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6. Nutritional Status of Small Indigenous Food Fishes W.R.T. Their Proximate Composition, Amino Acid, Fatty Acid, Vitamin and Mineral Contents

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Abstract:

Nutritional awareness is crucial in developing countries, as imbalanced nutrient consumption leads to malnutrition and poverty. Fish is a vital protein and essential nutrient source. More than one billion of people around the world include fish food in their regular diet in developing countries like India, poor villagers eagerly consume low-cost, easily available small fish species, which are abundant in water lands.

The nutrient status the small food fishes are of greater interest to the researchers in the field of biochemistry in terms of their socio-economic impact and sustainable human food chain. Advanced researches on the biochemical constituents of different fishes are signified and essential to the human health as well as medicinal practitioners to formulate newer medicines for the prevention of many life risk diseases of the community.

In this chapter mainly explain the small indigenous fish species and various types of nutrition present in the small fishes. This chapter discussed the proximate composition of SIF species such as protein, carbohydrate, lipids, minerals and vitamins contain in this species. Also explained the health benefits of these minerals and vitamin.

Keywords:

Proximate composition, Amino acid profile, fatty acid composition, proximate composition, minerals and vitamins

6.1 Introduction:

Fish is a dynamic source of food for human and it is mainly constituting the major source of dietary protein. Small fish is one of source of vitamin and calcium as dietary source (Sinha et al., 2024).

Small indigenous freshwater fish kinds (SIF) are the fishes which grow to the size of 25-30 cm in mature or adult stage of their life cycle (Sarkar & Lakhra, 2020). India, one of the 17 global mega biodiversity hotspots, is native to many freshwater fish species.

About 450 species are categorized as small indigenous fish species (SIF) in india (Mohanty et al., 2013).

Fish have bodies that are designed to contract coupled sets of muscles on both sides of their backbone alternately, which allows them to swim efficiently (Sfakiotakis et al., 1999). Fish swallow water through the gills that are located just behind their heads on both sides. Fish use their gills on either side of the pharynx to exchange gases. Filaments, which resemble combs, make up gills.

A capillary network that offers a sizable surface area for the exchange of carbon dioxide and oxygen is present in each filament. By sucking oxygen-rich water through their mouths and forcing it over their gills, fish exchange gases.

The gills' capillary blood flows against the direction of the water, facilitating effective countercurrent exchange. Via holes in the pharynx's sidewalls, the gills force the oxygen-poor water out (Romer & Parsons, 1977; Islam et al., 2023).

A large no. of native small fish species, which are available in natural resources, such as beels, floodplains, open water ponds, ditches, rivers, canals, rice fields, etc. As a consequence of the abundance of SIF in natural resources (Roos et al., 2002; Roos et al., 2003; Ahmed et al., 2022). Some important SIF species available in India are shown in Figure.6.1

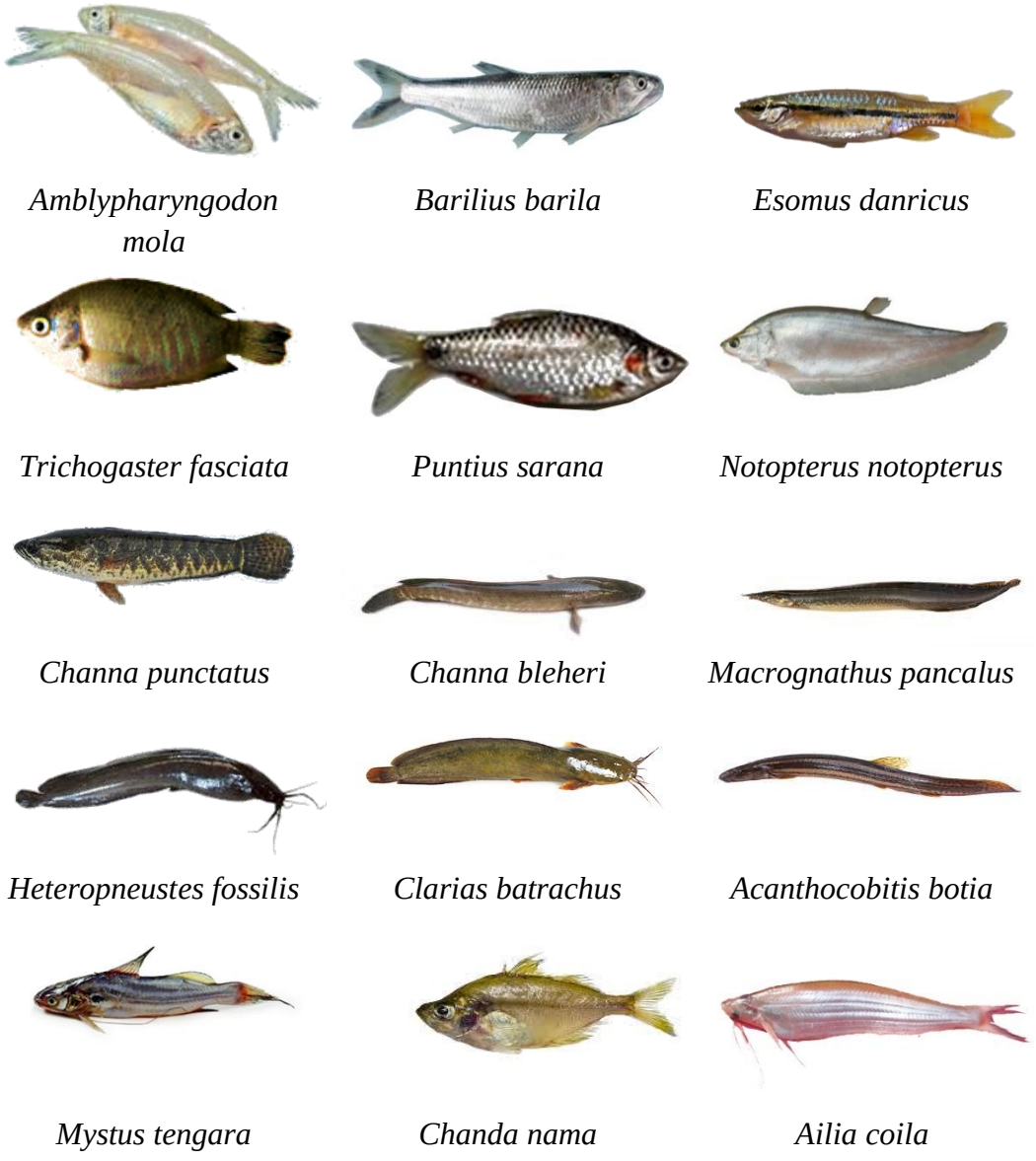

Figure 6.1: Images of Some Small Indigenous Fish Species.

Fish is one of essential source of dietary protein for people. In this chapter mainly explain the small indigenous fish species and various types of nutrition present in the small fishes.

This chapter discussed the proximate composition of SIF species such as protein, carbohydrate, lipids, minerals and vitamins contain in this species. Also explained the health benefits of these minerals and vitamin.

6.2 Proximate Composition of SIF Species:

Eating nutrient-dense foods is becoming more and more important in today's world, and fish is becoming more and more popular because of its special nutritional value.

Fish are regarded as a very nutritious component of the human diet due to their high content of micronutrients such as vitamins and minerals and also contain macronutrients as like proteins, fats, and ash (Love, 1970). Love et al.,1970 reported the main components of fish are 66%−81% water, 16%−21% protein, 1.2%−1.5% mineral, 0.2%−25% fat and 0%−0.5% carbohydrate (Begum et al., 2012).

Begum et al., 2012 described that 96%−98% of the body composition of fish is constituted by moisture, protein, fat and ash.[12] The assessment of these components is term as the ‘proximate composition' of fish (Bijaylakshmi et al., 2014).

A series of researcher reported the highly nutritive value of SIF. Bijayalakshmi et al., 2014 reported moisture and lipid content of some selected small indigenous fishes of Manipur 80-78% and 5.93-1.66% respectively (Tiwari et al., 2021).

Tiwari et al., 2021 reported protein, ash, calcium, phosphorus, potassium, magnesium, and iron content small indigenous fish species of Assam to be 55.15 ± 0.71 g/100 g to 61.32 ± 0.31 g/100 g,18.14 ± 0.69 g/100 g to 15.43 ± 0.45 g/100 g, 1,850.34 ± 2.40 mg/100 g to 2098.40 ± 2.37 mg/100 g, 799.17 ± 1.50 mg/100 g to 1,012.81 ± 3.86 mg/100 g, 653.26 ± 0.64 mg/100 g to 413.78 ± 1.47 mg/100 g,

331.02 ± 2.11 mg/100 g to 256.82 ± 1.65 mg/100 g, and 16.00 ± 1.29 mg/100 g to 12.53 ± 0.52 mg/100 g, respectively (Mohanty et al., 2014). In similar manner, Mahanty and coworkers also reported SIFs of Kolkata West Bengal contains essential amino acid histidine (22.94 ± 0.01 %), unsaturated fatty acid out of which oleic acid (28.63 ± 0.02 %), calcium (9,748.2 ± 23.96 mg kg^{-1}), followed by potassium (2,283.7 ± 12.75 mg kg^{-1}) and sodium (1,610 ± 22.34 mg kg^{-1}).micro minerals Fe (115.0 ± 8.81 mg kg-1), Zn (51.1 ± 10.15 mg kg-1) and Mn (11.2 ± 2.09 mg kg^{-1}), some fat soluble vitamins (A, D, E and K) and out of these vitamin E contain (30,685.8 μg kg^{-1}) (Masud and Halder, 2017).

Fish contain micronutrients and other elements helps for the maintenance of healthy body. Vitamins, minerals, and necessary nutrients possess the body healthy and sustain life (Mishra, 2020). The lipids of fish contain Cn-3 PUFA like EPA and DHA that not only maintains the blood pressure but also helpful in preventing the cardiovascular disease.

Iron helps in haemoglobin synthesis and prevents the occurrence of anaemia. Selenium is important for the functions of the thyroid gland.

Calcium and vitamin D naturally present in fishes, prevent the rickets, low bone-mineral density and osteomalcia to occur. Vitamin A helps to maintain the normal vision and normal immune system (Mayanglambum and Chungkham, 2018).

Fish meat contains essential amino acid as well as in the form of lipid and contains the high amount of polyunsaturated fatty acid which prevents a number of coronary heart diseases. The human body usually contains a small number of minerals and the deficiency of these principal nutritional elements causes various diseases which are the inability of the blood clot, osteoporosis, anaemia, etc (Memon et al., 2010).

Several researchers investigated the advantages of SIF fishes in healthy diet. Memon et al., 2010 described eight species of freshwater fish from the Indus River and

analyzed for their proximate composition and fatty acid. They reported fishes present moisture (59.95–79.45%), ash (0.05–4.95%), crude protein (17–20.09%) and lipid (0.85–18.32%). The monounsaturated (MUFA) fatty acid content (24.55–48.35 g/100 g) was higher than the saturated fatty acid (SFA) (25.04–41.02 g/100 g) and polyunsaturated fatty acid (PUFA) (15.72–35.34 g/100g). The predominant PUFAs were eicosapentaenoic acid (C20:5 n-3) and docosahexaenoic acid (C22:6 n-3).

Overall investigation reported reveals that Indus River fishes are good sources of n-3 fatty acids particularly EPA and DHA and should be recommended for dietary inclusion to reduce risks of cardiovascular disease (sarma et al., 2018).

Sarma et al., 2018 also investigated six small indigenous fish species namely Macrognathus aral, Setipinna phasa, Clupisoma garua, Aspidoporia morar, Barillius bendelisis and Semiplotus semiplotus which were collected from Brahmaputra River and its tributaries for analyzed their nutritional values. In proximate composition, protein and crude fat in all six fish ranged from 15.65 (S. phasa) to 20.88% (C. garua) and 2.91 (C. garua) to 13.23% (S. phasa), respectively. M. aral and C. garua, exhibited the healthy proximate compositional combination with high moisture, high protein and low lipid values. S. semiplotus, S. phasa and B.bendelisis were best in both n-3 LC-PUFAs content. M. aral and B. bendelisis showed best potential for mineral Ca; and S. phasa and M. aral showed for Fe (Ahmed et al., 2012). Tiwari et al. studied two small indigenous fish species, that are Puntius sophore and Amblypharyngodon mola. Fish flour developed from fresh fish species were analyzed for their nutritional compositions and results indicated the high content of protein, ash, calcium, phosphorus, potassium, magnesium, and iron content (Mohanty et al., 2014).

Ahmed et al. also reported nutrient composition of fishes collected from six diverse water areas locally mainly as Dogi. Cyprinus carpio contained the highest moisture

83.70% and Puntius ticto the lowest 75.02%. Puntius sophore had the most ash (3.56%), while Cyprinus carpio had the least (0.26%). Anabus testudineus had the highest protein percentage (19.50%), whereas Heteropneustes fossilis had the lowest proportion (15.14%).

Lepidocephalus guntea had the largest proportion of lipid (4.52%), while Pangasius pangasius had the lowest (1.40%). Fish from Dogi thus have a high concentration of nutritional components.

Mahanty et al., 2013 provide an analysis of the P. sophore nutrient profile that was obtained from ponds and wetlands in and around Kolkata, West Bengal.

6.3 Fatty Acids:

Fish's fatty acid content varies greatly between species and is affected by several variables, including season, food, water quality, and life stage. All things considered, fish is a great source of omega-3 polyunsaturated fatty acids (PUFAs), which are critical for human health since they affect inflammation, brain development, and cardiovascular health. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the two most nutritionally significant omega-3 fatty acids that are present in fish.

Broad Categories of Fatty Acids in Fish:

a. Saturated Fatty Acids (SFAs):

Present in all kinds of fish, although in less amounts than unsaturated fats. Stearic acid and palmitic acid are two examples.

b. Monounsaturated Fats (MUFAs):

Frequently contain oleic acid. Found in most fish at moderate levels.

c. Polyunsaturated Fatty Acids (PUFAs):

The most advantageous and talked-about class of lipids present in fish comprises omega-3 and omega-6 fatty acids.

d. Fish that contain particular omega-3 fatty acids include docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). Cold-water fish with high-fat content, such as salmon, mackerel, sardines, and herring, are the primary sources of these. They are essential for maintaining brain function, lowering inflammation, and improving cardiovascular health.

e. Alpha-linolenic Acid (ALA):

Although it is more frequently found in plant sources than in fish, this is a precursor to EPA and DHA.

Examples of Fish Species' Fatty Acid Content:

a. Salmon:

EPA and DHA, in particular, are highly abundant in this fish. The amount of omega-3s in 100 grams of salmon varies depending on whether it is farmed or wild.

b. Mackerel:

One of the best sources of omega-3 fatty acids, mackerel is similar to salmon in that it can contain up to 2.6 grams per 100 grams.

c. Sardines:

Packed with omega-3 fatty acids (1.4 grams per 100 grams), these little fish are also a wonderful source of vitamin D.

d. Tuna:

Depending on the kind and freshness of the tuna, the content varies significantly. For instance, 100 grams of fresh bluefin tuna has approximately 1.3 grams of omega-3 fatty acids, whereas 100 grams of light canned tuna in water contains only 0.3 grams.

6.3.1 Factors Affecting Fish's Fatty Acid Content:

a. Fish Diet:

Omega-3 fatty acid levels are typically higher in fish that consume large amounts of algae or other fish.

b. Environmental Conditions:

Contaminants, water quality, and temperature can all have an impact on the composition of fat.

c. Farming vs. Wild-Caught:

The diets of farmed and wild fish vary often, which may have an impact on the fatty acid profiles of the former.

Overall, farmed fish may have more fat, but the kind of fat in that fat can differ.

6.4 List of Fatty Acid found in Small Indigenous Fish species:

i. Fatty Acids Omega-3:

- **Eicosapentaenoic Acid (EPA)**:

EPA is renowned for its anti-inflammatory qualities and its support of brain function, mood management, and cardiovascular health.

- **Docosahexaenoic Acid (DHA):**

Especially in newborns and early children, DHA is essential for brain development, cognitive function, and visual acuity. It also lowers inflammation and promotes heart health.

ii. Fatty Acids Omega-6:

Linoleic Acid (LA):

Although omega-3 and omega-6 fatty acids are equally important for good health, the Western diet frequently has an imbalance between the two, which, if not balanced, can lead to inflammation and a host of chronic illnesses.

small indigenous fish that are smaller in size generally have lower concentrations of omega-6 fatty acids than omega-3s.

iii. Fatty Acids Omega-9:

Oleic Acid:

Because the human body is capable of producing them, omega-9 fatty acids are not regarded as essential.

They still have health advantages, though, such as improving insulin sensitivity, lowering inflammation, and promoting heart health.

iv. Saturated Fatty Acids:

Although consuming too many saturated fatty acids is frequently associated with health problems, small indigenous fish usually have lower saturated fat content than larger, fatty fish species. When consuming these fatty acids, moderation is essential.

v. Monounsaturated Fatty Acids:

Palmitoleic Acid:

Monounsaturated fats are considered to be heart-healthy fats that can lower cholesterol and lower the risk of heart disease. One such monounsaturated fatty acid that can be found in small indigenous fish is palmitoleic acid.

6.5 Health benefits of different fatty acids found in small indigenous fish species:

A. Fatty Acids Omega-3:

a. Eicosapentaenoic Acid (EPA):

- **Heart Health:**

Research has shown that EPA lowers triglyceride levels, reduces inflammation, and inhibits blood clot formation, all of which reduce the risk of heart disease.

Brain Function:

It is essential for maintaining memory, emotional regulation, and cognitive function as well as brain development.

- **Inflammatory Conditions:**

Due to its anti-inflammatory qualities, EPA is helpful in the treatment of inflammatory bowel disease, asthma, and arthritis.

b. Docosahexaenoic Acid (DHA):

- **Brain Development:**

DHA is essential for brain development in infants and children, contributing to improved cognitive function and visual acuity.

- **Eye Health:**

It lowers the risk of age-related macular degeneration and other eye problems by maintaining retinal health and vision.

- **Heart Health:**

DHA lowers the risk of cardiovascular disease by improving blood vessel function, reducing blood pressure, and helping to maintain a regular heart rhythm.

B. Fatty Acids Omega-6:

Linoleic Acid (LA):

- **Skin Health:**

LA is necessary to preserve the skin's protective layer and fight against irritation, dryness, and illnesses like dermatitis and eczema.

- **Hormone Regulation:**

It contributes to the production and control of hormones, including prostaglandins that are involved in immunological and inflammatory reactions.

- **Cell Structure:**

LA contributes to the integrity and fluidity of cell membranes as a structural element.

C. Fatty Acids Omega-9:

Oleic Acid:

- **Heart Health:**

Reduced inflammation, enhanced insulin sensitivity, and lowered LDL cholesterol are just a few of the heart disease risk factors linked to oleic acid.

- **Anti-inflammatory Effects:**

It has anti-inflammatory qualities that may help reduce the signs and symptoms of rheumatoid arthritis and lower the chance of developing chronic inflammatory disorders.

- **Brain Function:**

According to some research, oleic acid may protect against neurodegenerative illnesses like Alzheimer's and enhance cognitive function.

D. Saturated Fatty Acids:

Although saturated fats are commonly associated with heart disease, some saturated fats, like those found in small indigenous fish, can still be helpful for health when consumed in moderation. These benefits include promoting hormone production as well as providing energy.

E. Monounsaturated Fatty Acids:

Palmitoleic Acid:

- **Metabolic Health:**

Research has shown that palmitoleic acid reduces inflammation, improves insulin sensitivity, and lowers the risk factors for type 2 diabetes and metabolic syndrome.

- **Cardiovascular Health:**

Improving the ratio of LDL to HDL cholesterol and lowering LDL cholesterol levels, may help reduce the risk of heart disease.

- **Benefits for the Skin:**

By nourishing and hydrating the skin, palmitoleic acid may aid in preserving its smoothness and freshness.

Small indigenous fish species (SIFs) are vital to regional food systems, especially in Sub-Saharan Africa and South Asia, although they are frequently disregarded in global fisheries management.

Since these fish are usually eaten whole, their bones and organs provide vitamins in addition to fatty acids. Including small indigenous fish species in meals encourages sustainable fishing methods in addition to being good for health.

Harvesting small indigenous fish species is usually less fuel-intensive and produces less bycatch than large-scale commercial fishing, making it an environmentally viable solution (FAO, 2014). Fish's diet, which is impacted by environmental factors including water quality and food availability, can have a major impact on their fatty acid profile.

Fish's lipid content and composition can change due to seasonal changes in the water temperature and availability of food, which might impact the fish's nutritional value (Ahmed et al., 2008).

Especially in rural and low-income areas, small indigenous fish species are essential to biodiversity and nutrition. These species are frequently abundant in important nutrients, including omega-3 fatty acids, which are critical for maintaining good cardiovascular and cognitive health as well as general well-being.

Comprehensive information on the fatty acid profiles of various small indigenous fish species is lacking, despite their nutritional significance, hence a thorough assessment of the literature is required.

Research indicates that, in comparison to larger commercial fish, small indigenous fish species typically have higher levels of omega-3 fatty acids (Thilsted et al., 2016).

For instance, the high concentration of omega-3 fatty acids found in mola (Amblypharyngodon mola) and chela (Chela cachius) has been noted as contributing to their potential to address nutritional deficits in underdeveloped nations (Roos et al., 2007).

Season, environment, and species can all have a major impact on the fatty acid composition of small indigenous fish species. Freshwater small indigenous fish species from tropical locations showed seasonal fluctuations in fatty acid concentrations, with higher levels during the rainy season due to an increased abundance of phytoplankton, according to a study by Ahmed et al., 2011.

Meeting the necessary dietary intake of essential fatty acids, namely EPA and DHA, can be significantly aided by consuming small indigenous fish species. Regular small indigenous fish species consumption has been shown by Kumar et al., 2018 to lower risk factors linked to cardiovascular illnesses and raise serum HDL levels.

Including small indigenous fish species in meals encourages sustainable fishing methods in addition to being good for health. Harvesting small indigenous fish species is usually less fuel-intensive and produces less bycatch than large-scale commercial fishing, making it an environmentally viable solution (FAO, 2014). In their 2011 study, Kawarazuka and Béné explored the function of fish in household nutrition, pointing out that in areas where they are a staple food, small indigenous fish frequently provide a more concentrated amount of nutrients.

6.6 Vitamins:

Small native fish are sometimes disregarded, even though they pack an important impact when it comes to the nutritious quality of their diet, particularly in terms of the vitamin composition of their bodies.

Small indigenous fish, which can be found in a variety of freshwater bodies all over the world, are abundant in necessary vitamins, which are particularly important for ensuring that one's health is at its best.

These fish, despite their relatively small size, contain a wide variety of vitamins, such as vitamin A, vitamin D, vitamin B12, vitamin E, and different vitamin B. When analyzing the nutritional worth of small indigenous fish and the possible benefits they could make to human health, it is vital to have an excellent grasp of the vitamin makeup of these fish.

The exact vitamin composition may differ based on the type of fish, yet different kinds of small indigenous fish possess the following vitamins:

a. Vitamin D:

This vitamin is essential for healthy bones and the absorption of calcium. Natural vitamin D sources that are high in fat include salmon, trout, mackerel, and sardines.

b. Vitamin B12:

Found in abundance in a majority of fish, especially shellfish like clams, mussels, and crabs, as well as in mackerel, sardines, tuna, and salmon, B12 is necessary for nerve function as well as the synthesis of DNA and red blood cells.

c. Vitamin A:

Found in large quantities in fish liver oils and in smaller amounts in fatty fish, vitamin A is essential for healthy organs, vision, and immune system.

d. Vitamin E:

It is an antioxidant that helps in preventing harm to cells. Fish like salmon and trout contain smaller quantities of it.

e. Vitamin B6:

Found in tuna, salmon, and snapper, vitamin B6 is involved in immune system function, brain development, and protein metabolism.

f. Vitamin B3 (Niacin):

Found in most fish, particularly halibut, salmon, and tuna, niacin is essential for turning food into energy.

g. Vitamin B2 (Riboflavin):

Found in salmon, trout, and mackerel, this vitamin helps in the production of energy.

Oily fish is the best source of these vitamins, especially the fat-soluble ones like vitamin D because they store these nutrients in their fat stores.

A natural and available source of these vital vitamins can be obtained by including small indigenous fish in the diet, which promotes good health in general. These fish also often contain high levels of minerals, other nutrients, and omega-3 fatty acids, all of which boost their health advantages. It can meet our dietary requirements for these essential vitamins by including fish in your diet.

6.7 Health benefits of different vitamins found in small indigenous fish species:

A. Vitamin D:

Bone Health:

Vitamin D is essential for the mineralization of bones and the absorption of calcium, which supports the maintenance of strong, healthy bones. It lowers the chance of diseases like fractures and osteoporosis.

Immunological System:

By regulating the immunological response, adequate vitamin D levels have been associated with a lower risk of infections and autoimmune diseases.

Mood Regulation:

Research suggests that vitamin D may help control mood and lower the risk of depression.

B. Vitamin B12:

Nerve Function:

This vitamin helps maintain the integrity and health of nerve cells and is necessary for the nervous system to function properly.

Production of Red Blood Cells:

Important for the flow of oxygen throughout the body's red blood cells. Fatigue and anemia can result from deficiencies.

DNA Synthesis:

Vital vitamin B12 plays a vital role in cell division and DNA synthesis, which are essential for tissue growth, development, and repair.

C. Vitamin A:

Vision:

Vitamin A is essential for good vision, especially in dimly lit areas. It aids in the retina's production of pigments involved in vision.

Immune Function:

It aids in the body's defense against infections and diseases by providing essential support to the immune system.

Skin Health:

Vitamin A regulates cell turnover and production, which helps to maintain healthy skin and a smooth, radiant complexion.

Reproductive Health:

During pregnancy, adequate vitamin A levels are necessary for healthy reproduction and fetal growth.

D. Vitamin E:

Antioxidant Defense:

Vitamin E is an effective antioxidant that reduces the risk of chronic illnesses and early aging by protecting cells from damage carried on by free radicals.

Heart Health:

By preventing LDL cholesterol from oxidizing and lowering artery inflammation, it could help improve cardiovascular health.

Skin Health:

Vitamin E protects against UV rays, lowers inflammation, and promotes the growth of collagen in the skin.

E. Vitamin B6:

Metabolism:

This vitamin aids in the body's conversion of food into energy by participating in the metabolism of proteins, carbs, and lipids.

Brain Health:

It affects how one feels, thinks, and behaves by contributing to neurotransmitter production and brain growth.

Immunological Function:

By stimulating the development of white blood cells and antibodies, vitamin B6 promotes immunological function.

F. Vitamin B3 (Niacin):

Energy Production:

Niacin is necessary for the body to convert lipids, carbs, and proteins into energy, enabling several internal functions.

Heart Health:

It lowers triglyceride and low-density lipoprotein (LDL) cholesterol levels, which lowers the risk of cardiovascular disorders such as strokes and heart attacks.

Skin Health:

By maintaining the skin's barrier function and promoting cell regeneration, niacin supports healthy skin.

G. Vitamin B2 (Riboflavin):

Energy Metabolism:

Riboflavin helps break down proteins, lipids, and carbs, which is an essential step in the creation of energy.

Antioxidant Activity:

It functions as an antioxidant to help protect cells from oxidative damage and neutralize dangerous free radicals.

Eye Health:

Preventing diseases like cataracts and age-related macular degeneration is one of the most important ways that riboflavin contributes to the maintenance of good eyes and eyesight.

Research has shown that small indigenous fish contain a high concentration of vital vitamins, including vitamin A, which is essential for maintaining healthy vision, immunological function, and reproductive health.

Vitamin D, which is present in these fish in substantial quantities, is an essential component in the process of calcium absorption, the maintenance of bone health, and the regulation of the immune system (Nguyen et al., 2018).

Roos et al. (2017) found that small indigenous fish contain a significant amount of vitamin B12, which is an essential nutrient for neurological function, the creation of red blood cells, and the metabolism of energy. In addition, these fish are a rich source of vitamin E, which is a powerful antioxidant that helps the immune system work properly and protects cells from injury (Roos et al., 2017).

Furthermore, small indigenous fish are abundant in a variety of B vitamins, such as thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), and folate (B9). Each of these B vitamins contributes to the metabolism of energy, the function of the neurological system, and overall vitality (Bogard et al., 2017).

The nutritional significance of small indigenous fish in a variety of diets is made clear by the vitamin-rich content of many varieties of fish. Incorporating these fish into regular dietary habits can assist persons in fulfilling their daily vitamin requirements, which in turn improves general health and well-being.

In addition, the bioavailability of vitamins derived from fish is typically higher than that of vitamins derived from plant-based sources, which further enhances the nutritional value of fish oils.

On the other hand, the vitamin content and bioavailability of fish can be affected by a variety of factors, including the species of fish, the habitat, and the processing methods, resulting in the need for additional research in this field.

6.8 Minerals:

Small indigenous fish are an important part of regional ecosystems and traditional diets, providing communities all over the world with a nutrient-rich, sustainable food supply. Their mineral content is still mostly unknown, even though their protein and vitamin levels have received a lot of study. Minerals are necessary micronutrients that are crucial for many physiological functions, such as neuron and bone function and enzyme functioning. Thus, understanding the nutritional content and potential health advantages of small indigenous fish requires an understanding of their mineral profile. Below is an in-depth description of the minerals that are typically present in small indigenous fish:

Calcium:

Calcium is necessary for healthy bones, muscles, and nerve transmission. small indigenous fish can be an excellent supply of this mineral. Taking enough calcium improves the skeleton generally and prevents osteoporosis.

Phosphorus:

Another mineral that is prevalent in small indigenous fish is phosphorus. It is essential for DNA synthesis, energy metabolism, and bone production. Phosphorus contributes to cellular structure and function as well as bone health when combined with calcium.

Potassium:

An electrolyte that aids in controlling fluid balance, nerve impulses, and muscular contractions, potassium is found in small indigenous fish. Consuming enough potassium is linked to lowered blood pressure, a decreased risk of stroke, and a decreased risk of cardiovascular disease.

Magnesium:

The body uses magnesium for hundreds of biochemical processes, including the synthesis of energy, the maintenance of healthy bones, and muscle function. Magnesium can be found in small indigenous fish, which is beneficial to general health and wellness.

Selenium:

A trace mineral having antioxidant qualities, selenium helps in protecting cells from harm caused by free radicals. It also affects immunological response, reproduction, and thyroid function. Selenium from small indigenous fish can help thyroid function and antioxidant defenses.

Zinc:

Zinc is necessary for DNA synthesis, immunological response, wound healing, and growth and development. It also affects hormone regulation and taste perception. Zinc may be present in small indigenous fish, enabling these crucial physiological functions.

Iron:

Iron is required to make both myoglobin, which stores oxygen in muscles, and hemoglobin, which carries oxygen in the blood. Fatigue and anemia can result from an iron deficit. Iron may be present in small indigenous fish, helping to maintain them.

Copper:

Copper plays a role in energy metabolism, collagen synthesis, and red blood cell manufacturing.

It enhances immunological function and serves as an antioxidant as well. Small indigenous fish can supply copper, which is necessary for numerous vital physiological functions.

Iodine:

Thyroid hormone synthesis, which controls growth, development, and metabolism, depends on iodine. Sufficient consumption of iodine is essential for healthy thyroid function and general well-being. Small indigenous fish may have iodine, which supports thyroid function.

Trace Minerals:

Although needed in smaller levels, trace minerals like manganese, fluorine, and molybdenum are necessary for several physiological processes and can also be found in small indigenous fish. Small indigenous fish can therefore offer a wide variety of nutrients that are vital for general health and well-being when included in the diet.

These minerals are essential for many body functions, including immune system support, antioxidant defense, and the health of bones and muscles.

A. Calcium:

Bone Health:

Calcium lowers the risk of osteoporosis and fractures, especially in older adults, by helping to form and maintain healthy bones and teeth. Muscle

Function:

Calcium helps maintain healthy muscle function by promoting muscle contraction and relaxation as well as reducing cramps and spasms.

Nerve Transmission: Calcium ions are essential for nerve impulse transmission, which helps nerve cells communicate with one another and ensures effective signaling throughout the body.

B. Phosphorus:

Bone Health:

Phosphorus improves bone strength and mineralization with calcium, which lowers the risk of fractures and bone disorders while also supporting skeletal health.

Energy Metabolism:

An essential part of ATP, the main energy unit of cells, phosphorus is involved in both energy metabolism and cellular activity.

DNA Synthesis:

Phosphorus is necessary for the synthesis and repair of DNA, which in turn supports the body's functions of cell division, growth, and repair.

C. Potassium:

Blood Pressure Regulation:

Potassium promotes vasodilation, diminishes the risk of hypertension and cardiovascular disease, and counteracts the effects of sodium to assist control blood pressure.

Fluid Balance:

Potassium is necessary for maintaining the right balance of fluids in cells and tissues, which supports nerve and muscle function as well as adequate hydration.

Heart Health:

By maintaining normal heart rhythm and function, an adequate potassium consumption is linked to a lower risk of stroke, arrhythmias, and other cardiovascular disorders.

D. Magnesium:

Neuromuscular Function:

Magnesium plays a critical role in neuromuscular coordination, nerve transmission, muscle contraction and relaxation, and the prevention of cramps and spasms.

Bone Health:

When taken with calcium and vitamin D, magnesium helps to increase bone strength and mineral density, which lowers the risk of osteoporosis and fractures.

Energy Production:

Magnesium aids in the creation of ATP, which promotes energy production and metabolism in all of the body's cells.

a. Selenium:

Antioxidant Defense:

Selenium helps shield cells from oxidative damage brought on by free radicals and lowers the risk of chronic illnesses like cancer and heart disease.

It is a component of antioxidant enzymes like glutathione peroxidase.

Thyroid Function:

Selenium is necessary for the synthesis and metabolism of thyroid hormones, which supports healthy thyroid function and regulation of metabolism.

Immunological Support:

Selenium affects immunological function by boosting immune cell activity, regulating immune responses, and offering protection from infections and illnesses.

E. Zinc:

Immune Function:

Zinc supports both innate and adaptive immune responses and lowers the risk of infections and diseases. It is essential for immune cell growth, function, and signaling.

Wound Healing:

By encouraging cell proliferation, collagen formation, and immunological function at the site of damage, zinc plays a critical role in tissue regeneration and wound healing.

Hormone Regulation:

Zinc enhances the growth, development, and health of the reproductive system through its roles in hormone synthesis, receptor binding, and signal transmission.

F. Iron:

Oxygen Transport:

Iron is necessary for the creation of hemoglobin, which enables red blood cells to transport oxygen from the lungs to all bodily tissues, promoting the generation of energy and cellular activity.

Brain Function:

Iron prevents cognitive impairment and developmental delays, especially in newborns and children, by being essential for healthy brain development, neurotransmitter synthesis, and cognitive function.

Immunological Support:

Iron contributes to immunological function by boosting human defense mechanisms against infections and immune cell proliferation and activity.

G. Copper:

Collagen Formation:

Copper is necessary for the synthesis of collagen, which in turn strengthens and structures blood vessels, connective tissues, and skin, accelerating the healing of wounds and enhancing skin health.

Antioxidant Defense:

Superoxide dismutase and other antioxidant enzymes rely on copper as a cofactor to help combat free radicals and protect cells from inflammation and oxidative damage.

Iron Metabolism:

Copper plays a role in iron metabolism, promoting iron transport, absorption, and utilization, and guaranteeing sufficient iron levels for oxygen transfer and hemoglobin formation.

H. Iodine:

Thyroid Function:

Iodine is an essential part of thyroid hormones, such as triiodothyronine (T3) and thyroxine (T4), which regulate growth, development, and metabolism, and support healthy thyroid function and hormone synthesis.

Energy Metabolism:

Body weight, overall metabolic health, and energy balance are all maintained by thyroid hormones, which also affect metabolic rate and energy expenditure.

Brain Development:

To avoid developmental delays and intellectual disability, adequate iodine consumption during pregnancy and infancy is crucial for the healthy development of the fetal and infant brain, as well as for cognitive function and motor skills.

I. Trace Minerals:

Manganese:

Manganese supports bone health, wound healing, and protection against oxidative stress and inflammation. It also plays a role in collagen production, antioxidant defense, and bone formation.

Fluorine:

Fluorine strengthens tooth enamel, guards against cavities, tooth decay, and gum disease, and encourages good oral hygiene and general dental health.

Molybdenum:

This mineral supports the health of the liver, antioxidant defense, and cellular activity all over the body by acting as a cofactor for enzymes involved in purine metabolism, detoxification, and amino acid metabolism.

Minerals such as calcium, phosphorus, iron, zinc, magnesium, and selenium are abundant in small indigenous fish (Lingaiah et al., 2017; Njiru et al., 2018). These fish are high in calcium and phosphorus, which support strong teeth and healthy bones (Tacon & Metian, 2013).

Small indigenous fish are an effective dietary source for preventing iron deficiency anemia because they contain major levels of iron, a crucial component of hemoglobin (Njiru et al., 2018). According to Lingaiah et al. (2017), magnesium promotes muscular function, nerve transmission, and energy metabolism, while zinc is essential for immunological response, wound healing, and DNA synthesis. Small indigenous fish also contain selenium, a strong antioxidant that promotes thyroid function and shields cells from oxidative damage (Njiru et al., 2018).

The nutritional significance of small indigenous fish in a variety of diets is highlighted by their high mineral content. By including these fish in daily meal planning, people can meet their daily mineral needs and improve their general health and well-being. Furthermore, fish has a higher bioavailability of minerals than plant-based sources, which adds to its nutritional value. However, there is a need for more research in this area because variables including fish species, environment, and processing techniques can affect mineral content and bioavailability.

6.9 Summary and Conclusion

The chapter suggests that the small food fishes are nutrient-rich and can be recommended as health supplements. It emphasizes the importance of scientific awareness among citizens and the need to conserve food fish diversity and encourage aquaculture.

Regular monitoring of fish fauna, catching times, water quality analysis, and controlling anthropogenic activities can help conserve food fishes. Scientific measures should be opted for better preservation of them. They are important also from the medicinal point of views.

Furthermore, studies are required on investigation of the nutritional aspects of these fishes In our present study it may be inferred that these food fishes may be a good choice for human consumption as well as research works.

6.10 References:

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