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LIMITING AMINO ACIDS IN SORGHUM GRAIN PROTEIN FOR ADULT FEMALE SWINE

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Summary

Two 4 x 4 Latin square designs were used with 16 gilts at 10 mo of age and weighing 341 lb (gravid) and 301 lb (nongravid) to determine the limiting nitrogenous factors in sorghum grain protein for adult gravid (70th day postcoitum) and nongravid swine. Supplementation of the fortified sorghum grain diet with lysine increased ($P<.05$) nitrogen retention in both nongravid and gravid gilts. A further addition of threonine also increased ($P<.05$) nitrogen retention in both nongravid and gravid gilts. However, addition of both lysine and threonine to the sorghum diet failed to result in nitrogen retention equal to that observed for the control diet. Percentage of nitrogen digested was higher ($P<.05$) for the control diet than for the basal diet or the two diets with lysine and threonine added. Blood urea nitrogen was reduced ($P<.05$) when lysine was added to the basal diet with an additional reduction when threonine also was added to the diet. However, the control diet caused higher blood urea values when compared to both supplemented diets. These results suggest that another amino acid may be limiting in the sorghum grain diet supplemented with both lysine and threonine. These data and other published data demonstrate that lysine and threonine are the first and second limiting amino acids in sorghum grain for adult gravid and nongravid swine.

Introduction

Lysine and threonine are the first and second limiting amino acids, respectively, in sorghum grain protein for growing and finishing swine. However, little work has been conducted on the limiting order of amino acids for adult female swine. Also, a major problem in determining amino acid requirements for the lactating sow is the method of urine collection and amount of time required to collect urine to determine nitrogen balance. Therefore, the purpose of this study was: 1) to determine the limiting amino acids in sorghum grain protein for adult nongravid and gravid swine; and 2) to compare the collection of urine for only a 24 hr period with the conventional 5-day pooled collection needed to determine nitrogen balance.

Procedures

Sixteen gilts, 10 mo of age and weighing 301 lb (nongravid) and 341 lb (gravid), were utilized in two nitrogen balance studies. Two 4 x 4 Latin squares were used with gravid (70th day postcoitum) and nongravid gilts fed the following diets at 4.4 lb per day: (A) control sorghum grain-sorghum meal; (B) sorghum grain fortified with vitamins and minerals; (C) same as (B) supplemented with .27% L-lysine; and (D) same as B supplemented with .27% L-lysine and .15% L-threonine. Amino acid additions were designed to make the concentration of individual amino acids equivalent to the 12% protein sorghum grain-soybean meal control diet (table 1).

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Gilts were housed in individual metabolism cages with slatted floors and maintained in an environmentally controlled building. Gilts were allowed to adapt to the metabolic cages for 3 days followed by a 5-day adjustment to the diets. After adjustment to the treatments, a 5-day collection period was initiated. Ferric oxide was fed as an indicator in the morning meal. Fecal collection was initiated on the appearance of the first red-colored feces and discontinued on the appearance of the red dye from the meal fed 5 days later.

Catheters were inserted into the gilts' bladders to facilitate urine collection. Urine was collected quantitatively for the 5-day period as previously described for fecal collection. Total fecal collections were frozen (-20 C) until subjected to nitrogen (N) analysis. Urine was acidified and an aliquot of each daily collection was stored (-20 C) for future analysis. A separate urine sample was taken on the third day of the 5-day collection period, representing only a 24-h period.

Gilts were bled (4 h postprandially) by puncture of vena cava on the last day of each collection period. Feed, feces, and urine were analyzed for nitrogen content, while plasma was analyzed for urea nitrogen.

The relationship of the conventional nitrogen balance equation with the day 3 nitrogen balance (in which urine was collected only for a 24 h period) is shown in table 2.

Results and Discussion

The effects of additions of lysine and threonine to a fortified milo diet for nongravid and gravid swine are presented in table 3 and table 4, respectively. Nitrogen retained (g/d) was improved ($P<.05$) for both nongravid and gravid gilts when lysine and lysine and threonine were added to the basal diet. However, gilts (both gravid and nongravid) fed the basal diet with added lysine and threonine did not retain nitrogen equal to those gilts fed the control diet. This is in contrast to what was expected. If these two amino acids are the first and second limiting and no others are limiting, then additions of each to the control diet should increase nitrogen retention to be comparable with the sows fed the control diet.

Differences in nitrogen balance for gilts fed the basal diet plus lysine and threonine in comparison with gilts fed the control diet may be due to an increased digestibility of nitrogen for sows (both gravid and nongravid) fed the control diet. Gilts (whether gravid or nongravid) had similar digestibility values for control, control plus lysine, and control plus lysine and threonine diets.

Blood urea nitrogen was high with the basal diet for each gilt type, indicating endogenous protein catabolism. However, when adding lysine or lysine plus threonine to the basal diet, there was a reduction ($P<.05$) in urea nitrogen, indicating that the aminal was closer to amino acid adequacy (control plus lysine and threonine). However, plasma urea nitrogen levels in gilts fed the control diets were higher ($P<.05$) than levels in gilts fed the control diet plus lysine and threonine. This elevated level was due to amino acid levels in the diet being in excess of the gilts' requirements.

The relationship of blood urea nitrogen and day 3 nitrogen balance to the conventional nitrogen balance for determining amino acid adequacy is shown in table 5. Correlations were low for the blood urea nitrogen (BUN) method in comparison to both the day 3 nitrogen balance and the conventional nitrogen balance. However, there was a high correlation (r = .95) when the day 3 nitrogen method was compared to the conventional nitrogen balance method. This suggests that when a metabolism trial is used to determine amino acid adequacy a 24-hr sample of urine is sufficient instead of collecting urine for a 5-d period. This should save much time and labor.

In conclusion, these data suggest that another amino acid may be limiting in the sorghum diet supplemented with both lysine and threonine and fed to adult female swine. These results, along with other published results, demonstrate that lysine and threonine are the first and second limiting amino acids, respectively, in sorghum grain for adult gravid and nongravid swine.

Table 1. Composition of Basal Diet[a]

Ingredients	%
Sorghum grain, milo[b]	95.82
Dicalcium phosphate	2.05
Limestone	1.03
Salt	.50
Vitamin premix	.50
Trace mineral premix	.10

[a]Diet was ground
[b]Crude protein in diets for nongravid gilts was 9.0% and in diets for gravid gilts was 9.2%.

Table 2. Relationship of Nitrogen Balance to Day 3 Nitrogen Balance

5-day N-Bal = 5-d N Intake - (5-d Fecal N + 5-d Urine N)

3-day N-Bal = 5-d N Intake - (5-d Fecal N + 1-d Urine N)

Table 3. Effect of Additions of Lysine and Threonine to a Fortified Milo Diet for Nongravid Swine[a]

Criteria	Diet: Basal	+Lys	+Lys +Thr	Control	SE
Nitrogen Balance, g/d	7.62^{b}	11.09^{c}	12.29^{d}	17.02^{e}	.38
Day 3 Nitrogen Balance, g/d	6.68^{b}	10.91^{c}	12.12^{d}	16.15^{e}	.31
Digestible Nitrogen, %	75.25^{b}	76.47^{b}	75.15^{b}	81.35^{c}	.50
Blood Urea Nitrogen, mg/100 ml	6.33^{b}	4.81^{c}	4.45^{c}	6.92^{b}	.35

[a]Means with different superscripts differ significantly (P<.05).

Table 4. Effect of Additions of Lysine and Threonine to a Fortified Milo Diet for Gravid Swine[a]

Criteria	Diet: Basal	+Lys	+Lys +Thr	Control	SE
Nitrogen Balance, g/d	4.85^{b}	10.12^{c}	12.59^{d}	14.67^{e}	.39
Day 3 Nitrogen Balance, g/d	4.10^{b}	9.42^{c}	11.99^{d}	13.83^{e}	.58
Digestible Nitrogen, %	73.19^{b}	74.19^{b}	74.28^{b}	79.99^{c}	.60
Blood Urea Nitrogen, mg/100 ml	8.16^{b}	5.93^{c}	3.81^{d}	7.39^{b}	.45

[a]Means with different superscripts differ significantly (P<.05).

Table 5. Relationship of Blood Urea Nitrogen (BUN) and Day 3 Nitrogen Balance to Nitrogen Balance

	Correlation (r)		
Parameter:	Bun	Day-three N balance	N-balance
BUN	1.00	-.13	-.11
Day-three N-balance		1.00	.95
N-balance			1.00