

Effects of Diet Protein Level on Growing-Finishing Pig Performance in a Tropical Environment¹

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ABSTRACT

The effect of increasing the dietary crude protein (CP) level on the growth performance and carcass characteristics of *Large White* pigs reared in Guadeloupe under tropical climatic conditions was determined. Test animals included 32 females and 32 barrows, each weighing about 24 kg initially. They were individually fed one of four test diets based on corn and soybean-oil meal containing 12, 16, 20, and 24% CP, respectively. The 12 and 16% CP diets were supplemented with synthetic L-lysine hydrochloride. The animals were slaughtered at 95 kg liveweight.

On the basis of maximum daily gain and minimum feed conversion ratio, the best level of CP among the various levels compared was 16% for the growing pigs (from 24 to 60 kg liveweight) and 12% for the finishing pigs (from 60 kg to 95 kg liveweight). There was no significant effect of sex on growth performance, but the feed conversion ratio of the finishing females was 8% better than that of the barrows. As the dietary CP level increased, dressing percentage and backfat thickness decreased linearly ($P < 0.05$). Females were significantly leaner ($P < 0.05$) than barrows. Further work is needed to determine the optimum level of CP for finishing pigs.

INTRODUCTION

During the past 20 years, considerable attention has been paid to determination of the optimum crude protein level in diets for pigs reared in the temperate countries (1, 7, 19, 21). In contrast, less such information is available for tropical countries (2, 9). However, because of the reduction in feed intake (5, 11) and probable increase in urinary nitrogen losses (14, 15) occurring at high ambient temperatures, recommendations emanating from temperate countries may not be necessarily applicable to pigs raised in tropical climatic conditions. In addition, the optimum crude protein level varies according to various criteria (daily weight gain, nitrogen retention, body composition, and quality of protein used) (21). Thus, results reported by Babatunde et al. (2) suggest that the optimum crude protein level in diets for weaning and growing pigs is higher than that recommended for temperate countries. Nevertheless, it is difficult to generalize these results, which have been obtained with diets based on local feedstuffs, whose nutritive value is variable.

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The present experiment was designed to study the effect of increasing the dietary crude protein level on the performance of growing-finishing pigs reared in Guadeloupe (West-Indies) when fed diets based on corn and soybean meal, which are commonly used in both American and European temperate countries.

MATERIALS AND METHODS

CLIMATE

Relevant climatic data for the experiment (November 1973 to July 1974) were as follows: average minimum and maximum temperatures were 20.5° C and 27.5° C, respectively, with a mean of 24° C; average minimum humidity was 70%, while the maximum was always between 95 and 100% during the night. Total hours of bright sunshine averaged 180 h/mo (range 160 h in December to 192 h in April), and monthly rainfall was about 223 mm (range 98 mm in February to 405 mm in May). These data were recorded at the Bioclimatological Research Station of the Agronomical Research Center located about 300 m from the place of the present experiment.

HOUSING

All pigs were group-housed on concrete-floored pens. Each pen was divided into two areas: a dry sleeping area 1.5 × 2.2 m covered with a 1.8-m high corrugated galvanized iron roof, and with an open-front area 2.5 × 2.2 m, equipped with individual feeding stalls and automatic waterers. No bedding was used.

TREATMENTS

Four test diets based on ground yellow corn and soybean-oil meal were formulated (table 1) to contain 12, 16, 20, and 24% crude protein (CP). To the 12 and 16% CP diets, synthetic L-Lysine hydrochloride was added at levels of 0.26 and 0.03%, respectively, to satisfy the recommendations of the National Research Council (19).

ANIMALS AND MANAGEMENT

Sixty-four *Large White* pigs weaned at 5 weeks and reared to about 11 weeks of age, weighing initially 24.1 ± 3.1 kg, were assigned to 16 groups of 4 pigs each on the basis of sex and average initial weight. There were eight groups of castrated males (barrows) and eight groups of females. The animals were allocated at random within each group to each one of the four treatments. They were twice daily fed the amount they could consume in 45 min. Water was supplied ad libitum. The pigs were weighed once every two weeks in the morning before feeding. Feed intake was recorded daily. They were slaughtered at a mean live weight of 95 kg. After dressing and splitting the carcass into two longitudinal halves, it

was chilled for 24 h, after which average backfat thickness opposite the last rib and the last lumbar vertebra was measured on each half. The cold-dressing percentage was calculated as follows:

$$\frac{\text{Cold carcass without head (kg)}}{\text{Liveweight (kg)}} \times 100$$

All data collected were analysed according to a split plot design. Linear and quadratic terms of variance analysis were calculated according to Snedecor (24).

RESULTS

Results of average daily gain (ADG), feed intake, and feed conversion ratios (FCR) for the different weight class intervals from 24 to 95 kg liveweight are summarized in figures 1 and 2, and in table 2.

TABLE 1.—*Formulation and composition of the diets*

Ingredients	Dietary protein level (% as fed)			
	12	16	20	24
Ground yellow maize	78.4	68.0	56.6	45.1
Soybean meal (44% CP)	7.6	19.0	30.4	41.9
Wheat bran	10.0	10.0	10.0	10.0
Dicalcium phosphate	1.4	1.2	1.0	.8
Ground limestone	1.1	1.2	1.3	1.4
Salt (NaCl)	.30	.22	.27	.12
Vitamin mix ¹	1.00	1.00	1.00	1.00
Trace mineral mix ²	.20	.20	.20	.20
L-Lysine hydrochloride	.26	.03		
Analysed crude protein %	12.2	16.4	20.5	25.0
Analysed lysine %	.61	.92	1.10	1.42
Analysed methionine + cystine %	.48	.57	.72	.93
Calculated digestible energy (kcal/kg diet) ³	3,330	3,370	3,390	3,420

¹ The vitamin mixture supplied the following quantities per kg of mixed diet: vit. A, 4,000 I.U.; vit. D2, 1,000 I.U.; riboflavin, 2 mg; nicotinic acid, 10 mg; calcium panthothenate, 5 mg; choline, 100 mg; and vit. B12, 10 µg.

² The mineral mixture supplied the following quantities per kg of mixed diet: FeSO₄·7H₂O, 250 mg; ZnSO₄, 310 mg; MnSO₄·H₂O, 120 mg; CuSO₄·5H₂O, 50 mg; stabilised KI, 2 mg; CoSO₄·7H₂O, 2.4 mg; MgCO₃, 1250 mg.

³ According to Nat. Res. Council. (19)

Between 24 and 60 kg liveweight (fig. 1), the shape of ADG and FCR curves according to the level of CP was parabolic (quadratic effect significant at the 1% level). Best ADG and FCR were obtained on the 16% CP diet, but they were not significantly different from ADG and FCR on 20% CP diet. Feed consumption varied very little with the level of CP; it showed a tendency to decrease only at the highest level of CP. Sex had no significant effect on any of these criteria.

During the finishing period (from 60 to 95 kg liveweight), ADG decreased and FCR increased linearly (fig. 2) when the level of CP was increased (linear effect significant at the 5% level). The highest performance was obtained with the 12% CP diet: ADG dropped by 10% and FCR increased 13% when the level of CP rose from 12 to 24%. Sex showed no effect on ADG, but barrows consumed about 7% more feed ($P < .05$) and required 8% more feed per unit of gain ($P < .05$) than females.

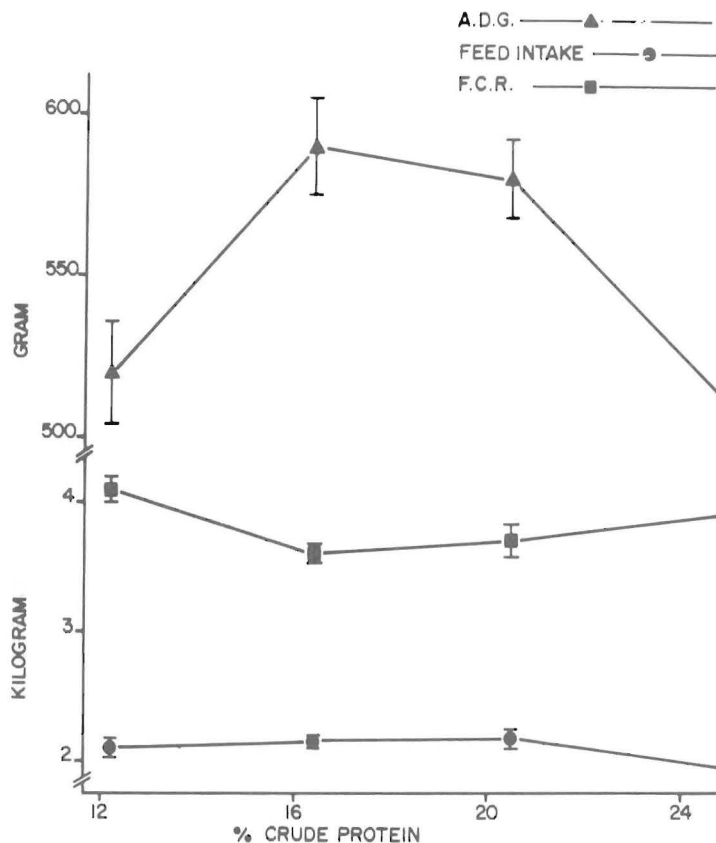


FIG. 1.—Effect of CP level on ADG (g/day), feed intake (kg/day), and FCR during the growing period (from 24 to 60 kg liveweight). Results are expressed as mean \pm SEM

During the entire fattening period, the best rates of gain and FCR were achieved with the 16% CP diet, but ADG was not significantly better than the rate of gain with the 20% protein diet; and FCR was not significantly better than the ratio of 12 and 20% protein diets. Pigs fed the 24% CP diet grew slower ($P < .05$) than those fed the 16% CP diet. Increase in the protein level from 12 to 16% did not significantly improve

daily feed consumption; but increasing the protein level beyond 16% resulted in a slight decrease in daily feed intake. The difference between the means of 16% and 24% protein diets was significant ($P < .05$). Sex had no significant effect on ADG, feed intake, and FCR.

Cold-dressing percentage and backfat thickness data are summarized in table 3. Dressing percentage decreased linearly as protein level in-

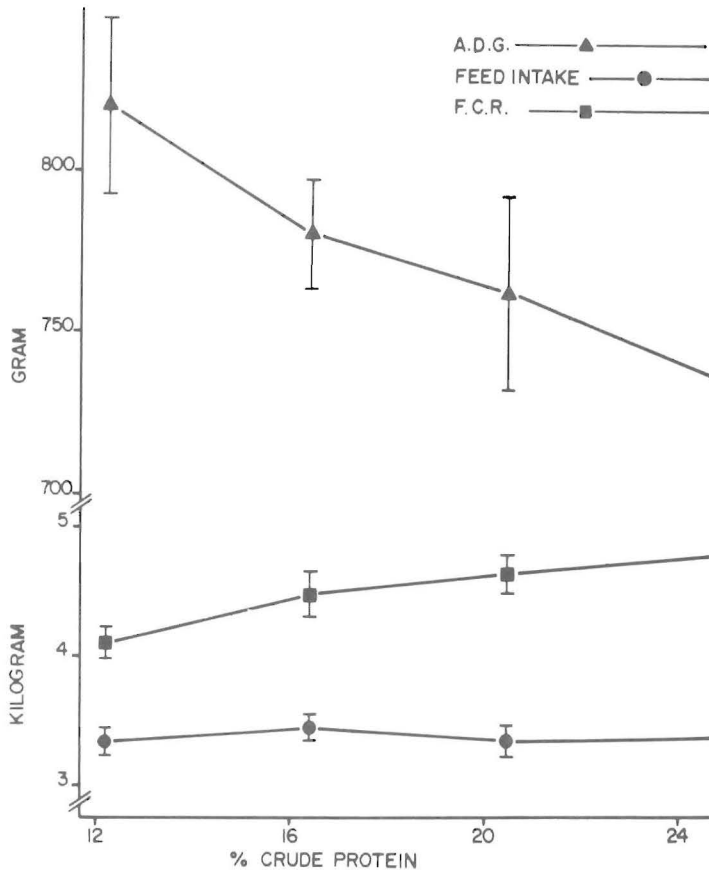


FIG. 2.—Effect of CP levels on ADG (g/day), feed intake (kg/day), and FCR during the finishing period (from 60 to 95 kg liveweight). Results are expressed as mean \pm SEM

creased, that of 24% protein diet being significantly lower ($P < .05$) than that observed for 12 and 16%, but not for 20% protein diets. Mean backfat thickness decreased when protein levels increased. Pigs fed 16 and 20% protein diets were significantly leaner than those fed 12% protein diet and significantly fatter ($P < .05$) than those fed 24% protein diet. Furthermore, barrows were fatter than females ($P < .05$).

TABLE 2.—Average daily gain, feed intake and feed/gain ratios for entire fattening period (from 24 to 95 kg liveweight)

Characteristics	Sex ¹	Dietary protein level (% as fed)				Mean	SE of means (C.V.) ²
		12	16	20	24		
ADG (g/day)	B	625	688	659	594	642 a	15.7 (10.0)Q**
	F	643	670	657	614	646 a	
	Mean	634 ac	679 b	658 bc	604 a ³		
Feed intake (kg/day)	B	2.60	2.84	2.80	2.54	2.69 a	.06 (8.9)Q*
	F	2.58	2.60	2.66	2.54	2.60 a	
	Mean	2.59 ac	2.72 ab	2.74 b	2.54 c		
FCR	B	4.16	4.12	4.25	4.28	4.20 a	.06 (5.7)Q*
	F	4.01	3.88	4.04	4.14	4.02 a	
	Mean	4.08 ab	4.00 a	4.14 ab	4.21 b		

¹ B, barrow; F, female.

² C.V., coefficient of variation $\left(\frac{s}{\bar{x}} \times 100\right)$ L, linear effect. Q, Quadratic effect*, P < .05; **, P < .01.

³ Means followed by one or more letters in common do not differ significantly at the 5% level.

TABLE 3.—*Effect of dietary protein level on carcass characteristics*

Characteristics	Sex ¹	Dietary protein level (% as fed)				Mean	SE of means (C.V.) ²
		12	16	20	24		
Cold dressing percentage	B	72.8	72.6	72.4	70.8	72.1 a ³	.41 (2.28)L*
	F	72.6	72.7	71.5	71.3	71.8 b	
	Mean	72.7 a	72.6 a	71.9 ab	71.1 b		
Average backfat thickness (mm)	B	36.0	32.0	31.7	28.9	32.1 a	.80 (10.4)L*
	F	31.1	30.7	30.7	28.0	30.1 b	
	Mean	33.6 a	31.3 b	31.2 b	28.5 c		

^{1, 2, 3} See footnotes of table 2.

DISCUSSION

Generally, the ADG values reported here are fairly comparable to those found in temperate countries (1, 7, 19, 21), whereas, the FCR, data are somewhat higher. This may be due to the level of feed intake which remains high in spite of the high energy density of the diets and the climatic conditions. Results of Holmes (14), Hsia (16), and McCracken (17) also indicate that at high temperature, the FCR increases with the feed intake level. Furthermore it is suggested that energy requirements for maintenance are increased in hot climates (14).

According to the present results, on the basis of maximum daily gain and minimum FCR, the optimum (or minimum) CP level of diets based on corn and soybean meal is 16 and 12%, respectively, for the growing and the finishing pigs reared in humid tropical conditions. Decrease in optimum CP level, relative to the energy requirement when the animals get older, is well known (21). However, because of the linear improvement of ADG and FCR when the level of CP decreases during the finishing period, it is possible that the optimum may be below 12% for the finishing pigs, especially for the finishing barrows. Optimum CP requirement of barrows is lower than that of females (8, 22). Further experiments are required to elucidate this suggestion. Present results are somewhat lower than the recommendations of Babatunde (2) in Nigeria. They are also lower than those of Devendra and Parris (9) in Trinidad, which were obtained in environmental conditions similar to those described here, but with diets based on local feedstuffs. The discrepancies noticed are probably due to the quality of the protein sources used, depending upon the composition and availability of the essential amino-acids. For similar levels of feed intake, results with the growing pig are in good agreement with the recommendations emanating from different temperate countries as reviewed by Clausen (7), ARC (1), N.R.C. (19) and Rerat (22). As for finishing pigs, the results presented are slightly lower than the corresponding recommendations for temperate countries.

The reduction of feed intake and growth performance observed with the highest level of CP supports the findings of Terril et al. (26) and Sugahara et al. (25), but not those of Rerat and Henry (22). However, judged from the decreasing rate of daily gain during the finishing period, as dietary CP level increases, pigs in hot climates seem to be more sensitive to high CP level than those reared in temperate countries. It is most likely that the heat increment arising from protein metabolism on high protein diets at high temperature increases the stress on pigs (6, 17, 18). This may also explain that the optimum CP level for finishing pigs seems to be somewhat lower than that recommended in temperate countries. Under the semi-ad libitum feeding regime of the present study, sex effect was not significant on ADG. But, during the finishing period, the finding that females required significantly less feed per unit of gain

than barrows is in accordance with the results of Bowland and Berg (4), Desmoulin (8), and Henry et al. (13).

Carcass characteristics indicated that the backfat thickness decreased when dietary CP level increased. The dependence of carcass leanness on protein intake in this study is in agreement with results obtained by almost all authors of both temperate and tropical countries (2, 3, 10, 21). Decrease in fatness probably explains decrease in dressing percentage when the CP level increases, in accordance with the data of Sugahara et al. (25). On the other hand, females provide leaner carcasses than barrows. This result, which is generally explained by the ability of females to retain more dietary nitrogen than barrows (20), may also be due to the lower voluntary feed intake, as observed in females, beyond the 60 kg liveweight in the present study and in other reports (12, 23, 27).

In conclusion, the present results indicate that on the basis of maximum ADG and minimum FCR, the optimum CP level for pigs reared in a humid tropical environment and fed diets based on corn and soybean meal should be 16% for the growing period and 12% or less for the finishing period. The values obtained here were somewhat lower than the recommendations of other tropical countries, probably because of the higher biological value of the protein sources used in the present study.

RESUMEN

Se investigó el efecto que podrían tener aumentos en las unidades alimentarias de proteína bruta (CP) en el crecimiento y características de la canal de cerdos de la raza *Large-White* criados en el ambiente tropical de Guadalupe. La temperatura y la humedad relativa fluctuaron entre 20.5 y 27.5° C, y 70 y 100%, respectivamente. Se usaron 32 cerdas y 32 cerdos con un peso inicial de alrededor de 24 kg., alojados en grupos. Dos veces al día se les suministró una de cuatro dietas experimentales. Estas consistían de maíz y harina de soja, las cuales contenían 12, 16, 20 y 24%, respectivamente de proteína bruta. Las dietas que contenían 12 y 16% de CP se suplementaron con hidrocloreuro de L-lisina sintético. Los animales se sacrificaron cuando el peso vivo alcanzó los 95 kg.

A base de la máxima ganancia diaria de peso y de una razón mínima de transformación del alimento, el mejor nivel de CP entre las unidades comparadas fue el de 16%, para los cerdos en crecimiento (de 24 a 60 kg de peso vivo) y 12% para los cerdos en el último período de cebadura (de 60 a 95 kg). No hubo efecto significativo en cuanto al sexo, pero la razón de transformación en la etapa final de los cerdos fue 8% mejor que en las cerdas. A medida que las unidades de CP aumentaron, el porcentaje de rendimiento a la canal y el grosor de la capa de tocino disminuyeron linealmente ($P < .05$). Las hembras eran significativamente más magras ($P < .05$) que los machos.

Es necesario continuar estas investigaciones para determinar el nivel óptimo de CP en el último período de cebadura del cerdo.

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