Nutritional Significance of Seafood

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Fish represents a food of high digestibility and nutritional value for the purpose of human nutrition. Nutrition is embedded in FAO's definition of food security as good nutrition, in turn, depends on agriculture to provide the foods – cereals, pulses, vegetables, fruit, meat, fish, milk and dairy products – for a balanced diet that meets our needs for energy, protein, vitamins and minerals (FAO, 2012). In the recent years, seafood represents a major role in human nutrition. In 2010, fish accounted for 16.7% of the global population's intake of animal protein and 6.5% of all protein consumed. Moreover, fish provided more than 2.9 billion people with almost 20% of their average per capita intake of animal protein, and 4.3 billion people with about 15% of such protein. For example, fish contributes, or exceeds, 50% of total animal protein intake in some small island developing states, as well as in Bangladesh, Cambodia, the Gambia, Ghana, Indonesia, Sierra Leone and Sri Lanka (FAO, 2014).

Proteins

Protein is the most important component of fish in the nutritional point of view. On an average, fish contains 15-20% protein. Protein content of cephalopods is generally lower than fish (8-15%). Fish and fishery products represent a valuable source of animal protein, as a portion of 150 g of fish provides about 50–60% of the daily protein requirements for an adult. Traditionally, fish constitute the important source of protein to all section of the communities located in the areas close to water resources. Most studies suggest that amino acid pattern of fish protein closely approximate that of any other class proteins. Fish protein contains all the common amino acids and their proportion varies from species to species. There are 20 number of naturally occurring amino acids and 10 of them are essential amino acids. Fish protein has all the essential amino acids in good proportions and especially rich in lysine and methionine which are the limiting amino acid in vegetable protein. There are no significant differences in the AA composition of freshwater and marine fish although marine fish is having slightly higher protein content. Generally, shell fishes including shrimp, crab, lobsters; contain larger amounts of arginine, glutamic acid, glycine and alanine than fin fishes.

Fish protein is generally classified into three categories, sarcoplasmic (enzymatic), myofibrillar (contractile/structural) and stroma (connective tissue) proteins. Myofibrillar proteins play an important role in determining the functionality of fish proteins. Myosin, actin, actomyosin, tropomyosin and troponins are the important myofibrillar fractions of fish muscle, account for 65-75% of total protein. Sarcoplasmic proteins contribute to 20-25% of the total protein of fish muscle. It includes myoglobin and several enzymes. Their functions are limited to metabolic activities of the cell. Stroma protein mainly consists of collagen, contributes to 3% of total protein in teleost fish and is having poor nutritional value. Collagen has important influence on the texture and rheological properties of the fish muscle and the products processed out of it.

Fish protein is easily digestible as it contains less connective tissue than that found in red meat. Studies show that the in vivo digestibility of proteins from raw finfish and shellfish meat is in the range of 90–98% and 85%, respectively. The superior digestibility of seafood proteins to meat proteins is due to the negligible amounts of stroma proteins, mainly connective tissue fibres which are abundant in terrestrial meat. The biological value of fish protein varies from 80-90% which is far above that of meat protein. Protein efficiency ratio (PER) ie., the weight gain per unit of protein consumed is a common index used for comparing the quality of different protein sources. PER of fish protein is found to be slightly higher than that of casein, the milk protein. Net protein Utilization refers to the ratio of amino acids used to synthesize protein in human body to the amount of AA consumed. NPU of fish protein is 83 when compared to 80 and 100 of red meat and egg meat, respectively. Fish protein, chiefly myofibrillar proteins have excellent functional properties. Hence it is being widely used for commercial applications in the forms of protein concentrates or hydrolysates.

Lipids

In fish, lipid is stored as triglycerides of fatty acids in the muscle and liver. Fat deposit in fish is found below the skin, usually along the lateral line and around the belly. Among all the components, lipid shows maximum variations between the species and within the species depending on age, sex, maturity and season. The lipid composition of fish varies from that of other oils or fat in terms of a wide range of fatty acids, occurrence of long chain fatty acids with more than 20 Carbon atoms and high degree of unsaturation particularly of n-3 series. Fish is classified as lean, semi fatty and fatty, depending on the lipid content in fish muscle. Fish containing less than 0.5% fat are categorized as lean fish; those with 0.55-2% are semi fatty and fish with more than 2% fat is considered as fatty fish. There is an inverse relation between fat content and other components of fish. When fat content is high, the moisture level and protein content are high and vice versa. In dark fleshed fishes like tuna, seer fish, mackerel, dark muscle contains more fat than white muscle.

Myristic, palmitic, and stearic acids are the dominant saturated fatty acid group in fishes. Palmitooleic acid and oleic acid are the important monounsaturated fatty acids and arachidonic acid, eicosapentaenoic acid and docosahexaenoic acid are the abundant polyunsaturated fatty acids occurring in fish. The long chain poly unsaturated fatty acids (LCPUFAs) of marine fish have very important nutritional role in human nutrition. Polyunsaturated fatty acids consist of two series of fatty acids, n-3 and n-6, designated by the location of the first double bond counting from the methyl end of the fatty acid molecule (in n -3 series this is located between the third and fourth carbon atoms, in n-6 between the sixth and seventh). The important n-3 fatty acids in nutrition are α-linolenic acid (ALA), eicosapentaenoic acid (EPA, C20:5), and docosahexaenoic acid (DHA, C22:6). Alpha linolenic acid (C18:3) is the parent fatty acid of n -3 family, that in human and animals bodies is metabolized to longer chain PUFA of 20 and 22 carbon atoms, increasing the chain length and degree of unsaturation. EPA and DHA together may account for 70-75% of the total PUFA, which is nutritionally most important.

Health benefits of EPA and DHA

EPA and DHA exert a strong positive influence on human health affecting proper neural development, ability of seeing and learning, and by modulation of eicosanoids synthesis decreasing the risk of cardiovascular diseases (atherosclerosis, thrombosis, stroke), certain cancers, diabetes, depression, immune disorders (rheumatoid arthritis, ulcerative colitis, asthma, psoriasis, atopic eczema, etc.), and others. Both n-3 and n-6 fatty acids are essential to the human diet. Infact n-3 and n-6 compete for the same metabolic enzymes, thus the n-6:n-3 ratio will significantly influence the ratio of the ensuing eicosanoids, (prostaglandins, leukotrines, thromboxanes etc.), and will alter the body's metabolic function (Kolanowski *et al.*, 2006). DHA has special importance in the brain and blood vessels, and is considered essential for pre- and post-natal brain and retinal development. It is believed that n-3 PUFA enable fluidity in neuronal membranes and help to regulate neurotransmitters, both crucial for optimal brain function. It has been reported that increasing n-3 PUFA intake during pregnancy can enhance maternal DHA status, potentially benefiting the foetus. Fatty fish, such as swordfish, tuna, salmon, mackerel, sardine and shark are rich source of n-3 PUFAs. Several recommendations have been made with respect to the intake of n-3 PUFA. Now, it is commonly recommended to increase the n-3 fatty acids content of the diet, mainly by frequent consumption of fish, at least two or three fish meals a week (200-300 g fish per week), that may provide approximately 200-400 mg of EPA and DHA a day. Depending on different recommendations, and physical activity, an optimal level is much higher, and may be estimated as 0.8-1.4 g (or even more) for EPA and DHA, or 3- 5.5 g for total n-3 PUFA per day.

Minerals

Minerals do not have any calorific value, but they are an essential part of the diet, and are required by the body to carry out various important metabolic functions. A large number of minerals are present in fish. Most of the minerals present in seawater are present in fish muscle too. The quantity of minerals presents in fish vary with the mineral composition of seawater and with changes in diet. The abundant minerals present in fish includes sodium, potassium, calcium, phosphorous, magnesium etc. Sodium content in fish ranges from 30- mg/100g and that of potassium ranges from 250-500 mg/100g. Sodium and potassium play important role in cellular physiology. Fresh water fish contains lower sodium and potassium content than marine fishes.

Calcium is required for children and old age people. Compared to fish, shell fishes are rich in calcium; meat of crab contains high amount of calcium at par with milk. The amounts of calcium in fish vary from 6-120 mg/100g depending on species and processing method. Seafood is also a very good source of selenium. Selenium exists in many enzymes and has several important tasks in the human body. Some of the selenium enzymes participate in the detoxification of heavy metals, as well as protecting the body against oxidation. Iron and copper are important minerals required for good nutrition. Magnesium content of seafood exceeds that of milk and beef.

Fish contains more iodine than that present in any other normal food item and also shows a wide variation between 0.01 to 0.2 mg/100g. Fluorine is also present in equal quantity as iodine in marine fish; however, it cannot be completely utilized by the human body. Oysters and mussels are rich source of copper. Crustaceans frequently contain 0.4-0.7 mg/100g or even more copper. Seafood especially shell fish and dark fleshed species are reasonably good source of iron, supplying 1-2mg/100 g muscle. Small fish, eaten whole, with head, organs and bones are particularly rich in calcium; some are also rich in vitamin A, iron and zinc, and these nutrients in fish are more effectively absorbed those in plant-source foods. In addition, fish has an enhancing effect on the absorption of iron and zinc from the food in a meal.

Vitamins

Both water soluble and fat soluble vitamins are present in fish. Vitamin A is mostly occurred in fish liver particularly those of shark and cod liver. Fatty fish contains modest amounts of Vitamin A in contrast to lean fish. Halibut liver oil contains about 100,000 International Units per 100 grams (272 milligrams per pound); cod liver oil, 85,000 I.U. (230 mgms); blue fin tuna oil, 78,000 I.U. (212 mgms); mackerel liver oil, as high as 120,000 I. U. (326 mgms per pound); and shark liver oil, from 5,500 to 1.20,000 I. U. (15 to 326 mgms per pound). Oysters are a good source of vitamin A, exceeding clams and comparing favourably with crustacean. Fish oils and certain fish such as herring, sardines, salmon, tuna, and halibut are good sources of vitamin D. Fish liver oil contains vitamin D which is associated with calcium transport and calcification of bone. The fatty fish species such as mackerel and sardine contain varying amounts of Vitamin D in their muscle.

Among seafood, best source of Vitamin C is clams and crabs while fresh oysters, scallops, shrimp, and lobsters are fairly good sources. Fish contain varying concentrations of B vitamins. Biotin, folic acid, niacin, pantothenic acid is present in moderate amounts while pyridoxine is present in reasonable quantity. Oysters, herring, mackerel, shad roe, and sardines are probably among the best sources of supply of Vitamin B_2. Modest amount of riboflavin is present in dark fleshed species. Fish and shell fish particularly anchovies, clams, oysters and sardine are rich source of cyanocobalamin. Fish roe is an important source of B vitamins. In some fishes, vitamins get accumulate in the depot fat. Fish liver especially that of shark contains remarkable amounts of vitamin A and cod liver contains good amount of D and E vitamins.

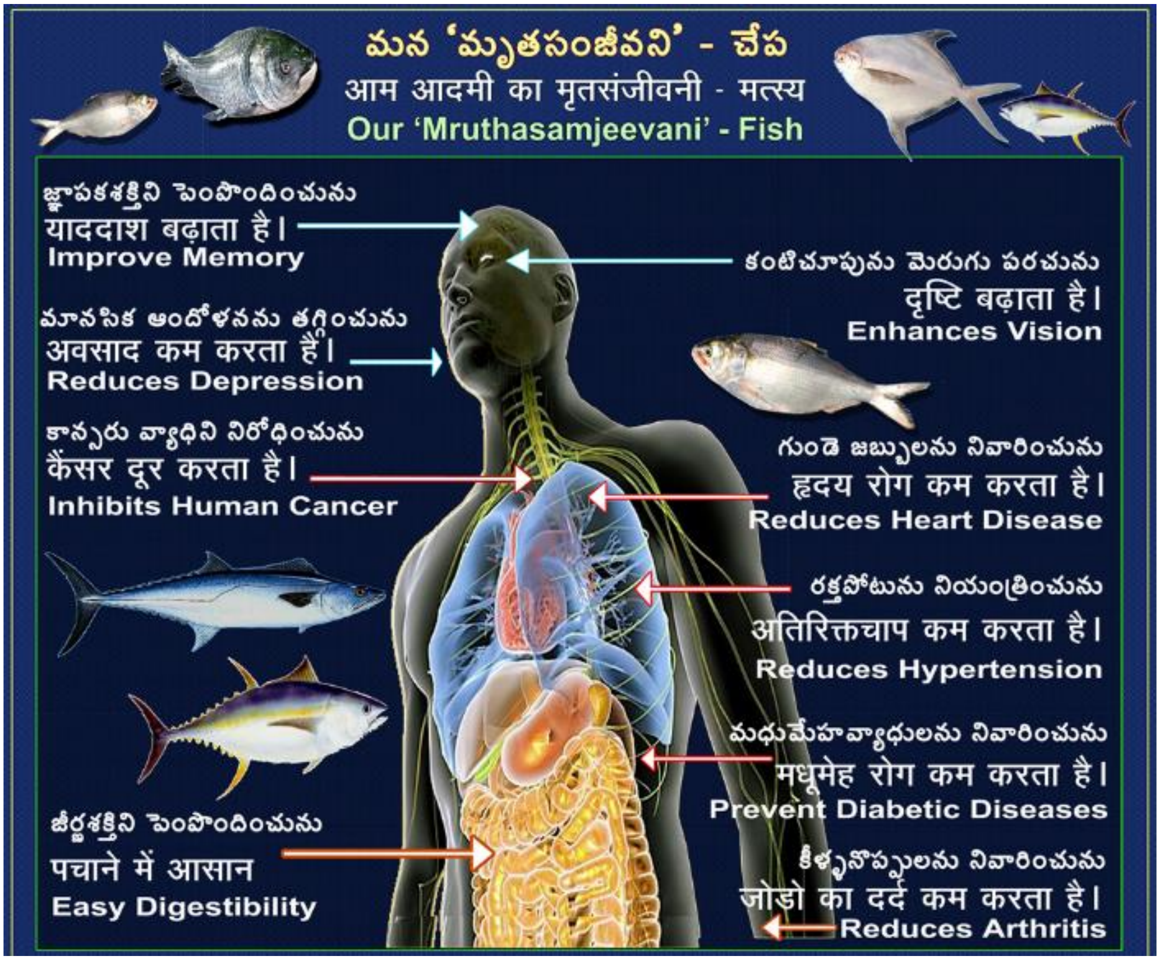

Fig. Fish for Human Health