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SUMMARY

Two trials involving 216 growing boars were conducted to study the effects of different levels of crude protein on daily gains, feed efficiency, feed intake and estimated carcass characteristics. The boars were fed either a 16, 18 or 20% crude protein ration from 23.8 to 55.8 kg (period 1). Upon completion of period 1, the protein level was reduced 2% for each treatment (14, 16 and 18%, respectively) from 55.8 to 99.6 kg (period 2).

Average daily gain increased linearly ($P<.01$) and feed required per unit gain decreased quadratically ($P<.05$) as the percent protein in the diet increased from 16 to 20% in period 1 and 14 to 18% in period 2. Average daily feed intake was similar for boars on each treatment. Scanned backfat thickness decreased linearly ($P<.01$) and scanned *longissimus* muscle area increased linearly ($P<.05$) as protein in the diet increased.

(Key Words: Protein Levels, Growing Boars.)

INTRODUCTION

A voluminous amount of research has been published on the protein requirements of growing-finishing barrows and gilts. References for much of this research are listed in Nutrient Requirements of Swine, N.R.C. (1973). Based on this research, N.R.C. (1973) has published protein recommendations for growing-finishing swine assumed to be barrows or gilts. However published research is very limited on the optimum levels of crude protein for growing boars as measured by performance traits.

Speer *et al.* (1957) reported that a 19% crude protein ration supported maximum gains for growing boars. However there were only small differences in growth rate and feed conversion among boars fed levels of crude protein ranging from 16 to 25%. They further reported that a 13% crude protein ration was inadequate for growing boars fed in a concrete lot but adequate for boars fed in a legume pasture. Creswell *et al.* (1975) fed boars a 13% or 17% crude protein ration from 25 to 56 kg and a 11% or 15% ration from 56 to 95 kilograms. The boars fed the lower protein ration had a decreased rate of gain and required more feed per unit of gain. The addition of lysine of the low protein diets improved performance.

Several studies (Christain, 1971; Omtvedt and Jesse, 1971; Wong *et al.* 1968) have shown that boars have leaner carcasses than barrows. This may mean higher protein requirements for boars than for barrows and gilts. Creswell *et al.* (1975) found that low protein diets depressed rate of gain more in growing boars than barrows.

Two trials were conducted at the Oklahoma Agriculture Experiment Station with growing boars to study the effects of different levels of crude protein on growth rate, feed conversion and estimated carcass traits.

EXPERIMENTAL PROCEDURE

Two trials were conducted with a total of 216 Duroc, Hampshire, Yorkshire, and Duroc x Hampshire boars. In each trial, 108 boars were allotted to three treatments. During the first period of each trial (23.8 to 55.8 kg) the boars were fed a 16, 18 or 20% crude protein ration for treatments 1, 2 and 3, respectively. In the second period (55.8 to 99.6 kg) the protein level of each diet was reduced 2% so that treatments 1, 2 and 3 consisted of 14, 16 and 18% crude protein, respectively. The composition of each ration is shown in table 1.

The boars were allotted to treatments as they reached 8 weeks of age. The allotment on any day included 27 boars with an equal

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TABLE 1. COMPOSITION OF EXPERIMENTAL RATIONS

	Ration designation[a]			
	14% CP	16% CP	18% CP	20% CP
Ingredients, %				
Corn, dent yellow, grain, gr 2 US mn wt 54 (4) 4-02-931 (corn)	75.00	69.50	64.00	58.30
Soybeans, seed, solv-extd grnd, mx 7% fiber (5) 5-04-604 (soybean meal)	16.50	22.10	27.75	33.50
Sugarcane, molasses, mn 48% invert sugar mn, 79.5 degrees brix (4) 4-04-696 (cane molasses)	5.00	5.00	5.00	5.00
Salt	.50	.50	.50	.50
Calcium carbonate, $CaCO_3$, commercial mn 38% calcium (6) 6-01-069 (calcium carbonate)	.70	.70	.70	.75
Calcium phosphate, dibasic commercial 6-01-080 (dicalcium phosphate)	1.75	1.65	1.50	1.40
Vitamin-trace mineral-antibiotic premix[b]	.55	.55	.55	.55
Calculated content				
Crude protein, %	14.01	15.99	17.99	20.02
Lysine, %	.62	.76	.92	1.07
Calcium, %	.71	.71	.69	.69
Phosphorus, %	.61	.61	.61	.60
Digestible energy, kcal/kg	3385.00	3373.00	3362.00	3349.00

[a]CP = crude protein.

[b]Supplied 3,000 IU vitamin A, 330 IU vitamin D, 6.6 IU vitamin E, 22 mg menadione, 4.4 mg riboflavin, 33 mg niacin, 22 mg pantothenic acid, 1,100 mg choline, 16.5 mcg vitamin B_{12}, .22 ppm iodine, 90 ppm iron, 22 ppm manganese, 11 ppm copper, 99 ppm zinc and 55.1 mg of chlorotetracycline per kilogram feed.

number of boars from each of three of the four breed groups. Assignment to pens was done randomly within breed and litter. This group of boars constituted one block of the experiment so that a block consisted of three pens with an equal number of boars of each of three of the four breed groups. In each trial there were four blocks.

The feeding floor was an open-front concrete finishing floor within 2.1 × 5.2 m pens equipped with a self-feeder and automatic waterer. After assignment of nine boars per pen, the boars were given a 1-week adjustment period after which on-test weights were recorded.

Protein levels in the ration were reduced for each pen individually as the boars in the pen averaged 54 kg and boars were individually removed from test weekly as they reached 100 kilograms. Ultrasonic estimates of backfat thickness and *longissimus* muscle area were obtained by the use of an Ithaco Scanogram Model 721 instrument and the measurements were adjusted to a 100 kg equivalent. Adjustments used were ± .022 cm for backfat thickness and ± .214 cm^2 for *longissimus* muscle area for each kg below or above 100 kilograms (adjustments suggested by National Association of Swine Records, 1970).

The data were subjected to two analyses. For traits that could be measured on individual boars, a model was fit within each trial including the effects of block, treatment, block × treatment, breed within block and treatment × breed within block, and pooled over trials. The results of these analyses provided no evidence for a treatment × breed interaction for growth rate, backfat thickness or *longissimus* muscle area. Since treatments were applied to pens, pens were the experimental unit for evaluating the effects of treatment. Consequently, a pen means analyses was conducted on each trait. With pens as the experimental unit, the design of each trial was a randomized block so that when trials were combined a model was fit including the effects of trial, blocks within trial, treatment, and treatment × trial. The treatment sum of squares was partitioned into that due to linear and quadratic effects.

RESULTS AND DISCUSSION

The mean performance for boars on each treatment is shown in table 2. The linear and quadratic responses that are significant at the $P<.10$ level are also indicated in the table.

From 23.8 to 55.8 kg there was a linear increase ($P<.01$) in average daily gain and a quadratic decrease ($P<.05$) in feed required per unit of gain as percent protein in the ration went from 16 to 20%. There was no evidence that average daily feed intake depended on the percentage protein in the diet.

From 55.8 to 99.6 kg, average daily gain increased linearly ($P<.05$) and feed required per unit of gain decreased quadratically ($P<.10$) as percent protein in the diet went from 14 to 18%. Once again, feed intake did not appear to be affected by the protein in the diet.

As would be expected from the results of the two periods, average daily gain over the entire period (23.8 to 99.6 kg) increased linearly ($P<.01$) and feed required per unit gain decreased quadratically ($P<.05$) as the percent protein in the diet increased from 16 to 20% in period 1 and 14 to 18% in period 2. Average daily feed intake was very similar for the boars on each treatment.

Scan backfat and *longissimus* muscle area measured at the end of the trial indicated a rather dramatic change in estimates of leanness as protein in the ration changed. Backfat decreased in a linear fashion ($P<.01$) and *longissimus* muscle area increased linearly ($P<.05$) as protein in the diet increased.

These data suggest that growth rate was increasing linearly as percent protein increased, but the quadratic response of feed efficiency indicates that diets containing protein percentages greater than 18% will not decrease the feed required per unit of gain as boars are fed from 23.8 to 55.8 kg or that diets with more than 16% protein will not improve feed efficiency as boars are fed from 55.8 to 99.6 kilograms. However, the 20% and 18% protein diets in periods 1 and 2, respectively, did improve growth rate. Feed intake, however, was not influenced by the percent protein in the diet.

The decreased performance of the boars on the low protein diet may have been the result of a lysine deficiency. Calculated lysine values were .76 and .62% for the 16 and 14% diets, respectively. However, Hines *et al.* 1975, suggests that a 12.0% crude protein rations containing .55% lysine is adequate for boars from 45 to 110 kilograms. Similar responses of larger *longissimus* muscle areas and less backfat thickness in barrows and gilts fed higher levels of crude protein have been reported by Gilster and Wahlstrom (1973), Hale *et al.* (1967), Lee *et al.*

TABLE 2. EFFECTS OF LEVELS OF CRUDE PROTEIN ON PERFORMANCE OF GROWING BOARS

	Treatments		
	1	2	3
	Protein levels, %		
Item	16–14	18–16	20–18
Avg daily gain, kg			
23.8 to 55.8 kg[b]	.73 ± .01[a]	.78 ± .01[a]	.79 ± .01[a]
55.8 to 99.6 kg[c]	.87 ± .02	.91 ± .02	.93 ± .02
23.8 to 99.6 kg[b]	.81 ± .01	.84 ± .01	.86 ± .01
Feed per kg gain			
23.8 to 55.8 kg[d]	2.51 ± .03	2.31 ± .03	2.30 ± .03
55.8 to 99.6 kg[e]	3.21 ± .05	3.02 ± .05	3.06 ± .05
23.8 to 99.6 kg[d]	2.93 ± .04	2.72 ± .04	2.74 ± .04
Avg daily feed intake			
23.8 to 55.8 kg	1.83 ± .03	1.79 ± .03	1.81 ± .03
55.8 to 99.6 kg	2.81 ± .06	2.75 ± .06	2.86 ± .06
23.8 to 99.6 kg	2.36 ± .04	2.29 ± .04	2.36 ± .04
Scan backfat thickness, cm[b]	2.63 ± .02	2.52 ± .02	2.45 ± .02
Scan *longissimus* muscle areas, cm[c]	34.73 ± .26	35.78 ± .26	35.77 ± .26

[a]Mean ± SE.

[b]Linear effects significant (P<.01).

[c]Linear effects significant (P<.05).

[d]Quadratic effects significant (P<.05).

[e]Quadratic effects significant (P<.10).

(1967), McBee *et al.* (1969) and Tjong-A-Hung *et al.* (1972). The significant linear response and lack of a quadratic response in the present experiment indicates that the level of protein that maximizes leanness has not been determined in this experiment. However, the economics of cost of protein as compared to cost of gain may be more important than feeding boars a diet that maximizes leanness.

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