THE EFFECTS OF PORCINE SOMATOTROPIN (PST) AND DIETARY LYSINE LEVEL ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF FINISHING SWINE[1]

R.D. Goodband, J.L. Nelssen, R.H. Hines,
D.H. Kropf, R.C. Thaler, B.R. Schricker,[2]
G.E. Fitzner, and A.J. Lewis[3]

Summary

Seventy-two finishing pigs averaging 130 lb were utilized to determine the effects of PST and dietary lysine on growth performance and carcass characteristics. Pigs were injected daily with 4 mg PST in the extensor muscle of the neck and fed either a pelleted corn-sesame meal diet (.6% lysine, 17.7% crude protein) or diets containing .8, 1.0, 1.2, or 1.4% lysine provided by L-lysine HCl. All diets were formulated to contain at least 200% of NRC (1979) recommendations for other amino acids. Control pigs received a placebo injection and the .6% lysine diet. Increasing levels of dietary lysine resulted in increased average daily gain (ADG) and improved feed conversion (F/G; linear and quadratic, P<.01) for PST-treated pigs. Adjusted backfat thickness (ABF) was not affected by dietary lysine; however, PST-treated pigs had less backfat (P<.05) than control pigs. Longissimus muscle area (LMA), trimmed ham, and loin weights increased as dietary lysine was increased among PST-treated pigs (linear and quadratic, P<.01). Percentage of moisture and crude protein of the longissimus muscle increased, (linear P<.05, linear and quadratic P<.05, respectively), whereas dry matter and fat content decreased (linear P<.05). Similar trends in composition were observed for other ham muscles (semimembranous, semitendinosus, and biceps femoris). Heart, liver, kidney, spleen, and lung weights were not affected by PST or lysine treatment. Urea concentrations in plasma on day 28 decreased linearly (P<.01) as lysine level increased, whereas plasma lysine and insulin increased (linear and quadratic, P<.01). Plasma glucose and free fatty acid concentrations on day 28 tended to increase (quadratic P<.10) with increasing dietary lysine level. Plasma somatotropin level was elevated 2 to 3 times in PST-treated pigs compared to control pigs, but was not affected by dietary lysine level.

Our results indicate a relatively high requirement for lysine in PST-treated pigs. Growth performance and carcass traits were optimized at dietary lysine levels of 1.2 to 1.4%, which corresponds to lysine intakes of 30 to 36 g/day. These results demonstrate that PST-administration nearly doubles the lysine requirment of finishing swine.

(Key Words: Porcine Somatotropin, Lysine, Growth, Carcass Composition, Swine.)

Introduction

Somatotropin has been demonstrated to be a potent growth promotant in swine. Its effects are not only limited to improvements in gain and feed conversion, but it also can reduce carcass lipid content and increase protein deposition. However, the magnitude of

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[2]Pitman-Moore, Inc. Terre Haute, IN. 47808.

[3]University of Nebraska, Lincoln.

response to PST treatment has varied between experiments. This may be a result of the form (pituitary or recombinant) or dosage of PST administered; however, it is our contention that possible nutrient deficiencies in the diets used in previous experiments may have limited growth performance. In general, those researchers feeding a 14% crude protein finishing diet have seen the smallest response to PST, while those researchers feeeding highly fortified diets have seen the largest improvements in pig performance.

Therefore, our objective was to determine the lysine requirement of finishing swine injected with PST and to determine its effects on growth and carcass characteristics.

Procedures

Seventy-two finishing pigs (36 barrows and 36 gilts) averaging 130 lb were allotted on the basis of weight and ancestry to one of six treatments. Treatments included either a daily injection of 4 mg PST or placebo, in combination with a pelleted corn-sesame meal diet (.6% lysine; Table 1) or diets containing .8, 1.0, 1.2 or 1.4% lysine provided by L-lysine HCl. All diets were formulated to contain at least 200% of NRC (1979) recommendations for other amino acids. Control pigs (placebo injection) received the .6% lysine diet. There were two pigs per pen and six observations per treatment. Pigs were weighed on day 14 and 28 and again when the pen mean weight reached 203 lb, at which time daily injections were terminated and a 7-day withdrawal period was observed. Pigs were bled via vena cava puncture (4 hr postinjection and 3 hr postprandial) on day 14, 28, and the last day of treatment administration. At this time, pigs were also ultrasonically probed for backfat thickness. The 36 barrows used in the study were slaughtered locally, and carcass measurements and organ weights were recorded. In addition, the right ham and loin were removed, evaluated for color, firmness, and marbling; trimmed to approximately 1/4 in fat thickness; and weighed. The ham was then separated into its major individual muscles, which were weighed, sampled along with the loin (10th and 11th thoracic vertebra), and taken for chemical analysis to determine percentage moisture, dry matter, crude protein, fat, and ash.

Data were analyzed using a factorial design with a control treatment. Main effects included sex and lysine level. Because of the nature of the statistical design, linear, quadratic and cubic comparisons apply to only PST-treated pigs, whereas control pigs are included for comparison only. Since no sex x lysine interactions were observed, only lysine main effects will be reported. Backfat, longissimus muscle area (10th thoracic vertebra), and length were corrected to a constant weight (230 lb) using NPPC guidelines. Other carcass data were corrected using final weight as a covariate.

Results and Discussion

Increasing levels of dietary lysine resulted in increased ADG (linear and quadratic, P<.01) for PST-treated pigs (Table 2). Average daily gain was maximized at the 1.2% dietary lysine level, with those pigs gaining approximately 35% faster than control or PST-treated pigs receiving the .6% lysine diet. Control pigs consumed more feed than PST-treated pigs; however, average daily feed intake (ADFI) was again maximized at the 1.2% dietary lysine level. Feed conversion (F/G) also improved (linear and quadratic, P<.01) with increasing levels of dietary lysine in combination with PST treatment. Porcine somatotropin-treated pigs fed either 1.2 or 1.4% lysine diets were 33% more efficient than control or PST treated pigs fed the .6% lysine diet.

Urea concentrations in plasma determined on day 28 of the experiment decreased linearly (P<.01) with increasing lysine levels (Table 3). Plasma lysine concentrations on the other hand, remained low for pigs fed the .6, .8, or 1.0% lysine diets, then increased (linear and quadratic, P<.01) for PST-treated pigs fed the 1.2 or 1.4% lysine diets. The decrease in plasma urea concentration in response to increasing dietary lysine level indicates that amino acids were no longer being deaminated, but rather were incorporated into protein, once the lysine requirement was met. This appears to have occurred at a dietary lysine level of 1.2%.

Plasma glucose, free fatty acids and insulin were elevated in PST-treated pigs compared to control treated pigs, whereas creatinine concentrations were unchanged. This response is typical throughout the literature and is a result of changes in carbohydrate and lipid metabolism induced by somatotropin administration. Furthermore, these metabolites also increased with increasing dietary lysine level. This may be an effect of increased metabolic rate of the faster growing pigs compared to control or slower growing pigs.

Pigs were removed from the experiment when pen mean weight reached 230 lb, thus hot carcass weight was unaffected by experimental treatment (Table 4). Dressing percent was also unaffected by experimental treatment. Values observed in this study were lower than typical dressing percentage values, since the pigs in this study were skinned at slaughter. Adjusted backfat thickness was unaffected by dietary treatment; however, PST-treated pigs had less backfat than control pigs. Increasing levels of dietary lysine in combination with PST treatment resulted in a 26% increase (linear and quadratic, $P<.01$) in longissimus muscle area. Trimmed ham and loin weights also increased (linear and quadratic, $P<.01$) with increasing dietary lysine level. Kidney fat decreased (linear, $P<.01$) with increasing dietary lysine level.

Individual muscle weights of the ham also increased in response to increasing dietary lysine and PST treatment (Table 5). Subjective evaluations of ham and loin color and firmness were unaffected by experimental treatment; however, loin marbling was decreased (linear $P<.05$) with increasing level of dietary lysine among PST-treated pigs.

Increasing levels of dietary lysine in combination with PST treatment resulted in increased ($P<.05$) moisture and crude protein content of the longissimus, semitendinosus, and biceps femoris (Table 6). In addition, fat content of these muscles was lowered ($P<.05$) with the longissimus having a 63% reduction in fat compared to control pigs. This decreased fat content is consistent with the lowered kidney fat and marbling scores. Taste panel and shear-force evaluations are in progress to determine if this response will affect meat tenderness or quality.

Weights of heart, liver, kidneys, spleen, and lungs were unaffecteda by dietary lysine level; however, organ weights of PST-treated pigs were numerically heavier than those of control pigs (Table 7).

Our data indicate that the magnitude of response to PST-treatment is directly dependent on the nutritional status of the animal. It would appear that the lysine requirement of PST-treated pigs is at least double that of present recommendations for finishing swine. Therefore, when evaluating the full potential of PST as a growth promotant for finishing swine, we must be cognizant of changes in the nutritional requirements because of PST treatment.

Table 1. Diet Composition[a]

Ingredient	Percentage
Corn	62.25
Sesame meal	23.40
Soybean meal (44%)	5.00
Soybean oil	5.00
Monocalcium phosphate	1.29
Limestone	.68
Salt	.50
Trace mineral premix[b]	.20
Vitamin premix[c]	.50
Selenium premix[d]	.05
Threonine	.10
Sucrose/L-lysine HCl[e]	1.03
	100.00

[a]Analyzed to contain: 17.7% crude protein, .6% lysine, .82% threonine, .25% tryptophan, 1% calcium, and .8% phosphorus.
[b]Contained 5.5% Mn, 10% Fe, 1.1% Cu, 20% Zn, 0.15% I, and 0.1% Co.
[c]Each lb of premix contained the following: vitamin A 800,000 IU, vitamin D 60,000 IU, vitamin E 4,000 IU, riboflavin 900 mg, d-pantothenic acid 24.0 g, choline chloride 92.2 g, niacin 5.0 g, B_{12} 4.4 mg, menadione dimethylpyrimidinol bisulfate 331 mg.
[d]Contained 90 mg Se/lb premix.
[e]Sucrose was replaced by L-lysine HCl to provide dietary lysine levels of .8, 1.0, 1.2, and 1.4%.

Table 2. Effect of PST and Dietary Lysine on Growth Performance[a]

	Control	PST-treated, % lysine				
Item	.6% lysine	.6	.8	1.0	1.2	1.4
Daily gain, lb						
Day 28[bc]	1.87	1.57	1.94	2.56	2.73	2.62
Overall[bc]	1.98	1.65	2.14	2.56	2.65	2.56
Daily feed intake, lb						
Day 28[d]	5.47	4.78	4.87	5.20	5.34	5.14
Overall[d]	6.11	4.98	5.42	5.53	5.45	5.29
Feed conversion (F/G)						
Day 28[bc]	2.91	3.13	2.52	2.04	1.96	1.98
Overall[bc]	3.07	3.03	2.54	2.18	2.07	2.08

[a]A total of 72 finishing pigs with an average initial weight 130 lb and average final weight 230 lb. Overall trial duration ranged from 42 to 66 days. Linear and quadratic comparisons correspond to only PST treatments.
[b]Linear effect of lysine ($P<.01$).
[c]Quadratic effect of lysine ($P<.01$).
[d]Quadratic effect of lysine ($P<.10$).

Table 3. Effect of PST and Dietary Lysine on Serum Criteria (day 28)[a]

Criteria	Control	PST-treated, % lysine				
	.6% lysine	.6	.8	1.0	1.2	1.4
Urea, mg/dl [bd]	32.10	29.30	23.10	17.90	16.10	13.70
Lysine, mg/dl[bc]	.99	.72	.86	1.08	1.92	3.36
Glucose, mg/dl[d]	102.20	107.00	116.20	118.90	115.50	112.10
Creatinine, mg/dl	1.36	1.39	1.42	1.42	1.39	1.44
Free fatty acids, meq/L[d]	278	379	396	411	435	425
Insulin, uU/ml[bc]	6.25	8.81	17.24	19.72	28.50	23.15
Somatotropin, ng/ml	2.05	6.31	5.45	4.59	5.05	5.50

[a]A total of 72 finishing pigs with an average initial weight 130 lb and average final weight 230 lb. Overall trial duration ranged from 42 to 66 days. Linear and quadratic comparisons correspond to only PST treatments.
[b]Linear effect of lysine ($P<.01$).
[c]Quadratic effect of lysine ($P<.01$).
[d]Quadratic effect of lysine ($P<.10$).

Table 4. Effect of PST and Dietary Lysine on Carcass Characteristics[a]

Characteristics	Control	PST-treated, lysine, %				
	.6% lysine	.6	.8	1.0	1.2	1.4
Hot carcass weight, lb	148.53	143.37	149.94	147.31	147.62	147.78
Dressing percent	60.24	58.12	61.08	60.25	60.31	60.57
Adjusted backfat thickness, in	1.02	.85	.84	.90	.85	.89
Longissimus muscle area, in[2bc]	4.94	4.87	6.06	6.28	6.56	6.59
Carcass length, in	31.41	31.31	31.32	31.20	30.91	31.05
Kidney fat, lb[b]	3.19	2.92	2.53	1.94	2.08	1.83
Loin weight, lb[bc]	14.97	14.20	15.57	16.21	15.72	15.99
Ham weight, lb[bc]	15.26	15.24	17.11	17.51	17.40	17.24

[a]A total of 72 finishing pigs with an average initial weight 130 lb and average final weight 230 lb. Overall trial duration ranged from 42 to 66 days. Linear and quadratic comparisons correspond to only PST treatments.
[b]Linear effect of lysine ($P<.01$).
[c]Quadratic effect of lysine ($P<.01$).

Table 5. Effect of PST and Dietary Lysine on Muscle Weights, Color, Firmness and Marbling, and pH[a]

Item	Control .6% lysine	PST-treated, % lysine .6	.8	1.0	1.2	1.4
Muscle, g						
Semimembranous[c]	900.6	919.8	1044.7	1011.3	1025.0	971.7
Semitendinosus[c]	369.8	376.2	446.1	423.8	443.1	439.2
Adductor[b]	345.3	299.4	327.1	380.3	414.8	468.9
Biceps femoris[bc]	1247.1	1285.3	1479.4	1540.2	1533.8	1514.2
Quadrecips femoris[bc]	988.5	970.1	1111.3	1189.3	1133.0	1113.4
Gastrocnemius[bc]	501.9	503.9	565.9	566.2	586.6	567.3
Lean trim[c]	1280.6	1344.7	1607.6	1557.0	1420.0	1430.1
Femur, g	349.6	380.7	360.0	357.6	336.4	347.4
Color[d]						
Ham	2.5	2.6	3.0	2.9	2.9	2.8
Longissimus	3.0	3.1	2.9	3.0	3.2	3.0
Firmness[e]						
Ham	2.2	2.6	2.5	2.6	2.3	2.3
Longissimus	2.6	2.9	2.4	2.7	2.7	2.8
Marbling[f]						
Longissimus[b]	2.3	2.1	1.8	1.9	1.6	1.4
pH, 24 hr[g]						
Semimembranous[b]	5.68	5.75	5.80	5.69	6.13	6.03
Longissimus	5.69	5.82	5.69	5.83	5.94	5.70

[a]Data taken from 36 barrows. Final weight was used as a covariate.
[b]Linear effect of lysine ($P<.05$).
[c]Quadratic effect of lysine ($P<.05$).
[d]Based on a scale with 1=extremely pale, 3=normal, 5=extremely dark.
[e]Based on a scale with 1=extremely soft, 3=normal, 5=extremely firm.
[f]Based on a scale with 1=trace, 3=small, 5=abundant.
[g]Determined at 24 hr after slaughter.

Table 6. Effect of PST and Dietary Lysine on Selected Muscle Composition[a]

Muscle	Control .6% lysine	PST-treated, % lysine .6	.8	1.0	1.2	1.4
Longissimus						
Moisture, %[b]	71.08	73.03	72.58	73.40	74.06	74.05
Dry matter, %[b]	28.92	26.97	27.42	26.60	25.94	25.95
Crude protein, %[bc]	20.05	19.51	20.52	21.15	21.97	21.23
Lipid, %[b]	7.19	5.07	5.10	3.40	2.54	2.61
Ash, %	1.01	1.02	1.09	1.04	1.14	.92
Semimembranous						
Moisture, %[b]	74.92	75.60	75.02	74.62	74.53	74.59
Dry matter, %[b]	25.08	24.40	24.98	25.38	25.47	25.41
Crude protein, %	21.05	20.91	21.01	21.71	21.74	21.37
Lipid, %	2.93	1.80	2.19	2.35	2.11	2.20
Ash, %	1.03	1.13	1.07	1.16	1.09	1.07
Semitendinosus						
Moisture, %[b]	72.71	73.59	73.76	74.06	74.81	75.29
Dry matter, %[b]	27.29	26.41	26.24	25.94	25.19	24.72
Crude protein, %[b]	18.76	19.43	20.30	20.26	20.72	20.78
Lipid, %[b]	7.38	5.70	5.50	4.65	3.51	3.25
Ash, %	.89	1.05	1.04	1.09	1.05	.98
Biceps femoris						
Moisture, %[d]	74.35	74.80	74.41	74.39	74.13	7.07
Dry matter, %[d]	25.65	25.20	25.59	25.61	25.87	2.93
Crude protein, %[bc]	20.45	19.98	21.10	21.36	21.63	2.39
Lipid, %[b]	4.13	2.96	3.23	2.60	2.34	1.98
Ash, %	1.32	1.23	1.20	1.30	1.21	1.26

[a]Data taken from 36 barrows. All percentages based on a fresh basis.
[b]Linear effect of lysine ($P<.05$).
[c]Quadratic effect of lysine ($P<.05$).
[d]Quadratic effect of lysine ($P<.06$).

Table 7. Effect of PST and Dietary Lysine on Selected Organ Weights[a]

Item	Control .6% lysine	PST-treated, % lysine .6	.8	1.0	1.2	1.4
Organ weight, g						
Heart	325.3	331.9	347.4	345.5	366.8	324.9
Liver	1800.2	1948.0	1889.3	1945.7	1878.8	1922.7
Kidneys	372.4	417.0	408.6	448.6	419.1	35.8
Spleen	166.8	180.0	169.7	172.7	159.0	69.3
Lung	782.5	798.3	744.5	725.5	760.7	587.9

[a]Data from 36 barrows. Final weight was used as a covariate.