

A REVIEW ON NUTRITIONAL BENEFITS OF FISH ON HUMAN HEALTH

Abstract

Due to its tremendous nutritional value, fish is one of the most significant foods in the human diet. A class of PUFAs, in particular omega-3 and omega-6, which help prevent thrombosis and atherosclerosis, are well-known to be found in fish. These fatty acids have properties that are anti-inflammatory, anti-arrhythmic, anti-hypertensive, and protective against coronary heart disease. Fish contains almost all of the minerals that our bodies require. Minerals found in fish include iron (Fe), calcium (Ca), zinc (Zn), phosphorus (P), selenium (Se), fluorine (F), and iodine (I). Due to their high bioavailability, these minerals are easily absorbed by the body. Chronic disease is greatly influenced by dietary practises, particularly those associated with metabolic and endocrine disorders. Fish, a dietary group, contains many vital nutrients that are necessary for the metabolism and hormone function, including omega-3 fatty acids, iodine, selenium, vitamin D, taurine, and carnitine. Fish is also rich in protein and often has a low calorie density. It has been extensively studied how these nutrients affect cardiovascular risk, but it hasn't always been clear how important fish is for overall endocrine and metabolic health. Only a small portion of the numerous mechanisms that mediate these effects have been found. It is true that a low background fish consumption is linked to greater prospective benefits for the bulk of these consequences. Current facts on the value of fish in human nutrition and the positive impact of essential fatty acids on human health are also discussed in this review.

Key words: Nutritional value, Human health, PUFAs, Vitamins and Minerals

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I. INTRODUCTION

In Southeast Asian nations like Hong Kong, Singapore, Malaysia, and Thailand, where the industry is extremely effective, fish are frequently raised as food (Frisch et al. 2016). In 2025, it is predicted by Pedro et al. that global fish production will increase to 196 million tonnes. The vast majority of fish is grown in tropical and subtropical climates. As the world's population grows, fish are in high demand due to their delicious flavour, effective feed conversion, and high commercial value (Tavares et al., 2021). Fish are acknowledged as being among the most nutrient-dense aquaculture products because they contain a well-balanced mixture of macronutrients like proteins and lipids and micronutrients like vitamins and minerals (Hassanien et al., 2021). According to the FAO (2016), 146.3 million tonnes of the 167.2 million tonnes of fish produced globally are used for human consumption. The remainder is put to non-food uses before being discarded as waste. High-quality fish and fishery products are in high demand due to their high nutritional value and abundance of healthy ingredients (FAO, 1986). Fish lipids, which usually include significant levels of omega-3 fatty acids, particularly -linoleic acid, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), are the most significant of them. These fish are a good source of nutrition for people since they support growth, shield the body from various illnesses like heart and circulatory problems, and shield children from rickets and other mental health issues (Sinn et al. 2007).

II. GLOBAL OVERVIEW OF FISH CONSUMPTION

Over 20% of the 3.3 billion people living in the world get their animal protein from fish, making it a crucial part of a nutrient-dense diet in many parts of the world. The increasing global population raises potential nutritional concerns, as fish is a major source of animal protein. By 2029, it is projected that the amount of fish produced for human consumption would have increased globally by 16.3%, meaning that 90% of the fish produced will be consumed by humans (Hasselberg et al., 2020). Over 20% of the 3.3 billion people living in the world get their animal protein from fish, making it a crucial part of a nutrient-dense diet in many parts of the world. The increasing global population raises potential nutritional concerns, as fish is a major source of animal protein. 90% of the fish produced will be used for human food by 2029, according to an estimate for the entire world, which projects a 16.3% increase in fish for human use. Not only has production increased, but consumption has also grown as a result of greater nutritional standards for the populace, decreased waste, better utilisation, enhanced distribution systems, and increased demand (FAO 2020). As a result, the increasing global consumption of fish is evidence that eating fish has several proven nutritional and scientific health benefits. Therefore, fisheries and aquaculture will continue to be essential in supplying the world's population with the animal protein they need, with aquaculture serving as the main source. (Fig. 1).

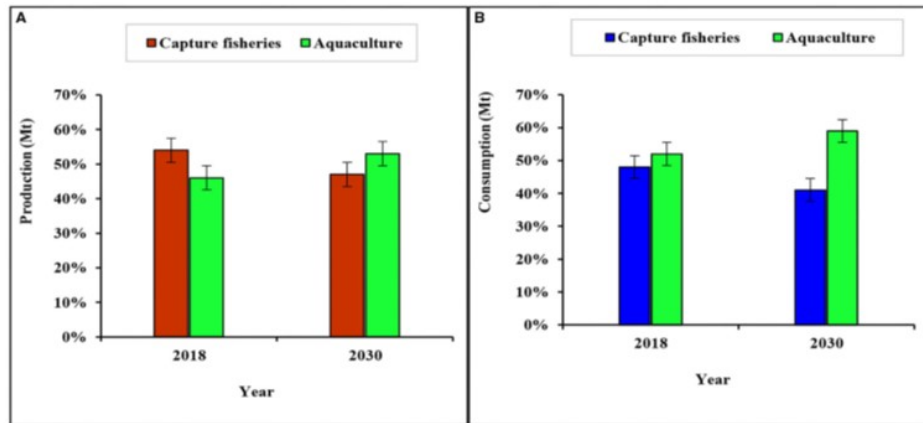


Figure:1 Global fish (A) production in 2018 and projected production in 2030, and (B) consumption in 2018 and projected consumption in 2030, from capture fisheries and aquaculture. Source: Adapted from FAO (FAO 2020)

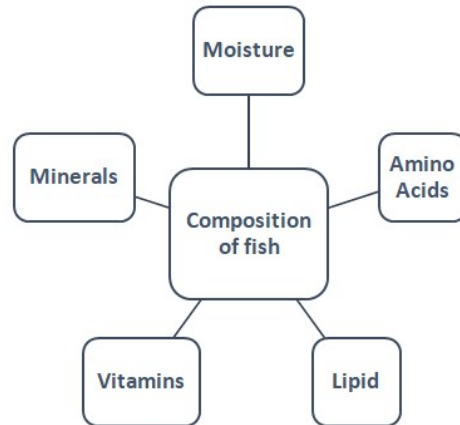
1. Nutritional Value of Fish: In Asia, fish are among the species with the highest commercial value. Additionally, fish are regarded as essential species in coastal ecosystems, and the ecology is significantly impacted by their reduction as a result of fishing pressure. As a result, there is a concern about overfishing to satisfy market demand (Soyano et al.2022). Additionally, the nutritional content of fish has demonstrated certain positive impacts on human health, including effective safeguards against cancer, Alzheimer's illness, and cardiovascular disorders (Ye silsu, A.F. and zyurt, G 2019). Due to its high protein, water, amino acid makeup, and fatty acid composition, fish has a great nutritional value. (Ahmed et al 2022).

III. BIOCHEMICAL COMPOSITION OF FISH

Numerous nutrients, including both macro and micronutrients, are found in fish. Protein, fat, and a very small quantity of carbohydrate make up the macronutrients (as shown in Table No.1). Vitamins and minerals are among the micronutrients and are crucial components. The following are some of the nutrients that are accessible in fish, according to Balami et al. (2019)

Table 1: Proximate composition of fish Balami *et al.* (2019)

Constituent	Percentage
Moisture	65-80%
Protein	15-20%
Fat	5-20%
Ash/Minerals	0.5-2%



- 1. Moisture:** Water makes up the majority of fish flesh and often makes up around 80% of the weight of fresh fish meat. Bombay duck has the highest moisture content, at 90%, although the average moisture content of the flesh of fatty fish is around 70%. Even under great pressure, the water in fish muscle is incapable of easily escaping due to its strong molecular bonds with the proteins that make up the structure. However, during extended refrigerated or frozen storage, the proteins lose part of the water, some of which contains dissolved molecules, as drip. Pal et al 2018. Whether caught in the Arabian Sea or the Bay of Bengal, Bombay duck fish (*Harponon nehereus*) has the odd property of having a very high moisture content (about 90 percent) and a low protein content (about 10 percent). It is lean fish with < 1 percent fat in its flesh. (Nimish et al 2018)
- 2. Protein:** Fish and shellfish supply 4% to 5% of the world's overall protein needs and about 14% of the demand for animal proteins (Venugopal, 1995). Fish proteins contain a range of amino acids and are highly digested (85–95%). Since fish is particularly high in the necessary amino acids lysine and methionine, it is regarded as a superb source of high-quality protein. For products like fish mince and surimi, the water-holding capacity and the gelling characteristics that determine the textural aspects of the products are key quality parameters (Venugopal, 1995). Fish proteins are rich in nutrients, but they also have useful properties like the capacity to hold water, gel, emulsify, and have textural characteristics. Fish muscles typically contain between 16 to 21 percent protein, however some species can occasionally have levels as low as 16% or as high as 28%. The maintenance of the organism, tissue healing, and growth and development all depend on proteins. Species, nutritional state, and muscle type all affect the amount of protein in fish muscle. Fish proteins have significant biological significance due to their high levels of lysine and other sulfur-containing amino acids, such as methionine and cysteine, that are lacking from plant proteins, as well as other essential amino acids in the proper ratios (as shown in Table No. 2).

Table 2: Fishes Rich in Particular Amino Acid (Nimish et al 2018)

Amino Acids	Species Recommended for Particular Amino Acid Deficiency
Arginine	<i>Oncorhynchus mykiss, Tor putitora, Neolissochilus hexagonolepis</i>
Histidine	<i>Rastrelliger kanagurta, Catla catla, Stolephorus waitei, Amblypharyngodon mola, Puntius sophore</i>
Isoleucine	<i>Oncorhynchus mykiss, Labeo rohita, Stolephorus commersonii</i>
Lysine	<i>Stolephorus commersonii, Thunnus albacores, Tor putitora</i>
Methionine	<i>Stolephorus waitei, Tor putitora, Rastrelliger kanagurata</i>
Phenylalanine	<i>Cirrhinus mrigala, Catla catla, Labeo rohita</i>
Threonine	<i>Thunnus albacores, Nemipterus japonicus, Stolephorus waitei, Stolephorus commersonii</i>
Tyrosine	<i>Oncorhynchus mykiss, Tor putitora</i>
Valine	<i>Nemipterus japonicus, Cirrhinus mrigala, Rastrelliger kanagurta</i>
Tryptophan	<i>Tor putitora</i>
Glutamine	<i>Cirrhinus mrigala, Catla catla, Labeo rohita</i>
Glycine	<i>Cirrhinus mrigala, Catla catla, Labeo rohita</i>
Alanine	<i>Nemipterus japonicus, Labeo rohita, Catla catla</i>
Aspartic acid	<i>Stolephorus commersonii, Nemipterus japonicus, Clarius batrachus</i>
Serine	<i>Stolephorus commersonii, Nemipterus japonicus, Thunnus albacares</i>

3. Lipids: Lipids are organic substances produced by living things that are soluble in organic solvents such as ether, chloroform, or benzene but insoluble in water. They also have long-chain hydrocarbon groups in their molecules. They are essential for preserving the integrity of plants and animals as structural compounds because they function as a barrier protecting the live cell from the outside. They serve as the main source of cellular energy and can be stored in living organisms. Species and season affect the lipid content of fish, but overall, fish has less fat than red meat (as shown in Table No. 3). In general, 0.2 to 25% of diet is fat-free. As fat content increases, water content decreases, and vice versa. Fish lipids are known to contain high concentrations of these essential nutrients for the human diet as lipid-soluble vitamins (A and D) and essential fatty acids (PUFA), which have been shown to play an important role in preventing a number of human diseases, including cardiovascular ones (Simopoulos, 1997). Marine fish lipids usually contain longer-chain fatty acids and a higher proportion of highly unsaturated fatty acids than other lipids. (1989, Ackman).

Table 3. Lipid Content of Seafood. (Nimish et al 2018)

Types of fish	Fat (%)
Fatty fish	10
Lean fish	0.5
Crustaceans	2.1
Mollusks	1.5

4. **Vitamins:** Fish contains appropriate amounts of all the vitamins needed for human health, however the amounts vary widely from species to species and season to season. The body requires many different vitamins, and fish is a great source of those vitamins. Oily fish is a great source of vitamins A and D, which are essential for a child's healthy growth and development. White fish has B vitamins. Vitamin A is required for healthy growth and development, the formation of bones and teeth, cell growth, the prevention of vision impairment, and the treatment of several eye diseases. In addition to vitamins A and C, vitamin D promotes calcium and phosphorus absorption, two elements necessary for developing strong bones and teeth. Vitamin B is essential for the effectiveness of enzymes and the acceleration of biological chemical reactions. Vitamin K helps maintain proper blood coagulation, which enables the avoidance of internal bleeding. High levels of vitamin A and D can be found in fatty fish including salmon, trout, mackerel, herring, and others. Both fish oil and vitamin E reduce rheumatoid arthritis-related inflammation, swelling, pain, and tenderness. Fish contain vitamin K, which is what produces the anti-haemorrhage factor. (Anon 2017).

5. **Minerals:** Fish is an excellent source of these nutrients since it includes between 0.4 and 1.5% (wet basis) of almost all the minerals found in seawater. Among the minerals contained in fish are iron, calcium, zinc (from marine fish), phosphorus, selenium, fluorine, and iodine. According to Balachandan (2002), these minerals have a high level of "bioavailability," which means that the body can easily absorb them. From a nutritional perspective, the iodine and selenium levels of marine fish is particularly significant. Children's growth and mental development, as well as the hormone thyroxin, which controls the body's metabolism, require iodine. Selenium is a crucial trace element for antioxidants. Iron is necessary for the production of haemoglobin, which transports oxygen throughout the body, in red blood cells. Calcium is important for the growth and mineralization of strong bones as well as for the proper operation of the neurological and muscular systems. Little fish eaten along with their bones instead of discarding fish bones increases calcium, phosphorus, and fluorine consumption (as shown in Table No. 4).

Table 4: Some important mineral constituent of fish muscle Pal *et al.*, (2018).

Element	Average value(mg/100g)
Sodium (Na)	72
Potassium(K)	278
Calcium (Ca)	79
Magnesium (Mg)	38
Phosphorus (P)	190

6. **Marine Collagen:** Collagens are a large family of triple helical proteins that are wide spread throughout the body and are important for a broad range of functions for a board range of functions, including tissue scaffolding, cell adhesion, cell migration, angiogenesis, tissue morphogenesis and tissue repair. Collagen is well known as the primary tensile component of vertebrate tissues like tendon, cartilage, bone, and skin. It appears as elongated fibrils in the extracellular matrix. The presence of collagen in basement membranes, such as the renal glomerulus, where it is involved in molecular filtration, is another well-known property of the protein (Nimish et al 2018). Different types of collagen (as shown in Table No.5).

Table 5: The common five types of Collagen. (Nimish et al 2018)

Type	Source
Type I	Skin, tendon, vascular ligature organ, bone
Type II	Main collagenous component of cartilage
Type III	Main component of reticulate fibres
Type IV	Forms basal lamina
Type V	Cell surfaces, hair and placenta

IV. BENEFICIAL ROLE OF FISHES IN HUMAN DIET

Due to their nutritional value, fish and fish products are wonderful foods that are healthy for human health. Fish and fish products are extremely important in the nutritional picture since they are a fantastic source of nutrients, have a good mix of protein, vitamins, and minerals, and have a relatively low calorie content. These characteristics also make them excellent sources of polyunsaturated fatty acids, which have been associated with favourable outcomes in a number of pathological conditions, including some types of cancer and arthritis, and which appear to have beneficial effects in reducing the risk of cardio-vascular diseases Pal *et al.*, (2018). Almost all of the minerals that our bodies need are found in fish. Iron (Fe), calcium (Ca), zinc (Zn), phosphorus (P), selenium (Se), fluorine (F), and iodine (I) are the minerals found in fish. These minerals have a high bioavailability, making it simple for the body to absorb them.

According to FAO (1986), the strong demand for high-quality fish and fisheries products is largely a result of the nutrients and other beneficial elements they contain. Fish lipids, which usually include significant levels of omega-3 fatty acids, particularly -linoleic acid, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), are the most significant of them. The omega-3 fatty acids are advantageous to human health in numerous ways. These include maintaining healthy brain function in people, lowering blood pressure and fat levels in the blood, lowering the risk of myocardial infarction, increasing the immune system, and Bucher *et al.*, 2002. They also protect against several types of mental diseases and cancer, according to Caygill and Hill (1995). Fish's superior nutritional value makes it a necessary part of the human diet. They are a known source of polyunsaturated fatty acids (PUFAs), particularly omega-3 and omega-6, which aid in the prevention of thrombosis and atherosclerosis. According to Erkan and Bilen (2010), they are also a good source of B vitamins and fat-soluble vitamins. These fatty acids have anti-inflammatory, anti-arrhythmic, anti-hypertensive, and anti-coronary heart disease characteristics. Fish and fishery products are abundant sources of easily digestible protein and frequently have an amino acid profile that contains the majority of the essential amino acids required by humans for a balanced diet, therefore they provide more critical nutrients than just fatty acids.

Cellular membranes are mostly made of long-chain, polyunsaturated fatty acids (LC-PUFAs; acids with 20 or more carbon atoms and at least three double bonds). Graham *et al.*, 2007. The unusually healthy fatty acid content of fish accounts for the majority of its nutritional benefits. Controlling physiological and metabolic processes requires the presence of LC-PUFAs. Because of these benefits to human health, LC-PUFAs are listed by Pond (1998) as one of the food ingredients. EPA and DHA are practically only found in fish lipids.

Adults who eat fish are known to benefit from its health properties. Eating fish, especially oily fish, lowers the chance of dying from coronary heart disease (CHD), according to a lot of data. The risk of dying from coronary heart disease can be decreased by up to 36% by consuming long-chain omega-3 fatty acids, which are mostly found in fish and fishery products. All demographics are affected by the widespread public health problem of CHDs.

The majority of the Inuit diet was made up of fatty fish and other sea creatures, which are rich in EPA and DHA among other things. According to Connor in 2000, EPA and DHA have a variety of properties that are advantageous to human health. They can enhance a number of bodily processes in addition to lowering the risk of some malignancies and cardiovascular disorders Calo et al., 2005; Wolk et al., 2006; and Berbert et al., 2005. Adults are most protected against coronary heart disease when they eat 250 mg of EPA+DHA daily. The optimal amount for children's brain development is only 150 mg per day. This is significant since the prevalence of brain diseases is rising quickly, and in industrialised countries, the cost of mental disorders now exceeds the total cost of CHD and cancer. Many of the minerals found in fish are really beneficial to the customer because it is believed that fish is easily digestible. A nutritious alternative to meat is fish that has been ethically raised in the wild and in aquaculture.

V. FISH CONSUMPTION AND THE METABOLIC SYNDROME

Insulin resistance, often known as a poor response to the hormone insulin, is the cause of a number of frequently noticed alterations collectively known as the metabolic syndrome. A substantial risk factor for the development of insulin resistance and the metabolic syndrome is obesity, especially abdominal obesity. The metabolic syndrome also includes hyperglycemia, high blood pressure, hypertriglyceridemia, low plasma HDL cholesterol (HDLc), and high plasma uric acid in addition to abdominal obesity. Aguilar et al. (2019) found that having metabolic syndrome increases the risk of acquiring diabetes, diabetic nephropathy, diabetic retinopathy, and diabetic neuropathy.

Numerous studies have looked into how eating fish affects the risk of developing metabolic syndrome. One of the most important interventional studies in this field was the SEAFOOD Plus research (Ramel et al. 2009), which randomly assigned 126 overweight individuals aged 20 to 40 to receive a diet with a 30% calorie restriction with or without 150 g/day of fish (cod), five times per week. In addition to losing an additional 1.7 kg of body weight in comparison to the control group, participants who included fish in their diets also saw 3.4 cm drops in waist circumference and 5.2 mmHg drops in systolic blood pressure. Another important study is the Spanish WISHCARE experiment, in which 273 patients with metabolic syndrome were randomly assigned to receive either the same dietary counselling programme without the addition of fish for 8 weeks or the same programme with 100 g/day of white fish (Namibia hake). Following the fish group intervention, waist circumference, diastolic blood pressure, and LDL cholesterol all dropped more sharply. (Vázquez et al. 2014).

VI. CONCLUSION

The nutritional makeup of fish has been interestingly explored in the current review, along with the many applications of using by-products of fish processing and preservative

technologies to increase the shelf life of fish. To preserve the fish for a longer period of time, numerous processing procedures are being used. The three main causes of fish spoilage are enzymatic autolysis, microbiological decay, and chemical deterioration. Regulating these factors is essential if the fish are to be maintained for a long period. Appropriate procedures include freezing, employing antimicrobials and antioxidants, and super-chilling. Along with effectively suppressing microbial growth, low-temperature treatments can effectively limit enzymatic and non-enzymatic breakdown activities. While several antimicrobial drugs can successfully stop the growth of germs, antioxidants can also reduce lipid oxidation. To satisfy consumer demand with the least amount of quality loss, the most affordable fish products are processed utilising a variety of technologies, including thermal and non-thermal treatments. With little processing and the inclusion of chemical preservatives, the major goals of these technologies are to increase the shelf life of fish products, improve their nutritional value, extract items with a high added value, and prevent any negative consequences. Since they are a fantastic source of nutrients, have a good mix of protein, vitamins, and minerals, and have a low calorie count, fish and fish products are significant in the nutritional picture. Along with these benefits, it is high in polyunsaturated fatty acids, which may lower the risk of cardiovascular and vascular diseases and have advantageous effects on a variety of other pathological conditions, including some forms of cancer and arthritis.

VII. SCOPE AND FUTURE PERSPECTIVES

The industrial application of new technologies and progressive management of fish parameter-related factors, such as quality, nutritional requirements, prolonged shelf life, new product development, freshness, and high yield, are key to the future of fish preservation and processing. More research is needed to understand the effects of processing and preservation factors on fish and fish products in order to make them more trustworthy and user-friendly for future development. For the benefit of society and the environment over the long run, it is still important to work on further research and creating technology to discard a variety of fish by-products.

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