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Full Length Research Paper

Performance of growing pigs of different genetic groups fed varying dietary protein levels

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Two feeding experiments were conducted, using a 2 x 2 factorial design, to determine the performance of two genetic groups of pigs fed two protein levels in each case. Each experiment was replicated three times. In the first experiment, 24 pigs, 12 each of indigenous Nigerian pigs (LC) and Large White x Indigenous cross-breeds (LW x LC) with average initial weights of 7.3 and 10.2 kg, respectively, were fed isocaloric (3.1 Mcal of ME/Kg) diets containing 12 or 16% crude protein for seven weeks. In the second experiment, 12 Large White (LW) pigs and 12 LW x LC pigs with average initial weights of 12.5 and 11.8 Kg, respectively, were fed isocaloric (3.1 Mcal of ME/Kg) diets containing 14 or 18% crude protein for seven weeks. Overall, the LC pigs performed better than the LW x LC pigs on the lower (12%) protein diet while the LW x LC pigs performed better than the LC pigs on the 16% protein diet. In experiment 2, the LW x LC pigs performed better than the LW pigs on the lower (14%) protein diet while the LW pigs performed better than the LW x LC pigs on the 18% protein diet.

Key words: Dietary protein, indigenous Nigerian pigs, Large-White x Indigenous cross-breeds, Large White, performance.

INTRODUCTION

The indigenous pigs of Nigeria (LC) are small sized, weighing about 0.5 Kg at birth and about 45.5 Kg at one year of age (Igboeli and Orji, 1980). Fetuga et al. (1976) showed that these LC pigs not only matured earlier than improved European and American breeds but also had lower percentages of lean and bone and greater proportions of fat and skin as several reports have indicated that when protein intake is liberal, improved European and American breeds of pigs such as the LW and Landrace (LD) have faster growth rate and better feed conversion efficiency than the unimproved LC pigs (Vohradsky, 1968; Ilori, 1974; Fetuga et al., 1976, 1977). On the other hand, limited information from Latin America shows that indigenous pigs of Latin America tend to perform better than their European and American counterparts under conditions of poor protein nutrition (Bressani, 1974).

Fetuga et al. (1977) reported on the comparative responses of Large White x Landrace (LW x LD) and LC pigs to diets varying in protein level from 12 to 20% crude protein. Increments in dietary protein improved both rate and efficiency of gain of the LW x LD pigs, the best performance being on the 18 and 20% crude protein diets. For the LC pigs, the best growth rates were obtained on the lowest two protein levels of 12 and 14% crude protein, while crude protein levels above 16% caused a decline in growth rate of the LC pigs. It was the objectives of the present study to compare the performance of LC, LW x LC and LW pigs fed different dietary protein levels.

MATERIALS AND METHODS

Tow feeding experiments were conducted using a 2 x 2 factorial design involving two genetic groups of pigs and two protein levels in each case.

Experiment 1

Two isocaloric diets (3.1 Mcal of ME/Kg) having 12 or 16% crude protein (Table 1) were fed far seven weeks to a total of 24 barrows, 12 barrows each of the LC and the LW x LC genetic groups. There

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Table 1. Composition of experimental diets (Experiment 1)

Ingredient	% of Diet	
	12% Crude protein level	16% Crude protein level
Maize	78.73	74.36
Groundnut cake	2.00	14.40
Fish meal	2.50	2.50
Wheat middling	12.00	4.00
Oyster shell	3.00	3.00
Vitamin-mineral premix[a]	1.00	1.00
Sodium chloride	0.50	0
dl methionine	0.27	0.24
Total	**100.00**	**100.00**
Analyzed composition		
Dry matter (%)	96.55	97.40
Crude protein (%)	12.03	16.40
Ether extract (%)	9.00	10.35
Crude fibre (%)	3.55	3.45
Ash (%)	6.15	6.50
Nitrogen-free extract (%)	65.82	60.70

[a]Provided the following in units per kg of diet vitamin A, 5280 I.U.; vitamin D3, 704 I.U.; vitamin E, 70 I.U.; vitamin K, 3.52 mg; vitamin B12, 26 Ug; riboflavin 5 mg; niacin, 28 mg; d-pantothanic acid, 21 mg; chlorine chloride 1,100 mg; biotin, 88 Ug; thiamine, 2.2 mg; Cu; 10 mg; Fe, 160 mg; Mn, 20 mg; Zn, 100 mg; Co, 2.5 mg; I, 2.5 mg.

were six pigs in each of the four treatment combinations. The pigs were housed two per pen according to genetic group, on concrete floor pens. Thus, there were three replicates per treatment. The LC and the LW x LC pigs had average initial weights of 7.3 and 10.2 Kg, respectively. Feed and water were offered *ad libitum*. Animals were weighed at weekly intervals and feed consumption was measured by the weigh-back technique.

Feed samples were assayed for dry matter, crude protein, crude fibre, ether extract and ash by the A.O.A.C. (1975) method of analysis. Data on feed intake, protein intake, growth rate, feed conversion ratio and protein efficiency ratio were obtained and subjected to a 2 x 2 factorial analysis of variance (Snedecor and Cochran, 1974). Comparisons of treatment means were made by Duncan's multiple range tests (Steel and Torrie 1960).

Experiment 2

A total of 24 barrows, 12 each of the LW and the LW x LC genetic groups, were used in this experiment. They were housed two per pen, according to genetic group, an average floor pens and fed two isocaloric (3.1 Mcal of ME/Kg) diets containing either 14 or 18% crude protein (Table 2). Thus, there were four treatment combinations (Six pigs per treatment) and three replicates per treatment. The average initial weights of the LW pigs were 12.50 and 12.41 Kg for those fed the 14 and 18% protein diets, respectively. Average initial weights of the LW x LC pigs were 12.0 and 11.58 Kg for those fed the 14 and 18% crude protein diets, respectively. Feeding, weighing, analysis of feed and statistical analysis of data were as described for Experiment 1.

RESULTS

Experiment 1

The main affects of genetic group and dietary protein level on performance of pigs in Experiment 1 are summarized in Table 3.

Effects of genetic group

The LW x LC pigs consumed 86.7 g more feed (P<0.05) and 12.8 g more protein (P<0.025) daily, and grew 33.4 g/day more rapidly (P<0.01) than the LC pigs. However, feed conversion ratios and protein efficiency ratios did not differ significantly (P>0.05) between the LC and the LW x LC genetic groups.

Effects of protein level

Feed intake was not significantly (P>0.05) affected by protein level but pigs fed the 16% crude protein diet consumed 39.5 g more protein and gained 30 g more weight daily (P<0.01) than those fed the 12% crude protein diet. Feed conversion ratio was not significantly (P>0.05) affected by protein level but pigs fed the 12% crude protein diet gained significantly (P<0.01) more weight per gram of protein consumed than pigs fed the 16% crude protein diet.

Interactions between genetic group and protein levels

The effects of the genetic group x protein level treatment combinations in Experiment 1 are given in Table 4. There

Table 2. Composition of experimental diets (Experiment 2).

Ingredient	% of diet	
	14% Crude protein level	18% Crude protein level
Maize	76.25	72.22
Groundnut cake	8.50	20.00
Fish meal	2.50	2.50
Wheat middlings	8.00	1.00
Vitamin-mineral premix[a]	1.00	1.00
Oyster shell	3.00	3.00
Sodium chloride	0.50	0.50
dl methionine	0.25	0.28
Total	**100.00**	**100.00**
Analyzed composition		
Dry matter (%)	95.60	96.00
Crude protein (%)	13.78	18.16
Ether extract (%)	10.20	11.00
Crude fibre (%)	3.50	3.60
Ash (%)	6.40	6.46
Nitrogen-free extract (%)	61.72	60.78
Metabolizable energy (Kcal/kg, calculated)	3,070.0	3,108.0

[a]Provided the following in units per kg of diet: vitamin A, 5280I.U.: vitamin D3, 704 I.U.; vitamin E 70 I.U.; vitamin K, 3.52 mg; vitamin B12, 26Ug; riboflavin, 5 mg; niacin, 28 mg; d-panthothenic acid, 21 mg; choline chloride, 1,100 mg; biotin, 88 Ug; thiamine, 2.2 mg; Cu, 10 mg; Fe, 160 mg: Mn, 20 mg; Zn, 100 mg; Co, 2.5 mg; I, 2.5 mg.

Table 3. Main effects of genetic group and protein levels on performance of pigs (Experiment 1).

Parameter	Genetic group			Crude protein level (%)		
	LC	LW x LC	S.E.	12	16	S.E.
Daily feed intake (g)	865.0[b]	951.7[a]	31.1	910.0	906.7	31.1
Daily protein intake (g)	122.7[a]	135.5[b]	4.1	109.5[c]	148.7[d]	4.1
Daily weight gain (g)	308.3[b]	341.7[a]	6.3**	310.0[d]	340.0[c]	6.3**
Feed (kg/gain kg)	2.81	2.84	0.12*	2.95	2.70	0.12*
Protein efficiency ratio	2.59	2.54	0.11**	2.84[c]	2.28[d]	0.11**

[a,b]Means of the main effects of genetic group having different superscripts are significantly different (P<0.05). [c,d]Means of the main effects of protein level having different superscripts are significantly different (P<0.01). **Significant genetic group x protein interaction (P<0.01).
*Significant genetic group x protein interaction (P<0.05).[e]Protein efficiency ratio = Weight gained (g) protein consumed (g).

were no significant (P>0.05) genetic group x protein interactions and no significant treatment effects on feed intake. Although protein intake different significantly (P<0.025) among treatments, these differences were not of interest because there were no significant (P> 0.05) genetic group x protein interactions on protein intake. Average daily weight gains showed significant (P<0.01) genetic group x protein interactions. The LC pigs fed the 12% crude protein diet gained more weight per day (P<0.01) than the LC pigs fed the 16% protein diet whereas the LW x LC pigs fed the 16% protein diet gained more weight per day (P<0.01) than the LW x LC pigs fed the 12% protein diet.

Average (P<0.05) genetic group x protein interactions were also observed in feed conversion ratios and protein efficiency ratios (P<0.01). The LC pigs fed the 12% protein diet had better (P<0.05) feed conversion ratios than the LC pigs fed 16% protein diet but the LW x LC pigs which consumed the 16% protein diet had better (P<0.05) feed conversion ratios than the LW x LC pigs which consumed the 12% protein diet. Weight gained by the LC pigs per gram of protein consumed was significantly (P<0.01) higher with the 12% protein diet than with the 16% protein diet. But weight gained by the LW x LC

Table 4. Treatment effects of genetic group and protein levels on performance of pigs (Experiment 1).

Parameter	LC		LW x LC		S.E.	P
	12 Crude protein level	16 Crude protein level	12 Crude protein level	16 Crude protein level		
Initial Weight (kg)	7.30	7.30	10.20	10.20		
Final weight (kg)	23.14	21.67	24.74	29.15		
Daily feed Intake (g)	876.7	853.3	943.3	960.0	44.0	(P>0.05)
Daily protein intake (g)	105.5[c]	139.9[b]	113.5[c]	157.5[a]	5.8	(P<0.025)
Daily weight gain (g)	323.3[b]	293.3[c]	296.7[c]	386.7[a]	8.9	(P<0.01)
Feed (kg/gain kg)	2.72[b]	2.91[a]	3.19[a]	2.49[b]	0.17	(P<0.025)
Protein efficiency ratio	3.07[a]	2.10[c]	2.61[b]	2.47[bc]	0.15	(P<0.05)

Table 5. Main effects of genetic group and protein levels on performance of pigs (Experiment 2).

Parameter	Genetic group			Crude protein level (%)		
	LW	LW x LC	S.E.	14	18	S.E.
Daily feed Intake (g)	1011.7[a]	970.0[b]	5.8**	1016.7[c]	965.0[d]	5.8**
Daily protein intake (g)	160.6[a]	153.8[b]	1.52**	140.1[c]	175.2[d]	1.52**
Daily weight gain (g)	383. 3[a]	361.7[b]	5.2**	346.7[c]	398.3[d]	5.2**
Feed (kg/gain kg)	2.73	2.69	0.05**	2.96[c]	2.46[d]	0.05**
Protein efficiency ratio	2.36	2.38	0.04**	2.47[c]	2.26[d]	0.04**

[a,b]Means of the main effects of genetic group having different superscripts differ significantly (P<0.01)
[c,d]Means of the main effects of protein level having different superscripts differ significantly (P<0.01).
**Significant genetic group x protein interaction (P<0.01)
Protein efficiency ratio = Weight gained (g)/protein consumed (g).

pigs per gram of protein consumed did not differ significantly (P>0.05) between the 12 and the 16% protein diets.

Experiment 2

The main effects of genetic group and dietary protein level on performance of pigs in Experiment 2 are summarized in Table 5.

Effects of genetic group

The LW pigs consumed significantly (P<0.01) more feed and more protein and also gained (P<0.01) more weight than the LW x LC pigs. However, feed conversion ratios and protein efficiency ratios were not significantly (P>0.05) influenced by genetic group.

Effects of protein level

The pigs consumed more (P<0.01) of the 14% protein diet than they did the 18% protein diet. But pigs fed the 18% protein diet consumed more (P<0.01) protein than those fed the 14% protein diet. The pigs fed the 18% protein diet also gained more weight and had better feed conversion ratios (P<0.01) than those fed the 14% protein diet. But weight gained per gram of protein consumed was more (P<0.01) with the 14% than with the 18% protein diet.

Interactions between genetic group and protein level

The effects of the genetic group x protein level treatment combinations in Experiment 2 are given in Table 6. There were significant (P<0.01) genetic group x protein interactions in all the parameters measured in Experiment 2. There were no significant differences (P>0.05) in feed intake between the LW pigs fed 14 or 18% protein diet but the LW x LC pigs fed 14% protein diet consumed 106.6 g more feed (P<0.01) per day than the LW x LC pigs fed the 18% protein diet. There were also significant (P<0.01) differences among treatments in protein intake. Protein consumed per pay (184 g) by the LW pigs fed the 18% protein diet was more (P<0.01) than that (166.5 g) consumed by the LW x LC pigs also fed the 18% protein diet. Protein consumption by the LW pigs fed the 14% protein (139.2 g/day) did not differ (P>0.05) from that of LW x LC pigs also fed the 14% protein diet (141 gm/day). The LW pigs fed the 18% protein diet had faster rates (P<0.01) of weight gain and better feed conversion ratios

Table 6. Treatment effects of genetic group and protein levels on performance of pigs (Experiment 2).

	LW		LW x LC			
Parameter	14 Crude protein level	18 Crude protein level	14 Crude protein level	18 Crude protein level	S.E.	P
Initial Weight (kg)	12.50	12.41	12.0	11.58		
Final weight (kg)	27.85	34.62	30.62	28.40		
Daily feed Intake (g)	1010.0[a]	1013.3[a]	1023.3[a]	916.7[b]	14.1	(P<0.01)
Daily protein intake (g)	139.2[c]	184.0[a]	141.0[c]	166.5[b]	2.2	(P<0.01)
Daily weight gain (g)	313.3[d]	453.3[a]	380.0 [d]	343.3[c]	7.3	(P<0.01)
Feed (kg/gain kg)	3.23[a]	2.24[c]	2.70[b]	2.67[b]	0.07	(P<0.01)
Protein efficiency ratio	2.25[a]	2.46[b]	2.69[c]	2.06[d]	0.06	(P<0.05)

[a,b,c,d]Means having different superscripts differ significantly at the levels of probability indicated.
Protein efficiency ratio = Weight gained (g)/protein consumed (g)

(P<0.025) than those fed the 14% protein diet, whereas the LW x LC pigs fed the 14% protein diet gained weight faster (P<0.01) than those fed the 18% protein diet. There were no significant (P>0.05) differences in feed conversion ratios between the LW x LC pigs fed 14% protein and those fed 18% protein. The genetic group x protein interaction in protein efficiency ratio was such that the LW pigs gained more weight (P<0.01) per gram of protein consumed when they ere fed the 18% protein diet than when they were fed the 14% protein diet. The LW x LC pigs, on the other hand, gained more weight (P<0.01) per gram of protein consumed on the 14% protein diet than on the 18% protein diet.

DISCUSSION

There were significant (P<0.01) genetic group x protein interactions with respect to feed intake and protein intake in Experiments 2 but not in Experiment 1 in which feed intake was significantly (P<0.05) affected by genetic group but not by protein level and protein intake was significantly (P<0.05) affected by both factors. The significant genetic group x protein interactions with respect to average daily weight gains, feed conversion ratios and protein efficiency ratios in both experiments is worthy of note. In Experiment 1, the LC pigs gained more weight and had better feed conversion ratios and protein efficiency ratios on the lower (12%) protein diet than on the 16% protein diet whereas the LW x LC pigs gained more weights and had better feed conversion ratios on the 16% protein diet than on the 12% protein diet. In Experiment 2, the LW pigs gained more weight and had better feed conversion ratios and protein efficiency ratios on the higher (18%) protein diet than on the 14% protein diet whereas the LW x LC pigs gained more weight and had better protein efficiency ratios on the 14% protein diet, although they also had better feed conversion ratios on the 18% protein diet. Fetuga et al. (1977) reported breed x diet interactions in daily live weight gains and efficiency of feed utilization for LC and LW x LD pigs fed protein levels varying from 12 to 20%. In that study, LC pigs had their fastest growth rate and best feed conversion ratios on the 12 and 14% protein levels whereas the LW x LD pigs had their best growth rates and efficiency of feed utilization on the 18 and 20% protein diets. The results of the present study are in consonance with these reports. Significant breed x diet interactions have also been reported even among different breeds and strains of the improved European or American pigs in weight gain (Bowland and Berg, 1959; Bayley and Summers, 1968) and efficiency of feed utilization (Hale and Southwell, 1967).

Overall, the LC pigs performed better than the LW x LC pigs on the lower (12%) protein diet while the LW x LC pigs performed better than the LC pigs on the 16% protein diet. In Experiment 2, the LW x LC pigs performed better than the LW pigs on the lower (14%) protein diet while the LW pigs performed better than the LW x LC pigs on the 18% protein diet. Consequently, on all performance parameters, the LC pigs were inferior to the LW x LC pigs which were, in turn, inferior to the LW pigs. These observations are in line with the reports of Cameron and Ashton (1969), Vohradsky (1968), Ilori (1974) and Fetuga et al. (1976, 1977). The difference in performance of the different genetic groups in response to differences in dietary protein may be related to the inherent differences in their ability to synthesize lean tissues. Fetuga et al. (1976) had shown that muscle development proceeded at a slower rate in the LC pigs compared to the LW x LD pigs, while the proportion of fat to lean increased rapidly with increasing live weight in the LC pigs. It would appear that because of the lower potential for growth in the LC pigs, their dietary protein requirement would be lower than that of the LW x LC and LW pigs. The tendency of the growth rate of the LC pigs to decrease at high dietary protein levels may, therefore, be related to the fact that protein levels in excess of dietary requirements for optimum growth and feed efficiency depress growth. This has been shown to be the case in LW x LD pigs (Cooke et al., 1972).

The weight gained per gram of protein consumed by the LC pigs and the LW x LC pigs in Experiment 1 and by the LW x LC pigs in Experiment 2 decreased as the dietary protein increased, while for the LW pigs in Experiment 2, the weight gained per gram of protein consumed increased as the level of dietary protein increased. These results would suggest that the 16% protein level probably exceeded the protein requirement of the LC and the LW x LC pigs while the 18% protein diet did not satisfy the protein requirement of the LW pigs. This view is supported by the evidence presented by Cunha (1980) which shows that feeding the finishing pig 2 more percentage units of protein than required results in a decrease of 10 to 15% in the efficiency of converting dietary protein to tissue protein.

Work is continuing to establish the exact protein requirements of the LC, LW x LC and LW pigs in order to achieve optimum protein nutrition and optimum performance of these pigs in the tropics.

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