FISH AS HEALTH-FOOD

Central Inland Fisheries Research Institute (CIFRI)

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Fish as a food is consumed by many animal species, including humans. It has been an important part of the diet of humans in almost all countries in the world. 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 comparison 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), at the same time, it is a health-food for the people in the other extreme of the nutrition scale owing to its proteins, oils, vitamins and minerals and the benefits associated with the consumption of small indigenous fishes. Under nutrition, malnutrition and starvation and resultant mortality are major problems in developing and underdeveloped countries. Two forms of child under nutrition, 'Marasmus' (chronic deficiency of calories) and 'Kwashiorkar' (chronic protein deficiency), often occurring together, are world health problems. In this context, fish, being one of the cheapest sources of animal proteins, is playing a big role and can still play a bigger role in preventing the protein-calorie malnutrition.

Nutrient profiling of fishes show that fishes are superior nutrients and umpteen number of health benefits are believed to be associated with regular fish consumption. Fish, especially saltwater fish, is high in ω (Omega)-3 fatty acids, which are heart-friendly, and a regular diet of fish is highly recommended by nutritionists. This is conjectured to be one of the major causes of reduced risk for cardiovascular diseases in Eskimos. It has been suggested that the longer lifespan of Japanese and Nordic populations may be partially due to their higher consumption of fish and seafood. Fish are also great for the skin. Nutritionists recommend that fish be eaten at least 2-3 times a week. The health benefits of eating fish are being increasingly understood now.

Massive studies to evaluate the health benefits of eating fish are being taken up globally. Recently, a $20-million US Government sponsored probe has been launched to examine whether fish oil and Vitamin D can help prevent heart disease, cancer and a range of other illnesses. Oily fish is claimed to help prevent a range of other health problems from mental illness to blindness. Similarly, there are on-going Govt of India-sponsored projects, running under ICAR and ICMR, which aim at nutrient profiling of important food-fishes from the Indian waters and also to study the health benefits of eating fish.

Nutrient Profile of Fish

Fish is an important component of human diet. More than 50% of Indian population is fish eating and in some states more than 90% of the population consume fish. Fish contains proteins and other nitrogenous compounds, lipids, minerals and vitamins and very low level of carbohydrates. The superior nutritional quality of fish lipids (oils) is well known. Fish lipids differ greatly from mammalian lipids in that they include up to 40% of long-chain fatty acids (C14 - C22) that are highly unsaturated and contain 5 or 6 double bonds; on the other hand, mammalian fats generally contain not more than 2 double bonds per fatty acid molecule. Fish is generally a good source of vitamin B complex and the species with good amount of liver oils

are good source of fat soluble vitamins A and D. Fish is particularly a good source of minerals like calcium, phosphorus, iron, copper and trace elements like selenium and zinc. Besides, saltwater fish contains high levels of iodine also. In fact, fish is a good source of all nutrients except carbohydrates and vitamin C. Some inland fish species like singhi (*Heteropneustes fossilis*), magur (*Clarias batrachus*), murrels (*Channa* sp.), and koi (*Anabas testudineus*) are known to be of therapeutic importance.

Fish and Macronutrients

Proteins

Protein content of fish varies from 15 to 20% of the live body weight. Fish proteins contain the essential amino acids in the required proportion and thus, improve the overall protein quality of a mixed diet.The importance of fish in providing easily digested protein of high biological value is well documented. In comparison to the other sources of dietary proteins of animal origin the unit cost of production of fish is much cheaper. Fish also come in a wide range of prices making it affordable to the poor. A common man can afford to meet the family's dietary requirement of animal proteins because he has the option to choose from a fairly large number of fish species available. A portion of fish provides with one third to one half of one's daily protein requirement. This explains how fish plays an important role in meeting the nutritional food security, especially in preventing the protein-calorie malnutrition. In the past this has served as a justification for promoting fisheries and aquaculture activities in several countries. On a fresh-weight basis, fish contains a good quantity of protein, about 18-20%, and contains all the eight essential amino acids including the sulphur-containing lysine, methionine, and cysteine.

Fatty acids / Fish Oils

There are mainly three types of fatty acids: saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs) and poly-unsaturated fatty acids (PUFAs). The first two are synthesized endogenously, but the third one cannot be synthesized by the humans and therefore must be obtained from the diet.

The human body cannot synthesize *n*-3 fatty acids, but it can form 20-carbon unsaturated *n*-3 fatty acids (like EPA) and 22-carbon unsaturated *n*-3 fatty acids (like DHA) from the eighteen-carbon *n*-3 fatty acid α-linolenic acid. These conversions occur competitively with *n*-6 fatty acids, which are essential closely related chemical analogues that are derived from linoleic acid (LA). Both the *n*-3 α-linolenic acid and *n*-6 linoleic acid are essential nutrients which must be obtained from food. Synthesis of the longer *n*-3 fatty acids from linolenic acid within the body is competitively slowed by the *n*-6 analogues. Thus accumulation of long-chain *n*-3 fatty acids in tissues is more effective when they are obtained directly from food or when competing amounts of *n*-6 analogs do not greatly exceed the amounts of *n*-3.

Importance of omega-3 fatty acids in diet

The long chain PUFA (LC-PUFA) (i.e. C20 and C22) that belong to the omega (ω)-3 family, have a number of neutraceutical and pharmaceutical applications. Eicosapentaenic acid (EPA, 20:5 ω3) and docosahexaenoic acid (DHA, 22:6 ω3) are the important ω3 PUFA. EPA and DHA are important in treatment of arthrosclerosis, cancer, rheumatoid arthritis, psoriasis and diseases of old age such as Alzheimer's and age-related macular degeneration (AMD). Fish oils are the major source of PUFA, and considerable evidence has indicated that ω3 PUFA in fish oil are actually derived via the marine food chain zooplankton consuming ω-3 PUFA-synthesizing micro algae. The most widely available source of EPA and DHA is cold water oily fish such as salmon, herring, mackerel, anchovies and sardines. Oils from these fish have a profile of around seven times as much *n*-3 as *n*-6. Other oily fish such as tuna also contain *n*-3 in somewhat lesser amounts.

Like *n*-3 fatty acids, *n-6* fatty acids (such as γ-linolenic acid and arachidonic acid) play a similar role in normal growth. *n-6* is "better" at supporting dermal integrity, renal function, and parturition. These preliminary findings led researchers to concentrate their studies on *n*-6, and it was only in recent decades that *n*-3 has become of interest.

Nutritional Significance of Fish Oils and PUFAs for Human Health-Some Clinical Correlations:

Coronary Heart Disease (CHD) and ω-3 fatty acids ω-3 fatty acids have been shown in epidemiological and clinical trials to reduce the incidence of Coronary Heart Disease (CHD). Studies have indicated decreases in total mortality and cardiovascular incidents (i.e. myocardial infarctions) associated with the regular consumption of fish and fish oil supplements. Recommendations made by American Heart Association (AHA) Dietary Guidelines include at least two servings of fish per week (particularly fatty fish).

Lack of Essential fatty acids and Attention-Deficit Hyperactivity Disorder (ADHD) Lack of Essential fatty acids causes behavioural problem in the pediatric population which is known as Attention-Deficit Hyperactivity Disorder (ADHD). Children suffering from ADHD are inattentive, impulsive and hyperactive. Studies have reported that children with ADHD had significantly lower levels of arachidonic (AA), eicosapentaenoic (EPA) and decosahexaenoic acids (DHA) in their blood and these hyperactive children suffered more from symptoms associated with essential fatty acid deficiency (thirst, frequent urination, and dry hair and skin) and were more likely to have asthma.

Fish Oils and Childhood Asthma Children who consume fresh, oily fish have significantly lower risk of developing asthma (airway hyper responsiveness). Omega-3 fatty acids, EPA and DHA, especially EPA is reported to prevent development of asthma or reduce its severity. Studies have suggested long-term fish oil supplementation may reduce asthma severity. Major dietary sources of DHA are fish and fish oils.

Dementia and AMD (Age-related Macular Degeneration) associated with low plasma concentration of n-3 fatty acids

Low dietary intakes and plasma concentration of n-3 fatty acids are associated with dementia (memory loss), cognitive decline and age-related macular degeneration (AMD) risk. AMD is a disease associated with aging that gradually destroys sharp, central vision. Central vision is needed for seeing objects clearly and for common daily tasks such as reading and driving. AMD affects the macula (located in the center of the retina, the light-sensitive tissue at the back of the eye), the part of the eye enables to see fine detail. AMD is a leading cause of vision loss in people over 60 years of age. It has been reported that n-3 Fatty acids, particularly DHA delay the progression of dementia and AMD. Major dietary sources of DHA are fish and fish oils.

Higher fish consumption associated with low risk of Low Birth Weight (LBW)

In a study of nearly 9,000 pregnant women, researchers found women who ate fish once a week during their first trimester had 3.6 times less risk of low birth weight (LBW) and premature birth than those who ate no fish. Low consumption of fish was a strong risk factor for pre-term delivery and low birth weight (LBW).

Seafood consumption, ω-3 fatty acid and supplementation and 'Mood disorders'

n-3 fatty acids are known to have membrane-enhancing capabilities in brain cells. One medical explanation is that *n*-3 fatty acids play a role in the fortification of the myelin sheaths. A benefit of *n*-3 fatty acids is helping the brain to repair damage by promoting neuronal growth. Several epidemiological studies suggest covariation between seafood consumption and rates of '*mood disorders*'. Long term disturbances of mood are considered mood disorders. Biological marker studies indicate deficits in omega-3 fatty acids in people with depressive disorders, while several treatment studies indicate therapeutic benefits from omega-3 supplementation.

Fish and Micronutrients

Vitamins: Fish is a rich source of vitamins, particularly vitamins A, D and E from fatty species, as well as thiamin, riboflavin and niacin (vitamins B_1, B_2 and B_3). Vitamin A from fish is more readily available to the body than from plant foods. Among all the fish species, fatty fish contains more vitamin A than lean species. Studies have shown that mortality is reduced for children under five with a good vitamin A status. Vitamin A is also required for normal vision and for bone growth. The small indigenous fish *Amblypharyngodon mola* is a very rich source of vitamin A as compared to many other species.

Vitamin D present in fish liver and oils is crucial for bone growth since it is essential for the absorption and metabolism of calcium. It also plays a role in immune function and may offer 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. Fish is also a good source of the B vitamins and can provide a useful contribution to the diet for this group of vitamins, as does red meat. The B group of vitamins is responsible for converting food to energy in the cells of the body and they help with the function of nerve tissue. If eaten fresh, fish also contains a little vitamin C which is important for proper healing of wounds, normal health of body tissues and aids in the absorption of iron in the human body.

Minerals: The minerals present in fish include iron, calcium, zinc, iodine (from marine fish), phosphorus, selenium and fluorine. These minerals are highly 'bioavailable' meaning that they are easily absorbed by the body.

India, like many other developing countries has not yet eliminated problems of under nutrition, especially among children of its poor communities. 'Low birth weight (LBW)' is indicative of intra-uterine growth retardation and studies carried out in India and abroad suggest that children who suffer from such problems show substandard growth and development and are susceptible to obesity in adulthood. Studies carried out in India have shown that the incidence of low birth weight (<2500 gms) deliveries among the poor is around 25-30% and nearly 50% of children less than three year of age are stunted (height less than WHO norms). Combating low birth weight would be a valuable contribution towards reducing incidence of obesity and type II Diabetes mellitus. Studies have shown that apart from correction of anemia, supplementation with foods rich in n-3 fatty acids could significantly reduce the low birth weight incidence. It is evident that fish contribute more to people's diets than just the high quality protein they are so well known for. Fish should therefore be an integral component of the diet, preventing malnutrition by making these macro-and micro-nutrients readily available to the body.

Courtesy: Outreach Activity Consortium (#3) on 'Nutrient Profiling and Evaluation of Fish as a Dietary Component', Project Coordination Unit, CIFRI, Barrackpore, Kolkata-700120, India.
Tel. +91-33-2592 1190/1191; Fax: +91-33-2592 0388; web: http://www.cifri.ernet.in