Nutritional Evaluation of Texturised Meat from *Nemipterus japonicus*

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Evaluation of the nutritional quality of texturised fish meat from threadfin bream (*Nemipterus japonicus*) is reported. Proximate composition and amino acid analysis showed that its protein content is very high with all the essential amino acids present in higher levels than those prescribed for man in the 1973 FAO/WHO amino acid scoring pattern. Lysine amounted to 11.0 g per 16 g N of which 75 percent is biologically available. Studies on PER and NPU also corroborate the excellent nutritional quality of the texturised meat.

The world shortage of protein has led to extensive studies on under and unutilized marine species as a major source of high quality protein (Rosivalli, 1976). Many such species at present are used as animal feed or manure. Recently a number of new processing techniques have been developed for the conversion of such fishes into palatable human food. By-catch from shrimp trawlers, which constitute a substantial quantity of under utilized fishery, may be processed into fish wafers, fish soup powder, fish fingers (Gopakumar *et al.*, 1975) or fish protein concentrate (Moorjani *et al.*, 1962; Lahiry *et al.*, 1962; Sen *et al.*, 1966; Sen & Rao, 1966; Bhatia *et al.*, 1959; Shenoy *et al.*, 1976). Only a part of the available low cost miscellaneous fish find use in the preparation of these speciality products.

Threadfin bream is the most common nemipterid in the catches both from the west and east coasts of India. It has been reported that in the depth zone of 75-100 m off the Kerala coast threadfin bream predominated in exploratory and experimental fishing operations, often forming 75% of the trawl catch (Talwar & Kacker, 1984). Estimated threadfin bream landing in India during 1984-85 is 38316 tonnes (CMFRI, 1986). At present a major portion of the threadfin bream landing is sold in the local markets in the fresh, iced or frozen condition. A small quantity goes for the preparation of minced meat or for drying. Suzuki (1981) has reported the nutritional value and safety of a new type of texturised fish protein concentrate called marinbeef from Alaska pollack and blue whiting. The method of production and biochemical characteristics of texturised meat prepared from five species of low cost fish has been described (Shenoy *et al.*, 1988). Results of studies on the nutritional evaluation of texturised meat prepared from *Nemipterus japonicus* are presented in this paper.

Materials and Methods

Threadfin bream purchased fresh from the local market or collected from vessels of Integrated Fisheries Project, Cochin was used for the preparation of texturised meat. The fish was cleaned and texturised meat was prepared according to the method of Shenoy *et al.* (1988).

Proximate composition of texturised meat was determined as per the methods of AOAC (1975). Determination of amino acids was carried out by hydrolysing the sample with 6 N hydrochloric acid in a sealed tube at 110°C for 22 h. The hydrolysed sample was filtered, freed of acid using a rotary vacuum evaporator, made up to volume with citrate buffer pH 2.8. The amino acid analysis was carried out on a Technicon NC 2P amino acid analysing system (single column). The area of each peak was integrated using spectraphysics computing integrator. Available lysine was determined by the FDNB method of Carpenter (1960) as modified by Booth (1971).

The protein quality of texturised meat was assayed as protein efficiency ratio (PER) in rats in a 4 week experiment by the method of Chapman *et al.* (1959). The experimental groups consisted of 8 male weaning rats each. The animals were divided at random into groups adjusted to give similar mean weights. The average results obtained with a diet based on casein as the sole source of protein were used for the purpose of comparison. On completion of feeding experiments, the rats were sacrificed to remove liver, kidney and spleen. Kidney and spleen were analysed for their nitrogen content in the fresh condition. The liver samples were frozen immediately and stored at -23°C pending analysis.

Net protein utilization (NPU) was estimated according to the method of Miller (1956) and NAS/NRC (1963) using rats body N technique. Potato starch was used for the preparation of the nonprotein diet. The level of protein in the diets was adjusted to 10%.

Results and Discussion

Yield and proximate composition of texturised meat from three different batches is presented in Table 1. Yield of texturised meat is comparable to the yield of marinbeef from Alaska pollack and hake (4-5% from whole bodies, moisture content 8%) as reported by Suzuki (1981). The product is colourless granules having no fish smell, and has good texture when rehydrated. It has very high protein content and a low fat content. The variations observed in the protein and fat content of the product from batch to batch can be attributed to the differences in the initial quality of the raw material. Frozen stored threadfin bream yielded a product with low protein content.

The amino acid pattern of the texturised meat is shown in Table 2. Glutamic acid is the major constituent of the amino acids followed by lysine, aspartic acid and leucine. Comparison with the amino acid contents of marinbeef from Alaska pollack and blue whiting (Suzuki, 1981) shows that values for texturised meat from threadfin bream lies between the values reported for these two products. The essential amino acid index is 44.5 while the values for marinbeef from Alaska pollack and blue whiting are respectively 43.3 and 43.0.

Table 3 summarises the essential amino acid pattern of casein (Craig et al., 1978), texturised meat from threadfin bream and the FAO/WHO (1973) reference protein. All the essential amino acids examined are present in higher amounts than those established for man in the FAO/WHO (1973) amino acid

Table 1. *Yield and proximate composition of texturised meat*

	Batch No. I	Batch No. II	Batch No. III	Mean ± SD
*Yield %	4.76	4.20	4.46	4.47 ± 0.28
Moisture %	9.80	7.40	10.03	9.08 ± 1.46
Fat %	0.49	0.40	1.37	0.75 ± 0.53
Protein %	85.30	90.25	85.21	86.92 ± 2.88
Ash %	5.06	2.44	2.54	3.35 ± 1.48

* Percentage of whole wet fish

Table 2. *Amino acid pattern of texturised meat*

Amino acid	g/16 g nitrogen
Aspartic acid	8.5
Threonine	4.5
Serine	3.8
Glutamic acid	22.0
Proline	4.9
Glycine	3.4
Alanine	5.9
Valine	5.3
Cystine	0.5
Methionine	3.4
Isoleucine	5.1
Leucine	8.1
Tyrosine	4.2
Phenylalanine	3.9
Histidine	2.8
Lysine	11.0
Arginine	6.0
Available lysine	8.25

Table 3. *Essential amino acid pattern of texturised meat as compared to casein and FAO/WHO amino acid scoring pattern* (1973)

g/16 g nitrogen

Amino acid	FAO/ WHO pattern 1973	Casein	Texturised meat
Isoleucine	4.0	16.7	5.1
Leucine	7.0		8.1
Lysine	5.5	8.2	11.0
Methionine+ Cystine	3.5	3.7	3.9
Phenylalanine+ Tyrosine	6.0	10.7	8.1
Threonine	4.0	4.5	4.5
Tryptophan	1.0	1.4	—
Valine	5.0	7.4	5.3
Total	36.0	52.6	46.0

scoring pattern. Level of lysine is twice that advocated in the pattern of which 75% is biologically available. Comparison of the essential amino acids in texturised meat and a few other proteins with the FAO suggested pattern of requirement (FAO, 1973) is presented in Table 4. It may be seen that the essential amino acid pattern is such that texturised meat is beneficial to growing children and will serve as an excellent supplement to cereal or vegetable diets which constitute the staple diet of a large segment of population of many developing countries. The deficiency of lysine and threonine in cereal diet of infants and growing children can be supplemented by the incorporation of the fish protein to the normal diet. The protein quality index calculated according to Arroyave (1975) based on the FAO/WHO recommended pattern of essential amino acids requirements for different age groups, viz. infant, pre-school child and adult is respectively 101, 107 and 162.

Rat feeding studies showed that the increase in weight of the rats fed with experimental diets was higher than that of the casein group (Table 5). The adjusted protein efficiency ratio ranged between 2.7 to 3.0. The dietary contribution of the higher levels of all essential amino acids of texturised meat probably accounts for the advantages observed in both growth and PER. Texturised meat (Batch III) was prepared from frozen stored threadfin bream and the lower value for PER obtained for this batch may be due to

Table 4. *Essential amino acids of texturised meat compared with those of some proteins and the FAO suggested pattern of requirement, mg amino acids per g protein (Windsor & Barlow, 1981).*

Amino acid	FAO pattern (1973) Infants[1] 0–6 months	Children[2] 10–12 years	Adults[3]	Wheat	Rice	Skim milk powder	Egg	FPC	Texturised meat
Histidine	14	0	0	23	22	35	22	29	29
Isoleucine	55	37	18	34	45	59	54	45	51
Leucine	80	56	25	68	80	107	86	75	81
Lysine	52	75	22	26	35	78	70	80	110
Methionine+ Cystine	29	34	24	36	34	32	57	41	39
Phenylalanine+ Tyrosine	63	34	25	75	103	109	93	74	81
Threonine	44	44	13	30	32	52	47	43	45
Tryptophan	8.5	4.6	6.5	11	6	15	17	12	—
Valine	47	41	18	46	54	64	66	52	53

1 – Based on a safe level of intake of 2 g protein per kg live weight per day
2 – Based on a safe level of intake of 0.8 g protein per kg live weight per day
3 – Based on a safe level of intake of 0.55 g protein per kg live weight per day

the leaching out of the nutrients during the preparation of minced meat from the thawed raw material. The PER values for threadfin bream are lower than those reported for marinbeef from Alaska pollack and sardine (Suzuki, 1981). It has been suggested by Suzuki (1981) that the amino acid pattern of the raw fish used for production of marinbeef affects the quality of the final product. Differences in PER observed for the Indian (batch to batch variation) and Japanese products can be attributed to these factors.

Table 5. *Protein efficiency ratio of texturised meat*

Protein source	PER	Adjusted PER
Batch I	2.96 ± 0.13	2.91
Casein	2.54 ∓ 0.26	2.50
Batch II	3.31 ∓ 0.26	3.03
Casein	2.73 ∓ 0.23	2.50
Batch III	2.51 ∓ 0.23	2.71
Casein	2.31 ∓ 0.18	2.50

The relative weights and nitrogen levels of the respective organs of the experimental animals are represented in Table 6. The organ weights of the two groups are comparable and significant differences are not observed. Organ nitrogen levels of the two groups are also similar.

Table 6. *Relative weights and nitrogen levels of organs of experimental rats*

		Texturised meat	Casein
Organ weight g	Spleen	0.30±0.04	0.32±0.05
	Kidney	0.94±0.09	0.88±0.06
	Liver	3.99±0.55	3.79±0.32
Nitrogen content	Spleen[1]	10.03∓0.41	11.13∓1.66
	Kidney[1]	28.23∓3.68	26.20∓2.03
	Liver[2]	26.77∓0.87	25.79∓2.17

[1] — mg N per total spleen and kidney
[2] — mg N per g liver

The NPU values for texturised fish protein from threadfin bream and marinbeef from Alaska pollack and sardine, whole egg protein and casein are presented in Table 7. The NPU values for the fish product is high compared to that of casein, but is significantly lower than that of whole egg. The availability of essential amino acids appears to have been impaired in some way, the cause of which is not clearly known. Wide variations in NPU value of fish flour from batch to batch and for different raw materials used for the preparation of the flour have been reported by Miller (1956) and by Bender (1956). Morrison (1962) has discussed the effects of processing variables including solvent treatment on the nutritional value of fish flour. The exact nature of such changes and their nutritional implications in the case of texturised meat from threadfin bream are not very clear yet and calls for more detailed investigations.

Table 7. *Nutritive value of proteins in feeding test*

Sample	Net protein utilization
Texturised meat from threadfin bream	83
Marinbeef from	
a) Alaska pollack	88
b) Sardine	90
Whole egg protein	95
Casein	76

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