

Effects of Increasing Soybean Meal in Diets Based on Corn and Dried Distillers Grains with Solubles on Growth Performance and Carcass Characteristics of Late Finishing Pigs¹

Julia P. Holen, Robert D. Goodband, Mike D. Tokach, Jason C. Woodworth, and Joel M. DeRouchey

Summary

A total of 1,827 pigs (L337 × 1050, PIC; initially 215.8 ± 2.5 lb) were used to evaluate the effects of increasing soybean meal (SBM) in corn-DDGS-based diets on growth performance of late finishing pigs. Pens were blocked by BW and randomly assigned to 1 of 5 dietary treatments with 14 replications per treatment. Experimental diets were corn-based with 25% DDGS. Soybean meal levels increased from 0 to 16% in 4% increments 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 and quadratic contrasts, and random effects of group and block. Overall, final BW of pigs marginally increased (quadratic; $P < 0.10$) as SBM increased, with the greatest improvement observed when diets contained 8% SBM. However, there were no differences among treatments in overall ADG, ADFI, or F/G. Furthermore, there was no influence of increasing SBM on carcass characteristics. These results suggest that increasing SBM concentrations in diets that contain 25% DDGS did not influence growth performance of late finishing pigs.

Introduction

Soybean meal (SBM) is a key dietary component and a commonly used protein source for swine due to its high digestibility, consistent processing methods, and excellent AA profile. However, it is common for swine diets to be formulated with increasing amounts of feed grade AA and corn co-products such as DDGS. These are used as partial or complete replacements of SBM due to widespread availability and lower cost. As a result, late finishing swine diets may contain very little SBM in corn-based diets.

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

Corn-based diets with low SBM levels typically contain CP concentrations below 12 or 13%, which may compromise growth performance or carcass characteristics of finishing pigs.² Recent studies have evaluated replacement of SBM with corn gluten meal³ and soy protein concentrate⁴ in diets containing 12% CP and observed linear reductions in growth performance of late finishing pigs, which suggests that there may be biological benefits to the pig when utilizing dietary SBM. Thus, the influence of dietary CP sources such as DDGS or from SBM must be further researched and understood. 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 and DDGS-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. 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.

Animals and diets

A total of 1,827 pigs (L337 × 1050, PIC; initially 215.8 ± 2.5 lb) were used in two groups, respectively, with 23 to 27 pigs per pen and 14 pens per treatment (7 per group). 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 25% DDGS and feed grade AA. Soybean meal levels increased from 0 to 16% in 4% increments, and replaced feed grade AA. All diets were formulated using assumed AA composition and SID from the NRC.⁵ Additionally, diets were formulated to be isocaloric and contained 0.70% SID Lys (Table 1). Dietary additions of feed grade AA were adjusted to meet the minimum AA requirements in relation to Lys between the two groups.

Pens of pigs were weighed and feed disappearance was measured on d 0, 15, and 29; or on d 0, 19, 34, and 42 for groups one and two, respectively, to determine ADG, ADFI, and F/G. On d 15 and 19 of the experimental period for groups one and two, respectively, two pigs within each pen were marketed. The remaining pigs were then marketed at the conclusion of the experiment.

² 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.

³ Soto, J. A., M. D. Tokach, S. S. Dritz, J. C. Woodworth, J. M. DeRouchey, and R. D. Goodband. 2017. 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. *Kansas Ag. Exp. Stat. Res. Report*, Manhattan. Vol. 3: Iss. 7. doi:10.4148/2378-5977.7492.

⁴ Soto, J. A., M. D. Tokach, S. S. Dritz, J. C. Woodworth, J. M. DeRouchey, and R. D. Goodband. 2018. 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. *Kansas Ag. Exp. Stat. Res. Report*, Manhattan. Vol. 4: Iss. 9. doi:10.4148/2378-5977.7683.

⁵ National Research Council. 2012. *Nutrient Requirements of Swine: Eleventh Revised Edition*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13298>.

At completion of the first group, final pen weights were recorded and each pig was tattooed with a pen identification number and transported to a commercial abattoir (JBS Swift, Worthington, MN) for processing and carcass data collection. Carcass measurements included HCW, backfat depth, loin depth, and percentage lean (as per JBS Swift's proprietary calculation). Carcass yields were then calculated by the pen average HCW divided by the pen average final BW. Additionally, two pigs/pen were randomly selected for collection of backfat tissue and analyzed at Iowa State University for determination of iodine value. Due to unforeseen circumstances relating to COVID-19, carcass data were not collected for pigs from the second group.

Statistical analysis

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

For overall growth performance, as dietary SBM increased in the late finishing period, pigs exhibited marginally increased BW at first marketing and at experiment end (Table 2; linear $P = 0.066$ and quadratic $P = 0.065$, respectively). There were no overall effects of SBM level on ADG, ADFI, nor F/G. For carcass characteristics, there was no influence of SBM level on carcass criteria measured.

In the present experiment, all treatments' CP exceeded the 13% requirement estimate for late finishing pigs established by Soto et al.² However, our results suggest that increasing dietary SBM concentrations up to 8% in diets that contain 25% DDGS marginally increased final BW but did not influence carcass characteristics of late finishing pigs.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

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

Item	Soybean meal, %				
	0	4	8	12	16
Ingredient, %					
Corn	71.40	67.70	63.95	60.10	56.30
Corn DDGS, 7.5% oil	25.00	25.00	25.00	25.00	25.00
Soybean meal, 47% CP	---	4.00	8.00	12.00	16.00
Beef tallow	1.00	1.00	1.00	1.00	1.00
Calcium carbonate	0.95	0.95	0.95	0.97	0.97
Monocalcium phosphate, 21.5% P	0.20	0.15	0.10	0.05	---
Sodium chloride	0.50	0.50	0.50	0.50	0.50
L-Lys-HCl	0.57	0.45	0.32	0.19	0.07
L-Thr	0.12	0.06	0.01	---	---
L-Trp	0.06	0.04	0.02	---	---
L-Val	0.005	---	---	---	---
L-Ile	0.020	---	---	---	---
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 nutrient analysis					
SID AA, %					
Lys	0.70	0.70	0.70	0.70	0.70
Ile:Lys	55	62	71	81	91
Leu:Lys	182	196	209	223	237
Met:Lys	32	34	37	40	42
Met and Cys:Lys	61	66	71	76	82
Thr:Lys	65	65	65	72	79
Trp:Lys	19.5	19.5	19.5	19.9	23.1
Val:Lys	70	78	88	97	107
His:Lys	41	46	52	57	63
SID Lys:NE, g/Mcal	2.68	2.68	2.68	2.68	2.68
NE, kcal/lb	1,185	1,184	1,184	1,184	1,184
Ca, %	0.47	0.48	0.48	0.49	0.50
STTD P, %	0.33	0.33	0.33	0.33	0.33
Chemical analysis, % ³					
DM	87.0	87.5	87.4	87.2	87.5
CP	13.7	13.2	14.9	17.4	19.1
Crude fat	6.5	4.3	4.2	4.5	4.6
Crude fiber	4.1	2.7	2.9	3.4	3.2

¹Experimental diets were fed from 215.8 lb to market.

²Opriphos 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 diet was collected and submitted to the University of Missouri Agricultural Experiment Station Chemical Laboratories (Columbia, MO) for proximate analysis.

Table 2. Effects of increasing levels of soybean meal in corn and soybean meal-based diets containing 25% DDGS on late finishing pig growth performance¹

Item	Soybean meal, %					SEM	P =	
	0	4	8	12	16		Linear	Quadratic
BW, lb								
Initial	216.3	215.6	215.7	215.7	216.0	2.55	0.661	0.218
Final ²	273.3	274.2	276.3	274.4	273.4	1.38	0.901	0.065
Growth performance								
ADG, lb	1.70	1.68	1.76	1.73	1.71	0.051	0.317	0.231
ADFI, lb	5.84	5.75	5.86	5.83	5.75	0.177	0.637	0.594
F/G	3.45	3.41	3.34	3.36	3.36	0.047	0.109	0.297
Carcass performance ³								
HCW, lb ⁴	203.7	203.1	203.3	203.1	202.7	1.14	0.505	0.992
Carcass yield, %	73.6	73.6	73.4	73.4	73.3	0.44	0.502	0.884
Backfat depth, in. ⁵	0.57	0.57	0.59	0.56	0.58	0.02	0.962	0.919
Loineye depth, in. ⁵	2.70	2.67	2.67	2.68	2.66	0.03	0.404	0.788
Carcass lean, % ⁵	58.2	58.1	57.8	58.3	57.9	0.28	0.760	0.790
Iodine value ⁶	68.2	67.9	66.9	67.5	67.8	0.71	0.555	0.294

¹A total of 1,827 pigs (L337 × 1050, PIC; initial BW = 215.8 lb) were used in 2 groups with 23 to 27 pigs per pen and 14 replications per treatment.

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

³Represents data from the first group and 7 replications per treatment.

⁴Final BW utilized as a covariate in the statistical model.

⁵HCW utilized as a covariate in the statistical model.

⁶Represents average of a subset of 2 randomly selected pigs/pen.