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Nutritional composition of different size groups of catfish *Rita rita* (Hamilton, 1822) from river Ganga

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ABSTRACT

The freshwater catfish *Rita rita* (Hamilton, 1822) (Family: Bagridae) inhabits the tropical rivers and estuaries and contributes to the capture fisheries production in the Indian subcontinent. It enjoys high consumer preference as a valuable food fish due to its muscle texture, good taste and lesser intramuscular spines; however, basic nutritional information on the species is not available. In the present study, we report the proximate composition, amino acid, fatty acid and mineral composition of different size groups of *R. rita*. Proximate analysis showed that the fish is rich in protein and low in fat. The protein content (19.55%) was found to be the highest in medium size fishes. Leucine, phenylalanine and glutamic acid are the predominant amino acids in all size groups and leucine (18.67 g 100 g^{-1} protein) and glutamic acid (10.55 g 100 g^{-1} protein) contents were significantly high in medium size fishes. The macro-minerals potassium (13800 ppm) and phosphorous (14100 ppm) were significantly high in the medium size group, whereas calcium (1900 ppm) was highest in large size group. The micro-minerals iron and zinc were present in significantly higher amount in the medium size fishes. *R. rita* is important as a rich source of protein, essential amino acids (leucine, phenylalanine, glutamic acid) and micro elements (Zn, Fe). Comparative nutritional evaluation of different size groups showed that the medium size fish (weighing 500-800 g) were nutritionally superior to the other groups.

Keywords: Amino acids, Fatty acids, Minerals, Nutritional composition, *Rita rita*

Introduction

Rita rita, an important member of Bagridae family, contributing significantly to riverine fisheries in the Indian subcontinent (Noor *et al*., 2013), enjoys high consumer preference as a valuable food fish due to its muscle texture, good taste and lesser intramuscular spines. The meat quality and texture is mainly determined by factors such as muscle protein content, organisation and composition (Picard *et al*., 2012). Earlier, we generated information on muscle proteome profile and functional genomics aspects of this catfish and identified proteins in muscle proteome associated with muscle texture, flesh quality such as elasticity, firmness and water holding capacity, which could possibly be linked to its taste and high consumer preference (Mohanty *et al*., 2015). Fish is an important source of multiple nutrients including essential amino acids, fatty acids and micronutrients that are essential for human health and nutrition (Nguyen *et al*., 2004; Mohanty *et al*., 2014). Amino acids are important molecules that both serve as building blocks of proteins and regulate key metabolic pathways to improve health, survival, growth, development, lactation and reproduction of organisms (Wu, 2009; Mohanty *et al.,* 2014). Similarly, fatty acids play crucial role in maintaining health and cellular functions. Minerals are required in very trace amount; however, they are essential for maintaining proper homeostasis in the body like health, development, growth (Mahanty *et al*., 2014; Mohanty *et al*., 2016). As information on the nutrients in this species is meagre, in the present study we investigated the nutritional composition of the species and how it can contribute to nutritional security. As the taste, nutrition, muscle composition and quality of fish meat are known to vary with age and growth, comparative nutrient profiling of three different size groups of the species was undertaken.

Materials and methods

Sample collection

The fish were collected from river Ganga at Allahabad in post-monsoon period (August-September, 2014) and transported in ice to the laboratory. The individual length (cm) and weight (g) of the fishes were recorded. They were divided into three groups based on body weight and length as small (200-400 g, 20-30 cm), medium (500-800 g, 30-40 cm) and large (1200-1800 g, 40-45 cm).

Proximate composition

Fish were cleaned, degutted, edible muscles were filleted and stored at 40°C until analysis. The proximate composition (moisture, crude fat, crude protein and ash)

were determined as per standard protocol (AOAC, 2006). Fish fillets of small (n=10), medium (n=10) and large (n=10) size groups were homogenised with the help of a mixer grinder. The minced samples were kept in an oven at 105±2°C overnight until constant weight was obtained. The crude protein and crude fat contents were estimated by Kjeldahl and Soxhlet methods, respectively (AOAC, 2006). Ash was obtained after incineration of moisture free dry sample in a muffle furnace at 600°C for 6 h until weight became constant. The ash content was determined gravimetrically and expressed as percentage.

Amino acids

Amino acid composition was determined following standard protocol (Ishida *et al*., 1981) and has been described earlier (Mohanty *et al*., 2012). Briefly, 50 mg muscle samples of individual fishes from small, medium and large size category were hydrolysed with 6N hydrochloric acid at 110°C under anaerobic condition for 12 h. The hydrolysed samples were neutralised with 6N NaOH and were derivatised using a kit (AccQ-Fluor Reagent, WAT052880, Waters). The derivatised samples were injected in HPLC (1525, Waters) equipped with a C_{18} RP column and a fluorescence detector (2475, Waters) with excitation and emission wavelengths 250 nm and 395 nm, respectively. The amino acids were identified and quantified by comparing the retention times and peak areas of standards (WAT088122, Waters). For tryptophan analysis, 50 mg minced meat was digested with 5% (w/v) NaOH for 12 h and neutralised to pH 7.0 with 6N HCl. Tryptophan content was measured using spectrophotometer at 530 nm (Sastry and Tammuru, 1985).

Fatty acids

Total lipid of the fish was extracted following the standard protocol (Folch *et al*., 1957). Briefly, 30 g wet fish muscle was homogenised with 2:1 mixture of chloroform and methanol to extract the total lipid content of the tissue. Fatty acid methyl esters (FAMEs) were prepared by trans-esterification with boron trifluoride (BF_3) in methanol from lipid fraction according to standard protocol (Metcalfe *et al.,* 1966). The FAMEs were quantified by injecting 0.5 µl (30:1 split ratio) into GC-MS column, and identified using a GC (Trace GC Ultra, Thermo Scientific) equipped with a capillary column (TR FAME 30 m × 0.25 mm, 0.25 µm film thickness) and an MS attached to it. The individual constituents showed by GC–MS were identified and quantified by comparing the retention times and peak areas to those of standards (ME-14-KT and ME-19-KT, SUPELCO Analytical).

Minerals

Fish samples of different size groups were analysed in ICP spectrometer (iCAP 6300 Radial, Thermo Scientific) after digesting the samples using nitric acid and hydrogen peroxide in a microwave oven. Quantification was done by comparing with multi-element standard IV, MERCK (NIST) for sodium, potassium, calcium, magnesium, iron, copper, zinc and manganese and Trace Cert (NIST) for phosphorous.

Statistical analysis

Results were subjected to analysis of variance (ANOVA) using SPSS 16.0 software. Level of significance was established at 5% level.

Results and discussion

Proximate composition

The proximate composition of different size groups of *R. rita* are presented in Table 1. The average moisture, crude protein, crude fat and ash content of different size groups of fishes were estimated to be 79.09, 18.12, 1.78 and 1.00%, respectively. Protein content of *R. rita* ranged between 17.2-19.55%. Protein content of medium size (19.55%) group was comparatively higher than other size groups and Indian major carps (IMCs), *Labeo rohita* (12.84%) (Ahmed, 2011) and similar to *Cirrhinus mrigala* (19.10%) and *Catla catla* (19.60%) (Gopakumar, 1997). Average protein content of *R. rita* (18.12%) was higher than that of many other catfishes like *Mystus vittatus* (15.62%), *Clarias batrachus* (14.78%), *Wallago attu* (17.00%) and is similar to bagridae catfish *Sperata aor* (19.05%) (Kamal *et al*., 2007; Memon *et al*., 2010) and *Sperata seenghala* (20.06%) (Mohanty *et al*., 2012). Crude fat content was significantly higher in large size fish and fat content in all the three size groups were lower as compared to other catfishes such as *Heteropneustes fossilis* (3.45%), *C. batrachus* (7.90%), *M. vittatus* (7.53 %) and *L. rohita* (4.33%) (Ramani *et al*., 2002). However, ash content in different size groups of *R. rita* was similar to that of other members of the Bagridae family, *S. aor* (1.78%) (Kamal *et al*., 2007; Memon *et al*., 2010) and *S. seenghala* (1.40%) (Mohanty *et al*., 2012).

Amino acid composition

The amino acid profiles of different size groups of *R. rita* are presented in Table 2. The sum of total essential amino acid (∑EAA) was 53.96, 60.51 and 43.25 g 100 g^{-1} protein in small, medium and large size groups, respectively. EAA content was found to be the highest in medium size groups.

Among the amino acids in *R. rita*, essential amino acid leucine was the predominant one and it was present in significantly high amount in medium size fishes (18.67 g 100 g^{-1} protein). Leucine is the only dietary amino acid that can stimulate muscle protein synthesis and has important role in stress conditions like burn, trauma, and sepsis (Mohanty *et al.,* 2014). Leucine content of *R. rita* is more than double the amount as compared to other

Table 1. Proximate composition of different size groups of *Rita rita*

Proximate composition (%)	Size group			
	Small	Medium	Large	Average
Moisture	80.32±0.99[a]	77.76 ±0.06[ab]	79.19 ±0.52[a]	79.09±1. 28
Crude protein	17.59 ±1.02[a]	19.55 ±1.22[a]	17.22 ±0.60[a]	18.12±1.25
Crude fat	1.01 ±0.03[a]	1.65 ±0.08[b]	2.70 ±0.12[c]	1.78±0.85
Ash	1.07 ±0.08[a]	1.04 ±0.14[a]	0.89 ±0.06[a]	1.00±0.09

Values are presented as mean ± standard deviation
Different superscripts within a row correspond to significant difference ($p<0.05$)

Table 2. Amino acid composition of different size groups of *Rita rita*

Amino acids (g 100 g^{-1} protein)	Size group			
	Small	Medium	Large	Average
Essential amino acids (EAA)				
Arginine	6.50 ±0.47[a]	4.58 ±0.73[b]	1.88 ±0.07[c]	4.30±2.20
Histidine	5.38 ±0.43[a]	5.69 ±1.50[a]	1.14 ±0.30[b]	4.02±2.51
Isoleucine	6.42 ±0.17[a]	2.49 ±0.21[b]	6.87 ±0.60[a]	4.66±2.07
Leucine	14.66±2.87[a]	18.67 ±0.22[b]	14.62±1.34[a]	17.06±2.15
Lysine	3.53 ±0.38[a]	8.51 ±0.05[b]	1.13 ±0.26[c]	4.38±3.77
Threonine	3.84 ±0.96[a]	5.64 ±0.22[b]	1.59 ±0.28[a]	3.91±1.70
Methionine	4.99 ±3.21[a]	6.85 ±0.03[a]	5.32 ±0.46[a]	4.62±2.65
Phenylalanine	9.65±0.81[a]	9.16 ±0.66[a]	9.77 ±0.61[a]	9.41±0.32
*Tryptophan	0.06 ±0.01[a]	0.06 ±0.01[a]	0.07 ±0.01[a]	0.06±0.00
Tyrosine	1.76 ±0.34[a]	2.03 ±0.30[a]	2.33 ±0.48[a]	2.07±0.24
Valine	5.43 ±1.49[a]	3.44 ±0.05[b]	2.74 ±0.29[b]	4.41±2.30
Cysteine	0.56 ±0.52[a]	0.45 ±0.69[a]	0.65 ±0.10[a]	0.57±0.10
Glutamic acid[1]	6.19 ±0.15[a]	10.55 ±0.21[b]	1.90 ±0.60[c]	6.18±4.32
Glycine[1]	5.35 ±2.39[a]	6.40 ±2.48[a]	4.93 ±0.19[a]	5.41±0.85
Proline[1]	1.73 ±0.27[a]	1.86 ±10.58[a]	0.25 ±0.25[b]	1.27±0.89
∑EAA	72.15	86.32	55.12	72.26
Non-essential amino acids (EAA)				
Alanine	4.26 ±0.10[a]	6.62 ±0.06[b]	6.61 ±0.21[b]	5.83±1.36
Aspartic acid	1.46±0.43[a]	4.61 ±0.85[b]	2.76 ±0.43[c]	2.94±1.58
Serine	1.93 ±0.17[a]	0.97 ±0.06[b]	1.59 ±0.41[a]	1.49±0.48
∑NEAA	7.65	12.20	10.97	10.27

Values are presented as mean ± standard deviation
Different superscripts within a row correspond to significant difference ($p<0.05$)
* Tryptophan content was measured using spectrophotometer at 530 nm.
EAA- essential amino acid as per human nutrition (Wu, 2009)
NEAA- non-essential amino acid (Wu, 2009)
[1]Conditionally essential amino acids (Wu, 2009)

freshwater catfishes like *S. seenghala* (0.7 g 100 g^{-1} protein), *H. fossilis* (8.2 g 100 g^{-1} protein) and *C. batrachus* (8.1 g 100 g^{-1} protein) and IMCs *C. catla* (7.7 g 100 g^{-1} protein), *L. rohita* (9.0 g 100 g^{-1} protein) and *C. mrigala* (8.4 g 100 g^{-1} protein). Phenylalanine was found to be the predominant amino acid followed by leucine. Phenylalanine content of *R. rita* were higher than *S. seenghala* (0.4 g 100 g^{-1} protein), *H. fossilis* (6.2 g 100 g^{-1} protein) and *C. batrachus* (3.7 g 100 g^{-1} protein). *R. rita* was found to contain fair amount of glutamic acid irrespective of its size variation which was higher than giant catfish *S. seenghala* (1.6 g 100 g^{-1} protein) but lower than IMCs *C. catla* (13.8 g 100 g^{-1} protein), *L. rohita* (14.6 g 100 g^{-1} protein), *C. mrigala* (14.8 g 100 g^{-1} protein) and freshwater catfishes *H. fossilis* (16.0 g 100 g^{-1} protein), and *C. batrachus* (14.5 g 100 g^{-1} protein) (Mohanty *et al*., 2014). A comparative view of leucine and phenylalanine content in *R. rita* as compared to other major catfishes and IMCs are shown in Fig. 1. Among non-essential amino

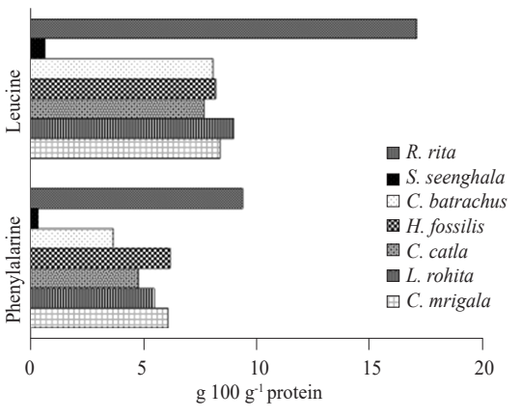


Fig. 1. Comparison of essential amino acids (leucine and phenylalanine) content of *Rita rita* with other catfishes (*S. seenghala, H. fossilis, C. batrachus*) and the Indian major carps *C. catla, L. rohita* and *C. mrigala*. For comparison, average of leucine and phenylalanine content of three size groups of *R. rita* has been used. Data for *S. seenghala, H. fossilis, C. batrachus* and the Indian major carps *C. catla, L. rohita* and *C. mrigala* has been taken from Mohanty *et al*., (2014)

acids, alanine and aspartic acid were the dominant amino acids in *R. rita*. In an earlier study, we reported the amino acid composition of 27 food fishes from India, discussed the richness of specific species for different amino acids and their importance in clinical nutrition (Mohanty *et al*., 2014). The present investigation adds further to the list, strengthening the knowledge base and based on the amino acid profile of *R. rita*, the fish can be recommended in clinical conditions related to leucine and phenylalanine requirement such as burn trauma and sepsis (Etzel, 2004; Bandt and Cynober, 2006).

Fatty acid composition

The fatty acid composition of different size groups of *R. rita* are presented in Table 3. GC-MS fingerprint of fatty acid profile shows that the sum of total saturated fatty acid (∑SFA) content in small, medium and large size fishes were 20.82, 26.59 and 24.05% respectively SFA content was lower in small fishes. Monounsaturated fatty acid (MUFA) was found to increase with size of fish (small 41.91%, medium 47.52% and large 49.37%). Total polyunsaturated fatty acid (PUFA) distribution was highest in small fishes (12.1%).

Among SFA, palmitic acid (C16:0) was found to be the dominant (11.02%) as in other catfishes like the channel catfish *Ictalurus punctatus* (19.2%), *Pangasianodon hypophthalmus* (42.63%) (Ho and Paul 2009), *S. seenghala* (21.10%) (Mohanty *et al*., 2012) and rainbow trout (*Oncorhynchus mykiss*) (21.3%) (Ho and Paul, 2009). Oleic acid (C18:1) was found to be the major MUFAs; however, it was found to be lower in *R. rita* as compared to other catfishes like *S. seenghala* (28.36%) (Mohanty *et al*., 2012) and *P. hypophthalmus* (34.69%) (Ho and Paul, 2009). The level of docosahexaenoic acid (DHA) (C22:6) was 3.97%, which was the highest among all PUFAs, followed by eicosapentaenoic acid (EPA) (C20:5), and arachidonic acid (C20:4). The amount of EPA and DHA was 7.90%. which was less than the catfish *S. seenghala* (10.56%) (Mohanty *et al*., 2012) and small indigenous fish *Puntius sophore* (9.47%) (Mahanty *et al*., 2014).

Mineral content

Minerals are required in very trace amount; but, they are vital for maintaining proper homeostasis in the body. Minerals that were detected in *R. rita* are sodium (Na), potassium (K), calcium (Ca), magnesium (Mn), phosphorous (P) (macro minerals) as well as iron (Fe), zinc (Zn) and manganese (Mg) (micro minerals). The mineral profiles of *R. rita* are presented in Table 4.

The mineral contents were found to vary significantly ($p<0.05$) in different size groups of the fish, except for Mg. The sodium, potassium, phosphorous and zinc contents were higher in medium size group than the other size groups whereas calcium and iron contents were higher in large and small size groups, respectively. Among the macro-minerals, potassium was predominant followed by phosphorous, sodium, calcium and magnesium. Potassium content in all the three size groups of *R. rita* was higher than other catfishes *viz*., *S. seenghala* (13780.01 ppm) (Mohanty *et al.,* 2012), *H. fossilis* (1864.67 ppm) and *C. batrachus* (2621.04 ppm) (Mohanty *et al*., 2016) and almost two times higher than that of the nutrient dense small indigenous fish, *P. sophore* (2283.7 ppm) (Mahanty *et al*., 2014). Similarly, phosphorus content was almost ten times higher in *R. rita* (13333.0 ppm) than other catfishes, *C. batrachus* (1300.59 ppm) and *H. fossilis* (1070.09 ppm) (Noor *et al*., 2013). Sodium content was also significantly high in medium size fishes like potassium. Average sodium content was higher in *R. rita* (2700 ppm) than other catfishes, *S. seenghala* (1983.11 ppm), *H. fossilis* (2040.38 ppm) and *C. batrachus* (2080.00 ppm) (Mohanty *et al*., 2016). Calcium content was significantly high in large fishes (1900.00 ppm) and it was higher than Indian major carp *L. rohita* (862.8 ppm) but lower in comparison to *S. seenghala* (4581.15 ppm) (Mohanty *et al.,* 2012), *H. fossilis* (1950.35 ppm) and *C. batrachus* (2250.75 ppm) (Gopakumar, 1997; Mohanty *et al*., 2016).

Iron was found to be the predominant micro-mineral in *R. rita* and was higher than in *S. seenghala* (45.1 ppm), *C. batrachus* (18.9 ppm) and *H. fossilis* (27.1 ppm) and the Indian major carps (IMCs), *C. catla* (16 ppm), *L. rohita* (22 ppm) and *C. mrigala* (3 ppm) (Ho and Paul, 2009) irrespective of its size variation. Thus, *R. rita* can be recommended as a dietary supplement in clinical conditions related to iron deficiency such as anaemia, impaired brain function and in infants suffering from poor learning ability

Table 3. Fatty acid composition of different size groups of *Rita rita*

Fatty acids (% of total area)	Small	Medium	Large	Average
Saturated fatty acids (SFA)				
Caproic (C6:0)	0.14±0.03^{a}	1.09±0.15^{b}	1.30±0.20^{b}	0.84±0.62
Caprylic (C8:0)	0.06±0.02^{a}	0.29±0.03^{b}	0.01±0.00^{c}	0.12±0.15
Pelargonic (C9:0)	0.29±0.04^{a}	1.65±0.15^{b}	0.51±0.18^{a}	0.82±0.73
Capric (C10:0)	0.15±0.08^{a}	0.68±0.06^{b}	0.17±0.10^{a}	0.33±0.30
Undecylic (C11:0)	0.62±0.05^{a}	1.07±0.20^{b}	0.74±0.10^{a}	0.81±0.23
Lauric (C12:0)	3.64±0.58^{a}	2.69±0.37^{b}	1.37±0.10^{c}	2.57±1.14
Tridecylic (C13:0)	0.34±0.07^{b}	0.19±0.02^{a}	0.16±0.03^{a}	0.23±0.10
Myristic (C14:0)	0.56±0.15^{a}	0.88±0.06^{b}	0.92±0.15^{b}	0.79±0.20
Pentadecylic (C15:0)	0.19±0.01^{b}	0.17±0.02^{a}	0.20±0.01^{b}	0.19±0.02
Palmitic(C16:0)	9.24±0.35^{a}	11.51±0.20^{b}	12.32±0.56^{b}	11.02±1.60
Margaric (C17:0)	0.45±0.04^{b}	0.29±0.02^{a}	0.35±0.04^{a}	0.36±0.08
Stearic (C18:0)	3.80±0.14^{a}	4.01±0.31^{a}	4.07±0.15^{a}	3.96±0.14
Nonadecylic (C19:0)	0.01±0.00^{a}	0.04±0.01^{ab}	0.13±0.09^{b}	0.06±0.06
Arachidic (C20:0)	0.02±0.01^{a}	0.01±0.00^{a}	0.01±0.00^{a}	0.01±0.00
Heneicosylic (C21:0)	0.14±0.17^{a}	0.14±0.18^{a}	0.35±0.24^{a}	0.21±0.12
Behenic (C22:0)	0.42±0.32^{a}	1.18±0.35^{ab}	0.79±0.09^{b}	0.80±0.38
Tricosylic (C23:0)	0.40±0.06^{a}	0.23±0.16^{a}	0.36±0.03^{a}	0.33±0.09
Lignoceric(C24:0)	0.35±0.25^{a}	0.48±0.08^{a}	0.29±0.18^{a}	0.37±0.10
ΣSFA	20.82	26.59	24.05	23.82
Monounsaturated fatty acids (MUFAs)				
Palmitoleic (C16:1)	4.25±0.14^{b}	4.54 ±0.07^{b}	2.90±0.14^{a}	3.90±0.88
Oleic (C18:1)	25.23±0.31^{b}	26.32±0.61^{a}	28.13±0.54^{b}	26.56±1.46
Nonadecylenic(C19:1)	10.24±0.77^{b}	14.44±0.61^{a}	15.85±0.12^{a}	13.51±2.92
Paullinic(C20:1)	2.18±0.25^{a}	2.21±0.09^{a}	2.49±0.15^{a}	2.29±0.17
ΣMUFA	41.91	47.52	49.37	46.27
Polyunsaturated fatty acids (PUFAs)				
Linoleic (C18:2 n-6)	0.64±0.07^{a}	0.37±0.22^{b}	1.34±0.09^{c}	0.78±0.50
γ-Linolenic (C18:3 n-3)	0.80±0.05^{a}	0.50±0.04^{b}	0.36±0.04^{c}	0.55±0.22
Arachidonic(C20:4 n-6)	1.87±0.23^{a}	1.24±0.04^{b}	2.66±0.20^{c}	1.92±0.71
Eicosapentaenoic (C20:5 n-3)	3.52±0.44^{a}	2.65±0.46^{b}	1.56±0.25^{c}	2.58±0.99
Docosahexaenoic (C22:6 n-3)	5.27±0.83^{b}	4.02±0.47^{a}	3.97±0.04^{a}	4.42±0.73
ΣPUFA	12.1	8.78	9.88	10.25
Σω-3	10.28±0.39	6.83±0.22	6.18±0.79	7.76±2.20
Σω-6	2.55±0.12	1.27±0.13	3.85±0.02	2.56±1.29
ω-3: ω-6	2.71±0.24	2.70±1.79	1.32±0.23	2.24±0.80
EPA+DHA	9.63±0.11	6.28±0.14	5.35±0.35	7.09±2.25

Values are presented as mean ± standard deviation
Different superscripts within a row correspond to significant difference ($p<0.05$)

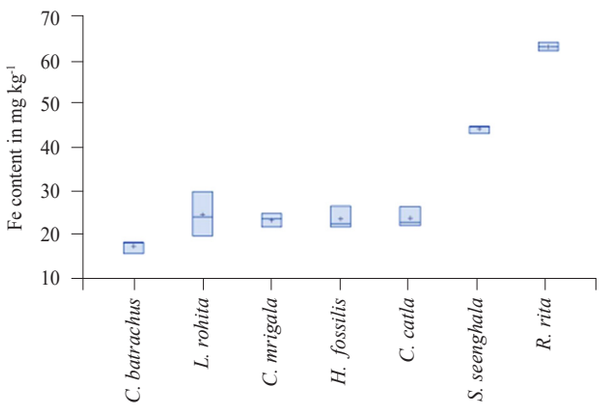
and poor behaviour. Zinc is an important micro-mineral required for growth and development as well as for the proper functioning of immune system, cell growth and healthy skin and also acts as a co-factor for many enzymes required in metabolism. Zinc content of medium and large size groups were higher than the small size group. Similar to iron, zinc content was also high in *R. rita* (37.52 ppm) than *S. seenghala* (29.4 ppm), *C. batrachus* (12.9 ppm), *H. fossilis* (13.0 ppm), IMCs *C. catla* (13.0 ppm), *L. rohita* (19.0 ppm) and *C. mrigala* (3.0 ppm) (Noor *et al*., 2013) but lower than small indigenous fish *P. sophore* (51.1 ppm) (Mahanty *et al*., 2014). Manganese content was higher than *S. seenghala* (2.36 ppm). Comparative micro mineral (Fe, Zn) content in different catfishes and IMCs is presented in Fig. 2 a, b.

Although the nutritional composition of fish varies with size, sex and season, only size variation was considered for the study. Seasonal variation was not studied as fish in sufficient quantity was not available in different seasons of a year. Similarly, sex variation was also not included in the present study, as sex is of very little concern for the consumers. However, based on nutritional composition

Table 4. Mineral composition of different size groups of *Rita rita*

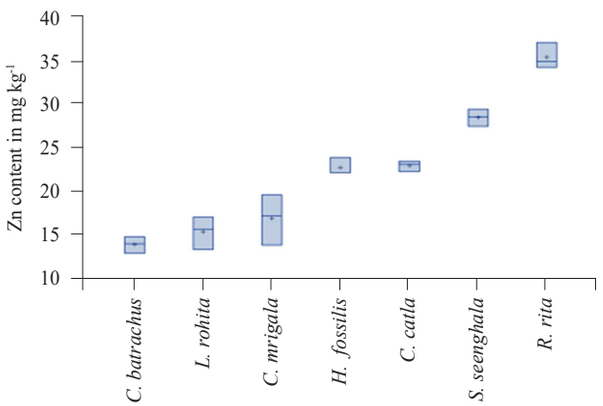
Size group	Small	Medium	Large	Average
Marco minerals				
Na	2800 ±5.00 [a]	3100 ±7.51 [b]	2200 ±9.02 [c]	2700.00±458.26
K	15900 ±2.00 [a]	17200 ±3.06 [b]	13800±1.00 [c]	15633.33±1715.61
Ca	1100 ±1.53 [a]	1200 ±1.53 [b]	1900 ±2.65 [c]	1400.00±435.89
Mg	1300 ±1.53 [a]	1300 ±2.65 [a]	1300 ±0.58 [a]	1300.00±0.00
P	14000 ±1.00 [a]	14100 ±5.13 [b]	11900±1.53 [c]	13333.33±1242.31
Micro minerals				
Fe	67.15 ±1.00 [a]	63.82 ±0.87 [b]	61.81 ±0.54 [c]	64.26±2.70
Zn	33.07 ±1.24 [a]	42.25 ±0.50 [b]	37.25 ±0.38 [c]	37.52±4.60
Mn	ND	6.26 ±0.28 [a]	7.05 ±0.14 [a]	6.66±0.56

Values are presented as mean ± standard deviation. Different superscripts within a row correspond to significant difference ($p<0.05$)
ND : Not detected



(a)

Fig. 2(a) Comparison of micro minerals (Fe) content of *Rita rita* with other catfishes (*S. seenghala, H. fossilis, C. batrachus,* IMCs *C. catla, L. rohita* and *C. mrigala*. For comparison, average leucine and phenylalanine content of three size groups of *R. rita* has been used. Data for *S. seenghala, H. fossilis, C. batrachus* and IMCs *C. catla, L. rohita* and *C. mrigala* have been taken from Mohanty *et al.* (2016).



(b)

Fig. 2b. Comparison of micro minerals (Zn) content of *Rita rita* with other catfishes (*S. seenghala, H. fossilis, C. batrachus)* and Indian major carps *C. catla, L. rohita* and *C. mrigala*.
[†]For comparison, average leucine and phenylalanine content of three size groups of *R. rita* have been used [††] Data for *S. seenghala, H. fossilis, C. batrachus* and the IMCs carps *C. catla, L. rohita* and *C. mrigala* have been taken from Mohanty *et al.,* (2016)

of *R. rita*, it can be concluded that high protein and low fat makes this species a good source of lean meat. It is also a good source of important amino acids like leucine, phenylalanine and glutamic acid and minerals potassium, phosphorous, iron and zinc. Reports indicate that there has been constant decline in the population of the fish both in India and neighbouring countries like Bangladesh. Fishing of juveniles and degradation of breeding grounds have been reported to be the major reasons for the decline (Noor *et al*., 2013). Special attention is necessary to revive and stabilise the population. The present study shows that the medium size fish is nutritionally superior than the small size group in terms of protein, amino acid and mineral content and provides scientific basis to educate stakeholders about the necessity to conserve the juveniles.

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