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### Abstract

Two hundred-three large white x Landrace or large white x Chester White x Landrace sows (40 or 41/ treatment, avg parity 3.7) were used in a 26 d lactation experiment to determine the valine requirement of high-producing sows. All diets were formulated to .9% lysine with all amino acids other than valine formulated to be at least 110% of their respective ratios relative to lysine. Synthetic valine replaced cornstarch to provide .75, .85, .95, 1.05, and 1.15% dietary valine. Corresponding valine:lysine ratios were 83, 94, 106, 117, and 128% of lysine. The experiment was conducted at two experiment stations from July, 1993 through January, 1994. Mean litter size of all treatments after adjustment was 10.33 pigs. Sow feed intake and grams of lysine intake were not different among treatments. Grams of valine intake increased linearly as dietary valine increased. Litter weight at d 21 and weaning increased linearly with increasing dietary valine. Litter weight gain from d 0 to 7 increased linearly as dietary valine increased to 1.15 %. Litter weight gain from d 0 to 21 and d 0 to weaning increased linearly as dietary valine increased, with the greatest portion of the response observed as valine increased to 1.05% of the diet. Dietary valine had no effect on sow weight change, 10th rib backfat (BF) change, or last lumbar BF change from d 0 to 21 or d 0 to weaning. Days to estrus postweaning were not affected by dietary valine. These results demonstrate that high-producing sows have a dietary valine requirement of at least 117% of lysine during lactation (66.4 g/d valine), much greater than is currently recommended by NRC (1988; 100% of lysine) or ARC (1981; 70% of lysine) to maximize litter weaning weight and litter weight gain.; Swine Day, Manhattan, KS, November 17, 1994

### Keywords

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# DETERMINING THE VALINE REQUIREMENT OF THE HIGH-PRODUCING LACTATING SOW[1]

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## Summary

Two hundred-three large white × Landrace or large white × Chester White × Landrace sows (40 or 41/treatment, avg parity 3.7) were used in a 26 d lactation experiment to determine the valine requirement of high-producing sows. All diets were formulated to .9% lysine with all amino acids other than valine formulated to be at least 110% of their respective ratios relative to lysine. Synthetic valine replaced cornstarch to provide .75, .85, .95, 1.05, and 1.15% dietary valine. Corresponding valine:lysine ratios were 83, 94, 106, 117, and 128% of lysine. The experiment was conducted at two experiment stations from July, 1993 through January, 1994. Mean litter size of all treatments after adjustment was 10.33 pigs. Sow feed intake and grams of lysine intake were not different among treatments. Grams of valine intake increased linearly as dietary valine increased. Litter weight at d 21 and weaning increased linearly with increasing dietary valine. Litter weight gain from d 0 to 7 increased linearly as dietary valine increased to 1.15%. Litter weight gain from d 0 to 21 and d 0 to weaning increased linearly as dietary valine increased, with the greatest portion of the response observed as valine increased to 1.05% of the diet. Dietary valine had no effect on sow weight change, 10th rib backfat (BF) change, or last lumbar BF change from d 0 to 21 or d 0 to weaning. Days to estrus postweaning were not affected by dietary valine. These results demonstrate that high-producing sows have a dietary valine requirement of at least 117% of lysine during lactation (66.4 g/d valine), much greater than is currently recommended by NRC (1988; 100% of lysine) or ARC (1981; 70% of lysine) to maximize litter weaning weight and litter weight gain.

(Key Words: Valine, Lactation, Sows.)

## Introduction

As genetic improvements continue to improve sow milk production, nutritional requirements also will continue to change. A previous study demonstrated that lysine requirement is highly correlated to the milk production of the sow. Research on other amino acids is scarce. Only one experiment has determined the valine requirement of the lactating sow. Piglets in that experiment gained only 3.62 lb from d 7 to 21 of lactation, approximately one-half of current piglet growth rates during lactation. Additionally, recent research in the lactating goat has demonstrated that valine has the highest oxidation rate of any amino acid in the goat mammary gland. As milk synthesis rates

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[2]University of Minnesota.
[3]Lonza, Inc., Fair Lawn, NJ.

increase with increased milk production, the valine requirement also would increase. Therefore, the objective of this experiment was to determine the valine requirement of the high-producing sow.

## Procedures

Two hundred three primiparous and multiparous sows from the South Central (n=101) and West Central Experiment Stations (n=102) at the University of Minnesota were used in this experiment. Sows farrowed from July, 1993 through January, 1994. All sows originated from maternal line breeds (Yorkshire × Landrace or Yorkshire × Landrace × Chester White). Sows were moved into farrowing crates on approximately d 110 of gestation. Four farrowing groups of sows were used at both experiment stations, with sows allotted to one of five dietary treatments based on parity group. The three parity groups used were 1 and 2, 3 to 5, and 6 to 11.

The basal lactation diet is shown in Table 1. All diets were formulated to be in excess (at least 110%) of all nutrient estimates based on the NRC (1988) and ARC (1981) suggested ratios, except for valine. Diets were formulated to 14.3% CP, .9% lysine, .9% Ca, and .8% P. Synthetic L-valine replaced cornstarch in the basal diet in .1% increments to achieve the five dietary treatments, with valine concentrations of .75, .85, .95, 1.05, and 1.15%. The calculated valine to lysine ratios were 83.3, 94.4, 105.6, 116.7, 127.8% of lysine, respectively.

**Table 1. Diet Composition[a]**

| Ingredient, % | Basal diet |
|---|---|
| Corn | 72.803 |
| SBM, 47% | 16.731 |
| Soybean oil | 5.000 |
| Dicalcium phosphate | 2.708 |
| Limestone | .594 |
| Salt | .500 |
| Cornstarch[b] | .400 |
| Sow add pack[c] | .250 |
| Vitamin premix[d] | .250 |
| Trace mineral premix[e] | .150 |
| Lysine-HCl | .268 |
| L-threonine | .140 |
| L-isoleucine | .090 |
| DL-methionine | .072 |
| L-tryptophan | .044 |
| Total | 100.0 |

[a]Basal diet was formulated to 14.3% CP, .9% lysine, .75% valine, .9% Ca and .8% P. Calculated levels of other amino acid in diets; .71% threonine, .20% tryptophan, .31% methionine, .59% methionine + cysteine, .69% isoleucine, 1.45% leucine, .39% histidine, .91% arginine.
[b]Cornstarch was replaced in .10% increments with L-valine to create the remaining four experimental diets with calculated dietary valine levels of .85, .95, 1.05, 1.15%.

Sows were allowed ad libitum access to feed and water from parturition until weaning. Feed intake was determined weekly, with orts collected and weighed once each week. Sows were weighed and scanned ultrasonically (Preg-Alert 2B; Renco, Minneapolis, MN) 2.4 inches off the midline on both sides of the body at the tenth rib and last lumbar to determine backfat thickness within 24 h postpartum, on d 21 of lactation, and at weaning. Sows were bled via vena puncture at d 21 of lactation to determine serum urea N, creatinine, and plasma amino acid concentrations. Piglets were cross-fostered between sows irrespective of dietary treatment until d 3 of lactation to improve uniformity of suckling intensity and to increase the number of pigs per sow to at least 10. Piglets were weighed at d 0, 7, 21, and weaning. Creep feed was not offered to the litters. On the day of weaning, sows were moved to a confinement breeding facility for observation of estrus. Sows were checked for signs of estrus daily for 15 days postweaning and were determined to be in estrus when the sow would stand to be mounted by a boar.

The GLM procedure of SAS was used to determine treatment effects. Litter size after cross-fostering was used as a covariate for all response criteria. Days of lactation were used as covariates for weaning litter weights, weaning litter weight gain, weaning sow backfat changes, and days to estrus. No treatment by parity group or treatment by station interactions (P>.10) occurred. All means reported are least squares means.

## Results

Litter weight at d 7 increased at a linear (P<.09) rate as dietary valine increased (Table 2). Litter weight continued to improve linearly (P<.02) at d 21 and weaning (26 days) as dietary valine increased from .75 to 1.15%. Litter weights increased by 6.9 and 8.2 lb for d 21 and weaning, respectively, as valine increased from .75 to 1.15% in the diet .

Sow weight change at d 21 and weaning (Table 2) was not affected (P>.21) by dietary valine. Sow backfat (BF) loss at the tenth rib and last lumbar was not affected (P<.28) by increasing dietary valine.

Sow feed intake and, therefore, grams of lysine intake, (Table 2) tended to decrease and then increase (quadratic, P=.13). Sow feed intake was highest at .75% valine and lowest at .85% dietary valine. All lysine intakes were at or above the previously determined lysine requirement (54 g/day) for sows from these herds. Valine intake increased linearly (P<.001) as valine concentration increased in the diet, giving a range of 48.3 to 72.1 g/d.

Serum urea nitrogen (Table 2) on d 21 increased linearly (P<.001) as dietary valine increased from .75 to 1.15% in the diet. Additionally, serum creatinine concentrations tended to increase (P<.12) with increasing dietary valine.

Days to estrus postweaning (Table 2) were not affected by dietary valine levels, with values ranging from 4.87 to 5.19 days. Dietary treatment had no effect (P>.06) on the distribution of the days to return to estrus as measured by Chi-Square analysis. The percentage of sows in estrus by d 7 postweaning ranged from 82.5 to 97.5 and from 89.7 to 97.5 by d 14 postweaning.

## Discussion

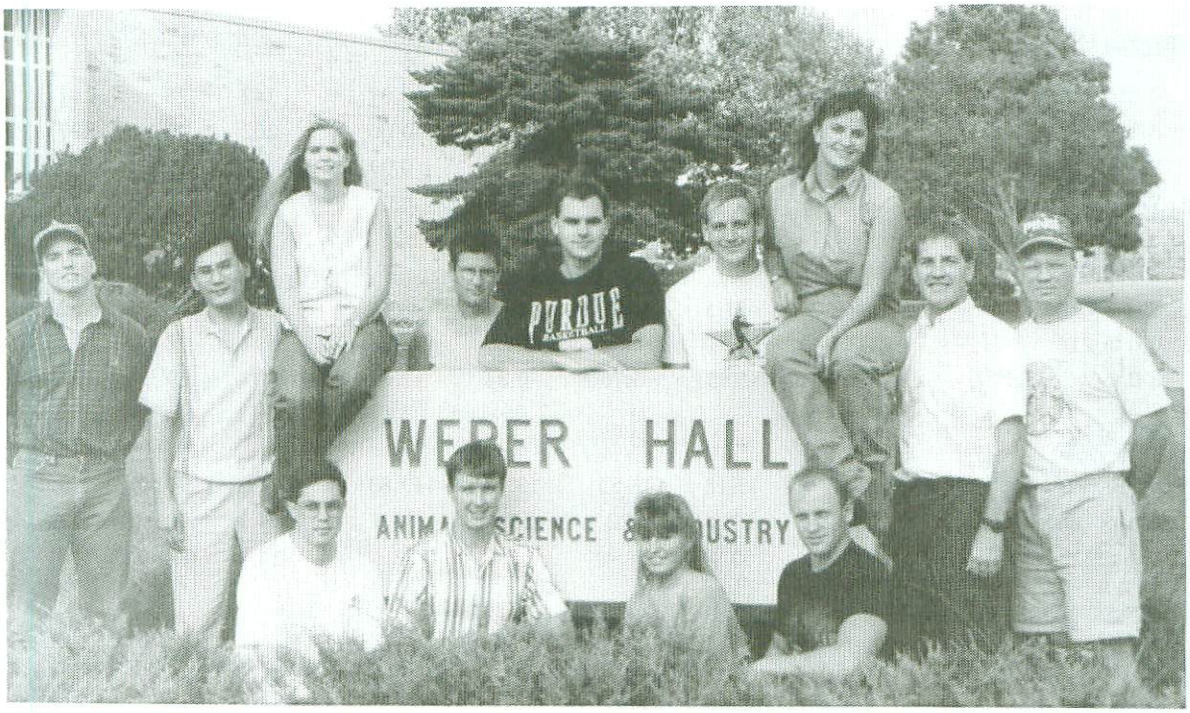
The linear increase in litter weight by d 7 of lactation was only a trend, but represents an 8% gain. This result demonstrates that even early in lactation, when milk production is still increasing, litter growth rate can be affected by dietary amino acid balance. This is important, as we continue to make the weaning age younger and younger for increased throughput in the farrowing house or for use in a segregated early-weaning program. The greater the piglets' weight at weaning, the easier it is to start them on feed.

Litter weight increased by 5% at d 21 and weaning with increasing dietary valine. Litter weight increased by 6% at d 21 and weaning with increasing valine in the diet. Litter weight gain tends to plateau at 1.05% dietary valine; a valine:lysine ratio of 117%. This is the same ratio that maximized litter growth rate in the only other sow lactation valine trial conducted. However, great differences occur in milk production and litter growth rate between this experiment and the previous research. The previous research had only a 3.62 lb increase in piglet weight from d 7 to 21 of lactation at a dietary valine to lysine ratio of 117%, whereas we achieved a 7.97 lb piglet weight gain for the same time frame and valine to lysine ratio. This indicates that an optimal ratio of amino acids may be needed by the mammary gland for milk synthesis.

Sow weight change was not affected by dietary treatment and was close to zero. This was primarily due to the high feed intake of the sows in this experiment. Sow BF losses were minimal. Backfat change was not affected at the tenth rib and last lumbar by dietary valine. Dietary valine had no effect on days to estrus postweaning. This is likely due to minimal or no sow weight loss and high feed intake of the sows. Therefore, the sows were in excellent condition at the end of the lactation period, resulting in no dietary effects on their reproductive function.

Serum urea nitrogen concentrations increased linearly with increasing dietary valine. We anticipated that the levels would have decreased as dietary valine approached the sow's requirement. However, in the only previous sow valine requirement trial, no change occurred in blood urea nitrogen. Serum creatinine concentrations also tended to increase, matching those of serum urea nitrogen. This may indicate an increased muscle catabolism to meet the increased milk production of the sows fed increased valine levels, therefore, leading to an increase in both BUN and creatinine.

This research demonstrates the need for a higher dietary valine concentration than is currently recommended by the NRC (1988) and the ARC (1981) for the high-producing lactating sow. The valine requirement for the lactating sow is at least 117% of lysine, and valine may be the first limiting amino acid in lactation diets formulated above .8% lysine.




**Swine Nutrition Graduate Students: back row, left to right, Ben Nessmith, In-Ho Kim, Angela Beasley, Lark Burnham, Jim Smith, II, Brian Richert, Mindy Rantanen, Steve Dritz, and Kevin Owen; front row, Mario Cabrara, Chad Kerr, Brenda Boese, and Jon Bergstrom; (not pictured, Jeff Peterson).**

**Table 2. Effects of Dietary Valine on Sow and Litter Performance**

| | Valine, % (Valine:Lysine) ratio | | | | | | P value | |
|---|---|---|---|---|---|---|---|---|
| | .75 | .85 | .95 | 1.05 | 1.15 | | | |
| Item, | (83.3%) | (94.4%) | (105.6%) | (116.7%) | (127.8%) | CV | Linear | Quadratic |
| Lactation length, d | 26.3 | 25.9 | 26.1 | 26.0 | 26.1 | — | — | — |
| Pigs weaned[a] | 10.16 | 10.18 | 10.13 | 10.17 | 10.25 | 3.7 | .31 | .38 |
| Mean parity | 4.35 | 4.30 | 4.29 | 4.27 | 4.16 | — | — | — |
| Litter wt., lb | | | | | | | | |
| d 0 | 34.3 | 34.1 | 34.5 | 34.1 | 35.1 | 13.9 | .52 | .57 |
| d 7[a] | 61.3 | 62.1 | 62.5 | 62.5 | 64.3 | 12.5 | .09 | .74 |
| d 21[a] | 137.6 | 137.9 | 141.1 | 143.3 | 144.5 | 11.9 | .02 | .92 |
| Weaning[ab] | 168.0 | 167.9 | 171.5 | 173.8 | 176.2 | 11.0 | .02 | .73 |
| Initial backfat, in. | | | | | | | | |
| Tenth rib | .85 | .89 | .89 | .88 | .89 | — | — | — |
| Last lumbar | .98 | 1.01 | 1.00 | 1.00 | .98 | — | — | — |
| Backfat change, in. | | | | | | | | |
| d 21 tenth rib[ac] | -0.04 | -0.05 | -0.06 | -0.05 | -0.07 | 147 | .28 | .91 |
| d 21 last lumbar[ac] | -0.03 | -0.04 | -0.06 | -0.02 | -0.06 | 202 | .38 | .97 |
| Weaning tenth rib[abc] | -0.08 | -0.09 | -0.10 | -0.08 | -0.09 | 86 | .91 | .75 |
| Weaning last lumbar[abc] | -0.07 | -0.06 | -0.07 | -0.05 | -0.07 | 146 | .75 | .76 |
| Initial sow wt. and change, lb | | | | | | | | |
| Sow wt. d 0 | 468.2 | 481.5 | 474.8 | 483.6 | 483.8 | 10.8 | .18 | .72 |
| d 0 to 21[ad] | 2.59 | -2.51 | -4.58 | 2.22 | -1.28 | 597 | .78 | .35 |
| d 0 to weaning[abd] | 2.22 | -5.85 | -5.76 | -0.84 | -2.60 | 407 | .69 | .21 |
| Feed intake | | | | | | | | |
| ADFI, lb[ab] | 14.17 | 13.18 | 13.55 | 13.97 | 13.83 | 14.3 | .90 | .13 |
| Lysine intake, g[ab] | 57.8 | 53.8 | 55.3 | 57.0 | 56.5 | 14.3 | .90 | .13 |
| Valine intake, g[ab] | 48.3 | 50.9 | 58.4 | 66.4 | 72.1 | 14.7 | .001 | .20 |
| Blood criteria, mg/dL | | | | | | | | |
| Blood urea nitrogen[a] | 16.4 | 17.6 | 17.8 | 19.2 | 19.5 | 19.9 | .001 | .76 |
| Creatinine[a] | 1.67 | 1.77 | 1.66 | 1.73 | 1.79 | 15.9 | .12 | .58 |
| Return to estrus | | | | | | | | |
| Days to estrus[ab] | 4.95 | 5.19 | 5.07 | 4.87 | 5.19 | 22.1 | .79 | .92 |
| Percent in estrus by d 7 | 97.5 | 82.5 | 89.7 | 90.2 | 93.0 | — | — | — |
| Percent in estrus by d 14 | 97.5 | 90.0 | 89.7 | 90.2 | 95.3 | — | — | — |

[a]Number of pigs postfostering used as a covariate.
[b]Days of lactation used as a covariate.
[c]Initial sow backfat used as a covariate.
[d]Initial sow backfat used as a covariate.