Available online at www.darshanpublishers.com
Volume -5; Issue - 4; Year -2018; Pages: 6-13
ISSN: 2393-8560
DOI: http://dx.doi.org/10.22192/ijcrbs.2018.05.04.002
Abbr: Int. J. Compr. Res. Biol. Sci.

International Journal of Comprehensive Research in Biological Sciences

Review Article

A REVIEW ON FISH OIL FOR HEALTHY LIVING

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Abstract

Fish is a source of protein and proteinous food are body building foods. Fish oil is the lipid fraction extracted from fish and fish by-products. Apart from the benefit derived from the consumption of fishes there are numerous other benefits to be derived from fishes due to its high nutritional content. Majority of the nutritionists recommend that human beings should eat fish every day. Regular consumption of fish can promote the defense mechanism for protection against invasion of human pathogens because fish food has antimicrobial peptide. The paper reviewed oil in fish for healthy living.

Keywords: Fish, nutritional content, antimicrobial peptide.

Introduction

Fish

Fish is a source of protein and proteinous food are body building foods. Fish oil is the lipid fraction extracted from fish and fish by-products. Apart from the benefit derived from the consumption of fishes there are numerous other benefits to be derived from fishes due to its high nutritional content.

Fish is a favorite foodstuff for the majority of societies. Fish meal contains most important nutritional components and serve as a source of energy for human beings (Ojewola and Annah, 2006; Sutharshiny and Sivashanthini, 2011). Fish is also a vitamin and mineral rich food for young as well as old people (Moghaddam *et al*., 2000 *;* *Edem* 2009).Eating fish during pregnancy may help to reduce the risk of delivery of premature baby (Olsen and Secher,2002).

Majority of the nutritionists recommend that human beings should eat fish everyday (Blanchet *et al,* 2000; Balk *et al.,* 2004). Regular consumption of fish can promote the defense mechanism for protection against invasion of human pathogens because fish food has antimicrobial peptide (Ravichandran *et al.*,2010).

Fish of various species don't provide the same nutrient profile to their consumer (Takama *et al.*, 1999) and the nutritive value of fish varies with season (Varljen *et al.*, 2003).

Moisture, dry matter, protein, lipids, vitamins and minerals are the most important components that act as a source of nutritive value of fish meat (Steffens, 2006). Quantifying the proximate composition is important in ensuring the requirements of food regulation and commercial specification (Waterman, 2000). Fish contains significantly low lipids and higher water than beef or chicken and is favoured over white or red meats. The total lipid and ash content of fish vary with the increasing weight or length of fish; it may also vary with season and varied habitats (Hassan, 1996).

Proximate body composition of fish is the analysis of water, fat, protein and ash content of the fish. Carbohydrate and non protein compounds are present in negligible amounts.

Among the proximate composition, protein in fish is the excellent source because of the amino acid composition and degree of digestibility (Louka *et al.,* 2004). Protein content which is an important component tends to vary little in healthy fishes (Hui, 2001).

Fresh Water Fish

Fish freshness is fundamental to fish quality. The state of freshness can be determined by definitive properties of fish these properties can be accessed by various indicators. Fresh water fish are the main aqua cultural products in Bayelsa. As a comparison with the marine fishes, fresh water fish usually contain higher level of C18 polyunsaturated fatty acid as well as substantial concentrations of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in addition to this, the fatty acid composition is characterized by high proportions of omega-6 PUFA, especially linoleic acid and arachidonic acid (Steffens, 1997). Just as the marine fish, the fatty acid composition of freshwater fish is markedly influenced by the lipid pattern of their natural food as pointed out by Steffens (1997) and Endinkeau and Tan (1993). Furthermore, freshwater fish can be used as a healthy diet for humans. Perhaps their nutritive quality is even better than marine fish. In addition to considerable amounts of omega-3 polyunsaturated fatty acids, freshwater fishes contain higher levels of arachidonic acid than marine species (Steffens, 1997).

Lipid content of fresh water fish

Lipids are an important component in fish and human diets, both as energy and fatty acids sources (Sargent *et al.,* 1995). Tee *et al.* (1989) has reported the composition of twenty species of freshwater fishes. The freshwater fishes studied were found to have high protein content, ranging from 15.0% to 20.6%. Most of the fishes had a fat content ranging from 1.0% to 5.0%.

Suriah *et al.* (1995) reported that most lean freshwater fish had fat content lower than 5-10%, the medium fat fish have 5-10% fat whereas the fatty fish have more than 10% fat by weight.

Frozen Fish

Fish is increasingly being traded as frozen foodstuff (39% of fish sold in the world in 2010 compared with 25% in 1980),while trading of live, fresh and chilled fish was only 10% reflecting improved logistics and increasing demand for unprocessed fish (FAO,2012a).

For Varhaecke *et al.* (2010), the success of freezing as a processing method can be explained by its ability to preserve an otherwise perishable product. Frozen fish also has some advantages over fresh fish. First, while growing demand for fish is putting up prices (Jiang, 2010) frozen fish enable consumption to be generalised at a lower price. Given the very inelastic supply of fresh fish in the short term (Barten and Battendorf 1989), the sharp rise in demand has had an effect on price. Generally speaking, on average fresh fish is priced higher in the market than frozen fish (Trondsen, 1997).Growing concern for health risks associated with fresh fish might result in a market shift towards frozen fish, as it provides

certain benefits appreciated by consumers who feel less certain about fish quality and safety (Vanhonacker *et al.,* 2010). In contrast to these positive aspects, many consumers perceive frozen fish to be of worse quality and less nutritious than fresh fish (Peavey *et al.,* 1994).

Fish Oil

Fish oil is one of the main fishery products. Fish oil is derived from the fatty tissue of an oily fish. Fish oil is the lipid fraction extracted from fish and fish by products (Adebiyi and Bawa, 2006). The need for high-quality fish oils is increasing due to growing nutraceutical markets as well as increased demand in the aquaculture industry. Fish oil is receiving a lot of attention because of the health benefits associated with the high levels of the long chain omega-3 polyunsaturated fatty acid (PUFA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Wu and Peter, 2008). According to Adebiyi and Bawa (2006) fish oil is more complex than terrestrial animal and vegetable oils. Currently, the production of fish oil is becoming more demanding as there is a sizeable and growing world market demand for high quality fish oils. The table below shows the local, common and scientific name and lipid content of fish (g/100g fillet).

Most fish oils in general are more complex than land animal oils or vegetable oil due to long chain unsaturated fatty acids. It is generally believed that fish oil odour is due to the unsaturated fatty acids since hydrogenation causes the oil to lose their colour.

The lipid is an edible part of the fish and is important to the food scientist in two respects. Firstly, any oil deposit, noticeably influence the sensation of the cooked flesh and secondly, fish oil has some medical applications. Fish oil deteriorates very rapidly due to the natural lipase and bacteria in the fat. Both of these factors hydrolyze fat to free fatty acids. The condition of the fish at the time of processing affects the oil physically, chemically and nutritionally. Fish of poor quality yields malodorous oil with high contents of free fatty acid and sulphur. These undesirable properties affect the economic values and application of the oil.

The processing and packaging of fish oil are crucial in determining its quality. Low quality oil may be quite unstable and contain significant amounts of mercury, pesticides and undesirable oxidation products. High quality oils are stabilized with adequate amounts of vitamin E and are packaged in industrial foil pouches or other sensitive packaging resistive to light and oxygen.

Essential fatty acids (EFAs)

In general, lipids of marine fish species are characterised by low levels of linoleic acid (18:2, n-6) and linolenic acid (18:3, n-3) as well as high levels of long chain n-3 polyunsaturated fatty acids (Steffens, 1997). There are two families of essential fatty acids (EFAs) ; omega-3 and omega-6. The most prominent omega-3 family member is alpha-linolenic acid, which is found in green, leafy vegetables, nuts, beans, and flaxseed and canola oils. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are also omega-3 fatty acids and are usually found in fish and fish oil. The main omega-6 EFA is found in grains, meats, seeds and various oils including corn, safflower, cottonseed and sunflower.

Omega-3 fatty acids

Omega-3 fatty acids are long chain polyunsaturated fatty acids (18-22 carbon atoms in chain length) with the first of many double bonds beginning with the third carbon atom (when counting from the methyl end of the fatty acid molecule). Omega-3 fatty acids can be divided into three main categories- eicosapentaenoic acids (EPA), docosahexaenoic acids (DHA) and alpha-linolenic acids; out of which EPA and DHA have the most beneficial effects.

The omega-3 is concentrated throughout the food chain, but is most abundant in the oils of cold-water fish such as mackerel, salmon, sardines, herring and cod (Adebiyi and Bawa, 2006).

In addition to the omega-3 PUFAs, fish oil also contains natural fat soluble antioxidants (Wu and Peter, 2008). Sidhu, (2003) reported that the potential health benefits related to fish consumption are due to the presence of protein, unsaturated essential fatty acids, minerals and vitamins. It has also been reported that the additional health benefits from the consumption of fish or fish oil may be related to polyunsaturated fatty acids (PUFAs) especially Omega-3.

Polyunsaturated fatty acids (PUFA) are considered as the physiologically active factor in many species. They actively participate in gonad maturation, egg quality (Izquierdo *et al.,* 2001) and larval growth of fish (Tulli and Tubaldi, 1997). Polyunsaturated fatty acids can enhance fluidity and flexibility of spermatozoa membrane and are believed to be actively involved in the regulation of cellular movement, gonadal metabolism of lipids. PUFAs also helps to regulate the production of eicosanoids. Lack of essential fatty acid are associated with some symptoms such as slow growth, deformation of tail fin, faded and fatty liver, skin pigmentation and shock (Acman and Eaton 1976). Hence polyunsaturated fatty acids are important in the health of man and fish.

Fatty acid composition

Fatty acids consist of a hydrocarbon chain (CH_2) 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 fatty acids have the maximum number of hydrogen atoms and therefore no double bonds, while polyunsaturated fatty acids contain two or more double bonds. The polyunsaturated fatty acids are termed as Omega 3 and Omega 6 fatty acids (abbreviated as w3 and w6, or n-3 and n-6) required for human nutritional benefit (Osman *et al.,* 2001).

Environmental factors including salinity, natural food and temperature have been shown to influence the fatty acid composition of fish (Ibarz et al, 2005). There are a number of experiments demonstrating the effects of other factors such as temperature, seasonal variation, age and species type on the fatty acid composition of aquatic animals especially fish (Rasoarahona *et al.,* 2004). The differences in nutritional composition of various fish species can only be known through the proximate analysis of the fish sample. Some fishes are higher in n-3 and n-6 polyunsaturated fatty acids depending on their source and type of food consumed. Fishes that feed on natural fish food are believed to be high in these n-3 and n-6 fatty acids. In general, whether the diet is natural or compounded the fatty acid composition of fish muscle is clearly influenced by their diet (Justi *et al.,* 2003). Thus the content in the diet provided will influence the composition in fish.

Suriah et al. (1995) analysed the total lipid and fatty acid composition of oil extracted from 20 species of freshwater fishes in Malaysia. Most of the fishes contained less than 20% lipid by weight. The composition of fatty acids is as follows: total monounsaturated fatty acids (17-53%) were the highest, followed by saturated (15-43%) and polyunsaturated (12-25%). The total omega-6 fatty acids (2.43-26.2%) were found to be higher than the omega-3 (1-11%). Most of the fish had an omega-3/omega-6 ratio less than 1 except for the Siamese Sepat (3.38), Black Siakap (2.20) and Tilapia (1.26). In polar lipids, arachidonic acid was found in high proportions. Tilapia lipids appear to be intermediate in nutritional quality between all species studied. It contains 16.27% DHA, 4.52% EPA and 9.36% arachidonic acid. The highest proportions of fatty acids in the neutral lipid fraction of freshwater fish species were myristic (C14:0, 1.56-4.67%), palmitic acid (C18:0, 8.51-12.74%), oleic acid (C18:0 9.50-48.76%) and veccenic acid (18:1 4.68-6.62%). However, major fatty acids in the polar lipid were palmitic acid (C16:0, 19.33-

29.26%), stearic acid (C18:0, 8.53-16.83%), oleic acid (C18:1n9, 6.16-25.02%), vaccenic acid (18:1n-7, 3.33-6.8%), linoleic acid (C18:2n6, 0.86-6.52%), arachidonic acid (3.35-10.67%), EPA (0.42-4.74%) and DHA (4.21-20.71%). The most saturated fatty acid in both fractions of lipids was palmitic acid.

Extraction of fish oil

According to Adebiyi and Bawa (2006), the production of fish oil deals with the separation of fatty substances (lipids) from other constituents of the fish. The separation starts from the preparation of the raw material up to the purification of the product which is the final stage of the process. It has been reported that one of the methods used industrially in obtaining fish oil is the batch hydraulic press. The hydraulic press is the process of obtaining oil expressed by the hydraulic press from a mass of moderately cooked oil bearing fish samples. Besides that, other various processing method have been adopted for the extraction of fish oil from the whole body. These include, Soxhlet method, supercritical fluid extraction (Sahena *et al.*, 2010), and extraction by pH adjustment. Adebiyi and Bawa (2006) extracted and characterised body oil from several fish species like sharks, rays, mackerel, herring, etc.

Solvent extraction

Solvent extraction, which is also referred to as leaching is a method used to separate compounds based on their relative solubilities in two different immiscible liquids, usually water and an organic solvent. Solvent extraction technique is the most commonly used method of isolating lipids from food sample for example fish and to determine the total lipid content of the foods (Adebiyi and Bawa, 2006). According to Adebiyi and Bawa (2006), the principle of the solvent extraction technique is based on fact that lipids are soluble in the organic solvents, but insoluble in the water. It makes it an easier method to separate the lipid components in food. In practice, the efficiency of solvent extraction depends on the polarity of the lipids present compared to the polarity of the solvent. Polar lipids such as the phospholipids are more soluble in polar solvents such as alcohol than the non-polar solvents such as hexane. On the other hand, the non-polar lipids such as triacylglycerols are more soluble in non-polar solvent than in the polar solvent. Aryee and Simpson (2009) conducted six different solvent extraction technique namely Folch method, the Bligh and Dyer method, Radin method, extraction at room temperature, Soxhlet and Soxtec methods on the salmon skin samples and evaluated for salmon skin oil and as well as the effect of mode of and extraction time on the yield and quality of the oil.

Rendering methods

Due to the increase in the industrial application and utilisation of these fats and oils from marine origin, recovery procedure that results in high yield without compromising the quality of the extracted oil are required. The traditional method of fish oil production is the continuous wet rendering, which involves cooking, pressing and centrifugation (FAO, 1986). Sheu and Chen (2002) conducted a study on the yield and quality characteristics of edible broiler skin fat obtained from five rendering methods. The five rendering methods used are microwave rendering, conventional oven baking, water cooking, griddle rendering and deep-fat frying. Based on the study, the yields of chicken fat from breast skin varied with the rendering method used. The 8 minutes microwave rendering had the highest yield that is 47.5% followed by 8 minutes deep-fat frying that is 33.4% , 40 minutes of conventional oven baking gave 31.6%, 10 minutes griddle rendering (25.8%) and lastly the 40 minutes water cooking 24.8%.

Physicochemical properties and stability of fish oil during storage

Fish oil has an important industrial application in food, pharmacy, cosmetics and paint products (Boran *et al*., 2006). Because of this wide

application, quality and stability of fish oil have become more important. Fish oil spoils in two major ways that is oxidative and hydrolytic spoilage. Due to its high content of polyunsaturated fatty acids, including EPA and DHA, fish oil is highly susceptible to oxidative spoilage and the rate of fish oil oxidation is significantly different from that of other oils. Fish oil also includes high concentrations of phospholipids, containing unsaturated fatty acids, which make them even more sensitive than other oils (Boran *et al*., 2006).

Many researchers determined the fatty acid composition using gas chromatography (Endinkeau & Tan (1993); Suriah et al. (1994)). Fatty acid composition data is needed by food scientists and nutritionists to aid them in dietary formulation, processing and product development (Ackman, 1989). For evaluation of oil stability and monitoring of deterioration during storage, the methods commonly used include; Free fatty acids determination (FFA), Peroxide value (PV), and Thiobarbituric acid test (TBA).

Conclusion

Fish is a source of protein and proteinous food are body building foods. Fish oil is the lipid fraction extracted from fish and fish by-products. Majority of the nutritionists recommend that human beings should eat fish every day. Regular consumption of fish can promote the defense mechanism for protection against invasion of human pathogens because fish food has antimicrobial peptide. Lipids are an important component in fish and human diets, both as energy and fatty acids sources

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Quick Response Code

DOI:10.22192/ijcrbs.2018.05.04.002

How to cite this article:
Obeagu Emmanuel Ifeanyi. (2018). A review on Fish Oil for Healthy Living. Int. J. Compr. Res. Biol. Sci. 5(4): 6-13.
DOI: http://dx.doi.org/10.22192/ijcrbs.2018.05.04.002