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Total Protein and Amino Acids Contents of Some Common Foods in South East Asia

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ABSTRACT

Analyses of amino acids and total protein have been carried out on some common foods in South East Asia including instant noodles, soy milk, soy sauce, bird's nest and shark's fin.

INTRODUCTION

The amino acid composition is a primary characteristic of a given protein. For a food protein it is now generally accepted that its supplementary value in a mixed diet depends on the availabilities of the essential amino acids. However, for all practical purposes, the nutritive value of a food protein is defined by its essential amino acid composition. Thus one of the measures in nutrient analysis is the accurate and rapid determination of each of the 18 essential amino acids.

A study was undertaken to determine the nutrient values of some selected local foods. The total protein and amino acid contents of: (a) instant noodles; (b) soy milk and soy-milk powder; (c) snack foods; (d) soy sauce; and (e) shark's fin and bird's nest were determined. These were chosen on the basis of their popularity in the case of (a), (d) and (e), and of having great potential as supplementary foods in the case of (b) and (c).

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MATERIALS

All reagents used were analytical grade and included the following: hydrochloric acid, sodium hydroxide (pellets), sodium chloride, sodium acetate, citric acid (monohydrate), hydrazine sulphate, lithium fluoride (all from E. Merck), norleucine standard, amino acid standard, methylcellosolve, thioglycol, Brij-35 (all from Technicon), octanoic acid (Aldrich), ninhydrin (Pierce), glacial acetic acid and EDTA (disodium salt) (both from BDH Chemicals).

All food samples purchased or obtained were used without further treatment.

METHODS

Hydrolysis of sample

This was carried out by heating the sample at 110 °C in 6N HCl (Davis, 1973) for a period of 24 h under vacuum. The hydrolysate was then treated by filtration, to remove any carbonaceous residue, followed by several rotary evaporations to remove excess HCl. The hydrolysate thus treated was made up to volume using 1–2 ml of 1N HCl.

Amino acid analysis

For this purpose a NC-2P Technicon Autoanalyzer was used (Moore & Stein, 1963). However, modifications were made for the methods of preparation of the three buffers as described in the operating manuals for the Technicon NC-2 and NC-2P chromatography systems. These resulted in the shortening of the time required for each analytical run from 3 to 2 h. For this new programme the compositions and pH of the three buffers were adjusted to achieve optimum resolution in the chromatogram. Buffer 1 had a lower concentration of thioglycol and its pH was raised from 3·0 to 3·20. The pH of buffer 2 was changed from 3·60 to 4·25 and sodium chloride was omitted. For buffer 3, the concentration of the added sodium chloride was doubled and the pH was adjusted from 6·50 to 6·80.

Lithium fluoride and octanoic acid were added to all the buffers as preservatives to bring the growth of mould under control.

Total protein

This was determined using the Kjeldahl distillation method (Pearson, 1976; Egan *et al.*, 1981). An accurately weighed sample was first heated for 30 min in 15 ml concentrated sulfuric acid containing three Kjeldahl catalyst tablets. On cooling, the solution was diluted to 100 ml with H_2O; 5 ml of this was transferred to the distillation apparatus and made alkaline with 10 ml 40 % NaOH. The ammonia was then steamed-distilled into 10 ml 4% boric acid. The distillate was then titrated with N/50 H_2SO_4.

RESULTS AND DISCUSSION

Instant noodles

Instant noodles have, in recent years, become extremely popular. This is reflected in the large number of such products on display in most supermarkets. Many of these are manufactured locally but there is also a significant number of imported types. Furthermore, the price per packet varies quite significantly, not only between locally manufactured and imported types, but also among the various local brands.

As instant noodles are consumed by adults as well as children of all ages, the nutritional values of these products are of interest. A total of 14 samples of instant noodles was analyzed for total protein content as well as amino acid content. Results of these analyses are given in Table 1. It will be noted that the amino acid contents vary quite significantly; eight are in the region of 95 ± 5 mg per g sample, four are 75 ± 2 mg per g sample and two are 133 ± 1 mg per g sample. The difference in total amino acids between the first and second types is due mainly to the larger amount of glutamic acid present in the first type. Samples 13 and 14 with the highest total amino acid contents, display higher values for each of the 18 amino acids. The protein contents follow the same trend as that of the total amino acids. All samples of instant noodles selected for this investigation possess an amino acid similar to that of the wheat flour (Orr & Watt, 1957). The two samples (13 and 14) with the high total protein and amino acid contents were probably manufactured from better quality wheat flour to which eggs were added.

It is interesting to note that the locally manufactured products are

TABLE 1
Amino Acid Content (mg/g of sample) and Total Protein Content of Instant Noodles

Amino acid	*Sample*													
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Aspartic acid	4·13	3·57	5·04	3·74	4·08	4·60	3·29	3·50	2·90	3·10	3·41	3·29	4·26	4·30
Threonine	2·83	2·43	2·70	2·62	2·45	2·29	2·18	1·93	2·04	2·12	1·89	2·01	3·27	2·88
Serline	3·92	4·50	4·50	3·55	4·21	4·12	3·60	3·51	3·80	3·91	3·06	3·26	5·87	5·07
Glutamic acid (estimated)	40·56	40·54	38·52	37·60	36·55	36·73	27·97	27·96	29·05	33·88	28·62	31·22	49·88	48·89
Proline	13·29	13·78	14·19	12·45	15·01	13·86	9·31	11·81	9·48	14·90	12·34	12·48	22·68	23·29
Glycine	3·07	3·42	3·93	3·28	3·46	3·65	2·91	2·59	2·32	2·87	2·10	2·54	4·44	4·33
Alanine	3·25	3·84	4·28	3·98	3·74	3·54	3·37	3·24	2·79	2·80	2·24	2·57	4·95	4·48
Cystine	1·47	0·79	1·54	0·95	0·85	0·77	1·01	0·53	—	0·89	0·92	0·68	0·87	3·40
Valine	3·53	3·40	4·37	3·36	3·51	3·87	3·17	2·51	3·01	2·82	2·38	2·35	4·25	4·24
Methionine	1·45	2·38	1·59	1·36	1·06	1·54	2·66	1·97	0·96	1·39	0·99	0·91	1·28	1·29
Isoleucine	2·11	2·04	2·01	1·93	2·02	2·22	1·71	2·56	2·40	2·97	2·30	2·66	4·16	4·31
Leucine	4·89	5·95	5·22	4·68	5·14	5·60	4·23	4·70	4·83	5·97	4·77	4·32	8·45	8·10
Norleucine	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tyrosine	2·11	2·61	2·62	2·75	2·27	2·52	2·13	1·70	1·92	2·68	2·03	2·47	3·80	3·53
Phenylalanine	4·19	4·72	4·47	3·96	5·22	4·80	3·56	3·15	3·54	4·33	3·76	3·51	7·06	6·16
Histidine	0·64	Trace	—	1·23	0·27	2·12	—	0·28	1·80	2·23	0·43	2·36	4·31	4·45
Lysine	1·31	1·79	1·09	1·60	2·02	1·97	1·57	1·86	—	—	—	1·78	—	—
Arginine	2·39	4·16	3·78	2·62	3·11	5·32	5·17	2·70	3·14	3·34	2·60	2·83	4·85	4·45
Total amino acids	95·14	99·92	99·85	91·66	94·97	99·52	77·84	76·50	73·98	90·20	73·98	81·24	134·4	133·2
Total protein	9·75	10·57	10·63	8·95	8·94	10·34	7·31	8·96	6·23	7·93	7·36	—	12·30	11·52

generally comparable in nutrient quality to those imported, and that the two with higher nutritional values are manufactured locally.

Soy milk and soy-milk concentrates from ultrafiltration

With the objective of introducing membrane technology to local food industry, a project was undertaken in which soy milk was concentrated using ultrafiltration (UF) (Porter & Michaeles, 1970). Water extract of soy beans was concentrated to varying extents using membranes of 20 000 and 50 000 cut-off. To determine the effects of UF on the nutritional values of soy milk, proximate analysis as well as amino acid composition of soy milk before and after UF were carried out. Table 2 sets out the results of total protein and amino acid contents, both of which are noted to increase proportionately with increasing percent water removal up to a total of 60%.

The soy-milk concentrates were, in each case, subject to spray-drying to yield soy-milk powder. The total protein and amino acid contents of these soy-milk powders from different batches of soy-milk concentrates are given in Table 3. These also increase with increasing percent water removal.

The increases in total protein and amino acids after UF have been related to the removal of undesirable components in soy proteins including oligosaccharides (Omosaiye *et al.*, 1978) and phytic acid (Omosaiye & Cheryan, 1979). A study employing HPLC (Graf & Dintzis, 1982) is currently being continued to quantify the amounts of oligosaccharides/phytic acid actually removed following UF.

Snack foods

Extrusion technology (Smith, 1969, 1974) applied to the manufacture of snack foods represents one of the most recent developments in the food industry. One of the ongoing research programmes is to apply extrusion technology to produce snack foods from different formulations based on mung beans, soy bean, corn and rice. The amino acid contents of the raw materials as well as the extrusion products were determined. Those of a few selected brands of commercially available snack foods were also obtained for comparative purposes. As will be seen from Table 4, the snack foods formulated in our laboratory are of higher protein and amino acid contents than those of commercial samples.

TABLE 2a

Amino Acid Composition (mg/ml of sample) and Total Protein in Concentrate from Ultrafiltration after using Membrane of 20 000 Cut-off

Amino acid	*Sample*																			
	Soy extract	*20% UF*	*Soy extract*	*40% UF*	*Soy extract*	*40% UF*	*Soy extract*	*40% UF*	*Soy extract*	*50% UF*	*Soy extract*	*50% UF*	*Soy extract*	*60% UF*	*Soy extract*	*60% UF*	*Soy extract*	*60% UF*	*Soy extract*	*70% UF*	*70% UF*
Aspartic acid	2·69	2·79	2·94	3·41	2·20	3·22	2·15	2·93	2·25	2·90	2·28	2·67	2·57	3·22	2·21	4·45	2·52	3·33	2·66	4·35	5·89
Threonine	0·73	0·80	0·88	1·59	0·71	0·96	0·66	1·04	0·68	1·01	0·67	0·96	0·84	1·44	0·79	1·50	0·88	1·27	0·70	1·78	1·91
Serine	0·78	0·86	0·87	1·25	0·74	1·04	0·87	1·18	0·94	1·25	0·92	1·10	0·96	1·33	0·88	1·79	0·90	1·44	0·93	1·97	2·20
Glutamic acid	3·43	4·15	3·87	5·08	3·24	4·66	3·16	4·28	3·23	4·22	3·06	3·98	3·34	4·50	3·46	6·41	3·54	5·41	3·63	7·32	8·32
Proline	0·77	1·05	0·85	1·87	1·14	1·33	1·56	1·65	1·50	1·82	1·04	1·96	1·31	2·81	1·63	2·31	1·66	2·34	1·44	3·37	2·72
Glycine	0·78	0·98	0·86	1·21	0·76	1·16	0·75	1·05	0·72	1·08	0·67	1·12	0·92	1·24	0·89	1·30	0·74	1·32	0·78	1·76	1·88
Alanine	0·92	0·97	0·72	1·45	0·80	1·20	0·90	1·12	0·94	1·28	0·94	1·21	1·01	1·32	1·06	1·80	0·85	1·46	1·07	2·14	2·17
Cystine	—	—	—	—	—	—	Trace	0·47	Trace	0·48	0·23	0·49	Trace	0·38	Trace	0·99	Trace	0·54	Trace	0·80	0·44
Valine	0·86	0·84	0·79	0·98	0·60	0·93	0·77	1·12	0·60	1·01	0·68	0·93	0·72	1·04	0·77	1·40	0·94	1·34	0·76	1·89	1·89
Methionine	Trace	Trace	Trace	0·15	Trace	Trace	0·16	0·41	0·37	0·21	0·13	0·24	0·19	0·39	0·11	0·44	0·34	0·42	0·25	0·69	0·67
Isoleucine	0·88	1·02	0·92	0·92	0·82	1·15	0·94	1·32	0·66	1·24	0·87	1·27	1·06	1·47	0·92	1·14	0·94	1·51	0·86	2·46	2·69
Leucine	1·29	1·63	1·42	2·28	1·43	2·79	1·19	1·68	1·05	1·56	1·20	1·54	1·19	1·90	1·14	1·90	1·22	2·31	1·19	2·83	2·89
Norleucine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tyrosine	0·74	1·02	0·71	0·88	0·87	1·18	0·62	0·93	0·53	1·04	0·73	0·92	0·68	1·25	0·57	1·33	0·57	1·12	0·71	1·58	1·64
Phenylalanine	0·93	1·24	1·12	1·46	0·88	1·46	0·93	1·44	0·83	1·43	0·92	1·23	0·99	1·61	0·97	1·73	0·89	1·72	1·25	2·43	2·17
Histidine	0·36	0·63	0·80	0·98	0·53	0·86	0·50	0·93	0·42	1·13	0·51	0·85	0·55	1·09	0·65	0·84	0·57	0·91	0·32	1·47	1·06
Lysine	1·28	1·43	1·52	2·14	1·23	1·92	1·37	1·83	1·41	1·83	1·28	1·74	1·29	2·02	1·28	2·29	1·06	2·02	1·18	2·85	2·98
Arginine	1·15	1·44	1·37	1·90	1·13	1·76	1·46	2·07	1·36	2·03	1·46	1·90	1·54	2·31	1·36	2·32	1·49	2·60	1·37	2·99	3·43
Total amino acids	17·62	20·85	19·64	27·55	17·08	25·62	17·99	25·45	17·49	25·52	17·59	24·11	19·16	29·32	18·69	33·94	19·11	31·06	19·10	42·68	44·93
Total protein	2·61	3·55	2·75	4·33	2·70	4·30	2·81	4·33	2·61	4·78	2·53	4·90	2·64	5·39	2·56	5·85	2·56	5·85	2·39	7·04	8·04

TABLE 2b

Amino Acid Composition (mg/ml of sample) and Total Protein in Concentrate from Ultrafiltration after using Membrane of 50 000 Cut-off

Amino acid	*Sample*														
	Soy extract	*20% UF*	*Soy extract*	*20% UF*	*Soy extract*	*20% UF*	*Soy extract*	*20% UF*	*Soy extract*	*40% UF*	*Soy extract*	*40% UF*	*Soy extract*	*40% UF*	*40% UF*
Aspartic acid	2·03	2·48	2·08	2·45	1·98	2·24	1·99	2·51	1·62	3·10	2·08	2·41	1·99	2·57	2·52
Threonine	0·58	0·76	0·51	0·69	0·47	0·68	0·62	0·76	0·45	0·94	0·56	0·81	0·64	0·79	0·88
Serine	0·61	0·82	0·78	0·70	0·50	0·63	0·58	0·72	0·49	1·14	0·71	0·89	0·69	0·79	0·90
Glutamic acid	3·03	3·49	3·00	3·30	2·93	3·22	2·86	3·56	2·43	4·57	3·13	3·83	3·19	3·79	3·91
Proline	1·13	1·47	1·11	1·52	0·67	1·49	1·17	1·69	1·00	2·48	1·45	1·71	1·45	2·05	2·25
Glycine	0·70	0·83	0·65	0·87	0·71	0·81	0·66	0·86	0·53	1·18	0·67	0·75	0·68	0·93	1·03
Alanine	0·77	1·02	0·96	0·90	0·73	0·81	0·75	0·83	0·55	1·13	0·69	0·96	0·79	0·88	0·99
Cystine	Trace	0·14	Trace	0·24	0·10	0·14	0·19	0·21	Trace	0·16	Trace	0·22	0·32	0·26	0·26
Valine	0·68	0·96	0·81	0·78	0·72	0·73	0·66	0·82	0·57	1·05	0·59	0·83	0·76	0·88	0·90
Methionine	0·28	0·32	0·31	0·35	0·31	0·40	0·38	0·37	0·33	0·41	0·26	0·33	0·18	0·32	0·31
Isoleucine	0·81	0·87	0·82	0·85	0·78	1·07	0·93	1·12	0·92	1·34	0·72	0·94	0·90	1·20	1·20
Leucine	1·18	1·30	1·18	1·33	1·05	1·37	1·30	1·36	1·05	1·69	1·06	1·03	1·14	1·52	1·56
Norleucine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tyrosine	0·55	0·73	0·68	0·69	0·68	0·78	0·78	0·72	0·61	0·94	0·64	0·67	0·46	0·84	0·79
Phenylalanine	0·89	1·19	0·49	1·15	0·91	1·00	0·92	0·99	0·78	1·34	0·84	1·18	0·77	1·13	1·18
Histidine	0·17	0·38	0·34	0·59	0·45	0·90	0·67	1·01	0·53	1·26	0·88	0·93	0·55	1·55	1·03
Lysine	1·17	1·23	0·97	1·47	1·15	1·37	1·24	1·57	1·07	1·79	1·09	1·46	1·29	1·65	1·58
Arginine	1·37	1·68	1·20	1·70	1·42	1·50	1·28	1·63	1·23	2·17	1·32	1·65	1·61	1·69	1·80
Total amino acids	15·95	19·67	15·89	19·58	15·56	19·14	16·98	20·73	14·16	26·69	16·69	20·60	17·41	22·48	23·09
Total protein	2·61	2·99	2·75	3·08	2·80	3·06	2·61	3·06	2·75	3·46	2·75	3·32	2·62	3·44	3·44

TABLE 3a
Total Amino Acids (mg/g of sample) and Total Protein in Spray-Dried Soy-Milk Powder (20 000 Cut-off)

Amino acid	*Sample*[a]								
	20% UF	*40% UF*	*40% UF*	*50% UF*	*50% UF*	*60% UF*	*60% UF*	*70% UF*	*70% UF*
Aspartic acid	18·98	24·09	19·03	27·46	25·92	27·01	25·51	25·35	25·49
Threonine	5·92	6·88	6·61	7·75	6·39	8·22	7·36	9·04	7·27
Serine	8·06	8·39	7·40	7·62	7·49	7·74	6·23	7·59	7·53
Glutamic acid	28·46	36·92	34·41	36·74	35·84	37·57	33·62	35·77	35·43
Proline	15·91	10·55	21·44	13·48	12·64	14·49	12·87	17·13	13·31
Glycine	5·78	7·85	7·61	8·74	8·23	9·80	8·92	9·27	9·26
Alanine	7·68	9·78	10·72	8·93	9·87	11·23	9·58	10·51	11·36
Cystine	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Valine	6·40	7·36	8·11	10·66	9·58	10·64	7·72	13·61	8·15
Methionine	2·89	2·84	2·91	2·83	2·41	2·60	0·78	4·02	2·64
Isoleucine	4·80	8·24	7·11	10·56	7·68	10·31	6·86	9·66	8·83
Leucine	9·90	12·41	12·54	12·59	12·82	13·74	11·31	15·03	15·08
Norleucine	—	—	—	—	—	—	—	—	—
Tyrosine	4·28	6·83	3·96	6·59	5·53	6·08	7·17	5·13	6·34
Phenylalanine	8·64	11·09	11·47	11·85	11·32	10·87	12·58	12·32	12·87
Histidine	1·42	1·21	2·01	4·99	5·08	8·26	9·21	5·13	7·81
Lysine	8·32	11·38	7·19	16·06	12·68	15·80	15·19	15·92	14·52
Arginine	10·19	10·42	15·38	16·55	13·48	15·02	13·54	16·46	17·58
Total amino acids	147·6	176·2	177·9	203·4	187·0	209·4	188·5	211·9	203·5
Total protein	18·42	23·39	26·02	23·28	23·67	28·6	25·8	30·13	32·14

[a] The percentages correspond to those of water removed by ultrafiltration.

TABLE 3b
Total Amino Acids (mg/g of sample) and Total Protein in Spray-Dried Soy-Milk Product (50 000 Cut-off)

Amino acid	*Sample*[a]				
	20% UF	*40% UF*	*50% UF*	*60% UF*	*70% UF*
Aspartic acid	20·31	28·52	27·76	27·62	38·22
Threonine	4·55	4·22	4·12	4·48	7·17
Serine	4·38	4·40	5·63	4·85	7·69
Glutamic acid	24·48	27·36	30·42	30·73	41·75
Proline	9·37	7·38	8·89	7·36	13·84
Glycine	6·72	6·77	7·31	8·57	8·78
Alanine	7·13	7·28	7·66	8·77	9·11
Cystine	Trace	1·59	1·00	2·46	1·52
Valine	6·00	6·06	6·11	6·62	7·93
Methionine	2·51	2·05	2·35	2·83	0·83
Isoleucine	6·40	6·65	8·16	8·11	10·43
Leucine	9·29	9·82	12·79	12·71	13·20
Norleucine	—	—	—	—	—
Tyrosine	4·04	3·29	5·56	5·90	6·40
Phenylalanine	6·70	6·12	8·18	8·77	11·29
Histidine	16·42	19·42	11·87	13·65	14·71
Lysine	12·89	11·53	12·70	14·10	17·56
Arginine	12·89	13·27	13·29	14·18	15·67
Total amino acids	154·1	165·7	173·8	181·7	226·1
Total protein	18·80	19·59	24·24	27·41	30·86

[a] The percentages correspond to those of the water removed by ultrafiltration.

Soy sauces

This study was undertaken to assist a food standard board to establish an indicator to discern between soy sauce from a fermentation-only process and that from an accelerated process by hydrolysis. Thus the amino acid compositions of samples from two well-known commercial brands as well as one hydrolyzed sample were determined. As can be seen from the results in Table 5, the hydrolyzed soy sauce displays amino acid contents that are much higher than those of soy sauce from fermentation.

Shark's fin and bird's nest

These two items of food are very popular despite the fact that they are expensive. They have long been regarded as highly nutritious. The amino

TABLE 4a

Protein Supplementation: Amino Acid Composition (mg/g of solid sample) of Extruded Product Formulated from Corn, Mung Beans and their Mixtures

Amino acid	*Corn*	*Rice*	*Mung bean*	*Corn:rice* (*2:1*)	*Corn:mung bean* (*1:1*)	*Corn:rice:mung bean* (*2:1:1*)
Aspartic acid	4·4	6·3	23·9	5·9	17·2	11·2
Threonine	3·0	2·5	8·6	3·1	5·7	4·1
Serine	4·1	3·4	12·3	3·9	8·1	6·1
Glutamic acid	16·1	13·3	44·2	15·7	31·6	24·5
Proline	8·5	3·6	15·3	6·1	11·0	7·7
Glycine	2·5	3·2	8·6	2·4	5·3	4·6
Alanine	5·6	3·8	9·2	4·3	7·7	6·1
Valine	3·2	3·6	11·7	3·7	7·7	5·6
Cystine	2·5	nil	nil	trace	trace	trace
Methionine	2·0	3·6	4·0	3·9	3·2	2·6
Isoleucine	2·8	3·0	10·4	3·5	7·2	5·1
Leucine	11·0	5·7	18·4	8·5	13·9	12·8
Tyrosine	3·5	3·4	6·7	3·9	4·7	4·7
Phenylalanine	4·1	3·8	15·3	4·1	12·0	8·2
Histidine	3·4	2·5	9·8	2·7	5·7	4·9
Lysine	2·3	3·2	22·1	3·5	12·4	7·1
Arginine	2·4	5·3	17·8	3·1	9·6	8·2
Tryptophan (estimated)	0·7	1·0	2·2	0·8	1·5	1·6
Total	82·1	71·2	240·5	79·1	164·5	125·1

TABLE 4b
Amino Acid Analyses (mg/g of solid sample) of Snack Foods Made from Various Starting Raw Materials

Amino acid	*Corn strawberry flavour*	*Corn: rice chicken flavour*	*Corn: mung beans (2:1) chicken flavour*	*Wheat flour crackers*		*Tapioca unflavoured*
				Prawn	*Fish*	
Aspartic acid	2·7	3·9	11·2	3·1	3·1	1·2
Threonine	1·6	2·2	4·1	1·9	2·2	trace
Serine	2·4	3·4	6·1	3·1	3·4	trace
Glutamic acid	8·0	18·2	24·9	25·0	29·4	5·7
Proline	4·3	6·1	7·7	8·3	8·8	trace
Glycine	1·3	2·0	4·6	2·2	2·8	trace
Alanine	3·1	4·3	6·1	2·8	3·4	trace
Cystine	trace	trace	trace	nil	nil	nil
Valine	2·1	2·8	5·6	2·1	2·3	trace
Methionine	1·0	2·0	2·6	1·0	1·9	trace
Isoleucine	1·8	2·5	5·1	2·1	2·6	trace
Leucine	5·5	7·9	12·8	4·1	4·3	trace
Tyrosine	1·0	2·7	4·7	2·8	2·2	trace
Phenylalanine	1·8	2·9	8·2	2·8	4·3	trace
Histidine	1·5	2·1	4·9	1·9	1·0	trace
Lysine	1·1	1·1	7·1	1·6	2·3	0·7
Arginine	1·3	1·7	8·2	2·4	2·5	2·0
Tryptophan (estimated)	0·7	0·8	1·2	1·3	1·3	nil
Total	41·2	66·6	125·1	68·5	77·9	9·6

TABLE 5
Amino Acid Content (mg/ml of sample) of Soy Sauce

Amino acid	*Sample*[a]		
	A	*B*	*C*
Aspartic acid	5·67	5·82	18·27
Threonine	2·42	1·44	5·80
Serine	2·35	1·96	6·09
Glutamic acid	11·54	8·94	32·65
Proline	4·85	4·52	16·95
Glycine	2·44	1·42	5·56
Alanine	3·81	1·72	7·45
Cystine	—	—	—
Valine	3·15	1·61	7·53
Methionine	1·16	0·94	1·98
Isoleucine	2·68	1·45	4·14
Leucine	4·76	2·55	4·88
Norleucine	—	—	—
Tyrosine	trace	0·52	1·33
Phenylalanine	3·14	1·97	6·77
Histidine	1·11	2·17	4·91
Lysine	3·28	2·62	13·99
Arginine	2·63	3·21	9·07
Total	54·99	42·86	147·4

[a] A and B—commercial brands; C—hydrolyzed sample.

TABLE 6
Amino Acid Content (mg/g of sample) of Shark's Fin and Bird's Nest

Amino acid	*Sample*[a]				
	A	*B*	*C*	*D*	*E*
Aspartic acid	51·02	21·02	11·83	24·51	30·49
Threonine	9·76	15·12	7·20	17·72	18·74
Serine	23·78	15·72	8·34	18·05	19·88
Glutamic acid	82·51	18·54	10·60	23·11	25·36
Proline	64·53	19·15	15·28	20·89	23·96
Glycine	76·95	7·68	3·95	9·41	10·72
Alanine	47·38	7·43	4·23	8·99	9·16
Cystine	9·62	0·86	0·45	5·68	7·43
Valine	21·31	11·85	6·12	13·93	17·30
Methionine	10·41	0·81	0·66	2·47	1·03
Isoleucine	17·88	9·76	4·13	9·60	10·46
Leucine	14·73	15·69	7·71	20·55	17·25
Norleucine	—	—	—	—	—
Tyrosine	116·92	18·90	7·96	33·20	19·85
Phenylalanine	15·43	16·55	8·41	14·59	23·88
Histidine	25·05	6·51	6·15	3·11	1·33
Lysine	27·02	8·25	5·13	10·94	15·61
Arginine	53·03	14·06	7·86	19·45	21·54
Total	667·3	207·9	116·0	256·2	289·9

[a] A—sample of shark's fin; B, C, D and E—samples of bird's nest.

acid analyses of several samples reveal that whereas shark's fin possesses a high amino acid content, the bird's nest amino acid content is rather low (Table 6).

REFERENCES

Davis, M. G. (1973). An investigation of hydrolytic techniques for the amino acids analysis of foodstuffs. *J. Food Sci. Agric.*, **24**, 1525–40.

Egan, H., Kirk, R. S. & Sawyer, R. (1981). *Pearson's chemical analysis of foods*, 8th edn. Churchill Livingston, Edinburgh.

Graf, E. & Dintzis, F. H. (1982). High performance liquid chromatographic method for the determination of phytate. *Anal. Biochem.*, **119**, 413–17.

Moore, S. & Stein, W. H. (1963). Chromatographic determination of amino acids by the use of automatic recording equipment. *Methods Enzymol.*, **6**, 819–36.

Omosaiye, O. & Cheryan, M. (1979). Low phytate, full-fat soy protein product by ultrafiltration of aqueous extracts of whole soybeans. *Cereal Chem.*, **56**, 58–64.

Omosaiye, O., Cheryan, M. & Mathews, M. E. (1978). Removal of oligosaccharides from soybean water extracts by ultrafiltration. *J. Food Sci.*, **43**, 354–60.

Orr, M. L. & Watt, B. K. (1957). Amino acids content of foods. *US Dept. Agric. Home Econ. Res. Report*, **4**, 82.

Pearson, D. (1976). *The chemical analysis of foods*, 7th edn. Churchill Livingston, Edinburgh.

Porter, M. C. & Michaeles, A. S. (1970). Applications of membrane ultrafiltration to food processing. 3rd International Congress of Food Science and Technology, Washington, DC.

Smith, O. B. (1969). History and states of specific protein rich food extrusion processed cereal foods. In: *Protein enriched cereal foods for world needs* (M. Milver (Ed.)). American Association of Cereal Chemists, St. Paul, Minnesota, pp. 140–53.

Smith, O. B. (1974). Textures of extrusion processing. In: *Fabricated food* (G. E. Inglet (Ed.)). The AVI Publishing Company Inc., Westport, Connecticut, pp. 89–108.