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Determining the threonine requirement of the lactating sow (2005)

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DETERMINING THE THREONINE REQUIREMENT OF THE LACTATING SOW[1]

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Summary

A total of 182 lactating sows were used in a study to determine the threonine requirement, and the relative difference in resulting performance of lactation diets with high concentrations of crystalline amino acids, compared with a conventional corn-soybean meal diet. All experimental diets were based on corn-soybean meal and formulated to contain 0.88% true ileal digestible (TID) lysine (1.00 and 0.97% total lysine for the control treatment and crystalline amino acid treatments, respectively). The control treatment was a conventional corn-soybean meal diet with no added crystalline amino acids. The other five experimental diets contained 0.37% L-lysine HCl, with other amino acids added to ensure that threonine was first limiting. The TID threonine contents in these diets were formulated to 0.44, 0.50, 0.57, 0.64, and 0.70%. Sows were farrowed in seven farrowing groups and were randomly allotted to the dietary treatments on the basis of parity. Over the entire lactation period, sows fed the diets containing crystalline amino acids consumed more (P<0.04) feed than did the sows fed the control corn-soybean meal diet. The sows fed the control diet also lost numerically (P>0.10) more weight over the lactation period. Sows fed the control diet had higher (P<0.01) PUN values at day 18 of lactation than did sows fed diets with added crystalline amino acids. There was no effect (P>0.10) on litter weaning weight with increasing dietary threonine. The numeric changes in PUN, litter weight gain, and feed intake suggest that the TID threonine requirement was 0.50%, which calculated to a threonine-to-lysine ratio of 57%. But the greatest implication of this study was that the use of crystalline amino acids as a replacement for soybean meal in lactation diets resulted in increased feed intake and decreased sow weight loss.

(Key Words: Crystalline Amino Acids, Lactation, Sows, Threonine.)

Introduction

To maximize milk production, nutritionists need to accurately formulate diets to contain the required amounts of amino acids for the sow. This can be challenging because overall production can dramatically affect the sow's amino acid needs. If diets are limiting in certain amino acids or energy, the sow will mobilize body protein or fat to meet their needs for milk production. Crystalline amino acids have become more readily and economically avail-

[1]The authors thank Ajinomoto Heartland LLC, for providing the crystalline amino acids used in this study.

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able in recent years. Increased use of crystalline amino acids increases the importance of understanding the requirements for amino acids other than lysine in sow lactation diets to prevent an imbalance of essential amino acids.

Therefore, our objective in this study was to determine the threonine requirement of the high-producing lactating sow by using diets that contained high concentrations of crystalline amino acids. We also wanted to compare the performance of sows fed the diets containing large amounts of crystalline amino acids with that of sows fed a control diet based on corn-soybean meal.

Procedures

This study was conducted in the Kansas State University Swine Teaching and Research Center farrowing facilities. One hundred and eighty-two sows were blocked by parity and allotted to one of six diets. The sows used in this study were PIC Line 1050 and were farrowed in seven groups, with approximately 29 sows per group. Sows were randomly assigned to treatments, balanced by parity when entering the farrowing house on day 110 of gestation. During lactation, sows were provided *ad libitum* access to feed and water, and feed disappearance was recorded. All sows were fed either a diet based on corn-soybean meal or a diet containing large amounts of crystalline amino acids, formulated to 0.44, 0.50, 0.57, 0.64, or 0.70% TID threonine (Table 1). All diets were formulated to contain 0.88% TID lysine and 1,536 kcal of ME per lb.

All sows were weighed after farrowing and again at weaning to calculate weight change during lactation. Backfat was measured upon entering the farrowing house on d 110 of gestation and on d 18 of lactation to determine change in backfat during lactation. Blood samples were obtained by venipuncture on d 18 of lactation from each sow after 3 h of feed withdrawal, and samples were analyzed for plasma urea N (PUN). Cross-fostering occurred before d 2 to standardize all litters with approximately 11 pigs. Pigs were weighed individually at birth, after fostering on d 2, and again at weaning. Any pigs removed from the trial were recorded, along with their date of removal and weight. Data were analyzed according to the MIXED procedure of SAS.

Results and Discussion

Increasing TID threonine had no effect on ADFI over the lactation period, but sows fed the diets containing crystalline amino acids consumed more feed ($P < 0.05$; Table 2) than did sows fed the corn-soybean meal control diet. Sow body weight loss during lactation was not affected by lactation treatment, although sows fed the conventional corn-soybean meal diet lost numerically more weight than did sows fed the diets containing large amounts of crystalline amino acids. There was no difference for initial backfat and final backfat measured on d 18 of lactation among treatments, but sows fed the diet containing 0.50% TID threonine lost more ($P<0.10$) backfat than did sows fed the diet containing 0.57% TID threonine. Increasing dietary threonine did not affect PUN when blood was sampled on day 18 of lactation, but sows fed the conventional corn-soybean meal diet had higher ($P<0.01$) PUN than did sows fed the diets with large amounts of crystalline amino acids. Threonine concentration did not affect total litter weight at weaning ($P>0.10$; Table 3), but litter weaning weights were numerically maximized at 0.50% TID threonine. Sows suckled an average of 10.5 piglets during lactation, and mortality rate of piglets ranged from 5.94 to 9.15%.

Regression analysis of litter weaning weights indicated that the threonine require-

ment was approximately 0.50% for sows in this study. To support the 149 lb litter weaning weight and 114 lb of litter weight gain from d 2 to 21 without losing body protein, sows would have had to consume more than 58 g of TID lysine per day. With ADFI of approximately 12 lb/day, sows on the diets with large amounts of crystalline amino acids actually consumed approximately 48 g of TID lysine per day. Thus, sows consumed less than their lysine requirement, allowing calculation of a threonine:lysine ratio. When 0.50% TID threonine and 0.88% TID lysine were used, the threonine:lysine ratio calculated to 57%. This ratio is similar to the ratio of approximately 58% calculated from estimates of the National Research Council.

Finally, we observed that the litter performance of the sows fed the crystalline amino acid diets was not different from that of the sows fed the conventional corn-soybean meal diet. This could be a very useful tool for producers who want to decrease the nitrogen excreted into manure storage by sows without adversely affecting piglet growth during lactation. It also may offer a means of increasing feed intake, compared with diets that contain large amounts of soybean meal.

Table 1. Composition of Diets (As-fed Basis)[a]

Item	Control[b]	Crystalline Amino Acids[c]
Corn	65.88	76.20
Soybean meal (46.5% CP)	27.47	16.00
Soybean oil	2.50	2.50
Monocalcium P (21% P, 18% C)	1.95	2.00
Limestone	1.05	1.00
Salt	0.50	0.50
Vitamin premix	0.25	0.25
Trace mineral premix	0.15	0.15
Sow add pack	0.25	0.25
L-valine	---	0.31
L-isoleucine	---	0.04
L-tryptophan	---	0.05
L-threonine	---	---
L-lysine HCl	---	0.37
DL-methionine	---	0.10
Sand	---	0.30
Total	100.00	100.00
Calculated analysis		
ME, kcal/lb	1534	1535
Crude protein, %	18.4	13.9
Total lysine, %	1.00	0.97
TID amino acids, %		
Lysine, %	0.88	0.88
Threonine, %	0.60	--
Methionine, %	0.27	0.31
Tryptophan, %	0.19	0.18
Isoleucine, %	0.69	0.53
Leucine, %	1.49	1.22
Ca, %	0.87	0.83
P, %	0.78	0.74
Available P, %	0.48	0.48

[a]All diets are formulated to contain 0.88% TID lysine.
[b]Corn-soybean meal diet containing 0.60% TID threonine.
[c]Crystalline amino acid diets are formulated to contain increasing TID threonine concentrations of 0.44, 0.50, 0.57, 0.64, and 0.70%. L-threonine was added to the crystalline amino acid diets at the expense of sand to achieve desired TID threonine content.

Table 2. Effects of Increasing Dietary True Ileal Digestible Threonine During Lactation on Sow Performance

		True Ileal Digestible Threonine (%)[g]						Probability, P <[f]		
Item	Control[h]	0.44[i]	0.50[i]	0.57[i]	0.64[i]	0.70[i]	SE	Linear	Quadratic	Corn-SBM vs. Crystallines
Number of sows	31	28	31	31	32	29				
Lactation length, d	21.3[a]	21.3[ab]	21.2[ab]	20.9[bc]	20.8[c]	21.0[ab]	0.21	0.07	0.28	0.12
ADFI, lb	11.1[a]	11.6[ab]	12.2[b]	12.1[b]	12.1[b]	12.0[ab]	1.2	0.57	0.41	0.05
Sow weight, lb										
Day 2	530.2	531.4	519.6	528.5	520.6	545.2	44.8	0.48	0.18	0.87
Weaning	496.9	500.5	491.9	501.4	493.7	512.1	53.7	0.42	0.31	0.77
Loss	33.2	29.9	28.5	27.6	27.0	29.0	9.3	0.86	0.53	0.37
Backfat										
Day 2	14.6	14.8	14.5	15.2	15.1	14.3	0.7	0.93	0.50	0.85
Weaning	11.9	12.4	11.3	12.9	12.2	11.9	0.5	0.99	0.69	0.59
Loss	2.8[ab]	2.3[ab]	3.1[a]	2.2[b]	2.9[ab]	2.3[ab]	0.7	0.87	0.49	0.60
PUN	5.60	4.42[a]	4.00[a]	4.49[a]	4.51[a]	4.53[a]	0.3	0.35	0.67	0.01

[abc]Means on the same row without common superscripts differ, P<0.10.

[f]Linear and quadratic probability refer to increasing TID threonine.

[g]All diets are formulated to contain 0.88% TID lysine.

[h]Corn-soybean meal diet containing 0.60% TID threonine.

[i]Crystalline amino acids used in diets.

Table 3. Effects of Increasing Dietary True Ileal Digestible Threonine During Lactation on Litter Performance

		True Ileal Digestible Threonine (%)[g]						Probability, P <[f]		
Item	Control[h]	0.44[i]	0.50[i]	0.57[i]	0.64[i]	0.70[i]	SE	Linear	Quadratic	Corn-SBM vs. Crystallines
Number of sows	31	28	31	31	32	29				
Day 2 No. pigs	11.2[a]	10.9[ab]	11.4[ab]	11.3[ab]	11.6[b]	11.5[b]	0.2	0.11	0.22	0.69
Day 2 litter wt.	36.9	35.2	36.7	36.3	37.4	36.9	1.2	0.28	0.35	0.59
No. of pigs weaned	10.5	10.1	10.6	10.5	10.5	10.5	0.3	0.51	0.17	0.66
Litter weaned wt.	148.3	142.4	149.6	145.0	146.6	140.1	5.8	0.69	0.17	0.39
Litter wt. gain	111.4	107.2	112.9	108.7	109.1	103.26	5.0	0.46	0.19	0.39
Pre-weaning mortality, %	5.94	8.00	6.39	7.20	9.15	8.89	0.02	0.44	0.58	0.31

[abc]Means on the same row without common superscripts differ, P<0.10.

[f]Linear and quadratic probability refer to increasing TID threonine.

[g]All diets are formulated to contain 0.88% TID lysine.

[h]Corn-soybean meal diet containing 0.60% TID threonine.

[i]Crystalline amino acids used in diets.