Digestion in the pig between 7 and 35 d of age
6. The digestion of hydrolyzed milk and soya-bean proteins

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1. Four pelleted diets were prepared containing milk or isolated soya-bean protein (ISP) as the major protein source. The milk and ISP were given either as intact proteins or partially (0·65) hydrolyzed with papain before feeding.

2. The diets were given *ad lib.* to thirty-two pigs from 7–28 d of age. The pigs were slaughtered at 28 d of age.

3. Weight gains, food conversion ratios and nitrogen balances of pigs given diets containing milk protein were better than those of diets containing ISP (231 g/d, 0·80 and 11·5 g/d compared to 209 g/d, 0·88 and 9·00 g/d respectively).

4. Partial hydrolysis of proteins before feeding did not affect the performance of the pigs.

5. Apparent digestibilities of N before the ileum and in the whole tract were 0·78 and 0·94 for the pigs given the ISP diets and 0·86 and 0·97 for the pigs given the milk-protein diets.

6. Retention time of ISP diets in the whole digestive tract was 1475 min and that of the milk-protein diets was 1089 min.

7. pH of digesta in the stomach was 5·0–5·3 for all diets and increased to 6·9–7·1 in the ileum.

8. There were no differences in flows of total N and protein N to the ileum and lower digestive tract between the pigs given the intact- and hydrolyzed-protein diets.

9. Apparent absorptions of N in the stomach, duodenum and jejenum were greater in the pigs given diets containing hydrolyzed proteins than in those given diets containing the intact proteins.

10. Flows of total N and protein N to the ileum tract were greater when the pigs were given the ISP diets than when they were given the milk-protein diets.

11. Hydrolysis of proteins before feeding resulted in a reduced trypsin and chymotrypsin activity in the duodenum and pancreas.

12. Retention of dietary N in the carcass was greater in pigs given the milk-protein diets (0·79) than in those given the ISP diets (0·68).

Numerous experiments (Hays *et al.* 1959; Maner *et al.* 1961; Wilson & Leibholz, 1981*a*) have shown that the performance of pigs given soya-bean meal, soya-bean flour or isolated soya-bean protein (ISP) was inferior to that of pigs given milk proteins between 7–28 d of age. The young pig has a limited capacity to secrete pepsin and acid, and this increases with age (Cranwell, 1977) and the proteinase activity of the pancreas also increases with age (Corring *et al.* 1978). It has been shown (Wilson & Leibholz, 1981*c*), that 46% of the nitrogen in the small intestine of 28-d-old pigs given soya-bean proteins was precipitated by trichloracetic acid (TCA) while only 24% of the N was precipitated in the pigs given milk protein.

It appeared possible that the growth of pigs given soya-bean proteins was limited by the hydrolysis of the protein in the intestines. The present experiment was designed to study the performance of pigs fed on normal milk and soya-bean proteins and the same products hydrolyzed before feeding.

EXPERIMENTAL

Diets

Dried skim milk and ISP (Supro 610; Ralston Purina, St Louis, Mo. USA) were dissolved in water at 38 ° (1 part protein: 10 parts water). Papain (Hopkins & Williams Ltd, Chadwell

Table 1. *Composition of diets*

Diets no. ...	1	2	3	4
Protein source ...	Milk		ISP	
	Untreated	Treated†	Untreated	Treated†
Variable ingredients (g/kg)*				
Dried skim milk	720	720	—	—
ISP	—	—	256	256
Lactose	85	85	523	523
Dicalcium phosphate	—	—	32	32
Lysine	—	—	1	1
Methionine	—	—	3	3

ISP, isolated soya-bean protein (Supro 610; Ralston Purina, St Louis, Mo. USA).
* All diets contained (g/kg): 150 dried whole milk, 20 calcium stearate, 20 Solka Floc (Brown Co., Berlin, New Hampshire, USA), 10 vitamin and mineral supplement supplying (mg/kg diet): 1·5 retinol, 0·025 cholecalciferol, 20 α-tocopherol, 2 menaphthone, 200 ascorbic acid, 20 μg cyanocobalamin, 1·5 thiamine, 6 riboflavin, 20 niacin, 10 pantothenic acid, 3 pyridoxine, 1 g choline chloride, 0·3 folic acid, 0·1 biotin. Minerals (mg/kg): 1000 sodium, 2600 potassium, 400 magnesium, 100 iron, 10 copper, 40 manganese, 70 zinc, 2 cobalt, 0·1 selenium, 0·1 iodine. Other additives (mg/kg): 100 ethoxyquin, 50 oxytetracycline, 50 neomycin sulphate.
† The dried skim milk and ISP in diets 2 and 4 were hydrolyzed with papain before mixing of the diets.

Heath, Essex) was added to half of each of the milk and ISP solutions at a rate of 30 g/kg protein. The solutions were maintained at 38 ° for 24 h and stirred manually at approximately hourly intervals.

The solutions were then spray-dried and the powders formed were mixed with the other dietary ingredients. The composition of the diets is given in Table 1.

Animals

Thirty-two Large White × Landrace male pigs were taken from sows at 4 d of age. The pigs were housed in four groups for a preliminary period of 3 d. At 7 d of age the pigs were allocated, one per cage, to the experimental diets, eight replicates per diet, by restricted randomization on the basis of initial live weight. The diets were offered *ad lib.* and water was available from nipple drinkers. The cages were in a draught-free room maintained at 30 °. The duration of the experiment was 21 d.

Faeces and urine were collected from 9–14 d of age and 23–28 d of age. Food intake was measured daily and the pigs were weighed weekly.

Indigestible markers were sprayed evenly on the diets given to sixteen pigs between 22 and 28 d of age. The markers were ^{51}Cr complex of ethylenediaminetetra-acetic-acid and ^{103}Ru-labelled Tris-(1,10-phenanthroline)-ruthenium (II) chloride and details of the procedures were described by Wilson & Leibholz (1981 *b*). The daily intakes of the isotopes were approximately 2 μCi ^{103}Ru and 10 μCi ^{51}Cr.

At 28 d of age the pigs were anaethetized by the intravenous administration of Surital (sodium thiamylal; Parke Davis & Co., Sydney). The intestinal tract was removed under these conditions to prevent, as much as possible, the shedding of epithelium into the intestinal lumen. The length of the small intestine was measured and then divided into three equal parts (duodenum, jejunum and ileum in the Tables). All digesta were rapidly removed from the intestines, stomach, caecum and colon, weighed, the pH determined and stored at −20 °. The pancreas was removed and weighed.

The empty bodies of the pigs were stored at −20 ° prior to mincing and freeze drying.

Table 2. *Performance of pigs given diets containing milk or isolated soya-bean protein (ISP)*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Gain (g/d)					
7–14 d	137	160	115	97	11·6
14–28 d	274	270	263	257	6·3
7–28 d	228	233	214	204	8·9
Food intake (g/d)					
7–28 d	180	189	186	180	6·5
Food conversion ratio					
7–28 d	0·79	0·81	0·87	0·88	0·023
Digestibility					
9–14 d					
Apparent digestibility:					
DM	0·948	0·952	0·929	0·919	0·0046
Nitrogen	0·966	0·972	0·944	0·933	0·0043
N balance (g/d)	4·94	5·05	3·74	3·92	0·41
23–28 d					
Apparent digestibility:					
DM	0·943	0·953	0·926	0·921	0·0045
N	0·967	0·979	0·946	0·936	0·0046
N to the ileum	0·871	0·851	0·810	0·750	0·0047
N balance (g/d)	11·8	11·2	9·5	8·4	0·84

DM, dry matter.
* For details of diet composition, see Table 1.

Analytical methods

The digesta samples were homogenized and samples were counted in an Auto Gamma Spectrophotometer (Model 5320, Packard Instrument Co. Inc., Ill.). Dry matter (DM) was determined in a forced-air oven at 95 °. Total N was determined by the Kjeldahl method. Carcass fat was determined in freeze-dried material by the Soxhlet method (Association of Official Agricultural Chemists, 1975) and TCA-precipitable-N content of food and digesta samples by the method of Ternouth *et al.* (1974). Trypsin and chymotrypsin activities in the pancreas and duodenal contents were measured by the methods of Gorrill and Friend (1970) using toluene arginine methyl ester (TAME) and benzoyl tryosine ethyl ester (BTEE) as substrates.

RESULTS

The hydrolysis of the dietary protein with papain was not complete; 39 and 35% of the N was precipitated by TCA in diets 2 and 4 respectively.

Performance

The performance of the pigs is shown in Table 2. The weight gains of the pigs given the ISP diets were significantly less (40%) than those of the pigs given the milk-protein diets between 7 and 14 d of age. However, between 14 and 28 d of age and over the whole experiment the differences were only 5–11%. Hydrolysis of the dietary proteins before feeding did not influence the weight gains of the pigs.

The food conversion ratio of the pigs given the ISP diets was significantly greater than that of the pigs given the milk-protein diets.

Table 3. *Mean retention time (min) of* ^{103}*Ru-labelled Tris-(1,10-phenanthroline)-ruthenium (II) chloride in the gastrointestinal tract of 28-d-old pigs given diets containing milk or isolated soya-bean protein (ISP)*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Stomach	52	64	70	54	7·5
Duodenum	10	10	13	12	2·9
Jejunum	33	49	47	38	9·4
Ileum	101	127	185	124	30·1
Caecum	114	109	121	152	27·8
Large intestine	429	343	707	605	78·6
Colon	372	375	380	430	80·4
Total	1111	1077	1523	1415	40·8

* For details of diet composition, see Table 1.

Table 4. *Flows of digesta (g/24 h) through the gastrointestinal tract of 28-d-old pigs given diets containing milk or isolated soya-bean protein (ISP)*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Stomach	2288	2612	2860	2320	258
Duodenum	2775	2938	2849	3177	319
Jejunum	1088	948	1145	1273	199
Ileum	353	398	341	432	35
Caecum	191	181	173	201	25
Large intestine	131	118	112	145	16
Colon	101	81	85	94	10

* For details of diet composition, see Table 1.

Apparent digestibilities of DM and N were less for the diets containing ISP than for the diets containing milk protein at both ages. Apparent digestibility of N to the ileum was less than the apparent faecal digestibility. At the ileum, the difference in apparent digestibility of N between the milk protein and ISP was 8% compared to a difference of only 3% in the faeces. Hydrolysis of dietary proteins before feeding did not improve apparent digestibility of N in the whole tract, but its digestibility to the ileum was improved.

N retentions at both ages were higher in pigs given the milk protein than in those given the soya-bean protein, but there was no significant effect due to the hydrolysis of the dietary proteins.

Retention times and digesta flows

Retention times of diets containing milk in the whole gastrointestinal tract were less than those of diets containing ISP (Table 3). This was mainly due to a longer retention time of the ISP diets in the large intestines. Hydrolysis of dietary protein before feeding did not affect the retention times of digesta. There were no significant treatment effects on flows of digesta (Table 4).

Table 5. *Flows of dry matter (g/24 h) through the gastro-intestinal tract of 28-d-old pigs given diets containing milk or isolated soya-bean protein (ISP)*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Intake	357	319	347	310	21·9
Intestinal section					
Stomach	345	334	359	305	31·6
Duodenum	141	124	157	146	12·2
Jejunum	66·7	58·9	66·2	76·9	7·51
Ileum	36·8	41·7	50·4	66·5	7·40
Caecum	33·3	31·9	36·7	39·6	3·59
Large intestine	29·5	23·6	36·0	42·5	2·89
Colon	21·7	22·1	29·5	33·1	1·58
Faeces	19·4	18·5	21·9	22·4	1·42

* For details of diet composition, see Table 1.

Table 6. *pH of digesta in the stomach and small intestine of 28-d-old pigs given diets containing milk or isolated soya-bean protein (ISP)*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Stomach	5·3	5·0	5·5	5·2	0·33
Duodenum	6·1	5·5	5·8	5·5	0·28
Jejunum	6·8	6·3	6·5	6·4	0·17
Ileum	7·1	6·9	6·9	7·0	0·13

* For details of diet composition, see Table 1.

Flow of DM through the stomach was similar to the dietary intake of DM (Table 5). Approximately 64% of the total apparent digestion of DM occurred in the duodenum of pigs given the milk diets and 56% in pigs given ISP diets. A further 21–22% of the digestion occurred in the jejunum in the pigs given the milk diets and 24–28% in the pigs given the ISP diets. Flows of DM to the large intestine, colon and faeces were greater for pigs given the ISP diets than for those given the milk diets.

pH

The pH of all sections of the gastointestinal tract (Table 6) tended to be lower for the pigs given the diets in which the protein had been hydrolyzed before feeding. There was no significant difference between the sources of protein given to the pigs on the pH of the digesta in the gastrointestinal tract.

N flow

Due to the slightly lower food intake (Table 5) and N contents of the diets containing ISP than of the diets containing milk proteins, N intakes of pigs given diets containing ISP were less than those of pigs given milk proteins (Table 7). To allow for this difference, N flows

Table 7. *Flows of nitrogen through the gastrointestinal tract of 28-d-old pigs given diets containing milk or isolated soya-bean protein (ISP) untreated or hydrolyzed with papain*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
N intake (g/d)	17·71	15·58	15·07	12·54	1·17
Intestinal section (g/d)					
Stomach	20·20	15·34	17·17	10·34	2·76
Duodenum	11·13	10·35	9·96	8·38	1·40
Jejunum	7·73	4·69	7·94	5·19	0·39
Ileum	2·28	2·31	2·97	3·14	0·37
Caecum	1·66	1·85	2·16	2·75	0·38
Large intestine	1·65	1·59	2·34	2·60	0·27
Colon	0·96	0·93	1·09	1·16	0·11
Faeces	0·54	0·42	0·68	0·70	0·06
N (% of intake)					
Stomach	114·1	98·5	113·9	82·7	4·62
Duodenum	62·8	66·4	66·1	66·9	8·10
Jejunum	43·6	30·1	52·7	41·3	3·51
Ileum	12·9	14·8	19·0	25·0	2·48
Caecum	9·4	11·9	14·3	21·9	1·98
Large intestine	9·3	10·2	15·5	20·7	1·30
Colon	5·4	6·0	7·2	9·3	1·04

* For details of diet composition, see Table 1.

Table 8. *Trichloracetic acid-precipitable-nitrogen: total N in the gastro-intestinal tract of 28-d-old pigs given diets containing milk or soya-bean protein (ISP) untreated or hydrolyzed with papain*

Diets no.* ...	1	2	3	4	
Protein sources ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Diet	0·96	0·39	0·94	0·35	—
Intestinal section					
Stomach	0·94	0·44	0·99	0·45	0·025
Duodenum	0·27	0·16	0·44	0·25	0·047
Jejunum	0·22	0·16	0·34	0·24	0·039
Ileum	0·23	0·26	0·69	0·66	0·063
Caecum	0·37	0·49	0·85	0·95	0·067
Large intestine	0·77	0·76	0·82	0·80	0·058
Colon	0·64	0·64	0·70	0·77	0·042

* For details of diet composition, see Table 1.

also have been expressed as a percentage of the N intake. Hydrolysis of protein before feeding resulted in a reduced flow of N through the stomach and jejunum. There were no differences in the other parts of the tract, but there was a large variation between pigs in the flow of N to the duodenum.

Flows of N through the jejunum and all lower parts of the digestive tract were greater for pigs fed on the ISP diets than for those given the milk-protein diets.

Table 9. *Weight of small intestine and pancreas, and trypsin and chymotrypsin activity in the duodenum and pancreas of 28-d-old pigs given diets containing milk or isolated soya-bean protein (ISP)*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Small intestine:					
Wt (g)	298	269	320	280	27
% of live weight	4·91	4·29	5·04	5·45	0·17
Pancreas					
Wt (g)	14·9	14·9	15·7	13·7	1·30
% of live weight	0·212	0·234	0·265	0·264	0·015
Chymotrypsin activity†					
Duodenum	20	18	16	12	3·8
Pancreas	2·50	1·96	1·86	1·50	0·17
Trypsin activity†					
Duodenum	38	12	33	10	6·3
Pancreas	1·12	1·07	0·95	0·88	0·10

* For details of diet composition, see Table 1.

† Expressed as mmol substrate (benzoyl tyrosine ethyl ester or toluene arginine methyl ester) hydrolyzed/min per g pancreas or 1 digesta.

Table 10. *Crude protein (nitrogen × 6·25) and fat contents of carcasses of 28-d-old pigs given diets containing milk or isolated soya-bean protein (ISP)*

Diets no.* ...	1	2	3	4	
Protein source ...	Milk		ISP		
	Untreated	Treated	Untreated	Treated	SEM
Carcass composition					
Fat: DM	0·164	0·159	0·231	0·242	0·021
Crude protein: DM	0·732	0·735	0·698	0·685	0·014
Nitrogen retention in carcass (% of N intake)	0·804	0·787	0·700	0·671	0·026
N retention in carcass (% N apparently absorbed to ileum)	0·935	0·932	0·883	0·907	0·028

DM, dry matter.

* For details of diet composition, see Table 1.

Hydrolysis of the proteins before feeding resulted in a smaller proportion of TCA-precipitable N in the total N in the stomach, duodenum and jejunum (Table 8). The portion of TCA-precipitable N in the total N was greater in all parts of the digestive tract for the pigs fed on ISP diets than for those given milk-protein diets.

Proteolytic enzymes

Weights of small intestines and pancreases were similar for all pigs (Table 9), but as percentages of the live-weight, values were higher for pigs given the ISP diets than for pigs given milk-protein diets.

Activities of trypsin and chymotrypsin in the duodenum and pancreas were reduced by the hydrolysis of proteins before feeding. There was also a tendency for lower activity of these enzymes in the pigs given the ISP diets than in the pigs given the milk-protein diets.

Carcass composition

The protein content of the DM in the carcasses was greater in the pigs given the milk-protein diets than in those given the ISP diets while the fat contents of the carcasses were greater in the pigs given the ISP diets (Table 10).

DISCUSSION

Soya-bean proteins have been extensively given to pigs of all ages, but with pigs of 14 d of age or less their performance has always been lower than that of pigs given diets containing milk proteins (Hays *et al.* 1959; Maner *et al.* 1961; Wilson & Leibholz, 1981 *a*).

Wilson & Leibholz (1981 *c*) showed that there was a greater hydrolysis of milk proteins in the small intestine of the 28-d-old pig than that of soya-bean proteins. This may be related to the secretion of proteolytic enzymes in the young pig.

The proteins in food are first acted on in the stomach by pepsins. Pig pepsinogens are hydrolyzed to pepsin in acid conditions, slowly at pH 4 and rapidly at pH 2 (Pyle, 1960). However, the capacity of the young pig to secrete pepsin and acid is limited at birth and increases with age (Cranwell, 1977; Decuypere *et al.* 1978). The mean pH of the stomach of the pigs in the present experiment was 5·2 which would limit proteolytic activity as indicated by a similar proportion of TCA-precipitated N in the stomachs and diets. Braude *et al.* (1970) also showed that in the very young pig little proteolysis occurred in the stomach.

The secretions of the pancreas and duodenum are alkaline and the pH of digesta rises progressively reaching 7 by the end of the small intestine in the present experiment and in mature pigs (Clemens *et al.* 1975). The pancreatic enzymes break down the proteins to mixtures of small peptides and free amino acids in the intestines. Crampton *et al.* (1971) and Matthews *et al.* (1968) have shown that small peptides are absorbed more rapidly than mixtures of free amino acids.

The proteinase activity of the pancreas increases with increasing age of the young pig (Hartman *et al.* 1961; Corring *et al.* 1978), but it has been shown to be similar in pigs given casein, fish-protein concentrate or ISP (Pond *et al.* 1971). However, Pekas *et al.* (1966) found that the volume of pancreatic juice secreted and its proteolytic activity was higher in pigs given soya-bean protein than milk proteins, while Newport (1979) showed that the trypsin and chymotrypsin activity in the duodenum and pancreas was less in pigs given fish protein than in those given milk protein. In the present experiment, there was slightly less proteolytic activity of the duodenal contents and pancreas in the pigs given ISP than in those given milk proteins.

Substitution of hydrolyzed casein for 600 g/kg casein in the diet of the rat was shown to reduce total tryptic activity to half (Howard & Yudkin, 1963). In the present experiment replacement of dried skim milk or ISP with their partially-hydrolyzed proteins resulted in a reduction of trypsin activity in the duodenum to a third, but the reduction in the pancreas was only 10%. There was also a reduction in the chymotrypsin activity.

As a result of the suggested deficiency of proteolytic enzymes in the young pig, several authors have given supplementary enzymes or predigested proteins to pigs. Cunningham & Brisson (1957) and Maner *et al.* (1961) found that the performance of young pigs was not improved by the supplementation of their diets with pepsin, pancreatin or trypsin. Enzymic digestion of proteins before feeding has resulted in poor performance (Cunningham & Brisson, 1957; Pettigrew *et al.* 1977). However, the extent of protein hydrolysis was not measured by these workers and, as mentioned previously, mixtures of small peptides are absorbed more rapidly than mixtures of free amino acids (Crampton *et al.* 1971; Matthews *et al.* 1968). Seve *et al.* (1975) gave hydrolyzed fresh fish to pigs from 12 d of age. The results showed that the performance of pigs was reduced by the elimination of the less soluble fraction of the hydrolysate. Seve *et al.* (1978) concluded that the enzyme treatment should be as mild as possible in order to facilitate protein digestion without degrading the biological value.

In the present experiment hydrolysis of the protein was incomplete and the remaining protein was not removed from the diets. This resulted in similar performance of pigs given the whole protein and hydrolyzed-protein diets. Performances of the pigs given both ISP diets were similar and less than those of pigs given the milk diets. It may be suggested that the extent of hydrolysis of the ISP was not limiting the performance of the pigs. However, 35% of the protein was not hydrolyzed and the N in this fraction was less digestible than the N in milk protein and may explain the reduced performance of the pigs.

Retention times of digesta in the whole tract were greater for pigs given ISP than those given milk which differs from our earlier results (Wilson & Leibholz, 1981 *b*). However, in the present experiments pigs were fed *ad lib.* and there were higher intakes of the milk-protein diet which would result in a faster passage rate. In the previous experiment, food intakes were restricted to 2 g N/kg live weight$^{0.75}$ per d.

Apparent digestion of DM between the ileum and faeces was greater for the pigs given the ISP diets than those given the milk diets which confirms the observations of Wilson & Leibholz (1981 *b*).

There was an apparent secretion of N into the stomach of the pigs given intact proteins, but not when the proteins were hydrolyzed. N secretion in the stomach was also found by Zebrowska & Buraczewska (1972) but Low & Zebrowska (1977) showed that the values for endogenous N flows to duodenal cannulas were influenced by the technique of collection. In the present experiment, the results should have been unbiased and indicate a real difference.

The observed difference in N flow through the stomach could be explained either by a stimulation of gastric secretion by intact proteins or a more rapid absorption of the hydrolyzed proteins. A greater apparent absorption of N from the hydrolyzed proteins than the intact proteins occurred in the duodenum and jejunum. There were no differences in the lower parts of the digestive tract suggesting that all readily-digestible protein had been digested and that the slower digestion of the less-digestible fractions including endogenous secretions (Zebrowska *et al.* 1976) occurred in the ileum, caecum and large intestines.

Flows of N to the ileum were greater in pigs given ISP than milk proteins suggesting again that the partial hydrolysis of the ISP protein did not hydrolyze the less-digestible components of the protein.

Apparent digestibility of ISP to the ileum was 0·78, while that of milk was 0·86. These values increased to 0·97 and 0·94 over the whole tract. With 60 kg pigs Zebrowska *et al.* (1978) found that there was a greater apparent absorption of N in the large intestine of pigs given soya-bean meal than in those given casein. These results may suggest microbial fermentation is more important in the breakdown of the less-digestible dietary proteins than in the readily-digested proteins in both the caecum and large intestine of the 6 and 60 kg pig.

Braude *et al.* (1970) and Wilson & Leibholz (1981 *c*) found that only 19% of the N at the duodenum was in the form of protein for young pigs given milk which is similar to the observations in the present experiment. With 60 kg pigs given soya-bean protein, 15–20% of N was found to be present in the form of protein at the duodenum (Zebrowska, 1973), while in the present experiment the value was 44% which would suggest that the hydrolysis of soya-bean protein increases with age.

Jordan & Weatherup (1976) and Wilson & Leibholz (1981*d*) found that the retention of milk N in the carcasses of 30-d-old pigs was 0·7–0·8 of the N intake which confirms the results in the present experiment, but is higher than the values reported by Hodge (1974).

N retention in the carcasses of the pigs given the ISP diets as a percentage of the N intakes was less than that of the pigs given milk protein, but this was partially due to the lower apparent digestibility of the ISP. The ISP diets were supplemented with lysine and methionine, hence, the lower retention of N in the carcasses should not have been due to a deficiency of these amino acids, but it may be related to other dietary differences as discussed by Wilson & Leibholz (1981*c*).

There was a trend for the better utilization of absorbed N in pigs given the hydrolyzed ISP than in those given the intact ISP. This may be due to a difference in the composition of the different fractions in soya-bean protein, and the amino acid composition of the residual protein after hydrolysis of the ISP should have been measured. During the processing of ISP under alkaline conditions amino acid derivatives may have been formed, such as a lysine-alanine complex (De Groot & Slump, 1969). These are poorly absorbed and utilized.

The body composition of young pigs is very sensitive to dietary changes in protein levels and quality (Reid & White, 1978). Wyllie *et al.* (1969) found that in pigs fed starter diets containing 100 g/kg crude protein from 5 to 24 kg live weight their carcasses contained 250 g fat/kg. When the starter contained 310 g/kg of crude protein the fat content of the carcasses was only 110 g/kg. In the present experiment, the pigs fed the ISP diet absorbed less protein than those fed the milk diet and the fat contents of the 6–7 kg carcasses were 162 and 236 g/kg respectively. This suggests that these pigs were extremely sensitive to either protein intake or protein quality or both.

It may be concluded that partial hydrolysis of ISP does not improve its nutritive value, and this may be due both to the lower digestibility of the less-readily fermented fraction of the ISP and to the poorer utilization of the absorbed N.

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