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Summary

Two experiments were conducted to evaluate the effects of increasing standardized ileal digestible (SID) Val:Lys ratio on the growth performance of 85 to 150 lb (Exp. 1) and 195 to 260 lb (Exp. 2) finishing pigs. In Exp. 1, 647 pigs (DNA 600 × 241) were randomly allotted to one of six dietary treatments with eight or nine pigs per pen and 12 replications per treatment. Diets were corn-soybean meal-based, and low and high Val diets were manufactured and blended to create intermediate Val:Lys ratio diets. Diets were formulated to contain 0.90% SID Lys, and treatments consisted of SID Val:Lys ratios of 60, 63, 66, 69, 72, and 75%. At the conclusion of the 27-d study, all pigs were fed a common diet for 30 days and then randomly re-allotted to one of six diets formulated to contain 0.65% SID Lys and SID Val:Lys ratios of 63, 66, 69, 72, 75, and 78% (Exp. 2). In both experiments, blood samples were drawn from three pigs per pen on d 15 for plasma urea nitrogen (PUN) analysis. In Exp. 1, final BW, ADG, and ADFI increased (quadratic, $P < 0.05$) as Val:Lys ratio increased. Pigs fed the diet with 66% SID Val:Lys ratio had the greatest ADG, whereas pigs fed 72% SID Val:Lys ratio had the greatest ADFI. As the Val:Lys ratio increased, feed efficiency worsened (linear, $P < 0.05$). Valine and Lys intake increased (quadratic, $P < 0.05$) as the Val:Lys ratio increased with the greatest Val intake observed at the 72% SID Val:Lys ratio. Valine and Lys intake per kg of gain increased (linear, $P < 0.05$) as the level of Val in the diet increased. Plasma urea nitrogen decreased (linear, $P < 0.05$) as the Val:Lys ratio increased. In Exp. 2, ADG and ADFI increased (linear, $P < 0.05$) as Val:Lys increased. However, for ADG there was little improvement from feeding greater than 69% SID Val:Lys. There were no effects ($P > 0.05$) of SID Val:Lys on final BW, feed efficiency, or PUN. Valine intake, Lys intake, and Val intake per kg of gain increased (linear, $P < 0.05$) as the Val:Lys ratio increased. There were no differences ($P > 0.05$) observed in Lys intake per kg of gain. Results of this study suggest the SID Val:Lys requirement for finishing pigs is approximately 66% for 85 to 150 lb and 69% for 195 to 260 lb.

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Introduction

Valine is generally the 5th limiting amino acid in corn-soybean meal-based diets.² Previous research has shown the SID Val:Lys requirement for nursery pigs is between 63% and 74%.³ In 86 to 150 lb pigs fed a diet containing 30% DDGS, a SID Val:Lys ratio of at least 68% has been found to maximize ADG.⁴ However, limited data is available on the SID Val:Lys ratio of heavier weight pigs fed corn-soybean meal-based diets. The NRC (2012) estimates dietary SID Val:Lys ratio requirements for finishing pigs at 65% from 55 to 110 lb BW, 66% from 165 to 220 lb BW, and 67% from 220 to 298 lb BW. Studies reviewed by NRC (2012) do not include any experiments conducted on pigs with a final BW greater than 73 lb. Therefore, our study aimed to determine the effect of increasing the SID Val:Lys ratio on the growth performance of finishing pigs from 85 to 150 lb and 195 to 260 lb.

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 barns were enclosed and environmentally regulated — each pen was equipped with a two-hole stainless steel dry self-feeder and a bowl waterer for access to feed and water. Feed was restricted for 10 hours prior to blood being drawn otherwise access was ad libitum.

Animals and diets

Two experiments were performed to determine the effects of increasing SID Val:Lys ratio in 85 to 150 lb (Exp. 1) and 195 to 260 lb (Exp. 2) finishing pigs. In Exp. 1, a total of 647 pigs (DNA 600 × 241) were used in a 27-d trial with 12 replications per treatment and eight to nine pigs per pen. Pens of pigs were randomly assigned to one of six dietary treatments, which were corn and soybean meal based with SID Val:Lys ratios of 60, 63, 66, 69, 72, and 75% (Table 1). At the conclusion of Exp. 1, a common diet was fed for 30 days. In Exp. 2, the same 647 pigs were re-allotted and used in a 27-d trial with 12 replicate pens per treatment and eight or nine pigs per pen. Pens were randomly assigned to one of six dietary treatments that were corn-soybean meal based with SID Val:Lys ratios of 63, 66, 69, 72, 75, and 78% (Table 1).

In each experiment, a basal diet was formulated with the lowest Val:Lys ratio and L-valine was added to create a diet with the highest Val:Lys ratio. Intermediate SID Val:Lys ratio diets were created by blending the high and low diets. Daily feed additions to each pen were accomplished using a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) able to record feed deliveries for individual pens. Pigs were weighed on days 0, 14, and 27 to determine ADG, ADFI, and feed efficiency. In both trials, blood was drawn from three pigs/pen, two barrows and one gilt randomly selected, on d 15

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 Clark, A., M. Tokach, J. DeRouchey, S. Dritz, R. Goodband, J. Woodworth, K. Touchette, and N. Bello. 2017. Modeling the effects standardized ileal digestible valine to lysine ratio on growth performance of nursery pigs. *Transl. Anim. Sci.* 1(4):448-457. doi:10.2527/tas2017.0049.

⁴ Clizer, D., B. Tostenson, S. Tauer, R. Samuel, and P. Cline. 2022. Impact of increasing standardized ileal digestible valine:lysine in diets containing 30% dried distillers grains with solubles on growing pig performance. *J. Anim. Sci.* 100:1-9. doi:10.1093/jas/skac228.

for plasma urea nitrogen (PUN) analysis. Pigs were restricted from feed for 10 hours prior to collecting blood. Following blood collection, all feeders were reopened, and pigs were given ad libitum access to feed.

Statistical analysis

Data were analyzed as a randomized complete block design using R studio version 3.5.2 (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. 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 $P \leq 0.10$.

Results and Discussion

In Exp. 1, final BW, ADG, and ADFI increased (quadratic, $P < 0.05$) as Val:Lys ratio increased (Table 2). Pigs fed the 66% SID Val:Lys ratio had the greatest final BW and ADG, whereas pigs fed 72% SID Val:Lys ratio had the greatest ADFI. As the Val:Lys intake increased, feed efficiency worsened (linear, $P = 0.002$). Like ADFI, Val and Lys intake increased (quadratic, $P < 0.05$) as the Val:Lys ratio increased with the greatest intake observed at 72% SID Val:Lys ratio. As the level of Val in the diet increased, Val and Lys intake per kg of gain increased (linear, $P < 0.05$). Plasma urea nitrogen decreased (linear, $P = 0.048$) as the SID Val:Lys ratio increased.

In Exp. 2, ADG and ADFI increased (linear, $P < 0.05$) as SID Val:Lys ratio increased (Table 3). However, little improvement in ADG was observed when feeding greater than 69% SID Val:Lys ratio. There were no effects of Val:Lys ratio on feed efficiency and PUN, although final BW tended to increase (linear, $P = 0.078$) as the SID Val:Lys ratio increased. Valine intake, Lys intake, and Val intake per kg of gain increased (linear, $P < 0.05$) as the SID Val:Lys ratio increased. There were no differences observed in Lys intake per kg of gain.

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 1.12% (23 g/d SID Lys intake) and 0.71% (21 g/d SID Lys intake) for Exp. 1 and 2, respectively (Royall et al., 2022).⁵ In Exp. 1, Lys intake ranged from 17.8 to 19.4 g/d, which is below the predicted requirement. In Exp. 2, Lys intake was approximately 21 g/d, which is at the predicted requirement.

In conclusion, in 85 to 150 lb pigs, final BW and ADG were maximized at 66% SID Val:Lys and pigs fed 72% SID Val:Lys had the greatest ADFI. In 195 to 260 lb pigs, only small increases in ADG were observed when feeding greater than 69% SID Val:Lys ratio and ADFI increased (linear, $P < 0.001$) as SID Val:Lys ratio increased. The response in ADFI in both experiments is consistent with previous research, although the reason for this response is not precisely known.³ Results of this study suggest the SID Val:Lys ratio requirement for 85 to 150 lb pigs is approximately 66% of Lys, which

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> (pdf)

is similar to the NRC (2012) estimated ratio of 65% for 55 to 110 lb pigs. For 165 to 220 lb and 220 to 298 lb pigs, the NRC (2012) estimates a SID Val:Lys ratio of 66% and 67%, whereas the requirement found in this study suggests a 69% SID Val:Lys ratio.

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Table 1. Diet composition (Exp. 1 and Exp. 2)¹

Item	Exp. 1 (85-150 lb) SID Valine, %		Exp. 2 (195-260 lb) SID Valine, %	
	Low	High	Low	High
Ingredients, %				
Corn	81.90	81.90	90.20	90.20
Soybean meal, 47.73% CP	14.65	14.65	6.65	6.65
Calcium carbonate	0.90	0.90	0.75	0.75
Monocalcium P, 21% P	0.85	0.85	0.90	0.90
Salt	0.50	0.50	0.50	0.50
L-Lys-HCl	0.46	0.46	0.39	0.39
DL-Met	0.12	0.12	0.04	0.04
L-Trp	0.18	0.18	0.14	0.14
L-Thr	0.05	0.05	0.04	0.04
L-Ile	0.07	0.07	0.06	0.06
L-Val	---	0.15	---	0.10
Vitamin premix	0.15	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15	0.15
SID AA, %				
Lys	0.90	0.90	0.65	0.65
Ile:Lys	80	80	60	60
Ile:Lys	128	128	149	149
Met:Lys	36	36	33	33
Met and Cys:Lys	60	60	60	60
Thr:Lys	65	65	150	150
Trp:Lys	19.0	19.0	18.9	18.9
Val:Lys	60	75	63	78
His:Lys	37	37	39	39
NE, kcal/lb	1,184	1,184	1,184	1,184
CP, %	14.4	14.5	11.2	11.2
Ca, %	0.61	0.61	0.54	0.54
STTD P, %	0.39	0.39	0.85	0.85
Ca:P	1.22	1.22	1.13	1.13

¹ Low and high diets in both experiments were formulated and produced then mixed to create intermediate diets.

Table 2. Effects of increasing SID Val:Lys ratio on the growth performance of 85 to 150 lb pigs (Exp. 1)¹

Item	SID Val:Lys ratio, %						SEM	P =		
	60	63	66	69	72	75		Treatment	Linear	Quadratic
BW, lb										
d 0	85.1	85.0	85.1	85.1	85.3	85.0	1.984	0.945	0.871	0.666
d 27	144.0	145.5	147.1	146.6	146.8	145.2	1.835	0.097	0.190	0.008
Overall										
ADG, lb	2.14	2.20	2.25	2.24	2.24	2.19	0.027	0.057	0.118	0.005
ADFI, lb	4.60	4.56	4.76	4.86	4.99	4.72	0.051	< 0.001	< 0.001	0.002
F/G	2.15	2.08	2.11	2.18	2.23	2.15	0.019	< 0.001	0.002	0.683
Val intake, g/d	11.12	11.47	12.53	13.38	14.27	14.06	0.576	< 0.001	< 0.001	0.011
Val intake, kg gain	11.40	11.50	12.26	13.21	14.10	14.14	0.550	< 0.001	< 0.001	0.874
Lys intake, g/d	18.14	17.83	18.61	19.02	19.44	18.40	0.960	< 0.001	< 0.001	0.007
Lys intake, kg gain	18.59	17.87	18.20	18.77	19.20	18.49	0.913	< 0.001	0.008	0.803
PUN, mg/dL	8.14	8.16	7.62	7.95	7.16	7.30	1.182	0.373	0.048	0.912

¹ A total of 647 pigs (DNA 600 × 241) were used in a 27-d trial with eight to nine pigs per pen and 12 replications per treatment.

Table 3. Effects of increasing SID Val:Lys ratio on the growth performance of 195 to 260 lb pigs (Exp. 2)¹

Item	SID Val:Lys ratio, %						SEM	P =		
	63	66	69	72	75	78		Treatment	Linear	Quadratic
BW, lb										
d 0	198.3	198.3	198.3	198.5	198.2	198.4	4.110	0.999	0.975	0.912
d 27	254.7	254.8	256.7	256.0	256.1	257.4	4.431	0.486	0.078	0.867
Overall										
ADG, lb	2.00	2.02	2.09	2.03	2.08	2.11	0.033	0.157	0.019	0.910
ADFI, lb	6.38	6.38	6.51	6.60	6.73	6.58	0.129	0.003	< 0.001	0.224
F/G	3.19	3.17	3.12	3.25	3.25	3.13	0.055	0.024	0.836	0.287
Val intake, g/d	13.07	13.55	14.38	15.34	16.19	16.54	0.225	< 0.001	< 0.001	0.665
Val intake, kg gain	14.41	14.82	15.22	16.67	17.23	17.32	0.231	< 0.001	< 0.001	0.587
Lys intake, g/d	20.74	20.53	20.84	21.31	21.59	21.21	0.319	0.007	< 0.001	0.611
Lys intake, kg gain	22.88	22.46	22.06	23.15	22.97	22.20	0.321	0.024	0.742	0.721
PUN, mg/dL	7.95	8.52	8.17	8.19	7.89	9.57	1.014	0.097	0.105	0.177

¹ A total of 647 pigs (DNA 600 × 241) were used in a 27-d trial with eight to nine pigs per pen and 12 replications per treatment.