

PUFA's in Fish- Imperative Demand for Health Benefits

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SUMMARY

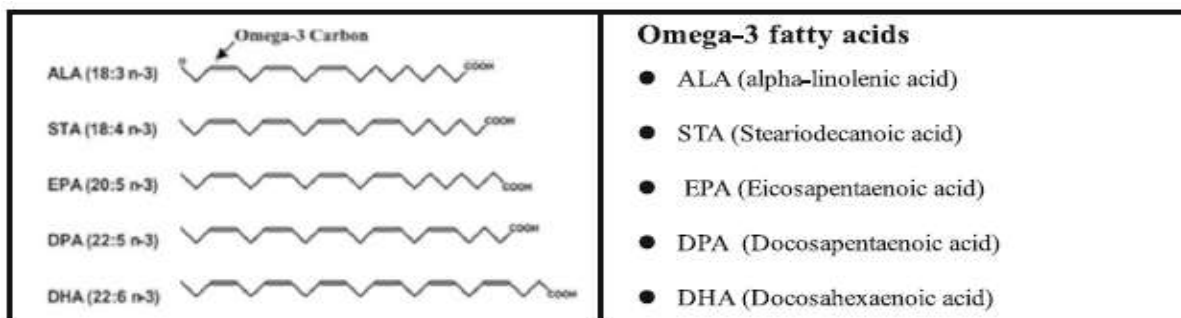
In many industrialized nations, fatty acids account for 30–35% of total energy intake. The most significant dietary sources of fatty acids include vegetable oils, dairy products, meat products, grains, and fatty fish or fish oils. Unsaturated fatty acids (UFAs) are divided into two groups such as polyunsaturated fatty acids (PUFAs), which have more than one double bond in their backbone, and monounsaturated fatty acids (MUFAs), which have just one double bond (e.g., omega-3 and -9 fats). Hence, polyunsaturated fatty acids (PUFA) have several unsaturations in each of their molecules, they may have positive health effects. ω -3 PUFAs are exclusively found in aquatic organisms and mainly originate in the liver of lean white fish such as cod and halibut, the body of oily fish such as mackerel and salmon, and the blubber of marine mammals such as seals and whale. Dietary polyunsaturated fatty acids (PUFA) affect a variety of physiological functions that have an impact on chronic diseases, including the control of plasma lipid levels, immunological, cardiovascular, and brain function, as well as insulin action.

INTRODUCTION

The world will produce over 176 million metric ton of fat and oil in the 2010- 2011 crop year. Among these 1 million metric ton of fish oil will be produced during that same period. Generally, fish contains 2-30% fat. The most common fatty acids in fish oil are grouped in three categories Saturated, monounsaturated and polyunsaturated fatty acids. The fish oil consists of two main poly unsaturated fatty acids, eicosapentaenoic acid (EPA 5 -26%] and docosahexaenoic acid (DHA 6 -26%]. The nutritional benefits of fish stems for the most part, from its exceptionally advantageous fatty acid profile. In recent years increasing attention has been focused on significance of n-3 polyunsaturated fatty acids (PUFAs) in human nutrition, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Although PUFA composition vary among different fish species of both freshwater and marine origins, it is important for human health to increase the consumption of fish and its products, which are rich in n-3 PUFA and poor in n-6 PUFA series. The lipid content and fatty acid profile of fish vary between and with species even in dark and white muscle, which are affected by many factors such as the temperature, salinity, season, size, age, species habitat, life stage, and the type and abundance of food, especially whether a species is herbivorous, omnivorous or carnivorous.

Polyunsaturated Fatty Acids (PUFA)

Fatty acids consist of a hydrocarbon chain (CH₂) or with an acid or carboxyl group (COOH) at one end and a methyl group at the other. Fatty acids are classified as saturated or unsaturated, depending on the number of hydrogen atoms present. Saturated fats have the maximum number of hydrogen atoms and therefore no double bonds, while polyunsaturated fatty acids contain two or more double bonds. The group of polyunsaturated fatty acids termed as omega-3 (abbreviated as w3 or n-3) fatty acids are distinguished by having the first double bond positioned on the third carbon atom from the methyl or N terminal end of fatty acid chain (Nettleton, 1995). The major varieties of PUFAs are n-3 PUFAs such as DHA (C₂₂: 6 n-3), EPA (C₂₀: 5 n-3) and n-6 PUFAs such as arachidonic acid (AA, C₂₀: 4n-6).



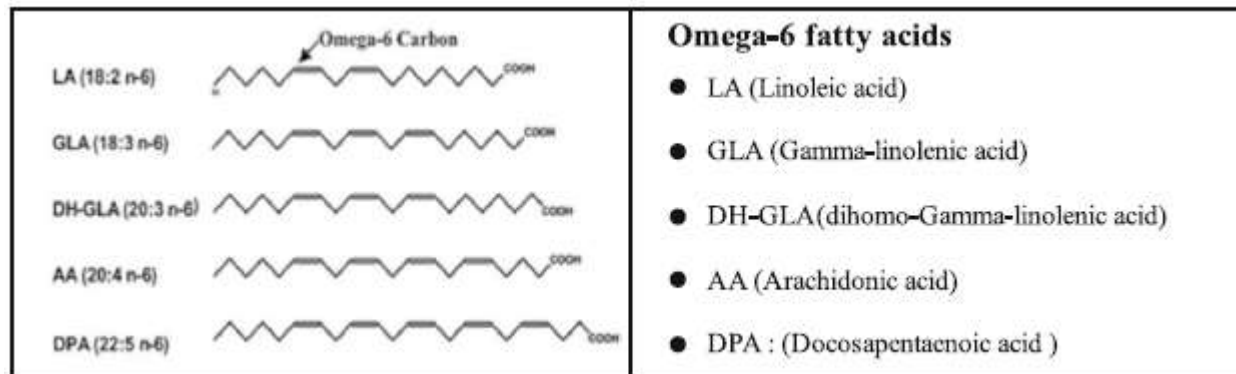


Fig 1. Structures of the omega-3 and omega-6 fatty acids

Table 1. Health benefits of PUFA

Fatty acid	Health Importance	Dietary Source	Microbial Source
GLA	Precursor for LC-PUFA, anti-inflammatory molecules, Treatment of rheumatoid arthritis inflammatory disorders, eczema, multiple sclerosis, chronic fatigue syndrome	Plants Evening primrose. Borage, Black currant	<i>Mucor spp.</i> , <i>Mortierella spp.</i> , <i>Cunninghumella japonica</i> , <i>Cunninghumella ezhinulaia</i> , <i>Thamniditon elegans</i> , <i>Gilberteiia persieara</i> ,
DGLA	Precursor for anti-inflammatory molecules	Human Milk, Animal tissue, Fish: <i>Scomber scrombus</i> , Moss : <i>Pogunatum</i>	<i>Mortierella alpina</i> Mutant forms
ARA	Precursor for prostaglandins Throtaboxane, Leucotrienes, Muscle development	Animal tissue, Fish: Brevoortia, aupea mosses	<i>Mortierella alpine CCF185</i> , <i>Porphyridium creuenium</i> , <i>Sargassum salicifolioium</i> <i>Euglena gracilis</i>
EPA	Reduces the ADHD symptoms,-anti-depression, (CVD) heart disease required for brain development	Fish herring henhaden, Shelfish blurcrab, oyster, lobster, mussel	<i>Mortierella spp.</i> , <i>Pythium Saprolegnia sp Shewanella violacea</i> <i>DSS12</i> , <i>Pseudomonas spp</i> <i>Vibrio spp.</i>
DHA	Decreases incidence of CHD, maintains heart health, required for brain development. neurotransmission	Fish- tuna, herring, cod, sardine, salmon, Shelfish; blurcrab, oyster, lobster, mussel	<i>Thraustochytriurn aureum</i> , <i>T. roseum</i> , <i>Schychitrium SR21</i> , <i>S. aggregatum</i> , <i>Aplanochytrium</i> , <i>Cryptocohidium cohinni</i> , <i>Ulkenia</i> ,, <i>Gyrodinium nelsonii</i> <i>Labyrinthuloides</i> , <i>Japonochytrium</i> , <i>Thraustochytriurn</i>

Sources of omega-3 fatty acids in fresh fish

The highest concentrations of the critical omega-3 PUFAs, EPA and DHA, are found in cold-water fish such as salmon, mackerel, halibut, sardines, tuna, and herring. Other sources of omega-3 fatty acids include krill oils and algae. Algae are the greatest source of EPA and DHA.

Grams of omega-3 fatty acids per 3oz (85g) serving of popular fish.

Swordfish	0.97
Greenshell/lipped mussels	0.95

Grams of omega-3 fatty acids per 3oz (85g) serving of popular fish.

Cod	0.15–0.24
Catfish	0.22–0.3
Grouper	0.23
Red snapper	0.29
Shark	0.83
King mackerel	0.36

Table 2. Sources of EPA and DH

Food	Serving	EPA (g)	DHA (g)
Herring, Pacific, cooked	3 ounces	1.06	0.75
Salmon, chinook, cooked	3 ounces	0.86	0.62
Oysters, Pacific, cooked	3 ounces	0.75	0.43
Tuna, white, packed in water	3 ounces	0.20	0.54
Crab, dungeness, cooked	3 ounces	0.24	0.10
Shrimp, cooked	3 ounces	0.15	0.12
Fish oil, salmon	1 gram	0.13	0.18

Table 3. EPA and DHA content in several common fish oils

Oil sources	EPA	DHA
Anchovy	9.0-18.2	8.7-13.0
Sardine	12.4-14.5	9.8-12.5
Mackerel	6.1 5.7	7.0-8.7
Halibut (wild)	12.2	25.4
Tuna	4.6	18.3

The EPA and DHA content of several common fish oils. Among them halibut, tuna, and mackerel oils showed higher DHA levels than their EPA levels. On the other hand, anchovy and sardine showed higher EPA levels than their DHA levels. The highest level of DHA (25%) and EPA (9.0 - 18.2%) were recorded in halibut and anchovy respectively. Currently fish oil is mainly a byproduct of fish meal and species used for fish oil production are not necessarily the richest in n-3 PUFAs. Most often oil is extracted from three categories of fish: species caught primarily for fish meal production, surplus of fish caught primarily for human consumption, and non-food grade fish. The manufacturers of fish oil supplements usually blend different sources of fish oil together to get a desired ratio of DHA and EPA. Fish oil capsules may contain 20 to 80% of EPA and DHA by weight, little or no mercury and variable levels of polychlorinated biphenyls (PCBs) and dioxins. The most common fish oil capsules in the United States provide 180 mg of EPA and 120mg of DHA per capsule. So, depending upon preparation up to three 1 g fish oil capsule per day may be necessary to provide 1g/d of n-3 PUFAs.

Extraction of PUFA from sardine waste

Sardine the important industrial fish, discharged considerable amount of wastes. These wastes include the head, liver and intestine. The predominant fatty acids in sardine wastes were palmitic(C16:0; 27.80- 35.56 %), stearic (C18:0; 5.90- 9.30 %), oleic (C18:1c; 15.47- 21.79 %) and docosaheaxaenoic acid (DHA; C22:6; 11.87- 15.95 %).

Lipid Extraction

The procedure for the lipid extraction was based on modified Kinsella method. About 50 g of fish wastes were selected randomly and homogenized in a warring blender for 2 min with a mixture of 50 ml chloroform and 100 ml methanol. One volume of chloroform (50 ml) and one volume of distilled water (50 ml) were added to the mixture and blended for 30 sec, respectively. The homogenate was filtered through a What man

No.1 filter paper on a No.3 Buchner funnel with a slight suction and the filtrate collected and transferred to a separatory funnel to allow for phase separation. The lower fraction was collected and filtered. It was then transferred to a rotary evaporator for evaporation. The sample was then collected for the fatty acid analysis.

PUFA extracted from tuna waste

Thailand has become the world largest exporter of canned tuna largest importer of fresh and frozen tuna. Tuna processing produced 30 – 35 % of product yield, 20 – 35 % of solid waste. Smoked fish processing is very traditional, and produces considerable waste. 40-60% wastes are usually dumped directly to sewage system. The highest content of total fatty acids, respectively tuna by-product, starting from the gonads (68.75%), skin (67.16%), head (64.99%) and liver (38.32%). The highest content of SFAs is palmitic acid (18.09%) recovered from the head, MUFA are oleic acid (11.96%) also recovered from the head, and PUFA are DHA (30.10%) recovered from gonad. Fatty acid content of tuna by-product generated in which the content of omega-3 fatty acids (DHA) and EPA amounted to 30.10% of 4.13%.

Health Benefits

Cancer

Several studies report possible anti-cancer effects of n-3 fatty acids found in fish oil. Among n-3 fatty acids (omega-3), neither long-chain nor short-chain forms were consistently associated with reduced breast cancer risk. High levels of Docosahexaenoic acid, however, the most abundant n-3 polyunsaturated fatty acid (omega-3) in erythrocyte membranes, were associated with a reduced risk of breast cancer.

Hypertension

There have been some human trials that have concluded that consuming omega-3 fatty acids slightly reduces blood pressure (DHA could be more effective than EPA). It is important to note that because omega-3 fatty acids can increase the risk of bleeding, a qualified healthcare provider should be consulted before supplementing with fish oil.

Pregnancy

Omega-3 polyunsaturated fatty acids (commonly found in fish oil) protect against fetal brain injury and promote fetal and infant brain health. Docosahexaenoic acid supplementation has also been found to be essential for early visual development of the baby. Omega-3 fatty acid supplementation is also beneficial to the mother. It has been shown to prevent pre-term labor and delivery.

Psoriasis

Diets supplemented with cod liver oil have shown beneficial effects on psoriasis

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