

### Amino acid requirements

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In establishing the amino acid requirements of pigs it is necessary to define the productive function which they need to support, e.g. growth, lactation or foetal development. Within a particular productive feature several parameters of importance may respond differently to protein or amino acid status, e.g. growth rate and lean content. Information concerning the response in terms of each parameter is desirable in order to allow recommendations regarding dietary allowances to be made.

There is considerable information available regarding the amino acid requirements of the growing pig (see R erat & Lougnon, 1968) but the findings are rather variable. This may be because of differences in the parameters used, the strain of animal, the physiological status or the nutritional status. The variation is, however, much less marked if the values are expressed relative to a particular amino acid, e.g. lysine. This emphasizes the importance of an optimum dietary balance of amino acids and makes possible the identification of relative inadequacies or surpluses. It would be expected that the absolute level of the reference amino acid could be moved up or down in relation to dietary energy status or food intake, age of animal and the potential performance standard of the animal.

Rather than review again the information available on requirements or the procedures that can be used to establish them, an account will be given of a particular programme designed to establish the sequence of amino acid limitation in a reasonably typical practical diet; the objective is to define relative requirements in a particular set of circumstances. It was assumed that in a diet based upon barley and a protein concentrate (soya-bean-fish 2:1, w/w), lysine would be the first limiting amino acid but it was difficult to establish the second and to decide the protein level at which the barrier to performance was reached.

In the first experiment in this series (Taylor, Cole & Lewis, 1973; Taylor, 1975) it was found that performance indices deteriorated as the protein level was reduced below 145 g/kg diet (Table 1). The lysine level was maintained at 9.5 g/kg throughout (Crehan, Cooke, Lodge & Lewis, 1975). In an attempt to identify the next limiting amino acid, the amino acid composition of the diet with 145 g protein/kg was compared with various recommended allowances for the four amino acids listed in Table 2. An experiment designed to identify the second

limiting amino acid by adding various groups of three of the four (Taylor, Cole & Lewis, 1974; Taylor, 1975) established this to be threonine (Table 3) and suggested that perhaps methionine plus cystine was next in sequence.

Table 1. *Crude protein level (nitrogen $\times$ 6.25) in diets for pigs, showing the level at which the second amino acid becomes limiting (underlined)*

Crude protein (g/kg diet)	Body-wt gain (g/d)	FCR	Lean %
176	705	2.41	51.9
164	718	2.41	48.8
155	708	2.44	49.8
145	<u>710</u>	<u>2.42</u>	<u>50.9</u>
133	<u>656</u>	<u>2.62</u>	<u>47.1</u>
125	645	2.64	47.4
114	606	2.82	44.3
100	552	3.12	42.8
SE	15	0.07	0.9

FCR, food conversion ratio (g food intake/g body-wt gain); lean %, percentage lean meat in carcass.

Table 2. *Various recommended dietary levels of amino acids (g/kg) for pigs compared with the levels present in a diet with 145 g crude protein (nitrogen $\times$ 6.25)/kg used in the present experiments*

	Present level	Agricultural Research Council (1967)	Clausen (1965)	Rérat & Lougnon (1968)	Lewis & D'Mello (1968)
Lysine	9.5	7.7	9.5	8.4	9.5
Methionine + cystine	5.4	5.5	5.7*	6.2	6.5
Tryptophan	1.8	1.5	1.5	1.9	1.6
Isoleucine	4.5	6.5	8.2	6.7	5.9
Threonine	5.7	4.7	5.8	5.8	4.5

\*Stated to be methionine.

Table 3. *Identification of the second limiting amino acid in diets for pigs by supplementing a basal diet with various groups of three of the four likely amino acids*

Diet	Body-wt gain (g/d)	Lean %	Blood urea (mmol/l)
Basal (125 g CP, 9 g Lys/kg)	630	48.9	4.32
Basal+Met+Try+Ileu	643	48.0	4.55
Basal+Thr+Try+Ileu	685	50.2	3.85
Basal+Thr+Met+Ileu	674	51.1	3.59
Basal+Thr+Met+Try	705	51.5	3.44
Control (145 g CP, 9 g Lys/kg)	705	51.6	4.88
SE	12	0.7	0.25
LSD	33	2.1	0.69

Lean %, percentage lean meat in carcass; CP, crude protein (nitrogen $\times$ 6.25); Lys, lysine; Met, methionine; Try, tryptophan; Ileu, isoleucine; Thr, threonine; LSD, least significant difference.

The research programme continued in order to establish the threonine requirement ((A. J.) Taylor, Cole & Lewis, 1975; Taylor, 1975), using a basal diet with 125 g crude protein (nitrogen $\times$ 6.25)/kg but with synthetic amino acid supplements to provide levels of lysine, methionine plus cystine and tryptophan of 9.5, 5.5 and 2.0 g/kg respectively. The basal diet contained 4.8 g threonine/kg and in the eight treatments used it ranged up to 6.6 g/kg. Various indices of performance were recorded but there was no benefit in providing levels of threonine above 5.6 g/kg (Table 4).

Table 4. *Determination of the threonine requirement of the growing pig, using various dietary levels of threonine*

Threonine (g/kg air-dry diet)	Body-wt gain (g/d)	FCR	Lean %
4.8	630	2.62	50.2
5.2	650	2.61	53.0
5.4	695	2.42	54.3
5.6	708	2.39	52.3
5.8	685	2.45	51.3
6.0	690	2.40	51.3
6.2	715	2.34	54.0
6.5	—	2.4	53.2

FCR, food conversion ratio (g food intake/g body-wt gain); lean %, percentage lean meat in carcass.

In a comparable trial the methionine plus cystine requirement was established ((S. J.) Taylor, Cole & Lewis, 1975; Taylor, 1976). The levels of lysine and tryptophan were maintained as in the previous programme, and the threonine content was 5.9 g/kg air-dry diet. The methionine plus cystine content of the basal ration was 3.8 g/kg and ten treatments ranged up to 5.6 g methionine plus cystine/kg. Various indices of performance were again recorded (Table 5) and we concluded that 4.6 g methionine plus cystine/kg met the needs of the growing pig.

Table 5. *Determination of the methionine plus cystine requirement of the growing pig, using various dietary levels of methionine plus cystine*

Methionine+ cystine (g/kg air-dry diet)	Body-wt gain (g/d)	FCR	Lean %
3.70	623	2.63	64.3
3.85	650	2.52	65.5
4.0	660	2.49	65.9
4.2	675	2.48	66.4
4.4	682	2.47	66.7
4.6	692	2.41	66.8
4.8	700	2.35	66.8
5.0	697	2.36	66.1
5.2	688	2.41	67.0
5.4	690	2.38	67.7
5.6	701	2.36	66.5

FCR, food conversion ratio (g food intake/g body-wt gain); lean %, percentage lean meat in carcass.

We have already emphasized that it is more meaningful to consider relative rather than absolute amino acid requirements when the findings or recommendations from different sources are being compared. In this respect it is of interest to compare changes during the decade 1965–75, and some selected values are given in Table 6. The values of (S. J.) Taylor *et al.* (1975) and Taylor (1976) suggest somewhat reduced proportions for isoleucine and methionine plus cystine: these are perhaps over-emphasized by the rather high absolute level chosen for lysine (9.5 g/kg).

Table 6. *Changes in recommended daily allowances of amino acids in diets for pigs (relative to the recommended lysine allowance) over the decade 1965–75*

	Clausen (1965)	Rérat & Lougnon (1966)	Agricultural Research Council (1967)	Lewis & D'Mello (1968)	Keith, Christensen & Owen (1972)	(S. J.) Taylor, Cole & Lewis (1975)
Lysine	100	100	100	100	100	100
Methionine + cystine	61	74	71	68	69	48
Threonine	61	69	61	47	64	59
Isoleucine	86	80	84	62	71	44
Tryptophan	16	23	20	17	19	16

Though there have not been many recent determinations of amino acid needs in the growing pig, there have been interesting findings for methionine plus cystine and for threonine. A selection of the results is given in Tables 7 and 8. In the instance of methionine plus cystine the daily allowances proposed are in good agreement with each other, while for threonine the proportion relative to lysine is quite consistent.

Table 7. *Daily allowances of lysine and of methionine plus cystine for a 40 kg pig, as given by various workers*

	Henry & Rérat (1970)	Braude & Esnaola (1973)	(S. J.) Taylor, Cole & Lewis (1975)
Lysine (g/d)	14.3	14.0	17.6
Methionine+cystine g/d	8.9	7.4	8.3
% lysine allowance	62	53	47

Table 8. *Recommended threonine levels in diets for pigs, as given by various authors*

	Live wt (kg)	Threonine level	
		g/kg diet	% Lysine level
Mitchell, Becker, Hannan, Norton & Jensen (1968)	10	6.0	67
Henry & Rérat (1970)	20–50	4.8	56
Lougnon & Brette (1971)	17–45	5.2	57
(S. J.) Taylor, Cole & Lewis (1975)	25–55	5.6	59

It would be of considerable interest to obtain a response curve to lysine input under various physiological circumstances while the other amino acids were present in adequate amounts and in good balance.

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