



Study of Role of Fish Oil in Human Health

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Abstract: Fish oil is the oil derived from the tissues of oily fish. It is recommended for a healthy diet because it contains the omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), precursors to eicosanoids that reduce inflammation throughout the body. Fish oils are required to be added in minute quantities for optimum health benefit, cellular metabolism and normal physiological functions. In recent times, seafood is getting more focus on account of its richness in omega-3 fatty acid. Numerous investigations carried out reveal the health benefits of omega-3 fatty acids as a nutritional supplement against various life threatening diseases like cardiovascular diseases, cancers, skin diseases and many inflammatory diseases etc. They also play a significant role for the proper growth and development of the foetus. National and International health authorities have set up recommendation of daily fish oil intake due to the immense health potential it carries and it is necessary to create an awareness in the society on its importance, as the modern world has become a hub of various lifestyle diseases.

Keywords: Omega-3 Fatty acids, Eicosanoid, Inflammation, Cardiovascular, Cancers, Diseases.

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INTRODUCTION

Fish oil was originally consumed to get enough vitamin A and vitamin D, which for many years have been known to be important micronutrients for the body's normal functions (homeostasis). It was not before the well-known publication by Dyerberg and Bang and their work on the Inuit diet in the mid-1970s, that the interest and awareness of the significance of the marine omega-3 polyunsaturated fatty acids (PUFAs) in human health increased. Inuit's living in the arctic region had quite an unusual health pattern. Despite a high intake of both fat and cholesterol, their heart health was extremely good. These findings were quite controversial, since a high fat diet previously had been correlated to poor heart health. However, there was one difference between "other" high-fat diets and the Inuit diet; the source of the fat. In other high-fat diets, the fat and cholesterol were mainly of animal and vegetable origin, while the diet of the Inuit's was mainly marine based ('Sushi' from raw whale, seal and fish meat). The positive effect of the

Inuit diet was partly explained by the high intake of the two marine omega-3 fatty acids, eicosapentaenoic acid (EPA, C20:5) and docosahexaenoic acid (DHA, C22:6) [1]. Similar effects have later also been observed in other communities, like the Japanese and Mediterranean countries, known for high intake of natural antioxidants like polyphenols and marine foods [2].

Life has become fast and convenient on account of the latest developments in technology but at the same time it has welcomed various health hazards also. Life style diseases are mainly associated with poor eating habits like the consumption of junk and processed foods rich in saturated fat, dietary deficiencies, over consumption of certain foods etc. Other reasons causing health risks include lack of physical activity, work stress, disturbed biological cycle and other factors which affect human beings of all generation. In this context it is of paramount importance to choose appropriate food which provides healthy balanced nutrition.

Genetic factors determine susceptibility to many diseases, while environmental factors such as nutrition and physical activities influence which genetically susceptible individuals will be affected. The spontaneous mutation rate for nuclear DNA is estimated to be 0.5% per million years. Thus, our genetic profile today is very similar to the one of our ancestors that was formed 40,000 - 50,000 years ago and shaped around their diet. During the last 150 years, there has been a substantial change in the food components included in our diet, mainly due to industrialization of agriculture and food production, increasing the intake of vegetable plants and fats [3].

Fish is considered as a cheap source of many essential nutrients especially fat and protein and hence is of value in human diet. It is highly recommended in the human diet due to its richness in two main fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These two fatty acids are polyunsaturated fatty acids. The main sources of these omega-3 PUFA rich oils are the meat of fatty fish such as sardine, herring, mackerel, menhaden, salmon, the liver of cod and the blubber of marine mammals such as seals and whales (Table-1).

Table-1: Amounts of Omega-3 Fatty acids in fish (g/100g meat) [4, 5]

Marine Sources	Omega-3 Fatty acids (EPA and DHA) (g/100g Fish Meat)
<i>Tuna</i>	0.3-1.3
<i>Rainbow Trout</i>	0.84-0.98
<i>Mackerel</i>	1.3 - 2.0
<i>Halibut</i>	0.7 - 1.3
<i>Salmon</i>	1.3-2.2
<i>Sword Fish</i>	1.14
<i>Green Shell/Lipped Mussels</i>	1.12
<i>Tile Fish</i>	1.06
<i>Shark</i>	0.98
<i>Sardine / Herring</i>	1.5-2.4

Fish lipids/oil consists of triglycerides, phospholipids, fatty acids, wax esters, sterols, other minor compounds like glyceryl esters, glycolipids, hydrocarbons like squalene, sulpholipids etc., phospholipids and sterols are structural components in cell membrane while other lipids act as energy stores and are important for maintaining buoyancy. The fatty acids compositions of fish lipids are more complex with mainly monounsaturated fatty acids (MUFA) along with polyunsaturated fatty acids (PUFA) and some saturated fatty acids in different proportions. PUFAs are mainly contributed by omega-5 and omega-3 fatty acids with former being high in fresh water fishes and the latter being the major contributors in marine fishes. The omega-3 fatty acids which are important in human nutrition are α -linolenic acid (18:3 ALA), Eicosa Pentaenoic acid (20:5 EPA) and Docosahexaenoic acid (22:6 DHA). The term omega-3 has been derived as the first double bond appear at the third carbon-carbon chain from methyl end.

The oil of some species of sharks especially deep sea sharks have high squalene content of about 90% and it has many pharmaceutical as well as cosmetic applications. Central Institute of Fisheries technology (ICAR-CIFT) has been developed methods of extraction, isolation and purification of squalene from *Centrophorus sp.* ICAR-CIFT has also developed the technology for extraction of Poly Unsaturated Fatty Acids (PUFA) from fish oil, thus

making a very important contribution towards nutritional security [6].

Omega-3 fatty acids are used as dietary supplements in the liquid or capsule form. Different forms like omega-3 concentrated oil, shark liver oil and cod liver oil are readily available in the market under different brands. The liver oils are often consumed not only due to their richness in omega-3 component but also associated vitamins like A and D. The significance of these oils has created a wide market demand and hence they are used for fortifying bakery products, dairy products such as milk, yogurt and juice, infant formulas etc.

Omega-3 fatty acids are dietary fibres having an array of health benefits. They are essential for various metabolic processes, form structural component to the cell membrane, essential for foetal development and is found abundant in brain and retina. Recent investigations conducted on omega-3 fatty acids has gained more recognition to seafood on account of the health benefit they provide and this is regarded to be one of the most promising development in human nutrition. EPA and DHA are precursors for several metabolites which are potential mediators beneficial for the prevention and treatment of numerous diseases. Studies revealed the role of long chain omega-3 PUFAs is the treatment of cardiovascular diseases, hypertension, diabetes, arthritis, depression, migraines, skin

diseases like psoriasis, eczema and other inflammatory and autoimmune disorders as well as cancer [7].

Omega-3 fatty acids and Cardiovascular Disease

Cardiovascular disease (CVD) refers to the health disorder associated with heart and related circulatory system. It is a prominent disease in the modern world and is mainly associated with the intake of fat rich in saturated and trans-components. Chronic inflammation is thought to be the cause of many chronic diseases; including CVDs. CVDs are associated with the narrowing of large arteries with atheromatous plaques, or the total occlusion of coronary arteries (thrombosis) caused by atheromatous blockages leading to myocardial tissue necrosis. Both conditions reduce the heart's ability to pump blood and can result in either chronic or sudden heart failure. It is becoming apparent that regular consumption of fatty fish or fish oil lowers the rate of incidence and deaths from cardiovascular disease. The cardioprotective effects of n-3 fatty acids in the combined effect of increased heart rate variability, reduced atheroma development and decreases platelet aggregation. In simple terms, omega-3 fatty acids decrease the platelet aggregation leading to a modest prolongation of bleeding time. Apart from these benefits, omega-3 fatty acid intake results in changes in blood lipid levels. It was observed to reduce the serum triglyceride concentration by 30% with associated increase in HDL (Good Cholesterol). This HDL increase reduces the risk of heart diseases [8, 5]. USFDA had given a qualified health claim status to EPA and DHA on coronary heart disease due to the curative effect they provide. The American Heart Association recommends one gram of EPA/DHA per day for patients with coronary heart disease [9].

Omega-3 fatty acids and Cancer

Cancer is one of the most threatening lifestyle disease having wide spread occurrence irrespective of the generation. Several studies have reported possible anticancer effect of omega-3 fatty acids particularly in breasts, colon and prostate cancer. Omega-3 fatty acids were found to reduce the tumour growth as well as slowed histopathological progression. Experimental and epidemiological studies suggested anti-tumour effects of n-3 fatty acids during the initiation and post initiation stages of colon carcinoma. Studies carried out in Sweden showed an inverse association between fatty fish consumption and prostate cancer. Similarly studies conducted in America population also revealed that long term consumption of fish meat and omega-3 fatty acids slowed down the progression of prostate cancer. Few epidemiological studies assessed on the effect of dietary n-3 fatty acids and breast cancer showed their protective

effects against breast cancer risk by inhibition breast carcinoma development by influencing the biochemical events that follow tumour initiation [10].

Omega-3 fatty acids and Inflammatory Diseases

EPA and DHA have anti-inflammatory effect and a role in oxidative stress and to improve cellular function through changes in gene expression. Inflammatory Bowel Disease (IBD) is a general term for chronic inflammatory disease of the GI tract which includes ulcerative colitis and Crohn's disease. Crohn's disease can affect the small intestine and large intestine, mouth, oesophagus, stomach and the anus whereas ulcerative colitis primarily affects the colon and the rectum. Studies using animal models provide strong evidence for the protective effects of omega-3 fatty acids against induced IBD. Similarly individuals having lower intake of omega-6/omega-3 ratios were 21% less likely to suffer from Crohn's disease.

In vitro and human studies suggest that omega-3 fatty acids serve as effective therapeutic agents for the management of inflammatory arthritic diseases. Comparative studies carried out between population having different fish oil consumption pattern revealed that diet rich in fish oil have an improvement in the number of tender joints when examined physically while some reports revealed improvement in Ritchie Articular Index (measure of joint tenderness) and in morning stiffness [11].

Omega-3 fatty acids in Mental health and Neural Function

Human nervous system has the highest lipid content compared to all other tissues excluding adipose tissue. 50-60% of the total dry weight of adult human is lipid and one third being omega-3 PUFAs; mostly DHA. Incorporation of DHA into graving neurons is a prerequisite for synaptogenesis. The Canadian Government has reported that DHA have a biological role supporting the normal development of brain, eyes and nerves. Omega-3 PUFAs are known to have membrane-enhancing capabilities in brain cells which are explained to be due to the major role played by them in fortification of the myelin sheaths and are also found beneficial in repairing brain damage by promoting neuronal growth [8].

Epidemiological and clinical studies suggest inverse relation between omega-3 PUFA consumption and depression. Change of traditional seafood to processed foods increase decline in mental health characterized by increased depression. A population survey carried out in the adults of Finland revealed that depression is more prevalent among infrequent fish consumers. Since

depression is linked to pro-inflammatory cytokines, beneficial effect of omega-3 PUFAs may be through modulation of pro-inflammatory eicosanoid and cytokine production.

Omega-3 fatty acids for Foetal Development

Supplementing with EPA and DHA in the diet during pregnancy is associated with multiple benefits for the foetal development. Deficiency of DHA during prenatal development increases likelihood of diminished visual activity, cerebellar dysfunction, cognitive impairment and neurological disorders. As per US Department of Health and Human Service Dietary Guidelines 2010 it is recommended that pregnant and breastfeeding mothers should consume about 8-12 ounces of seafood per week from a variety of seafood sources which accounts to nearly 300-900 mg EPA and DHA per day. This is found to be essential for the growth and development of the foetus. Omega-3 supplementation during pregnancy is also associated with longer gestation period and increase in concentration of EPA and DHA in foetal tissue. This is very important as prematurity is the cause of various infant diseases and can even lead to death. Some other reports suggest that mothers using omega-3 fatty acids rich diets during pregnancy and breast feeding may protect their children against allergies which may be due to the fact that fish oil supplementation leads to decreased levels of body cell associated with inflammation and immune responses [12].

Omega-3 fatty acids as Skin care

Dietary consumption of fish oils rich in omega-3 fatty acids are known to adjust the balance of lipid inflammatory mediators thereby important in the treatment of inflammatory skin disorders. Excessive exposure to UV light is associated with many undesirable skin alterations. Increased exposure to sunlight also increases the likelihood of non-melanoma skin cancer. Studies have shown that dietary supplementation with omega-3 PUFAs provides photo protection by being effective against UV-irradiation induced damage [13].

Psoriasis is a common skin disorder characterized by epidermal hyperproliferation and cutaneous inflammation. Severity varies from small localized area to whole body. Researchers carried out suggested that an increase in the dietary intake of fish oil and a reduction in the intake of food rich in arachidonic acid (omega-6 fatty acid) would be beneficial treatment to counteract the exaggerated inflammation in psoriasis.

Recommended Daily Intake of EPA and DHA

To create awareness to the modern population on the importance of omega-3 fatty acids,

guidelines have been established concerning their recommended daily intake. WHO and North Atlantic Treaty Organization together with a number of countries viz., Canada, Sweden, UK, Australia and Japan have made dietary recommendation for omega-3 fatty acids as 0.3-0.5 g/day of EPA and DHA. United States have recommended a daily intake of 0.65g per day for EPA and DHA whereas British Nutrition Foundation Task Force advised a daily intake of 0.5-1.0g of long chain omega-3 PUFAs which they suggest can be achieved through the consumption of an intake equivalent to 1-2 portions of oily fish per week.

CONCLUSION

In general one can say, "you are what you eat". What we eat is important both for our physical and mental health. Present life style demands more attention towards health foods on account of the aggravating health problems being generated. The ill effects of chronic diseases like cardiovascular diseases, inflammatory conditions etc. can be reduced by regular consumption of sea-foods which are rich sources of omega-3 fatty acids like EPA and DHA. Hence more awareness on the importance of this healthy diet needs to be created for the betterment of the society. In this context it is important for the humanity to have best nutrition and this comes from eating fishes. Fish is not only the main source of protein and fat but also has other qualities that make it very valuable as a human food item.

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