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Seasonal Variations in Proximate Composition of Nine Freshwater Fish

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ABSTRACT

The variation in proximate composition was determined in relation to season and body weight of nine freshwater fish *i.e. Mystus vittatus, Ompok bimaculatus, Channa striata, Wallago attu, Pangasianodon hypophthalmus, Labeo bata*, *Labeo calbasu*, *Cirrhinus reba* and *Puntius javanicus*. The samples were collected in different seasons from different places and divided into small and big body weight groups. Nutritional composition of fish species was determined during the three seasons *i.e*. S_1 (January-April), S_2 (May-August) and S_3 (September-December) of the year. Protein content ranged from 12.52-19.19% among the species on wet weight basis. Protein content was higher (P<0.01) in *C. reba* (>100 g) during January-April. Protein, fat and ash content of *P. javanicus* was higher (P<0.01) in fish of size (>100 g) during S_3 (September-December). Protein content was higher (P<0.05) in *O. bimaculatus* and *M. vitattus* during S_1 (January-April) irrespective of body weight. Protein content was higher (P<0.01) during the month of May-August in *C. striata* of (>500 g) size group. Fat content of the *L. bata* was higher (P<0.01) during S_1 (January to April) irrespective of body size. Fat content in *L. calbasu* was similar in different seasons. Fat content of *C. striata* was higher (P<0.01) in >100g size group during S_1 (January-April). Protein content was higher in *W. attu* of >1000 g size group during S_2 (May-August). *P. hypopthalamus* of (>1000 g) size group revealed that fat content was higher (P<0.01) during S_3 (September-December). Thus, Indian freshwater fish are rich in protein, fat and ash contents and qualify as health food though there were some seasonal variations in proximate composition within the fish species.

Key words: Body weight, Freshwater fish, Proximate composition, Seasonal variations

INTRODUCTION

Food is an important component of public health as the quality and quantity of food components greatly influence the health status of the consumers (Bamji, 2011). Fish is one of the cheapest sources of quality animal protein and availability and affordability of protein is better for fish in comparison to other animal protein sources (Louka *et al.,* 2004; Mohanty *et al.,* 2019). The nutrient compositions of a particular species often appear to vary from season to season (Deka *et al.,* 2012).

Protein in the form of enzymes and hormones are concentrated with a wide range of vital metabolic process in the body. On a fresh-weight basis, fish contain about 12-22% protein and all 10 essential amino acids with easily digestible protein of high biological value (Mohanty *et al.,* 2014). The fat content of fish ranges from 1.0 to 15% and it varies depending on the species as well as season. Lipids are one of the most important components of fish muscle providing energy reserves and components of cell bio-membranes. Though some information is available on nutrient composition of Indian major carp (Paul *et al.,* 2015a; 2016), catfish (Paul *et al.,* 2015), climbing perch (Paul *et al.,* 2017) and minor carps (Paul *et al.,* 2018). The chemical composition of fish varies according to individual and species depending on age, sex, environment, season and geographical location (Boran and Karacam, 2011). The knowledge of fish composition is essential for its maximum utilization (Silva and Chamul, 2000). Keeping in view of importance of eating fish, the seasonal variation in proximate composition of nine freshwater fish *(Labeo. bata, Labeo. calbasu, Cirrhinus. reba, Puntius. javanicus*, *Ompok. bimaculatus, Mystus. vittatus*, *Channa. striata*, *Wallago. attu* and *Pangasius. hypophthalmus*) was studied which could

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be helpful to dieticians, nutritionists, researchers, fish farmers and related stakeholders to promote fish as health food in human nutrition.

MATERIALS AND METHODS

The samples were collected from various places of West Bengal and Odisha throughout the year. The samples were further categorized into two groups according to their weight ranges based on the harvesting size available in market *i.e.,* for *L. bata* small (<100 g) and big (>100 g); *L. calbasu* small (<300 g) and big (>300 g); *C. reba* small (<100 g) and big (>100 g); *P. javanicus* small (<100g) and big (>100 g); *O. bimaculatus* small (<100 g) and big (>100 g); *M. vittatus* small (<15 g) and big (>15 g); *C. striata* small (<500 g) and big (>500 g); *W. attu* small (<100 g) and big (>100 g) and *P. hypophthalamus* small (<100 g) and big (>100 g). Nutritional composition of fish species were analyzed during the three seasons *i.e.* S_1 (January-April), S_2 (May-August) and S_3 (September-December) of the year. The number of fish samples such as *L. bata*, *L. calbasu, C. reba, P. javanicus, M. vittatus*, *O. bimaculatus, C. striata, W. attu and P. hypophthalmus* collected were 52, 54, 51, 53, 59, 52, 48 and 56, respectively.

Fish scales and fins were removed and then washed with running water followed by filleting of edible muscle, which were oven dried at 60°C until achieving constant weight powdered in mixer grinder and stored until chemical analysis. The sampling procedure and the sample preparation for analysis were followed as per Sankar *et al.* (2010).

The moisture content of the wet muscle was estimated by heating it in an oven to a constant weight at 60°C under atmospheric pressure. Dried samples were used for determination of proximate composition of fish muscle (AOAC, 1995). The data were statistically analysed as per Snedecor and Cochran (1994) by one way ANOVA and the least significant difference (LSD) was used for comparison of the mean values.

RESULTS AND DISCUSSION

The moisture content of *Labeo bata* (Table 1) was higher (P<0.01) in fish of (>100 g) during second season (S_2) *i.e.* May-August of the year in comparison to fish of <100 g during first season (January-April) of the year. It did not vary among other groups. Within the same season of the year, moisture content did not vary between small and large fish. The protein content of *Labeo bata* was higher (P<0.01) in <100 g group during S_1 (January to April). The fat content of the species (Table 1) was (P<0.01) higher during January to April irrespective of their body weights in comparison to the fish in other seasons of the year. However, the ash content was similar among the groups according to the size and different seasons of the year.

The moisture content of *L.calbasu* was higher (P<0.01) in size groups <300 g during S_2 (May-August). The protein content of *L. calbasu* was higher (P<0.01) in size group <300 g during Januar-April in comparison to the fish of same size group during May-

Table 1. Proximate composition (on % wet weight basis) of *Labeo bata* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	
Moisture	70.95^{a}±1.29	71.73^{ab}±0.29	74.01^{ab}±0.60	75.05^{b}±0.38	74.09^{ab}±0.42	73.19^{ab}±0.86	0.0058
Protein	18.27^{b}±1.01	16.28^{ab}±0.89	14.84^{a}±0.52	16.76^{ab}±0.33	14.32^{a}±0.23	16.27^{ab}±0.56	0.0002
Fat	4.94^{b}±0.13	4.86^{b}±0.21	3.29^{a}±0.27	2.93^{a}±0.14	3.35^{a}±0.27	3.29^{a}±0.34	0.0001
Ash	2.67±0.34	2.67±0.25	2.56±0.08	2.61±0.15	2.26±0.08	2.68±0.20	0.6054

[a,b]Means bearing different superscripts in a row differ significantly

Table 2. Proximate composition (on % wet weight basis) of *L. calbasu* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<300g)	Big (>300g)	Small (<300g)	Big (>300g)	Small (<300g)	Big (>300g)	
Moisture	74.51^{ab}±0.36	74.64^{ab}±0.29	76.36^{c}±0.55	73.70^{a}±0.55	76.08^{bc}±0.23	74.54^{ab}±0.25	0.0003
Protein	15.33^{b}±0.29	14.19^{ab}±0.14	13.34^{a}±0.50	15.22^{b}±0.45	14.02^{ab}±0.39	14.04^{ab}±0.12	0.0023
Fat	2.69±0.21	2.62±0.17	2.32±0.28	3.41±0.26	3.38±0.28	3.02±0.12	0.1500
Ash	2.30^{b}±0.05	2.19^{b}±0.04	1.80^{a}±0.12	2.12^{ab}±0.10	2.29^{b}±0.07	2.40^{b}±0.05	0.0005

[a,b,c]Means bearing different superscripts in a row differ significantly

August (Table 2). Moreover, during this period, the bigger fish (>300 g) showed higher (P<0.01) body protein content than their smaller counterparts (<300 g). Fat content in *L. calbasu* did not differ significantly according to the size of the fish and season of the year. However, the ash content of *L. calbasu* irrespective of body weight was higher (P<0.01) during S_1 (January-April) and S_3 (September-December) in comparison to the <300 g fish during S_2 (May-August).

The moisture content of *C. reba* was higher (P<0.01) during September-December months irrespective of their body weight in comparison to the fish of all size group during January-April (Table 3). Moreover, larger fish (>100 g) exhibited lower moisture content than their smaller counterparts (<100 g). However, protein content in *C. reba* of both size groups during January-April was higher (P<0.01) than the fish of other seasons of the year. Moreover, the larger fish (>100 g) sampled during May-August showed higher (P<0.01) protein content than the larger fish sampled during September-December. Fat content was more (P<0.01) in *C. reba* of >100 g size group during September to December. Ash content was similar in the groups according to the body weight and seasons.

The moisture content of *P. javanicus* was higher (P<0.01) in fish of <100 g size group during May-August whereas the lowest (P<0.01) moisture content was recorded in fish of >100 g size group during September-December (Table 4). Protein, fat and ash contents were higher (P<0.01) in fish of >100 g size group during September-December. Moisture content in *O. bimaculatus* fish (<100 g size group) was more (P<0.01) during May-August and September-December. Protein content was the highest (P<0.01) in both groups of *Ompok* during S_1 (January-April). The highest (P<0.01) fat content was recorded in fish of >100 g size group during January-April month. Total ash was also higher (P<0.01) in both groups during January-April and September-December.

The moisture content *M. vitattus*. was higher (P<0.01) in fish of <15 g size group during S_2 (May-August). Protein content was the highest (P<0.05) in

Table 3. Proximate composition (on % wet weight basis) of *Cirrhinus reba* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	
Moisture	71.99^{b}±0.53	69.52^{a}±0.29	73.29^{bc}±0.40	73.95^{bc}±0.17	74.43^{c}±0.40	74.72^{c}±0.18	0.0002
Protein	17.07^{cd}±0.55	18.61^{d}±0.31	15.05^{ab}±0.39	15.44^{bc}±0.68	$14.0^{ab}8$±0.25	13.31^{a}±0.19	0.0005
Fat	3.07^{a}±0.15	3.14^{a}±0.44	3.95^{a}±0.34	4.42^{a}±0.83	5.15^{ab}±0.48	6.79^{b}±0.34	0.0001
Ash	2.56^{b}±0.07	3.19^{c}±0.07	2.24^{ab}±0.05	2.46^{ab}±0.10	2.24^{ab}±0.06	2.22^{a}±0.06	0.0003

[a,b,c]Means bearing different superscripts in a row differ significantly

Table 4. Proximate composition (on % wet weight basis) of *Puntius javanicus* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	
Moisture	73.80^{b}±1.06	72.78^{b}±0.65	77.28^{c}±0.29	73.73^{b}±0.53	75.27^{bc}±0.46	65.75^{a}±1.10	0.0001
Protein	14.72^{ab}±0.60	15.33^{bc}±0.34	13.09^{a}±0.25	15.21^{bc}±0.33	13.90^{ab}±0.25	17.14^{c}±0.87	0.0001
Fat	3.03^{a}±0.22	4.46^{ab}±1.10	3.28^{a}±0.18	4.32^{ab}±0.16	5.54^{b}±0.56	9.40^{c}±0.76	0.0002
Ash	2.14^{a}±0.07	2.06^{a}±0.09	2.41^{a}±0.05	2.43^{a}±0.06	2.50^{a}±0.07	3.05^{b}±0.27	0.0003

^{a,b,c}Means bearing different superscripts in a row differ significantly

Mystus of both size group during the first season of the year *i.e.,* January-April (Table 6). The fat content was more (P<0.01) in fish of >15 g size group during S_2 (May-August). Total ash content was higher (P<0.01) in both groups during S_1 (January-April) and in >15 g size group during S_2 (May-August).

Moisture content *C. striata* was higher in fish of >500 g size group during S_3 (September-December) in comparison to fish of >500 g during both January-April and May-August. However, fish of >500 g size group during both January-April showed lower moisture content than the fish of <500 g during both April-August and September-December (Table 7). Protein content was more (P<0.01) during May-August in *Channa* of >500 g size group. Fat content was higher (P<0.01) in fish of >500 g size group during January-April. Ash content was also higher in *Channa* of >500 g size group during January-April. However, <500 g size group of channa also showed higher (P<0.01) ash content in S_1 (January-April) and S_2 (May-August).

Moisture contents of fish of <1000 g size group of *W. attu* was the highest (P<0.01) during January-April. Protein content was higher in fish of >1000 g during second season *i.e.,* May-August. Fat and ash content was similar in both groups during the year. The proximate composition of *P. hypophthalamus* has been given in Table 9. The moisture content was higher (P<0.01) in big sized (>1000 g) fish during May-August and small sized (<1000 g) fish during September-December. Protein content was higher (P<0.01) in small sized (<1000 g) fish during the first and second season of the year *i.e.* January-April and May-August. Big sized (>1000 g) *Pangas* exhibited higher (P<0.01) fat content during S_3 (September-December). Ash content was higher (P<0.01) in species of both the groups during January-April.

Moisture content of the fish in the present findings ranged from 64.53 to 77.34 which was within the reported values in IMC (Joseph *et al.,* 1990; Shakir *et al.,* 2013 and Paul *et al.,* 2016). However, Sankar and Ramachandran (2001) reported higher moisture content (77-81%) in IMC than our findings. The

Table 5. Proximate composition (on % wet weight basis) of *O. bimaculatus* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	Small (<100g)	Big (>100g)	
Moisture	74.86^{bc}±0.99	70.28^{a}±1.70	76.25^{c}±0.61	75.73^{bc}±0.40	77.34^{c}±0.16	72.39^{ab}±0.70	0.0002
Protein	15.97^{c}±0.79	15.87^{c}±0.75	13.79^{ab}±0.49	13.45^{ab}±0.24	12.71^{a}±0.05	14.34^{b}±0.45	0.0001
Fat	3.02^{a}±0.36	6.64^{c}±0.38	4.44^{b}±0.26	3.63^{ab}±0.21	3.02^{a}±0.18	4.20^{ab}±0.23	0.0004
Ash	1.82^{a}±0.07	2.45^{b}±0.12	1.78^{a}±0.07	2.09^{ab}±0.08	2.50^{b}±0.20	2.32^{ab}±0.08	0.0002

^{a,b,c}Means bearing different superscripts in a row differ significantly

Table 6. Proximate composition (on % wet weight basis) of *Mystus vittatus* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<15g)	Big (>15g)	Small (<15g)	Big (>15g)	Small (<15g)	Big (>15g)	
Moisture	$70.00^{a}\pm0.76$	$70.03^{a}\pm0.32$	$74.18^{b}\pm0.93$	$71.60^{ab}\pm0.53$	$73.70^{ab}\pm0.45$	$72.71^{ab}\pm0.92$	0.0003
Protein	$19.19^{b}\pm0.45$	$18.36^{b}\pm0.27$	$13.89^{a}\pm0.45$	$14.50^{a}\pm0.28$	$14.29^{a}\pm0.22$	$14.95^{a}\pm0.35$	0.0004
Fat	$5.63^{a}\pm0.36$	$5.76^{a}\pm0.25$	$7.24^{ab}\pm0.52$	$8.47^{b}\pm0.38$	$6.33^{a}\pm0.25$	$7.07^{ab}\pm0.20$	0.0004
Ash	$2.99^{b}\pm0.09$	$2.87^{b}\pm0.09$	$2.57^{ab}\pm0.13$	$2.94^{b}\pm0.19$	$2.50^{ab}\pm0.08$	$2.08^{a}\pm0.09$	0.0015

[a,b]Means bearing different superscripts in a row differ significantly

moisture content of *C. striata*, *O. bimaculatus* and *W. attu* in the present study was similar to Magur and Singhi as reported by Paul *et al.* (2015) and Pal and Ghosh (2013). Moisture content of *Anabas testudineus* (68.00%) reported by Paul *et al.* (2017) was similar to our findings.

In the present investigations, CP content of fish was in the range of 12.52 to 19.19% which was in agreement with protein levels for carp (FAO, 2008). Hossain *et al.* (2015) reported that protein content in small indigenous fishes ranged from 14.29 to 17.95%. In agreement with our findings, Chakraborty *et al.* (2015) reported that the protein content of *Amblypharyngodon mola* was 18.31%. Protein content of *C. reba* (19.74%) as reported by Mridha *et al.* (2005) was higher than our findings. The protein content of these fish species in the present study were in agreement with the protein content of *A. testudineus* (16.91%) as reported by Paul *et al.* (2017).

The fat content of nine freshwater fish was higher than the fat content of Indian major carps (Paul *et al.,* 2016). The fat content of freshwater fish ranged from 2.09 to 7.17%. There is an inverse relationship between moisture and lipid content of fish tissue (Jankowska *et al.,* 2007; Dempson *et al.,* 2008) as observed in fat and moisture content of *M. vittatus* and *P. hypophthalmus*. Our finding on fat contents are similar to those reported in magur and singhi (Paul *et al.,* 2015), small indigenous fish species of Bangladesh (Mazumder *et al.,* 2008), freshwater eel (Pal and Ghosh, 2013) and *Anabas testudineus* (Paul *et al.,* 2017). Shakir *et al.* (2013) also observed that crude fat content in Indian major carps varied from 1.75 to 2.71%. Begum and Minar (2012) found that crude fat content in small and large carp fishes of Bangladesh was 3-4%. The similar concentration of lipid in small indigenous fish in Bangladesh was found (Ahmed *et al.,* 2012).

The ash content of freshwater fish ranged from 1.37 to 9.40%. Our results are in agreement with earlier reports (Sankar, 2001; Mazumder *et al.,* 2008; Paul *et al.,* 2016 and 2015; Bogard *et al.,* 2015; Chrisolite *et al.,* 2015). In the present study, the protein

Table 7. Proximate composition (on % wet weight basis) of *C. striata* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<500g)	Big (>500g)	Small (<500g)	Big (>500g)	Small (<500g)	Big (>500g)	
Moisture	$75.68^{abc}\pm0.58$	$74.66^{a}\pm0.34$	$76.76^{bc}\pm0.39$	$75.06^{ab}\pm0.38$	$76.67^{bc}\pm0.22$	$77.19^{c}\pm0.35$	0.0009
Protein	$15.61^{cd}\pm0.58$	$14.95^{bc}\pm0.27$	$14.11^{ab}\pm0.50$	$16.95^{d}\pm0.72$	$13.43^{ab}\pm0.19$	$12.85^{a}\pm0.21$	0.0004
Fat	$1.77^{b}\pm0.31$	$2.68^{d}\pm0.18$	$1.37^{a}\pm0.12$	$2.31^{c}\pm0.20$	$1.89^{b}\pm0.13$	$2.50^{cd}\pm0.32$	0.0002
Ash	$2.39^{b}\pm0.10$	$2.48^{b}\pm0.05$	$2.55^{b}\pm0.09$	$2.37^{ab}\pm0.11$	$2.08^{ab}\pm0.07$	$1.98^{a}\pm0.07$	0.0002

[a,b,c]Means bearing different superscripts in a row differ significantly

Table 8. Proximate composition (on % wet weight basis) of *Wallago attu* in different seasons

Particular	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<1000g)	Big (>1000g)	Small (<1000g)	Big (>1000g)	Small (<1000g)	Big (>1000g)	
Moisture	76.78^{b}±0.57	74.50^{ab}±0.82	76.27^{ab}±0.61	71.86^{a}±1.22	73.19^{ab}±1.44	73.16^{ab}±0.58	0.0016
Protein	12.52^{a}±0.21	14.40^{bc}±0.59	12.96^{ab}±0.43	15.23^{c}±0.30	14.57^{bc}±0.67	14.72^{bc}±0.28	0.0008
Fat	3.49±0.09	4.13±0.41	3.58±0.23	3.61±0.35	4.11±0.78	2.91±0.09	0.1889
Ash	2.13±0.06	1.81±0.09	1.94±0.04	1.91±0.12	1.82±0.21	2.09±0.14	0.3792

[a,b]Means bearing different superscripts in a row differ significantly

and ash contents of *P. hypophthalmus* were similar to that of Thai Pangas whereas fat content was lower and moisture content was higher than Thai Pangas (Bogard *et al.,* 2015). The fat and ash content of *C. striata* in the present study was higher than shoal whereas protein content was lower than shoal (18.70%) (Bogard *et al.,* 2015). However, the protein content of *C. striata* in our study was similar to earlier study in the same species (Chrisolite *et al.,* 2015). The protein and ash content of *M. vittatus* was similar to tangra whereas fat and moisture content was lower than tangra (Bogard *et al.,* 2015). Hossain *et al.* (2015) reported that *Puntius puntio, Anabas testudineus* and *Channa punctata* contained more than 3% of ash which was also similar as observed in this study. In corroboration with our findings, Chakraborty *et al.* (2015) reported that the ash content of *Channa gachua* and *Channa punctatus* was 1.88 and 2.01%, respectively. The proximate composition of 9 fishes in our study was also similar to that reported by Mazumdar *et al.* (2008) and Sharma *et al.* (2009).

The study provided a base line data on the proximate composition of 9 indigenous freshwater fishes round the year suggesting greater variation in protein and fat content of muscle tissue. Highest fat content for *Bata* and *Channa* was recorded in January-April. However, *reba, Puntius* and *Pangas* showed higher fat content in second season of the year *i.e.,* May-August. The results were in agreement with the findings of Chrisolite *et al.* (2015) in sardine fish. Protein content of *Bata, Calbasu, reba, Puntius, Ompok* and *Mystus* was higher in January-April. However, moisture content was found to be lower during that period. It was observed that *Channa* and *Wallago* have higher protein content during May-August. However, moisture content was higher in September-December and January-April for both of the species, respectively.

CONCLUSION

Thus, it might be concluded that Indian freshwater fish are rich in protein, fat and ash and thus qualify as health food though there were some seasonal variations in proximate composition within the fish

Table 9. Proximate composition (on % wet weight basis) of *P. hypophthalmus* in different seasons

Particulars	S_1 (January-April)		S_2 (May-August)		S_3 (September-December)		P value
	Small (<1000g)	Big (>1000g)	Small (<1000g)	Big (>1000g)	Small (<1000g)	Big (>1000g)	
Moisture	64.53^{a}±0.68	72.59^{bc}±0.66	67.47^{ab}±1.35	74.07^{c}±0.44	74.88^{c}±0.66	68.77^{ab}±0.94	0.0001
Protein	17.42^{c}±0.22	14.39^{ab}±0.42	17.83^{c}±0.77	14.25^{ab}±0.19	13.03^{a}±0.38	16.16^{bc}±0.59	0.0001
Fat	7.32^{a}±1.13	5.12^{a}±0.36	8.44^{a}±1.07	6.27^{a}±0.62	6.37^{a}±0.68	13.15^{b}±0.50	0.0001
Ash	2.70^{b}±0.19	2.43^{b}±0.11	1.52^{a}±0.08	1.73^{a}±0.12	1.55^{a}±0.14	1.33^{a}±0.05	0.0002

[a,b,c]Means bearing different superscripts in a row differ significantly

species.

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REFERENCES

Ahmed, S., Rahman, A.F.M.A., Mustafa, M.G., Hossain, M.B. and Nahar, N. 2012. Nutrient composition of indigenous and exotic fishes of rainfed waterlogged paddy fields in Lakshmipur, Bangladesh. *World J. Zool.* 7: 135-140.

AOAC. 1995. *Official methods of Analysis.* 16th edn. Association of Official Analytical Chemists, Washington, DC., USA.

Bamji, M.S. 2011. Can a malnourished nation become a sporting nation? *Curr. Sci*. 101: 602-604.

Begum, M. and Minar, M.H. 2012. Comparative study about body composition of different sis, shell fish and ilish: commonly available in Bangladesh. *Trends in Fish Res*. 1: 38-42.

Bogard, J.R., Thilsted, S.H., Marks, G.C., Wahab, M.A., Hossain, M.A.R., Jakobsen, J. and Stangoulis, J. 2015. Nutrient composition of important fish species in Bangladesh and potential contribution to recommended nutrient intakes. *J. Food Comp. Analysis* 42: 120-133.

Boran, G. and Karacam, H. 2011. Seasonal changes in proximate composition of some fish species from black sea. *Turk J. Fish Aquatic Soc.* 11: 1-5.

Chakraborty, S., Brahma, B.K. and Goyal, A.K. 2015. Proximate composition of three Small indigenous fish species encountered in the local fish market of Kokrajhar, BTAD, Assam. *Indian J. Appl. Res.* 5: 712-714.

Chrisolite, B., Shanmugam, S.A. and Arumugam, S.S. 2015. Proximate and mineral composition of fifteen freshwater fishes of Toothukudi, Tamilnadu. *J. Aqua Tropics* 30: 33-43.

Dempson, I.B., Schwarz, C.J., Shears, M. and Furey, G. 2004. Comparative proximate body composition of Atlantic salmon with emphasis on part from fluvial and lacustrine habitats. *J. Fish Biol*. 64: 1257-1271.

Deka, K.B., Mahanta, R. and Goswani, U. 2012. Seasonal variation of protein and essential amino acid contents in *Labeo gonius* from Lotic and Lentic water bodies. *World J. Sci. Med. Res*. 2: 71.

FAO. 2008. *FAO Fisheries and Aquaculture- Chemical Elements of Fish.* http:// www.fao.org/fishery/topics/14820/en.

Hossain, Md. N., Afroz, H., Haque, Md. Z. and Begum, M. 2015. Evaluation of nutritional properties of small indigenous fish species in Bangladesh. *Int. J. Biosci.* 6: 102-109.

Jankowska, B., Zakes, Z., Zmijewski, T., Szczepkowski, M. and Kowalska, A. 2007. Slaughter yield, proximate composition and flesh colour of cultivated and wild perch *(Perca fluviatilis* L.). *Food Chem*. 118: 764-768.

Joseph, J., Perigreen, P.A., Surendran, P.K. and Gopakumar, K. 1990. I.I.F-I.I.R, Commission 2: 117, Aberdeen, U.K.

Louka, N., Juhel, V., Fazilleau, V. and Loonis, P. 2004. A novel colorimetry analysis used to compare different drying fish processes. *Food Control* 15: 327-334.

Mazumder, M.S.A., Rahman, M.M., Ahmed, A.T.A., Begum, M. and Hossain, M.A. 2008. Proximate composition of some small indigenous fish species (SIS) in Bangladesh. *Int. J. Sustainable Crop Prod*. 3: 18-23.

Mohanty, B.P., Ganguly, S., Mahanty, A., Mitra, T., Patra, S., Karunakaran, D., Mathew, S., Chakraborty, K., Paul, B.N., Sarma, D., Dayal, S., Singh, S. and Ayyappan, S. 2019. Fish in human health and nutrition. In: *Advances in Fish Research*. (B.P. Mohanty; ed.). Narendra Publishing House, Delhi, India. Vol: VII. pp 189-218.

Mohanty, B.P., Mahanty, A., Ganguly, S., Sankar, T.V., Chakraborty, K., Anandan, R., Paul, B.N., Sarma, D., Mathew, S., Asha, K.K., Behera, B.K., Afftabuddin, M., Debnath, D., Vijaygopal, P., Sridhar, N., Akhtar, M.S., Sahi, N., Mitra, T., Banerjee, S., Paria, P., Das, D., Das, P., Vijayan, K.K., Lamanan, P.T., Sharma, A.P. 2014. Amino acid composition of 27 Food fishes and their importance in clinical nutrition. *J. Amino Acid*. 1: 1-7. Doi.org/10.1155/2014/269797

Mridha, M.A., Lipi, S.Y., Narejo, N.T., Uddin, M.S., Kabir, M.S. and Karim, M. 2005. Determination of biochemical composition of *Cirrhinus reba* (Hamilton 1822) from Jessore, Bangladesh. *J. Sci. Technol. Univ. Peshawar*. 29: 1-5.

Pal, M. and Ghosh, M. 2013. Assay of biochemical composition of two Indian freshwater eel with special emphasis on accumulation of toxic heavy metals. *J. Aqua Food Product Technol.* 22: 27-35.

Paul, B.N., Bhowmick, S., Chanda, S., Sridhar, N., Saha, G.S. and Giri, S.S. 2018. Nutritional values of minor carps. *SAARC J. Agric*. 16: 215-231.

Paul, B.N., Chanda, S., Bhowmick, S., Sridhar, N., Saha, G.S. and Giri, S.S. 2017. Nutrient Profile of Indian Climbing Perch, *Anabas testudineus*. *SAARC J Agricult*. 15: 99-109.

Paul, B.N., Chanda, S., Sridhar, N., Saha, G.S. and Giri, S.S. 2016. Proximate, mineral and vitamin contents of Indian major carp. *Indian J. Anim Nutr*. 33: 102-107.

Paul, B.N., Chanda, S., Sridhar, N., Saha, G.S. and Giri, S.S. 2015. Proximate and mineral composition of Magur *(Clarias batrachus*) and Singhi *(Heteropneustes fossilis*). *Indian J. Anim Nutr*. 32: 453-456.

Paul, B.N., Chanda, S., Sridhar, N., Saha, G.S. and Giri, S.S. 2015a. Fatty acid profile of Indian major carp. *Indian J. Anim Nutr*. 32: 221-226.

Sankar, T.V. and Ramachandran, A. 2001. Changes in biochemical composition in Indian major carps in relation to size. *Fish Technol.* 38: 22-27.

Sankar, T.V., Susheela, M., Anandan, R., Asha, K.K., Mohanty, B.P. 2010. *Nutrient Profiling of Fish.* ICAR-Central Institute of Fisheries Technology, Handbook, Cochin, Kerala, India. pp 1-61.

Shakir, H.A., Qazi, J.I., Chaudhary, A.S., Hussain, A. and Ali, S. 2013. Nutritional comparison of three fish species co-cultured in an earthen pond. *Biologia.* 59: 353-356.

Sharma, P., Kumar, V., Sinha, A.K., Ranjan, J., Kithsiri, H.M.P. and Venkateshwarlu, G. 2009. Comparative fatty acid profiles of wild and farmed tropical freshwater fish rohu *(Labeo rohita*). *Fish Physiol. Biochem.* 36: 365-379.

Silva, J.J. and Chamul, R.S. 2000. Composition of marine and fresh water finfish and shellfish species and their products. In: *Marine and Fresh Water Handbook* (R.E Martin, E. Paine Carter, E.J. Flic and L.M.DaviS; eds.). Technomic Publishing Company Inc, USA. pp 31-46.

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods.* Oxford and IBH Publishing Company, Calcutta, India.

WHO. 2007. Protein and amino acid requirement in human nutrition: *Report of a Joint WHO/FAO/UNO Expert Consultation.* WHO Technical Report Series. World Health Organisation, Geneva, Switzerland.

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