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Effects of Increasing Soybean Meal in Corn-Wheat Midds-Based Diets on Growth Performance and Carcass Characteristics of Late Finishing Pigs[1]

Julia P. Holen, Robert D. Goodband, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Chad W. Hastad,[2] and Zach B. Post[2]

Summary

A total of 786 pigs (PIC TR4 × (Fast LW × PIC L02); initially 213.2 lb ± 2.37 lb) were used to evaluate the effects of increasing soybean meal (SBM) in corn-wheat midds-based diets on growth performance of late finishing pigs. Pens of pigs were blocked by BW and randomly assigned to 1 of 5 treatments with 9 replications per treatment. Experimental diets were corn-based with 30% wheat midds. Soybean meal levels increased from 0 to 16% replacing added feed grade AA. Pens of pigs were weighed to evaluate ADG, ADFI, and F/G. Data were analyzed with the GLIMMIX procedure of SAS 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 block. Overall, final BW of pigs increased (linear, $P < 0.05$) as dietary SBM increased. Additionally, overall ADG and F/G improved as SBM increased (linear and cubic; $P < 0.05$) with no differences in overall ADFI. Although diets were formulated to exceed minimum NRC[3] nutrient requirement estimates, we suspect that the increased Trp:Lys ratio in the 16% SBM diet may explain the cubic responses observed. These results suggest that corn-soybean meal-based diets with 30% wheat midds for late finishing pigs should contain at least 4% SBM.

Introduction

Soybean meal (SBM) is a commonly used protein source in swine diets due to its availability, AA profile, and digestibility. However, it is common for swine diets to be formulated with increasing amounts of feed grade AA and grain co-products, such as wheat midds, to replace SBM if economics allows. Thus, diets for late finishing pigs may contain very little, if any, SBM depending on the combination of other ingredients utilized in the diet.

[1] The authors appreciate the United Soybean Board for partial financial support and New Fashion Pork (Jackson, MN) for their animals, facilities, and assistance in conducting this experiment.

[2] New Fashion Pork, Jackson, MN.

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

Although dietary AA requirements may be met, swine diets with low amounts of SBM typically contain CP concentrations below the established recommendation of 12 to 13% for late finishing pigs, which can compromise growth performance.[4] Therefore, the objective of this experiment was to determine if SBM is needed to optimize growth performance of finishing pigs from 220 lb to market when provided corn-wheat midds-based diets.

Materials and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in these experiments. This study was conducted at a commercial research facility in southwestern Minnesota (New Fashion Pork, Jackson, MN). The barn was tunnel-ventilated with completely slatted flooring over deep pits for manure storage. Each pen was equipped with a 3-hole stainless steel dry feeder and a pan waterer to allow *ad libitum* access to feed and water. All feed additions were delivered and recorded using a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN).

Animals and diets

A total of 786 pigs (PIC TR4 × (Fast LW × PIC L02); initial BW = 213.2 lb ± 2.37 lb) were used in a 40-d trial with approximately 15 to 19 pigs per pen and 9 pens per treatment. 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 30% wheat midds and feed grade AA. Soybean meal levels increased from 0 to 16% in 4% increments and replaced feed grade AA. Prior to trial start, samples of corn, soybean meal, and wheat midds were collected and sent for proximate and AA concentration analysis to the University of Missouri Agricultural Experiment Station Chemical Laboratories (Colombia, MO; Table 1). The analyzed nutrient composition of ingredients was then utilized in diet formulation such that all diets were isocaloric and contained 0.70% SID Lys (Table 2). Throughout the experimental period, composite samples of each treatment were collected and submitted to the University of Missouri Agricultural Experiment Station Chemical Laboratories (Colombia, MO) for proximate analysis.

Pens of pigs were weighed and feed disappearance measured on d 0, 20, 32, and 40 to determine ADG, ADFI, and F/G.

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

[4] 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.

Results and Discussion

Overall (d 0 to 40), increasing dietary SBM increased (linear, $P < 0.05$) final BW of pigs (Table 3). This response was a result of an overall linear ($P < 0.05$) improvement in ADG. There was no effect on ADFI, but F/G improved (linear, $P < 0.05$) with increasing SBM in the diet.

Surprising to us, not only were the responses in ADG and F/G linear with increasing SBM, but they also tested cubic. The improved ADG and F/G response initially increased from 0 to 4% SBM, but then appeared to be similar through 12% SBM. Then, as SBM inclusion increased from 12 to 16%, ADG and F/G further improved. Although diets were formulated to exceed minimum NRC[3] requirement estimates, we suspect that the increased Trp:Lys ratio of 23.1 in the 16% SBM diet, compared to values of 19.5 to 20.0 in all other diets, may explain the sharp improvement observed.

To conclude, these results suggest that corn-soybean meal-based diets with 30% wheat midds for late finishing pigs should contain at least 4% SBM to improve overall growth performance of late finishing pigs. Additionally, increasing dietary SBM concentrations to 16% resulted in heavier final BW of late finishing pigs. Further research to understand the cubic response observed in late finishing pig ADG and F/G may be warranted.

Table 1. Chemical analysis of ingredients (as-fed basis)[1]

Analyzed composition, %	Corn	Soybean meal	Wheat midds
DM	82.08	88.27	87.54
CP	6.00	45.27	16.24
Crude fiber	1.39	4.15	9.04
Ether extract	2.30	0.90	3.40
Amino acids			
His	0.19	1.18	0.48
Ile	0.23	2.24	0.59
Leu	0.66	3.50	1.10
Lys	0.27	2.93	0.78
Met	0.14	0.60	0.25
Thr	0.22	1.69	0.56
Trp	0.05	0.64	0.20
Val	0.31	2.27	0.85
Cys	0.15	0.63	0.37

[1]Analyzed at the University of Missouri Agricultural Experiment Station Chemical Laboratories (Columbia, MO).

Table 2. Diet composition (as-fed basis)[1]

	Soybean meal, %				
Ingredient	**0**	**4**	**8**	**12**	**16**
Corn	65.57	61.97	58.34	54.63	50.89
Wheat midds	30.00	30.00	30.00	30.00	30.00
Soybean meal, 47% CP	---	4.00	8.00	12.00	16.00
Choice white grease	1.00	1.05	1.11	1.13	1.11
Calcium carbonate	1.28	1.28	1.25	1.25	1.25
Monocalcium phosphate, 21.5% P	0.30	0.25	0.20	0.15	0.10
Sodium chloride	0.50	0.50	0.50	0.50	0.50
L-Lys-HCl	0.49	0.37	0.25	0.12	---
DL-Met	0.120	0.085	0.050	0.020	0.005
L-Trp	0.06	0.04	0.01	---	---
L-Val	0.125	0.055	---	---	---
L-Ile	0.160	0.090	0.025	---	---
ThrPro80[2]	0.280	0.215	0.150	0.085	0.025
Vitamin trace mineral premix	0.100	0.100	0.100	0.100	0.100
Calculated nutrient analysis					
SID AA, %					
Lys	0.70	0.70	0.70	0.70	0.70
Ile:Lys	60	61	62	69	79
Leu:Lys	91	106	120	135	150
Met:Lys	37	34	32	30	30
Met and Cys:Lys	60	60	60	60	63
Thr:Lys	65	65	65	65	65
Trp:Lys	19.5	19.5	19.5	20.0	23.1
Val:Lys	70	71	73	83	93
His:Lys	32	37	42	48	53
SID Lys:NE, g/Mcal	2.81	2.81	2.81	2.81	2.81
NE, kcal/lb	1,135	1,135	1,135	1,135	1,135
Ca, %	0.60	0.60	0.60	0.60	0.60
STTD P, %	0.28	0.28	0.28	0.28	0.28
Chemical analysis, %[3]					
DM	86.7	86.9	86.9	86.5	86.5
CP	11.1	12.4	14.1	14.7	16.4
Crude fat	3.82	4.03	3.90	3.57	3.63
Crude fiber	3.64	3.64	4.01	4.02	3.57

[1]Experimental diets were fed from 213.2 lb to market.
[2]L-Threonine 80% with BioMass (CJ America Bio, Downers Grove, IL).
[3]A composite sample of each treatment was collected and submitted to the University of Missouri Agricultural Experiment Station Chemical Laboratories (Colombia, MO) for proximate analysis.

Table 3. Effects of increasing soybean meal on late finishing pig growth performance[1]

	Soybean meal, %						*P* =		
Item	**0**	**4**	**8**	**12**	**16**	**SEM**	**Linear**	**Quadratic**	**Cubic**
BW, lb									
Initial	211.8	213.3	213.4	214.4	213.2	2.37	0.213	0.244	0.809
Final	285.8	289.5	289.1	287.9	294.1	3.10	0.042	0.620	0.113
Growth performance									
ADG, lb	2.13	2.20	2.22	2.17	2.34	0.041	0.005	0.396	0.032
ADFI, lb	7.48	7.57	7.55	7.47	7.69	0.112	0.358	0.615	0.214
F/G	3.51	3.44	3.40	3.45	3.29	0.041	< 0.001	0.494	0.030

[1]A total of 786 pigs (PIC TR4 × (Fast LW × PIC L02); initially 213.2 lb) were used in a 40-d experiment with 15 to 19 pigs per pen and 9 replications per treatment.