Nutritive Value of Red and White Meat of Oil Sardine (*Sardinella longiceps*)

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Dried red and white meat of oil sardine was fed to albino rats along with protein free basal diet. Simultaneously controls were also run with casein and protein free basal diet. The study was conducted for a period of one month. The results showed that the PER is higher for fish fed animals than casein fed animals. Similarly the enzyme activities of lipase and protease were also high in fish fed animals. The difference between red and white meat in PER and the enzyme activities are also reported.

Shoaling fishes, especially of the scombroid group, contain appreciable amounts of red meat in their muscle. The amount of red meat varies from species to species. In small fishes like sardine it amounts to about 37% of the total muscle whereas in big fishes like tuna it is only to the extent of 10–12%. The content of red meat expressed as percent of the total muscle, generally shows an increase with age.

Consumers in general have some prejudice against red meat, though there is no evidence to suggest that red meat is in anyway inferior to white meat, from a nutritional point of view. Red meat is known to contain relatively more fat as well as oxidising enzymes than white meat (Love, 1970). But in fresh as well as properly preserved fish this should not pose any serious problem of increased rancidity. As such the prejudice against red meat is not justified.

Breakken (1956) made a thorough study of the biochemical composition of red and white meats of several cold water fish species and postulated that red meat plays the role of a supplementary liver in fish. Igarashi *et al.* (1957) studied the composition of lipid of red meat in fish. Chinnamma George (1975) and Mukundan *et al.* (1979) have reported results of a study on the composition of red and white meats of tuna from Indian waters. Similar studies on mackerel (Breakken, 1959; Nagayama, 1961 & George, 1962) and sardine (Watanabe *et al.*, 1977) from cold waters reported by earlier workers, also present interesitng data on the composition of red and white meats of fish. But relatively little information is available on the comparative nutritive values of red and white meats of Indian fishes. The present paper is an attempt in this direction. Data on the proximate composition, amino acid composition of the proteins, mineral content etc. of red and white meats of oil sardines (*Sardinella longiceps*) are presented in tihs paper. A comparative evaluation of the nutritional quality of the two types of meat, as judged by feeding trials using albino rats, is also presented. The changes in the protease and lipase activity in liver and serum of the different groups fed on red meat and white meat have also been studied.

Materials and Methods

Fresh oil sardine (*Sardinella longiceps*) weighing about 50 g were collected from landing centres, gutted and stored at 0°C pending analysis. The fishes were skinned, red and white meat from lateral sides were separated, minced and used for the study. All chemicals used in the study were the purest grade available.

Moisture, fat and ash were determined as described by AOAC (1970). The ash obtained as above was dissolved in normal hydrochloric acid and the solution used for the determination of sodium, potassium, calcium, (Vogel, 1960) and iron (Lawrence, 1960). Nitrogen content was estimated by micro Kjeldahl method (Hawk, 1954), which was converted to proteins by multiplication by 6.25.

Carbohydrate and inorganic phosphorus contents were estimated according to Umbriet & Burris (1959). Amino acid composition was determined by standard microbiological assay (Kavanagh, 1963) by hydrolysing the dry muscle with 6 N. hydrochloric acid at 110°C in a tube sealed under vacuum. Phenyl alanine, glycine, proline, serine, tyrosine, cystine, aspartic acid and alanine were analysed using *Leuconostoc mesenteroids*. All other amino acids were assayed by *Streptococcus faecalis*.

The nutritive value of red and white meat of oil sardine was determined by PER studies (NAS/NRC, 1963). The minced red and white meat were tunnel dried to 10% moisture. The protein and fat contents of the dry meat so obtained were determined and were incorporated in basal diet to give 10% protein content.

A control diet was prepared by incorporating 10% casein in the basal diet. The basal diet contained corn starch 80%, refined groundnut oil 10%, cellulose 5%, salt mixture 4% and vitamin mixture 1%. The salt mixture and vitamin mixture were also prepared as described by NAS/NRC (1963). The final fat content of the test diet was adjusted to be 10%. The diets were mixed with enough water and cooked in steam for 10 minutes just before feeding.

30, 28 ± 2 days old albino rats (Wistar strain) were distributed randomly into 3 groups of 10 rats each and housed in three cages. The groups were fed *ad libitem* on (1) red meat diet (2) white meat diet and (3) control diet respectively. Water was also provided *ad libitem*. Initial weight was noted and thereafter the animals were weighed weekly. After 28 days the rats were killed and the protease activity (Charles *et al.*, 1979) and lipase activity (Bier, 1955) in liver and serum were determined.

Results and Discussion

The proximate composition of red and white meat of oil sardine is shown in Table 1, alongwith the computed calorific value. From the Table it is evident that white meat has a higher protein and ash content than red meat. However, red meat is found to be richer in fat and carbohydrates than white meat. These body constituents excepting protein, have no significant role in tissue development, though they are important as energy sources. Hence data on the proximate composition suggests that white meat is superior in protein availability but inferior in calorie content, when compared to red meat.

Table 1. *Proximate composition and calorific value of red and white meat of oil sardine**

	Red meat	White meat
Moisture	64.6	72.8
Carbohydrate	0.9	0.5
Fat	14.1	4.8
Ash	1.4	1.7
Protein	19.1	20.7
Calorific value	206.9	127.2

*All values are given as percentage, except calorific value, which is in K calories per 100 g

Table 2 shows the mineral composition of red and white meat of oil sardine. Sodium and iron contents are more in red meat. Potassium, calcium and phosphorus contents are more in white meat but the difference in distribution is not as significant as iron, which is nearly 3 times more in red meat, making it a superoir source of minerals.

Table 2. *Mineral composition of red and white meat of oil sardine*

Mineral	Red meat mg (100g)$^{-1}$	White meat mg (100g)$^{-1}$
Sodium	149	131
Potassium	361	404
Calcium	103	112
Inorganic phosphorus	306	370
Iron	11	4

Table 3 shows the essential amino acid composition of red and white meat of oil sardine. Both red and white meat are found to be rich sources of essential amino acid like lysine and the sulphur amino acids. Excepting phenyl alanine and methionine all other essential amino acids are more in red meat; of which lysine and valine are significantly more in red meat. Moreover the proportion of distribution of these amino acids in red meat better suits the FAO/WHO suggested pattern of amino acids (FAO/WHO, 1973).

Table 3. *Essential amino acid g (100 g)$^{-1}$ content of red and white meat of oil sardine*

Amino acid	Red meat	White meat
Lysine	8.7	7.4
Leucine	6.4	5.7
Isoleucine	5.3	4.7
Phenyl alanine	3.8	4.9
Methionine	4.9	5.4
Tyrosine	4.8	3.8
Threonine	5.7	5.1
Valine	6.8	5.8

From the composition of major nutrients and amino acids red meat seems to be better for nutrition, than white meat. Further, investigations on the bioavailability of the nutrients in red and white meat of oil sardine in comparison with casein as judged by rat feeding are presented in Table 4. In all the three groups the growth of rats was normal. The PER values show that red meat is more nutritious than casein and white meat, further emphasising the conclusions drawn in the proceeding paragraphs.

Table 4. *Results of rat feeding studies of red and white meat of oil sardine*

Diet	Protein	PER	Lipase Liver	Lipase Serum	Protease Liver	Protease Serum
Red meat	10	2.62	31	20	1.3	3.6
White meat	10	2.4	45	12	1.2	3.4
Casein	10	2.5	32	12	1.28	2.9

Table 4 further shows that lipase activity is compartively more in the liver of white meat fed animals suggesting relatively higher mobilisation of fat in liver. In the case of red meat fed animals the serum liapse activity was more than the other two groups, showing better removal of serum fat probably to adipose tissue or liver.

Thus eventhough the protein content of the red meat is lower, it is better in nutritional quality, calorific value, amino acid content and mineral composition than the white meat of oil sardine.

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