

MEDICINAL, NUTRITIONAL AND BIOCHEMICAL VALUES OF FISHES

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ABSTRACT: *The nutritional value of fish meat is comparable and even higher than that of the other animal meat. Fish is not only the stuff to eat and relish. It has huge medicinal values and they can be used as a medicine for various diseases. The nutritive and medicinal value of fish has been recognized from time immemorial. The principle biochemical contents of fish flesh are: protein, vitamin, fat and water. Fish proteins comprise all the ten essential amino acids in desirable strength for human consumption, namely- lysine (high concentration), arginine, histidine, leucine, isoleucine, valine, theonine, methionine, phenylalamine and tryptophan. The principle minerals present calcium, magnesium, potassium, sodium, phosphorus, iron, chlorine, copper, manganese, iodine, bromine. Besides traces of Sr, Zn, Ba, Al, Pb, Mo, Co, Ni, Hg, Cd. Fish provides vitamins A, B and D all essential vitamins for human diet, particularly rich in vitamin B12 and B complex, vitamins A and D. Vitamin B complex includes thiamine, riboflavin and nicotinic acid. Omega-3 fatty acids are considered a boon to human beings. The fish oil consumption is linked to reduced risk of diabetes in children as well as adults and the autoimmune diseases. Fish, above all, is rich in linoleic acid [ω -3 (omega3) polyunsaturated fatty acids] a factor known for its role in prevention of coronary heart diseases, and other cardiovascular diseases.*

Keywords: Medicinal, Nutritional and Biochemical values of fishes

I. Introduction

Overall health is achieved through a combination of physical, mental, emotional, and social well-being, which, together is commonly referred to as the health triangle. One of the principle determinants of maintaining good physical health is to have nutritionally balanced food or nutrients. Fish was supposedly one of the foods of early humans (Cro-Magnon) who were cave dwellers and fish hunters, living by the riverside fossilized fish remains in the caves bear testimony to this. However, to-day preference to fish as food is not because of any legacy of the past but on its own merits, as judged by present standards of nutrition requirements and dietary allowances. Food value of fish may be adjudged by the kind, quality, availability (after processing and cooking) and digestibility of nutrients present. In this respect, fish is protein rich flesh food of good quality which, though not balanced diet, can make an ideal mixed (vegetarian food) diet. When consumed with rice or beans or wheat it certainly will improve the nutritional quality of the meal of the people. Fish is a good substitute for the pulses and so can lessen the pressure on agriculture to a considerable extent, especially when the fish potential of the country is great. Fish provides both the proximate principles (protein and fat but not the carbohydrates) as well as vitamins and minerals, the former for providing energy, essential amino acids (vitamins-like functions), and the later for meeting the metabolic and physiological needs. Fish protein compares well with egg protein but is better in one respect that it lacks trypsin inhibitors found in the egg white which interfere with digestion and hence utilization of protein in human body. It is highly digestible and provides essential amino acids which have a pattern close to that of human tissue. Relative to egg fish protein has biological value (% of nitrogen absorbed from the food) of 80. When mixed with cereal, the protein value of mixed diet (fish + cereal) is higher than the sum of the individual's foods protein values because of mutual supplementary effect of the competent amino acids. Like other animals-origin flesh food, fish is rich in saturated fatty acids as well as in B-vitamins, which both are absent in plant-origin food. It also lacks in such interfering substances, as phytates and oxalates (common in cereals/vegetables). Eating fish once in a week is recommended. Eat fish steamed, broiled, barbecued or cooked by microwave, if possible.

II. Objective of the study: To study the fish as a health food for human consumption and their Medicinal, Nutritional and Biochemical values.

III. Data source: Present study is based on secondary data information. Secondary data was collected from different books, journals, articles, periodicals, research papers and CMFRI official website.

IV. Fish as a food commodity

The nutritional value of fish meat is comparable and even higher than that of the meat of cattle calf (veal), cow or ox (beef), pig (pork), lamb and sheep (mutton) and poultry. The flesh of fish has less of "Stroma" protein which is of low nutritive value. The Indian pomfret (*stromateus argenteus*) and the Amazon *Arapaima gigas* are ranked high on the basis of their amino gram. About 300g of raw fish flesh suffices to supply about half of the total protein and fat requirement and one fourth of the calories need in a balanced daily diet for adult human being. Also, this amount of raw fish provides in addition, 50% of phosphorus, 30% of iron, 100% of Vit. A (fat fish only), 30% of Vit B1, Vit B2, requirement and 50 to 100% of niacin requirement. Fish protein is also highly nutritious as child food and it is easily tolerated by infants. The digestibility of fish flesh is in the order of 96%, fairly high as compared to the digestibility of beef and poultry. The protein content are easily and completely split up into unitary amino acid by the digestive enzyme (particularly trypsin) so is also the case with several linkages between amino acids and proteins.

The nutritive and medicinal value of fish has been recognized from time immemorial. Fresh fish flesh provides an excellent source of protein for human diet. This protein is relatively of high digestibility, biological and growth promoting value for human consumption. Nutritional studies have proved that fish proteins rank in the same class as chicken protein and are superior to milk, beef protein and egg albumen. Fish

proteins comprise all the ten essential amino acids in desirable strength for human consumption, namely - lysine (high concentration), arginine, histidine, leucine, isoleucine, valine, theonine, methionine, phenylalanine and tryptophan. Fish flesh therefore becomes a valuable supplement to human diet for people who are habitually taking cereals, starchy roots and sugar as their principle diet. Besides protein, fish flesh also offers minerals, iodine, vitamin and fat, over and above all; fish flesh cooks easily, offers a palatable taste and flavor and is easily digestible. Fish is consumed either as a preparation from freshly caught fish or from those that have been preserved in some form. However, fish in fresh condition makes a difference. The nutritional value, the look, the flavor and even the biochemical composition do not remain normal and undergo changes during preservation process and storage. Also, same species of fish may show variation in biochemical composition of its flesh depending upon the fishing ground, fishing season, age and sex of the individual, fat and water content being most affected.

V. Biochemical composition of raw fish

The principle biochemical contents of fish flesh are: protein, fat and water. Protein constitutes about 20%, fat and water vary widely and one varies inversely as the other. Besides there are minerals, vitamins and enzymes. Carbohydrates does not occur in the composition except as glycogen (C₆H₁₀O₅) in liver. Water content varies from 55 to 83%. This is relatively high as compared to the case in birds and mammals.

Protein- Protein occurs in fish as:

- 1) Myosin, myogen, myo-albumin and globulin all intracellular components of muscle fiber.
- 2) Collagen and connective tissue fibers
- 3) Phosphoprotein and nucleoprotein the connective tissue amounts to only 3 to 5%, thus rendering the fish protein more digestible than meat. About 90 to 95% of fish protein is assimilated by human subject.

These proteins are either,

- a) Simple plus or
- b) Conjugated.

The latter are characterized by a substance to which protein molecule is attached viz. Nucleoprotein has chromatin as the substance. Simple proteins are either soluble in water (albumin) or in salt solution, acids and alkalies (globulins). Electrophoresis of soluble proteins shows that these proteins are species specific. Protein exists as monomolecular solution with characteristic hydrophilic properties. The digestibility coefficient and biological value of the protein varies from species to species. Pelagic species (sardines, herring, mackerel, tuna, etc.) have high amino acid concentration, particularly that of histidine which is largely responsible for the meaty flavour of their flesh. The protein nitrogen amounts to only 2 to 3% of muscle weight.

The protein is contained chiefly in the skeletal muscle - the fish flesh, which constitutes about 50 to 60% of the total weight of fish. Red muscle and white muscle differ in the exclusive presence of myoglobin in the former. Also, the red meat has more of glycine, leucine, arginine and phenylalanine whereas white meat has more lysine, aspartic acid and glutamic acid.

The protein content of the muscle extractable by soluble fractionation is generally classified into 3 groups-

- 1) Albumin fraction, comprising 16 to 22% present in sarcoplasm and interstitial fluid, extractable with weak salt solution (ionic strength less than 0.3).
- 2) Protein fraction, comprising 75%, present in the contractile elements, extractable with strong electrolyte solution (ionic strength greater than 0.5).
- 3) Stroma, comprising 3% present in myocommata, cell membranes and connective tissue, extractable with difficulty.

The above three kinds of muscle proteins are considered not really pure types but mixtures as more modern techniques of electrophoresis and ultracentrifugation have revealed a number of fractions occurring in each. Albumin is shown to consist of at least six components. One protein fraction of the contractile elements is shown to consist of myosin, actin, actomyosin and tropomyosin fractions. Myosin is extractable by selective dialysis or ultracentrifugation in the presence of ATP. The myosin is obtained as the supernatant part. It is thought that myosin is particularly concentrated in the anisotropic band made up of myosin filaments. The actin fraction thus separable by the acetone method in which the muscle is first dehydrated in acetone and then this fraction is extracted with the salt solution of moderate strength. It is believed to represent a product of interaction between actin and myosin protein during the extraction process. The effect of ATP upon actomyosin is of considerable importance in the understanding of fish spoilage. The tropomyosin is extracted by dehydration of muscle in an organic solvent and subsequent purification by precipitation with KCl at pH 4.3 and by fractionation with ammonium sulphate or ethanol. The myosin, the actin, the actomyosin and the tropomyosin possess characteristics distinction in points of their sedimentation constant, diffusion constant, specific volume, molecular weight, intrinsic velocity, electrophoretic mobility, etc. Planktophagus fish have higher protein contents than do fish with other feeding habits. Lean fish have greater protein proportion than do fat fish. Cultivated fish, as compared to wild fish of the same species have comparable protein contents. Besides the protein, there are number of non protein nitrogenous components.

The principle ones include:

- 1) Peptides to which fish owes for much of its flavour
- 2) Free amino acid of which histidine is important. Red muscle is richer in histidine than white one.
- 3) Volatile bases like ammonia, trimethylamines particularly in marine fishes (viz. in red muscles of pelagic fishes like albacore and mackerel).
- 4) Creatine, taurine, betaine, histamine, glycine, uric acid, carnosine, anserine, etc.
- 5) Nucleic acid.

Nutrient profiling and evaluation of fish as a dietary component (Database on deep sea fishes): The biochemical composition of 21 deep sea fishes was generated (proximate composition, fatty acid and amino acid profile and mineral profile). It was noticed that the deep sea fishes are rich in aspartate, arginine, lysine and glutamate. These amino acids play major roles in modulating vascular endothelial function and neuronal function. Elemental and mineral profiling of deep sea fishes have shown that they are rich in beneficial macro and trace elements.

Fat:

Depending upon the fat content, the fish may be classified as oily or fat (fat content more than 8%), average fat (fat content between 1% to 8%) and lean (fat content less than 1%). Although fat is distributed in all tissues, in some it is present in extraordinary amounts which is in far excess of the amount normally required for cell function. Such fats are called depot fats. The principle sites of the depot fat are muscle, head tissue, roe, milt, liver, skeletal tissue, subcutaneous connective tissue and viscera (pyloric caeca and mesenteries). Liver in fish is often the main

site with large deposits. However brain shows the highest concentration of fat and heart the lowest. Liver and kidney rank intermediate. The fat content of fish flesh is a factor that determines the quality of the fish and hence its price. A number of parameters govern its variation; these includes species difference, diet of fish, selective mobilization and distribution of lipid in the fish body, salinity and temperature of water, etc. Fatty substances chiefly belong to either the glyceride group or the lipid group of fatty acids, which differ in points of melting, oxidation, solidification and similar other properties. In fatty acids there are straight chain monocarboxylic forms containing an even number of carbon atoms. The chain length varies from 12 to 28 carbon atoms. In the glyceride group, the fatty acids occur on the three -OH group of the glycerol molecule producing a variety of combination, often complex fats (triglycerides etc). There are some twenty fatty acids of which 16% make stable saturated fatty acid ($C_nH_{2n}O_2$). These commonly includes C16 (palmitic acid), C14 (myristic acid) and C18 (stearic acid) and arachidic, behenic and selachoceric. The remaining fatty acids, forming a high content, are unsaturated fatty acids with low melting point and which easily oxidise and polymerise i.e. rather unstable. These belong to $C_nH_{2n-8}O_2$ (therapinic) and $C_nH_{2n-10}O_2$ (clupanodonic).

Fish oils:

There are chiefly triglycerides ester of fatty acids combined with small amounts of free fatty acids, some vitamins, sterols, hydrocarbons, phospholipids and colour substances. Oil content of marine and freshwater fish differ in relative proportion of various fatty acids. Marine fish oil contains large quantities of the C18, C20 and C22 acids. Freshwater fish oil, on the other hand, contains large quantities of C16 and C18 acids but a smaller amount of C20 and C22 acids. In general fish oil differs from vegetable oils in containing a wider variety of fatty acids particularly of the highly saturated groups. Besides, as pointed out by Swain (1952), the commonest fatty acid in fish oils has six double bonds which make them attain a degree of unsaturation substantially higher than that of vegetable oils. Due to this characteristic, fish oils find large scale application in industries. Shark oil is rich in unsaponifiable substances, whereas sardine oil and herring oil are poor in this.

Minerals:

These constitute 1 to 2 % of fish flesh composition. The bulk is concentrated in fish bones. Some elements (boron, fluorine, bromine, lithium, strontium) are present in greater concentration in marine fish than in freshwater fish. Mercury is present in fish in greater concentration than it is in outside water. The principle minerals are calcium, magnesium, potassium, sodium, phosphorus, iron, chlorine, copper, manganese, iodine, bromine. Besides traces of Sr, Zn, Ba, Al, Pb, Mo, Co, Ni, Hg, Cd are also present. Phosphorus occurs in fish as phosphoproteins, phospholipids complex phosphoric acids (such as vitamin B1 and B12), glycerophosphatides and adenosinopolyphosphates. The adenosinopolyphosphate is the active substance in muscle breakdown during freezing and it is therefore a subject of importance in fish preservation.

Vitamins:

Fish provides vitamins A, B and D all essential vitamins for human diet. Liver is particularly rich in vitamin B12 and B complex, vitamins A and D. Vitamin B complex includes thiamine, riboflavin and nicotinic acid. The distribution of vitamins is however not uniform in the body. Vitamin B occurs more in liver, eyes, skin, roe, kidney, spleen, pyloric caeca and intestines. Also, the vitamin, content varies from species to species. Eels and prawns are rich in vitamin A, also the small indigenous fish *Amblypharyngodon mola* is a very rich source of vitamin A as compared to many other fishes. Whereas Mackerel is rich source of vitamin D. vitamin D present in fish liver and is the crucial for the bone growth since it is essential for the absorption and metabolism of calcium. It also plays a role in immune function and may offers protection against cancer. Oily fish is the best food source of unfortified vitamin D. Vitamin D is not found in many foods and tends to be a vitamin that many vulnerable groups go short of, such as teenage girls and the elderly. Vitamin A, D and E are fat soluble and therefore present where fat is present particularly in the liver. These owe their origin in the fish food. Vitamin A reaches fishes after conversion from carotene which is abundant in the plankton (diatoms and flagellates). The invertebrates do the conversion. The food chain being plankton- invertebrates- fish, Tuna halibut and cod are well known examples among marine fishes, and pike, pikeperch and perch from freshwater fishes, which accumulate vitamin A. The liver of hammerhead shark, dogfish, cod, Pollock, tuna etc. is the raw material for the manufacture of vitamin oils. Vitamin occurs in two forms A1 and A2 groups. A1 is abundant in marine fishes and catadromous fishes, whereas A2 in freshwater fishes and anadromous fishes. Vitamins of B group are water soluble. These include thiamine (B1), riboflavin (B2), vitamin B6 and vitamin B12. Other water soluble vitamins found in fishes are niacin, pantothenic acid, folic acid, choline and ascorbic acid (vitamin C). Red muscles contain greater quantities of vitamin B1, B2, B12 and pantothenic acid than do white muscles. On the other hand, white muscles contain larger quantities of folic acid than do red muscles. The marine fishes in India are rich in vitamins like B1, B2 and D. Niacin is particularly rich in the muscles of Indian shad, pomfret, clarius, and magur (a freshwater fish). Choline known for its medicinal value in treating hunger-edema in underfed patients is found in large quantities in fishes of Bengal. The different crucial nutrients which found in fishes are depicted in fig no 01.

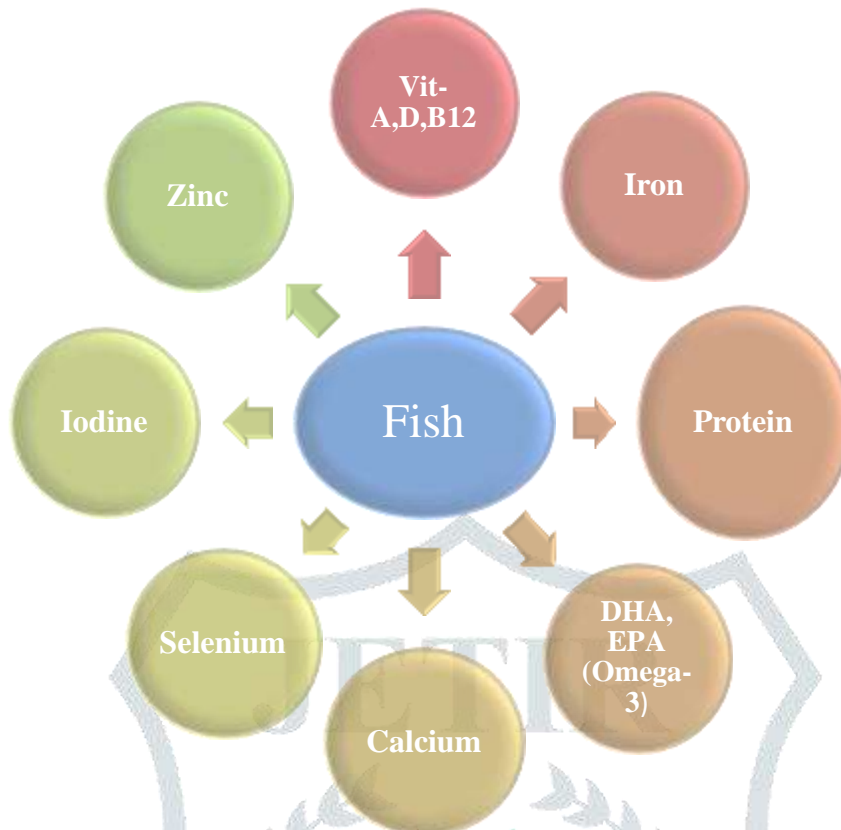


Fig. 01 Crucial nutrients in fishes

VI. Medicinal value of fishes

Fish is not only the stuff to eat and relish. It has huge medicinal values and they can be used as a medicine for various diseases. Most of the fishes are good for our health. Fishes are high in many nutrients that most people aren't getting enough of. This includes high quality protein, iodine and various vitamins and minerals. Cod liver oil is extensively used as a medicine. Shark cartilages are used as a medicine for cancer. Shell fish also have enormous medicine for cancer. The omega-3 fatty acid most found in fatty fish, it is crucial for our body and brain to function optimally and are strongly linked to reduced risk of many diseases. Heart attacks and strokes are the two most common cause of premature death in the world. Fish is considered to be among the best we can eat for healthy heart. There are mainly three types of fatty acids -1) saturated fatty acids (SFAs), 2) monounsaturated fatty acids (MUFAs),3) polyunsaturated fatty acid (PUFAs). The first two are synthesized endogenously, but the third one cannot be synthesized by the humans from other components by any known biochemical pathways, and therefore must be obtained from the diet. Fatty acids (FAs) are highly complex biomolecules and it is an important to know their nomenclature to understand them. In which The omega-3 fatty acid in the fatty fishes is more beneficial to the health of heart. The omega-3 fatty acid docosahexaenoic acid (DHA) is especially important because it accumulates in the developing brain and eye. Some fishes are high in mercury which ironically is linked to brain development problems. E.g. Salmon, sardines, trout, etc. Mechanism of body is related to grey matter in the brain. Grey matter is the major functional tissue in our brain, containing the neurons that process information, store memories and make us human. And the consumption of fish is useful to have more grey matter in the centers of the brain that regulates emotion and memory. Vitamin D has received a lot of mainstream attention in recent years. This is important vitamin function like a steroid hormone in the body. Fish and fish products are the best dietary sources of vitamin D. A disease called macular degeneration is a leading cause of vision impairment and blindness and mostly affects older individuals. The eating fish will provide an omega-3 fatty acid which is helpful to cure the visional impairment and blindness.

Autoimmune disease occurs when the immune system mistakenly attack and destroys healthy body tissues. The diabetes, which involves the immune system attacking the insulin producing cells in the pancreas. The omega-3 or fish oil consumption is linked to reduced risk of diabetes in children as well as adults and the autoimmune diseases. Fish, above all, is rich in linoleic acid [ω -3(omega3) polyunsaturated fatty acids] a factor known for its role in prevention of coronary heart diseases, and other cardiovascular diseases. Fatty fish (sardine, mackerel, herring salmon, etc.) are particularly rich in these fatty acids and compare well with plants (sunflower, corn, etc.). Omega-6 fatty acid is found in their seeds. It is for these reasons that heart attacks are uncommon among Greenland Eskimos and Japanese fisherman who consume fish daily and in large quantity (250gm to 400gm). The efficiency of omega-3 fatty acid lies in their capacity to prevent blood clotting, atherosclerosis and low blood pressure condition, in addition to lower triglyceride levels. Cardiologists recommend that if fish is taken twice a week it will prevent heart disease. The essential Omega-3 oil levels in various fish and sea foods is depicted in table no 01.

Table no. 01 Omega-3 oil levels in various fish and sea foods.

Sr. No.	Fish	Grams of Omega-3 oil Per 3-oz serving	No. of ounces per day to Equal 1G BPA/ DHA
1	Tuna -Light, canned in water, drained.	0.26	12

	- canned in water, drained.	0.73	4
	-Fresh.	0.24-1.28	2.5-12
2	Sardines	0.98-1.70	2-3
3	Salmon		
	-Sock eye or pink	1.05	3
	-Chinook	1.48	2
	-Coho, farmed	1.09	3
	-Coho, wild	1.09-1.83	1.5-2.5
	Atlantic, farmed	0.9-1.56	2-3.5
	Atlantic, wild	0.34-1.57	2-8.5

Medicinal value of certain fish (*heteropneustes fossilis*) is well known. Being rich in vitamins and minerals, such fish is recommended to convalescing patients in particular. An unorthodox therapy of chronic bronchial asthma is practiced using fish medicine. The long queue at private free service in Hyderabad once every year is proof in itself of the efficacy of this miracle medicine to cure asthma. Fingerlings of channa species are used live. The mouth of the fingerling is filled with some herb and the patient is made to swallow it. For complete cure the therapy has to be repeated for three consecutive years. However, there is yet no scientific explanation of this fish therapy of Ayurveda. Asthma is a disease that is characterized by chronic inflammation in the airways. The studies shoes that the children are who eat fishes have a lower risk of developing asthma.

VII. Seafood and crucial nutrients for healthy development

Throughout the world, expectant mothers face demanding nutritional needs. It is a crucial time to promote proper nutrition for development, transforming the infant's future prospects and promoting proper physical and mental development. Fish has a crucial role to play in this development

Key nutrients in seafood

Long chain omega-3 fats-Mainly found in fish and seafood, these fatty acid are essential for optimal brain development.

Iodine : Seafood is in practice the only natural source of this crucial nutrient. Iodine- serves several purposes like aiding thyroid function. It is also essential for neurodevelopment.

Vitamin D : Another nutrient crucial for mental development, this vitamin also regulates the immune system function and is essential for bone health.

Iron : During pregnancy, iron intake is crucial so that the mother can produce additional blood for herself and the body. Calcium, zinc, other minerals. As the key nutrients in seafood are depicted in table no 02.

Table no 02. Key nutrients in seafood

Sr. no.	Nutrients	Tuna bones per 100 gm	Maize flour per 100 gm	Daily requirements for children
1	Calcium	10.2 mg	7mg	700 mg/day
2	Iron	3.6 mg	2.4mg	8.9 mg/day
3	Zinc	8.6 mg	1.7mg	3.7 mg/day
4	EPA+DHA	3.1 mg	N/A	150 mg/day

VIII. CONCLUSION

Fish is an important component of human diet. More than 50% of Indian population is fish eating and some states like Asom and other North Eastern states, West Bengal, Odisha, Goa and Kerala more than 90% of the population consumes fish as daily food. Three quarters of the Earth are covered by water, so fish has been an important part of diet of human in almost all the countries in the world since the dawn of time. Animal proteins are generally superior to plant proteins and fish is one of the cheapest sources of animal proteins and availability and affordability is better for fish in comparisons to other animal protein sources. Fish serves as a health food for the affluent world owing to the fish oils which are rich in polyunsaturated fatty acids (PUFAs), specially to w-3 PUFAs and at the same time, it is a health food for the people in the other extreme of the nutrition scale owing to its protein, oils, vitamins and minerals and the benefits associated with the consumption of small indigenous fishes.

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