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Exploring Aquaculture's Role in Mitigating Global Hunger and Nutritional Deficiencies

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Abstract: *In order to combat hunger, achieving food security is the primary means of improving socioeconomic standing in each nation on Earth. This issue still exists in the current situation in developing nations. Therefore, the emphasis of human nutrition deficits is on how important animal protein is to a person's daily diet. Fisheries provide a substantial quantity of animal protein to people's diets all around the globe, which helps to solve this issue. The most affordable and nutrient-dense protein sources are aquatic animals. For the underprivileged, they provide vital vitamins, proteins, micronutrients, and minerals that may be added to meals as a valuable supplement. In developing nations, aquaculture is essential to both national economic growth and the world's food supply. According to the Food and Agriculture Organization (FAO), aquaculture has the ongoing potential to achieve economic development objectives for the nation and improve human welfare.*

Keywords: animal protein, aquaculture, food security, global economy, malnutrition.

I. INTRODUCTION

According to the Food and Agriculture Organization (FAO), 2000, food security is the ability for everyone to have safe access to adequate food at all times. For a person to survive, they need proper nutrition, a healthy environment, and enough health care; these factors are therefore intimately related to the social and economic well-being of a country, a community, and an individual. Food security at the local level is crucial for the country's economic development. With an increasing population and developing nations that often lack the resources, there is a need for a sufficient supply of food to ensure food security and safety.

Importance of Food Security

Concerns over food security are critical for emerging nations like India, where a sizable portion of the populace lives in poverty and where food accounts for a considerable portion of family expenses. Since a sizable section of India's rural population primarily relies on the aquaculture industry for their income and means of subsistence, this industry has a significant impact. This article's goal was to examine how the aquaculture industry contributes significantly to both national and household food security. India is compelled to use the green and blue revolutions to create food in order to feed its quickly expanding population. The adoption of transgenic animals and high-yielding rice varieties, together with the spread of better biotechnology applications and aquaculture output, were the key drivers of increases in food production (Srinivasan, 2003).

The idea of food security is altered by food preferences from just having high availability to the food of choice and sufficient access to food. This suggests that despite having equal availability to food, individuals with varying dietary choices may exhibit varying degrees of food security.

Aquaculture role in Food Security

An significant part of the global food economy is the fishing industry. About 200 million individuals who rely only on ocean fishing for their livelihoods find work in the fishing industry (Gareth, 2001). For around 950 million people globally, fish serves as their main protein source and is a significant component of the diets of many more. Numerous

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researchers have shown the relationship between total fish consumption and population increase, speculating on data from 1970 to 2010 (FAO, 2000; Delgado et al., 2002; Tacon, 2003).

The average global fish intake per person has almost quadrupled in less than 50 years (World Fish Center [WFC], 2002). Around 16% of the animal protein eaten by people worldwide comes from fish, which is also a great source of important fatty acids and minerals. The main food source of omega-3 fatty acids for humans is fish.

In addition to being essential for a baby's healthy brain and vision development, omega-3 fatty acids (Figure 2) can help prevent a variety of diseases in humans, including depression, lupus, cardiovascular disease, and other mental disorders (Crawford and March, 1989). Capture fisheries and aquaculture output are dominated by Asia, whereas India leads the globe in aquaculture production with about 13 lakh tons (Table 1; FAO, 2011).

According to Delgado et al. (2002), the majority of the expansion in the fisheries industry is expected to take place in emerging nations, which will produce 79% of the world's edible fish.

Fish Production Relation to Food Security

Conventional large-scale aquaculture typically contributes positively. Because fish production adds to the total amount of food available to the people, it also has a significant impact on food security. Aquaculture's contribution to the food security of the underprivileged, who are most vulnerable to malnutrition, must also be considered a major influence. However, the aggregate tonnage estimates rose between 2016 and 2018 (Figure 1 and Table 2) (FAO, 2018) express the substantial influence of aquaculture on global food supplies.

Contribution of Fisheries to Food Security

A significant portion of the issue of food security is regulated by the fishing industry. For around 1 billion people worldwide, fish is their primary source of animal protein. Food production is not the only aspect of food security. It is the ability to physically and financially get enough wholesome food to fulfill one's nutritional demands (Gareth, 2001). For many impoverished people in developing nations, in particular, fisheries play a critical role in ensuring food security. In food-insecure low-income nations, they account for 22% of total animal protein intake. The reliance on fish is often greater in coastal regions and the vicinity of significant river systems (WFC, 2002). The significance of small-scale fishing is paramount.

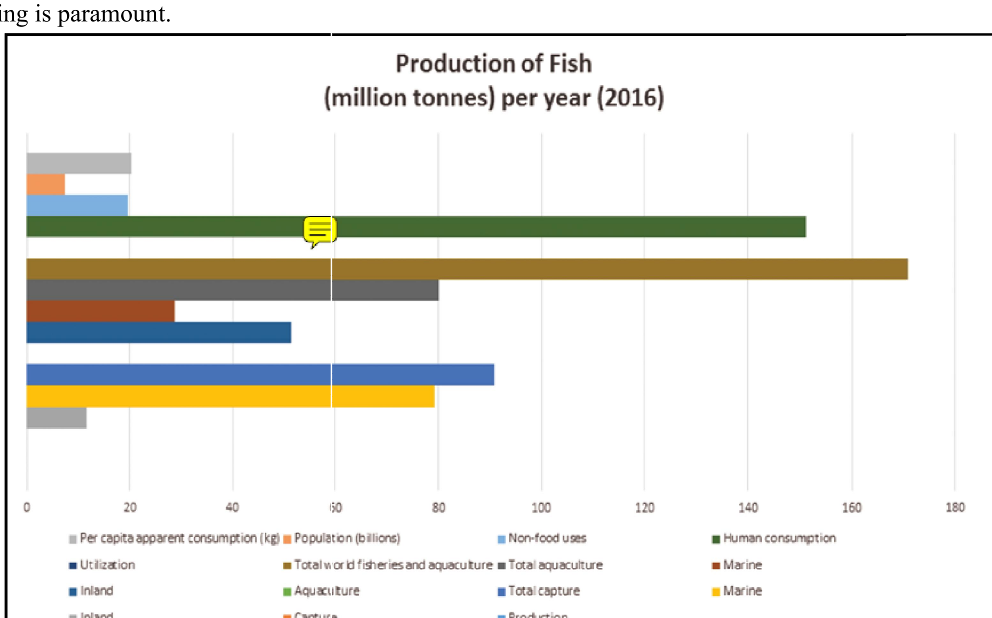

Figure 1. Global values of fish consumption and World Fisheries and Aquaculture latest FAO 2018 values in graphical representation.

Table 1. FAO in 2011 shows the global production of fish and sea foods utilized for direct human consumption

Sl. no.	Country	Production of fish (tons) per year
1	Asia total	18,826,453
2	China	11,315,492
3	Japan	1,397,020
4	India	1,395,444
5	Europe total	1,378,805
6	Korea, Democratic people's Republic	1,100,000
7	Republic of Korea	955,477
8	Americans total (North + South + Central)	810,110
9	Philippines	736,381
10	Indiana	645,368

Table 2. World fisheries and aquaculture production and utilization (million tons) in latest FAO 2018 reports

	Category	Production of fish (million tons) per year (2016)
	Production	
	Capture	
1	Inland	11.6
2	Marine	79.3
	Total capture	90.9
	Aquaculture	
1	Inland	51.4
2	Marine	28.7
	Total aquaculture	80.0
	Total world fisheries and aquaculture	170.9
	Utilization	
1	Human consumption	151.2
2	Nonfood uses	19.7
3	Population (billions)	7.4
4	Per capita apparent consumption (kg)	20.3

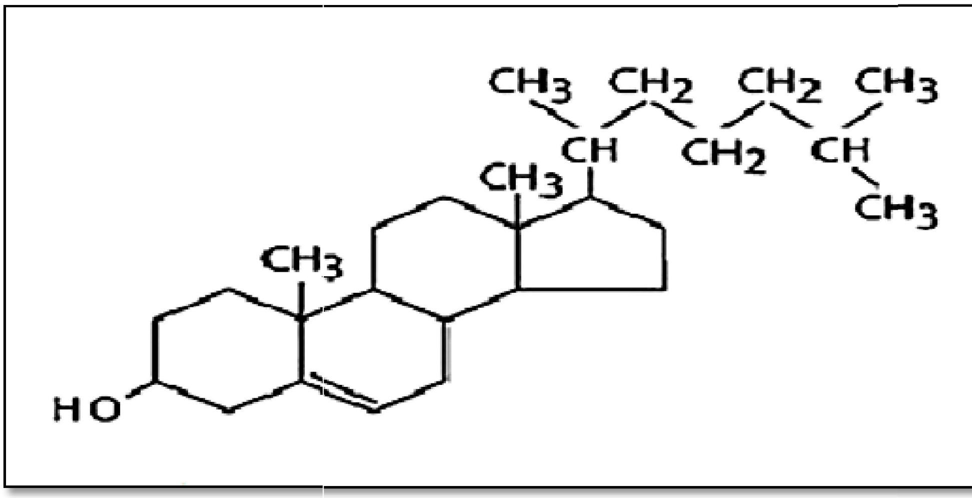

Figure 2. Structure of omega-3-fatty acid.

FAO emphasizes its importance in particular for food security (Crawford and March, 1989).

Total world fisheries and aquaculture

Use as a source of nourishment as they are consumed whole, "bones and all," providing calcium and other minerals. Furthermore, fish is a significant supply of vital fatty acids, minerals, and protein, making it a valuable complement to the diets of many impoverished individuals in developing nations, who mostly rely on carbohydrates (Bhaskar, 1994). According to the FAO (2011), the percentage change in fish consumption to the human diet is greater than the change in the overall amount of animal protein consumed (Table 1).

II. DISCUSSION

Biotechnology role in Aquaculture

Fish output is being greatly improved by biotechnology, which is contributing to the global challenge of food security. Aquaculture, or intense aquaculture, is the production of aquatic creatures under regulated systems using technology applications that enable the control of population densities greater than those found in nature and optimize culture management.

By introducing desired genetic features into fish via biotechnology, a tougher stock may be produced. Transgenic fish are created by transferring genes from one species to another. Researchers are working to enhance the genetic characteristics of the fish utilized in aquaculture using various transgenic approaches. Scientists are working to create fish that are bigger, grow quicker, convert feed into muscle more effectively, are immune to illness, can withstand low oxygen levels in the water, and can withstand freezing temperatures. Researchers experimenting with different forms of growth hormone application in fish want to develop fish that are bigger and longer. Fish dipped in a hormone-containing solution is one way to do this. There are a few issues with this method, however. First off, the process is labor-intensive, making it challenging to create huge amounts of pure growth hormone, and it may be challenging to gauge if the fish are receiving the proper dosage of the hormone. In order to accelerate their development, scientists have created new strains of transgenic fish that naturally manufacture the correct quantity of growth hormone. Because these fish would naturally create more growth hormone and would transmit this feature on to their progeny, they are more economically viable. Researchers mostly use two methods to transfer genetic material in fish. One method involves injecting genetic material into freshly fertilized fish eggs, and is referred to as microinjection. However, since this process takes a lot of time, researchers could rather use electroporation. This entails using an electric current to introduce DNA, or genetic material, into fish embryos. By inserting DNA into embryos or adult fish's somatic tissues directly, a foreign gene may be introduced into fish in vivo (Sudha et al., 2001). The straightforward method of directly delivering DNA into fish tissues yields quick results and does away with the requirement to screen transgenic individuals and choose germ line carriers. Numerous experiments have succeeded in achieving gene transfer and expression after intramuscular direct injection of foreign DNA into fish skeletal muscles (Hansen et al., 1991; Maclean

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et al., 2002). The phrase "genetic engineering" is ambiguous and has become almost synonymous with "gene transfer," which refers to the creation of transgenic fish or other genetically engineered organisms. With the fast advancement of technology, genes from distantly related species may now be transferred. Researchers and aquaculture firms have focused on genetically engineering fish that would grow faster and use less feed since the advent of GE fish in the early 1990s (Aken, 2000). As was previously indicated, several research teams have successfully inserted growth hormone genes—derived from either human or animal sources—into a variety of fish species, including tilapia, salmon, carp, trout, and others, enabling them to develop at a rate that is several times faster than that of their native species.

Hybridization

With the development of artificial breeding techniques, such as the use of pituitary gland extract and other hormones to initiate gamete development, induced spawning (the depositing of eggs), and a greater understanding of environmental cues that influence reproduction, such as day length, temperature, or water current, hybridization—a simple genetic technology—has become easier. Fish farmers can now circumvent many of the natural reproductive isolation measures that species evolve in the wild. Aqua culturists have benefited immensely from these advancements in reproductive technology in their endeavors to domesticate aquatic animals. Additionally, producers are able to mate with many more species at the most advantageous periods, helping to maintain a stable and regular supply of fish for the market by eliminating the natural limitations and timing of breeding. In cases when the sex-determining mechanisms in the parental lines vary, hybridization may also be utilized to generate single-sex groups of fish. One such example is the hybridization of Oreochromis aureus, the blue tilapia, with Nile tilapia, Oreochromis niloticus.

Cryopreservation

Gametes may now be stored for both short and extended periods of time because to advancements in cryopreservation and low-temperature technologies. These low-temperature methods are often not preserved in this manner and are now limited to usage on male gametes eggs and embryos. When breeding species when the sexes mature or migrate at separate times, when the mating season is short, when the breeders are far apart, or when one sex is very scarce, freezing gametes may help a fish breeder be more flexible (Hagedorn et al., 1997). This method helps farmers and aquaculture producers store and preserve species.

Health Improvement of Species

Significant prospects exist in biotechnology to enhance the health and welfare of aquacultured creatures. For example, the United States' fish and shellfish aquaculture industry suffers losses of tens of millions of dollars a year due to over fifty illnesses (Shelton, 1996). Biotechnology may lessen disease transmission between cultivated and wild stocks in addition to increasing the life, vitality, and well-being of farmed stocks. It is possible to create new goods and business prospects pertaining to the health and welfare of aquatic animals. Fish health is being improved via genetics and technological applications, including molecular diagnostics and traditional selection for disease resistance. Moreover, vaccinations using genetic engineering are being developed to protect fish against infections.

Malnutrition

When a child's consumption of proteins and energy foods—which are measured in joules or calories—is significantly below what their body requires, particularly for growth, it is referred to as malnutrition. Malnutrition, according to Sobharani et al. (1986), is caused by insufficient consumption of calories, protein, and other nutrients. The illnesses that are directly linked to inadequate nutritional intake are perhaps the most significant effects of malnutrition. Due to their prevalence, both kwashiorkor and marasmus—which mostly affect children in their first two years of life—have an impact on the economy. They are the extremes of malnutrition related to protein and energy. Kwashiorkor often occurs even when youngsters are consuming adequate food, if they are lacking in a certain nutrient (proteins, in this case). However, mar- asmus develops when a youngster is starving and does not get enough food of any type. When food consumption is lower than recommended nutritional levels, it is referred to as undernutrition. Young children's nutritional status is a sensitive measure of a population's health and amount of sustenance. Children who are malnourished develop slowly and are more susceptible to infectious infections. A diet high in fish is essential for reducing malnutrition, particularly in young children.

Many interconnected causes may lead to malnutrition. The two primary causes are infectious infections and an insufficient nutrition, which often coexist. According to Young and Jaspers (1995), there are three categories of underlying causes that give rise to the immediate causes. These include maternity and child care, basic health services, and food security. The three categories of underlying causes interact with each other in real life. It was formerly believed that eating meals rich in protein might treat malnutrition, which was caused by a protein shortage. When the relationship between energy and protein was understood by the middle of the 1970s, energy intake started to get more attention in nutritional issues. This broadened the definition of nutrition to include social and economic problems including food availability, poverty, and associated problems.

Fish and Macronutrients Proteins

The body needs proteins for growth and development, for the maintenance and repair of aging tissues, and for the synthesis of hormones and enzymes needed for several bodily functions. It is often known that fish plays a significant role in supplying very biologically valuable, readily digested protein. This has previously been used as an excuse to support aquaculture and fishing initiatives in a number of nations. Fish has a considerable amount of protein (18%–20%) on a fresh weight basis. It also provides all eight necessary amino acids, including sulfur-containing amino acids like cysteine, methionine, and lysine (Sobharani et al., 1985). Since most diets based on maize lack these compounds, rural African households who rely heavily on maize stand to gain a great deal by boosting their intake of fish.

Fats

Fish typically contain less fat than red meat, however this might vary depending on the species and time of year (Bhaskar, 1983; Murthy et al., 2000). The range of fat content is 0.2% to 25%. However, the polyunsaturated fatty acids (PUFAs) found in the fats from fatty fish species, such as DHA (docosahexaenoic acid; Figure 3b; omega 3 fatty acids) and EPA (eicosapentaenoic acid; Figure 3a) (Figure 2), are necessary for children's healthy growth and are not linked to the development of cardiovascular illnesses like coronary heart disease.

The right development of the unborn child's brain has been linked to pregnant women's diets containing PUFAs. Omega 3 fatty acids have also been linked in other studies to a lower risk of low birth weight and premature delivery. In addition, fat helps provide energy and facilitates the right absorption of fat-soluble vitamins, such as A, D, E, and K (Figure 4).

Micronutrients Vitamins

Fish is a great source of vitamins, especially B1, B2, and B3 vitamins niacin, thiamin, and riboflavin, which are found in fatty species. The body can absorb vitamin A from fish more easily than it can from plant-based diets. Bone development and proper eyesight both depend on vitamin A. Compared to lean fish, fatty fish have higher vitamin A content. Research has shown that children under five who have a healthy vitamin A level have a lower death rate. Sun drying obliterates the most of the accessible

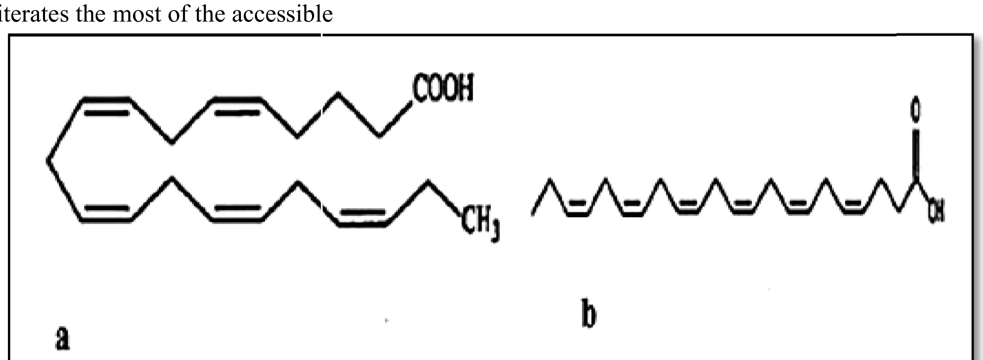

Figure 3. Structures of (a) eicosapentaenoic acid (EPA) and (b) docosahexaenoic acid.

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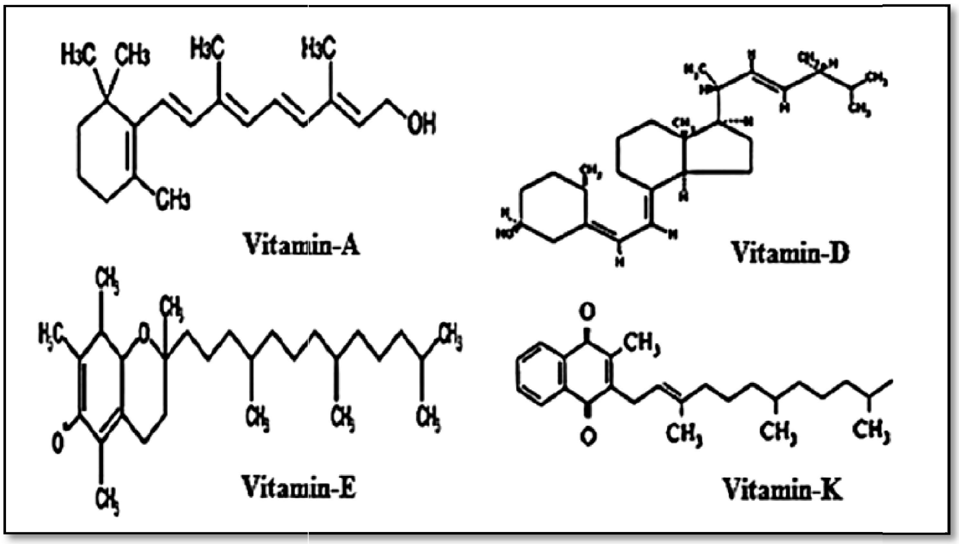

Figure 4. Structures of vitamins A, D, E, and K.

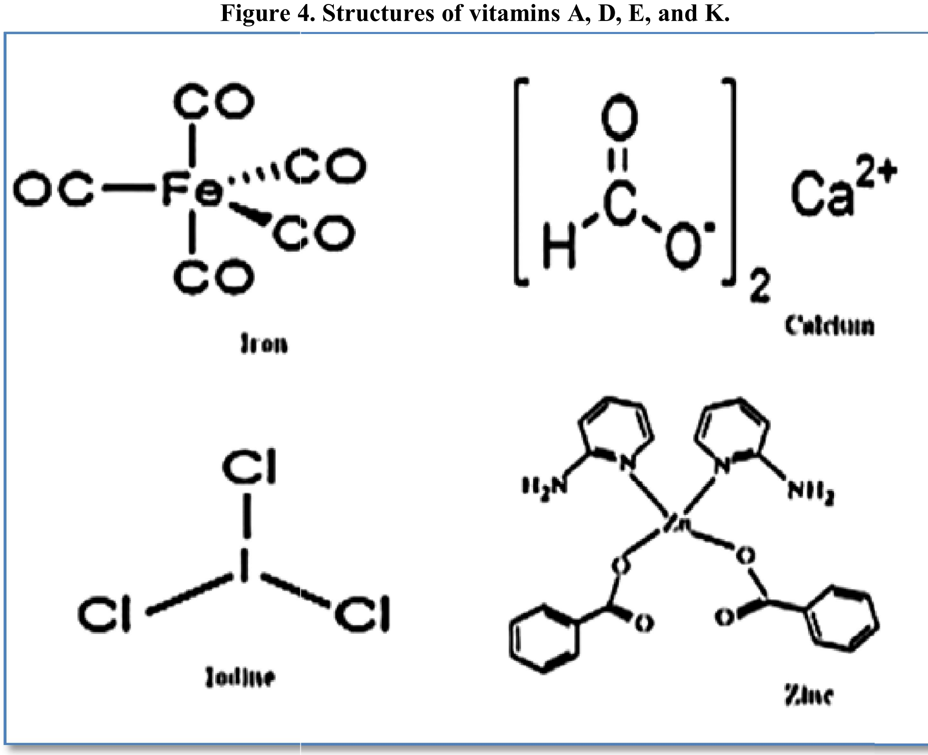

Figure 5. Structure of iron, calcium, iodine, and zinc.

improved processing techniques are needed to maintain vitamin A.

Because it is necessary for the absorption and metabolism of calcium, vitamin D, which is found in fish liver and oils, is crucial for the formation of bones. Niacin, riboflavin, and thiamin are necessary for energy metabolism. A little amount of vitamin C, which is necessary for healthy bodily tissues, effective wound healing, and iron absorption, is also present in fresh fish.

Minerals

Iron, calcium, zinc, iodine, phosphorus, selenium, and fluorine are among the minerals found in fish (Figure 5). These minerals are readily absorbed by the body due to their high "bio-availability." The production of hemoglobin in red

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blood cells, which is necessary for delivering oxygen to every area of the body, depends on iron. Anemia and reduced brain function are linked to iron deficiency, and in newborns, it is linked to bad conduct and low cognitive capacity. Its function in the immune system means that a lack in it may potentially raise the risk of infection. Strong bones (formation and mineralization), as well as the proper operation of muscles and the nervous system, depend on calcium. It is crucial to the process of blood clotting as well. For optimal absorption, vitamin D is necessary. When little fish are consumed with their bones rather than having the fish bones thrown away, the intake of calcium, phosphorus, and fluorine is increased. A calcium deficiency has been linked to osteomalacia (softening of the bones) in adults and elderly persons as well as rickets in young children. For healthy teeth and bones, fluorine is also essential. Because zinc coexists with proteins in vital enzymes needed for metabolism, zinc is necessary for the majority of bodily functions.
In addition to being essential for good skin and immune system function, zinc is also crucial for growth and development. Among other issues, a zinc shortage is linked to hair loss, skin issues, and poor development. Seafood contains iodine, which is necessary for hormones that control metabolism and for growth and good brain development in children. In youngsters, a lack of iodine may cause mental retardation and goiter, an enlarged thyroid gland. It is clear that fish adds more to diets than simply the high-quality protein that makes them so popular. Hence, fish ought to be a staple of every diet, since it helps the body absorb these macro- and micronutrients easily, avoiding malnourishment.

Health Benefits of Fish Oils

Fish, especially fatty fish like salmon, is rich in minerals and has many health advantages.

Table 3. Fish oil contents and sources, derived components, and their health and biological functional properties

Sl. no.	Contents	Properties
1	EPA	Lower serum levels of these two fatty acids
2	DHA	Designation of any fatty acid
3	Resolvin D1	Resolve inflammation
4	Resolvin D2	Resolve inflammation
5	Marisen 1	Macrophage mediators in resolving inflammation
6	Neuroprotectin D1	Anti-inflammatory properties
7	Protectins	Metabolites with a pentacyclic structure
8	Prostaglandins	PPARγ activation and platelet aggregation inhibition

and sushi. Iron and zinc are among the vitamins and minerals found in fish. Fish protein's many health benefits have mostly been linked to n-3 PUFAs like EPA and DHA. It has been shown that the only foods with a naturally high concentration of these fatty acids are fish. This results from fishes' high EPA and DHA ratio, which causes these fatty acids to build up in the food chain. sources and composition of fish oil The omega-3 polyunsaturated fatty acids (PUFAs) EPA and DHA have 20 and 22 carbons, respectively. Dietary supplements containing EPA and DPA have an effect on phospholipids, tri-glycerides, reesterified triglycerides, and ethyl ester. Table 3 shows that prostaglandins are engaged in PPARγ activation and platelet aggregation inhibition, resolvins and Marisen 1 are powerful signaling molecules derived from omega-3 fatty acids involved in resolving inflammation, and macrophage mediators in resolving inflammation.

III. CONCLUSION

Food insecurity is a complex issue that stems from several factors that restrict food supply or restrict the access of locals to it. A major component of the food insecurity issue facing lakeside communities is fish. Being a high-protein diet, it provides an answer to the children's protein deficiencies in the lake region. It might also be a source of revenue for those who grow, process, and sell fish. In spite of these benefits, national food policies place a low value on fish. The goals of the fisheries program recognize that fish may increase local food security, but the nation's need for foreign cash has taken precedence above domestic food security. The conversion of fishing into an industrial and commercial endeavor, issues with fisheries management, poor agricultural output, and societal barriers are some of the factors limiting food security. Given the substantial sums already invested in industrial fish processing, it would be necessary to for a certain level of exports to continue. Nonetheless, in order to maintain healthy fisheries and balance the demands for food security, the amount of fish that may be exported must be restricted.

REFERENCES

[1]. Aken, J. 2000. Genetically engineered fish: swimming against the tide of reason, Green Peace Canada 250 Dundas St. W, suite 60s, Toronto, Ontario MST25; p. 1–3.

[2]. Bhaskar, M. 1983. Tissue metabolic profiles of Tilapia mossam- bica (peters) acclimated to sublethal acidic and alkaline media [Ph.D. Thesis]. Tirupati (India): S. V. University.

[3]. Bhaskar, M. 1994. Changes in the liver protein fractions of Tilapia mossambica (peters) on acclimation to altered pH media. Fish Res. 19:179–196.

[4]. Crawford, M.A., and D. March. 1989. The driving force: food, evolution, and the future. New York (NY): Harper & Row.

[5]. Delgado, C., M. Rosegrant, N. Wada, S. Meijer, and M. Ahmed. 2002. Fish as food: projections to 2020 under different scenarios. MSSD Discussion Paper No. 52. Washington (DC): International Food Policy Research Institute.

[6]. FAO. 2000. The state of world fisheries and aquaculture. Rome (Italy): Fisheries Department.

[7]. FAO. 2011. Global aquaculture production, The State of World Fisheries and Aquaculture 2010. Rome (Italy): FAO; 2011.

[8]. FAO Fisheries and Aquaculture Department [online]. Rome. Updated 3 December 2018. [Cited 12 February 2019]. http://www.fao.org/fishery/

[9]. Gareth, P. 2001. Fisheries and the environment. Fisheries sub- sidies and overfishing: towards a structured discussion. Nairobi (Kenya): UNEP.

[10]. Hagedorn, M., E. Hsu, F.W. Kleinhans, and D.E. Wildt. 1997. New approaches for studying the permeability of fish embryos: toward successful cryopreservation. Cryobiology 34:335–347. doi:10.1006/cryo.1997.2014.

[11]. Hansen, E., K. Fernandes, G. Goldspink, P. Butter worth,P.K. Umeda, and K.C. Chang. 1991. Strong expression of foreign genes following direct injection into fish muscle. FEBS Lett. 290:73–76.

[12]. Maclean, N., M.A. Rahman, F. Sohm, G. Hwang, A. Iyengar, H. Ayad, A. Smith, and H. Farahmand. 2002. Transgenic tilapia and the tilapia genome. Gene 295:265–277.

[13]. Murthy, V.K., E. Madhuri, M. Bhaskar, and S. Govindappa. 2000. Changes in the lipid metabolism of freshwater fish, Sarotherodon mossambicus (Trewavas) on expo- sure to sublethal acidic stress. J. Trends in Life Scien. 15: 22–25.

[14]. Shelton, W.L. 1996. Reproductive manipulation of fishes: ecologically safe assessment of introductions. US-ARS. Biotechnology Risk Assessment Research Grants, Program Abstract of Funded Research. Mackie. Boca Raton (FL): Lewis Publishers; p. 12.

[15]. Sobharani, P., D. Bharathi, M. Bhaskar, and S. Govindappa. 1986. Pattern of selected amino acids in the tissues of fresh water fish on acclimation to sublethal acidic medium. Poll. Res. 5:93–96.

[16]. Srinivasan, P.V. 2003. Food security module India roles of agri- culture project International Conference, 20–22 October, Rome (Italy).

[17]. Sudha, P.M., S. Low, J. Kwang, and Z. Gong. 2001. Multiple tissue transformation in adult zebrafish by gene gun bombardment and muscular injection of naked DNA. Mar. Biotechnol. (NY). 3:119–125. doi:10.1007/s101260000056

[18]. Tacon, A.G.J. 2003. Global trends in aquaculture and com- pound aqua feed production: a review. In: International aqua feed directory and buyers' guide. p. 8–23.

[19]. WFC. 2002. World Fish Center. Fish for All: An Issue for Everyone. A Concept Paper.http://www.fishforall.org/ background/pdf/fishforall_issue_paper.pdf.

[20]. Young, H., and S. Jaspers. 1995. Nutrition matters: people, food and famine. London (United Kingdom): Intermediate Technology Publications.