THE EFFECTS OF DIETARY THREONINE AND PORCINE SOMATOTROPIN DOSAGE ON NITROGEN BALANCE IN FINISHING SWINE

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Summary

Fifteen crossbred barrows were utilized to determine the effects of porcine somatotropin (pST) administration in combination with increasing dietary threonine levels on nitrogen retention and growth performance. Barrows averaging 147.3 lb were allotted in a split-plot arrangement with pST dosage (0, 4, or 8 mg/d) as the whole plot, and dietary threonine level (.45, .55, .65, .75, and .85%) as the subplot. These threonine values ranged from 112 to 212% of the dietary threonine estimate for finishing pigs (NRC 1988). All pigs within each pST dosage treatment received each diet for an 8-d period in a Latin square design. Diets were fed for a 4-d adaptation period followed by a 4-d total collection of feces and urine. Pigs were also weighed and bled at the end of each 8-d period. Increasing threonine level increased average daily gain (ADG), reduced feed intake (ADFI), and improved feed efficiency (F/G). Porcine somatotropin had no effect on ADG; however, pigs injected with 4 or 8 mg/d had numerical increases in ADG as threonine level increased. Feed efficiency improved as pST dosage increased. Daily threonine intake increased as dietary threonine level increased. However efficiency of threonine utilization for gain became poorer for control pigs as threonine intake increased, but pST-treated pigs had little change in efficiency of threonine utilization up to the .75 and .85% threonine levels for 4 and 8 mg/d pST dosages, respectively. There was a threonine x pST interaction for plasma urea concentrations, with control pigs having little change in urea concentrations, whereas pigs injected with 4 mg/d pST had a decrease then an increase in urea concentrations and pigs injected with 8 mg/d had continual decrease in urea concentrations. Nitrogen retention (g/d) and percent nitrogen retention increased as dietary threonine level increased. However, pigs injected with either 4 or 8 mg/d pST had greater increases in nitrogen retention than control pigs. Biological value also improved as dietary threonine level increased, but again showed a greater improvement for pST-treated pigs than control pigs. These results indicate improvements in growth performance and nitrogen retention for finishing pigs fed increasing threonine levels. However, the data also indicated that the magnitude of response to added threonine was greater for pST-treated pigs, suggesting a possible threonine requirement of approximately .65% or 18 g/d.

(Key Words: Repartition, GF, Performance, AA, Nitrogen.)

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Introduction

Previous studies at Kansas State University have focused on determining the interactive effects of porcine somatotropin (pST) administration and nutrient density on growth performance and carcass characteristics of finishing pigs. These studies have suggested that pST administration and the associated increases in lean gain are optimized with a diet containing between 1.0 and 1.2% dietary lysine. Therefore, the objective of this study was to determine if pST administration increases the dietary threonine requirement of finishing pigs as measured by nitrogen retention.

Procedures

Fifteen crossbred barrows (Duroc × Yorkshire × Hampshire × Chester White) averaging 147.3 lb were placed in metabolism crates, which allowed for separate collection of urine and feces. Pigs were allotted in a split-plot arrangement with pST dosage as whole plot treatments (0, 4, and 8 mg/d pST). Subplot treatments consisted of 5 dietary threonine levels (.45, .55, .65, .75 and .85%; Table 1) administered in a Latin square design with each pig within a pST dosage receiving each of the diets. Diets were formulated to contain at least 200% of the pig's requirement for amino acids, vitamins and minerals with the exception of threonine (Table 2). This was to ensure that any change in response criteria was due to dietary threonine. Dietary treatments were fed for 8 d, with a 4-d adaptation period and a 4-d total collection of feces and urine. Pigs were fed a diet containing 1.2% lysine and injected with their respective pST dosage for a 7-d adaption period prior to the start of the experiment. Pigs were weighed at the end of every 8-d period, and feed intake was recorded. Feed and water were offered ad libitum. In addition, at 4 h postinjection and 3 h postprandial, pigs were bled for serum urea concentrations.

Results and Discussion

Increasing level of dietary threonine resulted in an increase (linear, $P<.05$) in ADG (Table 3). Although there was no effect of pST or pST × threonine interaction on ADG, control pigs appeared to show no improvement in ADG (avg 2.01 lb), whereas pigs injected with 4 or 8 mg/d pST had increasing ADG, which was maximized at .65 and .75% dietary threonine, respectively (2.48 and 2.36 lb/d). Average daily feed intake tended to decrease (linear $P<.10$) as dietary threonine increased and to decrease as pST dosage increased by 13 and 23% for pigs injected with 4 or 8 mg/d, respectively. Feed conversion was improved as dietary threonine level increased (linear, $P<.05$) and as pST dosage increased (linear and quadratic, $P<.05$). Control pigs had an 11% improvement in F/G as dietary threonine level increased; however, pigs injected with 4 or 8 mg/d pST had 21 and 34% improvements in F/G. Calculated daily threonine intakes (feed intake × % dietary threonine) increased as dietary threonine level increased (linear, $P<.05$ and quadratic, $P<.10$) but decreased as pST dosage increased (linear $P<.05$). When expressed as efficiency of threonine utilization for gain (g threonine/lb gain), increasing dietary threonine level resulted in poorer efficiency of gain (linear, $P<.05$), but as pST dosage increased, efficiency of threonine utilization for gain improved (linear and quadratic, $P<.05$). Although there was no pST × threonine interaction ($P>.30$), with each increasing threonine level, control pigs had poorer threonine utilization.

Pigs injected with 4 and 8 mg/d pST had similar threonine utilization until .75 and .85% dietary threonine, respectively, when threonine utilization then became poorer.

There was a pST × threonine interaction for plasma urea concentrations (P<.05). This appeared to be the result of very little change in urea concentrations of control pigs compared to a decrease then increase in 4 mg/d pST-treated pigs and a continued decrease in urea concentrations of 8 mg/d pST-treated pigs. High urea concentrations indicate that excess amino acids are being oxidized to produce urea, whereas low values indicate that amino acids are being incorporated into protein synthesis. In pigs treated with 4 or 8 mg/d pST, as dietary threonine level increased, threonine was no longer limiting protein synthesis, and other amino acids were no longer being deaminated into urea synthesis.

Table 1. Diet Composition

Ingredient	%
Milo	65.05
Peanut meal, solvent	20.03
Soybean oil	7.00
Monocalcium phosphate (21% P)	3.31
Limestone	1.13
L-lysine	1.47
Vitamin premix[a]	.50
Trace mineral premix[b]	.20
DL-methionine	.34
Salt	.25
L-Isoleucine	.21
L-Tryptophan	.06
Selenium premix[c]	.05
Sucrose/Threonine[d]	.40
	100.00

[a]Each lb of vitamin premix contains: vitamin A, 1,000,000 IU; vitamin D_3, 100,000 IU; vitamin E, 4,000 IU; menadione, 400 mg; riboflavin, 1000 mg; pantothenic acid, 2,500 mg; niacin, 5,500 mg; choline, 100,000 mg; and vitamin B_{12}, 5 mg.
[b]Contains 10% Mn, 10% Fe, 10% Zn, 4% Ca, 1% Cu, 0.4% K, 0.3% I, 0.2% Na, and 0.1% Co.
[c]Provided .3 ppm Selenium.
[d]Sucrose was replaced by threonine to provide levels of .55, .65, .75, and .85%.

Table 2. Chemical Analysis of Control Diet[a]

Item	%
DM	89.60
CP	15.90
Ca	1.10
P	1.00
Essential and semi essential amino acids	
Arginine	1.32
Cystine	.23
Histidine	.37
Isoleucine	.76
Leucine	1.45
Lysine	1.60
Phenylalanine	.80
Threonine	.45
Tryptophan	.24
Tyrosine	.55
Valine	.71

[a]Analyzed values are expressed on an as-fed basis.

Table 3. Effect of Dietary Threonine and pST on Growth Performance of Finishing Pigs

Item	% Threonine .45	.55	.65	.75	.85	CV
ADG, lb[a]						
Control	1.98	2.10	1.91	2.10	2.15	18.3
4 mg pST	2.00	2.18	2.47	2.08	2.36	
8 mg pST	1.50	2.02	2.03	2.37	2.13	
ADFI, lb[bc]						
Control	6.69	7.05	6.74	6.57	6.66	8.0
4 mg pST	5.93	6.01	6.23	5.72	5.46	
8 mg pST	5.20	5.27	5.07	5.35	5.00	
F/G[acd]						
Control	3.38	3.36	3.53	3.13	3.10	18.5
4 mg pST	2.97	2.76	2.52	2.75	2.31	
8 mg pST	3.47	2.61	2.50	2.26	2.35	
Threonine intake, g/d[acef]						
Control	13.55	17.56	19.82	22.4	25.76	8.4
4 mg pST	12.1	15.03	18.41	19.53	21.22	
8 mg pST	10.54	13.27	14.99	18.21	19.28	
Threonine efficiency, g threonine/lb gain[acd]						
Control	7.38	8.52	10.35	10.92	12.33	3.4
4 mg pST	6.08	7.18	7.49	9.47	9.12	
8 mg pST	7.09	6.70	7.68	7.74	9.17	

[a]Linear threonine effect (P<.05).
[b]Linear threonine effect (p<.10).
[c]Linear effect of pST (P<.05).
[d]Quadratic effect of pST (P<.05).
[e]Quadratic threonine (P<.10).
[f]Threonine × pST interaction (P<.15).

Nitrogen intake decreased as dietary threonine level increased (linear and quadratic, P<.05) and decreased as pST dosage increased (linear P<.05). Nitrogen retention (g/d) increased then decreased (quadratic, P<.05) as dietary threonine level increased. As pST dosage increased, there were 72 and a 38% increases in nitrogen retention for pigs injected with 4 and 8 mg/d, respectively. Similar trends were observed for nitrogen retention when expressed as a percentage of nitrogen intake. For pigs injected with 4 or 8 mg/d pST, nitrogen retention appeared to be maximized at .65% dietary threonine; however, control pigs maximized their nitrogen retention at .75% dietary threonine. This response is in disagreement with the other response criteria observed for the control pigs. Biological value of the diets tended to increased (linear and quadratic, P<.10) as dietary threonine level increased. As pST dosage increased, there were 90 and 81% increases in biological value for pigs treated with 4 or 8 mg/d pST (linear and quadratic, P<.05). Biological value is an indicator or protein quality, or how closely a protein comes to meeting all the pig's amino acid requirements. The higher BV of pST-treated pigs compared to control-treated pigs fed the same diets, indicated that amino acids were utilized more efficiently.

Porcine somatotropin had no effect on digestibility of nitrogen or dry matter. Threonine level had no effect on nitrogen digestibility, but dry matter digestibility increased with increasing threonine level (linear, P<.05).

In conclusion, these data suggest that approximately .65% dietary threonine maximized growth performance of pigs injected daily with 4 mg pST. However, pigs injected with 8 mg/d pST tended to have better performance when fed a diet containing .75% threonine. Pig performance appeared to plateau and be optimized with the 4 mg pST dosage; however, there were some improvements in feed conversion and nitrogen balance with the 8 mg/d dosage. Increasing threonine level appeared to give little or variable improvement in performance and nitrogen balance of control pigs. Pigs injected with pST tended to show a greater magnitude of response in nitrogen balance and growth performance to dietary threonine.

Table 4. Effect of Dietary Threonine and pST on Nitrogen Balance in Finishing Pigs[a]

	% Threonine					
Item	.45	.55	.65	.75	.85	CV
Plasma urea concentration, mg/dl[bcde]						15.0
Control	26.69	29.42	29.34	27.14	25.32	
4 mg pST	18.36	15.03	12.78	13.31	14.41	
8 mg pST	16.51	12.05	10.72	10.72	8.90	
Nitrogen digestibility, %						
Control	79.19	81.65	81.59	82.07	79.24	3.7
4 mg pST	80.64	81.48	81.49	80.88	82.44	
8 mg pST	77.92	79.32	80.19	81.13	80.54	
Dry matter digestibility, %[b]						
Control	82.78	84.31	84.45	84.86	83.24	2.2
4 mg pST	83.74	83.76	84.44	84.21	85.61	
8 mg pST	81.85	83.20	84.07	84.46	84.70	
Nitrogen intake, g/d[bcf]						
Control	78.11	81.64	80.31	79.31	76.05	8.4
4 mg pST	71.87	73.78	73.85	65.01	64.12	
8 mg pST	58.07	60.21	59.56	62.74	56.91	
Nitrogen retention, g/d[cdf]						
Control	18.38	12.91	23.84	32.12	21.56	13.0
4 mg pST	35.06	38.82	44.47	33.79	34.85	
8 mg pST	17.43	28.35	38.47	36.43	29.46	
Nitrogen retention, %[cdg]						
Control	26.24	16.79	31.39	36.57	28.25	36.3
4 mg pST	48.31	53.57	59.99	50.83	54.62	
8 mg pST	34.14	46.79	62.93	55.79	50.00	
Biological value, % [cdg]						
Control	33.29	20.77	37.87	43.91	35.92	35.4
4 mg pST	59.69	65.58	73.38	62.72	65.99	
8 mg pST	43.92	59.25	78.15	68.87	61.79	

[a]Each mean represents five observations. Average initial wt = 147.3 lb. Each collection period was 4 d in length.
[b]Linear effect of threonine (P<.05).
[c]Linear effect of pST (P<.05).
[d]Quadratic effect of pST (P<.05).
[e]Threonine × pST interaction (P<.05).
[f]Quadratic effect of threonine (P<.05).
[g]Linear and quadratic effect of threonine (P<.10).