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EFFECTS OF HEAT STRESS, DIETARY ENERGY DENSITY, AND EXOGENOUS PORCINE SOMATOTROPIN ON THE GROWTH PERFORMANCE OF FINISHING PIGS

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Summary

This experiment was conducted to determine the interactive effects of environmental temperature, porcine somatotropin (pST), and dietary energy density on the growth performance of finishing pigs. Forty-eight barrows were allotted randomly to four environmental chambers (EC) in a split plot design with two EC/whole plot (WP). Each EC (12 barrows/EC) represented one subplot (SP). The WP 24-h environmental cycles were: thermal neutral (TN), 8 h at 75°F and 50% relative humidity (RH)-1 h transition-14 h at 68°F and 60% RH-1 h transition; and heat stress (HS), 8 h at 95°F and 60% RH-1 h transition-14 h at 82°F and 80% RH-1 h transition. Each SP was a 2 × 3 factorial with two treatments (pigs were injected daily with either 4 mg pST (+) or placebo (−)) and three dietary energy densities (1.48, 1.60, and 1.71 Mcal ME/lb). Diets were formulated to contain 19.2% crude protein and at least 200% of NRC (1988) recommendations for essential nutrients. The study was conducted for 32 d. There were no interaction effects for ADG, average daily feed intake, d-14 respiration rate, or d-14 rectal temperature. Differences in respiration rate and rectal temperature were observed between the HS and TN environments (respiration rate, 76 vs 28; rectal temperature, 103.8 vs 101.8°F). There was an environment × pST interaction for feed efficiency (F/G). The F/G of barrows administered pST was similar in HS (2.23) and TN (2.29) environments. The F/G of placebo-treated barrows increased in HS (3.09) compared to the TN (2.80) environment. These results show that the growth response of finishing pigs treated with pST is similar in the HS and TN environments.

(Key Words: Heat Stress, Energy, Porcine Somatotropin, Pig, Growth Performance.)

Introduction

Increases in growth rate observed in pigs administered porcine somatotropin has been well documented. In addition to the accelerated growth rate, dramatic changes in carcass composition also have been reported. It has been suggested that the accelerated growth rate observed in pigs treated with porcine somatotropin is accompanied by a dramatic increase in metabolic rate. Researchers have speculated that the increased metabolic rate and associated increase in heat production would severely compromise the pig's ability to cope with high temperature thermal stress. Heat stress depresses feed intake. Increasing dietary energy density may help offset part of the reduction in growth observed during heat stress, as a result of depressed feed intake. No data are currently available on the response to heat stress of finishing pigs receiving porcine somatotropin. The objective of this study was to determine the

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interactive effects of environmental temperature, porcine somatotropin, and dietary energy density on growth performance of finishing pigs.

Experimental Procedures

Experimental diets are shown in Table 1. Diets were formulated to contain 19.2% crude protein and at least 200% of NRC (1988) recommendations for essential nutrients. Diets were formulated with increasing energy densities, expressed as Mcal ME/lb of feed: 1.48, 1.60, or 1.71.

Table 1. Experimental Diets

	Energy density, Mcal ME · lb^{-1}		
Ingredient, %	1.48	1.60	1.71
Corn	64.58	58.17	50.91
Soybean meal (48.5)	28.00	29.00	30.30
Solka floc	--	--	--
Soy oil	2.00	7.40	13.40
Dicalcium phosphate	3.00	3.07	3.09
Limestone	.95	.90	.87
L-lysine-HCl	.20	.19	.16
Threonine	.01	.01	.01
Tryptophan	.01	.01	.01
Salt	.50	.50	.50
Selenium premix[a]	.05	.05	.05
Vitamin premix[b]	.50	.50	.50
Trace mineral premix[c]	.20	.20	.20
Calculated to contain:			
Mcal ME/lb	1.48	1.60	1.71
Crude protein, %	19.27	19.19	19.18
Lysine, %	1.20	1.20	1.20
Threonine, %	.81	.80	.81
Tryptophan, %	.23	.23	.24
Calcium, %	1.10	1.10	1.10
Phosphorus, %	.90	.90	.90
g lysine/Mcal ME	3.7	3.4	3.2

[a]Contained 123 mg Se/lb premix.

[b]Each lb of premix contains the following: .80 million IU vitamin A, 60,000 IU vitamin D_3, 4,000 IU vitamin E, 900 mg riboflavin, 310 mg menadione, 2,400 mg d-pantothenic acid, 5,000 mg niacin, 92,200 mg choline chloride, 4.4 mg vitamin B_{12}.

[c]Each lb of premix contained 25 g Mn, 45.4 g Fe, 5 g Cu, 91 g Zn, .7 g I, and .45 g Co.

Forty-eight crossbred barrows averaging 157.5 lb were allotted randomly to four environmental chambers (EC) in a split plot design with two EC per whole plot. Each EC (12 barrows per EC) represented one subplot (SP). The WP 24 h environmental cycles were: thermal neutral (TN), 8 h at 75°F and 50% relative humidity (RH) − 1 h transition − 14 h at 68°F and 60% RH − 1 h transition; and heat stress (HS), 8 h at 95°F and 60% RH − 1 h transition − 14 h at 82°F and 80% RH − 1 h transition. Each SP was a 2 × 3 factorial with two treatments (pigs were injected daily with either 4 mg pST (+) or placebo (−) in the extensor muscle of the neck) and three dietary energy densities (Table 1).

Pigs were housed in individual pens (4.0 ft × 4.0 ft) and were allowed ad libitum access to feed and water. One single hole, self-feeder was provided per pen. Individual pig and feeder weights were taken weekly and at the termination of the trial. The trial lasted 32 d.

Results and Discussion

Interaction effects between environment, pST, and dietary treatments were not significant, with the exception of an environment by pST effect on feed efficiency (F/G). Main effect means for growth performance and intake data are given in Table 2. Interaction means are shown in Tables 3, 4, and 5.

The thermal neutral zone for finishing pigs is in the range of 66 to 77°F. Pigs exposed to environmental temperatures above or below their thermal neutral zone have been shown to produce more body heat and, thus, have a greater energy requirement compared to pigs maintained in their thermal neutral zone. The upper critical temperature has been defined as the effective ambient temperature above which total heat-production rate at a given feed intake will rise. It has been suggested that the point at which there is a rise in respiration rate may be used to identify the upper critical limit. The upper critical temperature for finishing hogs is estimated to be in the range of 80 to 84°F. In the present study, respiration rate and rectal temperature were both increased in HS compared to TN environment (respiration rate: 76 in HS vs 28 in TN; rectal temperature: 103.8°F in HS vs 101.8°F in TN). There were no differences in respiration rate or rectal temperature associated with pST or dietary treatment.

Pigs maintained in the HS environment displayed less efficient F/G and decreases in average daily gain (ADG), average daily feed intake (ADFI), and metabolizable energy (ME) intake compared with pigs in the TN environment (Table 2). These results are typical of the pig's response to heat stress. There were no differences in Mcal ME/lb gain (ME/G) in HS compared to TN environment.

Although overall growth performance and intake were reduced in the HS compared to the TN environment, responses to pST treatment were not affected by environment, with the exception of F/G. A pST by environment interaction effect ($P<.05$) was observed for F/G. The F/G of pST-treated pigs was similar in HS (2.23) and TN (2.29) environments. The F/G of placebo-treated pigs was increased ($P<.05$) in the HS (3.09) compared to the TN (2.80) environment.

Table 2. Effect of Heat Stress (HS) or Thermal Neutral (TN) Environment, Dietary Energy Density, and Porcine Somatotropin (pST) on the Growth Performance and Intake of Finishing Pigs

Item	Environment		Energy density, Mcal/ME · lb^{-1}			pST		
	HS[a]	TN[b]	1.48	1.60	1.71	4 mg · d^{-1}	Placebo	CV
Gain[c], lb/d	2.20	2.84	2.57	2.51	2.49	2.68	2.35	11.6
Feed intake[d], lb/d	5.76	7.08	7.02	6.34	5.87	6.05	6.82	9.3
F/G[e]	2.66	2.55	2.79	2.56	2.47	2.26	2.95	10.0
ME[f]/G[g]	9.30	9.09	9.10	8.93	9.56	7.93	10.46	11.9
Lysine[dh], g/d	31.3	39.3	38.3	34.5	33.1	32.5	38.1	12.9
ME[i], Mcal/d	9.10	11.42	10.39	10.06	10.33	9.41	11.10	13.3

[a]HS 24-h cycle: 8 h at 95°F and 60% relative humidity - 1 h transition - 14 h at 82°F and 80% relative humidity - 1 h transition.
[b]TN 24-h cycle: 8 h at 75°F and 50% relative humidity - 1 h transition - 14 h at 68°F and 60% relative humidity - 1 h transition.
[c]Environment effect P<.05; pST effect P<.01.
[d]Environment effect P<.05; Energy density effect linear P<.01; pST effect P<.01.
[e]Environment effect P<.10; Energy density effect linear P<.01; pST effect P<.01.
[f]Average daily metabolizable energy intake.
[g]pST effect P<.01.
[h]Average daily lysine intake.
[i]Environment effect P<.05; Energy density effect P>.10; pST effect P<.01.

Increasing dietary energy density was not associated with any change in ADG, ME intake, or ME/G. Pigs ate to a constant ME intake regardless of dietary energy density.

Treatment of finishing pigs with pST resulted in increased (P<.01) ADG, decreased (P<.01) ADFI, reduced (P<.01) ME intake, and improved (P<.01) F/G. Similar reductions in gains of both pST- and placebo-treated pigs were observed in heat stress (HS) and in thermal neutral (TN) environment (Table 3). Daily gain of pigs administered pST was higher (P<.01) than that of placebo-treated pigs in both HS and TN environments.

The results of this study confirm the increase in daily gain and improved feed efficiency reported by other researchers for finishing pigs treated with porcine somatotropin. In terms of metabolizable energy intake (Mcal/d), efficiency was improved approximately 15% with porcine somatotropin treatments. Pigs administered porcine somatotropin and control pigs fed ad libitum both responded to heat stress by reducing feed intake and increasing respiration rate and rectal temperature. Thus, finishing pigs administered pST and control pigs responded similarly to heat stress. In conclusion, treatment of finishing pigs with pST does not influence the pig's capacity to tolerate heat stress.

Table 3. Effect of Heat Stress (HS) or Thermal Neutral (TN) Environment and Porcine Somatotropin (pST) on Growth Performance and Intake of Finishing Pigs

Item	4 mg pST · d^{-1}		Placebo		CV
	HS[a]	TN[b]	HS[a]	TN[b]	
Gain, lb/d[cd]	2.40	2.97	2.00	2.73	11.6
Feed intake, lb/d[cd]	5.35	6.67	6.14	7.48	9.3
F/G[cef]	2.23	2.29	3.09	2.80	10.0
ME[g]/G	7.83	8.02	10.78	10.14	19.5
Lysine[h], g/d[cd]	29.2	35.7	33.4	42.8	12.9
ME[g], Mcal/d[cdf]	8.48	10.34	9.71	12.49	13.3

[a]HS 24-h cycle: 8 h at 95°F and 60% relative humidity - 1 h transition - 14 h at 82°F and 80% relative humidity - 1 h transition.
[b]TN 24-h cycle: 8 h at 75°F and 50% relative humidity - 1 h transition - 14 h at 68°F and 60% relative humidity - 1 h transition.
[c]pST effect P<.01.
[d]Environment effect P<.05.
[e]Environment effect P<.10.
[f]pST × environment effect P<.05.
[g]Metabolizable energy intake.
[h]Lysine intake.

Dr. Dave Schoneweis, DVM.

Table 4. Effect of Heat Stress or Thermal Neutral Environment and Dietary Energy Density on Growth Performance and Intake of Finishing Pigs

Item	Heat stress[a]			Thermal neutral[b]			CV
	1.48[c]	1.60[c]	1.71[c]	1.48[c]	1.60[c]	1.71[c]	
Gain, lb/d[d]	2.22	2.29	2.12	2.93	2.71	2.88	11.6
Feed intake, lb/d[de]	6.29	5.74	5.21	7.77	6.93	6.53	9.3
F/G[df]	2.91	2.53	2.56	2.68	2.59	2.38	10.0
ME[g]/G	9.46	8.82	9.63	8.74	9.05	9.49	19.5
Lysine, g/d[deh]	34.3	31.1	28.5	42.4	37.8	37.7	12.9
ME, Mcal/d[dg]	9.29	9.09	8.91	11.48	11.02	11.75	13.3

[a]HS 24-h cycle: 8 h at 95°F and 60% relative humidity - 1 h transition - 14 h at 82.4°F and 80% relative humidity - 1 h transition.
[b]TN 24-h cycle: 8 h at 75.2°F and 50% relative humidity - 1 h transition - 14 h at 20°F and 60% relative humidity - 1 h transition.
[c]Mcal ME/lb.
[d]Environment effect P<.05.
[e]Energy density effect linear P<.01.
[f]Environment effect P<.10.
[g]Metabolizable energy intake.
[h]Lysine intake.

Table 5. Effect of Porcine Somatotropin (pST) and Dietary Energy Density on the Growth Performance and Intake of Finishing Pigs

	4 mg pST · d^{-1}			Placebo			CV
	1.48[a]	1.60[a]	1.71[a]	1.48[a]	1.60[a]	1.71[a]	
Gain, lb/d[b]	2.82	2.60	2.64	2.31	2.42	2.33	11.6
Feed intake, lb/d[bc]	6.75	5.74	5.52	7.28	6.93	6.23	9.3
F/G[bc]	2.41	2.20	2.18	3.17	2.91	2.75	10.0
ME[d]/G	7.88	7.63	8.25	10.32	10.20	10.87	19.5
Lysine[e], g/d[bcd]	36.9	31.2	29.3	39.8	37.7	36.9	12.9
ME[d], Mcal/d[b]	10.00	9.10	9.14	10.77	11.02	11.51	13.3

[a]Mcal ME/lb.
[b]pST effect P<.01.
[c]Energy density effect linear P<.01.
[d]Metabolizable energy intake.
[e]Lysine intake.