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Review

Small Indigenous Fish: A Potential Source of Valuable Nutrients in the Context of Bangladesh

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Abstract: Peoples can readily and affordably obtain small indigenous fish species (SIS), with a maximum length of 25 cm, that can be found in niches in small bodies of water (such as canals, ponds, wetlands, streams, etc.). SIS contribute valuable and significant macro- and micronutrients in Bangladesh. SIS are excellent suppliers of vitamins and minerals. The main micronutrients are copper, iodine, iron, selenium, chromium, and zinc, which can help prevent mineral deficiency and enzymatic response in the human body. SIS, such as the mola (*Amblypharyngodon mola*), cotio (*Osteobrama cotio*), darkina (*Esomus danricus*), etc., are easily digestible by the human gut. Nutrients of these fish are quickly accessible by the intestine. These fish are comparatively cheap and easy to capture and promote the presence of particular vitamins in SIS, including A, D, E, and K, as well as vitamin B components. This review paper focuses on the SIS nutritional contribution and their efficacy of preventing malnutrition in developing countries such as Bangladesh and the whole world.

Keywords: micronutrients; small indigenous fish; vitamins; minerals; bioactive compounds

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1. Introduction

A variety of native small fish species, as well as other fish, are available in natural resources, including beels, floodplains, open water ponds, ditches, rivers, canals, rice fields, etc. As a result of the richness of small indigenous fish (SIF) in natural resources, the majority of rural communities frequently devoured small indigenous fish in old days [1–5], which accounted for between 50 and 80 percent of all fish consumed by families [4,6]. For many impoverished people in developing nations, fisheries play a significant role in ensuring food security. With 18.1 kg consumed per person each year, fish accounts for 60 percent of the country's protein consumption, making it an essential animal source diet for most people in Bangladesh [7]. The nation's aquatic resources are diversified and plentiful, with 267 freshwater fish species [8] and 3.1 million tons of annual production [9]. The consumption of many underprivileged people in developing nations, typically high in carbohydrates, can benefit from fish as a good source of protein, micronutrients, and essential fatty acids. The Food and Agriculture Organization (FAO), 2003, emphasizes the significance of small-scale fishing specifically for diet protection. Fish provide diet protection in diverse ways. According to Kostori et al. [2], the small indigenous fish species are a rich source of nutrition and mature at a length of around 25 cm or 6 inches. According to the study by [10], SIS offer higher nutrition since it is more common for humans to ingest entire fish from nutrient-rich SIS.

SIS provide better nutrition because they are frequently consumed whole, including the head, bones, and eyes, utilizing all available nutrients, including micronutrients. These fish are valued for their high protein, fatty acid, vitamin, and mineral content. According to

reports, certain species, including *Amblypharyngodon mola*, *Osteobrama cotio*, *Esomus danricus*, and *Corica soborna*, have high levels of vitamin A as well as other vitamins and minerals [11]. In addition, the amount of vitamins and minerals included in one kilogram of SIS is equivalent to about fifty kilograms of large fish, such as Indian Major carp [12]. It has been stated that SIS are one of the significant contributors of vitamin A and minerals to the common people of Bangladesh [4]. Several studies reported that fish is the most frequently consumed protein source, over meat, in Bangladesh [3,7,13]. The SIS are crucial in reducing malnutrition and protecting rural communities' nutritional and economic securities [12,14].

It is widely believed that the ability of self-recruiting species (SRS) to exist in both natural and controlled ecosystems is crucial for the survival of rural people [15]. In addition to providing additional earnings and essential protein for rural families, extensive carp production and small indigenous species are also environmentally favorable [16]. When micronutrient deficiency is a major issue, SIS play a crucial function in supplying micronutrients [10]. Animal protein, fatty acids, vital vitamins, and minerals are abundant in small indigenous fish [17]. Most of the small fish are consumed whole, including the head, organs, and bones, and they provide calcium, vitamin A, iron, and zinc to the underprivileged people of Bangladesh [18]. They make up a considerable portion of the finfish and shellfish population overall, which significantly improves the nutritional stability of rural people. The SIS are prolific breeders, require little to no management, and thrive in lentic and lotic water systems such as wetlands, beels, home ponds, abandoned water bodies, irrigation and drainage channels, and rich fields. The initial pisciculture methods eradicated SIS as insects because they were treated as weeds or trash fish having a negative impact on the preservation of valuable species [1]. Modern aquaculture practices have shown that integrating small indigenous species into polyculture systems is wise because it increases pond fish productivity overall [12]. The wide majority of fish consumed by the impoverished rural people is the small indigenous species of fish. Due to their availability and low market demand compared to large-sized fish, they eat these fish species since they are more prevalent. The rural people frequently rely on these small fish that they obtain as by-catch because it might be expensive to buy pulses and vegetables [12].

SIS is an essential source of macro and micronutrients in Bangladesh [10,19]. However, there are few research articles on SIS's micro and macronutrient compositions. Factual information is necessary for the popularization of this SIS to the people both domestically and abroad. SIS species are most abundant in monsoon season in the floodplain areas [2,4,7]. To ensure the market price of SIS and their best probable processing, methods are required to provide year-round availability to the consumers and export. There is no review of Bangladesh's SIS species' nutritional qualities and processing techniques. We believe this study will help fishery scientists and food/fish processors think about the SIS and their best possible utilization. In recent years, Bangladesh has achieved self-sufficiency in the food production sector, although, malnutrition is still of concern. Several studies showed that SIS can effectively promote a healthy diet among all kinds of people, including the poor [3,5,20–22].

Thus, the main goals of this study are to compile detailed nutritional content profiles of important small indigenous fish species in Bangladesh. Specific species and nutritional components were selected for studies to "fill the gaps" in the available data. Estimating the allowance of SIS species to recommended nutrient intakes (RNIs) is one of our secondary goals. Certain nutrients such as iron, calcium, zinc, iodine, vitamin A, and vitamin B12 are considered since they are recognized as health concerns of the public in Bangladesh. The information reported in this study is the most extensive collection of data about the nutritional content of important small indigenous species of fish in Bangladesh that has been examined so far. The review paper demonstrates how some nutrients, such as iron, zinc, iodine, and vitamin complex, interact with the molecular makeup of the human body and could potentially be used in food in the future. Additionally, this study also addresses the effect of small indigenous species of fish on human wellbeing. Moreover, this study

also highlights Bangladesh's prospective future usage of small indigenous species of fish in food production.

2. Methodology

2.1. Search Strategy

The research articles on the nutritional composition, processing techniques, and utilization of SIS in Bangladesh and southeast Asia were considered for this review. Research articles available on Google Scholar as well as indexed in Pubmed and Science Direct databases were searched using the combination of keywords "Small indigenous fishes", "Nutritional importance", and "Bangladesh".

2.2. Selection Process and Data Extraction

The article selection process in this article was based on the screening of titles and abstracts. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines to screen and identify scientific literature related to SIS. During the screening process, all articles were filtered according to language. The information of searched papers in English was considered for this review work (Figure 1).

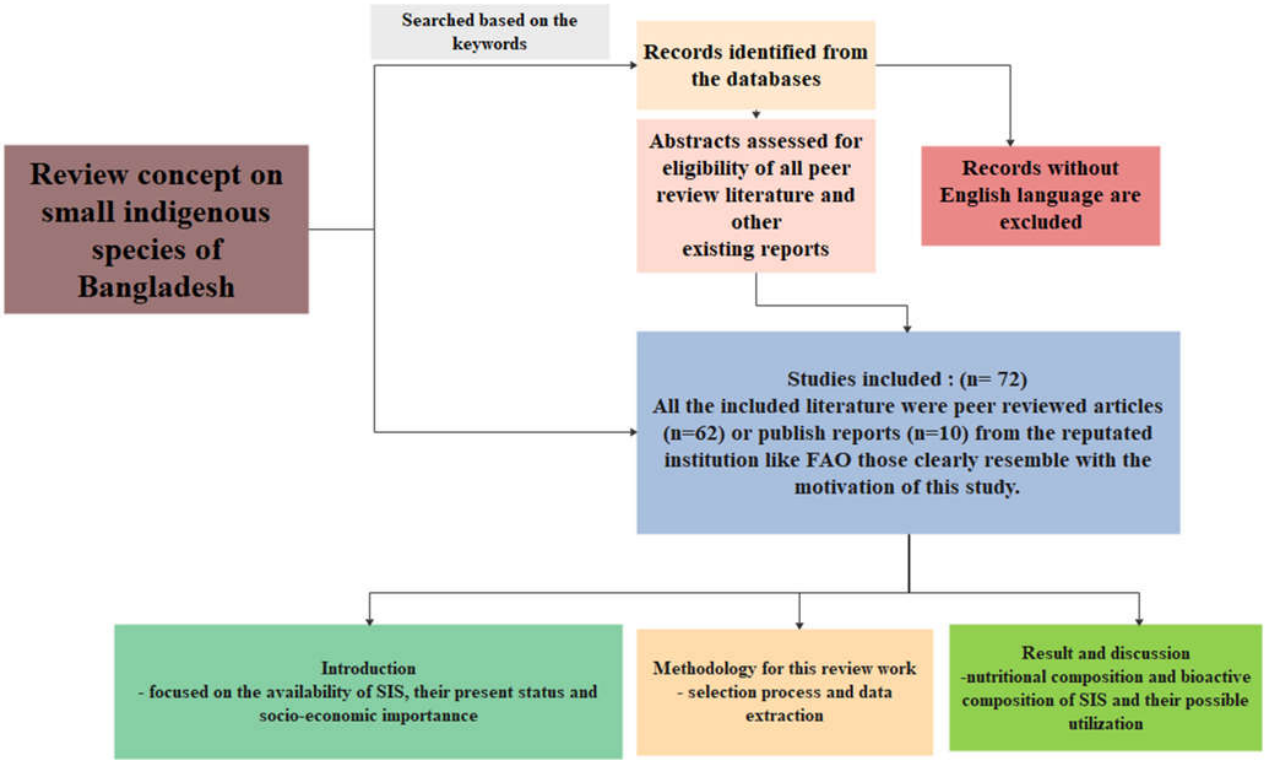

Figure 1. Representative scheme of this review article.

3. Results and Discussion

3.1. Small Indigenous Fish Species (SIS)

According to several scientists, fish that can grow to 25 cm or 9 inches at the mature or adult life cycle stage are known as SIS [3,23]. However, some SIS such as *Heteropneustes fossilis* can grow more than 9 inches or 25 cm. SIS are an essential source of nutrition for many communities worldwide. These small fish are often overlooked when considering sources of protein, yet they provide a vital source of nutrition for people living in poverty. They also provide essential nutrients to those living in remote areas who may not have access to other food sources. The importance of these SIS lies in their ability to provide essential nutrients and vitamins that are hard to find elsewhere. This article will explore the nutritional significance of SIS and how they can be a sustainable food in Bangladesh and the world.

3.2. SIS Resources and Their Micronutrients

Bangladesh is one of the most significant inland fishing countries in the world. Out of 251 different inland fish species, Bangladesh's water bodies are home to more than 150 SIS of fish (Table 1) [24]. Diversified water bodies (ponds, beels, haors, baors, rice fields, floodplains, etc.) are excellent breeding and rearing grounds, with an abundance of natural food (Table 1), space, and appropriate environment [12]. They can spread quickly to other natural water bodies due to their ability to spawn in narrow and shallow water bodies; as the rainy season passes, their abundance rises, especially when water bodies reach their maximum levels. These water bodies do not have any naturally occurring species-specific populations. It essentially aids in obtaining the fundamental broodstock required for pond production through breeding and recruitment [24]. The most common catches of SIS are Puti, Darkina, Mola, Chanda, Koi, Taki, Cheng, Tengra, Gochi, and Magur [21].

In the Indian sub-continent, SIS of fish in inland water bodies (freshwater wetlands and rivers) are found in sufficient quantity. Except for a few exceptions, most SIS do not integrate into a standard cultural context even though they differ in classification, shape, size, and eating habits. In addition to their unique cultural systems, they are regarded as one of the traditional dishes in most Asian nations, such as India, Bangladesh, Vietnam, Laos, etc., to make up for dietary deficits [9,25–27]. SIS are a valued food ingredient that supplies a variety of vitamins and minerals in addition to proteins [4,28] (Figure 2) (Table 2). Small fish species, being widely available, are a boon for persons of lower socio-economic status, even though it allows people to have essential dietary components.

Different types of fish species, amphibians, molluscs, crustaceans, etc., coexist in natural resources (e.g., rivers, canals, banks, ponds, low water bodies, rice fields) in very varied quantities. Among them, the nutrition content is highest in small fish, and they live in diverse and abundant ecosystems [8]. The local people catch small fish from their local water bodies and bring them to sell in the local market. The soil topography and ecosystem sample of various rivers, channels, and rice fields of Bangladesh, West Bengal, and Assam bring diversity among small fish. The relative abundance of these species is consistent with observations made from paddy fields and associated trap ponds in the respective areas [29]. Traditional fishing gear is usually used to collect SIS from paddy fields and attached trap ponds. Due to the structural characteristics of the equipment [30,31], fish with low biomass are more prone to such traps than fish with high biomass, resulting in species size and composition as observed of different SIS species sold on the market. Biomass and abundance characteristics of SIS are similar to those observed from the Padma River in Bangladesh [32]. Perhaps the connections between rivers, irrigation canals, and rice fields provide a continuum of freshwater habitats that facilitate the movement of fish species across different landscapes. Fish species' specific preferences for habitat (canals, rivers, or rice fields) may contribute to differences in encounter rates and captures in the three systems [25]. The diverse ecosystem services attributed to SIS qualify as a valuable aquatic living resource that requires sustainable exploitation. Due to SIS's abundance and food value, continued exploitation is essential, especially locally. Strategies to increase the abundance of SIS through polyculture [33] or rice fish farming [34,35] can be a viable option to maintain demand at the local scale of the respective geographical area [36]. Apart from their role in food security, various species of SIS are in high demand in the ornamental fish trade and biological control of mosquitoes.

Table 1. Some SIS species and their identification, by [1] Mohanty et al. [12] and [2] Bogard et al. [21].

Species	Order	Family	Local Name
[1] *Aborichthys elongates* (Hora, 1921)	Cypriniformes	Nemacheilidae	Rimum, Ribb
[1] *Acanthocobitis botia* (F. Hamilton, 1822)	Cypriniformes	Nemacheilidae	Gadera, Chikli
[1] *Ailia coila* (F. Hamilton, 1822)	Siluriformes	Ailiidae	Patasi, Kajuli
[1] *Ailiichthys punctate* (Day, 1872)	Siluriformes	Ailiidae	Jamuna ailia
[1] *Amblyceps laticeps* (McClelland, 1842)	Siluriformes	Amblycipitidae	Amblyceps
[1] *Amblyceps mangois* (Blyth, 1858)	Siluriformes	Amblycipitidae	Tayek, Chikka
[1] *Amblypharyngodon microlepis* (Bleeker, 1854)	Cypriniformes	Cyprinidae	Indian carplet
[1] *Amblypharyngodon mola* (Hamilton, 1822)	Cypriniformes	Cyprinidae	Mola carplet,
[1] *Anabas cobojius* (F. Hamilton, 1822)	Anabantiformes	Anabantidae	Ganjetic koi
[1] *Anabas testudineus* (Bloch, 1792)	Anabantiformes	Anabantidae	Koi, Kawai
[1] *Aplocheilus parvus* (Sundara Raj, 1916)	Cyprinodontiformes	Aplocheilidae	Dwarf panchax
[1] *Aplocheilus panchax* (F. Hamilton, 1822)	Cyprinodontiformes	Aplocheilidae	Charbeki
[1] *Aspidoparia jaya* (Hamilton, 1822)	Cypriniformes	Cyprinidae	Chola, Jaya
[1] *Cabdio morar* (Hamilton, 1822)	Cypriniformes	Cyprinidae	Olahalale
[1] *Badis badis* (F. Hamilton, 1822)	Cypriniformes	Badidae	Badis
[1] *Barilius bendelisis* (F. Hamilton, 1807)	Cypriniformes	Cyprinidae	Bhareli, Zhorya, Korang
[1] *Barilius vagra* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Korang
[1] *Barilius shacra* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Bola, Shacra baril
[1] *Batasio batasio* (Blyth, 1860)	Siluriformes	Bagridae	Tista batasio
[1] *Botia dario* (F. Hamilton, 1822)	Cypriniformes	Botiidae	Botuk mach, loach
[1] *Botia rostrata* (Günther, 1868)	Cypriniformes	Botiidae	Gangetic loach
[1] *Danio rerio* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Poncha geraldi
[1] *Chanda nama* (F. Hamilton, 1822)	Cypriniformes	Ambassidae	Chanda, Kachki
[1] *Parambassis ranga* (F. Hamilton, 1822)	Cypriniformes	Ambassidae	Chanari, Ranga chanda
[1] *Channa gachua* (F. Hamilton, 1822)	Anabantiformes	Channidae	Dokrya, Bothua
[1] *Channa orientalis* (Bloch and J. G. Schneider, 1801)	Anabantiformes	Channidae	Cheinga, Cheng
[1] *Channa punctata* (Bloch, 1793)	Anabantiformes	Channidae	Lata, Spotted snake head, Gadisha

Table 1. *Cont.*

Species	Order	Family	Local Name
[1] *Channa stewartii* (Playfair, 1867)	Anabantiformes	Channidae	Sengalee, Assamese snake head
[1] *Clarias batrachus* (Linnaeus, 1758)	Siluriformes	Clariidae	Magur
[1] *Trichogaster chuna* (F. Hamilton, 1822)	Anabantiformes	Osphronemidae	Sunset gourami
[1] *Trichogaster lalius* (F. Hamilton, 1822)	Anabantiformes	Osphronemidae	Khosti, Kunggee
[1] *Crossocheilus latius* (Hamilton, 1822)	Cypriniformes	Cyprinidae	Gangetic latia
[1] *Danio dangila* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Laupati, Nipati
[1] *Danio rerio* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Zebra fish, Anju, Pocha-geraidi
[1] *Devario aequipinnatus* (McClelland, 1839)	Cypriniformes	Cyprinidae	Balooki, vannathipodi
[1] *Esomus danrica* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Darikana, jongia, Dendu
[1] *Eutropiichthys vacha* (Hamilton, 1822)	Siluriformes	Schilbeidae	Bacha, Neemuch
[1] *Gagata cenia* (Hamilton, 1822)	Siluriformes	Sisoridae	Indian gagata
[1] *Garra annandalei* (Hora, 1921)	Cypriniformes	Cyprinidae	Nungnga
[1] *Garra lamta* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Pathorchata, Dohjei
[1] *Glossogobius giuris* (F. Hamilton, 1822)	Gobiiformes	Gobiidae	Tank goby, Gulah
[1] *Glyptothorax chindwinica* (Vishwanath and Linthoingambi, 2007)	Siluriformes	Sisoridae	Nau, Pattarchatta
[1] *Gudusia chapra* (F. Hamilton, 1822)	Clupeiformes	Clupeidae	Khoira, Karati, Chapra
[1] *Heteropneustes fossilis* (Bloch, 1794)	Siluriformes	Siluriformes	Singhi
[1] *Laubuka laubuca* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Dankena, Dorikana
[1] *Mystus bleekeri* (F. Day, 1877)	Siluriformes	Bagridae	Palwa, Tengara
[1] *Mystus gulio* (Hamilton, 1822)	Siluriformes	Bagridae	Nona tangra, Gule tangra
[1] *Mystus malabaricus* (Jerdon, 1849)	Siluriformes	Bagridae	Shingeti
[1] *Mystus tengara* (Hamilton, 1822)	Siluriformes	Bagridae	Striped dwarf catfish
[1] *Mystus vittatus* (Bloch, 1794)	Siluriformes	Bagridae	Tangra
[1] *Nandus nandus* (Hamilton, 1822)	Siluriformes	Nandidae	Gangetic leaffish
[1] *Ompok siluroides* (Lacépède, 1803)	Siluriformes	Siluridae	Pabda, Khababia

Table 1. *Cont.*

Species	Order	Family	Local Name
[1] *Oreichthys cosuatis* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Khavli
[1] *Osteobrama cotio* (Hamilton, 1822)	Cypriniformes	Cyprinidae	Maura
[1] *Pellona sp.* (Valenciennes, 1847)	Clupeiformes	Pristigasteridae	Pellona
[1] *Chagunius chagunio* (Hamilton, 1822)	Cypriniformes	Cyprinidae	Chaguni
[1] *Puntius chola* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Swamp barb
[1] *Pethia gelius* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Glass barb
[1] *Pethia phutunio* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Dwarf barb
[1] *Puntius sarana* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Olive barb
[1] *Puntius sophore* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Sona punti/Pool barb
[1] *Puntius tirio* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Onespot barb
[1] *Puntius ticto* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Punti
[1] *Rasbora daniconius* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Dohni cona, Danikono
[1] *Salmostoma bacaila* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Chela, Kataria
[2] *Salmostoma phulo* (F. Hamilton, 1822)	Cypriniformes	Cyprinidae	Orali, Finescale razorbelly minnow
[2] *Macrognathus aculeatus* (Bloch, 1786)	Synbranchiformes	Mastacembelidae	Lesser spiny eel
[2] *Channa marulius* (F. Hamilton, 1822)	Anabantiformes	Channidae	Great snakehead
[2] *Channa striata* (Bloch, 1793)	Anabantiformes	Channidae	Striped snakehead
[2] *Xenentodon cancila* (F. Hamilton, 1822)	Beloniformes	Belonidae	Freshwater needlefish
[2] *Macrognathus pancalus* (F. Hamilton, 1822)	Synbranchiformes	Mastacembelidae	Striped spiny eel
[2] *Mystus cavasius* (Hamilton, 1822)	Siluriformes	Bagridae	Gangetic mystus
[2] *Notopterus notopterus* (Pallas, 1769)	Osteoglossiformes	Notopteridae	Bronze featherback
[2] *Mastacembelus armatus* (Lacepède, 1800)	Synbranchiformes	Mastacembelidae	Zig-zag eel
[2] *Trichogaster fasciata* (Bloch and J. G. Schneider, 1801)	Anabantiformes	Osphronemidae	Trichogaster fasciata

People worldwide have a common need to consume safe and nutritious food. Availability, adequate access, utilization, and safety combine to define food security [34] entirely. According to Gross et al. [37], "food security is the excess of enough food for every person in the world to lead a healthy life at all times". Food insecurity occurs whenever this standard amount cannot be fulfilled, especially in developing countries. Despite the improvement in the sector, currently, 36 percent of the total population is suffering from IPC Level 1, and 43% is suffering from IPC Level 2, which, in 2009–2010 was two-thirds of the population, mainly rural household people.

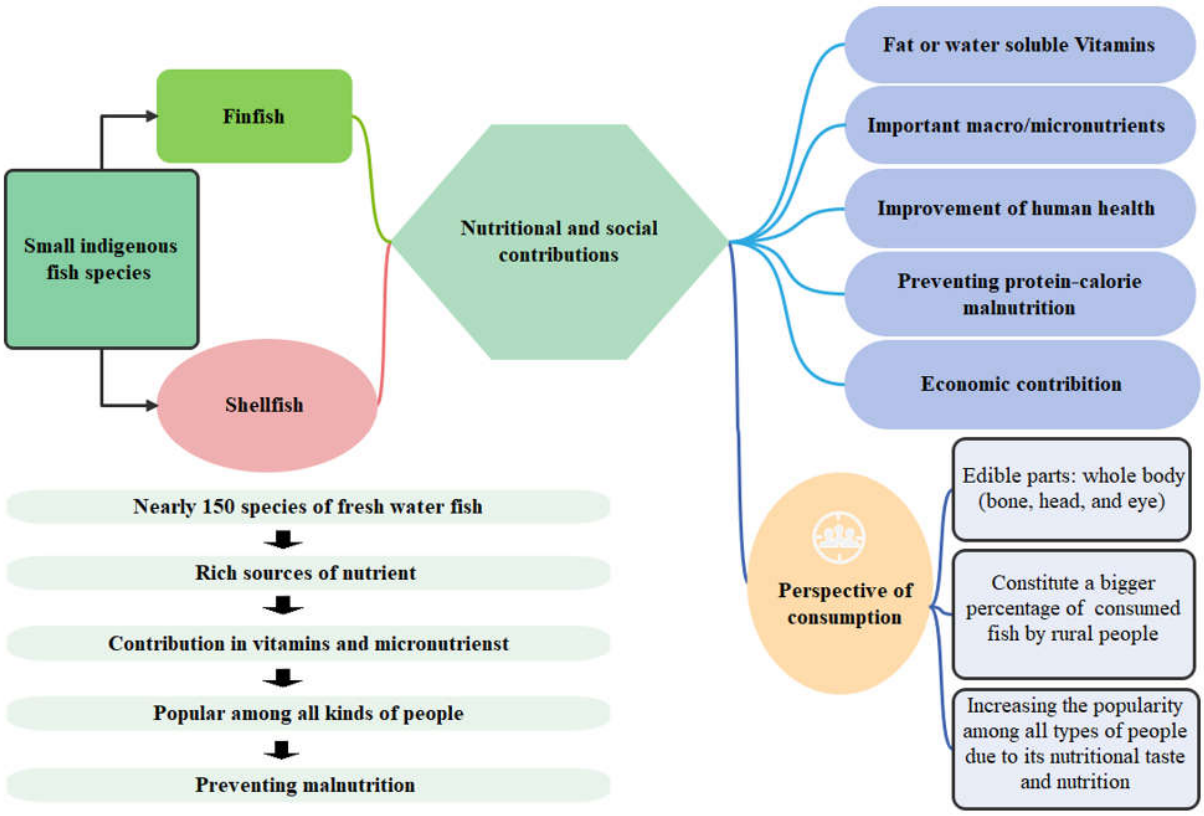

Figure 2. Importance of SIS in the context of Bangladesh.

In most cases, women are more vulnerable to food insecurity since they have less access to land and water, have less financial support, and look after the needs of others in the family rather than themselves, and a thing is to raise them in malnutrition and under-nourishment from a young age. Small fish are one of the food items that make it possible for rural people to meet the adequate demand for these nutrients and eliminate food insecurity. For example, the most available small fish, mola, is one of the main sources of vitamin A. It is considered one of the easiest ways to cure diseases, as it is necessary to eat this fish to cure significant diseases such as night blood disease and vitamin A deficiency. In addition, small fish are a reservoir of different minerals (e.g., Zn, P, Mg, Ca, etc.) compared to other food sources. In Cambodia, less expensive small fish also meet the zinc requirement of the lower class. The calcium from skimmed milk is often equal to that from small fish. In addition to meeting the requirements of macronutrients, the role of SIS is immense in meeting the needs of micronutrients, eliminating animal protein deficiency, and as a natural supplement [36]. Based on the size, age, variety, food habits, and feeding habits of small fish, their amount of nutrients can vary [12].

Table 2. Quantity of the amino acids (g/100 g protein) of some common SIS species available in Bangladesh [38].

Fish Species	Amino Acids																	
	Asp	**Thr**	**Ser**	**Glu**	**Pro**	**Gly**	**Ala**	**Val**	**Cys**	**Met**	**Iso**	**Leu**	**Tyr**	**His**	**Lys**	**Arg**	**Try**	**Phe**
A. mola	9.82	5.72	6.68	16.31	0.38	13.74	10.50	0.84	3.15	1.72	5.45	9.62	1.39	4.41	5.17	1.87	1.73	1.5
P. sarana	9.63	4.79	3.48	20.31	4.61	4.47	6.47	5.21	0.80	1.83	3.07	8.05	2.58	1.21	11.17	5.66	1.13	-
H. chela	6.33	4.29	2.41	10.79	3.86	4.74	4.47	4.07	0.50	1.34	4.56	6.92	1.84	4.86	10.98	2.78	1.38	3.84
C. phulo	3.78	1.87	1.40	6.96	2.25	2.99	2.93	2.50	0.31	1.46	2.35	3.51	1.84	1.03	4.13	3.20	-	2.07
Ambassis spp.	9.52	3.23	2.34	14.88	3.29	3.31	4.39	4.48	0.74	2.05	4.22	7.05	4.81	3.30	11.30	6.21	1.12	-
P. stigma	2.80	1.68	1.30	5.76	2.31	3.22	2.88	2.24	0.24	1.22	2.02	3.00	1.60	1.11	3.36	2.71	-	1.85
C. striatus	10.74	4.24	3.60	21.6	4.0	3.75	5.49	5.54	2.40	2.47	4.50	8.76	1.90	3.16	13.26	4.87	-	2.91
G. chapra	3.53	1.93	1.43	6.72	2.30	3.22	3.03	2.64	0.26	1.49	2.31	3.48	1.81	1.08	4.10	3.17	-	2.13
O. niloticus	12.91	5.32	4.05	17.05	4.07	6.68	7.36	5.81	0.84	2.97	6.58	9.83	1.47	2.53	15.76	5.62	-	3.10

Abbreviations: Asp, aspartic acid; Thr, threonine; Ser, serine; Glu, glutamic acid; Pro; proline, Gly, glycine; Ala, alanine; Val, valine; Cys, cystine; Met, methionine; Iso, isoleucine; Leu, leucine; Tyr, tyrosine; His, histidine; Lys, lysine; Arg, arginine; Try; tryptophan; Phe, phenylalanine.

The successful linking of human nutrition and fisheries to address micronutrient deficiencies is relevant for other countries with rich fishery resources, such as Cambodia and those in the Lake Victoria region of Africa [17].

The nutritional content of these fish varies depending on cleaning techniques, discarded parts, and pre- and post-cooking weights. In this case, the nutrient analysis of their raw, clean cuts and waste materials has been documented and connected in the above-mentioned table. Small fish are preserved and consumed all year round in Bangladesh through a variety of techniques, including pickling during the pick production phase and drying and preserving small prawns using Sidal and Shut. Small fish are consumed in enormous quantities in Cambodia in various forms, such as fish sauce, fish paste, and preserved small fish. Some are consumed as dried fish, salted fish, fermented fish, and smoked fish [39]. Thus, tiny fish directly cooked or stored meet 40% and 31% of Bangladesh's needs for vitamin A and calcium, respectively [17]. Small plants and animals make up the majority of the diet of small fish. They have more nutrients in their bodies since they grow up in a natural setting and eat natural foods. Small fish are the only method to ensure that the next generation is talented and healthy (Figure 3). "The more popular little fish are in countries, the healthier and smarter children are growing up", said World Fish's nutrition and public health director.

The whole body of SIS is edible, with head, bones, eyes, and viscera, without any plate waste, making the food rich in nutrients. Mola fish has the most vitamin E in the eyes, so one must be careful while cleaning this fish so that the head is not separated from the body and is eaten with the head, eyes, and bones. The amount of vitamin A in sun-dried fish reaches almost zero [40]. The amount of minerals (e.g., Ca, Zn, Fe, P, etc.) present in the fish with a head is comparatively higher during cleaning than in the whole fish except the head [8]. Based on the growth percentage of Vitamin A2 in a rat's body, 40% of biological activity is shown to calculate RAE from fish samples [41]. The high amount of calcium found in the human body and rat's milk can be obtained from mallow fish [42,43]. A total of 25% from both haem iron and non-haem iron and 10 percent from inorganic iron we can get from fish bodies. However, the cooking method can alter this bioavailability, as trey changwa plieng, a Cambodian fish dish, provides more heme iron than fried fish [17]. The animal body has more zinc than plants, especially fish. Boiled rice and sour soup is one of the traditional, everyday food items of Cambodia's poor population; when cooked with a trey changwa plieng, it meets 45% of a woman's daily iron needs. On average, a woman consumes 367 g of rice and 257 g of sour soup, and 49 g of fish per day. Again, 100 g of sour soup for a child contains only 25% and covers 42% of the child's daily iron requirement, whereas a child's daily iron requirement is 0.42 g of iron [17]. Apart from these, the absorption of non-heme iron and zinc can be obtained from everyday ingredients, especially fatty acids, in addition to easily absorbable iron [8].

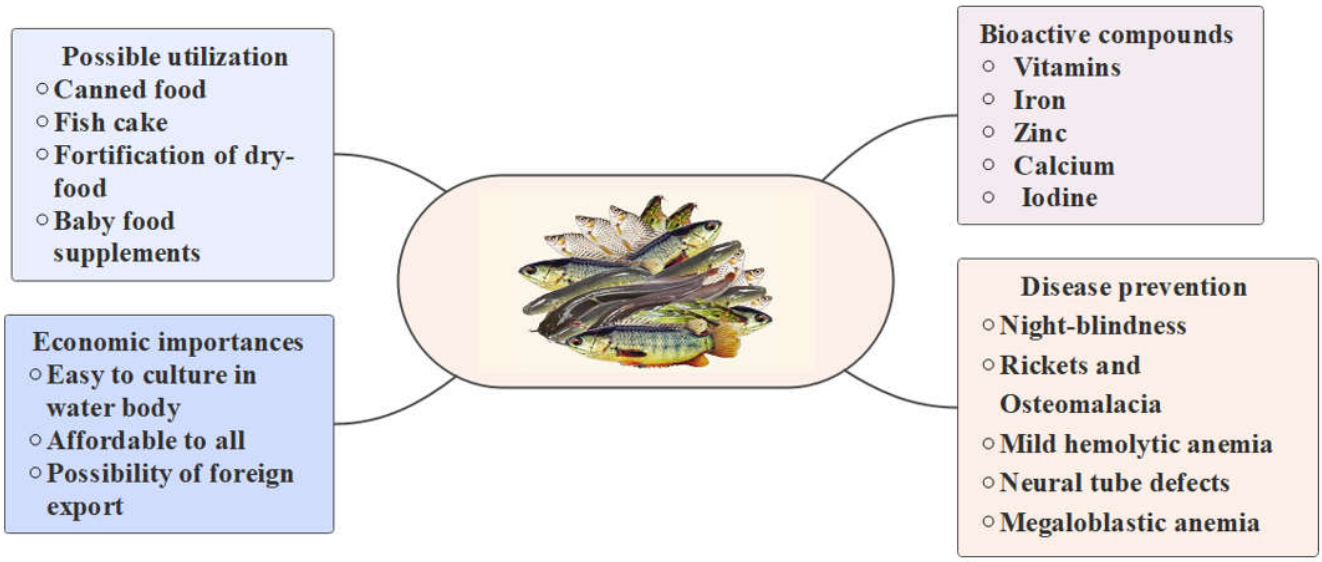

Figure 3. A diagram for the better utilization of SIS, their economic importance, and their impact on the human body.

3.3. Vitamins

Every organism needs very modest amounts of vitamins to carry out its essential tasks. They play similar roles at each stage of the life cycle. Many physical and mental illnesses are brought on by a deficiency of these microelements (Figure 4). Depending upon their solubility, vitamins are one of two types: fat-soluble (vitamins A, D, E, K) [44] or water-soluble (vitamin C and vitamin B complex) [12]. The vitamin B series (vitamin B1, vitamin B2, vitamin B3, vitamin B5, vitamin B6, vitamin B7, vitamin B9, and vitamin B10) have been recognized as coenzymes or cofactors. The components of coenzymes participate in numerous biochemical reactions involving blood coagulation, hormone production, energy release, etc. For example, the active coenzyme forms of Thiamine (B1), Riboflavin (B2), and Niacin (B3) are TPP, FAD, and NAD/NADH, respectively. Pantothenic acid (vitamin B5) is a component of coenzyme A that is necessary for metabolizing carbohydrates, amino acids, and other biomolecules [12]. Pyridoxine is a coenzyme form of vitamin B6. Biotin (vitamin B7), as a coenzyme, supports the function of carboxylase, pyrimidine synthesis, and urea formation [21].

Folate (vitamin B9) is a coenzyme required for purine biosynthesis and plays a vital role in forming heme, the iron-containing substance in hemoglobin. Cobalamin (B12), a component of cobamide coenzymes, is required to maintain cellular integrity by keeping the standard structure of the cell membrane intact. Fish is an excellent source of vitamins, particularly vitamins A, D, and E as well as B1 and B2. Vitamin A produces eye pigments that prevent eye damage and blindness, and its deficiency is prevalent in developing countries, especially for children and women [45]. Some studies indicate that vegetarians (80–90%) suffer from vitamin B12 deficiency since it is only sufficient in animal food (i.e., small indigenous fish). Some vitamin components in small fish are below in Table 3.

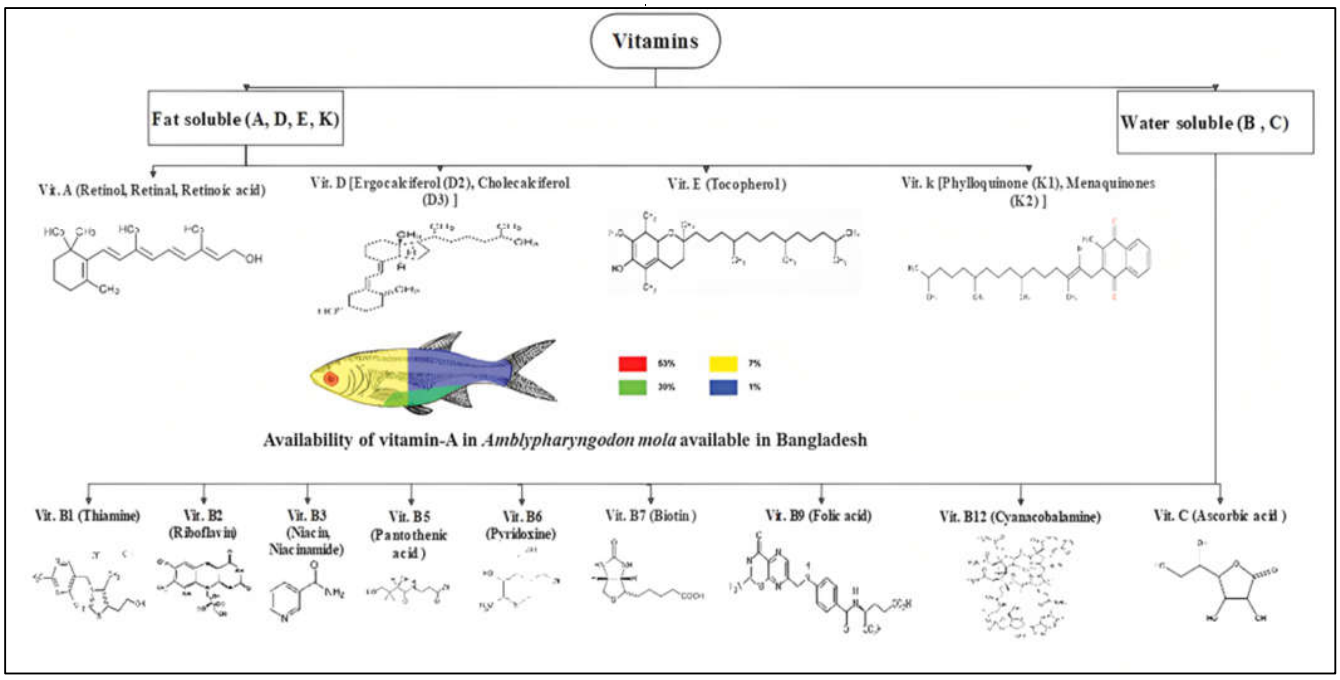

Figure 4. Contribution and preventive deficiency of vitamins in the presence of SIS, effective activities on the cellular level in the human body. The deficiency of fat-soluble vitamins can create several health-related problems, including night blindness and xerophthalmia [45,46] in the human body. Mola is a typical SIS of Bangladesh containing a huge amount of vitamin A; distribution of vitamin A in the different parts of the mola was based on the study of Roos et al. [3]. The figure was partially modified from Thilsted [8].

3.3.1. Vitamin A

Vitamin A (retinol, retinoic acid) is essential for eye health, immune function, cell growth, and reproduction [44]. The most common and first sign of Vitamin A deficiency is night blindness (poor vision at night or in dim light). According to WHO, 250,000–500,000 children become blind, and half of them die within 12 months because of losing sight. Humans generally need little amount of this vitamin: the recommended daily allowance of micrograms is 900 micrograms for men and 800 micrograms for women, with an additional dose for pregnant women [21]. Mola is a vitamin-A-rich SIS consumed by most households in Bangladesh. Twenty-eight species mentioned by Bogard et al. [21] are represented in Table 3 with varying vitamin A levels. The only species in which total vitamin A could not be measured was Foli. Mola fish had the most significant levels of vitamin A of the species listed in Table 3 (2503 mg RAE). Mola and cultured mola both had substantial levels of retinol and dehydroretinol, which were 340, 4590, and 323, 4990, respectively [47]. The aforementioned discussion makes it quite evident that fish are the only food source in Bangladesh that can fully satisfy the needs of SIS for vitamin A [17]. As a result of poor nutrition, their absence is the primary cause of night blindness [48].

Table 3. Several SIS species are found in nearby tiny or shallow freshwater lakes and contain vitamins such as water-soluble or fat-soluble vitamins (µg RE/100 g).

Small Indigenous Fish Species (SIS)	Nutrient Presence in 100 g Raw Fish (Different Edible Parts)										
	Vit- B12, D, E and B9					Vit-A					
	V-B12 (µg)	V-D3 (µg)	V-D2 (µg)	V-E (µg)	B9 (µg)	β-Carotene (µg)	13-Cis-Retinol (µg)	13-Cis-dehyDroretinol (µg)	All-Trans-Retino (µg)	All-Trans-Dehydroretinol (µg)	Total Vitamin A (µg RAE)
Tit Punti	6.74	0.995	nd	0.16	nd	25 [a]	4 [a]	5 [a]	11 [a]	8 [a]	21
Rani, Bou	6.4	0.12	–	0.63	3.2	–	nd	nd	nd	60	24
Jat Punti	4.01	1.29	nd	0.15	nd	13 [a]	4 [a]	9 [a]	27 [a]	49 [a]	54
Darkina	12.5	6.31	nd	0.84	nd	100 [a]	63 [a]	48 [a]	433 [a]	381 [a]	660
Boro Kholisha	5.55	3.13	2.1	0.12	nd	11 [a]	5 [a]	5 [a]	34 [a]	14 [a]	46
Guchi	2.47	2.29	nd	0.11	nd	110 [a]	1 [a]	14 [a]	9 [a]	133 [a]	78
Meni, Bheda	0.90	0.78	–	0.36	3.5	–	nd	nd	36	61	60
Taki	1.60	nd	nd	0.14	nd	22 [a]	9 [a]	13 [a]	84 [a]	104 [a]	139
Koi	2.38	1.19	nd	nd	11.4	74 [a]	61 [a]	30 [a]	163 [a]	171 [a]	295
Chela	5.64	4.00	nd	0.11	nd	21 [a]	25 [a]	9 [a]	90 [a]	45 [a]	132
Kajuli, Bashpata	4.1	0.091	–	0.28	2.9	–	nd	nd	37	nd	37
Tengra	3.5	0.19	–	0.23	10	–	nd	nd	nd	29	12
Foli	2.0	0.70	–	0.64	18	–	nd	nd	nd	nd	nd
Chapila	6.99	4.92	nd	nd	nd	nd [a]	1 [a]	21 [a]	9 [a]	136 [a]	73
Baim	1.72	1.30	0.76	nd	nd	5 [a]	1 [a]	5 [a]	1 [a]	51 [a]	27
Mola (cultured)	5.9	3.0	–	0.91	4.3	–	44	42	340	4590	2226
Magur	4.83	nd	nd	0.13	9.4	64 [a]	4 [a]	8 [a]	7 [a]	15 [a]	25
Tara Baim	5.20	nd	nd	0.17	nd	135 [a]	2 [a]	15 [a]	16 [a]	120 [a]	83
Dhela	4.7	0.14	–	0.24	6.6	–	15	68	28	2130	918
Mola	7.98	2.03	2.9	0.27	nd	nd [a]	nd [a]	460 [a]	323 [a]	4990 [a]	2503
Shing	12.8	nd	nd	0.34	nd	45 [a]	5 [a]	11 [a]	11 [a]	22 [a]	32
Kachki	3.55	1.5	nd	0.09	nd	15 [a]	2 [a]	30 [a]	14 [a]	122 [a]	78
Chanda	6.42	11.9	nd	0.18	nd	43 [a]	14 [a]	51 [a]	128 [a]	433 [a]	336
Kuli, Bhut Bailla	1.4	22	–	0.55	3.7	–	nd	nd	37	nd	37
Gutum	8.75	nd	nd	0.19	nd	25 [a]	1 [a]	9 [a]	17 [a]	131 [a]	76
Bele, Bailla	2.1	1.6	–	0.17	6.7	–	nd	nd	18	nd	18
Kakila	2.89	1.4	0.66	0.40	9.2	56 [a]	9 [a]	12 [a]	54 [a]	53 [a]	91
Ekthute	3.0	2.4	–	0.65	11	–	18	nd	84	nd	98

[a] Data were published by Roos et al. [3]. Data without superscript were published by Bogard et al. [21]. µg RAE, the activity of retinol equivalent. –, data that are not available. nd, not detected.

3.3.2. Vitamin B12

Food derived from animals, including fish and shellfish, is a good source of vitamin B12, which is essential for cell division, blood formation, DNA formation, nerve function, etc. It is a highly complex essential vitamin chemically known as Cobalamin. The vitamin B12 content of the above-mentioned small fish ranged from 0.90 to 12.8 µg per 100 g, and their analytical methods varied [21]. The highest amount was found in Shing fish and the lowest in Meni and Bheda fish [21]. A total of 22% of adult women are vitamin B12 deficient, with negative effects on their health, neural development, and function, which has drawn special attention in the public health sector nationally [49]. As the whole source of vitamin B12 is animal-based, in the context of Bangladesh, small fish can play a very important and increasing role in meeting its deficiency and maintaining a proper diet chart [50].

3.3.3. Vitamin D

Naturally-produced vitamin D3 (cholecalciferol) is found in animals. It is stated that only zooplankton and microalgae are considered plankton sources of vitamin D2, and fish eat these as a part of their diet [51]. Several studies show that vitamin D helps calcium and phosphorus absorption, controls infection, reduces inflammation, prevents cancer, etc. Lack of vitamin D can cause osteoporosis, bone loss, muscle weakness, rickets, etc., [21]. Fish have been considered an excellent source of vitamin D, especially fish oil [44]. Out of the 28 species, the average value of vitamin D is 6.02 µg. It is undetectable in five species, i.e., taki, shing, magur, tara Baim, and gutum, and chanda has the highest amount (11.9 µg/100 g) of vitamin D3 (Table 3). Analysis of vitamin D2 found only four species with concentrations ranging from 0.66 to 2.9 µg/100 g. Basically, vitamin D2 is obtained from plant-based food items, especially yeast and fungi; from the data in Table 3 above, it can be understood that more species in Bangladesh play a role in the vitamin D diet [21]. The main function of this vitamin is calcium homeostasis; it increases the efficiency of dietary calcium in the body in the intestine. When a sufficient amount of calcium does not meet the body's calcium requirement, dissolved calcium accumulates in the body through the osteoblast and osteoclast tissue [52].

3.3.4. Vitamin E

Naturally-sourced vitamin E exists in eight chemical forms: alpha-, beta-, gamma-, and delta-tocopherol, and alpha-, beta-, gamma-, and delta-tocotrienol. Among all of them, only alpha-tocopherol, with the highest biological activity, can meet human requirements. According to the analysis, alpha-tocopherol could not be found in 3 species (koi, chapila, baim) out of the 28 species tested. It is found to be highest (0.91 µg) in mola and lowest (0.09 µg) in kachki (Table 3). Vitamin E is involved in immune function, preventing blood clogging, metabolic process, regulation of gene expression, and activity of protein kinase, and also increases the expression of two genes [53]. Vitamin E deficiencies cause nerve impulses, muscle weakness, and the inherited disorder AVED (ataxia and vitamin E deficiency) [54]. From the sources of vitamin E described in Table 3 above, we can understand that the amount of a-tocopherol obtained using the standard method is very high in some species of small fish [21]. In contrast, the amount of d-tocopherol was not found in any of the species analyzed, and the amount of g-tocopherol was found in only two species. They are Tara baim and Shing with 0.01 and 0.04 IU/100 g, respectively.

3.3.5. Vitamin B9 (Folate)

In the above-mentioned table, maximum vitamin B9 was obtained at 18 µg in Foli and at a minimum of m 2.9 µg in Bashpata and Kajuli. The required amount of vitamin B9 for adults is 500–600 µg per day, but, for children, it is 80–150 µg/per day, most of which is met through the consumption of small fish in the population of Bangladesh [21]. Folate is a component in various physiological needs, including red blood cell formation, cell growth and function, RNA and DNA formation, and protein metabolism. A total of 30 to 50 percent of the human body's cellular folate resides in microconidia [50].

3.4. Minerals

Minerals are essential food components of the human body that are required in minimal quantities, but they play a key role in managing various important physical and biological functions. Minerals can be of two types, micronutrients and macronutrients. Small fish usually contain a large number of macro minerals such as calcium and phosphorus [12]. According to FAO, we can broadly divide food into three categories: 1. cereals, 2. non-staple plant food, and 3. animal and fish products. Cereals are the primary level of energy among these three types, but they contain very few micronutrients. Basically, micronutrient-complete foods can be included in non-staple plant food lists. We obtain the maximum amount of energy, vitamins, minerals, and other air molecules in food from animal and fish products. Small indigenous fish species from inland water bodies are not only a source of protein but also a large storehouse of various minerals (Table 4), micronutrients, and macronutrients [49,55].

Table 4. Several SIS are found in nearby tiny or shallow freshwater lakes and contain various nutritional trace elements (as micronutrients) (mg/100 g raw edible parts).

Small Indigenous Fish Species (SIS)	Nutrient Presence in 100 g Raw Fish											
	Fe (mg)	Zn (mg)	Ca (mg)	I (μg)	Se (μg)	P (mg)	Mg (mg)	Na (mg)	K (mg)	Mn (mg)	S (mg)	Cu (mg)
Tit Punti	3.4 [a]	3.8 [a]	1480 [a]	19	10 [a]	–	47 [a]	61 [a]	187 [a]	–	–	–
Rani, Bou	2.5	4.0	1300	25	31	820	45	48	160	1.5	170	0.094
Jat Punti	2.2 [a]	2.9 [a]	1042 [a]	20	9.5 [a]	–	39 [a]	53 [a]	203 [a]	–	–	–
Darkina	12 [a]	4.0 [a]	891 [a]	81	12 [a]	–	38 [a]	110 [a]	200 [a]	–	–	
Boro Kholisha	4.1	2.3	1700	20	26	910	44	61	210	2.0	190	0.046
Guchi	2.7 [a]	1.3 [a]	491 [a]	19	45 [a]	–	34 [a]	52 [a]	294 [a]	–	–	–
Meni, Bheda	0.84	1.6	1300	13	29	810	44	68	250	1.4	210	0.029
Taki	1.8 [a]	1.5 [a]	766 [a]	18	15 [a]	–	35 [a]	47 [a]	260 [a]	–	–	–
Koi	0.87	0.60	85	nd	19	160	21	31	260	0.052	190	0.052
Chela	0.84	4.7	1000	19	32	590	39	28	85	0.60	170	0.052
Kajuli, Bashpata	0.82	1.2	110	7.1	27	140	22	26	130	0.17	200	0.059
Tengra	4.0 [a]	3.1 [a]	1093 [a]	28	24 [a]	–	36 [a]	57 [a]	203 [a]	–	–	–
Foli	1.7	1.6	230	nd	22	270	34	53	280	0.078	260	0.058
Chapila	7.6 [a]	2.1 [a]	1063 [a]	13	13.4 [a]	–	41 [a]	57 [a]	281 [a]	–	–	–
Baim	1.9 [a]	1.1 [a]	449 [a]	13	12 [a]	–	35 [a]	47 [a]	322 [a]	–	–	–
Mola (cultured)	19	4.2	1400	33	19	700	49	31	58	1.9	160	0.047
Magur	1.2	0.74	59	22	22	210	26	61	350	0.021	180	0.050
Tara Baim	2.5 [a]	1.2 [a]	457 [a]	13	15 [a]	–	34 [a]	46 [a]	290 [a]	–	–	–
Dhela	1.8	3.7	1200	9.5	29	660	39	37	110	0.60	170	0.046
Mola	5.7 [a]	3.2 [a]	853 [a]	17	5 [a]	–	35 [a]	39 [a]	152 [a]	–	–	–
Shing	2.2	1.1	60	nd	31	220	37	54	300	0.038	230	0.057
Kachki	2.8 [a]	3.1 [a]	476 [a]	6.0	7.5 [a]	–	26 [a]	38 [a]	134 [a]	–	–	–
Chanda	2.1 [a]	2.6 [a]	1153 [a]	24	22 [a]	–	45 [a]	61 [a]	206 [a]	–	–	–
Kuli, Bhut Bailla	0.79	2.0	980	31	49	580	39	55	190	0.29	210	0.030
Gutum	3.3	2.5	950	16	36	650	57	45	240	0.46	190	0.054
Bele, Bailla	2.3	2.1	790	25	31	520	38	56	210	2.3	200	0.030
Kakila	0.65	1.9	610	37	29	450	35	49	190	0.47	240	0.046
Estate	1.5	3.6	1300	11	28	770	51	52	140	0.73	240	0.030
Golsha	1.8	1.3	120	13	41	180	26	33	210	0.22	220	0.039
Modhu Pabda	0.46	0.90	91	7.0	27	150	23	47	230	0.073	190	0.042

[a] Data were published by Roos et al. [5]. Data without superscript were published by Bogard et al. [21]. –, data are not available. nd, not detected.

The presence of a standard amount of these minerals (e.g., copper, zinc, selenium, iodine, magnesium, iron, cobalt, and chromium) in the diet is essential for human health. A lack of sufficient amounts of minerals causes many diseases in the human body. For example, calcium deficiency can cause osteoporosis and bone loss [56]; lack of zinc causes immune dysfunction, growth inhibition, and sexual dysfunction. The deficiency of iron and copper causes diseases such as anemia [57]. Not only can food intake meet all the physiological needs of the human body, but a sufficient supply of minerals is essential for its full functioning [58]. Currently, various minerals are commercially available within the market, but their absorption levels and solubility are very low. Required health of minerals is shown in Figure 5.

3.4.1. Iron

From the data of Bogard et al. [21], we can see that three species (chapila, darkina, and mola) can meet 25% of the RNI for PLW by having iron contents that range from 0.46 to 19 mg/100 g. Compared to wild mola fish (5 mg/100 g), cultivated mola has been found to have a significantly greater iron content (19 mg/100 g). Analyses of iron content may reveal systematic variations or actual variations in iron buildup among various species depending on the context. The data provided here suggest that a number of locally endemic tiny fish species may considerably contribute to the consumption of iron, the most essential trace element in the diet in Bangladesh, which has a high bioavailability as foods derived from animals [59]. It is found in every body cell of vertebrates. It is crucial for many processes, including biochemical ones, reactions involving the transfer of electrons, the control of genes, the movement of oxygen, and the growth, regulation, and differentiation of cells [60]. Iron's primary function in the body is to produce hemoglobin for red blood cells, which contains heme in its pure form (Figure 6). The molecule known as hemoglobin transports oxygen to tissues and removes carbon dioxide from cells [12]. It is well known that the Fe-containing enzyme hydrogen peroxidase reacts with reactive

compounds produced as byproducts of oxygen metabolism. Non-heme, iron-content enzymes including succinate dehydrogenase, nicotinamide adenine dinucleotide (NADH) dehydrogenase, and xanthine oxidase aid in energy metabolism. These enzymes are found in iron-sulfur cluster proteins [60].

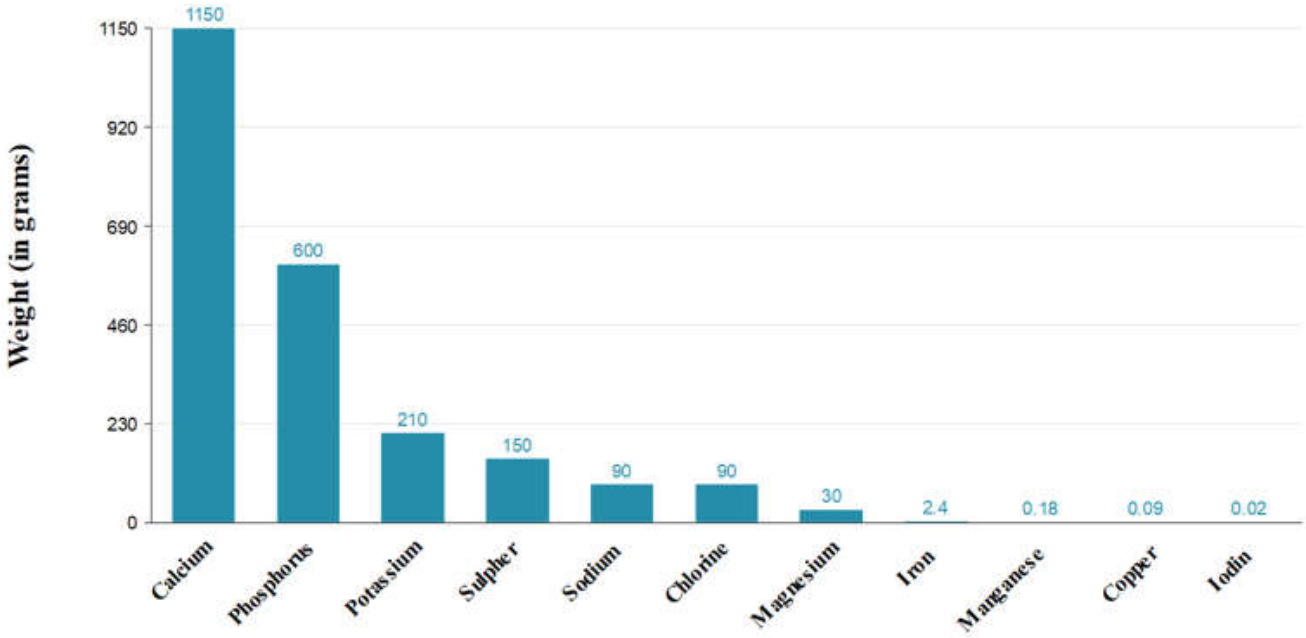

Figure 5. Average mineral requirements for the human body [21].

3.4.2. Zinc

Zinc is essential to maintaining good health because it involves more than 200 enzymatic reactions in catabolic processes, immune response, wound healing, and sexual maturation [12] (Figure 6). Indigenous species of fish carry Zn in high concentrations. The zinc concentration varies from about 0.60 to 4.7 mg/100 g in fish and seafoods [61]. Among the species, four species, chela, mola, darkina, and rani, meet 25% of the RNI for PLWs, and only chela and mola meet 25% of the RNI standard for infants. In addition, six naturally-occurring species, dhela, ekthute, kachki, mola, and Ttengra, fill 20 to 25 percent of RNIs, and darkina, dhela, ekthute, mola, tit punti, and rani fill 20 to 25% of RNIs for infants [21]. According to recent studies, 57% of women and 44% of preschool children in the total population of Bangladesh suffer from zinc deficiency, which has become a national concern [62]. SIS are rich in zinc, so they can easily be added to diet plans to meet zinc requirements. Zinc is a core element in various genetic processes, including DNA formation and replication and cell division and growth [58].

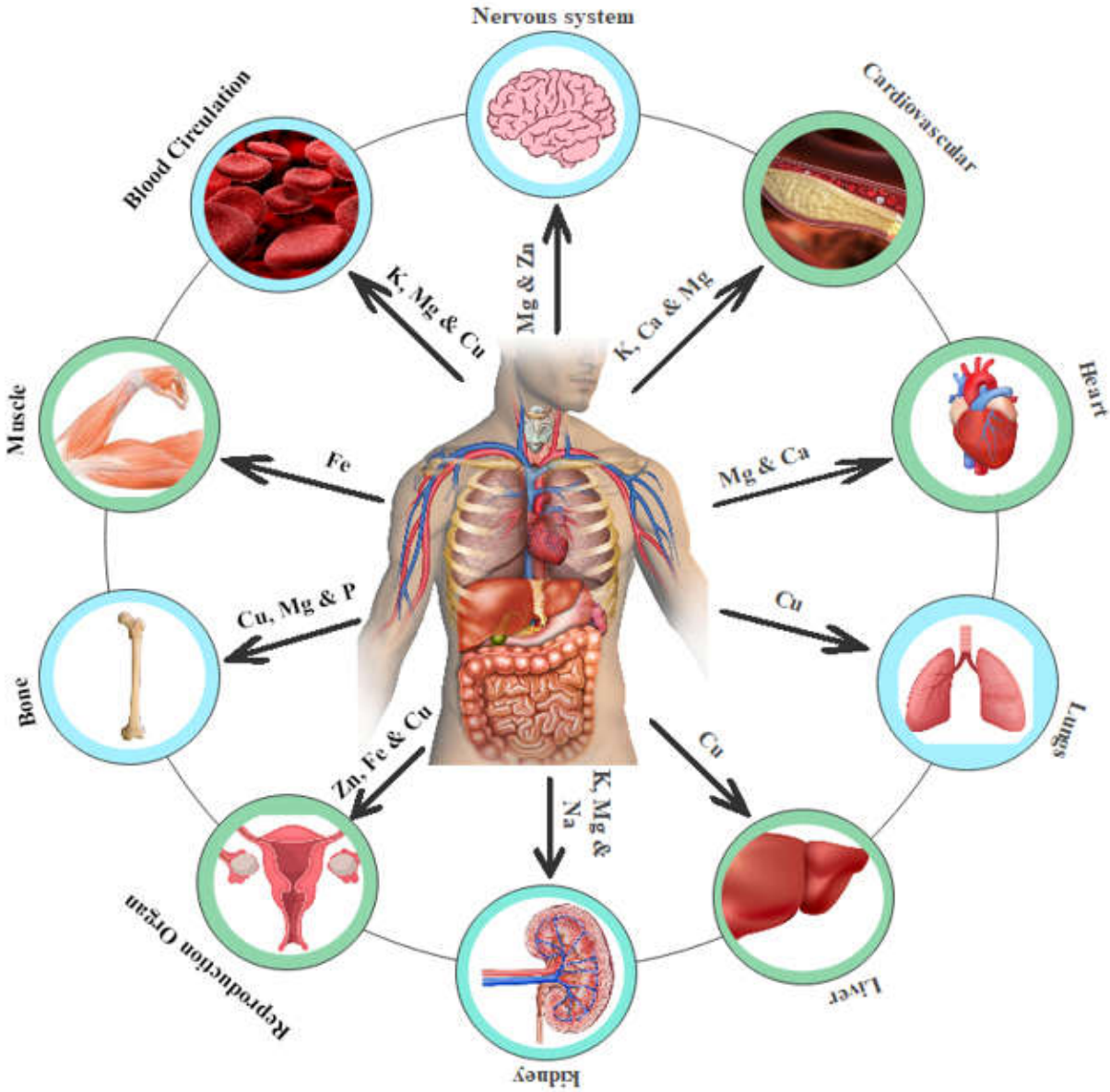

Figure 6. Bioactivity of different minerals in the human body [63] Small fish contain several minerals [64] that are helpful for human health.

3.4.3. Calcium

Calcium is the most abundant mineral in the body that makes up 1.5–2.0 percent of the total body weight. As 99% of the body's bones are composed of calcium, the major function of calcium is to maintain healthy bones, teeth, or components related to these (Figure 6). Scientists suggest that one should consume 100 mg of calcium per day [21]. This trend is also seen in the calcium content of the 29 species in the table above, with an average value of 879.5 mg. Since SIS are consumed whole with bones, calcium is considered a highly available dietary food item for humans [17,43]. According to the report, 550,000 children suffered from rickets due to calcium deficiency in 2008, and, from various studies, two sub-discs of Bangladesh, especially women and children, do not have enough calcium in their daily diet [65,66]. Although, in developed countries, there is a trend to meet the demand for most of the calcium calcium-containing products, in developing countries such as Bangladesh, it is challenging to meet this demand for dairy products. Therefore, the importance of small fish is immense in filling calcium deficiency [9]. The contribution of

calcium to muscle contraction, relaxation, normal heart rhythm, fatty acid oxidation, nerve function, and as a carrier of ATP in mitochondria is irreplaceable [50].

3.4.4. Iodine

The iodine content of food typically depends on its environmental conditions. Marine fish are rich in iodine. The average iodine content of small freshwater fish is 43.6 µg/100 g; the highest value is 81 µg/100 g in darkina, and the lowest is 6 µg/100 g in kachki fish. In the table above, the amount of iodine could not be detected in these three fish: koi, shing and foli [21]. Iodine plays an essential role in regulating the biochemical functions of the human body, maintaining hormone levels, and maintaining the release of thyroxine hormone to support the body's metabolism (Figure 6). Currently, the economic importance of iodine has appeared beyond the function of the human body. Its commercial demand is increasing as various pharmaceuticals, disinfectants, photography elements, and feed supplements [12].

3.4.5. Selenium

Selenium is a critical trace mineral that plays a vital part in enzymatic contrast, antioxidant and catalyst generation, cellular production, immunological function, fertility, etc (Figure 6). Selenium is also needed to develop human skin, hair, and nails. In the human body, selenium exists in two different forms: inorganic forms, which are free of amino acids, and organic forms, which are bound to amino acids. Small fish should be consumed frequently by everyone, but especially by individuals with thyroid issues. Small fish contain selenium, which enhances thyroid function. Selenium aids in preventing cancer, cardiovascular disease, thyroid problems, oxidative damage, lowering inflammation, and preventing artery aggregation [12]. The amount of selenium in the environment, particularly in the soil and water where it grows, often varies. Selenium is typically found in fish eggs [21]. According to FAO reports, the selenium level in small fish typically ranges from 5 to 49 µg/100 g.

3.4.6. Other Minerals

Phosphorus is a body's electrolyte that maintains an electric charge and is essential for structural components of nucleotide coenzymes. Phosphate is a building block necessary for teeth and bone formation and energy production [50]. Phosphorus ranged from 140 to 190 mg/100 g in the edible parts, including bones in small fish species, reported by FAO [21]. Phosphorus content is measured either spectrophotometrically or by ICP-ACE. Magnesium ranged between 21 and 57 mg/100 g obtained from the whole fish body. It is a critical intracellular divalent cation that is essential for protein synthesis, cell replication, energy metabolism, muscle contraction, nerve conduction, and so on [50]. About 50–70% of the fish Mg was located in skeletal tissue and scales. The sodium concentration of fish varied between 26 mg and 110 mg/100 g, which was generally similar to other SIS reports. The required amount of sodium ions mentioned in Figure 5 is 90 g in the human body. In a constrained level, the noticeable dimensions of fine scheelite with its floatation value rise according to the variation of energy input, the size distribution of fine scheelite shifts from unimodal to bimodal [67]. The potassium level of fish varied from 58–350 mg/100 g, which was generally comparable with other reports of small indigenous fish. According to the committee, a fair amount of research shows a link between potassium consumption and adult blood pressure decrease, which consequently affects their risk of coronary heart disease and stroke. Additionally, there is growing documentation that sufficient digestible potassium has a preventive impact against kidney stone formation and age-related bone loss. The manganese level of fish was 0.021–2.3 mg/100 g, which was generally similar to values noted previously by small indigenous fish species. General activities of manganese on health by gluconeogenesis and the impact on cofactors of numerous enzymes are involved in carbohydrate metabolism [50]. The concentration of sulfur in the fish varied from 160–260 mg/100 g, which was generally comparable with other reports of small

indigenous fish. The increasing levels of primary and secondary metabolites, H_2O_2, and malondialdehyde (MDA) were found both in the roots and the leaves, indicating that the growth was negatively impacted by oxidative stress and that the antioxidant defense system was insufficiently able to maintain the redox equilibrium of the cell [68]. The copper level of fish varied from 0.029 mg to 0.094 mg/100 g, substantially in line with other reports of small indigenous fish. An important cofactor of the mitochondrial respiratory chain enzyme, cytochrome-C-oxidase, is involved in iron metabolism [50]. Nearly every species had indistinguishable levels of chromium. There is an exception of cultivated mola, which had extremely low quantities of chromium of 0.027 mg/100 g, which was also compatible with information from other sources. People who exercise vigorously have been observed to have increased urine levels of chromium. The health impact potentiates insulin activity, boosting glucose absorption by the cells [50].

4. Possible Utilization of SIS in Future Foods

Small indigenous species (SIS) of fish can be used to encourage the consumption of micronutrient-rich fish species, particularly in vulnerable population groups such as young children, pregnant and lactating women, the sick, and the elderly. To enhance the intake of animal-sourced meals by women and children, it is therefore immensely advantageous to include small fish species that are rich in micronutrients in the development and execution of agricultural policy decisions and programs. Data from Bangladesh authenticate this method. According to the Nutrition Surveillance project by Helen Keller International in 2000, data on the consumption of four nutrient-rich foods (egg, fish, green leafy vegetables, and lentils) were collected twice a month on more than 51,000 rural children aged 12–59 months [8]. The most often consumed food was fish, while lentils and vegetables were only consumed once every two days, and more than 60% of children had not had an egg. Due to the availability and rising consumption rates of small fish, they offer excellent prospects for ready products and are also more affordable than other sources of protein (Figure 7).

Additionally, even though more than 90% of homes claimed to have chickens, other family members seldom ate eggs [69]. In 2005, mothers of children under the age of five in rural Bangladesh showed a pattern of food recurrence intake. In terms of the recurrence of intake of food, green leafy vegetables, eggs, lentils, milk, fruits, poultry, and beef were consumed less frequently than fish, which was the second most popular food after rice. For instance, many studies show that fermentation is an age-old, conventional process that adapts the perishability of fish with shellfish. Various products of shidal include a lot of protein and essential amino acids. Due to the widespread protein insufficiency among Bangladeshis, a close combination of two distinct shidals manufactured from punti (*Puntius sophore*), and darkina (*Esomus danricus*) will be very efficient in solving the lack of affordable protein by increasing its availability. Concurrently, by expanding shidal industrial output, job possibilities can be generated [14]. The Dermestes sp. bug invasion was successfully resisted by the preservation and processing of dry SIS, neem, and turmeric pesticides that had been used to control pests and received outstanding and suitable scores for essence, shade, and taste [70]. Suppressing the dermestid beetle in both the refining and storage of dry fish can employ unprocessed turmeric and neem dust, which might be an excellent alternative to dangerous chemical pesticides [71]. An illustration of families participating in a highly effective intervention of poultry production reported producing eggs and chickens. In line with expectations, the intervention group's families produced much more eggs and chickens than those receiving no assistance. Small indigenous fish were identified as the second most favored item of food by women to purchase when family earnings rose. According to the recorded data, fruits scored first, followed by the leafy vegetables in third place, and two items derived from animals, namely milk and meat, in fourth and fifth place [72]. All findings indicate that there is significant room to boost the intake of small indigenous species of fish, a popular cuisine in Bangladesh and

maybe other developing nations, which is rich in bioavailability and numerous nutrients with micronutrients.

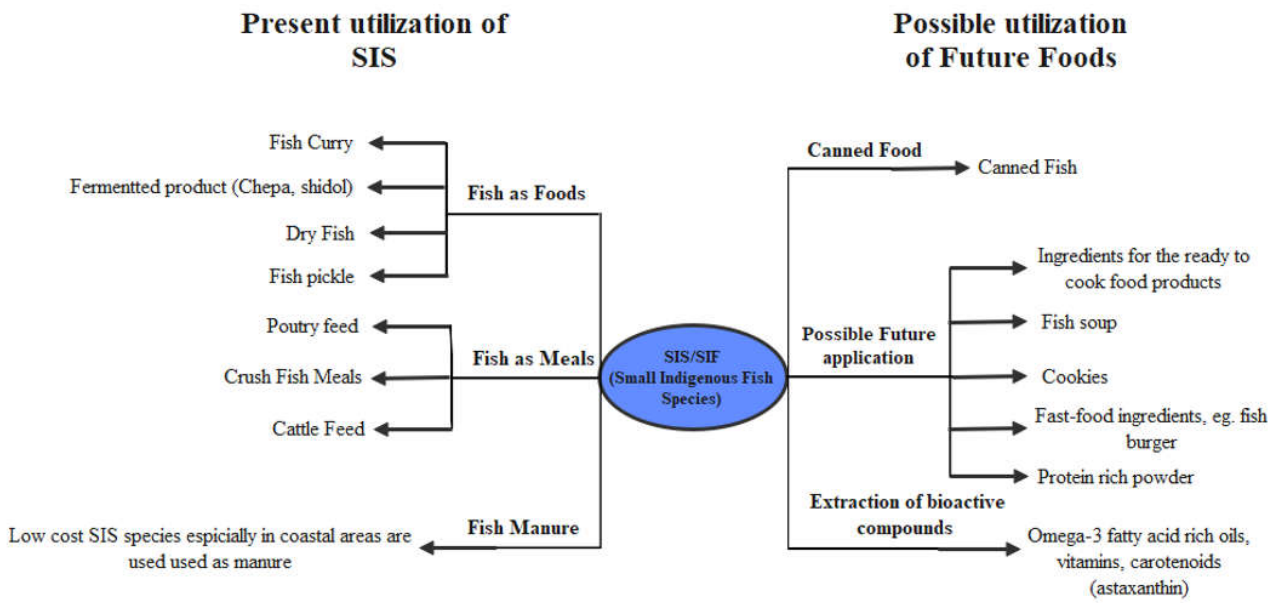

Figure 7. Utilization of SIS for human welfare.

5. Implication of This Review Work

The accumulated findings of this study provide up-to-date information on the nutritional composition of SIS, which will help the experts in the relevant fields, owing to the improved country's diet guidelines and nutrition security. Developing countries such as Bangladesh run several nutrition-based programs to ensure a healthy diet for their people, especially in rural and poor households. The policymakers of these programs, as well as public health practitioners and nutrition experts, can take necessary action to improve the nutritional composition of the dining tables of general people by creating an awareness of the nutritional quality of SIS.

The nutritional quality of the raw SIS has been explored; however, further exploration of the fate of nutrients after cooking is still necessary. The data available in the databases cannot show how much the human body can absorb nutrients such as vitamins after processing the existing cuisine techniques in Bangladesh.

Nutritious food items such as fish are always at the attention of global healthy diet industries [20]. Bangladesh is one of the significant contributors to the world's aqua foods sector. We believe this study can help to popularize its highly nutritious SIS all over the globe.

6. Conclusions

It has been determined that several SIS might dramatically increase the RNIs for certain nutrients essential to public health. In the present decades, SIS is playing an essential role in the food sector, which is important for nutritional security in Bangladesh. The information provided here demonstrates that SIS have a substantially larger perspective to contribute to the micronutrient consumption of susceptible populations in Bangladesh. This is probably a result because small indigenous fishes are typically eaten entirely, including the head and bones. Moreover, the nutritional makeup of the various small indigenous species of fish described here is to encourage a more comprehensive nutrient consumption. This study concentrated the data available on the SIS in the context of Bangladesh, which will help to create a strategic plan for better utilization of these fish species. This study will give a direction for future research to focus on their processing and preservation with modern techniques.

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References

1. Aziz, M.S.B.; Hasan, N.A.; Mondol, M.M.R.; Alam, M.M.; Haque, M.M. Decline in fish species diversity due to climatic and anthropogenic factors in Hakaluki Haor, an ecologically critical wetland in northeast Bangladesh. *Heliyon* **2021**, *7*, e05861. [CrossRef] [PubMed]
2. Kostori, F.A.; Parween, S.; Islam, M.N. Availability of small indigenous species (SIS) of fish in the Chalan Beel-the largest wetland of Bangladesh. *Univ. J. Zool. Rajshahi Univ.* **2011**, *30*, 67–72. [CrossRef]
3. Roos, N.; Leth, T.; Jakobsen, J.; Thilsted, S.H. High vitamin A content in some small indigenous fish species in Bangladesh: Perspectives for food-based strategies to reduce vitamin A deficiency. *Int. J. Food Sci. Nutr.* **2002**, *53*, 425–437. [CrossRef] [PubMed]
4. Roos, N.; Mazharul Islam, M.; Thilsted, S.H. Small fish is an important dietary source of vitamin A and calcium in rural Bangladesh. *Int. J. Food Sci. Nutr.* **2003**, *54*, 329–339. [CrossRef]
5. Roos, N.; Islam, M.M.; Thilsted, S.H. Small indigenous fish species in Bangladesh: Contribution to vitamin A, calcium and iron intakes. *J. Nutr.* **2003**, *133*, 4021S–4026S. [CrossRef]
6. Bogard, J. The Contribution of Fish to Nutrition and Food Security: Informing the Evidence Base for Agricultural Policy in Bangladesh. Ph.D. Thesis, The University of Queensland, Brisbane, Australia, 3 November 2017.
7. Belton, B.; van Asseldonk, I.J.M.; Thilsted, S.H. Faltering fisheries and ascendant aquaculture: Implications for food and nutrition security in Bangladesh. *Food Policy* **2014**, *44*, 77–87. [CrossRef]
8. Thilsted, S. The potential of nutrient-rich small fish species in aquaculture to improve human nutrition and health. In Proceedings of the Global Conference on Aquaculture 2010, Phuket, Thailand, 22–25 September 2010; pp. 57–73.
9. Belton, B.; Thilsted, S.H. Fisheries in transition: Food and nutrition security implications for the global South. *Glob. Food Secur.* **2014**, *3*, 59–66. [CrossRef]
10. Kongsbak, K.; Thilsted, S.H.; Wahed, M.A. Effect of consumption of the nutrient-dense, freshwater small fish Amblypharyngodon mola on biochemical indicators of vitamin A status in Bangladeshi children: A randomised, controlled study of efficacy. *Br. J. Nutr.* **2008**, *99*, 581–597. [CrossRef]
11. Thilsted, S.H.; Roos, N.; Hassan, N. The role of small indigenous fish species in food and nutrition security in Bangladesh. *Naga ICLARM Q.* **1997**, *20*, 82–84.
12. Mohanty, B.; Pati, M.K.; Bhattacharjee, S.; Hajra, A.; Sharma, A. Small Indigenous Fishes and Their Importance in Human Health. In *Advances in Fish Research*; Narendra Publishing House: Delhi, India, 2013; pp. 257–278.
13. Tacon, A.G.; Metian, M. Fish matters: Importance of aquatic foods in human nutrition and global food supply. *Rev. Fish. Sci.* **2013**, *21*, 22–38. [CrossRef]
14. Faridullah, M.; Roy, V.C.; Begam, H.; Nushy, N.H.; Ashrafullah, M.; Talha, M.A.; Rana, M.M. Assessment of Physicochemical, Nutritional and Biochemical Properties of "Shidal" Processed from Two Different Species of SIS Available in Bangladesh. *Middle East J. Sci. Res.* **2022**, *30*, 40–48.
15. Mazumder, D.; Lorenzen, K. Developing aquaculture of small native species (SNS) in Bangladesh: Village level agroecological change and the availability of SNS. *Naga ICLARM Q.* **1999**, *22*, 20–23.
16. Bayen, S.; Sinha, A.; Aftabuddin, M.; Roy, A.; Parida, P.; Ghosh, A.; Das, B. Developing mola (*Amblypharyngodon mola*) based fish culture practices for addressing livelihood and nutritional security of rural populace of Indian Sundarban. *J. Entomol. Zool. Stud.* **2020**, *8*, 7880.

17. Roos, N.; Wahab, M.A.; Chamnan, C.; Thilsted, S.H. The role of fish in food-based strategies to combat vitamin A and mineral deficiencies in developing countries. *J. Nutr.* **2007**, *137*, 1106–1109. [CrossRef]
18. Siekmann, J.H.; Allen, L.H.; Bwibo, N.O.; Demment, M.W.; Murphy, S.P.; Neumann, C.G. Animal source foods to improve micronutrient nutrition and human function in developing countries. *J. Nutr.* **2003**, *133*, 3972S–3980S. [CrossRef]
19. Dey, M.M.; Surathkal, P. Value chains in aquaculture and fisheries in Bangladesh. In *Transforming Agriculture in South Asia*; Routledge: Abingdon-on-Thames, UK, 2020; pp. 195–210.
20. Banna, M.H.A.; Al Zaber, A.; Rahman, N.; Siddique, M.A.M.; Siddique, M.A.B.; Hagan, J.E., Jr.; Rifat, M.; Nsiah-Asamoah, C.N.A.; Seidu, A.-A.; Ahinkorah, B.O. Nutritional Value of Dry Fish in Bangladesh and Its Potential Contribution to Addressing Malnutrition: A Narrative Review. *Fishes* **2022**, *7*, 240. [CrossRef]
21. Bogard, J.R.; Thilsted, S.H.; Marks, G.C.; Wahab, M.A.; Hossain, M.A.; Jakobsen, J.; Stangoulis, J. Nutrient composition of important fish species in Bangladesh and potential contribution to recommended nutrient intakes. *J. Food Compos. Anal.* **2015**, *42*, 120–133. [CrossRef]
22. Khalili Tilami, S.; Sampels, S. Nutritional value of fish: Lipids, proteins, vitamins, and minerals. *Rev. Fish. Sci. Aquac.* **2018**, *26*, 243–253. [CrossRef]
23. Hossain, M.; Ahmed, Z.; Leunda, P.; Roksanul Islam, A.; Jasmine, S.; Oscoz, J.; Miranda, R.; Ohtomi, J. Length–weight and length–length relationships of some small indigenous fish species from the Mathabhanga River, southwestern Bangladesh. *J. Appl. Ichthyol.* **2006**, *22*, 301–303. [CrossRef]
24. Saha, M.K.; Barman, B.K. A Strategy on increase production and marketing of Mola and other Small Indigenous Species of Fish (SIS) in Bangladesh. In *The WorldFish Center Working Papers*; WorldFish: Dhaka, Bangladesh, 2020.
25. Dey, M.M.; Garcia, Y.T.; Praduman, K.; Piumsombun, S.; Haque, M.S.; Li, L.; Radam, A.; Senaratne, A.; Khiem, N.T.; Koeshendrajana, S. Demand for fish in Asia: A cross-country analysis. *Aust. J. Agric. Resour. Econ.* **2008**, *52*, 321–338. [CrossRef]
26. Nurhasan, M.; Maehre, H.K.; Malde, M.K.; Stormo, S.K.; Halwart, M.; James, D.; Elvevoll, E.O. Nutritional composition of aquatic species in Laotian rice field ecosystems. *J. Food Compos. Anal.* **2010**, *23*, 205–213. [CrossRef]
27. Burke, T.J.; Segrin, C. Examining diet- and exercise-related communication in romantic relationships: Associations with health behaviors. *Health Commun.* **2014**, *29*, 877–887. [CrossRef] [PubMed]
28. Thilsted, S.H.; Thorne-Lyman, A.; Webb, P.; Bogard, J.R.; Subasinghe, R.; Phillips, M.J.; Allison, E.H. Sustaining healthy diets: The role of capture fisheries and aquaculture for improving nutrition in the post-2015 era. *Food Policy* **2016**, *61*, 126–131. [CrossRef]
29. Aditya, G.; Pal, S.; Saha, G. An assessment of fish species assemblages in rice fields in West Bengal, India: Implications for management. *J. Appl. Ichthyol.* **2010**, *26*, 535–539. [CrossRef]
30. Manna, R.; Bhattacharjya, B. Incorporation of new construction material into indigenous technological knowledge—A case study of V shaped fish trap of eastern India. *Indian J. Tradit. Knowl.* **2009**, *8*, 548–550.
31. Samajdar, I.; Saikia, S.K. Traditional fishing gears of Birbhum district, West Bengal, India. *Indian J. Tradit. Knowl.* **2014**, *13*, 187–194.
32. Hossain, M.Y. Morphometric relationships of length-weight and length-length of four Cyprinid small indigenous fish species from the Padma River (NW Bangladesh). *Turk. J. Fish. Aquat. Sci.* **2010**, *10*, 131–134. [CrossRef]
33. Kohinoor, A.; Wahab, M.; Islam, M.; Thilsted, S. Culture potentials of mola (*Amblypharyngodon mola*), chela (*Chela cachius*) and punti (*Puntius sophore*) under monoculture system. *Bangladesh J. Fish Res.* **2001**, *5*, 123–134.
34. Wahab, M.A.; Kunda, M.; Azim, M.E.; Dewan, S.; Thilsted, S.H. Evaluation of freshwater prawn-small fish culture concurrently with rice in Bangladesh. *Aquac. Res.* **2008**, *39*, 1524–1532. [CrossRef]
35. Kunda, M.; Azim, M.E.; Wahab, M.A.; Dewan, S.; Roos, N.; Thilsted, S.H. Potential of mixed culture of freshwater prawn (*Macrobrachium rosenbergii*) and self-recruiting small species mola (*Amblypharyngodon mola*) in rotational rice–fish/prawn culture systems in Bangladesh. *Aquac. Res.* **2008**, *39*, 506–517. [CrossRef]
36. Sinha, A.; Gogoi, P.; Dam Roy, S. Small Indigenous Fish (SIF): Status and Contributions in Nutrition and Livelihood Security of India: A Review. *Agric. Rev.* **2022**. [CrossRef]
37. Gross, R.; Schoeneberger, H.; Pfeifer, H.; Preuss, H.-J. The four dimensions of food and nutrition security: Definitions and concepts. *SCN News* **2000**, *20*, 20–25.
38. Gopakumar, K. *Biochemical Composition of Indian Food Fish*; Central Institute of Fisheries Technology: Cochin, India, 1997.
39. Vilain, C.; Baran, E.; Gallego, G.; Samadee, S. Fish and the nutrition of rural Cambodians. *Asian J. Agric. Food Sci.* **2016**, *4*, 26–34.
40. Negesse, T.; Tera, A. Effects of feeding different levels of cooked and sun dried fish offal on carcass traits of growing Rhode Island Red chicks. *Trop. Anim. Health Prod.* **2010**, *42*, 45–54. [CrossRef]
41. Shantz, E.M.; Brinkman, J.H. Biological activity of pure vitamin A2. *J. Biol. Chem.* **1950**, *183*, 467–471. [CrossRef]
42. Grases, F.; Simonet, B.M.; Prieto, R.M.; March, J.G. Dietary phytate and mineral bioavailability. *J. Trace Elem. Med. Biol.* **2001**, *15*, 221–228. [CrossRef]
43. Larsen, T.; Thilsted, S.H.; Kongsbak, K.; Hansen, M. Whole small fish as a rich calcium source. *Br. J. Nutr.* **2000**, *83*, 191–196. [CrossRef]
44. Park, J.S.; Kim, S.Y.; Lee, S.C.; Jeong, Y.R.; Roy, V.C.; Rizkyana, A.D.; Chun, B.S. Edible oil extracted from anchovies using supercritical CO_2: Availability of fat-soluble vitamins and comparison with commercial oils. *J. Food Process. Preserv.* **2021**, *45*, e15441. [CrossRef]

45. West, K.P., Jr. Extent of vitamin A deficiency among preschool children and women of reproductive age. *J. Nutr.* **2002**, *132*, 2857S–2866S. [CrossRef]
46. Rice, A.L.; West, K.P., Jr.; Black, R.E. Vitamin A deficiency. In *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors*; WHO: Geneva, Switzerland, 2004.
47. Roos, N. Fish Consumption and Aquaculture in Rural Bangladesh: Nutritional Contribution and Production Potential of Culturing Small Indigenous Fish Species (SIS) in Pond Polyculture with Commonly Cultured Carps. Ph.D. Thesis, The Royal Veterinary and Agricultural University, Frederiksberg, Denmark, 2001.
48. Suo, L.; VanBuren, C.; Hovland, E.D.; Kedishvili, N.Y.; Sundberg, J.P.; Everts, H.B. Dietary Vitamin A Impacts Refractory Telogen. *Front. Cell Dev. Biol.* **2021**, *9*, 571474. [CrossRef]
49. De Benoist, B. Conclusions of a WHO Technical Consultation on folate and vitamin B12 deficiencies. *Food Nutr. Bull.* **2008**, *29*, S238–S244. [CrossRef] [PubMed]
50. Huskisson, E.; Maggini, S.; Ruf, M. The role of vitamins and minerals in energy metabolism and well-being. *J. Int. Med. Res.* **2007**, *35*, 277–289. [CrossRef] [PubMed]
51. Lock, E.J.; Waagbø, R.; Wendelaar Bonga, S.; Flik, G. The significance of vitamin D for fish: A review. *Aquac. Nutr.* **2010**, *16*, 100–116. [CrossRef]
52. Holick, M. A Millenium Perspective Vitamin D. *J. Cell Biochem.* **2003**, *88*, 296–307. [CrossRef] [PubMed]
53. Martínez-Moneo, E.; Stigliano, S.; Hedström, A.; Kaczka, A.; Malvik, M.; Waldthaler, A.; Maisonneuve, P.; Simon, P.; Capurso, G. Deficiency of fat-soluble vitamins in chronic pancreatitis: A systematic review and meta-analysis. *Pancreatology* **2016**, *16*, 988–994. [CrossRef]
54. Cavalier, L.; Ouahchi, K.; Kayden, H.J.; Di Donato, S.; Reutenauer, L.; Mandel, J.-L.; Koenig, M. Ataxia with isolated vitamin E deficiency: Heterogeneity of mutations and phenotypic variability in a large number of families. *Am. J. Hum. Genet.* **1998**, *62*, 301–310. [CrossRef]
55. Roos, N.; Wahab, M.A.; Hossain, M.A.R.; Thilsted, S.H. Linking human nutrition and fisheries: Incorporating micronutrient-dense, small indigenous fish species in carp polyculture production in Bangladesh. *Food Nutr. Bull.* **2007**, *28*, S280–S293. [CrossRef]
56. Shaalan, A.; El-Sherbiny, M.; El-Abaseri, T.; Shoaeir, M.; Abdel-Aziz, T.M.; Mohamed, M.I.; Zaitone, S.; Mohammad, H. Supplement with Calcium or Alendronate Suppresses Osteopenia Due to Long Term Rabeprazole Treatment in Female Mice: Influence on Bone TRAP and Osteopontin Levels. *Front. Pharmacol.* **2020**, *11*, 00583. [CrossRef]
57. Wu, W.; He, L.; Liang, Y.; Yue, L.; Peng, W.; Jin, G.; Ma, M. Preparation process optimization of pig bone collagen peptide-calcium chelate using response surface methodology and its structural characterization and stability analysis. *Food Chem.* **2019**, *284*, 80–89. [CrossRef]
58. Oatley, K. Fiction: Simulation of social worlds. *Trends Cogn. Sci.* **2016**, *20*, 618–628. [CrossRef]
59. World Health Organization. *Vitamin and Mineral Requirements in Human Nutrition*; World Health Organization: Geneva, Switzerland, 2004.
60. Lall, S.P.; Kaushik, S.J. Nutrition and metabolism of minerals in fish. *Animals* **2021**, *11*, 2711. [CrossRef]
61. Bilandžić, N.; Sedak, M.; Đokić, M.; Varenina, I.; Kolanović, B.S.; Božić, Đ.; Brstilo, M.; Šimić, B. Determination of zinc concentrations in foods of animal origin, fish and shellfish from Croatia and assessment of their contribution to dietary intake. *J. Food Compos. Anal.* **2014**, *35*, 61–66. [CrossRef]
62. Rahman, S.; Ahmed, T.; Rahman, A.S.; Alam, N.; Ahmed, A.S.; Ireen, S.; Chowdhury, I.A.; Chowdhury, F.P.; Rahman, S.M. Status of zinc nutrition in Bangladesh: The underlying associations. *J. Nutr. Sci.* **2016**, *5*, e25. [CrossRef]
63. Heard, M.; Chamberlain, A.; Sherlock, J. Uptake of lead by humans and effect of minerals and food. *Sci. Total Environ.* **1983**, *30*, 245–253. [CrossRef]
64. Clase, C.M.; Ki, V.; Holden, R.M. Water-Soluble Vitamins in People with Low Glomerular Filtration Rate or On Dialysis: A Review. *Semin. Dial.* **2013**, *26*, 546–567. [CrossRef]
65. Craviari, T.; Pettifor, J.M.; Thacher, T.D.; Meisner, C.; Arnaud, J.; Fischer, P.R.; Group, R.C. Rickets: An overview and future directions, with special reference to Bangladesh: A summary of the Rickets Convergence Group Meeting, Dhaka, 26–27 January 2006. *J. Health Popul. Nutr.* **2008**, *26*, 112.
66. Fischer, P.; Rahman, A.; Cimma, J.-P.; Kyaw-Myint, T.; Kabir, A.; Talukder, K.; Hassan, N.; Manaster, B.; Staab, D.; Duxbury, J. Nutritional rickets without vitamin D deficiency in Bangladesh. *J. Trop. Pediatr.* **1999**, *45*, 291–293. [CrossRef]
67. Chen, W.; Feng, Q.; Zhang, G.; Li, L.; Jin, S. Effect of energy input on flocculation process and flotation performance of fine scheelite using sodium oleate. *Miner. Eng.* **2017**, *112*, 27–35. [CrossRef]
68. Singh, R.; Parihar, P.; Prasad, S.M. Simultaneous exposure of sulphur and calcium hinder As toxicity: Up-regulation of growth, mineral nutrients uptake and antioxidants system. *Ecotoxicol. Environ. Saf.* **2018**, *161*, 318–331. [CrossRef]
69. Moestue, H.; De Pee, S.; Hall, A.; Hye, A.; Sultana, N.; Ishtiaque, M.; Huq, N.; Bloem, M. Conclusions about differences in linear growth between Bangladeshi boys and girls depend on the growth reference used. *Eur. J. Clin. Nutr.* **2004**, *58*, 725–731. [CrossRef]
70. Roy, V.C.; Kamal, M.; Faridullah, M.; Haque, S.A.; Reza, M.S. Influence of salt and herbal substance on the drying and reconstitution performance of Bombay duck, Harpodon nehereus. *J. Fish.* **2014**, *2*, 59–63. [CrossRef]

71. Lithi, U.J.; Faridullah, M.; Roy, V.C.; Roy, K.C.; Alam, A.N. Efficiency of organic pesticides, turmeric (*Curcuma longa*) and neem (*Azadirachta indica*) against dry fish beetle (*Dermestes* sp.) during storage condition: Efficiency of organic pesticides against beetle. *J. Bangladesh Agric. Univ.* **2019**, *17*, 110–116. [CrossRef]
72. Nielsen, H.; Roos, N.; Thilsted, S.H. The impact of semi-scavenging poultry production on the consumption of animal source foods by women and girls in Bangladesh. *J. Nutr.* **2003**, *133*, 4027S–4030S. [CrossRef] [PubMed]