased as SBM decreased to maintain 12% CP. For overall growth performance, decreasing SBM marginally decreased (linear, $P = 0.062$) average daily gain (ADG) and worsened (linear, $P = 0.061$) feed efficiency (F/G). In conclusion, regardless of the 12% CP level, reducing the concentration of SBM and replacing it with SPC worsened ADG and F/G.

Introduction

Previous research² suggested that a significant reduction in performance and carcass characteristics occurs when finishing pigs are fed corn-soybean meal diets formulated below 12% CP, but fortified with all amino acids (AA) at or above minimum requirement estimates relative to lysine. Subsequent research attempted to determine whether the reduction in performance was due to the low CP itself or decreased concentrations of SBM. In those trials, corn gluten meal was used to replace the SBM and performance was linearly reduced as SBM was replaced with corn gluten meal.³ Research is

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²J. A. Soto, M. D. Tokach, S. S. Dritz, J. C. Woodworth, J. M. DeRouchey and R. D. Goodband. 2016. Determination of the optimum levels of dietary crude protein for growth performance and carcass characteristics of finishing pigs from 240 to 280 lb, Kansas Agricultural Experiment Station Research Reports: Vol. 2: Iss. 8. <http://dx.doi.org/10.4148/2378-5977.1309>

³J.A. Soto, M.D. Tokach, S.S. Dritz, J.C. Woodworth, J.M. DeRouchey, and R.D. Goodband. Effects of dietary soybean meal concentration with dietary crude protein fixed at 12% on growth and carcass performance of finishing pigs from 250 to 300 lb. 2017. Kansas Agricultural Experiment Station Research Reports: Vol. 3: Iss. 7. <http://newprairiepress.org/kaesrr/vol3/iss7/39/>

needed to validate those results and to ensure that pigs didn't simply prefer soybean meal over corn gluten meal. Thus, the objective of the present study was to determine the effects of dietary soybean meal concentration, with dietary crude protein fixed at 12%, on growth performance of finishing pigs from 240 to 280 lb. The soybean meal was replaced with soy protein concentrate in this experiment to keep the levels of soy protein and amino acid profile similar in all diets.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. This study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The facility was totally enclosed and environmentally regulated, containing 32 pens. Each pen was equipped with a dry single-sided feeder (Farmweld, Teutopolis, IL) and a 1-cup waterer. Pigs were stocked at a floor space of 7.83 ft² per pig. Pens were equipped with adjustable gates to allow space allowances per pig to be maintained if a pig died or was removed from a pen during the experiment. Pens were located over a completely slatted concrete floor with a 4-ft pit underneath for manure storage. A robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) was used to deliver and record daily feed additions to each individual pen.

A total of 252 pigs (DNA 600 × 241, initially 251.8 lb) were used in a 21-d trial. There were 7 or 8 mixed gender pigs (50:50 castrated males to females) per pen and pigs were allotted by BW to pens. Pens were randomly assigned within weight blocks in a completely randomized block design with 8 replications per treatment. There were 4 dietary treatments that included 3 diets with decreasing SBM (10.6, 5.3, and 0%) all fixed at 12% CP and a negative control diet with 4.0% SBM and 10% CP.

To create the experimental diets, a 12% CP corn-soybean meal diet with 10.6% SBM and 0.13% L-Lys HCl was formulated. Then, a 12% CP corn-soy protein concentrate diet with 0.15% L-Lys HCl at 12% CP was formulated. The 10.6 and 0% SBM diets were blended to provide the 5.3% SBM diet and maintain 12% CP (Table 1). Lastly, a 10% CP corn-soybean meal with 4.0% SBM and 0.33% L-lysine HCl was formulated. In all these diets, ratios of other AA to Lys were maintained well above minimum requirement estimates to ensure that other AA relative to lysine were not limiting. Diets contained 1,206 kcal/lb net energy (NE) by adjusting the amount of fat as corn, soy protein concentrate, and SBM changed in the diet.

Diet samples were taken from 6 feeders per dietary treatment 3 d after the beginning of the trial and 3 d prior to the end of the trial and stored at -20°C until they were homogenized, subsampled, and submitted to Cumberland Valley Analytical Service (Hagerstown, MD) for analysis of dry matter (DM), CP, Ca, P, ether extract, and ash.

Pigs were weighed on d 0, 7, 14, and 21 of the trial to determine ADG, ADFI, and F/G. Data were analyzed using the GLIMMIX procedure of SAS (Version 9.4, SAS Institute, Inc., Cary, NC) in a randomized complete block design with pen serving as the experimental unit and initial BW serving as the blocking factor. Dietary treatments were the fixed effect and block served as the random effect in the analysis. Preplanned orthogonal contrasts were used to determine the effects of increasing soybean meal.

Results and Discussion

The analyzed total DM, CP, Ca, P, ether extract, and ash contents of experimental diets (Table 2) agreed closely with formulated estimates. For overall growth performance (d 0 to 21), decreasing SBM marginally decreased (linear, $P = 0.062$) average daily gain and worsened (linear, $P = 0.061$) F/G (Table 3). Similar to some of our previous research experiments in this area, there was no evidence for differences in ADG for pigs fed the negative control diet with 10% CP and 4.0% SBM compared with pigs fed the diet with 12% CP and 10.6% SBM. Although not significant in these experiments, average daily feed intake numerically increased as SBM was reduced from 12 to 10% CP, leading to a numerical worsening of feed efficiency. The magnitude of response appears to differ between experiments; however, poorer feed efficiency often results when soybean meal is removed and crude protein is less than 12% in diets for pigs over 240 lb.

These results support our previous research suggesting that dietary SBM concentration could represent one of the reasons why we observed decreased growth performance in finishing pigs fed low CP diets. Additionally, it suggests that one or more biologically active compounds found in SBM may be contributing to the responses observed. Further research is needed to understand the reasons why pigs fed diets with seemingly adequate levels of AA, but with less than 10.6% SBM, have decreased growth performance.

Table 1. Diet composition (as-fed basis)¹

	Soybean meal, %:	Crude protein, %			
		10	12	0.0	
Ingredient, %		4.0	10.6	5.3	0.0
Corn	91.86	84.94	87.28	89.63	
Soybean meal (46.5% crude protein)	4.00	10.63	5.31	---	
Soy protein concentrate	---	---	3.35	6.70	
Choice white grease	1.30	2.25	1.80	1.35	
Monocalcium phosphate (21% phosphorus)	0.56	0.52	0.54	0.55	
Limestone	1.05	0.98	1.01	1.05	
Salt	0.35	0.35	0.35	0.35	
L-Lysine-HCl	0.33	0.13	0.14	0.15	
DL-Methionine	0.06	---	---	---	
L-Threonine	0.11	0.03	0.03	0.03	
L-Tryptophan	0.04	0.00	0.01	0.01	
L-Valine	0.06	---	---	---	
L-Isoleucine	0.11	---	---	---	
Trace mineral premix	0.10	0.10	0.10	0.10	
Vitamin premix	0.08	0.08	0.08	0.08	
Phytase ²	0.02	0.02	0.02	0.02	
Total	100.00	100.00	100.00	100.00	
Calculated analysis					
Standardized ileal digestible (SID) amino acids, %					
Lysine	0.55	0.55	0.55	0.55	
Isoleucine:lysine	75	75	74	73	
Leucine:lysine	164	191	193	195	
Methionine:lysine	51	37	37	37	
Methionine and cystine:lysine	76	76	75	74	
Threonine:lysine	70	70	70	70	
Tryptophan:lysine	20.0	20.0	20.0	20.0	
Valine:lysine	80	88	88	89	
Histidine:lysine	40	50	50	50	
SID lysine:net energy, g/Mcal	2.07	2.07	2.07	2.07	
Net energy, kcal/lb	1,206	1,206	1,206	1,206	
Crude protein, %	10.0	12.0	12.0	12.0	
Calcium, %	0.53	0.53	0.53	0.53	
Phosphorus, %	0.41	0.43	0.43	0.43	
Available phosphorus, %	0.26	0.26	0.26	0.26	
Standardized digestible phosphorus, %	0.29	0.30	0.30	0.30	

¹Diets were fed from 238 to 280 lb.

²Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Inc, Parsippany, NJ). Provided 181.8 phytase units (FYT) per lb of diet with a release of 0.10% available P.

Table 2. Chemical analysis of experimental diets (as-fed basis)¹

	Crude protein, %			
	10	12		
Soybean meal, %:	4.0	10.6	5.3	0.0
Item, %				
Dry matter	85.4	85.7	85.5	85.5
Crude protein	10.3	12.3	12.7	12.6
Calcium	0.64	0.67	0.62	0.57
Phosphorus	0.42	0.45	0.45	0.43
Ether extract	3.9	4.1	4.4	4.1
Ash	3.5	3.2	3.2	2.6

¹Diet samples were taken from 6 feeders per dietary treatment 3 d after the beginning of the trial and 3 d prior to the end of the trial and stored at -20°C, until analysis. Samples of the diets were submitted to Cumberland Valley Analytical Service (Hagerstown, MD) for analysis.

Table 3. Effects of soybean meal level with dietary crude protein fixed at 12% on growth performance of finishing pigs from 240 to 280 lb¹

	NC ²		PC ³			SEM	Probability, <i>P</i> <		
	10	12	10.6	5.3	0.0		NC vs. PC	Linear	Quadratic
Soybean meal inclusion, %:	4.0		10.6	5.3	0.0				
Item									
Body weight, lb									
d 0	238.8	238.8	238.8	238.8	1.98	0.929	0.955	0.990	
d 21	281.2	281.5	280.0	278.9	2.22	0.853	0.092	0.887	
d 0 to 21									
ADG, lb ⁴	2.02	2.04	1.96	1.91	0.046	0.819	0.062	0.886	
ADFI, lb	7.52	7.38	7.42	7.34	0.127	0.431	0.847	0.709	
Feed/gain	3.73	3.64	3.79	3.85	0.076	0.441	0.061	0.646	

¹A total of 252 pigs (DNA 600 × 241) were used with 7 or 8 pigs per pen and 8 replications per treatment.

²NC = negative control.

³PC = positive control.

⁴ADG = Average daily gain; ADFI = Average daily feed intake.