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Effects of Increasing Standardized Ileal Digestible Valine:Lysine Ratios on the Growth Performance of 50 to 80 lb Pigs

Samantha A. Swanson, Jason C. Woodworth, Mike D. Tokach, Robert D. Goodband, Joel M. DeRouchey, Katelyn N. Gaffield, and Jordan T. Gebhardt[1]

Summary

A total of 351 pigs (DNA 600 × 241; initially 47.1 ± 0.77 lb) were used in a 21-d experiment to determine the effects of increasing standardized ileal digestible (SID) Val:Lys ratio in 50 to 80 lb pigs. There were 12 replications per treatment with five pigs per pen. Pens of pigs were randomly assigned to one of six corn-soybean meal-based dietary treatments with SID Val:Lys ratios of 60, 63, 66, 69, 72, and 75%. A basal diet was formulated with the lowest SID Val:Lys ratio and L-valine was added to create the diet with the highest Val:Lys ratio. The high and low diets were then blended to create the intermediate diets. On d 0, 10, and 21, pigs were weighed to determine ADG, ADFI, and F/G. Blood was drawn on d 10 for plasma urea nitrogen (PUN) analysis. From d 0 to 10, BW, ADG and F/G improved (linear, $P < 0.05$) as SID Val:Lys ratio increased, but with little improvement past a 72% Val:Lys ratio. No differences were observed from d 10 to 20 ($P > 0.10$). Similar to d 0 to 10, the overall F/G improved (linear, $P = 0.012$) as Val:Lys ratio increased but with little improvement past 72% Val:Lys ratio. As Val:Lys ratio increased, there was an increase in PUN concentration (linear, $P = 0.029$). Valine intake grams per day and Val intake per kg of gain increased (linear, $P < 0.001$) as Val:Lys ratio increased. Lysine intake per kg of gain decreased (linear $P = 0.029$) as the Val:Lys ratio increased. Broken-line analysis indicated overall feed efficiency improved with increasing Val:Lys ratio with the breakpoint at a 69% SID Val:Lys ratio. The results of this study suggest that a 69 to 72% SID Val:Lys ratio may be ideal for 50 to 80 lb pigs.

Introduction

Valine is generally the fifth limiting amino acid in corn-soybean meal-based diets.[2] Previous research suggests a minimum of 65% increase in the standardized ileal digestible (SID) Val:Lys ratio for pigs weighing 28 to 70 lb to maximize performance.[3]

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[2] Figueroa, J., A. Lewis, P. Miller, R. Fischer, and R. Diedrichsen. 2003. Growth, carcass traits, and plasma amino acid concentrations of gilts fed low-protein diets supplemented with amino acids including histidine, isoleucine, and valine. J. Anim. Sci. 81:1529-1537. doi:10.2527/2003.8161529x.

[3] Gaines, A. M., D. C. Kendall, G. L. Allee, J. L. Usry, and B. J. Kerr. 2011. Estimation of the standardized ileal digestible valine-to-lysine ratio in 13- to 32-kilogram pigs. J. Anim. Sci. 89:736-742. Doi:10.2527/jas.2010-3134

Similarly, the NRC (2012) estimates a 65.3% SID Val:Lys ratio in 55 to 110 lb pigs, although there are not any studies with pigs exceeding 70 lb cited. An experiment evaluating 55 to 100 lb pigs found that the Val:Lys ratio requirement was likely between 63.5 and 73% SID Val:Lys.[4] Therefore, the objective of this study was to determine the effect of various dietary SID Val:Lys ratios on the growth performance of 50 to 80 lb pigs.

Materials and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The experiment took place in a totally enclosed and environmentally regulated barn, each pen contained a 4-hole stainless steel dry self-feeder and nipple waterer for access to feed and water. Feed was restricted for 5 h prior to blood being drawn, otherwise access was *ad libitum*.

Animals and diets

A total of 351 pigs (DNA 600 × 241; initially 47.1 ± 0.77 lb) were used in a 21-d experiment. There were 12 replications per treatment with five pigs per pen. Pens of pigs were randomly assigned to one of six corn-soybean meal-based dietary treatments with SID Val:Lys ratios of 60, 63, 66, 69, 72, and 75% (Table 1). A basal diet was formulated with the lowest SID Val:Lys ratio and L-valine was added to create the diet with the highest Val:Lys ratio. The high and low diets were then blended to create the intermediate SID Val:Lys ratio diets. On d 0, 10, and 21 pigs were weighed to determine ADG, ADFI, and feed efficiency. Blood was drawn on d 10 for plasma urea nitrogen (PUN) analysis. Pigs were restricted from feed for 5 h prior to blood collection by removing feeders from pens. Following blood collection, feeders were placed back into their respective pens to allow for *ad libitum* access to feed.

Statistical analysis

Data were analyzed as a randomized complete block design using R studio version 4.3.1 (R Core Team., Vienna, Austria) with pen as the experimental unit. Linear and quadratic contrasts were used to evaluate the effects of increasing SID Val:Lys ratio. Body weight on d 0 was used as a covariate for analysis on all reported growth performance measures except for d 0 BW. For the analysis of PUN, treatment was included as a fixed effect, and block and plate were included as random effects. Results from the experiment were considered significant at $P < 0.05$ and marginally significant at $P \leq 0.10$. Dose response curves were evaluated in SAS (v. 9.4, SAS Institute, Inc., Cary, NC) using linear, quadratic, and broken-line linear models.

Results and Discussion

From d 0 to 10, BW, ADG and F/G improved (linear, $P < 0.05$) as SID Val:Lys ratio increased, but with little improvement past a 72% Val:Lys ratio (Table 2). No differences were observed from d 10 to 20. Similar to d 0 to 10, overall F/G improved (linear, $P = 0.012$) as the Val:Lys ratio increased, but with little improvement past 72% Val:Lys ratio. No other differences were observed in growth performance. As the Val:Lys ratio increased, there was an increase in PUN concentration (linear, $P = 0.029$). Valine intake (g per d) and Val intake per kg of gain increased (linear, $P < 0.001$) as Val:Lys

[4] Goncalves, M. A., M. D. Tokach, S. S. Dritz, N. M. Bello, K. J. Touchette, R. D. Goodband, J. M. DeRouchey, and J C. Woodworth. 2018. Standardized ileal digestible valine:lysine dose response effects in 25- to 45-kg under commercial conditions. J. Anim. Sci. 96:591-599 doi:10.1093/jas/skx059.

ratio increased. Lysine intake per kg of gain decreased (linear, $P = 0.029$) as Val:Lys ratio increased.

For amino acid ratio requirement studies, it is important to be below the pig's Lys requirement to accurately determine the amino acid requirement relative to Lys. The projected Lys requirement for pigs in this facility is 1.41%, and 20.37 g/d SID Lys intake (Royall et al., 2022).[5] In this experiment, Lys intake ranged from 17.4 to 19.2 g/d, which is below the predicted requirement.

Broken-line analysis shows overall feed efficiency improves as the Val:Lys ratio increases with the breakpoint being at 69% of Lys (Figure 1). The results of this study suggest that a SID Val:Lys ratio of 69 to 72% may be ideal for 50 to 80 lb pigs. This is similar to previous research findings.[3,4] However, this level is greater than the NRC (2012) estimated ratio of 65% SID Val:Lys in 55 to 110 lb 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.

[5] Royall, Rafe Q, Robert D Goodband, Mike D Tokach, Joel M DeRouchey, Jason C Woodworth, and Jordan T Gebhardt. 2022. Effects of standardized ileal digestible lysine level on growth performance and economic return for 18 to 128 kg Duroc-sired pigs, Trans. Anim. Sci. txac103, https://doi.org/10.1093/tas/txac103.

Table 1. Composition of experimental diets (as fed basis)[1]

	SID Valine	
Item	**Low**	**High**
Ingredients, %		
Corn	74.28	74.10
Soybean meal, 47.73% CP	22.18	22.19
Calcium carbonate	0.90	0.90
Monocalcium P, 21% P	0.75	0.75
Salt	0.50	0.50
L-Lys-HCl	0.48	0.48
DL-Met	0.17	0.17
L-Trp	0.05	0.05
L-Thr	0.21	0.21
L-Ile	0.07	0.07
L-Val	---	0.17
Vitamin premix	0.20	0.20
Trace mineral premix	0.15	0.15
Phytase[2]	0.06	0.06
Total	100	100
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lys	1.10	1.10
Ile:Lys	60	60
Leu:Lys	121	121
Met:Lys	37	37
Met and Cys:Lys	59	59
Thr:Lys	65	65
Trp:Lys	19.4	19.4
Val:Lys	60	75
His:Lys	37	37
NE, kcal/lb	1,126	1,127
CP, %	17.4	17.4
Ca, %	0.63	0.63
STTD P, %	0.40	0.40
Ca:P	1.24	1.24
Analyzed values, %		
CP	18.1	16.8

[1]Low and high diets in both experiments were formulated and produced then mixed to create intermediate diets.
[2]HiPhorius 2,400 (DSM-Firmenich, Maastricht, Netherlands) was added at 1,500 FYT/kg and provided an estimated release of 0.12% STTD P.

Table 2. Effects of increasing SID Val:Lys ratio on the growth performance of 50 to 80 lb pigs[1,2]

	SID Val:Lys ratio, %							*P* =	
Item	**60**	**63**	**66**	**69**	**72**	**75**	**SEM**	**Linear**	**Quadratic**
BW, lb									
d 0	47.4	47.3	46.9	46.8	47.5	46.7	0.77	0.380	0.832
d 10	65.79	65.80	65.91	66.08	66.63	66.49	0.376	0.042	0.753
d 20	87.72	87.51	87.56	88.01	88.20	88.71	0.674	0.162	0.481
d 0 to 10									
ADG, lb	1.87	1.87	1.90	1.90	1.95	1.94	0.036	0.042	0.968
ADFI, lb	3.10	3.09	3.12	3.08	3.07	3.14	0.056	0.809	0.662
F/G	1.66	1.65	1.65	1.62	1.58	1.62	0.018	0.002	0.523
d 10 to 20									
ADG, lb	2.19	2.17	2.17	2.19	2.16	2.19	0.034	0.925	0.614
ADFI, lb	4.00	3.96	3.93	3.90	3.90	3.98	0.064	0.543	0.231
F/G	1.82	1.82	1.82	1.77	1.81	1.82	0.021	0.383	0.312
Overall									
ADG, lb	2.03	2.02	2.03	2.04	2.05	2.06	0.031	0.242	0.739
ADFI, lb	3.55	3.52	3.52	3.49	3.48	3.55	0.054	0.815	0.346
F/G	1.75	1.74	1.73	1.70	1.70	1.72	0.015	0.012	0.252
Val intake, g/d	10.61	11.07	11.59	12.00	12.52	13.29	0.194	< 0.001	0.376
Val intake, kg gain	11.53	12.08	12.59	12.93	13.45	14.20	0.114	< 0.001	0.301
Lys intake, g/d	17.69	17.57	17.56	17.40	17.38	17.73	0.279	0.815	0.346
Lys intake, kg gain	19.22	19.18	19.07	18.74	18.67	18.94	0.163	0.016	0.243
PUN,[3] mg/dL	5.12	5.56	5.37	5.45	6.48	6.05	0.400	0.029	0.872

[1]A total of 351 pigs (DNA 600 × 241; initially 47.1 lb) were used in a 20-d trial with five pigs per pen and 12 replications per treatment.

[2]Body weight at d 0 was used as a co-variate for all measurements excluding d 0 BW.

[3]Plasma urea nitrogen.

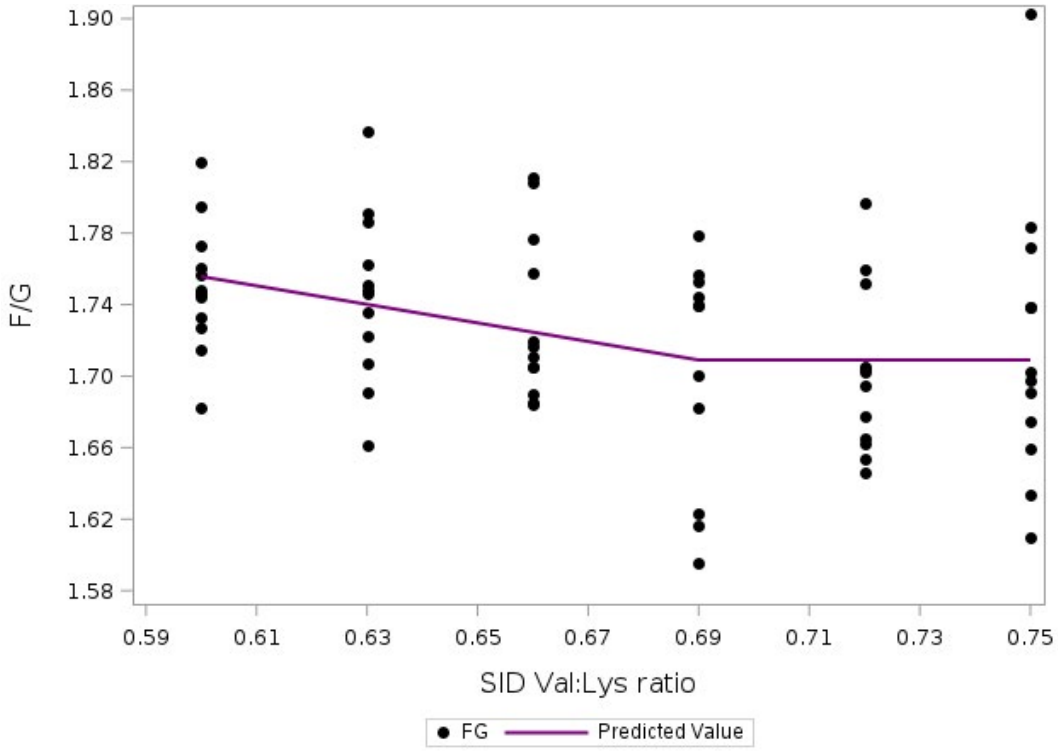

Figure 1. Estimation of the SID Val:Lys ratio requirement to minimize F/G for 50 to 80 lb pigs using a broken-line linear model (• Pen, — broken-line linear predictor).