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Nutritional Quality Assessment of Small Indigenous Fish Species (SIS) from the Mathabhanga River in Bangladesh

Md. Aslam Khan[1], Md. Anwar Hossain[2], Mona Ashis Chowdhury[3], Nahid Sultana[4*], Mohajira Begum[5], M Nazrul Islam[1]

[1] Department of Zoology, University of Rajshahi, Rajshahi-6205, Bangladesh
[2] Department of Biotechnology and Genetic Engineering, Noakhali Science and Technology University, Noakhali-3814, Bangladesh
[3] Fish seed multiplication Farm, Naogaon Sadar, Naogaon-6500, Bangladesh
[4] Department of Fisheries and Marine Science, Noakhali Science and Technology University, Noakhali-3814, Bangladesh
[5] Applied Zoology Research Division, BCSIR Laboratories Rajshahi, Bangladesh Council of Scientific and Industrial Research, Rajshahi-6205, Bangladesh

[*] **Corresponding Author: nahid.nstu22@gmail.com**

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ABSTRACT

Fish provide an affordable and readily available source of animal protein for human consumption that plays a vital role in maintaining the livelihoods of Bangladeshi people. The study was conducted to evaluate the proximate composition of five different small indigenous fish species (SIS): *viz.*, *Glossogobius giuris*, *Mastacembelus pancalus*, *Mystus tengra*, *Heteropneustes fossilis*, and *Puntius ticto*. The samples were collected from the Mathabhanga River. The proximate composition of the studied samples revealed varying proportions of moisture content (68.60 to 79.05%), crude protein (46.22 to 65.99%), crude fat (4.77 to 22.93%), ash content (12.03 to 19.22%), carbohydrate (11.22 to 15.73%), crude fiber (0.09 to 0.25%), whereas the energy value was 374.04 to 444.91Kcal/ 100g. Among the examined fish species, *Glossogobius giuris* contained significantly ($P<$ 0.5) higher level of protein content but less amount of lipid content. Addittionally, *Puntius ticto* showed significantly ($P<$ 0.05) higher lipid, ash and energy contents as compared to others. The results of the study clearly revealed that *Glossogobius giuris* and *Puntius ticto* fish species are rich in macronutrients in alliance with the tested fish species. Hence, the research findings suggest that commonly consumed small indigenous fish species (SIS) offer a valuable source of high-quality protein and essential macronutrients. This implies that the consumption of these fish can help alleviate protein and other nutrient deficiency, as well as livelihood security in Bangladesh. Further biochemical and molecular research can be conducted to analyze all the essential nutrients and genetic improvement of the fish.

INTRODUCTION

Bangladesh, among South Asian countries, is abundant in water resources, featuring a multitude of rivers and water bodies across its terrain. These rivers play a crucial role in supporting the livelihoods of a majority of people by supplying fish and shellfish, which form a significant part of daily diet **(Shamsuzzaman *et al.*, 2020)**. Among the rivers in Bangladesh, the Mathabhanga River is a trans-boundary river between Bangladesh and India located in the southwestern part, having particular importance due to its rich diversity of fish and shellfish species. According to FAO's report, Bangladesh achieved the third position in terms of inland open-water capture production and secured the fifth position in global aquaculture production, with a total production of 47.59 lakh MT in FY 2021- 22 **(DoF, 2022)**.

Fish are considered as a highly nutritious food, offering quality animal proteins at a relatively low cost with their availability and affordability tending to be better in comparison to other animal protein sources. Within the fish small indigenous fish species (SIS) that reach sizes ranging from 25 to 30cm during their mature or adult life stage **(Lin *et al.*, 2020)**. They offer better nutrition as they are commonly consumed as a whole, incorporating the head, bones, and eyes, thereby utilizing all the accessible nutrients, including micronutrients **(Islam *et al*., 2023)**. In Bangladesh, each individual consumes roughly 63g of fish daily as a part of their nutritional intake, owing to the high population density **(DoF, 2020)**. Nevertheless, the population in the country primarily derives the majority of their animal-based protein from fish, accounting for around 60% of the total consumption at 18.1kg per person per year **(Belton *et al*., 2014)**. As fish serve as a crucial supplier of protein and vital nutrients, fish also act as a dietary staple food in Bangladesh. Furthermore, the fishing industry offers employment prospects to millions of Bangladeshis, enhancing livelihoods and alleviating poverty, as well as contributing to the national economy through the export of fish and various fish food products **(Shamsuzzaman *et al*., 2020)**.

Fish are a life-giving source of essential nutrients, particularly high quality proteins and fats (macronutrients), along with numerous vitamins and minerals (micronutrients), which play a crucial role in enhancing global food and nutrition security **(FAO, 2020)**. Fish proteins are used to strengthen the immune system, improving blood quality, and repairing muscle tissues. They can also be employed to combat protein-calorie malnutrition (PCM) in animals **(Lees & Carson, 2020)**. Fish contain a wide range of micronutrients, including calcium (Ca), iron (Fe), zinc (Zn), selenium (Se), iodine (I), phosphorus (P), and potassium (K), among others **(Marques *et al*., 2019)**. The consumption of small fish along with their bones increases the intake of calcium, phosphorus, and fluorine, as opposed to discarding the fish bones. However, the nutritional content of fish can vary substantially depending on various factors, such as species, size, gender, dietary habits, season, and the level of physical activity **(Ali *et al*., 2006; Fawole *et al*., 2007)**.

The small indigenous fish species (SIS) are frequently eaten in Bangladesh which are rich in vital nutrients, such as vitamin A, calcium, iron, and zinc. These nutrients play a critical role in bolstering the body's immune system and enhancing its ability to resist diseases **(Hasan *et al*., 2012)**. Hence, a better understanding of a product's nutritional content and food quality is essential to ensure the proper utilization of the product.

The reason for selecting the Mathabhanga River in Chuadanga district as the focus of the research study was driven by its rich diversity of fish and shellfish species, its ecological significance, and its substantial contribution to the local fisheries sector. The people in this area rely totally on the resources of the river for their livelihoods, catching fish and shellfish to meet the demand of their daily dietary needs. Surprisingly, despite its importance, no prior study has investigated the fish species within the river. From public health standpoint, comprehending the nutritional compositions of the frequently consumed fish species from the Mathabhanga River becomes pivotal.

The main objective of this study was conducting a comprehensive analysis of the proximate composition of several important freshwater fish species commonly found in the Mathabhanga River of Bangladesh. Through laboratory analyses, we also aimed to determine the composition (%) of various nutrients in these fish species, offering valuable insights into their nutritional significance.

The outcome of the research aids in improving our understanding of the nutritional value of locally available fish species, which can help in devising effective strategies to enhance food security and protein consumption in the region. Moreover, the findings also serve as a valuable resource for policymakers, scientists, researchers, nutritionists, and public health officials, enabling them to make informed decisions regarding the promotion of healthy diets, nutritional security, and poverty alleviation in Bangladesh.

MATERIALS AND METHODS

1. Sample collection

The chosen set of five experimental fish species were procured from diverse local markets and fish landing spots along the Mathabhanga River (Latitude 23˚24ˈ to 24˚04ˈ N and Longitude 88˚76ˈ to 90˚36ˈ E.) at Chuadanga district, Bangladesh (Fig. 1). These specimens, locally known as Bele, Pancal, Tengra, Shing and Puti, were collected as fresh condition and stored within a sterile zipper polythene bag, and subsequently placed in an icebox. Immediately, the samples were transported in an icebox to the laboratories of the Bangladesh Council of Science and Industrial Research (BCSIR), Rajshahi. The specimens were maintained in a -20°C refrigerator until being ready for analysis.

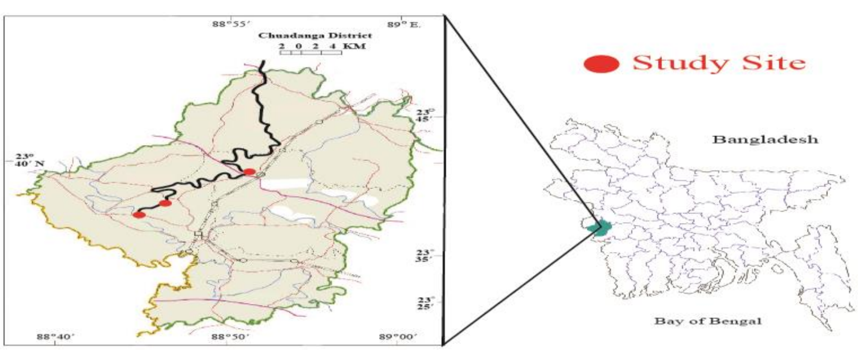

Fig. 1. Map of the study area and locations of the study sites

2. Sample preparation

The fish samples were prepared for nutritional value assessment in triplicate fashion at the laboratories of BCSIR at Rajshahi, Bangladesh. The resultant average values were recorded for each scrutinized parameter. The frozen samples were initially kept at room temperature before being subjected to wash with deionized water at least three times for elimination of impurities from the exterior of the fish bodies. Subsequently, the samples were oven dried overnight at a temperature of 105°C, and then grinding with a mortar and pestle, and stored at -4°C for subsequent assessment. The scientific names of the fish are listed in Table (1).

Table 1. Identification of fish samples and anatomical parts prior to analysis

Local name	Scientific name	Average body length (cm)	Average body weight (g)	Anatomical parts analysis
Bele fish	*Glossogobius giuris*	11.06±0.97	11.8±2.81	Flesh and bone
Pancal fish	*Mastacembelus pancalus*	8.51±0.94	2.2±0.86	Whole fish
Tengra fish	*Mystus vittatus*	12.25±1.42	13.33±4.64	Flesh and bone
Shing fish	*Heteropneustes fossilis*	9.25±1.31	4.53±2.03	Flesh and bone
Puti fish	*Puntius ticto*	6.13±0.67	3.47±1.06	Whole fish

Here, N= 75 fish individuals.

*Data are represented as Mean± Standard deviation (SD) at significant level $P< 0.05$.

3. Biochemical analysis of fish

Consistent with established procedure **(AOAC, 1970)** and previous research **(Ferdousi *et al*., 2022)**, the levels of proximate composition (moisture, ash, crude protein, crude fat, carbohydrate, energetic value) were analyzed using the grinded powder sample. Furthermore, each parameter was succinctly explained as follows: the unprocessed samples were subjected to drying in an oven at 105°C until a consistent weight loss was attained to determine the moisture content of the processed sample. The protein content was determined through the micro-Kjeldahl method. The quantity of crude protein was calculated by multiplying the total nitrogen measurement by 6.25, which serves as the conversion factor. The crude fat was assessed using the Soxhlet extraction method. The ash content was ascertained by incinerating the samples at 600°C for 6 hours in a muffle furnace (JSMF-45HT, South Korea). The moisture, protein, fat, ash, and carbohydrate levels were all expressed as percentage (%). The energy values of the samples were calculated based on the caloric content of carbohydrate, protein, fat and expressed as kilocalories per 100 grams (Kcal/ 100g).

4. Data analysis

The result was presented as mean ± standard deviation which was obtained from the average of three replications. A one-way ANOVA was used to determine the differences between species, with a significance level of $P < 0.05$. The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (SPSS Inc., Chicago, IL, USA), as well as Microsoft Excel version 2013.

RESULTS

Fish are the most commercially valuable species in Bangladesh. Small indigenous fish species (SIS) play a crucial role in providing nutrition for numerous communities in the world. These small fishes are often overlooked when considering protein sources, even though they provide a vital source of nutrition for the people living in poverty level. The proximate composition of the studied five fish species are presented in Table (2).

The main components of fish muscle were moisture. In the context of the present investigation, it was found that, the moisture content values of the fish species (*G. giuris*, *M. pancalus*, *M. tengra*, *H. fossilis* and *P. ticto)* in the Mathabhanga River were 77.75± 1.55, 76.10± 0.04, 73.89± 0.49, 79.05± 0.20, and 68.63± 0.00%, respectively (Table 2). Among the species, *H. fossilis* exhibited the highest moisture content at 79.05± 0.20%, while *P. ticto* displayed the lowest moisture content at 68.63± 0.00%, and both were significantly ($P < 0.05$) different as compared to other species.

Table 2. Proximate composition (% on dry weight basis) of the selected fish species

Name of Fish species	Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)	Carbohydrate (%)	Crude fiber (%)	Energy (Kcal/100gm)
G. giuris	77.75±1.55	65.99±0.31	4.77±0.21	14.49±0.07	14.64±0.03	0.09±0.01	374.04±0.72
M. pancalus	76.10±0.04	59.81±0.51	14.91±0.03	12.03±0.06	13.06±0.59	0.20±0.00	434.41±0.08
M. tengra	73.89±0.49	54.53±0.52	13.98±1.50	15.55±0.06	15.73±1.02	0.21±0.04	415.27±7.36
H. fossilis	79.05±0.20	62.66±0.31	8.05±0.30	14.82±0.03	14.38±0.56	0.09±0.01	389.11±1.64
P. ticto	68.63±0.00	46.22±0.26	22.93±0.57	19.27±0.05	11.28±0.29	0.25±0.04	444.91±2.91

Here, N= 75 fish individuals.
*Data are represented as Mean± Standard deviation (SD) at a significant level $P < 0.05$.

In the current study, the protein content of the fish species were examined in the Mathabhanga River with a range of 46.22± 0.26 to 65.99± 0.31% (Table 2). The highest crude protein was found in *G. giuris* at 65.99± 0.31%, whereas the lowest was recorded in *P. ticto* at 46.22± 0.26% which was significantly (*P*< 0.05) different as compared to others. In case of fat content, there was variation, ranging from 4.77 to 22.93% (Table 2). The highest fat content was recorded in *P. ticto* at 22.93± 0.57%, while the lowest was in *G. giuris* at 4.77± 0.21%, and both were significantly (*P*< 0.05) different from other species.

The ash component plays a crucial role in the formation of body structure of fish species. In the Mathabhanga River, the results of the studied species, *P. ticto* showed the highest ash content at 19.27± 0.05%, whereas *M. pancalus* had the lowest at 12.03± 0.06%. Both values significantly differed *(P*< 0.05) from the other species (Table 2).

The carbohydrate content of fish is important as an organic food since it serves as the major source of energy generation in the body. The carbohydrate content of the examined fish of the Mathabhanga River varied from 11.28± 0.29 to 15.73± 1.02% (Table 2). The highest values of carbohydrate contents were estimated in *M. tengra* at 15.73± 1.02% and the lowest values were in *P. ticto* at 11.28± 0.29%, both significantly (*P*< 0.05) differing from other species.

The amount of crude fiber in the examined fish was very low and it varied from 0.09± 0.01 to 0.25±0.04% (Table 2). In this study, we found that the energy content of Mathabhanga river species varied among the examined species, ranging from 374.04± 0.72 to 444.91± 2.91kcal/ 100g, as shown in Table (2). The highest values of energy was recorded in *P. ticto.*

The findings of the study recorded slight differences in the nutrient composition among fish species in the Mathabhanga River. These variations could stem from factors like food quality, fish size, life cycle stage, water quality, and laboratory processes. However, it is essential to recognize that this study didn't delve into these variations due to its limited scope. Additionally, it is crucial to note that this research exclusively examined the proximate composition and didn't assess the environmental contaminants. Hence, further research is necessary to comprehensively investigate these factors and evaluate the potential health risks linked to consuming fish from the Mathabhanga River.

DISCUSSION

This study focused on analyzing the proximate composition profile of frequently consumed fish species from the Mathabhanga River in the southwestern part of Bangladesh. The rationale for selecting the Mathabhanga River as the primary research area stems from several key factors. Firstly, the Mathabhanga River holds a significant importance in Bangladesh due to its ecological differences and its substantial contribution to the local fishing industry. Secondly, by concentrating on this river, the research was aimed to capture the variations in environmental conditions specific to the region, which can potentially affect the nutritional composition of aquatic organisms. Variables such as water quality, pollution levels, and habitat characteristics may diverge across different river systems. Therefore, studying the Mathabhanga River offers a localized understanding of how these factors influence the nutritional profiles of fish and shellfish. Moreover, the Mathabhanga River possesses distinctive environmental characteristics and is subjected to a wide range of human activities, including agricultural runoff, industrial pollution, and fishing practices. These activities have an impact on the water quality and habitat conditions of the river. Analyzing the biochemical parameters of the experimental fish provide insights into the potential effect of these environmental factors on the nutritional content of aquatic organisms. Furthermore, the choice of this specific location enables a targeted investigation into the local fish consumption patterns and dietary habits in Chuadanga district, Bangladesh. This research study offers valuable information for public health initiatives, dietary guidelines, and interventions aimed at enhancing the nutritional status and food security of the local, as well as national communities of Bangladesh.

As demonstrated in Table (2), the moisture content of the Mathabhanga River species varied across the studied species, ranging from 68.63 to 79.05%. These results are compatible with the finding of moisture content of freshwater fish and shellfish of River Tista and Baral ranging from 62.79 to 82.18% **(Ferdousi *et al*., 2023)**. Six species of SIS fish displayed varying moisture contents between 72.97 and 76.35% **(Nurullah *et al*., 2003)**, while *A. testudineus*, *P. sophore*, *M. pancalus*, and *A. mola* exhibited moisture contents of 70.50, 73.20, 76.70, and 75.60%, respectively **(Bogard *et al*., 2015)**.

G. giuris, M. pancalus, M. tengra, H. fossilis and *P. ticto* fish species were estimated to have protein contents of 65.99, 59.81, 54.53, 62.66, and 46.22%, respectively (Table 2). A research study found that *A. testudineus, A. mola, C. punctatus, P. sophore, T. fasciata, M. pancalus,* and *M. vittatus* exhibited protein contents of 38.88, 53.81, 61.56, 55.06, 58.19, 64.56, and 45.56%, respectively **(Ferdousi *et al*., 2023)**. The results of the study found that the fat contents were estimated in *G. giuris* (4.77± 0.21%), *M. pancalus* (14.91± 0.03%), *M. tengra* (13.98± 1.50%), *H. fossilis* (8.05± 0.30%) and *Puntius ticto* (22.93± 0.57%) (Table 2). In a previous research study **(Bogard *et al*., 2015)**, fat contents in various fish species were observed, revealing that *A. testudineus, P. sophore*, *M. pancalus*, and *A. mola* had respective values of 12.80, 7.20, 3.90, and 4.50%. Similarly, **Jena *et al*. (2018)** reported fat content findings in their study, noting values of 3.51, 1.77, 6.19, 5.06, 4.79, and 3.84% regarding *A. testudineus*, *N. nandus, P. sophore, A. mola*, *T. fasciata*, and *M. vittatus*, respectively.

The ash content was recorded at 14.49, 12.03, 15.55, 14.82, and 19.27% in *G. giuris, M. pancalus, M. tengra, H. fossilis* and *P. ticto* fish species, respectively (Table 2). In a prior research study, it was reported that the ash content of *A. mola, P. sophore, M.*

pancalus, M. vittatus and *M. cuchia* had 17.87, 19.84, 23.81, 14.76, and 8.58%, respectively **(Ferdousi *et al*., 2022)**.

The carbohydrate contents were estimated at 14.64, 13.06, 15.73, 14.38, and 11.28% in *G. giuris, M. pancalus, M. tengra, H. fossilis* and *P. ticto* fish species, respectively, in the study area (Table 2). In a previous research study **(Begum *et al*., nd)**, varying carbohydrate contents were discovered across different fish species and locations, with the values of 6.27% for Loittya, 4.42% for Chepa, and 4.18% for Chhuri. The crude fiber contents were recorded at 0.09± 0.01, 0.20± 0.00, 0.21± 0.04, 0.09± 0.01, and 0.25±0.04% in *G. giuris, M. pancalus, M. tengra, H. fossilis* and *P. ticto,* fish species, respectively (Table 2). Previous researcher reported that the ash content of *R. rita*, *E. vacha*, *M. vittatus, P. sophore,* and *T. fasciata* were 0.98, 1.41, 4.41, 5.36, and 7.96%, respectively **(Ferdousi *et al*., 2022)** which is comparatively higher than the studied fish.

The energy contents were found at 374.04± 0.72, 434.41± 0.08, 415.27± 7.36, 389.11± 1.64, and 444.91± 2.91Kcal/ 100g in *G. giuris*, *M. pancalus*, *M. tengra, H. fossilis*, and *P. ticto* fish species, respectively (Table 2). The study by **Bogard *et al.* (2015)** recorded the energy contents of *A. testudineus, P. sophore, M. pancalus*, and *A. mola* as 737, 541, 394, and 445Kcal/ 100g, respectively.

CONCLUSION

In a nutshell, the study's findings reveal that five small fish species commonly consumed from the Mathabhanga River are nutrient-rich and have the potential to enhance the nutritional stability in rural areas, as well as in urban areas. Consequently, these small fish species could serve as a viable dietary option for individuals facing poverty in Bangladesh, assisting them to meet their daily nutritional needs and maintaining improved overall health. These results also provide valuable insights into the biochemical composition of local food fish, empowering consumers to make informed choices regarding their nutritional benefits. Ultimately, the consumption of these commonly consumed small fish and shellfish from the Mathabhanga River has the potential to contribute the nation's nutritional security significantly.

Author’s contribution

Md. Aslam Khan contributed to the collection of primary data, statistical analysis, and drafting the manuscript. Nahid Sultana, assisted in the collection of secondary data and statistical analyses. Md. Anwar Hossain Reviewed and edited the manuscript. Mohajira Begum assisted in the collection of secondary data and statistical analyses. Mona Ashis Chowdhury contributed in the collection of secondary data. M. Nazrul Islam supervised the research and finalized the manuscript.

REFERENCES

Ali, M.; Iqbal, F.; Salam, A.; Sial, F. and Athar, M. (2006). Comparative study of body composition of four fish species in relation to pond depth. Int. J. Environ. Sci. Technol., *2*: 359-364. https://doi.org/10.1007/BF03325897.

AOAC. (1970). A. International, Official Methods of Analysis of the Association of Official Analytical Chemists, Association of official analytical chemists.

Begum, M.; Al Mamun, M. Z. U.; Saleh-E-In, M. M.; Miah, M. A. S.; Yeasmin, S. and Sathee, R. A. J. (nd). Agric. Food Sci. and Biotechnol.

Belton, B.; van Asseldonk, I. J. M. and Thilsted, S. H. (2014). Faltering fisheries and ascendant aquaculture: implications for food and nutrition security in Bangladesh. Food Pol., *44*: 77-87.

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 Compos. Anal., *42*: 120-133. https://doi.org/10.1016/j.jfca.2015.03.002.

DoF. (2020). Yearbook of fisheries statistics of Bangladesh, 2018-19. Fisheries Resources Survey System (FRSS), Department of Fisheries, Bangladesh; Ministry of Fisheries and Livestock *31*: 76.

DoF. (2022). Yearbook of Fisheries Statistics of Bangladesh 2021-22, Fisheries Resources Survey System (FRSS), Department of Fisheries; Ministry of Fisheries and Livestock, *39*: 1-4.

FAO. (2020). The State of World Fisheries and Aquaculture. Sustainability in Action. Rome: FAO

Fawole, O. O.; Ogundiran, M. A.; Ayandiran, T. A. and Olagunju, O.F. (2007). Proximate and mineral composition in some selected fresh water fishes in Nigeria. Int J. Food Saf., *9*: 52-55.

Ferdousi, L.; Kabir, H.; Ali, M. A.; Begum, M.; Salma, M.; Sarker, M. M.; Ahmed, S.; Miah, M. A.; Khatun, H.; Mim, F. and Reza, M. S. (2023). Biochemical analysis of commonly consumed fishes and shellfishes from the Tista and the Baral River in Bangladesh. J. of Agri. and Food R., 14. https://doi.org/10.1016/j.jafr.2023.100671.

Ferdousi, L.; Sultana, N.; Bithi, U. H.; Lisa, S. A.; Hasan, M. R. and Siddique, M. A. B. (2022). Nutrient profile of wild black soldier fly (*Hermetia illucens*) prepupae reared on municipal dustbin's organic waste substrate. Proc. Natl. Acad. Sci. India B Biol. Sci., *92*(2): 351-357. https://doi.org/10.1007/s40011-021-01340-0.

Hasan, M.; Lucky, N.S. and Hossain, M. A. R. (2012). Natural food abundance and sis biodiversity of matshaya rani fish sanctuary. J. Environ. Sci. Nat. Resour., *5*(1): 319-328. https://doi.org/10.3329/jesnr.v5i1.11599.

Islam, M. R.; Yeasmin, M.; Sadia, S.; Ali, M. S.; Haque, A. R. and Roy, V. C. (2023). Small Indigenous Fish: A Potential Source of Valuable Nutrients in the Context of Bangladesh. Hydrobiology., *2*(1): 212-234. https://doi.org/10.3390/hydrobiology2010014.

Jena, D.; Jena, A. K.; Panda, A.; Parhi, J.; Biswas, P. and Pattanaik, S. S. (2018). Proximate analysis of some small indigenous fish species (SIS) of Tripura, India. J. Entomol. Zool. Stud., *6*(4): 470-474.

Lees, M. J. and Carson, B. P. (2020). The potential role of fish-derived protein hydrolysates on metabolic health, skeletal muscle mass and function in ageing. Nutrients, *12*: 2434.

Lin, H. H.; Maung, K. W. and Aung, T. (2020). Nutritional values of some selected small indigenous fish species (SIFS) in Bawle Kyun, Htantabin township, Yangon region. J. Myanmar Acad. Arts Sci., *18*: 281-94.

Marques, I.; Botelho, G. and Guiné, R. P. F. (2019). Comparative study on the nutritional composition of fish available in Portugal. Nutr. Food Sci., *49*(5): 925-941.

Nurullah, M.; Kamal, M.; Wahab, M. A.; Islam, M. N.; Ahasan, C. T. and Thilsted, S. H. (2003). Nutritional quality of some small indigenous fish species of Bangladesh, 151-158.

Shamsuzzaman, M. M.; Mozumder, M. M. H.; Mitu, S. J.; Ahamad, A. F. and Bhyuian, M. S. (2020). The economic contribution of fish and fish trade in Bangladesh. Aquac. Fish., *5*(4): 174-181. https://doi.org/10.1016/j.aaf.2020.01.001.