MARINE OMEGA-3 FATTY ACIDS AND THEIR HUMAN HEALTHCARE APPLICATIONS

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INTRODUCTION

Chemically polyunsaturated fatty acids (PUFA) belong to the class of simple lipids and have two or more double bonds. The location of the first double bond, counted from the methyl end of the fatty acids, is designated by the omega or n- number. Two broad categories of PUFAs that are of concern with respect to cardiovascular homeostasis are E-PUFAs (essential PUFAs) and NE-PUFAs (nonessential PUFAs). The essential PUFAs must be provided in the diet as they can't be synthesized from simple carbon precursors in mammalian organisms. The presence of a high proportion of highly polyunsaturated fatty acids-those having more than four double bonds- makes the fish oil unique in nature. While fish oils contain primarily ω-3 series of fatty acids, vegetable oils contain mainly ω-6 series of fatty acids. The most important PUFA present in fish are eicosapentaenoic acid (EPA, C20:5n-3) (**Fig 1)** and docosahexaenoic acid (DHA, C22:6n-3) (**Fig 2**). These belong to ω-3 series of fatty acids. They cannot be synthesized by the body but are needed, particularly, for the formation of the retina and of the brain. α-Linolenic acid can be converted to EPA and DHA in the human body. However, the extent of this conversion is not precisely known and, at best, very limited.

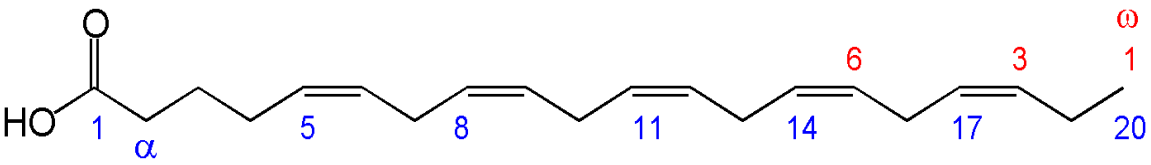

Fig 1. Chemical structure of eicosapentaenoic acid (EPA)

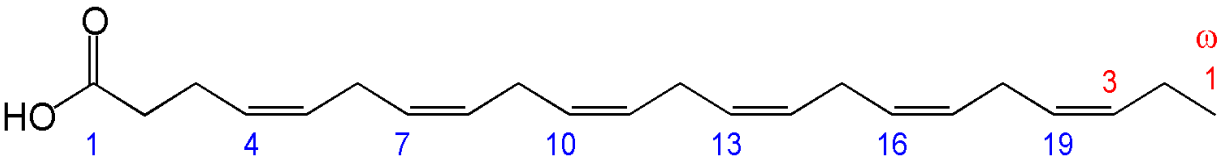

Fig 2. Chemical structure of docosahexaenoic acid (DHA)

Fish oils tend to contain relatively high concentrations of long chain n-3 PUFA of which EPA and DHA are the most prominent. Fish oil composition varies markedly depending on a variety of factors including fish species, sex and season. India is one of the largest fish oil producers and exporters in the world, it will be no wonder, if marine fish oils find a place to boost the economy of India, the country which is considered as Global Pharmaceutical Hub. The marine small pelagic Indian oil sardine, *Sardinella longiceps*, contains rich amount of *ω*-3 PUFA, DHA, and EPA (**Fig 3,4)**.

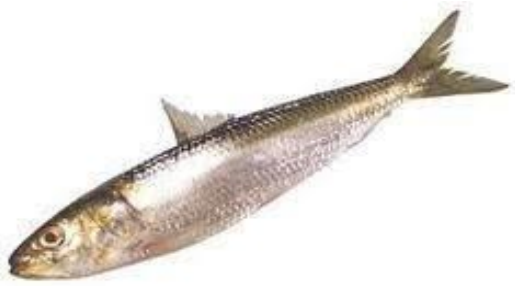

Fig 3. Indian oil sardine [*Sardinella longiceps*], marine fish rich in ω-3 PUFA

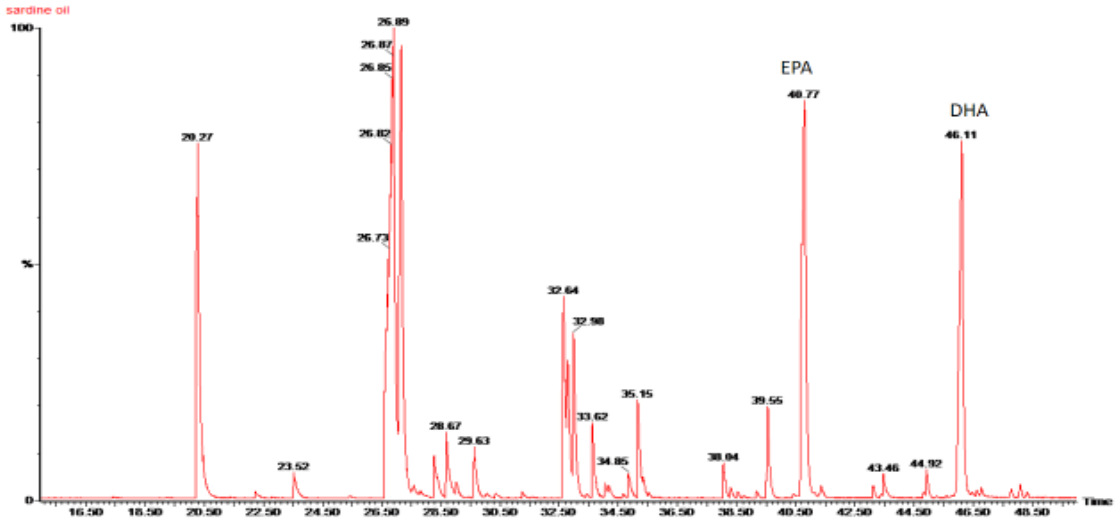

Fig 4. Gas Chromatographic Pattern of EPA and DHA in *Sardinella longiceps*

APPLICATIONS IN HUMAN HEALTHCARE

Fish and fish oils contain very-long chain and highly unsaturated n-3 PUFA such as eicosapentaenoic acid and docosahexaenoic acid, which are well known for prevention of myocardial infarction. For general cardio protection, the American Heart Association (AHA) recommends about 1 g of EPA/DHA daily for patients with known coronary heart disease. Epidemiological evidence suggests EPA and DHA appear to reduce the susceptibility of the myocardium to fatal arrhythmia. Observational studies indicate that intake of fish is associated with less fatal coronary heart disease in several populations. Fish oil consumption was inversely related with fatal coronary heart disease and sudden cardiac death -but not with non-fatal myocardial infarction- in a dose-dependent way, where each 20 g/day increase in fish intake was associated to a 7% lower risk of fatal coronary heart disease. Major beneficial effects of marine n-3 PUFAs in coronary heart disease are relating to their ability to decrease level of triglycerides, platelet reactivity, leukocyte reactivity and blood pressure and their antiarrhythmic properties.

It is possible that through similar mechanisms, EPA could prevent calcium overload in the diabetic heart, which is known to induce mitochondrial pore transition leading to cytochrome c release and cardiomyocyte apoptosis. Many trials using fish oil or PUFAs from fish oil as diet shows promising results in the area of cancer treatment. The potential of n-3 fatty acids to prevent

recurrence and metastases of mammary cancer when used in adjuvant therapy is associated with a (n-6) to (n-3) ratio < 2:1. In contrast, low α-linolenic acid (precursor of EPA and DHA) levels in mammary adipose tissue are associated with an increased risk of breast cancer in women. The consumption of diet enriched in n-3 PUFA, specifically EPA and DHA provide a significant mechanism for the prevention of human cancers. Liver disease must be one of the major causes of PUFA deficiency because long chain PUFA biosynthesis mostly occurs in the liver. PUFAs are synthesized from their essential precursors in the smooth endoplasmic reticulum, especially in the liver, by successive desaturation (i.e., oxidation with double bond formation) and elongation (i.e., lengthening of the chain with two methylene groups) reactions. PUFA deficiency is related to a number of diseases like Alzheimer's disease, Liver cirrhosis, Parkinson's disease, hypertension, cancer, diabetes, inflammatory and auto-immune disorders, depression, schizophrenia, multiple sclerosis etc. Indeed, deficits in the peripheral amounts of PUFA have been described in subjects suffering from neurological and psychiatric disorders.

CONCLUSION

The marine oils rich in ω-3 long chain polyunsaturated fatty acids, especially, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are well known to exert promising human healthcare benefits such as cardioprotective, antilipidemic, anti-inflammatory, anticancer, antiaging, antihypertensive, antidepression and antiarthritic properties. The n-3 PUFAs are promising health promoting compounds and the dietary intake can suppress the inflammation-associated health obstacles and complications related with the disease.