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The Beneficial Effect of Fish Oil on Human Health

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Abstract—*Fishes are rich sources of different types of nutrients. Some species are found in marine water; on the other hand some varieties are available in fresh water. Consumption of fish is very beneficial to the health and development of the human body and fish becomes an integral part of the food culture of populations in many countries. They provide essential nutrients to the human. Fish or fish oil contains omega-3 polyunsaturated fatty acids (PUFAs) that appear to play several useful roles for human health. Omega-3 FAs have unlimited usages, and they are considered as omnipotent since they may benefit heart health, improve brain function, reduces cancer risks and improves people's moods. Omega-3 FAs also have several important biological effects on a range of cellular functions that may decrease the onset of heart diseases and reduce mortality among patients with coronary heart disease, possibly by stabilizing the heart's rhythm and by reducing blood clotting. Consumption of 1.0g fish oil daily will help the human being to combat the coronary heart disease. In this studies have described the beneficial roles of Omega-3 FAs in cardiovascular diseases (CVDs), cancer, diabetes, and other conditions, including inflammation. Studies aimed at finding superior combinative effects of fish oil and bio-active compounds, along with their mechanisms of action, may eventually lead to reductions in the mortality and morbidity rates associated with human health disorders and complications that are of growing concern in modern society.*

1. INTRODUCTION

Fish are an important source of protein, and their importance in the diet has increased among health-conscious peoples. Fishing is a popular pastime, and for many, provides protein not otherwise available [1-4]. Consumption of fish is very beneficial to the health and development of the human body and fish becomes an integral part of the food culture of populations in many countries. Fish or fish oil contains omega-3(ω−3) polyunsaturated fatty acids (PUFAs) that appear to play several useful roles for human health. Essential fatty acids (EFAs) are one type of fatty acids. They cannot be de novo synthesized within our body. Because our body lack the enzymes required to make certain fatty acids so they must be acquired through the diet from plant or animal sources. But they are very essential for us as they are involved in important biological processes. Essential fatty acids are polyunsaturated and grouped into two families, the omega-6 (ω−6) EFAs and the omega-3 (ω−3) EFAs. The body can convert one ω−3 to another ω− 3, for example, but cannot create a ω−3 from ω−6 or saturated fats. Essential fatty acids so named because without them we cannot survive. The structure of PUFAs including omega-3 PUFAs—namely, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)—are shown in (see Table 1). EPA and DHA were actually highly beneficial. Fish oil has numerous beneficial effects to human body. It prevents atherosclerosis, angina, heart attack, congestive heart failure, arrhythmias, stroke, and peripheral vascular disease. Clinical trials have shown that it is also effective in the treatment of many disorders including rheumatoid arthritis, diabetes, cancer etc [5].

The objective of this article is to evaluate the beneficial health effect to fish consumption.

2. OMEGA-3 FATTY ACIDS

Omega-3 fatty acids (FAs) are considered important fatty acids, because they are vital for normal metabolism [6]. DHA, the most abundant Omega-3 FAs in most tissues, is in higher concentration in the myocardium, retina, and brain, and is essential for proper functioning of these tissues and growth [7-8]. Different classes of lipids in the body contain Omega-3 FAs. For instance, EPA is found in cholesterol esters, triglycerides, and phospholipids, whereas DHA is existed mostly in phospholipids [9].

The human body can convert about 5 % of a-linolenic acid to EPA; the blood level of EPA is not witnessed to be raised during the consumption of a-linolenic acid [10] because humans lack the D12- and D15- desaturases enzymes necessary to insert a double bond at the Omega-3 of an FA carbon chain [11]. The dietary intake of Omega-3 FAs in the recent report of the Food and Agriculture Organization (FAO) has recommended a dose of 0.250 gm/day of EPA plus DHA for adult males and non-pregnant/non-lactating adult females, but with insufficient evidence to set a specific minimum intake of either EPA or DHA alone [12]. The upper value of acceptable macronutrient distribution range for EPA plus DHA consumption has been set at 2 gm/day due to experimental evidence indicating that high supplement intakes of Omega-3 FAs could increase lipid peroxidation and reduce cytokine production [13].

3. BIO-CHEMISTRY OF PUFA

As fish oil contains ω-3 and ω-6 types of fatty acids, the mechanism of action of fish oil reflects the action of these EFA. Both must be obtained through the diet because they are

not synthesized de novo by vertebrates. Both types can support important physiological and developmental processes. They can form eicosanoids i.e prostaglandins, leukotrienes, lipoxins, etc. These ω-3 and ω-6 fatty acids can be esterified. and hydrolyzed from tissue glycerolipids, and can be metabolically elongated and desaturated to a variety of highly unsaturated fatty acids [14].The conversion occurs slowly. There is a competition between alpha lenolenic acids and linoleic acids. Linoleic acids of high level inhibit conversion of alpha lenolenic to its long chain derrivatives. These longer chain fatty acids are very important. Because they are precursors of eicosanoids. Eicosanoids have wide range of functions including ability to influence platelet aggregation, blood pressure, blood clotting, inflammation etc. Eicosanoids from ω-3 fatty acids are less potent than ω-6 fatty acids in case of producing inflammation, platelet aggregation. ω-3 and ω-6 fatty acids being a component of cell membrane compete with each other for incorporation into it. As there is a competition between both of the family of fatty acids there must be a proper balance of their intake.

4. MECHANISM OF ACTION OF THE ESSENTIAL FATTY ACIDS

(See table 2) lists the biochemical actions of the key members of the n-6 and n-3 classes of essential fatty acids. The need for arachi- donic acid (20:4n-6) ahnost certainly is the primary reason why n-6 PUFA are essential. Arachidonic acid is the main sub- strate for synthesis of the eicosanoid mediators produced by the cyclooxygenase, lipoxygenase, and cytochrome P450 pathways [15], and it is highly enriched in the inositol phospho- ipids that are involved in signal transduction [16]. Linoleic acid (18:2n-6) also probably is essential because it is utilized for the synthesis of the complex lipids that form the permeability barrier of the epidermis [17]. The biochemical reason that the n-3 PUFA are essential is not presently known. In fact, it is not certain whether EPA, DHA or both can 3, out the essential biochemical functions. Like arachidonic acid, EPA (20:5n-3) is a substrate for eicosanoid synthesis [18], and EPA competes with arachidonic acid for the same meta- bolic pathways [19-20]. However, no requirement for the eicosanoids produced from EPA has so far been demonstrated, and very little EPA is present in the tissues of individuals who consumethe usual Western diet. Therefore, competition with arachidonic acid seems improbable unless an individual is consuming supplemental amounts of EPA. Under ordinary conditions, DHA (22:6n-3) is the most abundant n-3 PUFA contained in the tissues, especially in the brain and retina. For this reason, it seems more likely that DHA rather than EPA is the essential n-3 component.

5. BENEFITS OF CONSUMPTION OF FISH OIL

Fish oil supplements have numerous benefits over consuming fish directly. Fish oil can be consumed by eating the fish directly or by drinking fish oil which is often available in the form of supplements such as tablets, capsules, pills, soft gels, etc. Some of the benefits of fish oil are listed here: [21]

- Regular consumption of fish oil may lead to reduction of anti-oxidants such as vitamin E in the body. Certain fish oil supplements help us to tackle this problem as they contain added vitamin E in them.
- Sometimes, in severe cases, when we require large dosage of fish oil for treatment and try to take the fish oil by eating fish; we will have to eat a lot of fish. Fish oil supplements provide us this convenience as they contain fatty acid in a concentrated form.
- Fish oil supplements are very handy. If we want to consume fish oil daily, we just have to open up the jar, pick a tablet and gulp it. Cooking fish, on the other hand, daily becomes very troublesome. [21]

5.1 Nutritional benefits

The nutritional benefits of fish consumption are due to the presence of proteins of high biological value, unsaturated essential fatty acids, minerals (calcium, iron, selenium, zinc, etc.), and vitamins, namely A, B3 (nicotinamide), B6 (pyridoxine), B12 (cobalamine), E (dtocopherol), and D in fish tissues. The functions and metabolism of the above-mentioned nutrients are well described in nutrition and biochemistry text books, and therefore will not be described here. [22]

5.2 Cardiovascular diseases

The strongest and most established body of science for the marine Omega-3 FAs is in relation to cardiovascular health. In addition to a lower risk of cardiovascular disease (CVD) risk, research has also linked Omega-3 FAs to improved heart rhythms, and a reduced risk of a second heart attack [23]. Fish oil, which is abundant in ω-3 fatty acids, therefore, reduces the risk of heart diseases and heart arrhythmias. It helps to maintain the elasticity of artery walls, prevent blood clotting, reduce blood pressure, stabilize heart rhythm and help combat inflammation. It lowers the levels of low-density lipoprotein (LDL) cholesterol, which is bad cholesterol, and increases the high-density lipoprotein (HDL) levels, which is good cholesterol. Fish oil prevents accumulation of triglycerides and further reduces the levels of excess triglycerides. Arachidonic acid derived from silver carp has pronounced effect on blood pressure, serum lipid and platelet functions [24].Thus fish oil can be used for preventing atherosclerosis in coronary patients and also effective in treating heart strokes and regular usage of fish oil can help avoid numerous sudden cardiac deaths. [25]

5.3 Depression

By year of 2020, depressive disorder will be the second leading cause of disability worldwide and first in developing countries based on World Health Organization (WHO) report [26].Based on the epidemiologic studies, societies with a high

consumption of fish, which contains high amounts of PUFAs, appear to have a lower prevalence of major depressive disorder. [27]

5.4 Diabetes

Fish oil intake has been associated with a low incidence of diabetes mellitus [28-29]. Omega-3 PUFAs appear to improve many metabolic squelae of insulin resistance in humans by lowering hypertension and plasma triglycerides. [30]

5.5 Cancer

There is experimental evidence that n-6 PUFAs via eicosanoid production may increase breast cancer invasion and metastasis, and omega-3 PUFAs may suppress these effects [31]. In other experimental studies, it appeared that omega-3 PUFAs may retard the progression of prostate cancer [32-33]. Further research work is needed to validate these findings.

5.6 Reproductive system

Omega-3 PUFAs may have specific health benefits for pregnant women. These fatty acids may also be important for optimal prenatal and postnatal development [34]. It appears that the onset of labor is affected by the prostaglandins made in vivo from dietary omega-6 and omega-3 PUFAs. The metabolism of eicosapentaenoic acid (EPA), an omega-3 PUFA, is important for in vivo production of these prostaglandins [34]. In a survey of 12,000 women, Denmark scientists found that placental weight, head circumference, and birth weight of babies increased with increasing weekly consumption of fish [34-35] Premature babies required a supply of DHA and arachidonic acid (AA), because they cannot make their own [36]. It had been shown that without dietary DHA and AA supply either from breast milk or from supplemented formulas, the premature babies were unlikely to continue to build their brains, eyes, and nerves in the way their genetic blue print was set up [34,36].

5.7 Inflammation

Fish oil has anti inflammatory properties; therefore, it is effective in reducing inflammation in blood and tissues. Regular consumption of fish oil supplements, tablets, pills and capsules is helpful to those suffering from chronic inflammatory diseases. Fish oil is effective in treating gastrointestinal disorders, sprue, short bowel syndrome and inflammatory bowel disease (IBD) including Crohn's Disease and ulcerative colitis, which are typical disorders of the intestine. Patients suffering from Crohn's disease find it difficult to absorb vitamins, fats and essential supplements. Fish oil supplements are an effective diet for such patients. In ulcerative colitis, fish oil prevents the accumulation of leukotriene on the colon. It should be noted that the anti inflammatory properties of fish oil are limited to reducing inflammation. Fish oil provides little effect in preventing inflammation. Research is also being conducted to enhance the anti-inflammatory action of fish oil by addition of other dietary supplements and drugs. [21]

5.8 Arthritis

Fish oil is useful in treating arthritis, rheumatism [37] Raynaud's symptoms and similar conditions. In case of osteoarthritis, fish oil can be helpful in reducing the impact of enzymes that destroy cartilages. ω-3 fatty acid suppresses the production of inflammatory eicosanoids. So they are able to reduce pain.

1.1. Development of Nervous system (brain)

Our current understanding of the importance of omega-3 PUFAs in neurological development and physiological functions of the brain was obtained from the studies of the effects of restricted availability of omega-3 essential fatty acids in experimental animals and human infants [34]. Results of such studies point out that optimal neurological development and physiological functions of the brain are dependent on adequate incorporation of docosahexaenoic acid during specific periods of neural membrane maturation [34].

1.2. Photoreception system (vision)

The major physiological effects of decreased availability of DHA on photoreception appear to be impaired electroretinogram responses and decreased visual acuity [34].

2. Source and Requirement:

Fish are the major food source of EPA and DHA (See table 3). [38] All fish contain EPA and DHA; however, the quantities vary among species and within a species according to environmental variables such as diet and whether fish are wild or farm-raised. Farm-raised catfish tend to have less EPA and DHA than do wild catfish, whereas farm-raised salmon and trout contain similar amounts versus their wild counterparts. Although taking fish oil supplements gives many health benefits to the body, wrong dosage of such can also have harmful effects. The American Heart Association recommends the consumption of 1g of fish oil daily, preferably by eating fish, for patients with coronary heart disease. Optimal dosage relates to body weight.

3. Conclusion

Fish oil has a number of beneficial effects. Fish oil is an excellent and usually uncontaminated source of Omega-3 FAs. Omega-3 FAs are essential dietary requirements that are used in preventing and treating many health conditions. In previous review studies, Omega-3 FAs have used in

CVDs, diabetes, cancer, depression, inflammation and many other conditions. Eating a modest amount of fish oil ensures a direct supply of EPA and DHA. So in conclusion we must say that fish oil is highly beneficial Consumption of 1.0g fish oil daily will help the human being to combat the coronary heart disease. Fish oil supplements are generally safe. But the processing and packaging of the fish oil is very crucial.

Table 1 Polyunsaturated fatty acids

Name	Number of carbons	Number of double bonds	Symbol
Linoleic	18	2	18:2, n-6
c-Linolenic	18	3	18:3, n-6
a-Linolenic	18	3	18:3, n-3
Arachidonic	20	4	20:4, n-6
Eicosapentaenoic	20	5	20:5, n-3
Docosahexaenoic	22	6	22:6, n-3a

Table 2 Biochemical Functions of the n-6 and n-3 Fatty Acids

Class	Fatty acid	Function
n-6	Arachidonic	Eicosanoid synthesis Component of the inositol phospholipids
n-6	Linoleic	Synthesis of lipids that form the epidermal permeability barrier
n-3	Eicosapentaenoic	Eicosanoid synthesis Structural analog and competitor of arachidonic acid
n-3	Docosahexaenoic	Structure of membrane lipid domains Modulation of integral membrane proteins Metabolism of phosphatidylethanolamine, ethanolamine plasmalogens, and phosphatidylserine Formation of free radicals Regulation of gene expression

Table 3 Amounts of EPA_DHA in Fish and Fish Oils and the Amount of Fish Consumption required providing _1 g of EPA_DHA per Day

Fish	EPA_DHA Content, g/3-oz Serving Fish (Edible Portion) or g/g Oil	Amount Required to Provide _1 g of EPA_DHA per Day, oz (Fish) or g (Oil)
Tuna		
Light, canned in water, drain	0.26	12
White, canned in water, drained	0.73	4
Fresh	0.24–1.28	2.5–12
Sardines	0.98–1.70	2–3
Salmon		
Chum	0.68	4.5
Sockeye	0.68	4.5
Pink	1.09	2.5
Chinook	1.48	2
Atlantic, farmed	1.09–1.83	1.5–2.5
Atlantic, wild	0.9–1.56	2–3.5
Mackerel	0.34–1.57	2–8.5
Herring		
Pacific	1.81	1.5
Atlantic	1.71	2
Trout, rainbow		
Farmed	0.98	3
Wild	0.84	3.5
Halibut	0.4–1.0	3–7.5
Cod		
Pacific	0.13	23
Atlantic	0.24	12.5
Haddock	0.2	15
Catfish		
Farmed	0.15	20
Wild	0.2	15

Data from the USDA Nutrient Data Laboratory. [38]

The intakes of fish given above are very rough estimates because oil content can vary markedly (_300%) with species, season, diet, and packaging and cooking methods.

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