The Response of Early Weaned Pigs to Low Protein Diets Supplemented with Synthetic Lysine

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Introduction

Supplementation of lower protein diets with crystalline amino acids, especially lysine, has recently become of more interest because of the increased cost of supplemental protein sources. Meade *et al* (1965), Miller (1971) and Katz *et al* (1973) have shown that the protein level of conventional corn soya bean meal diets can be reduced from 18-19% to 16% without reducing the performance of pigs weaned between 21 and 30 days of age if lysine is maintained at the level present before protein reduction. However there is very little information available on the response of early weaned pigs to lysine supplementation of diets with crude protein levels below 16%.

This experiment studied the response of weaned pigs growing over the liveweight range 5.5 to 20 kg to increasing levels of lysine in diets with 14.6 and 16.6% crude protein. The performance and carcass composition of pigs offered the two low protein diets was also compared with that of pigs offered a control diet containing 20% crude protein which was found to promote optimum performance in weaned pigs growing over the liveweight range 5.5 to 20 kg in a previous experiment (Campbell 1977).

Materials and methods

Animals and design

Thirty male crossbred, $^3/4$ Large White x ¼ Berkshire, pigs weaned at 20 days of age and with an average liveweight of 5.5 kg were allocated according to a randomized block design to three replicates of ten treatments. The ten treatments consisted of a 2 x 4 factorial - protein level (14.6 and 16.6%) x supplemental lysine (0, 0.18, 0.36 and 0.54%) - and a control treatment (20% crude protein) duplicated.

Diets and feeding

Three basal diets (Table 1) were formulated to have a digestible energy (DE) level of 15.1 mJ/kg and protein levels of 15, 17 or 19% crude protein. Actual protein levels determined by Kjeldahl analysis (A.O.A.C. 1964) are shown in Table 1.

Table 1

Composition of experiment diets (%)

	Diet		
	Control	Low Protein	Medium Protein
Wheat	71.3	84.1	79.2
Soyabean meal	16.0	5.0	10.0
Meat meal	9.0	5.0	5.0
Tallow	2.7	2.7	2.7
Wheaten starch[+]	-	1.6	1.6
Bone flour	-	0.9	0.8
Salt	0.2	0.2	0.2
Vitamin, mineral[++] premix	0.5	0.5	0.5
Determined crude protein (%)	20.1	14.6	16.6
Determined D.E. Mcal/kg	3.56	3.56	3.57

The essential amino acid contents of the basal diets (Table 2) were determined from the amino acid analyses of the major ingredients according to the methods described by Fox (1971). Synthetic lysine hydrochloride (92% lysine) was added at the expense of wheaten starch to the diets with 14.6 and 16.6% crude protein to provide levels of total lysine ranging from 0.52 to 1.08% and 0.72 to 1.26% respectively (Table 3).

Table 2

Essential amino acid composition of basal diets and total lysine contents of experimental diets

	Basal diets		
	Control	14.6% C.P.	16.6% C.P.
Lysine	1.10	0.54	0.72
Available lysine	0.99	0.50	0.67
Methionine & cystine	0.62	0.51	0.56
Tryptophan	0.26	0.18	0.21
Histidine	0.50	0.35	0.42
Tyrosine	0.55	0.39	0.46
Phenyalamine	0.43	0.68	0.76
Threonine	0.75	0.51	0.59
Leucine	1.44	1.05	1.17
Isoleucine	0.84	0.58	0.68
Valine	1.00	0.72	0.80

Table 3
Total lysine contents of experimental diets (%)

	Dietary crude protein %							
	15.0				17.0			
Lysine supplementation (%)	0.00	0.18	0.36	0.54	0.00	0.18	0.36	0.54
Total lysine	0.54	0.72	0.90	1.08	0.72	0.90	1.08	1.26

The D.E. contents of the basal diets were determined from the gross energy values of the diets and faeces collected over a five day period after pigs weighed 12.0 kg liveweight.

All diets were offered *ad-libitwn* and feed intakes and spillages were recorded daily.

Housing and management

All pigs were housed in individual cages kept in a fully air conditioned room maintained at 21^{o}c. As soon as each pig was observed to be above 18.0 kg liveweight at the weekly weighing it was weighed daily thereafter until reaching 20 kg liveweight, and then slaughtered.

Carcass evaluation

After slaughter the carcass was chilled overnight and measurements made the following day, these included fat thickness over the eye muscle at P_1 and P_2, eye muscle length A and depth B, thickness of mid-line back-fat at the rump, mid-back and at the point of maximum fat thickness over the shoulder.

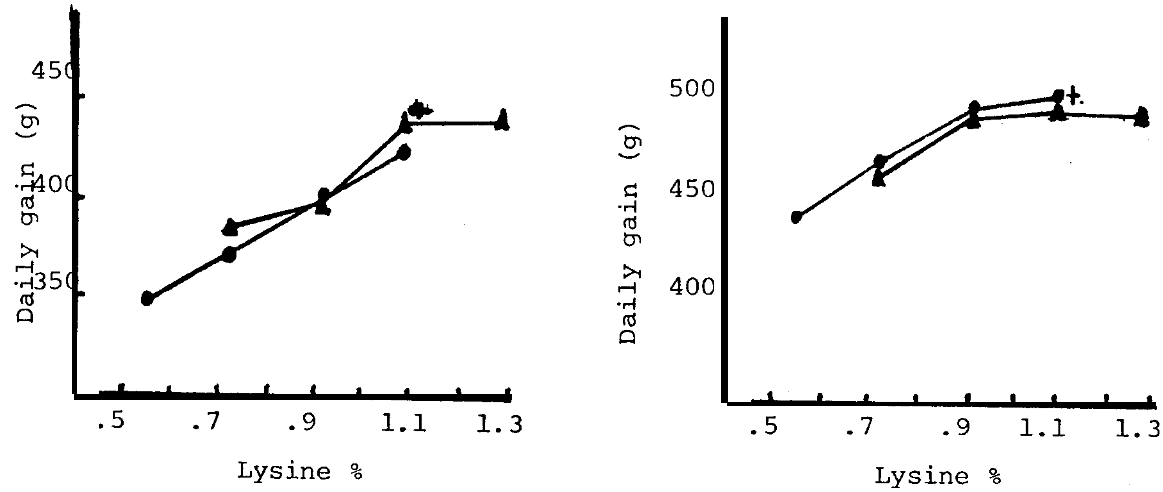
Statistical analysis

Treatment effects were assessed by analysis of variance.

Results

Pig performance was compared over the liveweight periods, 5.5 to 12, 5.5 to 20 and 12.0 to 20 kg. Average food intake tended to be higher on the lower protein diet however there were no significant differences in food intake between treatments.

During the liveweight periods 5.5 to 20 and 12.0 to 20 kg daily gain and food conversion improved with increasing lysine independantly of the protein content of the diet (Fig. 1). It can also be seen from Figure 1 that the daily gain of pigs offered the control and low protein diets were equal when the low protein diets contained 1.08 and 0.90% lysine during the liveweight periods 5.5 and 20 and 12.0 and 20.0 kg respectively.



a) Daily gain (5.5 to 20 kg)

- • 14.6% protein
- ▲ 16.6% protein
- \+ Control diet

b) Daily gain (12.0 to 20 kg)

- • 14.6% protein
- ▲ 16.6% protein
- \+ Control diet

Fig 1 - The growth response of early weaned pigs to increasing levels of dietary lysine

Between 5.5 and 12.0 kg liveweight there was a significant protein x lysine level interaction with pigs offered the 16.6% crude protein diet exhibiting more rapid growth at the same levels of dietary lysine than pigs offered the diet with 14.6% crude protein (Table 4). It can also be seen from Table 4 that although both growth rate and food conversion were optimised when the 14.6 and 16.6% crude protein diets contained 1.08% lysine only the pigs offered the diet with 16.6% crude protein and 1.26% lysine grew as fast as the pigs offered the control diet.

Table 4

The effect of dietary protein and lysine on the performance of young pigs (5.5 to 12.0 kg liveweight)

Protein	Lysine	Daily gain	Food conversion ratio
%	%	g	
14.6	0.54	280	2.95
	0.72	298	2.69
	0.90	320	2.60
	1.08	350	2.40
16.6	0.72	298	2.76
	0.90	362	2.38
	1.08	376	2.30
	1.26	392	2.26
Control	1.10	401	2.08
L.S.D. between means for low protein diets P =(0.05)		26	0.20
L.S.D. between means for control and low protein diets (P = 0.05)		23	0.17

Carcass characteristics

There was a significant reduction in linear fat measurements with increasing lysine however the response was much more marked in the carcasses of pigs offered diets with 16.6% crude protein (Table 5). It can be seen from Table 5 that although the fat measurements remained relatively constant after 0.72% lysine in the diet with 14.6% crude protein, they continued to decrease with increasing lysine in the diet with 16.6% crude protein and were significantly lower than those for the control when the diet contained 1.26% lysine.

Table 5

The effect of protein and lysine on carcass characteristics at 20 kg liveweight

Protein %	Lysine %	Average back fat thickness cm	P_1 cm	P_2 cm
14.6	0.54	2.10	1.26	1.62
	0.72	1.96	1.20	1.50
	0.90	1.96	1.03	1.40
	1.08	1.95	1.00	1.40
16.6	0.72	2.02	1.10	1.30
	0.90	1.79	0.90	1.16
	1.08	1.64	0.87	1.09
	1.26	1.45	0.78	1.00
Control	1.10	1.68	0.90	1.12
LSD between means for low protein diets (P = 0.05)		0.16	0.09	0.09
LSD between means for control and low protein diets (P = 0.05)		0.14	0.08	0.07

Discussion

The results show that weaned pigs growing over the liveweight ranges 5.5 to 20 and 12.0 to 20 kg require 1.1 and 0.9% lysine respectively, in a diet with approximately 3.6 Mcal DE/kg, and that the requirement was not affected by dietary protein levels of 14.6, 16.6 or 20.0% crude protein.

However during the liveweight period 5.5 to 12.0 kg the dietary lysine required to promote optimum performance tended to increase as dietary protein decreased. The limited range of lysine levels tested in the experiment did not permit an optimum level to be determined for the diet with 14.6% crude protein. However 1.26% lysine was required in the 16.6% protein diet to raise the pigs growth rate to the level achieved on the 20% protein (1.1% lysine) control diet.

Because pig performance responded to increasing lysine in 14.6% protein diet, it would seem unlikely that a second amino acid had become limiting but that the depressed performance was due to the diet containing inadequate nitrogen to promote optimum performance during this initial period of growth.

The results also indicate that the diet with 14.6% crude protein was unable to supply enough nitrogen to promote optimum carcass quality. This limitation was overcome by raising the crude protein content of the diet to 16.6% when carcass quality improved over the entire lysine range and at the highest level was superior to that of pigs offered the control diet.

The experiment establishes the lysine requirements of weaned pigs offered a wheat, soya bean meal diet with a DE concentration of approximately 3.6 meal/kg and suggests that lysine is the only limiting amino acid in a diet with 14.6% crude protein for pigs growing over the liveweights 5.5 to 20 or 12.0 to 20 kg. The results also indicate that if dietary protein falls below a certain minimum, which would appear to be above 16.6%, between 5.5 and 12.0 kg liveweight, the pigs requirement for lysine will vary depending on the degree of protein deficiency. However over the entire growth period, 5.5 to 20 kg liveweight, it was possible to reduce the protein content of the diet from 20 to 14.6% without adversely affecting pig performance if the lysine level was maintained at approximately 1.1%. The results show therefore that the use of synthetic lysine can allow reasonable protein savings to be made in the diets for early weaned pigs which may prove economical especially during periods of high prices for conventional protein supplements.

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