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Nutrient Status of Some Food Fishes with Respect to Their Proximate Composition: A Review

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

The nutritional awareness is a vital issue in most of the developing countries. Consumption of imbalance nutrients is globally responsible for the malnutrition, a curse for the people who belongs to below poverty line. Fish is a vital source of protein and many other essential nutrients for the human health. More than one billion of people around the world include fish food in their regular diet. Many of the developing countries like India are resided by poor villagers who gladly consume the small fish species which are of low cost and easily available in the 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. This review article is an attempt to review the current scientific

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literatures on the nutrient status with respect to their proximate composition of different fish species across the globe. The significance of such study on Food-to-food fortification (FtFF) on the basis of proximate composition of fish along with challenges and future perspectives are also highlighted.

Keywords: Nutrient status; malnutrition; proximate composition; food fish; aquaculture; health supplements.

1. INTRODUCTION

Now a days, a growing awareness is felt on nutritional biochemistry with a special reference to human health and fish consumption due to the nutritional excellence of fish nutrients. All over the world fishes are largely accepted as food items due to their low cholesterol, high palatability and tender flesh. Fishes are known to be the cheapest source of protein as well as other vital nutrients required for the human diet [1]. The primary biochemical components of the fishes include water, protein, lipid (fat or oil) and ash (minerals). The analysis of the basic components of fish muscles are generally termed as proximate analysis. Approximately fishes contain 70-80% water, 15-24% protein, 0.1-22% fat, 1-2% minerals, 0.5% calcium, 0.25% phosphorus and 0.1% vitamins A, D, B & C [2]. A clear knowledge on the biochemical constituents of fish is of wide applicability in several sectors of the community.

The medicinal values of fish depend on the contents of protein, lipids, minerals and vitamins [3]. Fish proteins are having high biochemical potentialities [4-6]. The requirement of ω-3 polyunsaturated fatty acids for the human health is satisfactorily met by the consumption of food fishes [7]. Previously studied records reveal that ω-3 fatty acids play the major role in the prevention of coronary heart diseases (CHD), cancers, rheumatoid arthritis and inflammation [8,9]. Fishes can be vital components of diet due to the presence of fair contents of complete protein and polyunsaturated fatty acids especially eicosapentaenoic acid (EPA), eocosahexanoic acid (DHA) and arachidonic acid (AA) [10]. The ω-3 fatty acids are contributed by fish food, which are the key nutrients for the development of brain in the young groups of human body [11,12]. There are several other health benefits including decrease in the risk of myocardial infarction [13], lowering of blood pressure and concentration of triglyceride in blood, improving the immune system [14], and nourishing proper brain function of the human body. They also defend human body against various psychological disorders, depressions and disorder in deficit of attention as well [15]. All these nutrients are required for proper growth as well as physical development and specially to prevent some terrible diseases.

It has been reported that small fish species are vital sources of minerals in the human body. Mineral contents of fish are required for the formation about hemoglobin of the human body [16]. The micronutrients present in the fish flesh are useful for maintaining water balance, formation of bones and teeth in human body and also catalyzing a lot of metabolic reactions [17]. Fish minerals are stored in the skeleton especially in the vertebra. Fishes are enriched in good amounts of vitamins and minerals. Fair contents of calcium, iron, zinc, Vitamin A & Vitamin C are provided by small fishes which are consumed in whole with organs and bones [18]. The fish proteins provide all the essential amino acids in right proportions. So, the inclusion of fish makes a balanced diet for the human being having large contribution to the heart health and also children's proper growth and development.

There are four major constituents in the edible portion of fish. These are moisture or water, protein, lipid (fat or oil) and ash or minerals. The analysis of these four basic constituents of fish muscle is often referred to as proximate composition analysis. The analysis of the proximate composition of the various fish species provides a nutritional profile, indicating commercial and nutritional value, and aiding in regulating food standards [19]. The study of the proximate composition of fish has a great significance for consumers, aquaculture and researchers from various angle. These works not only provide information on the nutritive value of fish but also aid in understanding the preservation and processing of fish and fish products [20]. The analysis of the proximate composition of fish also helps the nutritionists to determine readily available sources of high-protein low-fat food sources required as human food [21,22]. It also helps the scientists

for classifying high-protein foods with high nutritive value [23].

The biochemical compositions of maximum food fishes had been studied by various researchers. The variations of the contents are attributed to their nutritional quality, which is directly linked to their feeding habits, season, adaptation, temperature, age, and sex etc. [24]. The biological characteristics of fish flesh is a reliable predictor of the nutritional value, physiological state and habitat [25]. These parameters are good indicators of the physiological and nutritional status of a fish [26]. According to the survey of literature the nutritional contents of fish species are varied with the variation of environmental and geological factors. So, proper information about the biochemical compositions of different fishes is important in the field of processing and preservation of fish and fishery products. With the rapid growth of human population, the fish habitats are declined leading to dwindling fish stocks. Therefore, a distinct knowledge about the biochemical data of fish nutrients is essential for the nutritive awareness and sustainable development of aquaculture and inland fisheries. These investigations adopting more advanced scientific researches will not only ensure the health security but also open up steady source of livelihood of many poor communities of the world.

This review article is an attempt to review the current scientific literatures on the substantial difference in proximate composition of different fish species present in fish muscle across the globe. On the basis of the findings, a nutritional chart may be easily made accessible for better and justifiable use of the nutritional fish and fish food products. The significance of such study of proximate composition of fish investigated since last ten years are discussed along with challenges and scope for further research are also highlighted. We believe that this review paper will help the young researchers as a literature survey for further research in this area of research and the policy makers to create awareness among the community people about the nutritional qualities of food fishes and also to conserve those fishes as well.

2. ANALYSIS OF PROXIMATE COMPOSITION OF FISH

The analysis of the proximate composition of food fishes explore the use of standard methods to estimate vital components in fish, which significantly influence their nutritional status. The composition of fish body is affected by both exogenous and endogenous factors [27]. The exogenous factors affect the body composition as well as the diet of the fish (composition, frequency) and also their existing environment (salinity, temperature). A number of researchers studied the impact of temperature, light, pH, and oxygen concentration on the proximate composition of fish. The endogenous factors include some genetic factors linked to the life stage, size, age, sex and anatomical position of the fishes [27]. The characteristic data of proximate and mineral composition of a typical fish is shown in Table 1.

Table 1. Representative data of proximate composition and mineral content of a typical fish [28]

Parameter	Specific Parameter	Composition
Proximate Composition	Moisture	59.1 – 87.8%
	Protein	9 – 24%
	Lipid	1.6 – 6.2%
	Ash	-
Mineral Composition (per 100g)	Sodium	190 mg
	Magnesium	38 mg
	Zinc	72 mg
	Potassium	384 mg
	Phosphorus	210 mg
	Iodine	30 mcg
	Calcium	15 mg
	Iron	0.3 mg
	Selenium	40 – 92 mcg

Skałecki and co-workers [29] compared the proximate composition, mineral content and some selected trace elements in the roe and muscle tissue of aquaculture-reared rainbow trout (*Oncorhynchus mykiss*) fish. The research group investigated 20 farmed rainbow trout females collected from a certified fish farm located in the Lublin Voivodeship (Poland) (Fig. 1). It was reported that the fish species have lower moisture content in roe (61.45%) than that in fillete (72.69 %) but higher content of protein in roe (29.53%) than that in fillete (20.31 %). Similarly, the lipid in roe (7.55%) is also higher than that found in fillete (5.31%). Similar studies [30] carried out on in the muscle tissue of farmed rainbow trout obtained in Poland have reported lower protein. Rainbow trout are classified as medium-fat fish with lipid content from 2 to 7% [31] and similar results have been reported here as well. The mineral content in roe have significantly higher than that present in the fillet, Zn is almost 11 times, Mn is about 7 times, Fe and Cu both are about 5 times, Ca is about 3 times, Mg is about twice than that found in fillet. Whereas, fillet contained 3 times as much K as the roe. The findings are found to be consistent with that of Topuz and co-workers [32]. The results were analyzed to determine whether 100 g of edible portion of roe or fillet satisfies the requirements for these elements in adult consumers and children or not and it was reported that both roe and fillet from rainbow trout can become a significant source of metallic elements.

Acharya and co-workers [33] had investigated the proximate composition, mineral profile and fatty acid content of *Tenualosa* sp. (*Tenualosa ilisha*, *Tenualosa keli*) at collected from Chilika, Chandravaga, and Chandipur area of east coast of India. The results of the study are shown in Table 2, where, the values are presented as avg. ± SD mg/100g (n = 5). It was found that the moisture content varied from 61.36 to 73.95% which is higher as compared to earlier recorded in the *Tenualosa* sp. species found in Bay of Bengal [34]. *Tenualosa* sp. recorded higher protein content (20.59 to 26.81%) as compared to the Indian carps *Labeo rohita* (15.9%), *Catla catla* (16.2%), and *Cirrhinus mrigala* (14%), respectively [35]. The maximum protein content of *T. ilisha* (28%) was recorded at Chandravaga region and minimum protein content (18%) was recorded at Chilika region. The *T. ilisha* species found in Chandravaga area was found to contain higher protein content as compared to the *Tenualosa* sp. found in Bay of Bengal (18 to 19%) [36]. Protein is an essential nutrient found in fishes which is varied among *Tenualosa* sp. found in various regions in the study area.

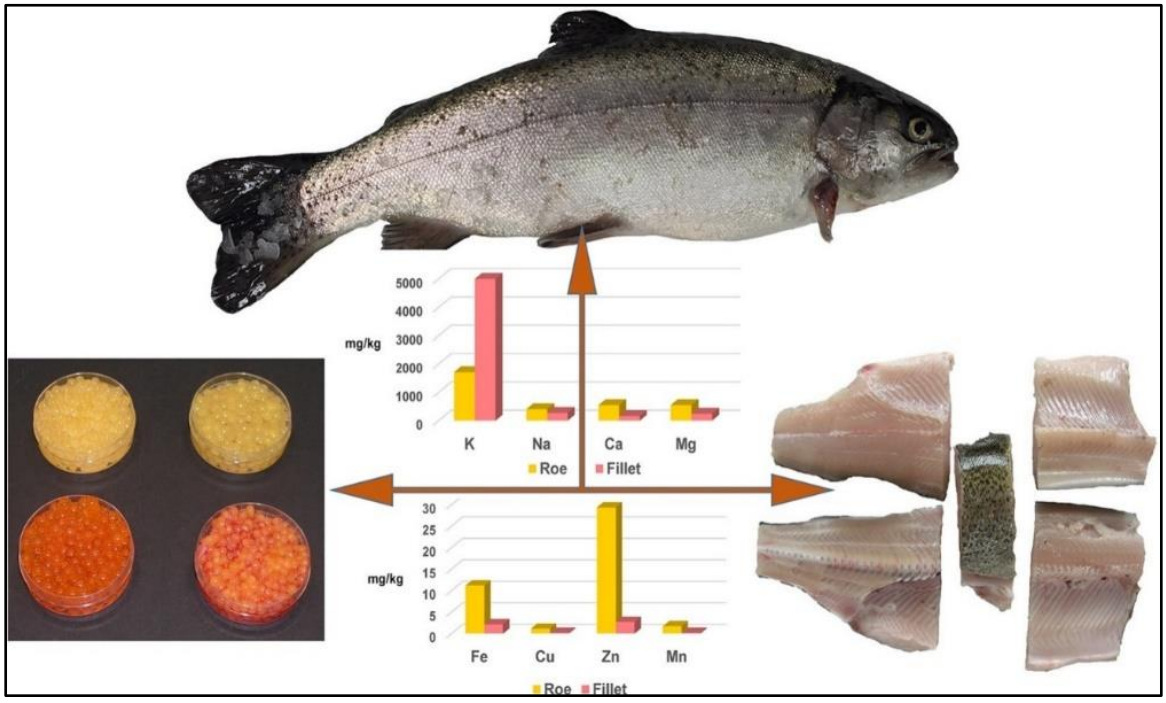

Fig. 1. Aquaculture-reared rainbow trout (*Oncorhynchus mykiss*) Reproduced with permission from [29] © 2020 Elsevier GmbH

The lipid content of *Tenualosa* sp. varied from 5.92 to 9.74% with an average value of 7.76%. Similar data for the lipid content was recorded for the same species found in Diamond Harbor, Kolkata coast [35] and Hooghly and Padma River [37] in India. On the other hand, the lipid content of *Tenualosa sp.* species of this study was found to be remarkably lower than that recorded for *Tenualosa sp.* (17.56%) from Sunderban area of West Bengal [38]. It was observed that the *T. keli* found in Chandravaga area recorded the maximum (9.74%), and *T. keli* from Chandipur area recorded the lowest (5.92%) lipid content which is almost twice than lipid content content of Indian big carps *Labeo rohita* (4.33%) and *Labeo calbasu* (0.98%) [39].

The ash content ranges from 0.54 to 1.32%. The salt content (Na and K) of the fish species ranged from 10.03 to 42.1 mg/100 g with an average value of 28.89 mg/100 g. Na varies from 11.1 to 39.1 mg/100g with an average of 26.31 mg/100g which is within the limit of FAO's criteria (19 – 881 mg/100 g). The Ca content was significantly higher than other sources of Calcium. The Mg content varied from 5.7 to 11 mg/100g with an average of 8.34 mg/100g which is far below the FAO's criteria of 452 mg/100 g. Begum et al. 2016 [34] found Mg level of 5.3 to 13 mg/100g in *Tenualosa* sp. from Bangladesh. Whereas the Mg levels of the same species found at Ganga was 38.33 mg/100g [35] and 39.44 mg/100g at Hooghly estuary [7]. The Cr content varied from 0.04 mg/100g in the *T. keli* species to 0.12 mg/100g in the *T. ilisha* species found in Chandravaga area with an average of 0.08 mg/100g which is within the limits set by FAO 2001. The Fe content of *Tenualosa* sp. was found to be between 10.4 and 21.5 mg/100g with an average of 17.24 mg/100g which is within the safe limit. Cu ranged from 0.82 to 1.76 mg/100g, with an average of 1.10 mg/100 g. Among the studied fish species, the *T.ilisha* species found in Chandipur area had the highest (1.76 mg/100g), whereas the *T.keli* species of Chandipur area had the lowest (0.82 mg/100g) Cu content. All of the *Tenualosa* sp. fish that were studied were found to have the least amount of carbohydrates 0.09 to 3.91 with an average of 2.17±1.61%. Out of 33 detected fatty acid components, myristic acid (C14:0) (684.67 mg/100g) was found to be the predominant saturated fatty acid (SFA) content.

Ara and co-workers [40] investigated the proximate composition in terms of moisture, protein, lipid, ash and mineral contents in the fresh muscles of freshwater hilsa (*Tenualosa Ilisha*) collected from Sandhya river and marine hilsa fish collected from Chittagong Port of Bangladesh. The proximate composition results revealed that freshwater hilsa contained higher moisture content (70 ± 0.34%) than marine hilsa. While, the protein content (20.06 ± 0.94 %), lipid (13.8 ± 2%) and ash contents (1.26 ± 0.15%) were relatively higher in marine hilsa. It was also reported that the freshwater hilsa contain higher amount of calcium (182.4 ± 3.48 mg/100 g) and phosphorus (133 ± 4.52 mg/ 100g) but the marine hilsa had higher iron content (3.30 mg /100 g). The result of the study discovered that both marine and freshwater hilsa are nutritionally enriched and such fishes are more popular in Bangladesh. Debnath and co-workers [41] also reported that riverine hilsa contained relatively more moisture (61.01%) than marine fishes (58.91%) and more ash content (2.04%) than marine hilsa (1.69%), higher calcium content (394.14mg/100g), phosphorus content (113.44mg/100g). Begum et al. 2018 [34] recorded calcium content in hilsa fish ranged considerably from 144.21 to 372.67 mg/100 g and the phosphorus content in hilsa fishes collected from six regions of Bangladesh ranged from 118.17 to 204.06 mg/100 gm. While, there is no significant difference in protein content in freshwater (17.37%) and marine hilsa (16.17%). The marine hilsa has significantly higher lipid content (18.27%) in than freshwater hilsa [42].

Table 2. Proximate composition of *Tenualosa* fish species collected from three different area of east coast, India [33]

Parameters	Area/Species					
	Chilka / *T.ilisha*	**ChiJika / *T.keli***	**Chandipur / *T.ilisha***	**Chandipur / *T.keli***	**Candravaga / *T.ilisha***	**Candravaga / *T.keli***
Moisture (%)	70.47±2.85	70.25±5.89	64.22±2.89	71.25±2.36	63.35±1.87	69.7±2.98
Protein(%)	22.03±3.44	21.8±3.95	26.81±2.08	21.6±2.79	25.6±3.22	20.59±2.43
Lipids(%)	6.84±1.42	7.43±2.4	7.92±1.51	5.92±0.78	9.74±3.12	8.74±1.27
Ash(%)	0.68±0.36	0.54±0.21	1.08±0.47	1.25±0.37	1.32±0.09	0.99±0.14

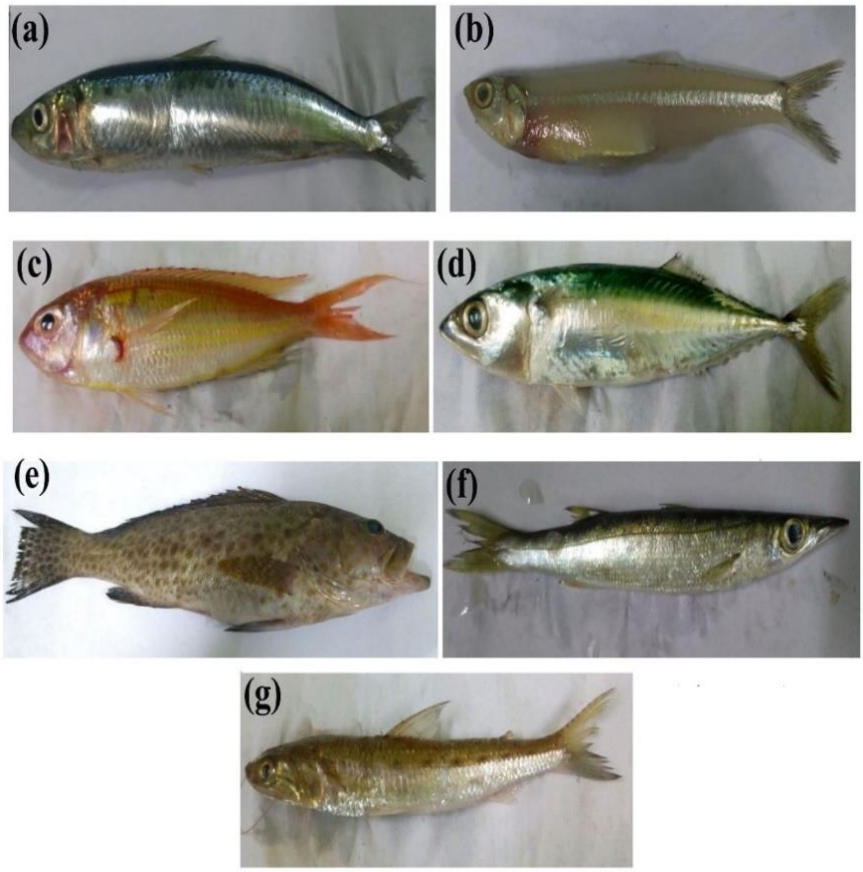

Fig. 2. Some commercially important marine fin fishes collected from Kasimedu coast, Chennai, India (a) Spotted sardinella (*Amblygaster sirm*) (b) Indian anchovy (*Stolephorus indicus*), (c) Thread fin bream (*Nemipterus japonicas*) (d) Indian mackerel (*Rastrelliger brachysoma*) (e) Tiger grouper (*Epinephelus fuscoguttatus*) (f) Yellowtail barracuda (*Sphyraena flavicauda*) and (g) Lizard fish (*Saurida undosquamis*). Reproduced from ref [45] © 2020 JFLS

According to Rahman and co-workers [41], the moisture content was the most abundant composition of the *Channa punctatus* and *Amblypharyngodon mola* of ponds. The studies of Bijayalakshmi and co-workers revealed the similar report of moisture content on the same species. The small indigenous fish species namely *Channa striata*, *Trichogaster fasciatus* and *Puntuys sophore* contained higher lipid content than the other fish species [43]. The study on protein and mineral compostion of some local small food fishes namely *Amblypharyngodon mola*, *Esomus. danricus*, *Puntius sophore*, *Channa fasciata*, *Labeo bata*, *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* collected from Tripura, India were analyzed and the reports concluded that all the fish species were nutritionally competitive even in their dried state [44]. The study found that small indigenous fishes are highly nutritious and can provide nutritional security to the poor due to their low cost and widespread availability.

Ali and co-workers [45] investigated the proximate composition and mineral content of some commercially important marine fishes (Fig. 2) collected from Kasimedu coast, Chennai, India. The moisture content varied from 72.37 to 77.90 %, the crude protein ranges from 65.61 to 77.90 % with the highest crude protein observed in *Amblygaster sirm* and *Rastrelliger brachysoma*. The crude lipid content ranged from 1.31 to 8.68 % with the highest content of 8.68 % observed in *Sphyraena flavicauda*. The average ash content of the fish samples varied from 14.57 to 25.44 % with *Nemipterus japonicus* and *Epinephelus fuscoguttatus* exhibit the highest values of ash content of 22.1 and 25.44% respectively. It was reported that although most of fishes are rich source of

Table 3. Proximate composition w.r.t. moisture, protein, fat and ash of some important fish species

Fish species (Scientific name)	Common name	Moisture (%)	Protein (%)	Fats (%)	Ash (%)	Reference
AmblypÍnaryngodon mola	Mola carplet	78.16	18.31	3.56	1.86	[47]
Channa gachua	Dwarf snakehead	78.10	21.41	2.87	1.88	
Channo punctatus	Green snakehead	77.53	22.75	2.85	2.01	
Chrysichthys nigrodigitatus	Bagrid catfish	66.19	14.20	10.62	5.30	[48]
Cynoglossus senegalensis	Large tonguesole	63.90	18.56	2.57	7.70	
Polydactylus quadrifilis	Giant African threadfin	67.54	17.83	3.39	5.94	
Hilsa Ilisha	Hilsa herring	55.28	20.77	18.88	1.23	[49]
Mugil cephalus	Grey mullet	55.47	18.00	3.85	1.25	
Silla$o sihama	Northern whiting	56.79	17.47	3.45	1.20	
Ailia coila	Gangetic ailia	82.80	12.90	1.80	2.00	
Bogrus docmak	Sudan catfish	76.81	15.35	4.32	0.88	[50]
Clarias gariepinus	African catfish	75.92	15.44	5.74	0.83	
Cyprinus carpio	Common Carp	77.24	17.25	1.26	0.94	
Labeobarbus intermedius	Baringo barb	78.18	14.98	2.32	0.92	
Labeobarbus nedgia	Nech asa	77.98	15.09	2.28	0.89	
Aoricthyes aor	Whiskered catfish	75.44	14.88	5.46	4.19	[51]
Barbodes somni	Olive barb	68.24	17.20	9.95	4.58	
Colla catla	Catla	75.19	14.86	5.06	4.80	
Labeo rohita	Rohu	75.54	14.44	5.36	4.63	
Wollago attu	Helicopter catfish	77.64	15.00	4.08	3.24	
Pseudoto/ithus efongofus	Bobo croaker	78.24	13.40	0.36	7.17	[52]
Pseudoto/ithus typus	Longneck croaker	76.17	16.17	0.46	7.28	
Briri/ius pakistanicus	Pakistani bariil	58.13	20.00	1.00	4.33	[53]
Garra gotyla	Sucker head	72.13	14.dó	ó.00	8.00	
Schizothorax plagiostomus	Snow trout	59.73	15.33	2.50	4.66	
Pampus orgenteus	Silver pomfret	73.30	18.60	5.óo	1.20	[54]
Pampus chinensis	Chinese silver pomfret	75.80	19.05	2.70	1.10	
Pampus niger	Black pomfret	73.80	19.60	3.60	1.40	
Rastrel/iger brochyosomo	Short mackerel	72.90	21.50	3.10	1.30	
Rastreiliger kanagurta	Indian mackerel	76.50	19.39	1.50	1.50	
Tachysurus caelatus	Engraved catfish	75.60	18.20	1.90	1.30	
Tochysurus dussumieri	Tropiese eebaber	76.10	18.30	1.60	1.20	

Fish species (Scientific name)	Common name	Moisture (%)	Protein (%)	Fats (%)	Ash (%)	Reference
Tachysurus sona	Dusty catfish	76.60	17.90	2.20	1.90	
Chrysicthys nigrodigitotus	Bagrid catfish	80.10	19.30	0.88	7.Só	[55]
Nlalapterurus electricvs	Electrïc catfish	75.90	16.80	1.33	3.95	
Oreochromis niloticus	Nile tilapia	76.40	17.60	1.89	3.84	
Parachanna obscura	Obscure snakehead	78.60	16.90	1.67	2.91	
C!arias gariepinus	African catfish	80.50	15.20	1.80	1.30	[56]
Lobeobarbus intermedius	Baringo barb	80.40	15.40	2.40	1.40	
Oreochromis niloticus	Nile tilapia	79.00	18.80	0.60	1.40	
Colossoma macropomum	Tambaqui	79.25	20.73	0.84	1.21	[57]
Pioroctus brach/pomus	Red-bellied pacu	70.47	16.79	9.23	0.97	
Pioroctus mesopolamiCuS	Pacu	73.75	25.00	4.34	1.28	
Piaractus mesopotamicus × *Colossoma macropomum*	Pacu × Tambaqui	79.17	21.44	1.24	1.25	
Clarias batrachvs	Walking catfish	78.58	15.70	NA	NA	[58]
Heteropneustus fossilis	Stinging catfish	71.20	18.14	NA	NA	
Mystus vittatus	Striped dwarf catfish	79.41	14.49	NA	NA	
Epinephelus chlorostigma	Brown spotted grouper	79.87	15.28	2.05	5.04	[59]
Parastromateus niger	Black pomfret	80.65	17.21	1.66	3.42	
PJectropomus oreolotus	Squaretail coral grouper	79.55	17.28	2.97	5.03	
Polysteganus coeruleo punctatus	Blue skin sea bream	79.29	17.66	152	6.72	
Pristipomoides multidens	Gold banded job fish	77.90	16.74	2.53	5.07	

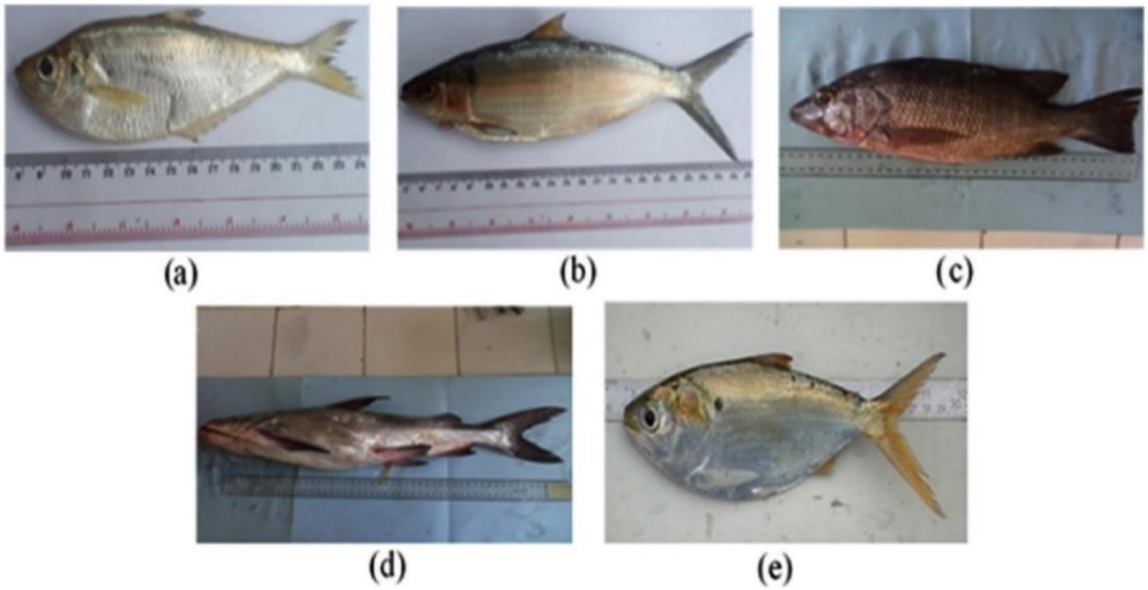

Fig. 3. The fish samples (a) *Ilisha africana* (b) *Sardinella maderensis* (c) Cyprinus carpio (d) *Arius parkii* and (e) *Ethmalosa fimbriata*, collected from Douala fishing seaport. Reproduced from ref [46] © 2023 The Authors

phosphorus, *Amblygaster sirm*, *Rastrelliger brachysoma* and *Epinephelus fuscoguttatus* have higher iron and calcium content. Recently, Manz et. al. 2023 [46] investigated the proximate composition of five food fishes, *Ilisha africana*, *Sardinella, maderensis*, *Cyprinus carpio*, *Arius parkii* and *Ethmalosa fimbriata* (Fig. 3) collected from the Douala sea port, Cameroon Coast The proximal composition was analyzed using AOAC standard methods. The results of the inversigation revealed that the content of proteins (18.43%), and lipids (3.69%) were higher in *Ilisha Africana* as compared to others. However, *Cyprinus carpio* had the, highest ash content (4.59%). All the species, contain various minerals and heavy metals that followed the order P > Mg > K > Ca > Na > Fe > Zn > Cu > Mn and Hg > Pb > Cd > As. The proximate composition data w.r.t. four parameters viz. moisture, protein, lipid and ash content investigated by various research groups of some fresh and marine water commercially important food fish species is shown in Table 3.

3. FACTORS EFFECTING PROXIMATE COMPOSITION

Fish have high nutritive value enriched with essential nutrients, unique protein content of high quality and easy digestibility. The chemical composition of fish varies significantly between species and also among the individual fishes within the same species with the variation of age, sex, reproducing cycle, breeding season and region of catching [60,61]. The difference in proximate composition may also be due to the fact that the species belonged to different locations. The variation in proximate composition of food fishes may be influenced by species location, age, season, and maturity within the same species. For example, the lower protein content of *Amblypharyngodon mola* may be justified from the point of view that *Channa punctatus* are carnivorous and consume animal protein whereas *Amblypharyngodon mola* is mainly a plankton feeder [47].

Basically, there are two important factors that affect the proximate composition of fish. These factors are endogenous and exogenous. The endogenous factors include life cycle of the fish i.e. life stage, size, age, sex, anatomical position which are mainly genetically controlled [27]. Whereas, the exogenous factors are associated with various environmental fluctuations and changes in composition as well as the availability of feed in fish habitat [62] and variations in the temperature and salinity of the water body where the fish is available [63]. Among the above-mentioned factors, the exogenous factors, however, possess a significant effect on the proximate composition of the fishes. On the other hand, other factors such as changes in temperature, pH, salinity, light, dissolved oxygen concentration have limited effect. The seasonal variation in proximate composition has a

significant influence on the nutritional qualities of fishes which is supported by various studies on seasonal variation in the proximate composition of food fish [64]. It has been also found that the variation in proximate composition were noticed within the same species of fishes depending upon the fishing area, age and sex of the individual, geographical location of catching, environmental conditions, spawning cycle and food supply, sexual maturity, size and reproductive status of the fish [65]. In addition to these factors, it was reported that storage, transport, handling and spoilage of fish may also significantly affect the nutritional quality of fishes. As soon as the fish becomes dead, due to cessation of circulation leads to the diminution of oxygen levels in the fish body and it results in the known synthesis of ATP, as ETC and oxidative phosphorylation are no longer functional [63].

The proximate composition of nine freshwater fishes viz. *Mystus vittatus, Ompok bimaculatus, Channa striata, Wallago attu, Pangasianodon hypophthalmus, Labeo bata, Labeo calbasu, Cirrhinus reba and Puntius javanicus* were studied by Paul et. al. 2019 [66]. It has been reported that the proximate composition basically varied w.r.t. season and body weight. The moisture content of *Labeo bata* was higher in larger fish (size >100 g) species during autumn whereas, the protein content of *Labeo bata* was found higher in smaller fish (size <100 g) species during summer season [66]. However, Pal and Ghosh, 2013 [67] had reported that within the same season of the same year, the moisture content did not vary significantly between small and large fish [67]. The lipid content of *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* was found to be higher during summer regardless of their body weights in comparison to the fish in other seasons of the year [68]. The moisture content higher in autumn and lower in summer and fat content higher in winter and lower in autumn due to the inverse relationship [69]. Proximate composition as moisture, protein, lipid and ash content of *Labeo gonius* were found to vary from season to season. A higher moisture content was found in May than August. Most of the fishes has higher moisture content and may vary according to size, sex, season of the year [70]. The protein content also show significant variation. The highest value of protein was found in May and the lowest value in August. The lipid content has the highest value in the month of July, while the lowest value was observed in in May. The ash percentage was higher in August and lower in May [71]. The ash content varied among different species according to the size and different seasons of the year. The muscle proximate composition of some fish species in different seasons as summer=Pre-monsoon (pre-spawning), autumn=monsoon (post-spawning) and Winter=post-monsoon (spawning) season of the year are shown in Table 4.

Table 4. Seasonal variations in the proximate composition of some food fish

Species	Particulars	Summer	Autumn	Winter	References
Sillaginopsis panijus	Moisture	77.60±0.15	76.26±0.03	57.79±0.21	[70]
	Protein	73.93±0.17	64.55±0.12	57.79±0.21	
	Lipid	11.87±0.05	13.09±0.16	14.73±0.05	
	Ash	11.50±0.09	14.13±0.06	15.64±0.03	
Labeo gonius	Moisture	72.67± NA	72.84± NA	72.42± NA	[71]
	Protein	17.21± NA	17.23± NA	15.54± NA	
	Lipid	4.73± NA	3.92± NA	4.02± NA	
	Ash	5.21± NA	5.87± NA	7.19± NA	
Harpodon nehereus	Moisture	82.21±2.07	88.15±0.96	85.54±0.17	[72]
	Protein	27.6±0.17	21.0±0.12	31.7±0.05	
	Lipid	0.26±2.09	0.25±0.11	0.19±0.41	
	Ash	0.72±3.07	0.60±0.05	1.31±0.64	
Cyprinus carpio	Moisture	72.54±0.55	73.70±0.63	74.53±1.07	[73]
	Protein	20.07±0.19	18.71±1.07	18.25±1.18	
	Lipid	4.19±0.23	3.80±0.36	3.36±0.40	
	Ash	3.02±0.637	3.13±0.42	3.44±0.53	
Sardinella gibbosa	Moisture	76.47±0.28	76.5±0.28	75.16±0.10	[74]
	Protein	17.5±0.14	15.5±0.20	15.43±0.23	
	Lipid	2.34±0.02	3.89±0.01	6.33±0.03	
	Ash	1.92±0.01	2.11±0.04	2.19±0.005	

Species	Particulars	Summer	Autumn	Winter	References
Schizothorax niger	Moisture	71.92±2.09	72.12±1.89	76.87±1.31	[75]
	Protein	17.53±0.61	16.26±0.99	12.92±0.57	
	Lipid	5.56±0.52	5.14±0.69	3.18±0.26	
	Ash	2.42±0.32	3.02±0.18	3.20±0.33	
Auxis hazard	Moisture	79.71±0.36	74.87±0.18	76.55±0.34	[76]
	Protein	18.86±0.30	23.34±0.21	21.34±0.35	
	Lipid	0.69±0.19	1.25±0.07	1.17±0.05	
	Ash	0.86±0.20	0.77±0.19	1.01±0.27	
Labeo boga	Moisture	83.11± NA	78.62± NA	81.4± NA	[77]
	Protein	16.41± NA	16.46± NA	17.21± NA	
	Lipid	2.33± NA	1.95± NA	2.96± NA	
	Ash	1.06± NA	1.03± NA	1.17± NA	
Labeo calbasu	Moisture	77.27± NA	-	74.82± NA	[78]
	Protein	14.6± NA	-	16.13± NA	
	Lipid	2.84± NA	-	3.65± NA	
	Ash	1.99± NA	-	2.54± NA	

4. CHALLENGES AND SCOPE OF FURTHER RESEARCH

The proximate composition of fishes will ensure whether the fish fulfill the essential quality parameters or not, which will help us to assess the nutritional quality and commercial importance of the food fish. This study is an attempt to provide an in-hand data source about the proximate composition of some commercially important fish species which are used by consumers as food in different parts of the world. It will also help in assessing how the nutritional qualities vary from species to species depending on various factors. The present study on the nutritional qualities of food fishes w.r.t. the proximate composition shall help the young researchers to carry out future research on the nutrient profile of commercial and economic fish species which are yet to be studied. These types of studies provide a basis for obtaining nutritional data and highlights the importance of various nutrients found in food fish. The studies on proximate composition concentrates the nutritional values of various food fishes and how the available food fish may address the issues of malnutrition and provide a nutritional profile of the various fishes based on the biochemical profile of diverse fishes. There are so many studies were carried out by various research groups on proximate composition, amino acid, fatty profile, vitamins and mineral contents on various food fishes. But, there are limited number of literatures available on biochemical aspects and nutritional values of fishes with respect to their endogenous and exogenous factors as well as seasonal variations. Therefore, it is very much essential to study the proximate composition considering the important factors that affects the proximate compositions significantly before deciding about the nutritional profile of the fish species.

5. SUMMARY AND CONCLUSION

The review paper suggests that the studies on food fishes analyzed are nutrient-rich and can be recommended as a vital health supplements. It can be summarized that the nutritional studies of the food fishes carry a key role to develop scientific awareness among the citizens and creative attempts to utilize the fishes in their daily diets to mitigate the problem of malnutrition. The government as well as the local bodies and citizens must be aware of the nutritional qualities and the importance of food fishes in our daily diet, conserve the diversity of food fishes and encourage aquaculture for production of food fishes. We must create awareness among the community people to conserve the food fishes by regular monitoring the fish fauna, to aware them about the best time of catching fishes, to analyze the water quality of the different water habitats of different fishes and controlling the anthropogenic activities.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sadiku SOE, Oladimeji AA. Relationship of proximate composition of *Lates niloticus* (L), synodontis schall. Res. Commun. 1991;3:29- 40.
2. Abraha B, Admassu H, Mahmud A, Tsighe N, Shui XW, Fang Y. Effect of processing methods on nutritional and physico-chemical composition of fish: A review. MOJ Food Process Technol. 2018;6(4):376-82.
3. Njinkoue JM, Gouado I, Tchoumbougnang F, Ngueguim JY, Ndinteh DT, Fomogne-Fodjo CY, Schweigert FJ. Proximate composition, mineral content and fatty acid profile of two marine fishes from Cameroonian coast: Pseudotolithus typus (Bleeker, 1863) and Pseudotolithus elongatus (Bowdich, 1825). NFS Journal. 2016;4: 27-31.
4. Guizani SEO, Moujahed N. Seasonal variation of chemical and fatty acids composition in Atlantic Mackerel from the Tunisian Northern-East Coast. J. Food Process Technol. 2015;6(9):1-4.
5. Shaji SA, Hindumathy CK. Chemical composition and amino acid profile of Sardinella longiceps collected from Western coastal areas of Kerala, India. J. Biol. Earth Sci. 2013;3(1):B1 29–B134.
6. Tenyang N, Womeni HM, Linder M, Tiencheu B, Villeneuve P, Tchouanguep Mbiapo F. The chemical composition, fatty acid, amino acid profiles and mineral content of six fish species commercialized on the Wouri river coast in Cameroon. La Rivista Italiana delle Sostanze Grasse Grasse-Vol. XCI-April/Giugno. 2014; 129-130.
7. De Deckere EAM. Possible beneficial effect of fish and fish n-3 polyunsaturated fatty acids in breast and colorectal cancer. European J. Cancer Prev. 1999;8(3): 213-221.
8. Clandinin MT, Foxwell A, Goh YK, Layne K, Jumpsen JA. Omega-3 fatty acid intake results in a relationship between the fatty acid composition of LDL cholesterol ester and LDL cholesterol content in humans. Biochimica et Biophysica Acta (BBA)-Lipids and Lipid Metabolism. 1997; 1346(3):247-252.
9. Raatz SK, Silverstein JT, Jahns L, Picklo Sr MJ. Issues of fish consumption for cardiovascular disease risk reduction. Nutrients. 2013;5(4):1081-1097.
10. Polak-Juszczak L, Komar-Szymczak K. Fatty acid profiles and fat contents of commercially important fish from Vistula Lagoon. Pol. J. Food Nut. Sci. 2009;59(3):225-229.
11. Kris-Etherton PM, Harris WS, Appel LJ. American Heart Association. Nutrition Committee. Fish Consumption, Fish Oil, Omega-3 Fatty Acids, and Cardiovascular Disease. Circulation. 2002;106:2747-2757.
12. Saravanan P, Davidson NC, Schmidt EB Calder PC. Cardiovascular Effects of Marine Omega-3 Fatty Acids. Lancet. 2010;375:540-550.
13. Bucher HC, Hengstler PSC, Meier G. Polyunsaturated fatty acids in coronary heart disease: A meta-analysis of randomized controlled trials. Am. J. Medicine. 2002;112:298-304.
14. Damsgaard CT, Lauritzen L, Kjaer TMR, Holm PMI, Fruekilde MB, Michaelsen KF, et al. Fish oil supplementation modulates immune function in healthy infants. The J. Nutrition. 2007;137:1031-1036.
15. Sinn N. Physical fatty acid deficiency signs in children with ADHD symptoms. Prostaglandins Leukot. Essent. Fatty Acids. 2007;77:109-115.
16. Duran A, Tuzen M., Soylak M. Trace element concentrations of some pet foods commercially available in Turkey. Food Chem. Toxicol. 2010;48(10):2833-2837.
17. Mendil D, Demirci Z, Tuzen M, Soylak M. Seasonal investigation of trace element contents in commercially valuable fish species from the Black sea, Turkey. Food Chem. Toxicol. 2010;48(3):865-870.
18. Thilsted SH, 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.
19. Marichamy G, Haq MB, Vignesh R, Sedhuraman V, Nazar AR. Assessment of proximate and mineral composition of twenty Edible fishes of parangipettai coastal waters. Int. J. Pharma Bio Sci. 2012;3(2):54–64.
20. Mridha MA, Lipi SY, Narejo NT, Uddin MS, Kabir MS, Karim M. Determination of

biochemical composition of Cirrhinus reba (Hamilton, 1822) from Jessore, Bangladesh. J. Sci. Technol. Univ. Peshwar. 2005;29(1):1–5.

21. Foran JA, Carpenter DO, Hamilton MC, Knuth BA, Schwager SJ. Risk based consumption advice for farmed Atlantic and wild pacific salmon contaminated with dioxins and dioxin like compounds. Environ. Health Persp. 2005;113(5): 552–556.
22. Mozaffarian D, Rimm EB. Fish intake, contaminants, and human health: Evaluating the risks and the benefits. J. the Am. Med. Assoc. 2006;296(15): 1885–1899.
23. Mohamed HAE, Al-Maqbaly R, Mansour HM. Proximate composition, amino acid and mineral contents of five commercial Nile fishes in Sudan. African J. Food Sci. 2010;4(10):640–654.
24. Pal J, Shukla BN, Maurya AK, Verma HO, Pandey G, Amitha A. A review on role of fish in human nutrition with special emphasis to essential fatty acid. Int. J. Fish. Aq. Stud. 2018;6(2):427-430.
25. Ravichandran S, Kumaravel K, Florence EP. Nutritive composition of some edible fin fishes. Int. J. Zool. Res. 2011; 7(3):241-251.
26. Romharsha H, Sarojnalini C. Micronutrient contents of some fresh water fish species of Manipur, India. Oriental J. Chem. 2019;35(4):1426-1432.
27. Huss HH. Quality and quality changes in fresh fish. FAO Fisheries Technical paper No.348, Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy; 1995.
28. Awuchi CG, Chukwu CN, Iyiola AO, Noreen S, Morya S, Adeleye AO, Okpala COR. Bioactive compounds and therapeutics from fish: revisiting their suitability in functional foods to enhance human wellbeing. BioMed Res. Int. 2022;3661866.
29. Skałecki P, Florek M, Kędzierska-Matysek M, Poleszak E, Domaradzki P, Kaliniak-Dziura A. Mineral and trace element composition of the roe and muscle tissue of farmed rainbow trout (*Oncorhynchus mykiss*) with respect to nutrient requirements: Elements in rainbow trout products. J. Trace Elements Med. Biol. 2020;62:126619.
30. Tkaczewska J, Migdał, W. Comparison of slaughter yield, contents of basic nutrients, and heavy metals levels in muscles of carp (*Cyprinus carpio* L.) farmed in various regions in Poland. Żywność. Nauka. Technologia. Jakość. 2012;6:180-189.
31. Creţu M, Cristea V, Dediu L, Petrea SM. The influence of different stocking densities on biochemical composition of rainbow trout meat reared in a recirculating aquaculture system. Anim. Sci. Biotechnol. 2014;47:200-204.
32. Topuz OK, Yerlikaya P, Yatmaz HA, Kaya A, Alp AC, Kilic M. Comparison of essential trace element profiles of rainbow trout fish (*Oncorhynchus mykiss*) meat and egg. Sci. Pap. Ser. D. Anim. Sci. 2017;60:316-319.
33. Acharya P, Muduli PR, Das M, Mahanty A. Fatty acid, proximate composition and mineral content of Tenualosa sp. from east coast of India. Food Chem. Adv. 2022;1:100121.
34. Begum M, Bhowmik S, Juliana FM, Hossain MS. Nutritional profile of hilsa fish [*Tenualosa Ilisha* (Hamilton, 1822)] in six selected regions of Bangladesh. J. Nutr. Food Sci. 2016;6(6):1-4.
35. Mohanty BP, Paria P, Mahanty A, Behera BK, Mathew S, Sankar TV, Sharma AP. Fatty acid profile of Indian shad *Tenualosa ilisha* oil and its dietary significance. Nat. Acad. Sci. Lett. 2012;35(4): 263–269.
36. Hossain MA, Almatar SM, Al-Hazza AA. Proximate, fatty acid and mineral composition of hilsa, *Tenualosa ilisha* (Hamilton 1822) from the Bay of Bengal and Arabian Gulf. Indian J. Fish. 2014;61(2):58–66.
37. Ganguly S, Mahanty A, Mitra T, Mohanty S, Das BK, Mohanty BP. Nutrigenomic studies on hilsa to evaluate flesh quality attributes and genes associated with fatty acid metabolism from the rivers Hooghly and Padma. Food Res. Int. 2018;103: 21–29.
38. Pal M, Mukhopadhyay T, Ghosh S. Proximate, fatty acid, and amino acid compositions of fish muscle and egg tissue of hilsa (*Tenualosa Ilisha*). Journal Aq. Food Prod. Technol. 2011;20(2):160–171.
39. Sharma P, Kumar V, Sinha AK, Ranjan J, Kithsiri HMP, Venkatesh-warlu G. Comparative fatty acid profiles of wild and farmed tropical fresh-water fish rohu

(*Labeo rohita*). Fish Physiol. Biochem. 2010;36(3):411–417.
40. Ara I, Ayubi MM, Huque R, Khatun MA, Islam M, Hossain MA. Morphometric, meristic and proximate composition between freshwater and marine hilsa fish. Int. J. Fish. Aqua. St. 2019;7(6):125-129.
41. Rahman MA, Shikha FH, Hossain MI, Asadujjaman M, Nahar N, Rahman MM. Comparative study on proximate composition and heavy metal concentration of amblypharyngodon mola and channa punctatus collected from pond water and open water. American-Eurasian J. Toxicol. Sci. 2014;6(4): 131-135.
42. Debnath S, Latifa GA, Bhowmik S, Islam S, Begum M. Comparative analysis of nutritional values of riverine and marine hilsa (*Tenualosa ilisha*; Hamilton, 1882). Korean J. Agri. Sci. 2018;45(2): 258-264
43. Bijayalakshmi C, Romen N, Shomorendra M. Proximate composition of small indigenous fish (*Amblypharyngodon mola*) tissue of Manipur. Int. J. Curr. Res. 2014;6(2):4965-4967.
44. Debnath C, Sahoo L, Singha A, Yadav GS, Datta M, Ngachan SV. Protein and mineral compositions of some local fishes of Tripura, India. Indian J. Hill Farming. 2014;27(1):210-218.
45. Ali SSR, Abdhakir ES, Muthukkaruppan R. Proximate and mineral composition of commercially important marine fin fishes from the Kasimedu fish landing centre Chennai. J. Fish. Life Sci. 2020;5(1):20-25
46. Manz JCK, Nsoga JVF, Diazenza JB, Sita S, Bakana GMB, Francois A, Mamonekene V. Nutritional composition, heavy metal contents and lipid quality of five marine fish species from Cameroon coast. Heliyon. 2023;9:e14031
47. Chakraborty S, Brahma BK, Goyal AK. Proximate composition of three small indigenous fish species encountered in the local fish market of Kokrajhar, BTAD, Assam. Indian J. Appl. Res. 2015; 5(10):712–714.
48. Daniel IE. Proximate composition of three commercial fishes commonly consumed in Akwa Ibom state, Nigeria. Int. J. Multidisci. Acad. Res. 2015;3(2):1–5.
49. Mohanty SS, Dash BP, Pramanik DS. Proximate composition of three marine fishes of Chandipur, Bay of Bengal, India. Int. J. Fish. Aqua. St. 2015;2(4): 354–358.
50. Teame T, Natarajan P, Tesfay Z. Proximate and mineral composition of some commercially important fish species of tekeze reservoir and lake Hashenge, Ethiopia. Int. J. Fish. Aqua. St. 2016;4(1):160–164.
51. Hussain MZ, Naqvi AA, Shahzadah WA, Latif A, Hussain S, Iqbal R, Ali M. Effect of feeding habit, size and season on proximate composition of commercially important fishes from lentic water bodies of Indus river at Ghazi Ghat, Pakistan. Pakistan J. Zool. 2016;48(6):1877–1884.
52. Njinkoue JM, Gouado I, Tchoumbougnang F, Ngueguim JY, Ndinteh DT, Fomogne-Fodjo CY, Schweigert FJ. Proximate composition, mineral content and fatty acid profile of two marine fishes from Cameroonian coast: Pseudotolithus typus (Bleeker, 1863) and Pseudotolithus elongatus (Bowdich, 1825). NFS Journal. 2016;4:27-31.
53. Gul S, Hasan Z, Khan GN, Gul S. Proximate body composition of five commercial fish species of family Cyprinida commonly consumed in Swat Khyber Pakhtunkhwa Pakistan. J. Entomol. Zool. St. 2017;5(3):1255–1257.
54. Mohanty N, Nayak L. Proximate composition of fishes comprising of three families Aridae, Scombridae and Stromateidae collected from Gopalpur coast, east coast of India. Int. J. Sci. Invent. Today. 2018;7(1):108–118.
55. Ayanda IO, Ekhator UI, Bello OA. Determination of selected heavy metal and analysis of proximate composition in some fish species from Ogun River, Southwestern Nigeria. Heliyon. 2019; 5(10):e02512.
56. Geremew H, Abdisa M, Goshu G. Proximate composition of commercially important fish species in southern Gulf of Lake Tana, Ethiopia. Ethiopian J. Sci. Technol. 2020;13(1):53–63.
57. Rodrigues BL, Monteiro MLG, Vilhena da Cruz Silva Canto AC, Costa MPD, Conte-Junior CA. Proximate composition, fatty acids and nutritional indices of promising freshwater fish species from Serrasalmidae family. CyTA J. Food. 2020;18:591–598.
58. Bezbaruah G, Deka DD. Variation of moisture and protein content in the

muscle of three catfishes: A comparative study. Int. J. Fish. Aqua. St. 2021;9(1):223–226.
59. Younis EM, Abdel-Warith AWA, Al-Asgah NA, Elthebite SA, Rahman MM. Nutritional value and bioaccumulation of heavy metals in muscle tissues of five commercially important marine fish species from the Red Sea. Saudi J. Biol. Sci. 2021;28(3):1860–1866.
60. Oliveira ERND, Agostinho AA, Matsushita M. Effect of biological variables and capture period on the proximate composition and fatty acid composition of the dorsal muscle tissue of *Hypophthalmus edentatus* (Spix, 1829). Brazilian Arch. Biol. Technol. 2003;46(1):105-114.
61. Shija SM, Shilla DA, Mihale MJ. Variation of proximate contents in selected marine fish from Tanzanian coast due to seasonality and processing methods. Huria J. Open Univ. Tanzania. 2019;26(1):30–49
62. Olsson GB, Olsen RL, Carlehog M, Ofstad R. Seasonal variation in chemical and sensory characteristics of farmed and wild Atlantic halibut (*Hippoglossus hippoglossus*). Aquaculture. 2003;217(1-4):191–205
63. Khalili Tilami S, Sampels S. Nutritional value of fish: Lipids, proteins, vitamins, and minerals. Rev. Fish. Sci. Aqua. 2018;26:243–253.
64. Rao GP, Simhachalam G. Seasonal changes in biochemical composition of fresh water fish *Labeo bata* (Hamilton, 1822). Int. Arch. Appl. Sci. Technol. 2018;9:17–20
65. Padmavati G. Proximate and elemental composition of *Stolephorus commersonnii* (Lacepede, 1803) from the coastal waters of South Andaman. Indian J. Geo Marine Sci. 2017;46(5):1000–1007
66. Paul BN, Bhowmick S, Singh P, Chanda S, Sridhar N, Giri SS. Seasonal variations in proximate composition of nine freshwater fish. Indian J. Anim. Nutr. 2019;36(1):65-72.
67. Pal M, Ghosh M. Assay of biochemical compo-sitions of two indian fresh water eel with specialemphasis on accumulation of toxic heavy metals. J. Aqua. Food Prod. Technol. 2013;22:27–35
68. Shakir HA, Qazi JI, Chaudhry AS, Hussain A, Ali A. Nutritional comparison of three fishspecies cocultured in an earthen pond. Biologia (Pakistan). 2013; 59:353–358.
69. Bogard JR, Thilsted SH, Marks GC, Wahab MA, Hossain MA, Jakobsen J, Stangoulis J. Nutrient composition of important fish species in Bangladesh and potential contribution to recommended nutrient intakes. Journal of Food Composition and Analysis. 2015;42:120-133.
70. Azim MA, Islam MR, Hossain MB, Minar MH. Seasonal variations in the proximate composition of Gangetic Sillago, *Sillaginopsis panijus* (Perciformes: Sillaginidae). Middle-East J. Sci. Res. 2012;11:559–562.
71. Begum A, Minar MH, Mahfuj MSE, Begum M. Monthly variation of biochemical com-position of gonia (*Labeo gonius*) collected from Bangladeshi water. Int. J. Life Sci. Biotechnol. Pharma Res. 2013;2:227–232.
72. Shingadia HU. Seasonal variation in proximate composition of bombay duck, Harpodon nehereus (Ham-Buch) from Mumbai Coast. Int. J. Adv. Res. 2013;1:52–55.
73. Manon MR, Hossain MD, Khanom A, Jewel MAS, Khatun MM. Biochemical composition of Cyprinus carpiovar specularison the basis of sex and seasonal variation in Atrai River Univ. J. Zool. Rajshahi Univ. 2015;34:15-19.
74. Bagthasingh C, Aran SS, Vetri V, Innocen A, Kannaiyan SK. Seasonal variation in the proxi-mate composition of sardine (*Sardinella gibbosa*) from Thoothukudi coast. Indian J. Geo Marine Sci. 2016;45:800–806.
75. Ahmed I, Sheikh ZA. Study on the seasonal variation in the chemical composition, hematological profile, gonadosomatic index and hepatosomatic index of snow trout, schizothorax niger from the freshwater Dal Lake, Kashmir. Am. J. Food Technol. 2016;12:1–13.
76. Rani PSCHPD, Kumar VP, Rao RK, Shameem U. Seasonal variation of proximate composition oftuna fishes from Visakhapatnam fishing harbor, east coast of India. Int. J. Fish. Aqua. St. 2016;4:308–313.
77. Gandotra R, Sharma M, Kumari R. Studies on the seasonal variations in proximate composition of Labeo boga. Int. J. Sci. Res. Modern Edu. 2017;2:2455–5630.

78. Munny FJ, Uddin MS, Islam MS, Debnath P, Suravi IN, Alam MMM. Proximate composition of Labeo calbasu at different seasons in Sunamgonj of Bangladesh. J. Fish. Life-sci. 2020;5: 1–4.

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