Fish in Human Nutrition

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Fish is a health food, with very few 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. People are now more health conscious. Diets low in fat and cholesterol with high vitamins and minerals are often preferred by people.

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. Compared to meat products, which are viewed as unsafe due incidences of diseases like mad cow disease; good quality fish is an extremely safe. Consumers are increasingly demanding for natural food stuffs, which contain no chemical residue and are not genetically manipulated. Fish is organic and is harvested from both wild as well as from farm. 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.

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 polyunsaturated fatty acids. Eskimos also have a reduced tendency to blood clotting and longer bleeding times compared to other people. Medical researchers carried out detailed

Table 1: Principal constituents of fish and beef muscle (in percentage)

Constituent	Fish fillet			
	Minimum	Normal variation	Maximum	Beef muscle
Protein	6	16-21	28	20
Lipid	0.1	0.2-25	67	3
Carbohydrates		<0.5		1
Ash	0.4	1.2-1.5	10.5	1
Water	28	66-81	96	75

investigations and showed that men who ate fish once or twice per week were protected against coronary heart disease. An increase in fish oils in the diet results in a marked reduction in blood cholesterol and triglyceride levels and also thrombosis problem.

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 (Table 1). 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, C20:5 n-3) and docosahexaenoic acid (DHA, C22:6 n-3) are the major components. 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.

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. Fish oils improve the functionality of cell membranes, which helps in proper signal transmission. 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. The new slogan in the west is that *'a tuna sandwich a day keeps heart problems at bay'.*

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. The effect of DHA appears to be related to its ability to induce apoptosis or cell death. 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. The importance of PUFAs in the maintenance of insulin in the blood has also been proved in experiments. Clinical and biochemical studies have shown that fish oil, and to a lesser extent fish can be used as a source of n-3 fatty acids in the treatment of rheumatoid arthritis. 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, psoriasis, and multiple sclerosis also. Older people who eat fish at least once a week may reduce their risk of Alzheimer's disease by more than half. Other diseases, which are reduced due to the consumption of PUFAs include primary Raynaud's disease, gastric ulcer and Crohn's disease.

Along with fish oils, proteins in fish are also having positive role in reducing blood cholesterol. Recent studies have shown that fish proteins have a clear protective effect in diabetic renal diseases. 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 compare well with the FAO reference pattern.

Protein content of fish muscle ranges between 16 and 20% depending on the species, the nutritional condition, and the type of muscle. 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, is around 3.5 for fish, 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. Nutritional quality of protein is generally determined by factors like essential amino acid composition, digestibility and biological value. Fish protein is rich in all the above qualities and is considered as a good dietary protein in all respects (Table1, 2 & 3).

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 amount 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, 100 to about 4500 IU of this vitamin is present 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/100g. 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 B1, riboflavin, pyridoxine, folic acid, biotin, and B12.

The total minerals content in the raw flesh of fish and aquatic invertebrates is in the range of 0.6 to 1.5% of wet weight. Fish is a good source of almost all the minerals present in seawater. Certain seafood such

Table 2: Essential amino-acids (percentage) in various proteins

Amino-acid	Fish	Milk	Beef	Eggs
Lysine	8.8	8.1	9.3	6.8
Tryptophan	1.0	1.6	1.1	1.9
Histidine	2.0	2.6	3.8	2.2
Phenylalanine	3.9	5.3	4.5	5.4
Leucine	8.4	10.2	8.2	8.4
Isoleucine	6.0	7.2	5.2	7.1
Threonine	4.6	4.4	4.2	5.5
Methionine-cystine	4.0	4.3	2.9	3.3
Valine	6.0	7.6	5.0	8.1

Table 1 and 2. Sourace : Lahsen Ababouch, 2000 Fish Utilization and Marketing Service http://www.oceansatlas.com/world_fisheries_and_aquaculture/html/util/compos/compos/proteins.htm

as snails and tuna are good source of the macro mineral magnesium. Fish 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. 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.

Protein malnutrition is a serious problem facing the world. 828 million people in the developing countries are undernourished, 15 per cent of them are in South Asia. Protein Energy Malnutrition (PEM) also is the most widespread nutritional disorder among children in India. Fisheries is fast emerging as a priority area in the national economy of India, the main aims being increase of production, improving export earnings, providing more and better animal protein to the weaker sections and expanding employment opportunities, especially among the rural poor and women. Fish is the ultimate answer to the problem of protein calorie malnutrition in countries like India, where aquaculture is also developing fast.

When we consider the beneficial effects of dietary fish, vegetarianism in dietary habits does not seem to be wise from health point of view. 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 nutrients body needs on a daily basis for effective functioning. The argument that fish lives in unhygienic habitat and polluted waters is also not valid as pollution is a universal phenomenon, affecting air, land and water.

Modern society is more concerned about human health especially in relation to diet. Previously man was conscious about the delicious nature of a food rather than its nutritional quality. The awareness regarding health has improved the situation today and people especially in the affluent countries think more of nutrition, while consuming a food. The lack of time in preparing food is yet another factor for the modern society while choosing a food. Today consumers are exposed to a wide range of processed foods and prefer to have the nutrition facts in detail in the packs.

Even after years of nutrition studies, the complexity of the processes that the nutrients undergo in the body still remains unclear. However it is highly essential for the body to have the nutrients at the required level for the maintenance of health. Malnutrition and excess food are at the same time not beneficial. The most dreaded diseases of today, viz., coronary heart diseases and cancer are created by over-consumption or negligence in proper food consumption. The National Academy of Sciences (1989) has given specific recommendations for dietary consumption. Reduction in the dietary fat and cholesterol and incorporation of more fruits and vegetables in the diet as mineral and vitamin supplements is the need of the day. The concern for safe food had led many countries to introduce laws and regulations to reveal the nutrient content of the food

Table 3 – Mineral contents of the muscle of some important species

Name of fish	Na	K	Ca	Fe	P
Fresh water fish			(mg /100g)		
Calbasu (*Labeo calbasu*)	103.2	310.1	318.5	0.9	395.0
Catla (*Catla catla*)	58.0	161.7	495.2	1.0	245.0
Mrigal (*Cirrhinus mrigala*)	69.5	170.5	352.1	1.1	283.2
Murrel (*Channa striatus*)	45.5	270.2	46.8	2.5	139.5
Mussullah Mahser (*Tor mussullah*)	49.4	250.2	97.2	3.8	78.5
Rohu (*Labeo rohita*)	112.2	132.2	86.3	1.4	128.7
Tilapia (*Oreochromis mossambica*)	-	-	585.2	1.5	235.0
Freshwater shark (*Wallago attu*)	130.0	169.3	160.0	0.6	4.9
Brackish water fish					
Grey mullet (*Mugil cephalus*)	136.4	252.8	136.9	4.4	175.0
Milk fish (*Chanos chanos*)	83.5	251.4	9.3	1.3	179.5
Mullet (*Mugil parsia*)	116.2	204.1	31.6	1.3	168.2
Pearl spot (*Etroplus suratensis*)	126.9	296.7	315.3	1.8	251.0
Marine fish					
Mackerel (*Rastrelliger kanagurta*)	100.2	424.5	42.9	4.6	308.0
Oil sardine (*Sardinella longiceps*)	88.1	196.2	68.3	1.2	118.1

Table 4. Nutritional labeling

Nutrition Facts Serving Size ½ cup (114g)Servings Per Container 4

Amount per Serving

Calories 260 Calories from Fat 120

	% Daily Value*
Total Fat 13g	20%
Saturated fat 5g	25%
Cholesterol 30mg	10%
Sodium 660mg	28%
Total Carbohydrate 31g	11%
Dietary Fiber 0g	0%
Sugars 5g	
Protein 5g	

Vitamin A 4%		Vitamin	C 2%
Calcium 15%		Iron	4%

* Present Daily Values are based on a 2000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

Calories	2,000	2,5000
Total fat	Less than	65g	80g
Sat fat	Less than	20g	25g
Cholesterol	Less than	300g	300g
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram

Fat 9 – Carbohydrate 4 – Protein 4

being sold in processed and packaged form. However the consumer is still overburdened to have the knowledge of the diet – disease relationship as well as the nutrition related facts.

Nutrition labeling has been made mandatory only in certain countries. Nutrition Labeling and Education Act (NLEA) has made nutrition labeling mandatory in the United States of America. Accordingly, nutrition labeling is required for most of the processed and packaged foods except for bulk foods and foods of no nutritional significance (unsweetened coffee). More emphasis is given to over-consumption rather than under – nutrition and the aim is to reduce the risk of obesity, cardiovascular diseases and cancer. NLEA

of 1990, the Public Law 101 -535, 104 Stat. 2353, 1990, is the most comprehensive and elaborate one in this category. NLEA has included status of certain nutrients as mandatory. They are total calories, calories from fat, total fat, saturated fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, protein, vitamin A, Vitamin C, calcium and iron. A second group of nutrients are listed voluntarily: calories from saturated fat, polyunsaturated fat, monounsaturated fat, stearic acid, potassium, soluble fiber, insoluble fiber, sugar alcohols, other carbohydrates and other vitamins and minerals.

The nutrition label format has a title 'Nutrition Facts'. The top of the nutrition panel should include the serving size of the food expressed in metric units and the number of servings in the container. The mandatory nutrient factors must appear in bold type on the middle left side of the panel. Allowable sub components must be in lighter type and intended below the major component. The amounts should be in light print adjacent to each respective food component. The right column must list the percent daily value for each nutrient. The bottom section will have a footnote indicating that the percent daily values are based on a 2000-calorie diet and individual requirements may vary (Table 4). A standard Nutrition Label format is given below.

In India nutrition labeling is still in its infancy. India has Prevention of Food Adulteration Act (PFA) and Fruit Products Order (FPO), as regulations to prevent adulteration. A time has come to think seriously about Nutrition Labeling in India as the diseases caused by nutritional imbalances are increasing day by day.

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The daily recommended values for the energy – producing nutrients are given below .

Nutrient	Daily Recommended Value
Fat	30% of total caloriesSaturated fat
10% of total caloriesCarbohydrate	60% of total calories
Protein	10% of total calories
Fiber	11.5g per 1000 calories

Because of the current public health concerns upper limits have been set for some nutrients, which is given below

Nutrient	Upper limit
Total fat	65g
Saturated fat	20g
Cholesterol	300mg
Sodium	2400mg

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