NUTRITIONAL VALUE OF PROTECTED LYSINE IN PIG PRODUCTION

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SUMMARY

A growth experiment involving three groups of seven individually penned pigs was conducted for 10 weeks to investigate the nutritional value of a form of protected synthetic lysine against its unprotected equivalent. The control group was fed to appetite a basal diet with 18.5% CP and 0.64% total lysine and the other two groups were fed the basal diet supplemented with 0.3% of either ordinary commercial grade synthetic lysine or protected lysine. Two metabolism trials were also conducted with three pigs each to measure urinary nitrogen excretion. Results showed that weight gain in the two lysine supplemented treatments were significantly ($P < 0.01$) higher than the control and that gain in the protected lysine treatment was significantly ($P < 0.05$) above the unprotected lysine. There were no significant treatment differences in backfat depth (at P2 position) but feed conversion efficiency in the lysine protected treatment was significantly ($P < 0.01$) better than the unprotected which was in turn better ($P < 0.10$) than the control. Urinary nitrogen excretion in the protected lysine group was significantly lower than the unprotected ($P < 0.01$) and the control.

INTRODUCTION

The use of synthetic lysine and methionine in practical concentrate diets has been practised for a number of years in order to increase the biological value of the protein in the nutrition of single stomached animals. However, the efficient utilization of protein (amino acids) for maximum production has always been hampered by insufficient knowledge with regard to the degree to which pure amino acids can be utilised by the animal, and interactions during imbalances of amino acids, especially when some of them are used in pure form (Mitchell 1964). Lysine is known to be the first limiting amino acid in cereal based concentrate diets (Russo 1969; Braude et al. 1972; Baig et al. 1977) and therefore an extensive use of synthetic lysine has taken place since it became commercially available so reducing the dependence on the use of expensive protein concentrates (Fetuga et al. 1975; Abrams 1966; Ivan and Farrell 1975; Batterham 1979; Harrison and Batterham 1978). Unfortunately, it has been shown that a large proportion of the pure amino acid is wasted in the pig during the absorption and metabolism stages (Batterham 1974, 1979; Godden and Batterham 1977).

Free lysine is known to be rapidly absorbed from the digestive tract (Batterham 1979; Williams and Dunkin 1980) and as Jones et al. (1961), Robinson and Lewis (1963) have reported, the rapid absorption of synthetic amino acids may create imbalances leading to deamination and their inefficient utilization. The efficiency of utilization of pure amino acids is influenced by various factors, one of which is frequency of feeding (Batterham 1974; Batterham and O'Neill 1978; Williams and Dunkin 1980) and antagonistic interactions which can further complicate the amino acid balance (Beames and Pepper 1969; Buracewski 1971).

In view of thebiologicaland economic importance associated with the need of increasing the efficiency of utilization of synthetic lysine and protein as a whole, a new compound which contains pure lysine in a protected form was tested with encouraging results.

MATERIALS AND METHODS

Growth experiment

(i) Animals Twenty-one Large White pigs of mixed sexes and 21–25 kg live weight were used in a 10 week growth experiment in a minimal disease piggery. They were

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allotted into three treatment groups on a live weight basis and penned individually. Each pen was supplied with a drinking nipple and all pigs were allowed a two day settle-in period during which they all continued being fed a commercial type early grower diet.

(ii) Diets Three diets were fed based on a commercial type basal diet which was used as the control. This was supplemented with either ordinary synthetic lysine (unprotected) or with protected synthetic lysine. Protection was achieved by coating lysine with a natural protein in an attempt to reduce the rate of absorption from the digestive tract.

The basal diet was formulated to contain 18.5% crude protein (N% x 6.5) and composed of: 62% wheat, 20.5% maize, 14.5% cottonseed meal, 2% limestone, 0.5% salt and 0.5% of a vitamins and mineral mix. It provided sufficient levels of all essential amino acids for growth except for total lysine which represented only 0.64% of the diet. Table 1 shows the full amino acid profile of the basal diet expressed as percent of an air dry sample.

TABLE 1 Total amino acid content as % of basal diet

Amino acid	%	Amino acid	%	Amino acid	%
Lysine	0.64	Isoleucine	0.65	Serine	0.84
Methionine	0.31	Valine	0.79	Glycine	0.86
Threonine	0.61	Leucine	1.42	Glutamic	4.77
Arginine	1.28	Aspartic	1.27	Proline	1.21
Histidine	0.48	Cystine	0.34	Tyrosine	0.60
Falanine	0.90	Alanine	0.81		

The basal diet (Treatment 1) was supplemented with 0.3% of ordinary synthetic L-lysine (Treatment 2) or with protected synthetic lysine (Treatment 3). The experimental diets were fed to almost appetite twice a day as determined by the amount of feed consumed within one hour of feeding. All pigs were fed the same amount offered daily in two portions (8 am and 3 pm). At the beginning of the experiment when the pigs were about 11 weeks old, they were fed 1 kg/head/day and by the end of the trial their daily intake had been increased to 2.5 kg.

(iii) Observations Live weight was recorded at 1, 3, 5, 7 and 10 weeks before the afternoon feed. Backfat measurements were taken at the end of the 17th week (18 weeks old) and end of the trial when they were about 22 weeks old. The data were statistically analysed using one-way analysis of variance.

(iv) Metabolic nitrogen trials Two trials were conducted to measure the urinary nitrogen excretion from pigs fed in succession one of three experimental diets. Each trial involved three pigs of 20 kg average live weight kept in metabolism cages. Each animal was fed for seven days one of the diets. The first two days was the settling-in period and the other five urine collection. After each seven day period, the diets were rotated until each animal had been fed all three diets. The daily ration of 1 kg feed was offered in two 500 g lots, one at about 8 am and the other at 3 pm. Water was always available.

All urine voided daily from each animal collected using 10% sulphuric acid and analysed for nitrogen at the end of each seven day run.

(v) Methods Nitrogen determination was by the method of McKenzie and Wallace (1954) and amino acids using ion exchange chromatography (Bidmead and Ley 1958).

RESULTS

Growth experiment

Table 2 shows the mean body-weight gain of pigs per treatment expressed as Progressive (total) or Incremental, during each of the five growth periods.

TABLE 2 Mean progressive and incremental body-weight (kg) gain of pigs

End of experimental week	Progressive weight gain			Incremental weight gain		
	Control	Unprot. lysine	Prot. lysine	Control	Unprot. lysine	Prot. lysine
1 (1 week)	2.86	3.47	4.14	2.86	3.47	4.14
3 (2 weeks)	11.77a	13.23	14.68c	8.91	9.76	10.54
5 (2 weeks)	20.71a	23.46	25.35c	8.94	10.23	10.67
7 (2 weeks)	31.18a	35.36b		10.47	11.90	12.32
10 (3 weeks)	47.64a	52.16b		16.46a	16.80a	19.37b

Means on each line with different subscripts are significantly different

Both lysine treatments gave significantly higher growth rates than the control.

Table 3 gives a summary of the observations made in the growth experiment.

TABLE 3 Mean weight gain (kg/d), F.C.E. and backfat (mm) throughout theexperiment

	Control	Unprotected	Protected
Liveweight gain	0.68a	0.75b	0.82c
Feed conv. efficiency	3.01a	2.71	2.49b
Backfat depth: uncorrected	17.71	18.14	18.00
corrected	18.29	18.07	16.86

Means per parameter with different subscripts are significantly different

Backfat as such was not significantly different in any of the three treatments although there was a trend for the corrected values in pigs on the protected lysine to be more than 1.2 mm below the other two treatments (Table 3).

Feed conversion was significantly different, with pigs on protected lysine being better ($P < 0.01$ and 0.1) than the "control" and "unprotected" treatment respectively. Values of N excretion are presented in Table 4.

TABLE 4 Total urinary nitrogen excretion (mg) of pigs fed for seven days each of the three experimental diets in succession

	Animals - Trial 1				Animals - Trial 2				Overall mean
	1	2	3	$\bar{M}_1$	4	5	6	$\bar{M}_2$	
Control	1758	1769	1808	1778	1854	1916	1819	1863	1825.2
Unprotected	1615	1587	1658	1620	1745	1681	1653	1693	1656.5,a
Protected	1354	1370	1342	1355	1374	1468	1394	1412	1383.7,b

L.S.D. 65.06 (0.05 level) and 97.57 (0.01 level) for the overall mean

Results in both trials showed signficant differences ($P < 0.01$) in urinary N-excretion between treatments. Those on the unprotected lysine treatment lost an average of 26% more nitrogen than those on the protected lysine diet.

DISCUSSION

Results showed that pigs on the protected lysine treatment grew at a significantly faster rate than those in thecontroland unprotected groups throughout the experiment and there was a significant difference ($P < 0.05$) of about 4.6 kg live weight in favour of the protected as compared to the unprotected lysine group. As the conditions were generally similar for the two treatments it can be assumed

that the weight gain difference was due to the protected form of synthetic lysine. The better biological properties of protected lysine were also demonstrated by the group on this diet (Table 2) which grew at a significantly faster rate than the controls from the early part of the experiment whereas the difference between the unprotected group and the controls was signficant only after the fifth week. As the animals grew older and their requirements in lysine would be expected to be reduced, the incremental differences between the control and unprotected groups were also reduced whereas there was an increase between the two lysine supplemented groups. The difference in total growth between the protected and unprotected groups continued increasing and became significant ($P < 0.05$) after the seventh week when the progressive difference had reached the level of about 4.6 kg.

It is known (Batterham and O'Neill 1978; Williams and Dunkin 1980) that synthetic lysine (unprotected), as used here, can be rapidly absorbed and poorly utilized by the animal due to the relatively slower rate of release of the protein bound amino acids (Mitchell 1964; Batterham 1974, 1979; and Godden and Batterham 1977). The present results have also indicated that for the same level of lysine supplementation, pigs responded significantly better to the protected lysine supplement which would be expected to be absorbed at a slower rate. The amino acid imbalance in the control diet, as a result of the lysine deficiency and the partial correction by supplementation with the unprotected lysine were reflected not only in the lower growth response of pigs to these diets but also in the excessive urinary nitrogen excretion (Table 4). The faster growth rate in the lysine protected group could be attributed to the significantly better F.C.E., an effect which may ultimately offer economic advantages in the use of the protected form of lysine. There were no significant differences in backfat depth between the three treatments but there was a large inconsistency in the values which may have confused the result. The net growth differences of 4.6 kg/pig in favour of the protected as against the unprotected lysine treatment over the ten week experimental period, shows the substantial advantage in the use of the protected amino acid.

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