



# A Review on Nutritional Benefits of Fish on Human Health

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## ABSTRACT

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Fish is one of the most important foods in human diet because of its high nutritional quality. Fish are a well-known source of a class of PUFAs, particularly omega-3 and omega-6, which can fend off thrombosis and atherosclerosis. These fatty acids have protective properties against autoimmune illnesses, arrhythmias, elevated blood pressure, and coronary heart disease. 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, meaning that the body can quickly absorb them. Dietary behaviours, particularly those related to metabolic and endocrine disorders, are a significant risk factor for chronic disease. Omega-3 fatty acids, iodine, selenium, vitamin D, taurine, and carnitine are just a few of the essential elements found in fish, which is a food group, that are important for metabolism and hormone function. Additionally, fish has a high protein content and a generally low-calorie density. The effects of these nutrients on cardiovascular risk have been thoroughly explored, but the significance of fish for endocrine and metabolic health in general has not always been fully understood. Only a few of the many pathways that these effects are mediated by have been identified. For the majority of these impacts, it is true that low baseline fish consumption is associated with more significant potential benefits. In this review up-to-date information about importance of fish in human nutrition and beneficial effect of essential fatty acid in human health is also reviewed.

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## KEYWORDS

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Fatty acid, fish, nutrition, human health

## **Introduction**

In Southeast Asian nations including Hong Kong, Singapore, Malaysia, and Thailand, fish is a widely cultivated food product with extremely profitable commerce (Frisch et al. 2016). According to Pedro et al. (2019) fish production is expected to reach 196 million tonnes globally in 2025. Fish is a widely varied food product that is primarily cultivated in tropical and subtropical areas. Because of their delicious flavour, effective feed conversion, and high commercial value, fish are in great demand as the world's population grows (Tavares et al., 2021). Fish are regarded as extremely nutritious aquaculture products because they contain a well-balanced combination of macronutrients like proteins and fats and micronutrients like vitamins and minerals (Hassanien and Rashada 2021). According to the FAO (2016), the total amount of fish produced worldwide is 167.2 million tonnes, of which 146.3 million tonnes are used for human consumption. The remaining amount is used for non-food purposes and discarded as waste. The fact that high-quality fish and fishery products are in high demand is mostly because of their nutritional value and plenty of healthful, useful ingredients (FAO, 1986). Fish lipids, which often contain a high amount of omega-3 fatty acids, particularly

-linolenic acid, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), are the most significant of these. These fish are a good source of human food that supports development, shields the body from a range of illnesses like cardiovascular and coronary heart disorders, and shields children from rickets and mental illnesses (Sinn et al. 2007).

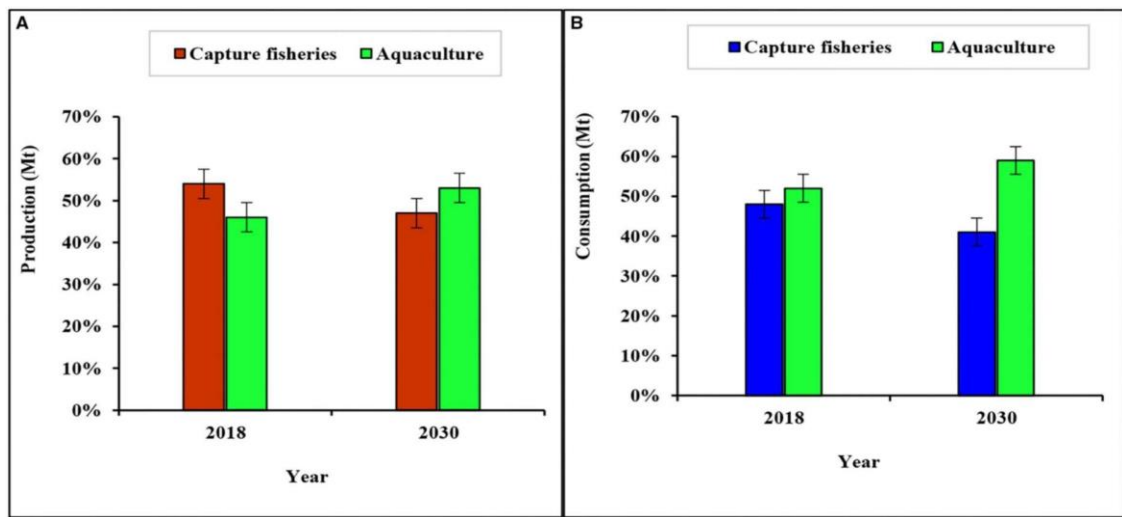
## **Global overview of fish Consumption**

Fish contributes over 20% of the average per capita animal protein intake of the world's 3.3 billion people, making it an essential component of a nutrient-dense diet in many regions of the globe. Potential nutritional issues are brought up by the growing world population, and fish is a significant source of animal protein. This means that 90% of the fish produced will be used for human use by the year 2029, considering a 16.3% rise in fish for human consumption forecast for the entire world (Hasselberg et al., 2020). According to FAO 2020, 7% of the animal protein consumed worldwide in 2018 was fish, which made up around 17% of all animal protein. Over the past few decades, there have been significant changes in both the consumption of fish and fish products. According to OECD/FAO (2018), global per capita fish consumption has been continuously rising from an average of 12.5 kg in the 1980s to 14.4 kg in the 1990s and

20.5 kg in 2017. 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).

Therefore, the rise in global consumption is proof that eating fish has numerous health benefits that are well-known from both a scientific and nutritional standpoint. As a result, fisheries and aquaculture will continue to be extremely important in supplying the world's population's needs for animal protein, with aquaculture serving as the main source. (Maulu et al., 2021). 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 and zyurt 2019). Due to its high protein, water, amino acid composition, and fatty acid content, fish has a high nutritional value (Ahmed et al 2022).



**Fig: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)**

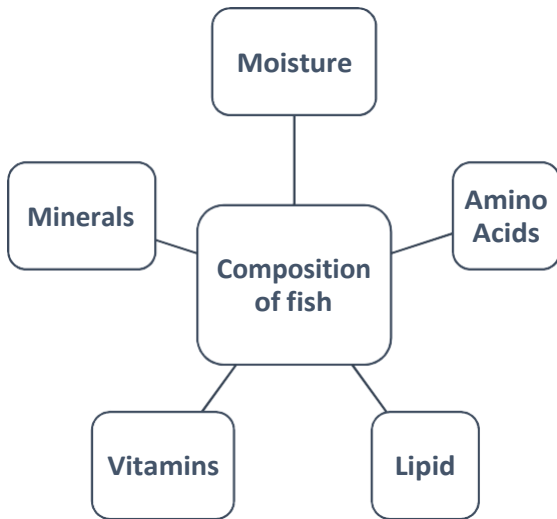
**Biochemical Composition of fish**

Fish is known to have a lot of nutrients including macro and micro

nutrients. The macronutrients are protein, lipid and a very little amount of carbohydrate. The micronutrients include

vitamins and minerals which are important constituent as well. According to Balami *et al.* (2019), various nutrients available in fish are as under:

**Figure 2:** Proximate composition of fish (Balami *et al.* 2019)



**Moisture**

Water makes up the majority of fish flesh and often makes up around 80% of the weight of fresh fish meat. The maximum moisture level, at 90%, is found in Bombay duck, but 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.) Bombay duck fish (*Harpodon nehereus*) whether it is a catch from the Arabian Sea or the Bay of Bengal has the peculiarity of having veery high moisture content (about 90 percent) and low protein content (about 10 percent).It is lean fish with < 1 percent fat in its flesh.(Nimish et al 2018)

**Protein**

Approximately 14% of the world's demand for animal proteins and 4% to 5% of the total protein requirement are met by fish and shellfish (Venugopal, 1995). Fish proteins have high 85–95% digestibility and amino acid composition. Particularly rich in the crucial amino acids lysine and methionine, fish are regarded as a superb source of high-quality protein. For products like fish mince and surimi, the water-holding capacity and the gelling properties that determine the textural attributes of the products are important quality parameters (Venugopal, 1995). In addition to their high nutritional value, fish proteins also have good functional properties such as water-holding capacity, gelling, emulsification, and textural attributes. Fish muscle typically contains between 16 and 21% protein, however some species can occasionally have values as low as 16% or as high as 28%. Proteins are necessary for the body's growth and development,

maintenance, and tissue repair. Fish muscle protein content varies by species, nutritional state, and muscle type. Fish proteins are of significant biological significance because they are rich in lysine

and other sulfur-containing amino acids like methionine and cysteine that are lacking in plant proteins, as well as other essential amino acids in the proper proportions.

**Table 1: Amino Acid in particular fish (Nimish et al 2018)**

<b>Amino Acids</b>	<b>Species Recommended for Particular Amino Acid Deficiency</b>
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 kanagurta</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>

## **Lipids**

Lipids are chemicals that are formed from living creatures and are insoluble in water but soluble in organic solvents like

chloroform, ether, or benzene. They also contain long-chain hydrocarbon groups in their molecules. They are the primary source of cellular energy and function in living creatures where they can be stored, and they serve a crucial role in maintaining

the integrity of plants and animals as structural compounds by building a barrier separating the living cell from the outside. Species and season affect the lipid content of fish, although in general, fish have less fat than red meat. The average fat content is between 0.2 to 25%. As the fat level increases, the water content decreases and vice versa. 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, fish lipids are known to contain high concentrations of these essential nutrients for the human diet (Simopoulos, 1997). However, unlike other lipids, marine fish lipids often contain longer-chain fatty acids and a higher percentage of highly unsaturated fatty acids (Ackman 1989).

**Table 2:** Marine fish with their lipid content. (Nimish et al 2018)

<b>Types of fish</b>	<b>Fat (%)</b>
Fatty fish	10
Lean fish	0.5
Crustaceans	2.1
Mollusks	1.5

### **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. Fish is a fantastic source of various vitamins that are essential to the body. Oily fish are a great source of vitamins A and D, which are essential for children's growth and development. White fish has B vitamins. Vitamin A is crucial for normal growth and development, the formation of bones and teeth, cell proliferation, the prevention of vision impairment, and the treatment of a variety of eye diseases. Together with vitamins A and C, vitamin D promotes the efficient utilisation of calcium and phosphorus, both of which are necessary for healthy bones and teeth. Vitamin B is required for the proper operation of enzymes and the acceleration of biological chemical processes. Internal bleeding is avoided thanks to vitamin K's promotion of healthy blood coagulation. Vitamin A and D levels are high in salmon, trout, mackerel, herring, and other fatty fish. Rheumatoid arthritis-related inflammation, joint swelling, pain, and tenderness are reduced by fish oil and vitamin E. Vitamin K, which is present in fish, is what causes the anti-haemorrhage factor (Anon 2017).

### **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. The intake of calcium, phosphorus, and fluorine is increased when little fish are eaten alongside their bones as opposed to discarding fish bones.

**Table 3:** 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

### 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, including tissue scaffolding, cell adhesion, cell migration, angiogenesis, tissue morphogenesis and tissue repair. Collagen is best known as the principal tensile element of vertebrate tissue such as tendon, cartilage, bone and skin, where it occurs in the extra cellular matrix as elongated fibrils. Collagen is also well known for its location in basement membranes-for example :in the kidney glomerulus, where it involves in molecular filtration. (Nimish et al 2018)

**Table 4:**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

### Beneficial role of fishes in human diet

The nutritional properties of fish and fish products render them valuable foodstuffs that are beneficial for human health. Fish and fish products play tremendous part in the nutritional picture because they are rich source of nutrients and provide a good balance of protein, vitamins and minerals, and a relatively low caloric content. In addition, these properties it also excellent sources of polyunsaturated fatty acids which appear to have beneficial effects in reducing the risk of cardio-vascular diseases and are linked with positive benefits in many other pathological conditions particularly, certain types of cancer and arthritis (Pal *et al.*, 2018). The minerals present in fish are iron (Fe), Calcium (Ca), Zinc (Zn), Phosphorus (P), Selenium (Se), Fluorine (F), Iodine (I). These minerals are with high bioavailability; they can easily absorbed by the body.

The omega-3 fatty acids are advantageous to human health in a number of ways. These include lowering blood pressure and lipid levels in the blood, decreasing the risk of myocardial infarction (Bucher *et al.*, 2002), boosting the immune system (Damsgaard *et al.*, 2007), and maintaining healthy brain function in humans. They also guard against cancer and a variety of mental illnesses (Caygill and Hill 1995). Due to its tremendous nutritional value, fish is one of the most significant foods in the human diet. They are a well-known source of

polyunsaturated fatty acids (PUFAs), particularly omega-3 and omega-6, which can fend off thrombosis and atherosclerosis. They are also a good source of B vitamins and fat-soluble vitamins, according to Erkan and Bilen (2010). These fatty acids have protective properties against autoimmune illnesses, arrhythmias, elevated blood pressure, and coronary heart disease. However, fish and fishery products offer more vital nutrients than only fatty acids; they are also a rich source of easily digestible protein and often have an amino acid profile that includes the majority of the essential amino acids needed by humans for a balanced diet.

The primary constituents of cellular membranes are 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 majority of fish's nutritional advantages come from its extraordinarily beneficial fatty acid composition. LC-PUFAs are crucial for controlling physiological and metabolic processes. Practically the only source of EPA and DHA is fish lipids. Adults who eat fish are recognised to benefit from it in terms of health. There is ample proof that eating fish, especially oily fish, reduces the chance of dying from coronary heart disease (CHD). Long-chain omega-3 fatty acids, which are mostly found in fish and fishery products,



can reduce the risk of dying from coronary heart disease by up to 36%. CHDs are a widespread public health issue that affect all demographics.

The Inuit diet mostly consisted of fatty fish and other sea creatures, which among other things include a lot of EPA and DHA. According to (Connor 2000) EPA and DHA exhibit various qualities that are beneficial 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 who consume 250 mg of EPA+DHA per day are most protected from coronary heart disease. Only 150 mg per day are necessary for children's brain growth to be at its best. This is crucial because the prevalence of brain illnesses is rising sharply, and in the industrialised world, the cost of mental disorders is now higher than the total cost of CHD and cancer. Fish are considered to be easily digestive, therefore a high percentage of the nutrients are truly beneficial to the customer. Wild and ethically farmed fish are a nutritious and good alternative to animal products.

### **Fish Consumption and the Metabolic Syndrome**

The metabolic syndrome is a collection of often observed changes that are connected to insulin resistance, or a poor response to the hormone insulin. Obesity is a major risk factor for the development of insulin resistance and the metabolic syndrome, 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. According to Aguilar et al. (2019), having metabolic syndrome raises the chance of developing ischemic heart disease, stroke, and diabetes, including diabetic nephropathy, retinopathy, and neuropathy.

The impact of fish diet on the likelihood of developing metabolic syndrome has been examined in several research. The SEAFOOD Plus research (Ramel et al. 2009), which randomised 126 overweight people 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, for eight weeks, is one of the most significant interventional studies in this area. 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). Waist circumference, diastolic blood pressure, and LDL cholesterol all decreased more dramatically after the fish group intervention (Vázquez et al. 2014).

## **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. To ensure that the fish will be kept for a long time, it is vital to regulate these elements by using appropriate techniques including freezing, antimicrobials and antioxidants, and super-chilling. In addition to effectively controlling microbial growth, low-temperature treatments can also effectively stop enzymatic and non-enzymatic breakdown processes. Antioxidants are also employed to reduce lipid oxidation, while a

variety of antimicrobial drugs are successfully utilised to inhibit bacteria development. Industries use a wide range of technologies, including thermal and non-thermal treatments, to process the most affordable fish products in a way that satisfies market demand with the least amount of quality loss. 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. Because they are a wonderful source of nutrients, have a good balance of protein, vitamins, and minerals, and have a relatively low calorie content, fish and fish products play a significant part in the nutritional picture. Along with these benefits, it is also a great source of polyunsaturated fatty acids, which are believed to lower the risk of cardiovascular and vascular diseases and have positive effects on a variety of other pathological conditions, including some forms of cancer and arthritis.

## **Scope and Future Perspectives**

The future of fish with respect to preservation and processing depends upon the industrial utilization of new technologies and progressive management

of the factors related to fish parameters such as quality, nutritional requirements, prolonged shelf life, new developmental products, freshness and high yield. In terms of future perspectives, more research is needed to understand the effects of processing and preservation parameters on fish and fish products and to make them more reliable and user-friendly for future development. To date, the discarding of various fish by-products is still considered a challenging factor that requires subsequent work and developmental technologies to recover highly valuable and new products for the long-term benefit of society and the environment.

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