Fish for health and prosperity

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As far as India is concerned, the successful outcome of green revolution has answered the challenges of food security due to rapid growth in population. But considering the fact that 35% of Indian population falls still below the poverty line emphasizes the need to recognize fisheries as an important sector of the National economy for meeting the food and nutritional security. In the days ahead, "blue revolution" will be the buzzword to meet the challenges of food and nutritional security.

Fish and fishery products form an important food component for a large section of world population. They represent 15.6 % of animal protein supply and 5.6 % of total protein supply on a worldwide basis. Fish is the primary source of animal protein for over one billion people of developing countries. It is estimated that 60% of people in developing countries obtain 40-100 % of the animal protein in their diets from fish [Lowe *et al*., 1998). Protein.lipids and bioactive compounds from seafood's have unique features that differ from those of land animals. The uniqueness of fish protein is due to its excellent nutritive value, high digestibility and presence of all essential amino acids. In general, fish flesh contains 60-84% water, 15-24% protein, 0.1-22 % fat and 1-2% minerals. Seafood serves as a rich source of polyunsaturated fatty acids [PUFAs], especially omega-3 PUFAs, minerals and vitamins [Fierens and Corthout *et al*., 2007].

Fish is a health food, with relatively lesser taboos connected to it, unlike meat. World over fish is considered as a delicious item and in nutritional point of view, it is the balanced diet one can easily think of, when consumed along with cereals. A health food should contain all the principal constituents like carbohydrates, proteins, lipids, minerals, vitamins etc. in the right proportion. Detailed biochemical composition of all important Indian food fishes (including proximate composition, fatty acid composition of body and liver oils, content of important minerals, amino acid composition of muscle proteins etc from fresh water, brackish water and marine and deep sea waters have been compiled and reported by the Central Institute of Fisheries Technology (Gopakumar *et al* ., 1997). People are now more health conscious. Diets low in fat and cholesterol with high vitamin and mineral contents are often preferred, especially in the affluent west. For a healthy lifestyle, fish is a good starting point. Importance of fish as a source of high quality, balanced and easily digestible protein is now well understood. For the affluent it is the best health food with curative properties whereas for the less privileged section in developing nations it is the only source of high-quality protein available at affordable cost and in sufficient quantity.

Fish plays a major role in human nutrition. Fish and shellfish form an important part of the human diet, both of the poor and of the wealthy. Good quality fish is an extremely safe food. Meat products are viewed as unsafe after the incidences of diseases like mad cow disease. Fish is a versatile, tasty and easy to prepare food. Consumers are increasingly demanding for

natural food stuffs, which contain no chemical residues and are not genetically manipulated. Fish is organic and is considered as wild, and for the same reason safer, though of late farmed fish has posed minor problems of harmful residues.

For thousands of years, fish has been an important part of the human diet. The ancient Assyrians, Romans and Chinese were famous for their fish farming. During the past decades per capita consumption of fish has gone up globally. Fish is the diet of the poor fishermen, which meets most of their nutritional requirements

Researchers all over the world have repeatedly emphasized the beneficial effect of eating fish, after conducting systematic research for many years. In recent years, the link between fish oil and heart disease has been the subject of thousands of scientific papers. The whole story began following the discovery that coronary heart disease, while being one of the biggest killers in the world, is practically unknown among the Eskimos. The investigations found that their diet is mostly fish based and is rich in long chain n –3 poly unsaturated fatty acids (Lee and Lip 2003; Von Sehachy and Dyerberg,2001). Eskimos also have a reduced tendency to blood clotting and longer bleeding times compared to other people (Krishnan, *et al.* 2001). Medical researchers carried out detailed investigations and showed that men who ate fish once or twice per week were protected against coronary heart disease (Ite *et al.* 2004: Eokkila *et al.* 2004). An increase in fish oils in the diet results in a marked reduction in blood cholesterol and triglyceride levels and also thrombosis problem (Bjerregaard *et al.*, 2004).

Lipid content in fish varies between species as also within the species depending on many factors. Fish with fat content as low as 0.5% and as high as 18-20% are common. Squalene and wax esters are other components found in unusually high concentrations in certain fish. The fatty acid composition of marine lipids is much more complex than others. Lipids of fish and other aquatic animals contain high proportion of highly unsaturated long chain fatty acids. Fatty acids with carbon chain varying from 10 to 22 and unsaturation varying from 0–6 double bonds are common. Among the saturated acids palmitic and stearic acids are the important ones and in the monounsaturated group, palmitoleic and oleic acids are the major constituents. Among the polyunsaturated acids arachidonic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the major components. In Central Institute of Fisheries Technology, marine, fresh water and brackish water fishes were screened for evaluating their fatty acid composition and in the flesh. Fish and shellfish from tropical waters were analysed for their cholesterol content, showing higher levels in shellfish compared to fish (Mathew *et al.*, 1998).

Fish oils have no effect on the levels of low-density lipoprotein cholesterol (LDL); but they do raise high-density lipoprotein (HDL) by about 10%. HDL is a protective type of lipoprotein since it takes excess cholesterol away from the tissue and returns it to the liver. Diseased heart muscle is susceptible to bouts of irregular electrical activity (arrhythmias), which are potentially lethal and often cause sudden cardiac arrests. There is evidence from animal studies that increasing fish oil in the diet helps to reduce cardiac arrhythmias (Sellmayer *et al.* 2004; Covington 2004). Fish oils improve the functionality of cell membranes, which helps in proper signal transmission. Fish oil inhibits platelet aggregation, which also reduces the risk of heart disease (Vanschoonbeek *et al.* 2004). Raised blood pressure is known to be a

major risk factor in coronary heart disease. Most studies on the effects of fish oil given as dietary supplements have shown modest reductions in blood pressure, especially in hypertensed people (Aguilera *et al.* 2004; Wilbuurn *et al.* 2004; Maano *et al.* 1995).

As stated earlier, fish oils are rich sources of the essential fatty acids eicosapentaenoic acid (EPA, C20:5 n-3) and docosahexaenoic acid (DHA, C22:6 n-3). Both EPA and DHA fall into a larger category of polyunsaturated fatty acids (PUFAs). Approximately 50% of the fatty acids in lean fish and 25% in fattier fish are polyunsaturated fatty acids. In contrast, the polyunsaturated and saturated fatty acids in beef are 4 – 10 % and 40 – 45 % respectively. EPA and DHA reduce vasoconstriction by competing with arachidonic acid for the enzyme cyclo-oxygenase (Sametz *et al.* 2000). EPA, the main n-3 acid is converted by platelet cyclo-oxygenase to thromboxane A3, which is only a very weak vasoconstrictor, unlike thromboxane A2, which is formed by the action of cyclooxygenase on arachidonic acid, the n-6 acid and is a strong vasoconstrictor (Tapiero *et al.* 2002; Akiba *et al.* 2000). The American Heart Association recommends including fatty fish at least twice a week in the diet (Kris-Etherton *et al.* 2002; Krauss *et al.* 2000). Institute of Human Nutrition in New York also recommends eating plenty of fish. Italian study involving 985 people who survived heart attacks, also proved the beneficial effect of fish oil (Tavani *et al.* 2001). The new slogan in the west is that a tuna sandwiches a day keeps heart problems at bay (Mozaffarian *et al.* 2004; O'Neill 2002). It is also stated that if a person wants to reduce the risk of heart attack by more than 20 %, he has to eat a tuna sandwich just once a month. No wonder they say, "Seafood is heartfood".

Recently the inhibitory role of n-3 PUFAs in the development and progression of a range of human cancers have been established by researchers, world over. Studies have found that the anti-tumor effect of EPA is mainly related to its suppression of cell proliferation (Pham and Ziboh 2002; Yuri *et al.* 2003). The effect of DHA appears to be related to its ability to induce apoptosis or cell death (Baumgartner *et al.* 2004; Chiu *et al.* 2004). The dietary n-3/n-6 fatty acid ratio, rather than the quantity administered, appears to be the principal factor in the anti-tumor effect of n-3 PUFAs.

Apart from heart disease and cancer, fish oil is proved to be effective for preventing wide variety of diseases. In several observational studies, low concentrations of n-3 PUFAs were predictive of impulsive behaviours and severe mental depression (Ruxton 2004; Freeman *et al.* 2004). The importance of PUFAs in the maintenance of insulin in the blood has also been proved in experiments (Holness *et al.* 2004). Clinical and biochemical studies have shown that fish oil, and to a lesser extent fish can be used as a source of n-3 fattyacids in the treatment of rheumatoid arthritis (Ruxton 2004; Remans *et al.* 2004). Supplementations with fish oils can markedly reduce inter leukin – 1 beta production and results in a significant reduction in morning stiffness and the number of painful joints in arthritis patients. Studies have shown fish oil to be effective in the treatment of acute respiratory distress syndrome (Pacht *et al.* 2003), psoriasis (Mayser *et al.* 2002), and multiple sclerosis (Nordvik *et al.* 200) also. Older people who eat fish at least once a week may reduce their risk of Alzheimer's disease by more than half (Yazawa 2004; Morris *et al.* 2002). Other diseases which are reduced due to the consumption of PUFAs include primary Raynaud's disease (DiGiacomo 1989; Swanson 1986),

gastric ulcer (Olafsson *et al.* 2000; Manjari and Das 2000) and Crohn's disease (Geerling *et al.* 2000).

Along with fish oils, proteins in fish are also having positive role in reducing blood cholesterol (Ait Yahia *et al.*, 2004). Recent studies have shown that fish proteins have a clear protective effect in diabetic renal diseases (Mollsten *et al.*, 2001). Fish proteins are having high biological value, as they contain all essential amino acids in the right proportion. Plant proteins, although rich in certain essential amino acids do not always offer all essential amino acids in a single given food. Legumes lack methionine, while grains lack lysine. Fish protein is also an excellent source of lysine as well as the sulphur-containing amino acids, methionine and cysteine. Amino acid scores of fish protein compares well with the FAO reference pattern. In the studies conducted in the Central Institute of Fisheries Technology, Kochi, it was seen that the amino acid composition of the protein is crucial in determining its hypocholesterolemic properties. The alanine/proline ratio in a protein was found to be the significant factor determining its hypocholesterolemic properties (Ammu,K., *et al*.,1994).

Protein content of fish muscle ranges between 16 and 20% depending on the species of the animal, the nutritional condition, and the type of muscle. The crude protein calculated on the basis of the total nitrogen content represents proteins and other nitrogenous compounds, such as nucleic acids, nucleotides, trimethylamine (TMA) and trimethylamine oxide (TMAO), free amino acids, urea, etc**.** Protein from fish is easily digested, with most species showing a protein digestibility greater than 90%. The chemical score or amino acid score compares a food's amino acid pattern to that of whole egg protein. The chemical score of finfish is 70, an indication of its high quality, beef is 69 and cow's milk is 60. The protein efficiency ratio (PER) another measure of protein quality of fish is around 3.5, which is much higher than beef (2.30) and milk proteins (2.5) and close to that of egg (3.92). Fish is a good dietary source of taurine, a non-protein amino acid with multiple functions like neurotransmission in the brain, stabilization of cell membranes and in the transport of ions such as sodium, potassium, calcium and magnesium (Franconi *et al.*, 2004; Birdsall, 1998; Del Olmo *et al.*, 2000). Nutritional quality of protein is generally determined by factors like essential amino acid composition, digestibility and biological value. Fish protein is rated high in all the above qualities and is considered as a good dietary protein in all respects.

In general, both water soluble and fat-soluble vitamins are present in fish. Fat soluble vitamins A, D, K and E are present in fish in varying amounts-often in higher concentrations than in land animals. The number of vitamins and minerals is species-specific and can vary with season. The flesh of lean white fish, such as cod, haddock, and pollock, contains from 25 to 50 IU of vitamin A per 100 g, while in the fatty species such as herring, there is from 100 to about 4500 IU of this vitamin in 100 g of meat. The content of vitamin D in sardines and pilchards and in tuna is in the range of 530 to 5400 and 700 to 2000 IU per 100 g, respectively. The contents of vitamin E in the edible parts of fish and marine invertebrates range from about 0.2 to 270 mg/100 g. Fish is a good source of B vitamins. The red meat has higher content of vitamin B than white meat. Fish liver, eggs, milt and skin are good sources of Thiamine (B_1), riboflavin (B_2), pyridoxine (B_6), folic acid, biotin, and Cyanocobalamine (B_{12}).

Fish also contributes appreciable amounts of dietary calcium, iron and zinc. Fish contains copper and those who relish fish bones get a fair share of calcium and phosphorous. Salt-water fish are rich in iodine. The iodine in marine fish ranges from 300-3000 µg/kg. Fish is a good source of almost all the minerals present in seawater (Nair and Mathew, 2000). The total content of minerals in the raw flesh of fish and aquatic invertebrates is in the range of 0.6 to 1.5 % of wet weight. Certain seafoods such as snails and tuna are good source of the macro mineral magnesium. Seafood, especially tuna, is an important source of the essential antioxidant trace element selenium, which provides protection against heavy metal poisonings and a variety of carcinogens. Functioning cooperatively with vitamin E, selenium is also a vital factor in protection of lipids from oxidation as part of the enzyme glutathione peroxidase, which detoxifies products of rancid fat. The carbohydrate content of finfish is insignificant, but certain shellfish store some of their energy reserves as glycogen, which contributes to the characteristic sweet taste of these products.

When we consider the beneficial effects of dietary fish, vegetarianism in dietary habits does not seem to be wise. When one decides to become an obligate vegetarian and cuts out meat/dairy/fish out of diet, he decides to cut out some of the major nutrient's body needs on a daily basis for effective functioning. The argument that fishes lives in unhygienic habitat and polluted waters is also not valid as pollution is a universal phenomenon, affecting air, land and water Fish is the heart food which gives you both satisfaction and health and it is the word for nutritional security.

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