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Effects of Increasing Soybean Meal in Corn-Based Diets on Growth Performance of Late Finishing Pigs

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Summary

A total of 1,793 pigs (L337 × 1050, PIC, Hendersonville, TN; initially 231.2 ± 2.4 lb) were used to evaluate the effects of increasing soybean meal in corn-based diets on growth performance of late finishing pigs. Pens of pigs were blocked by initial weight and randomly assigned to 1 of 5 dietary treatments with 22 to 27 pigs per pen and 12 to 14 pens per treatment. Experimental diets were corn-based, formulated to 0.70% SID Lys, and contained varying amounts of feed grade AA to meet or exceed requirement estimates. Soybean meal gradually increased from 5 to 20% of the diet and replaced feed grade AA. Thus, experimental diets contained 9.6, 10.8, 12.0, 13.4, or 14.7% CP. Pigs were weighed to evaluate ADG, ADFI, and F/G. Data were analyzed with the GLIMMIX procedure of SAS using pen as the experimental unit. The statistical model considered fixed effects of treatment, linear, quadratic, and cubic contrasts, and random effects of group and block. Overall, pigs fed increasing soybean concentrations in the late finishing period exhibited increased ADG (linear and cubic, $P < 0.05$), and improved F/G (linear and cubic, $P < 0.05$). The greatest improvements were observed as dietary soybean meal increased from 5 to 8.75% and from 16.25 to 20%. Additionally, final BW of pigs increased (cubic, $P < 0.05$) as SBM increased from 5 to 8.75% and from 16.25 to 20%. Although diets were formulated to exceed the minimum NRC (2012)² nutrient requirement estimates, we suspect the observed response may be due to the increased Trp:Lys ratio of 21.6 in the 20% SBM diet compared to 20% in all other diets. These results suggest that at least 8.75% soybean meal should be utilized to increase dietary CP content beyond 11% to improve growth performance of late finishing pigs in corn-based diets.

Introduction

Soybean meal (SBM) is a highly digestible and consistently produced protein source in swine diets that provides many essential AA for the pig. However, swine diets are often

¹ The authors appreciate the United Soybean Board for partial financial support and New Horizon Farms (Pipestone, MN) for their animal and facility use, and assistance in conducting this experiment. The authors would also like to recognize Dr. Jose Soto (Ajinimoto; Chicago, IL) for providing feed-grade amino acids utilized in this experiment.

² National Research Council. 2012. Nutrient Requirements of Swine: Eleventh Revised Edition. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13298>.

formulated to incorporate feed grade AA as a replacement for some SBM to reduce diet cost. As a result, late finishing swine diets may contain minimal quantities of SBM.

Typically, corn-based diets with feed grade AA can be formulated for late finishing pigs to meet individual AA requirements. However, there is evidence to suggest that beyond meeting individual AA requirements, late finishing pigs require at least 12 to 13% dietary CP to optimize growth performance.³ Utilizing intact protein sources such as SBM to increase dietary CP may improve growth performance of late finishing pigs. Therefore, the objective of this experiment was to determine the ideal amount of SBM needed to optimize growth performance of finishing pigs from 220 lb to market when provided with corn-based diets.

Materials and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. This study was conducted at a commercial research facility in southwestern Minnesota. The barn was naturally ventilated and double-curtained-sided. Each pen was equipped with a 4-hole stainless steel dry feeder and a cup waterer to allow *ad libitum* access to feed and water. Daily additions of feed to each pen were recorded through a robotic feeding system (FeedPro, Feedlogic Corp., Wilmar, MN).

Animals and diets

A total of 1,793 pigs (L337 × 1050, PIC, Hendersonville, TN; initially 231.2 ± 2.4 lb) were used in two groups with 22 to 27 pigs per pen and 12 to 14 pens per treatment (7 per trial). Pens of pigs were blocked by initial BW and randomly assigned to 1 of 5 dietary treatments in a randomized complete block design. Experimental diets were corn-based with feed grade AA. Soybean meal levels gradually increased from 5 to 20% in 3.75% increments and replaced feed grade AA. All diets were formulated using analyzed AA composition and assumed AA SID from the NRC² (Table 1). Diets were then formulated to be isocaloric and contained 0.70% SID Lys (Table 2). Dietary additions of feed grade AA were adjusted to ensure identical AA ratios between the two groups.

Pens of pigs were weighed and feed disappearance measured on d 0, 13, and 23 or on d 0, 14, and 35 for group one and two, respectively, to determine ADG, ADFI, and F/G. On d 13 and 21 of the experimental period for groups one and two, respectively, three pigs within each pen were marketed. The remaining pigs were then marketed at the conclusion of the experiment.

Statistical analysis

Data were analyzed using the GLIMMIX procedure in SAS (v. 9.4, SAS Institute, Inc., Cary, NC) and pen was considered as the experimental unit. The statistical model considered fixed effects of dietary treatment, linear, quadratic, and cubic contrasts, and random effects of group and block. Additionally, initial BW was utilized as a covariate

³ Soto, J. A., M. D. Tokach, S. S. Dritz, J. C. Woodworth, J. M. DeRouchey, R. D. Goodband, and F. Wu. 2019. Optimal dietary standardized ileal digestible lysine and crude protein concentration for growth and carcass performance in finishing pigs weighing greater than 100 kg. *J. Anim. Sci.* 97:1701-1711. doi:10.1093/jas/skz052.

in the statistical model. All data are reported as least square means and considered statistically significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

Overall, as dietary SBM increased in the late finishing period, pigs exhibited linear improvements in ADG (Table 3; $P \leq 0.001$). Additionally, pigs exhibited a linear improvement in F/G ($P < 0.001$). There were no linear or quadratic responses on final BW of pigs ($P > 0.05$)

Interestingly, not only were the improvements in overall ADG and F/G linear with increasing SBM, but a cubic response among overall ADG and F/G was also observed ($P < 0.05$). The greatest improvements in ADG and F/G were observed as dietary SBM increased from 5 to 8.75% and from 16.25 to 20%. Additionally, final BW of pigs tested cubic ($P < 0.05$) as SBM increased from 5 to 8.75% and from 16.25 to 20%, similar to the responses observed for overall ADG and F/G. We suspect that the observed response may be due to the increased Trp:Lys ratio of 21.6 in the 20% SBM diet compared to 20% in all other diets.

These results suggest that utilizing corn-SBM-based diets with increasing dietary SBM concentrations up to 20% resulted in improved growth performance of late finishing pigs. Moreover, in this experiment, increasing dietary CP up to 15% supplied by increasing SBM optimized the growth performance of late finishing pigs. However, further research is necessary to fully understand the cubic response observed in overall ADG, F/G, and final BW of late finishing pigs in this study.

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Table 1. Chemical analysis of ingredients (as-fed basis)^{1,2}

Analyzed composition, %	Group 1		Group 2	
	Corn	Soybean meal	Corn	Soybean meal
DM	85.55	87.52	86.75	88.94
CP	7.90	48.48	6.74	47.31
Crude fiber	1.57	2.85	1.49	2.91
Ether extract	2.64	0.5	2.39	0.49
Amino acids, %				
His	0.19	1.25	0.18	1.27
Ile	0.23	2.29	0.24	2.35
Leu	0.71	3.66	0.71	3.67
Lys	0.22	3.04	0.22	3.07
Met	0.13	0.66	0.13	0.67
Thr	0.23	1.82	0.22	1.80
Trp	0.05	0.67	0.05	0.66
Val	0.30	2.32	0.30	2.39
Cys	0.15	0.70	0.14	0.70

¹Range of values represent analyzed composition between groups.

²Samples analyzed at the University of Missouri Agricultural Experiment Station Chemical Laboratories (Columbia, MO).

Table 2. Diet composition (as-fed basis)

Item	Soybean meal, %				
	5.00	8.75	12.50	16.25	20.00
Ingredient, %					
Corn	90.70	87.30	83.95	80.55	77.00
Soybean meal, 47% CP	5.00	8.75	12.50	16.25	20.00
Choice white grease	0.85	0.95	1.00	1.00	1.05
Calcium carbonate	0.80	0.80	0.77	0.77	0.77
Monocalcium phosphate (21% P)	0.65	0.60	0.55	0.50	0.45
Sodium chloride	0.50	0.50	0.50	0.50	0.50
L-Lys-HCl	0.53	0.41	0.28	0.16	0.04
DL-Met	0.16	0.12	0.08	0.05	0.01
L-Thr	0.22	0.17	0.12	0.07	0.02
L-Trp	0.07	0.05	0.03	0.01	---
L-Val	0.18	0.11	0.04	---	---
L-Ile ¹	0.15	0.07	0 to 0.01	---	---
His ¹	0.025	0 to 0.010	0 to 0.005	---	---
Vitamin trace mineral premix	0.150	0.150	0.150	0.150	0.150
Phytase ²	0.025	0.025	0.025	0.025	0.025
Calculated analysis					
SID AA, %					
Lys	0.70	0.70	0.70	0.70	0.70
Ile:Lys	60	60	60	69	79
Leu:Lys	103	117	132	146	160
Met:Lys	40	38	35	33	30
Met and Cys:Lys	60	60	60	60	60
Thr:Lys	65	65	65	65	65
Trp:Lys	20.0	20.0	20.0	20.0	21.6
Val:Lys	72	72	72	75	85
His:Lys	32	34	39	44	49
SID Lys:NE, g/Mcal	2.62	2.62	2.62	2.62	2.62
NE, kcal/lb	1,209	1,209	1,209	1,209	1,209
Ca, %	0.48	0.48	0.48	0.48	0.48
STTD P, %	0.33	0.33	0.33	0.33	0.33
Chemical analysis, % ³					
DM	85.8	87.5	87.4	87.2	87.5
CP	11.0	11.8	12.5	12.3	14.1
Crude fat	2.4	2.7	2.5	2.8	3.2
Crude fiber	1.8	2.5	2.0	2.1	2.3

¹Range of values reflect diet composition fed from 231.3 lb to market in groups one and two, respectively.

²Optiphos 2000 PF (Huvepharma Inc., Peachtree City, GA) provided 395 FTU/lb with a release value of 0.13% available P.

³A composite sample of each treatment was collected and submitted to the University of Missouri Agricultural Experiment Station Chemical Laboratories (Columbia, MO) for proximate analysis.

Table 3. Effects increasing levels of soybean meal in corn-based diets on late finishing pig growth performance¹

Item	Soybean meal, %					SEM	P =		
	5.00	8.75	12.50	16.25	20.00		Linear	Quadratic	Cubic
BW, lb									
Initial	232.3	231.4	230.7	231.0	231.0	3.09	0.593	0.644	0.906
Final ²	275.9	280.3	278.1	278.4	280.3	4.60	0.114	0.602	0.048
Overall									
ADG, lb	1.64	1.80	1.77	1.76	1.83	0.035	0.001	0.142	0.011
ADFI, lb	6.18	6.28	6.14	6.16	6.05	0.079	0.118	0.331	0.624
F/G	3.78	3.50	3.48	3.49	3.33	0.081	< 0.001	0.217	0.020

¹A total of 1,793 pigs (L337 × 1050, PIC, Hendersonville, TN; initially 231.2 ± 2.4 lb) were used with 22 to 27 pigs per pen and 12 to 14 replications per treatment.

²Initial BW utilized as a covariate in the statistical model.