VALINE: A LIMITING AMINO ACID FOR HIGH-PRODUCING LACTATING SOWS[1]

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Summary

A total of 152 lactating sows was used to determine the influence of dietary valine level on sow and litter performance. During lactation, sows were fed corn-soybean meal based diets containing .9% lysine and either .75 or .9% valine. Lactation diet had no influence on litter birth weight, pig survivability, pigs weaned per litter, or daily sow feed intake. However, sows fed the .90% valine diet had increased pig and litter weaning weights. These differences were magnified as number of pigs weaned and sow milk production increased. These results indicate that further research is needed to determine the valine requirement of the high-producing sow. However, the practical implication of this trial is that valine deficiencies limit the amount of synthetic lysine that can be used in high protein diets for the lactating sow.

(Key Words: Valine, Amino Acids, Sows.)

Introduction

Recent research at Kansas State University, University of Kentucky, and University of Minnesota suggests that the lysine requirement of the high-producing sow is much greater than listed by NRC (1988). This change in lysine recommendations has led to questions concerning the requirement of other amino acids. We typically use an ideal amino acid ratio to determine the requirement for other amino acids based on lysine. The amino acid ratios suggested by NRC (1988) and ARC (1981) are used most often (Table 1). The ARC ratio is based on the composition of milk, whereas the NRC ratio was developed from feeding trials. These ratios are similar for all amino acids except valine.

Table 1. NRC and ARC Amino Acid Ratios for Lactating Sows

Amino Acid	ARC Ratio	NRC Ratio	% Diff
Lysine	100	100	0
Isoleucine	70	65	7
Met & Cys	55	60	9
Threonine	70	72	3
Tryptophan	19	20	5
Valine	70	100	43

The reason that the valine to lysine ratio is important is that, according to the NRC ratio, valine is the second limiting amino acid in high protein diets for the lactating sow. If 3 lb of synthetic lysine is added to the diet, valine actually is the first limiting amino acid using the NRC ratio. However, valine is not a concern using the ARC ratio. Therefore, this experiment was designed to determine if the valine to lysine ratio suggested by ARC (1981) is too low.

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Procedures

On a commercial swine operation, 152 lactating sows were randomly allotted at farrowing to the experimental diets. Diets were formulated to contain .9% lysine and .75 or .9% valine giving valine to lysine ratios of .83:1 and 1:1, respectively (Table 2). L-valine replaced corn to formulate the high valine diet. All other amino acids were fortified at 105% of the ratio suggested by NRC (1988) (Table 3). Diets were corn-soybean meal-based and contained equal amounts of all synthetic amino acids except valine. Diets were calculated to contain .9% Ca and .8% P.

Table 2. Composition of Diets, %

Item	Control	Valine
Corn	70.43	70.28
Soybean meal, 48%	16.78	16.78
Soybean oil	7.5	7.5
Dicalcium phosphate	2.76	2.76
Sodium bentonite	.50	.50
Limestone	.57	.57
Salt	.50	.50
Vitamin premix	.30	.30
Trace mineral premix	.20	.20
L-Lysine HCl	.255	.255
L-Valine	—	.15
L-Threonine	.107	.107
DL-Methionine	.052	.052
L-Tryptophan	.033	.033
L-Isoleucine	.012	.012
Total	100	100

Litters were equalized by 24 h after farrowing. Litters were weighed at birth and weaning (21 $\pm$ 2 d after farrowing). Sows were provided ad libitum access to feed and water, and feed intake was recorded daily. Following weaning, sows were moved to a breeding facility and checked twice daily for signs of estrous. Days from weaning to estrous were recorded. This experiment was conducted from July 1 to October 25, 1992. Sows were housed in individual farrowing crates in environmentally controlled farrowing rooms. Flooring under the sow and creep area was plastic-coated expanded metal. The minimum air temperature in the farrowing room was 70°F. Drip coolers were activated when air temperature exceeded 80°F.

Table 3. Dietary Amino Acid Levels, %

Item	Control	Valine
Lysine	.90	.90
Valine	.75	.90
Threonine	.68	.68
Methionine	.30	.30
Met & Cys	.57	.57
Tryptophan	.19	.19
Isoleucine	.61	.61

Results

Lactation diet (.75 vs .90% valine) had no influence ($P > .45$) on litter birth weight (35.0 vs 34.9 lb), pig survivability (91.8 vs 92.7%), pigs weaned per litter (10.12 vs 10.25), and daily sow feed intake (9.2 vs 9.2 lb). However, sows fed the .90% valine diet had increased pig ($P < .09$) and litter ($P < .04$) weaning weights (Table 4). These differences were magnified as the number of pigs weaned and sow productivity increased (≤ 10 vs > 10 pigs).

Discussion

Increasing dietary valine from .75% to .90% resulted in a substantial increase in litter weaning weights. These results indicate that the ideal valine to lysine ratio is greater than .83:1 (.75% valine in a diet containing .90% lysine). Certainly, the ratio of .70:1 proposed by ARC (1981) from the amino acid composition of milk is too low. We are currently conducting further research to more closely determine the valine requirement of the high-producing sow.

The practical aspect of this research is the impact that it has on synthetic amino acid use in sow lactation diets. Previously, most nutritionists believed that the most limiting amino acids in corn-soybean meal diets for lactating sows were lysine, threonine, methionine, and tryptophan. Thus, a common recommendation was to use .15% L-lysine HCl in sow lactation diets. The impact of synthetic lysine on the order of limiting amino acids in sow lactation diets is demonstrated in Tables 5 and 6. For these tables, the NRC (1988) and ARC (1981) ratios were used to determine the deficient amino acids in corn-soybean meal diets formulated without (Table 5) or with (Table 6) L-lysine HCl. These tables demonstrate that the order of limiting amino acids changes as lysine levels increase. Lysine is the first limiting amino acid at the lower dietary lysine levels. However, at high lysine levels (> .90%), valine becomes the first limiting amino acid using the NRC (1988) ratio (Table 5). When synthetic lysine is used in formulation (Table 6), valine becomes limiting at a relatively low lysine level (.7%).

Our research indicates that valine deficiencies limit the use of L-lysine HCl in sow lactation diets and that diets formulated on predictions of amino acid requirements based on milk production and maintenance will underestimate the valine requirement of the lactating sow.

Table 4. Influence of Valine Level (.75 or .90%) in Sow Lactation Diet on Litter Performance

	All Sows		< 10 Pigs		> 10 Pigs		
Item	.75	.90	.75	.90	.75	.90	CV
No. of sows	75	77	39	39	36	38	--
No. of pigs weaned	10.12	10.25	9.21	9.28	11.18	11.17	10.5
Pig weaning wt, lb[a]	12.7	13.2	13.3	13.6	11.9	12.7	13.6
Litter weaning wt, lb[b]	127.0	134.0	122.0	125.8	133.4	141.4	15.3

[a]P<.09.
[b]P<.04.

Table 5. Amino Acid Ratios of Corn-Soybean Meal Diets

	Dietary Lysine, %				
Amino Acid	.60	.70	.80	.90	1.0
Lysine	100	100	100	100	100
Isoleucine	92	87	84	82	80
Methionine and Cystine	83	76	71	67	64
Threonine	88	83	79	77	74
Tryptophan	27	26	25	24	24
Valine	115	109	104	100	97[a]

[a]Deficient according to NRC (1988) amino acid ratio.

Table 6. Amino Acid Ratios of Corn-Soybean Meal Diets with 3 lb L-Lysine HCl

	Dietary Lysine, %				
Amino Acid	.60	.70	.80	.90	1.0
Lysine	100	100	100	100	100
Isoleucine	80	77	75	73	72
Methionine and Cystine	75	70	65	62	59[a]
Threonine	77	74	71[a]	69[a]	68[a,b]
Tryptophan	23	23	23	22	22
Valine	102	97[a]	94[a]	91[a]	89[a]

[a]Deficient according to NRC (1988) amino acid ratio.
[b]Deficient according to ARC (1981) amino acid ratio.