Fish as Food: A Nutritional and Functional Superfood for Human Health

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Abstract

Fish is considered one of the most nutritious foods for human health due to its rich composition of proteins, omega-3 fatty acids, vitamins, minerals and bioactive compounds. Fish proteins possess high digestibility and contain all essential amino acids required for growth, tissue repair and maintenance of body functions. Fish lipids are rich in omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which contribute significantly to cardiovascular protection, brain development, anti-inflammatory responses and neurological health. Fish also contains important micronutrients including calcium, selenium, iodine, iron, phosphorus, zinc and vitamins A and D that support bone health, immunity, thyroid function, blood formation and metabolic regulation. Recent studies have further highlighted the role of fish-derived bioactive compounds and peptides that possess antioxidant, antimicrobial, antihypertensive, neuroprotective and wound-healing properties. In addition to its nutritional importance, fish contributes significantly to food security, livelihood generation and sustainable nutrition globally. Despite these benefits, fish consumption remains low in several developing countries because of lack of awareness and dietary preferences. Therefore, increasing awareness regarding the health and nutritional significance of fish can improve public health and nutritional security worldwide.

Keywords: Fish Nutrition, Omega-3 Fatty Acids, Functional Food, Bioactive Compounds, Human Health

1. Introduction

Fish has been an important source of food and nutrition for humans since ancient times and continues to contribute significantly to global nutritional security (Tacon & Metian, 2013). Fish is widely recognized as one of the healthiest animal protein sources because it contains highly digestible proteins, essential fatty acids, vitamins, minerals and biologically active compounds that are beneficial for human health (Yadav et al., 2025: Mehta et al., 2025). Compared to terrestrial animal meat, fish contains lower amounts of saturated fats and higher levels of polyunsaturated fatty acids, especially omega-3 fatty acids, making it nutritionally superior for maintaining health and preventing chronic diseases (Mozaffarian & Rimm, 2006). Fish consumption has increased globally due to growing awareness about its nutritional value and therapeutic properties. Fish not only provides essential nutrients but also contributes to prevention of cardiovascular diseases, obesity, hypertension, inflammatory disorders, arthritis, osteoporosis and neurological diseases such as Alzheimer's disease and Parkinson's disease (Li et al., 2020). According to Balami et al. (2019), fish is often referred to as "rich food for poor people" because it provides affordable, high-quality nutrition with excellent digestibility.

The nutritional composition of fish varies depending on species, feeding behavior, habitat, environmental conditions, season and whether the fish is farmed or wild-caught. However, most fish species contain abundant proteins, lipids, vitamins and minerals that are essential for growth, metabolism, tissue repair and maintenance of body functions (Mohanty, 2015). Fish proteins contain all essential amino acids including lysine, methionine and cysteine, which are often limited in plant-based diets (Pal et al., 2018). Recent studies have also identified fish as a functional food because fish-derived compounds exhibit antioxidant, antimicrobial, anti-inflammatory, antihypertensive and neuroprotective activities (Ryan et al., 2011). Marine bioactive peptides derived from fish skin, muscle, bones and hydrolysates are now increasingly used in pharmaceutical and nutraceutical industries due to their therapeutic importance.

2. Nutritional Composition of Fish

Fish contains both macronutrients and micronutrients that are necessary for maintaining healthy body functions and metabolic activities. The proximate composition of fish generally includes 15-20% protein, 5-20% fat, 65-80% moisture and 0.5-2% minerals and ash content (Mohanty, 2015). This balanced nutrient composition makes fish one of the most nutritious foods available for human consumption. Fish proteins are classified as high biological value

proteins because they contain all essential amino acids required for human growth and development (Pawar & Sonawane, 2013). Fish lipids are particularly important because they contain long-chain omega-3 polyunsaturated fatty acids such as EPA and DHA that are associated with cardiovascular and neurological health benefits (Swanson et al., 2012). Fish also provides essential vitamins such as vitamins A, D and B-complex vitamins along with minerals including calcium, phosphorus, selenium, zinc, iodine, potassium and iron (Balami et al., 2019).

Fatty fish species such as salmon, tuna, sardine and mackerel contain higher amounts of omega-3 fatty acids, whereas lean fish species provide lower fat content but still serve as excellent sources of protein and micronutrients (Mozaffarian & Rimm, 2006). According to FAO (2010), fish contributes significantly to the intake of micronutrients that are often deficient in diets of developing countries. Fish also possesses lower connective tissue content compared to red meat, which makes fish protein easier to digest and absorb (Venkatraman & Chezhian, 2015). Due to this characteristic, fish is highly recommended for children, elderly people, pregnant women and patients recovering from illness.

3. Importance of Fish Protein in Human Health

Fish is one of the richest sources of highly digestible animal protein and contributes significantly to growth, development, tissue repair and metabolic regulation. Fish protein digestibility ranges from 85-95%, which is higher than many terrestrial animal proteins due to the lower connective tissue content in fish muscle (Venkatraman & Chezhian, 2015). Fish proteins contain essential amino acids including methionine, lysine, cysteine and tryptophan that are necessary for enzyme synthesis, muscle growth, immune regulation and maintenance of body tissues (Mohanty, 2015). Fish proteins also contain immunoglobulins and bioactive peptides that provide defense against bacterial and viral infections and improve immune responses (Ryan et al., 2011).

Protein deficiency remains a major nutritional problem in many developing countries. Fish plays an important role in preventing protein-calorie malnutrition because it provides affordable and high-quality protein to economically weaker populations (FAO, 2010). According to Balami et al. (2019), a 140 g serving of fish can provide nearly 50-60% of the daily protein requirement for adults. Several studies have reported that regular fish consumption helps maintain muscle mass, electrolyte balance, healthy blood circulation and proper metabolic functions (Pawar & Sonawane, 2013). Fish proteins are also important in

maintaining satiety and supporting healthy body weight management compared to other animal proteins (Bogati, 2018).

4. Omega-3 Fatty Acids and Their Health Benefits

One of the most important nutritional characteristics of fish is the presence of omega-3 polyunsaturated fatty acids, especially EPA and DHA. These fatty acids play essential roles in cardiovascular protection, neurological development, inflammation control and maintenance of cellular functions (Swanson et al., 2012). Numerous studies have demonstrated that omega-3 fatty acids reduce plasma triglyceride levels, regulate blood pressure, improve blood circulation and reduce platelet aggregation, thereby lowering the risk of cardiovascular diseases and coronary heart disease (Bucher et al., 2002). Regular fish consumption has also been associated with lower incidences of heart attack, arrhythmia and stroke (Mozaffarian & Rimm, 2006).

DHA is particularly important for brain and nervous system development in infants and children (David, 2013; Yadav et al., 2025). During pregnancy and lactation, omega-3 fatty acids support fetal brain development and visual function. EPA and DHA also contribute to memory improvement, cognitive performance, and neuroprotection against diseases such as Alzheimer's disease and Parkinson's disease (Butt & Salem, 2016).

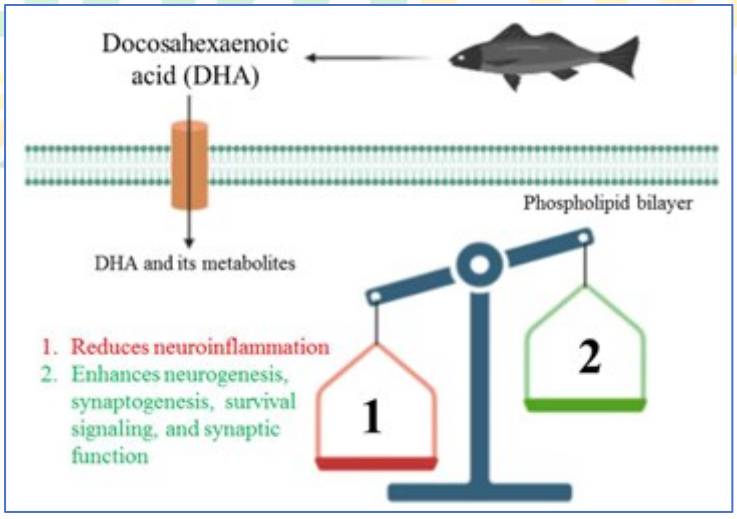

Fig. 1 Neuroprotective action of DHA obtained from fish

Fish oils possess strong anti-inflammatory properties that help reduce inflammatory disorders such as arthritis, ulcerative colitis, obesity and metabolic syndrome (Wall et al., 2010). Omega-3 fatty acids reduce oxidative stress and inflammatory cytokine production, thereby improving overall health and immunity.

5. Vitamins and Minerals Present in Fish

Fish is an important natural source of vitamins and minerals that are essential for human growth, metabolism and immunity (Balami et al., 2019). Fish provides significant amounts of vitamins A, D and B-complex vitamins, all of which are important for maintaining healthy physiological functions. Vitamin A supports vision, bone development, epithelial tissue maintenance, immune function and cellular growth (Pal et al., 2018). Vitamin D present in fish and fish oils plays a critical role in calcium absorption, bone mineralization and prevention of osteoporosis, osteomalacia and rickets (Holick & Chen, 2008).

Fish also supplies important minerals such as calcium, phosphorus, iron, selenium, zinc, iodine and potassium. Calcium and phosphorus contribute to bone strength and metabolic activities, while iron is necessary for hemoglobin synthesis and oxygen transport in blood . Selenium acts as an antioxidant and supports thyroid gland function, whereas iodine is essential for hormone synthesis and metabolic regulation (Holben & Smith, 1999). Small indigenous fish species consumed with bones are excellent sources of calcium and micronutrients and contribute significantly to nutritional security in rural populations.

6. Fish as Functional Food

In recent years, fish has gained attention as a functional food because it provides health benefits beyond basic nutrition (Ryan et al., 2011). Fish-derived peptides and bioactive compounds possess antioxidant, antimicrobial, antihypertensive, anti-inflammatory and neuroprotective activities that contribute to disease prevention and healthy aging (Sila & Bougatef, 2016).

Marine bioactive peptides isolated from fish skin, muscle, bones and hydrolysates have demonstrated strong antioxidant properties by reducing oxidative stress and protecting cells against free radical damage. Fish-derived antimicrobial peptides also inhibit the growth of pathogenic microorganisms and strengthen immune defense mechanisms (Ryan et al., 2011). Fish oils and peptides have shown beneficial effects in wound healing and tissue repair by regulating inflammation and collagen synthesis (McDaniel et al., 2008). Due to these therapeutic properties, fish-derived compounds are increasingly being utilized in pharmaceutical, cosmetic and nutraceutical industries.

Recent studies have also suggested that bioactive compounds from fish may help regulate hypertension, diabetes, inflammatory disorders and neurodegenerative diseases (Li et al., 2020). Therefore, fish is now recognized not only as a nutrient-rich food but also as a valuable source of functional ingredients for promoting human health.

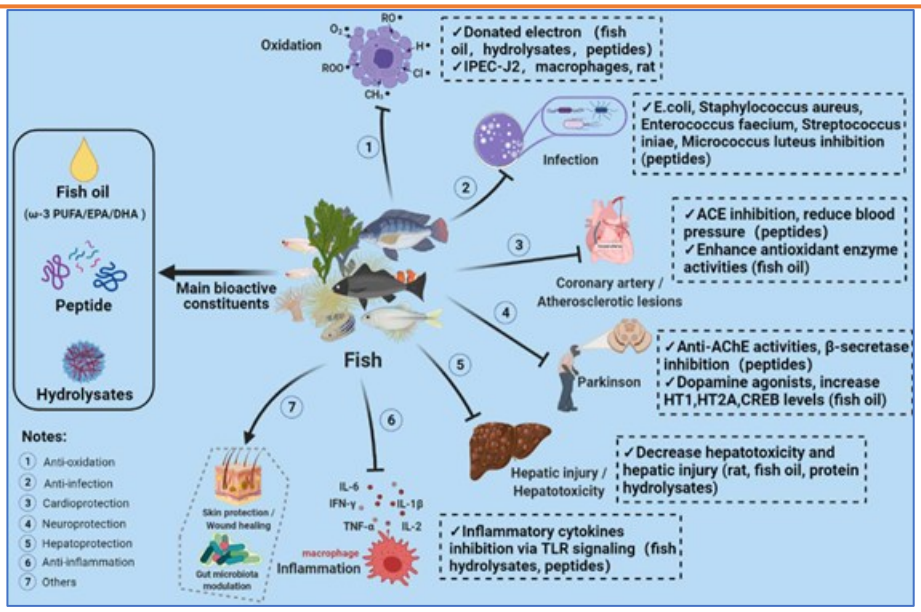

Fig. 2 Health benefits of fish consumption and their corresponding bioactive constituents

7. Conclusion

Fish is one of the most valuable foods for human nutrition because it provides high-quality proteins, essential fatty acids, vitamins, minerals and bioactive compounds that contribute significantly to human health and disease prevention. Fish proteins support growth, tissue repair, immunity and prevention of protein-calorie malnutrition, while omega-3 fatty acids such as EPA and DHA play major roles in cardiovascular protection, neurological development and inflammation control. Fish also serves as an important source of vitamins A and D along with essential minerals such as calcium, iron, selenium and iodine that are required for bone health, thyroid function, blood formation, metabolism and immunity. In addition, fish-derived bioactive peptides exhibit antioxidant, antimicrobial, anti-inflammatory, antihypertensive and neuroprotective activities that make fish an important functional food for healthy aging and disease prevention. Despite its nutritional and therapeutic importance, fish consumption remains lower than recommended levels in many regions due to lack of awareness and dietary habits. Therefore, increasing awareness regarding the health benefits of fish and promoting sustainable fisheries and aquaculture development can significantly improve nutritional security, public health and economic growth worldwide.

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