THE EFFECT OF DIETARY ENERGY DENSITY ON GROWTH PERFORMANCE OF FINISHING SWINE TREATED WITH PORCINE SOMATOTROPIN

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Summary

A growth study (60 barrows averaging 125.4 lb) was conducted to evaluate the effect of dietary energy density on growth performance of finishing pigs treated with porcine somatotropin (pST). Barrows were blocked on weight and allotted randomly to pens (2 barrows/pen, 5 pens/treatment). Barrows were injected daily with 4 mg pST and fed six experimental diets with four energy densities (1.37, 1.48, 1.60, or 1.71 Mcal ME/lb) and four lysine:energy ratios (4.0, 3.7, 3.4, or 3.2 g lysine/Mcal ME). Diets were formulated to contain at least 200% of NRC (1988) recommendations for essential nutrients. Increasing dietary energy density and adjusting the lysine:energy ratio to maintain 3.4 g lysine/Mcal ME decreased average daily feed intake and improved feed efficiency, but did not affect average daily gain. Increasing dietary energy density without adjusting the lysine:energy ratio increased average daily gain, decreased average daily feed intake, and improved feed efficiency linearly. These results indicate that finishing pigs injected daily with 4 mg pST and consuming 30 g lysine per day require approximately 9 Mcal ME per day to optimize growth performance and efficiency.

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

Introduction

Numerous studies have demonstrated dramatic improvements in growth performance of pigs treated with porcine somatotropin (pST). Daily injections of pST have been shown to improve growth rate and feed efficiency of growing-finishing pigs. Chronic administration of pST also depresses feed intake. It has been suggested that this reduction in feed intake limits the growth response of pigs treated with pST. Research conducted at Kansas State University has shown that dietary lysine content must be increased twofold compared to NRC (1988) requirements to maximize growth performance of finishing pigs receiving daily injections of pST. This indicates that the nutrient density of the diet must be increased beyond NRC (1988) recommendations in order to take full advantage of the potential for increased growth performance offered by treating pigs with pST. This study was conducted to examine the effect of dietary energy density on growth performance of finishing pigs treated with pST.

Experimental Procedures

The composition of the experimental diets is shown in Table 1. In four diets, lysine and crude protein levels were held constant, while energy density was increased. The four

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Table 1. Composition of Experimental Diets

	Energy density, Mcal ME/lb					
	1.37	1.48	1.60	1.71	1.48	1.71
Ingredient, %	1.20[a]	1.20[a]	1.20[a]	1.20[a]	1.11[a]	1.29[a]
Corn	55.33	64.58	58.17	50.91	68.24	47.40
Soybean meal (48%)	29.60	28.00	29.00	30.30	24.30	33.90
Solka floc	7.70	--	--	--	--	--
Soybean oil	2.00	2.00	7.40	13.40	2.00	13.40
Dicalcium phosphate	3.04	3.00	3.07	3.09	3.02	3.02
Limestone	.90	.95	.90	.87	.94	.88
L-lysine-HCl	.16	.20	.19	.16	.23	.13
Threonine	.01	.01	.01	.01	.01	.01
Tryptophan	.01	.01	.01	.01	.01	.01
Salt	.50	.50	.50	.50	.50	.50
Selenium premix[b]	.05	.05	.05	.05	.05	.05
Vitamin premix[c]	.50	.50	.50	.50	.50	.50
Trace mineral premix[d]	.20	.20	.20	.20	.20	.20

[a]Percentage dietary lysine.
[b]Contained 123 mg Se/lb premix.
[c]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}.
[d]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.

calculated dietary energy densities, expressed as Mcal ME/lb of feed, were 1.37, 1.48, 1.60, and 1.71. The calculated g lysine/Mcal ME for these diets were 4.0, 3.7, 3.4, and 3.2, respectively. Two additional diets were formulated maintaining g lysine/Mcal ME constant at 3.4 with dietary energy densities of 1.48 and 1.71 Mcal ME/lb. Thus, three diets maintained the same lysine:energy ratio with increasing energy densities of 1.48, 1.60 and 1.71 Mcal ME/lb. Two diets had the same caloric density of 1.48 Mcal ME/lb, and two diets had caloric densities of 1.71 Mcal ME/lb. Results are reported as: 1) the effects of increasing dietary energy density and maintaining dietary lysine constant (1.2%) and 2) the effects of increasing dietary energy density and maintaining the lysine:energy ratio constant (3.4 g lysine/Mcal ME). It is important to note that the diet containing 1.60 Mcal ME/lb and 3.4 g lysine/Mcal ME was used in determining both effects.

Sixty crossbred barrows averaging 125.4 lb were blocked by weight and randomly assigned to pens with two barrows per pen and five pens per treatment. Pigs were housed in an open-front facility in pens measuring 15 ft × 4 ft. One single hole, self-feeder was provided per pen. Feed and water were provided ad libitum. Each pig was injected daily with 4 mg pST

in the extensor muscle of the neck. Individual pig and feeder weights were taken on d 14 and weekly thereafter until termination of pST administration.

Results

The mean particle size for each diet is shown in Table 2. Pellet quality was acceptable, even for the high fat diets (13.4% soybean oil), and no problems were experienced with feed flowing through the feeders.

Table 2. Nutrient Composition of Experimental Diets

	Energy density, Mcal ME/lb					
	1.37	1.48	1.60	1.71	1.48	1.71
Ingredient, %	1.20[a]	1.20[a]	1.20[a]	1.20[a]	1.11[a]	1.29[a]
Calculated values						
Crude protein, %	19.19	19.27	19.19	19.18	17.80	20.60
Lysine, %	1.20	1.20	1.20	1.20	1.11	1.29
Threonine, %	.80	.81	.80	.81	.74	.84
Tryptophan, %	.23	.23	.23	.24	.21	.26
Calcium, %	1.10	1.10	1.10	1.10	1.10	1.10
Phosphorus, %	.90	.90	.90	.90	.90	.90
g lysine/Mcal ME[b]	4.0	3.7	3.4	3.2	3.4	3.4
Analyzed values						
Gross energy, Mcal/lb	1.87	1.87	2.02	2.13	1.87	2.14
Crude protein, %	19.06	19.19	19.25	19.12	17.85	20.68
Lysine, %	1.16	1.20	1.21	1.19	1.10	1.30
Particle size analysis						
Mean particle size, microns	554	528	535	542	524	531

[a]Percentage dietary lysine.
[b]Calculated as g lysine/Mcal ME in a kilogram of diet.

Growth performance results are shown in Table 3. Progressively increasing the energy density from 1.37 to 1.71 Mcal ME/lb and maintaining lysine constant at 1.2% of the diet resulted in a linear increase ($P<.05$) in average daily gain (ADG). Average daily feed intake (ADFI) was decreased as energy density increased (linear and quadratic, $P<.10$). Despite the reduction in ADFI, average daily metabolizable energy intake increased ($P<.01$) linearly with

increasing energy density. Feed efficiency (F/G) also was improved (linear, P<.01) as energy density increased.

When maintaining a constant lysine:energy ratio, increasing the dietary energy density resulted in no differences in ADG. A linear decrease (P<.01) in ADFI with increasing dietary energy density was observed, resulting in no difference in daily metabolizable energy intake. Increasing dietary energy density improved F/G (linear, P<.05).

Discussion

Recent research conducted at Kansas State University indicates that diets for finishing pigs injected daily with 4 mg pST should be formulated to contain 1.2% dietary lysine, and provide at least 30 g lysine intake/d. In the present study, average daily lysine intake on all treatments was at least 30 g/d. Increasing daily energy intake from 8.05 to 9.61 Mcal ME/d and maintaining a lysine intake of at least 30 g/d resulted in a linear (P<.05) improvement in ADG. The increased energy intake (19%) increased ADG 12% and improved F/G 14%. Other researchers also have reported increased gains associated with increased energy intake in finishing pigs.

Maintaining the lysine:energy ratio constant and increasing energy density resulted in no differences in ADG. The similar growth performance observed on these three diets is a result of similar ME intakes. Pigs on the diets in which lysine:energy was maintained constant consumed approximately 9 Mcal ME/d, apparently adjusting feed intake to maintain a constant energy intake. In contrast, when dietary lysine was held constant (1.2%) and energy density increased, intake appeared to be adjusted to a constant lysine intake. Pigs on diets containing 3.4 or 3.2 g lysine/Mcal ME consumed at least 30 g lysine/d and 9.0 Mcal ME/d. When the lysine:energy ratio was greater than 3.4 g lysine/Mcal ME, energy intake limited ADG.

Daily gain increased and F/G improved as ME intake increased. Diets containing 3.4 g lysine/Mcal ME or less improved ADG and F/G of finishing pigs treated with 4 mg pST/d. However, reducing the lysine:energy ratio from 3.4 to 3.2 g lysine/Mcal ME resulted in only marginal improvements in ADG and F/G. In conclusion, a diet containing 3.4 g lysine/Mcal ME will allow daily intakes of approximately 9.0 Mcal and 30 g lysine. Intakes in this range appear to optimize gain and efficiency of finishing pigs injected daily with 4 mg pST.

Table 3. Effect of Dietary Energy Density on the Growth Performance of Finishing Pigs Treated with Porcine Somatotropin

Item	Energy density, Mcal ME/lb				Energy density, Mcal ME/lb			CV
	1.37	1.48	1.60	1.71	1.48	1.60	1.71	
	1.20[a]	1.20[a]	1.20[a]	1.20[a]	1.11[a]	1.20[a]	1.29[a]	
ADG, lb[b]	2.40	2.46	2.57	2.60	2.62	2.57	2.54	10.2
ADFI, lb[cde]	5.90	5.63	5.54	5.63	6.05	5.54	5.43	6.0
F/G[f]	2.45	2.32	2.16	2.11	2.28	2.16	2.12	9.9
Lysine intake, g/d[cdg]	32.2	30.7	30.2	30.8	30.2	30.2	32.2	6.0
ME intake, Mcal/d[fh]	8.05	8.32	8.81	9.61	8.94	8.81	9.28	5.8

[a]Percentage dietary lysine.
[b]Increasing energy density with constant lysine (linear, P<.05).
[c]Increasing energy density with constant lysine (linear, P<.10).
[d]Increasing energy density with constant lysine (quadratic, P<.10).
[e]Increasing energy density with increasing lysine (linear, P<.01).
[f]Increasing energy density with constant lysine (linear, P<.01).
[g]Increasing energy density with increasing lysine (linear, P<.05).
[h]Metabolizable energy intake.