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Abstract

Eighty crossbred pigs (initially 85.2 lb BW) were used in a 2 Ã— 4 factorial arrangement to determine the influence of dietary threonine:lysine ratios on growth performance and plasma urea N in growing-finishing pigs. The experiment was conducted in three phases from 85.2 to 124.2, 139.1 to 203.1, and 204.9 to 241.1 lb, with pigs fed one of eight dietary treatments. Two levels of dietary lysine were fed (low vs high) and four levels of dietary threonine were fed within each lysine treatment (60, 65, 70, and 75% of dietary lysine). Dietary lysine decreased from 1.0% and .8% at 85.2 to 124.2 lb to .9 and .7% at 139.1 to 203.1, then to .7 and .5% at 204.9 to 241 1 lb. Average daily gain (ADG) and feed efficiency (F/G) were not influenced by lysine or threonine treatment from 85.2 to 124.2 lb. However, average daily feed intake was decreased for pigs fed 1.0% dietary lysine compared to .8% dietary lysine. From 139.1 to 203.1 lb, an interaction between dietary lysine and threonine existed for ADG. Average daily gain was maximized at 65 and 70% of dietary lysine for pigs fed .7 and .9% dietary lysine, respectively. Conversely, ADFI and F/G were not influenced by threonine:lysine ratios. From 204.9 to 241.1 lb, ADG and ADFI were not influenced by dietary treatment. However, F/G was improved for pigs fed .7% dietary lysine compared to pigs fed .5% dietary lysine. Plasma urea N was increased at 124.2 and at 203.1 for pigs fed greater dietary lysine. At 241.1 lb, plasma urea N was decreased linearly at the percentage of threonine increased from 60 to 75% of lysine. The data from this experiment indicate that excess lysine and threonine intakes do not decrease growth performance. Because high ADFI resulted in high amino acid intake, growth performance was not influenced by the amino acid ratios used in this experiment.; Swine Day, Manhattan, KS, November 18,1993

Keywords

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THE INFLUENCE OF THREONINE:LYSINE RATIOS ON GROWTH PERFORMANCE AND ON PLASMA UREA NITROGEN IN GROWING-FINISHING PIGS FED FROM 85 TO 240 LB

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Summary

Eighty crossbred pigs (initially 85.2 lb BW) were used in a 2 × 4 factorial arrangement to determine the influence of dietary threonine:lysine ratios on growth performance and plasma urea N in growing-finishing pigs. The experiment was conducted in three phases from 85.2 to 124.2, 139.1 to 203.1, and 204.9 to 241.1 lb, with pigs fed one of eight dietary treatments. Two levels of dietary lysine were fed (low vs high) and four levels of dietary threonine were fed within each lysine treatment (60, 65, 70, and 75% of dietary lysine). Dietary lysine decreased from 1.0% and .8% at 85.2 to 124.2 lb to .9 and .7% at 139.1 to 203.1, then to .7 and .5% at 204.9 to 241 1 lb. Average daily gain (ADG) and feed efficiency (F/G) were not influenced by lysine or threonine treatment from 85.2 to 124.2 lb. However, average daily feed intake was decreased for pigs fed 1.0% dietary lysine compared to .8% dietary lysine. From 139.1 to 203.1 lb, an interaction between dietary lysine and threonine existed for ADG. Average daily gain was maximized at 65 and 70% of dietary lysine for pigs fed .7 and .9% dietary lysine, respectively. Conversely, ADFI and F/G were not influenced by threonine:lysine ratios. From 204.9 to 241.1 lb, ADG and ADFI were not influenced by dietary treatment. However, F/G was improved for pigs fed .7% dietary lysine compared to pigs fed .5% dietary lysine. Plasma urea N was increased at 124.2 and at 203.1 for pigs fed greater dietary lysine. At 241.1 lb, plasma urea N was decreased linearly at the percentage of threonine increased from 60 to 75% of lysine. The data from this experiment indicate that excess lysine and threonine intakes do not decrease growth performance. Because high ADFI resulted in high amino acid intake, growth performance was not influenced by the amino acid ratios used in this experiment.

(Key Words: Pigs, Lysine, Threonine, Growth Performance.)

Introduction

Previous research at Kansas State University has suggested that the dietary threonine requirement for growing pigs is greater than current NRC (1988) estimates. Our data suggest that the 70 lb pig requires at least .50 to .60% (10 to 11 g/d) dietary threonine to maximize growth performance. These data represent a 13% increase in dietary threonine compared to NRC estimates. Similar results have been reported from the University of Kentucky and Georgia for the growing pig. Results from the University of Illinois suggest that the ideal ratio of threonine to lysine is 70% of the dietary lysine content. If these data are correct, current NRC estimates would slightly underestimate the threonine requirement for growing-finishing pigs. Thus, the objective of this experiment was to determine the dietary threonine requirement relative to lysine for pigs fed from 85 to 240 lb.

Procedures

Animals. Eighty Duroc × (Yorkshire × Hampshire) pigs (40 barrows and 40 gilts) with an 85.2 lb initial BW were used in a 2 × 4 factorial arrangement. The

experiment was conducted in three phases and designed as a randomized complete block, using initial BW as the blocking factor for each of the three phases. Pigs (one barrow and one gilt) were housed in an environmentally controlled finishing barn with total slatted flooring (4 ft × 4 ft pens) with five replicate pens per treatment. Each pen contained a single-hole self-feeder and a nipple waterer to provide *ad libitum* access to feed and water. Drip coolers were activated when temperatures exceeded 80°F, cycling on for 3 out of every 15 min. Pig weights and feed disappearance were recorded weekly to determine ADG, ADFI, and feed efficiency (F/G). The first experiment (85 to 124 lb) was conducted for 18 d. At the end of the experiment, pigs were reallotted based upon final BW and given a 7 d adjustment period. This same procedure was followed at the end of the second experiment (139 to 203 lb). Pig weights and feed disappearance were collected weekly to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (F/G).

Diets. The experiment was conducted in three separate phases. Diets were formulated on a digestible lysine basis (Table 1), using a 65% ratio of isoleucine, a 70% ratio of methionine + cystine, a 20% ratio of tryptophan, and a 68% ratio of valine to ensure that threonine would be first limiting. From 85 to 124 lb, pigs were fed either a 1.0 or a .8% total dietary lysine diet, with threonine being either 60, 65, 70, or 75% of lysine. Dietary lysine was decreased to .9 and .7% and to .7 and .5% from 139 to 203 lb and from 205 to 241 lb, respectively. The diets contained .65% Ca and .5% P, with all other nutrients formulated in excess of NRC estimates.

Plasma Urea N. Plasma samples were taken at the end of each growth phase (124, 203, and 241 lb) and analyzed for urea N content. Samples for analysis were taken from both pigs in a pen and pooled to give a pen mean urea N concentration.

Results and Discussion

Growth Performance. From 85.2 to 124.2 lb (Table 1), ADG (P>.10), ADFI (P>.10), and F/G (P>.10) were not influenced by the threonine:lysine ratio. Lysine intake was increased (P<.01) for pigs fed 1.0% dietary lysine compared to pigs fed .80% dietary lysine. Threonine intake increased (P<.01) for pigs fed 1.0 vs .80% dietary lysine. Within lysine treatment, threonine intake increased (quadratic, P<.10; linear, P<.10) as the threonine: lysine ratio increased.

Average daily gain from 139.1 to 203.1 lb showed an interactive effect (P<.05) between dietary lysine and threonine. Pigs fed .70% dietary lysine had optimal ADG when a 70% threonine:lysine ratio was fed. Conversely, pigs fed .90% dietary lysine had optimal ADG when a 65% threonine:lysine ratio was fed. Average daily feed intake (P>.10) and F/G (P>.10), however, were not influenced by the threonine:lysine ratio. Lysine intake was greater (P<.01) for pigs fed .90% dietary lysine compared to pigs fed .70% dietary lysine. Similarly, threonine intake was increased (P<.01) for pigs fed greater dietary lysine. Within lysine treatment, threonine intake increased (linear, P<.01) as the ratio of threonine to lysine increased.

From 204.9 to 241.1 lb, neither ADG (P>10) nor ADFI (P>.10) were influenced by dietary treatment. However, F/G showed an interactive effect (P<.10) between dietary lysine and threonine. Feed efficiency for pigs fed .50% dietary lysine was optimized at a 65% threonine:lysine ratio. However, when .70% dietary lysine was fed, a 70% threonine:lysine ratio was required to optimize F/G. Feed efficiency was improved (P<.05) by increasing dietary lysine from .50 to .70%. Lysine and threonine intake were greater (P<.05) for pigs fed .70 vs .50% dietary lysine. Within lysine treatment, threonine intake increased (linear, P<.01) as the threonine:lysine ratio increased.

Plasma Urea N. Plasma urea N was

greater (P<.01) from 85.2 to 124.2 and from 139.1 to 203.1 lb for pigs fed greater dietary lysine. From 204.9 to 241.1 lb, plasma urea N was decreased (linear, P<.05) as the threonine:lysine ratio increased. Plasma urea N was numerically minimized at 65% threonine:lysine for both lysine treatments.

The results from this experiment do not indicate a strong relationship between dietary threonine:lysine ratios from 85.2 to 124.2 and 139.1 to 203.1 lb. Potentially, the lack of relationship can be explained by excess threonine and lysine intakes. Threonine intakes were 3 to 8 and 1 to 6 g/d in excess of NRC estimates for the 44 to 110 lb pig. Previous research from Europe and the University of Illinois suggests that excess amino acid intake will not result in poorer growth performance. However, diets formulated at 200% of the dietary lysine requirement will impair ADG and F/G (Oklahoma State University).

The lack of response to dietary lysine in this experiment suggests that the lysine requirement is being adequately met by the low lysine diet for each phase of the experiment. Average daily gain from 139.1 to 203.1 lb showed an interactive effect between dietary threonine and lysine. It appears that the dietary threonine requirement is potentially greater (70 vs 60% threonine:lysine, respectively) in this instance for pigs fed greater dietary lysine.

From 204.9 to 241.1 lb, dietary threonine intakes were below NRC estimates by 4 to 5 and 1 to 2 g/d for the low and high lysine diets, respectively. However, this did not affect ADG or F/G. Conversely, increasing dietary lysine resulted in improved F/G. Thus, the results from this experiment indicate that the high ADFI achieved in this experiment negated any potential relationship between dietary threonine dietary lysine and relative to ADG and F/G.

Table 1. Composition of Basal Diets

	Dietary Lysine, %				
Item, %	.5[a]	.7[ab]	.8[c]	.9[b]	1.0[c]
Corn	90.91	82.83	78.75	74.68	70.61
Soybean meal, 48% CP	2.21	10.50	14.65	18.80	22.96
Soybean oil	3.00	3.00	3.00	3.00	3.00
Monocalcium P (18% P)	1.82	1.67	1.59	1.52	1.44
Limestone	.99	.96	.94	.93	.91
Salt	.35	.35	.35	.35	.35
Vitamin premix	.20	.20	.20	.20	.20
Trace min. premix	.15	.15	.15	.15	.15
Sugar	.07	.08	.10	.11	.13
L-lysine-HCl	.270	.215	.198	.170	.151
L tryptophan	.035	.029	.018	.017	.016
DL methionine		.023	.048	.072	.087
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
CP (N × 6.25), %	8.98	12.32	14.00	15.69	17.36
Threonine, %	.37	.50	.56	.63	.69
Digestible Threonine, %	.25	.35	.40	.45	.50
Digestible Lysine, %	.42	.58	.67	.75	.84
Ca. %	.75	.75	.75	.75	.75
P, %	.65	.65	.65	.65	.65
ME, mcal/lb	1545	1545	1545	1545	1545

[a]Diets fed from 204.9 to 241.1 lb. [b]Diets fed from 139.1 to 203.1 lb. [c]Diets fed from 85.2 to 124.2 lb.

Table 2. Effect of Threonine:Lysine Ratios on Growth Performance in Growing-Finishing Pigs Fed from 85 to 240 lb[a]

	Low[b]				High[c]				
	60[d]	65	70	75	60	65	70	75	CV
85.2 to 124.2 lb									
ADG, lb	2.13	2.23	2.14	2.23	2.18	2.12	2.20	2.13	5.97
ADFI, lb[e]	5.22	5.17	5.01	5.79	5.02	4.81	5.03	5.08	9.03
F/G	2.24	2.32	2.35	2.60	2.30	2.26	2.29	2.38	10.87
Lys I, g[fg]	18.98	18.76	18.16	20.99	22.76	21.81	22.81	23.08	12.43
Thr I, g[egh]	11.37	12.19	12.71	15.73	13.66	14.18	15.97	17.32	12.51
139.1 to 203.1 lb									
ADG, lb[i]	2.34	2.14	2.44	2.36	2.26	2.47	2.27	2.21	8.19
ADFI, lb	6.77	6.32	6.93	7.04	6.89	7.02	6.78	6.45	8.72
F/G	2.90	2.96	2.84	2.99	3.06	2.86	2.98	2.92	7.23
Lys I, g[f]	21.49	20.07	22.02	23.36	28.15	28.66	27.67	26.34	8.65
Thr I, g[fj]	12.89	13.05	15.41	16.77	16.89	18.63	19.37	19.75	8.94
204.9 to 241.1 lb									
ADG, lb	1.71	1.69	1.83	1.92	1.81	1.90	2.27	1.68	15.28
ADFI, lb	5.07	5.02	5.50	5.13	5.14	5.33	5.40	4.87	10.32
F/G[ek]	3.16	3.07	3.05	2.82	2.85	2.86	2.43	2.97	10.52
Lys I, g[e]	11.51	11.40	12.47	11.64	16.33	16.92	17.09	15.48	10.16
Thr I, g[ej]	6.91	7.41	8.73	7.82	9.80	11.00	11.97	11.60	10.18

[a]Means calculated from 80 pigs, two pigs/pen, five pens/treatment.
[b]Low lysine equals .80% from 85.2 to 124.2 lb, .70% from 139.1 to 203.1 lb, and .50% from 204.9 to 241.1 lb.
[c]High lysine equals 1.00% from 85.2 to 124.2 lb, .90% from 139.1 to 203.1 lb, and .70% from 204.9 to 241.1 lb.
[d]Percentage of threonine relative to lysine.
[e]Dietary lysine effect (P<.05).
[f]Dietary lysine effect (P<.01).
[g]Quadratic effect of dietary threonine (P<.10).
[h]Linear effect of dietary threonine (P<.10).
[i]Dietary lysine × threonine effect (P<.05).
[j]Linear effect of dietary threonine (P<.01).
[k]Dietary lysine × threonine effect (P<.10).

Table 3. The Effect of Threonine:Lysine Rations on Plasma Urea N in Growing-Finishing Pigs Fed from 85 to 240 lb[a]

	Low[b]				High[c]				
Item, mg/dL	60[d]	65	70	75	60	65	70	75	CV
85.2 to 124.2 lb[e]	11.82	10.78	10.58	11.20	15.43	15.09	16.85	15.87	17.36
139.1 to 203.1 lb[e]	10.85	10.58	12.78	11.79	15.95	15.25	15.84	12.53	16.72
204.9 to 241.1 lb[f]	10.67	8.86	9.08	8.36	11.71	9.48	9.56	9.65	23.05

[a]Means calculated from 80 pigs, two pigs/pen, five pens/treatment.
[b]Low lysine equals .80% from 85.2 to 124.2 lb, .70% from 139.1 to 203.1 lb, and .50% from 204.9 to 241.1 lb.
[c]High lysine equals 1.00% from 85.2 to 124.2 lb, .90% from 139.1 to 203.1 lb, and .70% from 204.9 to 241.1 lb.
[d]Percentage of threonine relative to lysine.
[e]Dietary lysine effect ($P<.01$).
[f]Linear effect of dietary threonine ($P<.05$).