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5. Harvesting Nutritional Treasures: Unveiling the Vital Role of Fish in Human Nutrition

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Abstract:

Fishes play a pivotal role in human nutrition and make multifaceted contributions to overall well-being. From being a rich source of omega-3 fatty acids that support cardiovascular health to providing high-quality protein crucial for muscle development, fish emerges as a nutritional powerhouse. The chapter explores the abundance of vitamins and minerals in fish, emphasizing their significance in immune function and bone health. Beyond the physiological benefits, the cognitive advantages linked to omega-3s are discussed, highlighting fish as a brain-boosting dietary component. Understanding the holistic impact of fish consumption enhances our appreciation for its vital role in fostering a nutritious and resilient human diet.

Keywords:

Fish, dietary intake, human nutrition, omega 3, proteins

5.1 Introduction:

Despite significant technological advancements over the previous 50 years, malnutrition is becoming the world's most critical problem due to the constant rise in population over the past few decades. According to estimates from FAO (2018), 11% of the world's population lives in poverty and lacks access to enough nutrient-rich food for healthy growth and human development.

Not alone is undernutrition a cause for concern, overnutrition is also becoming more and more of an issue. Since 1975, the number of obese persons has tripled, according to WHO (2020), making up 13% of all adults worldwide.

Additionally, the number of fatalities worldwide from cardiovascular diseases linked to obesity and hunger grew to 17.8 million by 2017.

By 2050, it is estimated that the population of developing nations in South Asia and Sub-Saharan Africa would increase by 2.4 billion people (Lipper et al., 2010). Although most people in these areas live off of agricultural products, sustainable production is limited by a number of issues including salinization, desertification, irregular rainfall patterns, and overuse of natural water resources (Godfray et al., 2010).

It is only through the adoption of novel approaches that increase production while reducing the strain on natural resources, that the most optimal and sustainable supply of nutrients can be achieved.

Aquaculture is considered a highly effective means of supplying food, especially in less developed countries. According to the World Bank's 2013 research, "Fish to 2030: Prospects for Fisheries and Aquaculture," aquaculture is expected to supply about 62% of all fish used for human consumption by the year 2030. Fish is thought to be a great source of nourishment and health benefits for people.

The fish that are cultivated most frequently are tilapia, carps, and catfish. It is projected that by 2030, the worldwide aquaculture yield will reach 7.3 million tons in order to meet this target. At present, fish is a source of nearly 20 percent of average per capita consumption of total animal protein intake to 3.2 billion people.

The fisheries and aquaculture sector is very crucial for improving food security and human nutrition.

Majority of the population has already accepted the importance of fish as a part of a healthy diet. Fish can be considered as a treasure of nutrients. A large portion of the world's population consumes 20% or more of their protein from fish, making it a nutritious diet that is especially important in developing nations (Bene et al., 2007).

Furthermore, fish is a great source of health-promoting oils, particularly omega (α)-3 polyunsaturated fatty acids (PUFAs), Eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). Small indigenous fish (SIFs) are particularly rich in micronutrients, which may help eliminate diseases associated with micronutrient deficiencies that are common in developing nations (Mohanty et al., 2016a; 2017).

A few micronutrients, such as vitamin D in fatty fish and/or minerals like iodine, selenium, magnesium, zinc, and calcium, are more prevalent in aquatic animals than in other sources, such as plants or meats from mammals.

Being able to reach individuals from all income levels high, medium, and low makes them one of the most widely consumed forms of animal protein. Fish plays a significant role in this since it is a rich source of vital nutrients that are needed to offer a balanced diet. In light of this, the Fisheries Science Division of the Indian Council of Agricultural Research (FSD-ICAR) has collaborated with various research institutes to generate the nutritional composition of food fish from India that come from a variety of habitats, including freshwater, coldwater, brackishwater, and marine environments. The goal of this effort is to create and record comprehensive scientific data on the nutrient profiles of commercially important food fish.

5.2 Fish and Its Benefits as a Food Source:

Fish, a culinary delight and a nutritional powerhouse, stands out as a remarkable food source with a plethora of health benefits. There are multifaceted advantages that are offered by fish to human health and well-being.

Foremost among the benefits is the rich presence of Omega-3 fatty acids, a class of essential fats crucial for optimal bodily function. These fatty acids, notably EPA and DHA, are renowned for their cardiovascular benefits.

Regular consumption of fish has been associated with a reduced risk of heart diseases, owing to the ability of Omega-3s to lower blood pressure, reduce triglycerides, and improve overall heart health.

Fish also emerges as a superior source of high-quality protein. The proteins found in fish are easily digestible and provide all essential amino acids, making it an ideal dietary component for muscle development, repair, and maintenance.

This aspect is particularly valuable for athletes and individuals engaged in physical activities. Beyond protein, fish is a treasure trove of vitamins and minerals vital for various physiological functions. B vitamins, including B12, play a crucial role in energy metabolism, while vitamin D supports bone health. Minerals like iodine and selenium contribute to thyroid function and antioxidant defense, respectively.

The benefits extend to cognitive health, with Omega-3s being linked to improved brain function and a potential reduction in the risk of neurodegenerative disorders. Studies suggest that regular fish consumption may contribute to enhanced memory, concentration, and a lowered risk of conditions like Alzheimer's disease.

Moreover, fish exhibits anti-inflammatory properties, a quality attributed to its Omega-3 content. This anti-inflammatory effect is not only beneficial for cardiovascular health but also contributes to the alleviation of various inflammatory conditions in the body. The advantages of incorporating fish into one's diet also extend to weight management. Being a low-calorie, nutrient-dense food, fish can be a valuable ally in maintaining a healthy weight. Its ability to induce a sense of satiety makes it a satisfying yet calorie conscious choice for those conscious of their dietary intake.

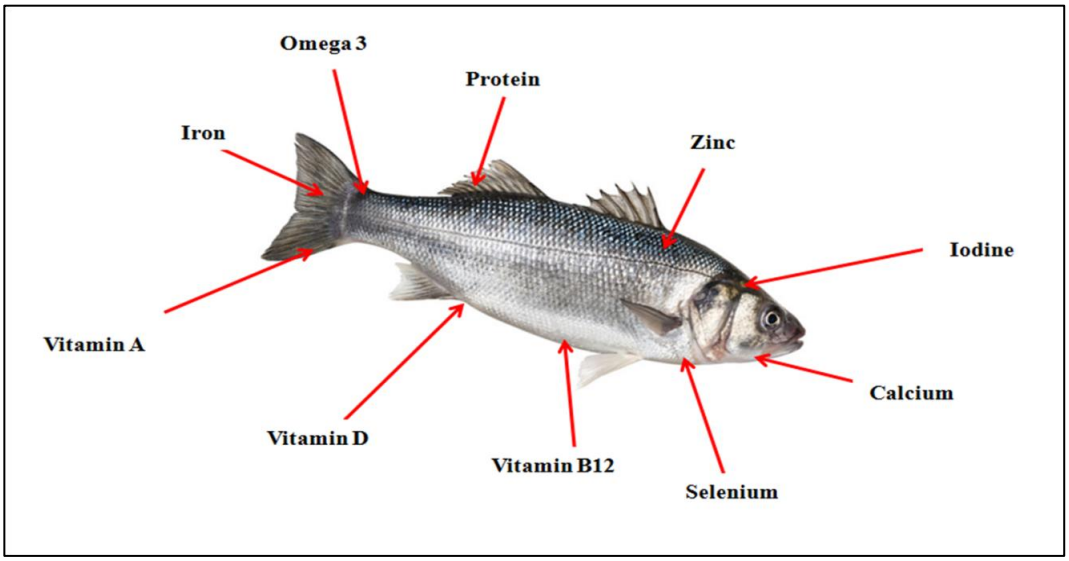

Figure 5.1: Some Important Constituents in Fish food

5.3 Nutritional Value of Fish:

5.3.1 Proteins and Amino Acids:

One of the most crucial structural and functional elements of bodily cells, proteins are practically necessary for maintaining the integrity and functionality of the cells. Numerous studies indicate that fish and fish-based products are an excellent source of high-quality protein and may even be advantageous to human health (Vildmyren I et al., 2018)

The amount of important amino acids presents in the protein, its susceptibility to enzymatic digestion, its amino acid composition, and the chemical alterations brought about by processing techniques are some of the elements that affect the protein's nutritional value in food. Higher concentrations of the essential amino acids are indicative of high-quality protein, and diets based on fish are enhanced with these amino acids especially the leucine and lysine. Besides these other non-essential amino acids such as alanine, glutamic acid and aspartic acid are also abundantly present in the fish (Ross A et al., 2017).

Just because each amino acid has a distinct function in our body, it is needed in varying amounts under both normal and pathological circumstances. For instance, Arginine consumption helps in treating hypertension and anxiety; Leucine helps in muscle protein synthesis and sepsis; Methionine helps in treating liver disorders, asthma and Parkinsons's disease and Trypthopham helps to treat premenstrual dysphoric disorder and insomnia (Dorniak et al., 2014; De Bandt & Cynober 2006; Mischoulon & Fava 2002 ; Segura & Ventura 2009).

Therefore, dietary advice to meet specific requirements of individual amino acids would benefit from a complete analysis of the amino acid composition of different food fishes. In general, it was observed that among the various fishes studied, lysine and leucine content is rich in cold water fishes, leucine alone is rich in marine fishes and glycine and glutamic acid is richly present in carps and catfishes (Mohanty et al., 2019).

5.3.2 Lipids and Fatty Acids:

Lipids are macro-biomolecules that are insoluble in water but soluble in organic solvents. They have a range of biological activities in the body, including that of fuel molecules, energy reserves, and membrane components.

The two types of lipids found in the body are structural and storage lipids. Structural lipids make up the vital components of cell structure, including cell membranes, whereas storage lipids serve as the body's fuel reserve.

Lipids come in three main categories: cholesterol, glycolipids, and phospholipids. Cell membranes are made entirely of phospholipids, glycolipids serve as indicators for cellular recognition, and cholesterol is a crucial component of fat transport, a major modulator of membrane fluidity, and the precursor to steroids. Fatty acids are the fundamental building blocks of the various lipid types; they are carboxylic acids with long aliphatic chains.

Lack of the necessary fatty acids in proteins can cause poor wound healing, increased susceptibility to infection, and impaired growth in babies and children (Jeppesen et al., 1998).

Additionally, fat is a necessary component of the human body that provides energy when needed excessively. It is also a crucial part of the cell membrane, which is required for the absorption of fat-soluble vitamins. Therefore, it becomes vital to consume fat in adequate quantities for maintaining good health and well-being.

In this context there are many fishes which have varied levels of fat and fatty acids. Fish oil is a great source of EPA and DHA and therefore fishes such as tuna, salmon and sardines are very much exploited for their oils. The fishes' fat percentages ranged widely from 0.6 to 10.5%. The migratory fish Tenualosa ilisha has the highest fat content (10.5%), followed by Sardinella longiceps (9.2%). C. catla, L. rohita, and C. mrigala are the three main freshwater fish farmed nationwide; their relative fat contents are 2.8, 2.7, and 2.8% (Mohanty et al., 2016b). The majority of the fish in the SIFs fell into the category of medium fat (4–8%). Cellular processes and overall health depend on fatty acids.

The role of omega (α)-3 polyunsaturated fatty acids (PUFAs) in preventing cardiovascular diseases has been demonstrated by a number of studies conducted on humans, animals, tissue cultures, and clinical trials (Abeywardena and Patten 2011).

The field of PUFAs first gained attention when researchers examined the health of Greenland Eskimos, whose diet included a notably high proportion of fat from whale, seal, and fish but had a low incidence of cardiovascular disease (Bang and Dyerberg 1976). Subsequent research revealed that the sort of fat they ate contained high concentrations of omega-3 polyunsaturated fats (DHA, 22:6) and EPA, 20:5), which deficits cause a variety of symptoms and illnesses. DHA is the principal PUFA found in brain neurons, retinal cells, and other main structural constituents of skin, testicles and sperms.

DHA is a nutrient that is primarily acquired from diet and is considered important. Fish from cold-water and marine environments make up good dietary sources of DHA. The primary source of DHA is marine microalgae, and as these microalgae are at the base of the food chain, the supply of DHA progressively grows (van der Voort et al., 2017). Diabetes, abnormal plasma lipid levels, insulin resistance, hypertension, and obesity are cardiovascular risk factors that are also brought on by dietary and lifestyle issues. These findings suggest that diet-related interventions may be beneficial (Abeywardena and Patten 2011).

Consuming fish, especially oily fish high in omega-3 LC-PUFA, has been shown to reduce the risk of cardiovascular death in previous epidemiological and clinical trial research (Abeywardena and Patten, 2011).

5.3.3 Vitamins:

Micronutrient deficiencies, such as those in vitamins and minerals, are also known as "hidden hunger" since them both dictate and worsen a person's quality of life and state of health. Micronutrients are essential for maintaining tissue functioning and metabolism.

In illness situations, the flux of micronutrients is regulated by a highly coordinated system. One in three people worldwide suffer from hidden hunger, which is a chronic lack of minerals and vitamins.

In light of this, at the United Nations Millennium Summit in 2000, programs to supplement micronutrient intake were included as a crucial part of the Millennium Development Goals, with the goal of using micronutrient initiatives to build a world free of hunger.

Vitamins are a class of organic chemicals that the body needs primarily for cell growth and development as well as appropriate cell functioning.

The human body's lack of certain nutrients can result in a number of health issues. Vitamins are rich in fish meals (Erkan N et al., 2007), primarily fat-soluble vitamins and several B-complex vitamins. Compared to plant sources, vitamin A is more easily obtainable in fish food. It is commonly known that oily fishes are high in Vitamin D (Spiro A et al., 2014).

Vitamin A –

The human body basically needs vitamin A to function properly in a number of areas, including growth, vision, and the immune system. Fruits and vegetables that are yellow or orange are high in provitamin a carotenoid.

These can be converted by humans into retinol, but how well they are converted depends on a variety of factors, including dietary fat consumption, food matrix, and genetics (Olson JA et al., 1989). However, diets derived from animals are preferred because they include preformed retinol, which has a higher absorption capacity and bioavailability (Kwasek K et al., 2020). Whole eating small fish species provide higher levels of vitamin A.

Vitamin D –

Vitamin D is formed in the body by the action of sunshine on human skin, however with today's lifestyle, vitamin D supplements are becoming more and more necessary because people choose to spend less time outside. It is essential to the body because it facilitates the intestinal absorption of calcium and phosphorus, which keeps the blood's calcium levels at their ideal levels (Sanjurjo P et al., 2003). As a result, it encourages bone mineralization and facilitates the growth of teeth. Three times as strong as the vitamin D found in mushrooms, ergocalciferol, is the type of vitamin D found in fish, cholecalciferol (Holick MF 2008). Furthermore, it can also be stated that different processing techniques have an impact on the amount of vitamin D.

Vitamin E –

Widely recognized for its antioxidant qualities, vitamin E shields the cell from extremely reactive free radicals, which could otherwise cause oxidative damage to the cell or trigger any other chronic illness linked to it, including cancer, Alzheimer's disease, dementia, eye problems, and cardiovascular diseases. It also has a major impact on immune system regulation, preventing platelet aggregation and anti-inflammatory responses.

Fish species include Anabas testudineus, Puntius sophore, Amblypharyngodon mola, Sardinella longiceps, Tenualosa ilisha and Epinephelus spp. have higher fat-soluble vitamin contents.

Vitamin B12 –

Vitamin B12 is necessary for DNA synthesis, healthy blood cell development, and a number of neurological processes. Supplementing with it could lower the chance of developing cardiovascular diseases. Fishes are abundantly rich in this Vitamin.

5.3.4 Minerals:

Seafood is also abundantly loaded with minerals such as Calcium, Phosphorous, Iron, Zinc and Iodine. Fishes have a well blanched amount of most minerals either macro minerals or trace minerals.

Calcium –

One of the most prevalent and vital micronutrients in the human body is calcium. About 99% of it is found in the soft tissues and bones. Due to insufficient calcification of the bones, a calcium deficit in developing children can result in rickets, and in adults, it can induce osteomalacia and osteoporosis (Hays V et al., 1985).

Additionally, an insufficient amount of calcium might affect an organism's dentition. Because they have a higher need for calcium and phosphorus, women who are pregnant, growing, or nursing can benefit from taking supplements of calcium.

Small fish are an excellent source of calcium if they are eaten whole, including the bones. Similar to milk calcium, it has a high bioavailability; in fact, its concentration is about eight times higher than that of milk (Larsen T et al., 2020).

An analysis of the data indicates that consuming 65 grams of edible fish flesh per person each day can fulfill 31% of the average daily requirement (Roos N et al., 2007). Small fish is therefore the best complementary food to have on hand in the event that milk and other rich sources are unavailable.

Phosphorous –

Phosphorus is a crucial component of nucleic acids, phosphorylated metabolic intermediates, adenosine triphosphate (ATP) molecules, bones, and teeth. Phosphorus oxide bonds, which are high-energy molecules, are formed and broken during the energy exchange process in live cells (Hays V et al., 1985). The final stage of cell signaling is the phosphorylation of signaling molecules. Phosphorus deficiency can cause De Toni-Fanconi Syndrome, osteomalacia, and rickets. According to reports, fish and seafood are a better supplier of phosphorus than diets based on other terrestrial animals.

Iron –

Numerous processes related to development, immunity, and healing require iron. One of the most prevalent dietary disorders affecting people worldwide is iron deficiency (Blanco R.R. et al., 2019). Low oxygen transport to the tissues may arise from it, which could impair cognitive function and cause weakness, exhaustion, fatigue, and reduced work ability (Camaschella C 2015).

Fish-based iron sources differ from plant-based iron sources in that fish-based iron sources include a significant proportion of heme iron, which plant-based sources do not.

Zinc –

Zinc is necessary for wound healing, nucleic acid metabolism, and the creation and digestion of proteins. The staple foods that make up the human diet often have lower zinc contents (Kawarazuka N et al., 2011). Furthermore, people cannot store zinc in their bodies; as a result, daily dietary supplements containing zinc are required. Since small fish is a superior source of zinc than other animal-based zinc sources, it should be supplemented with staple food. This will also help to offset the staple food's low bioavailability because it contains phytate.

Selenium –

The body needs selenium because it supports immune function and antioxidant activity, both of which keep the body healthy. It is known to reduce the risk of several diseases, including thyroid disorders and cancer, and is essential for both male and female fertility.

5.4 Conclusion:

The population of the Indian subcontinent makes up to 20% of the global population. One of the biggest challenges facing humanity is providing enough food for billions of people in an environmentally friendly way. In this scenario, researchers are looking for more resources to increase food production, and they are paying close attention to the prospect of using water as a major source of food. For the great majority of people in the undeveloped and impoverished globe, fish is an excellent source of most nutrients aside from carbohydrates helping to prevent protein calorie malnutrition and micronutrient deficiencies.

Fish is an extremely nutrient-dense dietary source that serves a variety of structural and functional purposes in the body, including providing building blocks for the synthesis of genetic material (DNA or RNA). Abundant in omega-3 fatty acids, it promotes heart health, reducing the risk of cardiovascular diseases.

Beyond cardiovascular benefits, fish provides high-quality protein, supporting muscle development and repair. Packed with vitamins (such as B12, D) and minerals (like iodine and selenium), it contributes to immune function and bone health.

Moreover, the omega-3s in fish have been linked to improved cognitive function, making it a brain-boosting addition to the diet. Embracing the multifaceted advantages of fish enhances our nutritional intake, fostering a healthier and more resilient lifestyle.

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