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Md. Mirazul Islam
Department of Biochemistry and Molecular Biology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Md. Tanvir Abedin
Department of Biochemistry and Molecular Biology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Md. Azizul Haque
Department of Biochemistry and Molecular Biology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Sharika Hayder
Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

Md. Niamotullah Sujon
Department of Biochemistry and Molecular Biology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Md. Ashraful Alam
(1). Faculty of Science and Engineering, Iwate University, Morioka 020-8551, Iwate, Japan
(2). Department of Chemistry, International University of Business Agriculture and Technology (IUBAT), Uttara-1230, Dhaka, Bangladesh

Md. Abu Sayed
Department of Biochemistry and Molecular Biology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Corresponding Author:
Md. Abu Sayed
Department of Biochemistry and Molecular Biology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh

Evaluation of nutritional status of small indigenous fish species under climate change found in northern region of Bangladesh

Md. Mirazul Islam, Md. Tanvir Abedin, Md. Azizul Haque, Sharika Hayder, Md. Niamotullah Sujon, Md. Ashraful Alam and Md. Abu Sayed

Abstract
The present study was conducted on small indigenous dry fish for evaluating proximate composition *viz* ash, protein, total sugar, fibre, fat, phosphorus, sulfur and sodium content. Three species were used such as *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*), and *Darkina* (*Esomus danricus*). Our study showed that there was a little variation in the nutrients and mineral content of *Mola*, *Puti* and *Darkina* fish collected from different northern region of Bangladesh. *Puti* fish shows good nutrients in all districts except sodium and phosphorus in Dinajpur district. In case of *Mola* fish the protein, total sugar and fiber content is slightly higher in Bogura, Rajshahi and Dinajpur districts respectively, whereas the phosphorus content is slightly higher in Dinajpur district compare with other districts. From the analysis of *Darkina* fish it was found that, ash content in Dinajpur is slightly higher than other districts. The ash content of the dried fishes obtained was in the range of 14.30 to 18.65% and the highest value obtained from *Darkina* (*Esomus danricus*) and the lowest from *Puti* (*Puntius sophore*). The protein content was found in the range of 41.59 to 61.96% with the highest value in *Mola* (*Amblypharyngodon mola*) and the lowest in *Darkina* (*Esomus danricus*). There was a variation in total sugar content which is in the range of 1.61 to 2.65% where the highest value in *Mola* (*Amblypharyngodon mola*) and the lowest in *Puti* (*Puntius sophore*). Fibre content was in the range of 2.17 to 8.74% with the highest value obtained from *Puti* (*Puntius sophore*) and the lowest value from *Mola* (*Amblypharyngodon mola*). The fat content was in the range of 2.17 to 7.77% with the highest value obtained from *Puti* (*Puntius sophore*) and the lowest in *Mola* (*Amblypharyngodon mola*). It is concluded that climate change, species variation, and the feeding habit may be the major factors to uphold the nutrient content in SIS.

Keywords: *Darkina*, *Mola*, *Puti*, Proximate composition

1. Introduction
Bangladesh is a land of river which is located in the Asia-pacific region of the world. It is holding third position in aquatic biodiversity in Asia and the richest freshwater resources. In 2017-18, this sector contributes 3.57% to the national GDP and more than one-fourth (25.30%) to the agricultural GDP. More than 11 percent of total population of Bangladesh is engaged in this sector on full time and part time basis for their livelihoods. This sector also has high potential for the perspective of economic development of the country [1]. Fish provides essential nourishment, especially quality proteins and fats, vitamins and minerals for human. Increasing number of people are involved now in fisheries aquaculture and fish trade. In accordance with the Food and Agriculture Organization (FAO) of the United Nations, nowadays, aquaculture makes a major contribution to human nutrition [2]. As a potential source of animal protein, fish received widespread attention for essential nutrients of human diets [3-4]. Fisheries contribute about 80% to the nation's animal protein intake [5]. Fish and shellfish are the primary sources of animal protein and valuable in the diet because they provide a good quantity (usually 70% or more) of protein of high biological value, particularly sulfur containing amino acids [6]. Fish proteins are easily digestible in nature and are important source of essential minerals. Minerals constitute the micronutrients, serve as the components of many enzymes and are necessary for all metabolic activities by which the human body acquires and utilized food to maintain health and physical activity. The fresh water species specially small indigenous fish species have been found inundated with various macro and micronutrients.

The small indigenous fish species (SIS) are those species which can grow maximum to a length of 5-30 cm in the mature or adult stage of their lifecycle [7]. These fish are commonly referred to as "*Chhotomach*" in contrast to the large and commercially important large fish "*Baromach*". Although small in size they constitute a major part of fish caught in the inland fisheries due to their large numbers and abundance. There are many small indigenous species (SIS) available in Bangladesh viz. *Baim* (*Mastacembelus armatus*), *Bele/Bailla* (*Glossogobius giuris*), *Kholisha* (*Colisa fasciata*), *Nama Chanda* (*Chanda nama*), *Ranga Chanda* (*Parambassis ranga*), *Folui* (*Notopterus notopterus*), *Gulsha* (*Mystus cavasius*), *Guchi* (*Mastacembelus pancalus*) *Sor Puti* (*Puntius sophore*), *Koi* (*Anabas testudineus*), *Magur* (*Clarias batrachus*), *Meni* (*Nandus nandus*), *Morala* (*Amblypharyngodon mola*), *Rani/Bou* (*Botia Dario*), *Shinghi* (*Heteropneustes fossilis*), *Taki* (*Channa punctatus*), *Tara Baim* (*Macrognathus aculeatus*), *Tangra* (*Mystus vittatus*), *Tit Puti* (*Puntius ticto*), *Shol* (*Channa striatus*), *Chitol* (*Notopterus chitala*) etc. Small indigenous fish particularly *Mola* (*Amblypharyngodon mola*), *Puti* (*Putius chola*), *Darkina* (*Esomus danricus*), *Chapila* (*Gudusia chapra*) *Chanda* (*Chanda nama*), *Batashi* (*Pseudeutropius atherinoides*) and *Kajuli* (*Ailia coila*) are believed to have high degree of nutritive elements. Thus, the SIS can play a key role in preventing the widespread micronutrient deficiencies and allied diseases [8]. As the landless, marginal farmers and the people with low income are unable to afford costly species such as carp, there is an increasing demand for small indigenous fishes but now climate change is the major issue both in aquatic and terrestrial ecosystem. Components of the aquatic ecosystem is unorganized due to climate change which partially effects the production as well as nutrient content of aquatic life. So it is essential to know the proximate composition of the fish to report their nutrient composition from the public health point of view. There are some information on the biochemical and nutritional studies of some fresh water fish species [9]. Information on the nutritive value and its food quality are equally important regarding the proper utilization of products. Although a good number of works on biochemical composition of fishes in Bangladesh has been done by many researchers [10-17]. But the objectives of this present study were to investigate the nutritional status of small indigenous fish species, availability of small indigenous fish species and to know the impact of nutrient due to climate change.

2. Materials and Methods

2.1 Experimental fish collection

The small indigenous fish species viz *Mola* (*Amblypharyngodon mola*), *Puti* (*Puntius sophore*), and *Darkina* (*Esomus danricus*) were collected as the experimental fish from local market of the five districts viz. Dinajpur, Rangpur, Bogura, Naogaon and Rajshahi on the northern region of Bangladesh for the study on evaluation of nutritional status of SIS. Biochemical composition measured in the laboratory, Department of Biochemistry and Molecular Biology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur.

2.2 Sampling technique

After collection, the samples were dressed by removing viscera, scales and fins properly. Then samples were washed by pure water. Properly washed fish samples were dried in the sun for a few days. Finally the dried samples were preserved in polythene bags for the laboratory analysis.

2.3 Estimation method

The sun dried samples were heated in the oven at 60° C for 72 hours in the laboratory. After heating, the heated fish samples were grinded in the grinder machine properly. The fish samples were taken for analysis and try to observe the proximate composition *viz* ash, protein, total sugar, fibre, fat, phosphorus, sulfur and sodium content were determined by previously studied method [18-21].

2.4 Statistical analysis

All data were analyzed with the IBM SPSS statistics 22. A P-value of <0.05 was considered to indicate a significant difference between groups, and a comparison of means was made using Duncan's multiple range test [22]. The results are expressed as average ± standard deviation of five replications ($n = 5$). Data points bearing different letters are significantly different ($P<0.05$)

3. Results

3.1 Proximate composition analysis

This study was conducted to evaluate the nutritional status viz. ash content, protein, total sugar, fat, fibre and minerals such as phosphorous, sulfur, sodium etc. of small indigenous fish species on the northern region of Bangladesh.

3.2 Ash content

Figure 1 showed the ash content of different fishes in different regions. Ash content in *Puti* fish ranged from 14.30% to 17.85% whereas in *Mola* fish it was found in between 15.76% to 18.50%. In case of *Darkina* fish the total ash content was recorded in 15.26% to 18.65%. Ash content of *Puti* was statistically different in Dinajpur and Bogura district, but there was no statistical difference in other districts for ash content of *Puti*. The ash content of *Mola* and *Darkina* were statistically significant in Dinajpur and Rangpur but no statistical difference were found in other districts for two species *viz Mola* and *Darkina*.

3.3. Protein content

Figure 2 showed the percentage of protein content of fishes. It was found in 44.55% to 60.61% in *Puti* fish and in *Mola* fish it was estimated as 44.55% to 60.61%. All the data of Puti and *Mola* fish were statistically significant. In case of *Darkina* fish protein content was found ranged from 41.59% to 56.64%. There was no statistical difference between Rangpur and Naogoan, but statistical difference was found in rest three districts for protein content of *Darkina* fish.

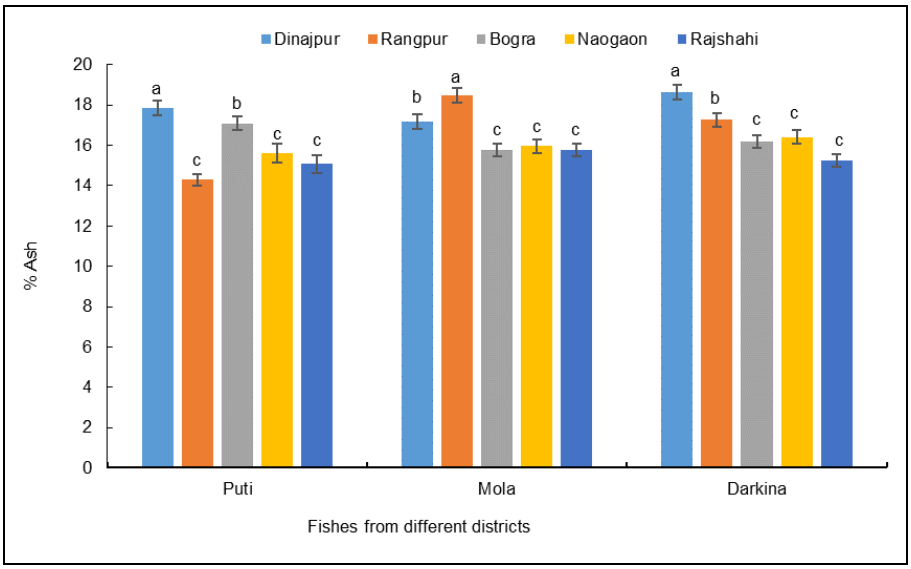

Fig 1: Ash content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh.

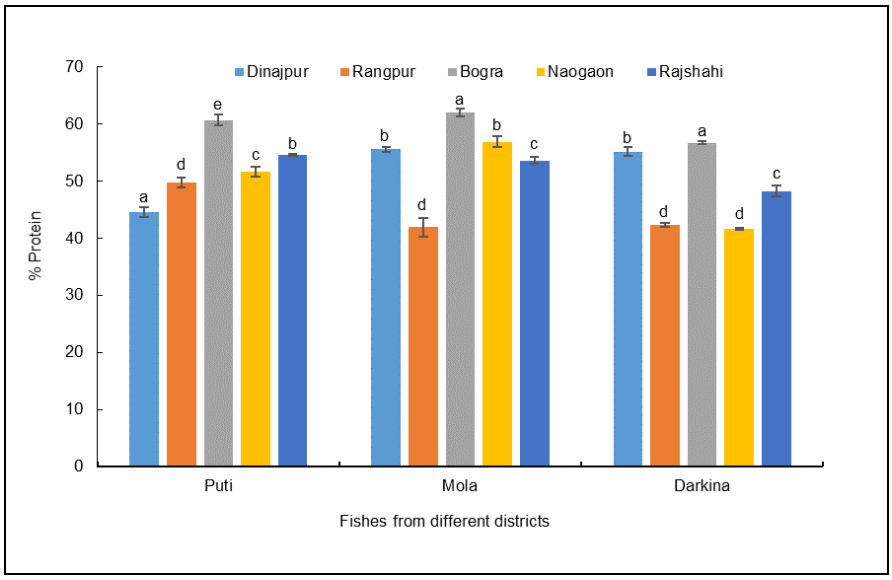

Fig 2: Protein content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh.

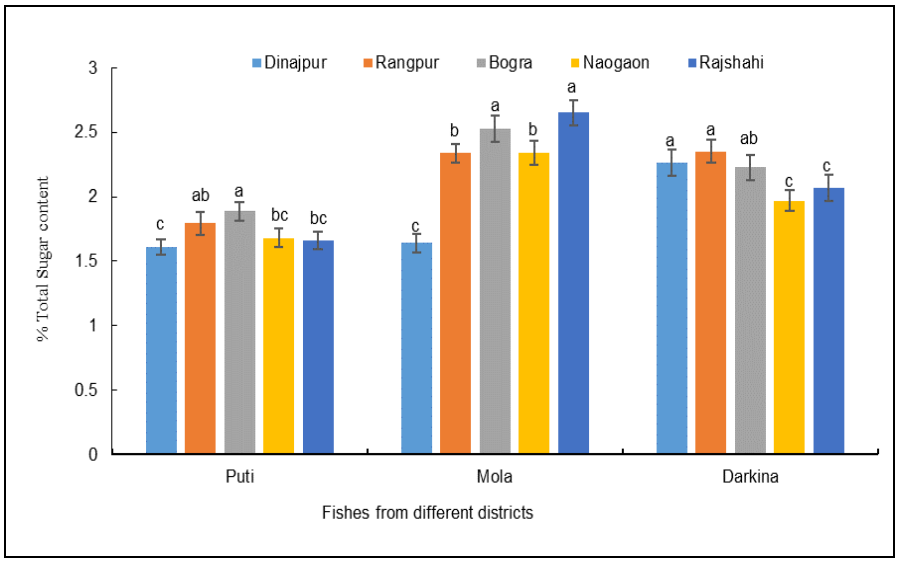

Fig 3: Total Sugar content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh.

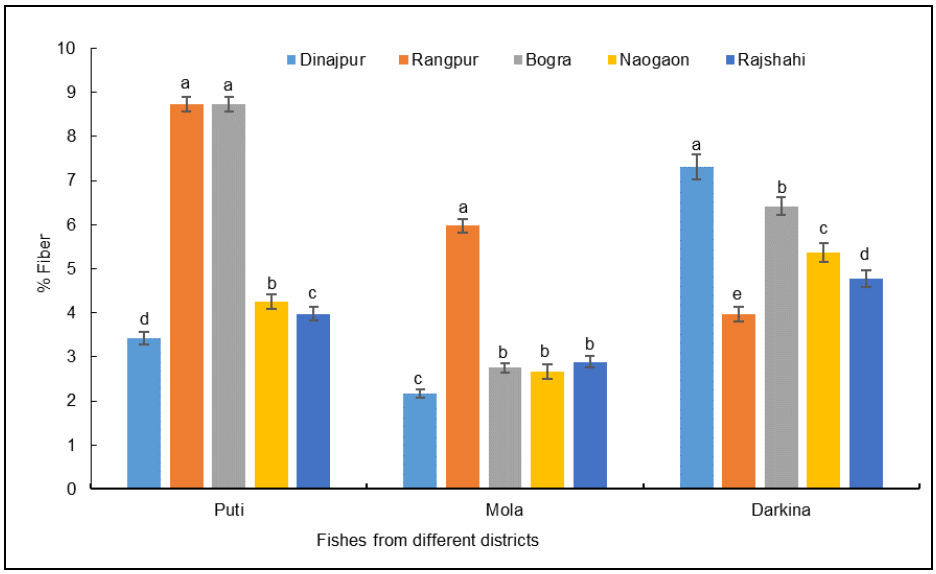

Fig 4: Fibre content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh.

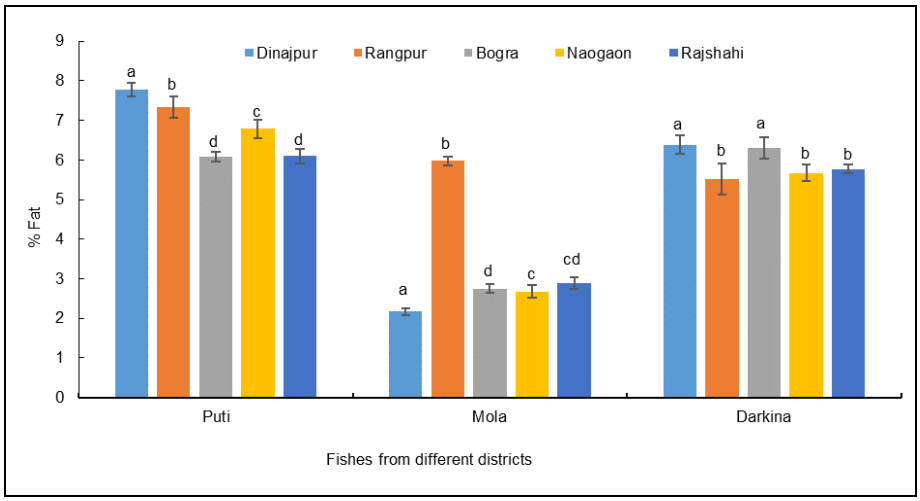

Fig 5: Fat content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh.

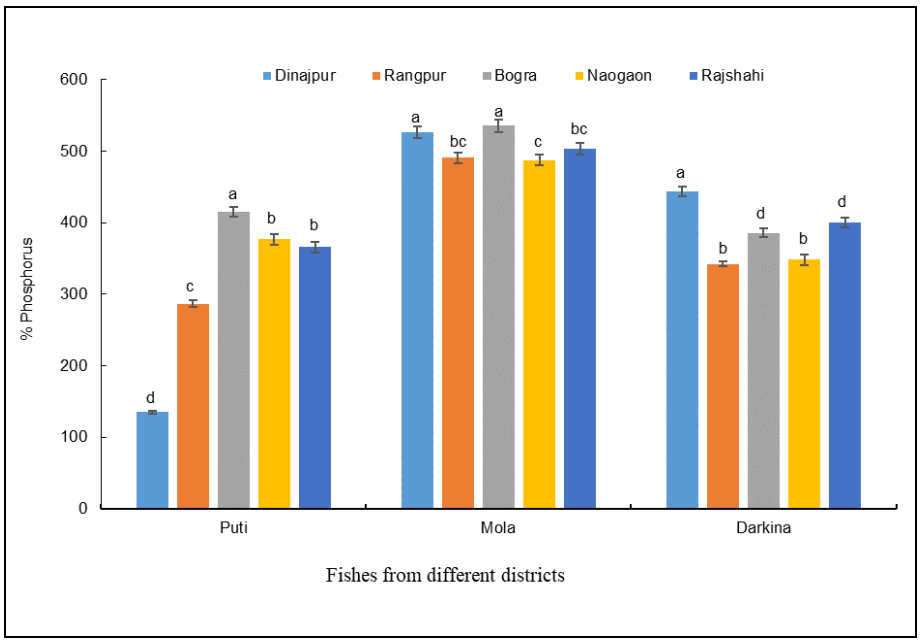

Fig 6: Phosphorus content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh.

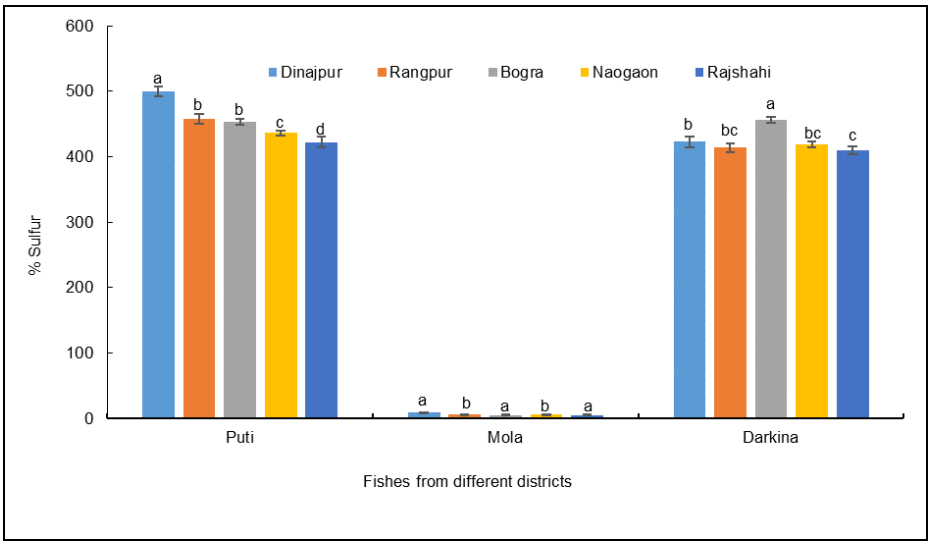

Fig 7: Sulfur content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh

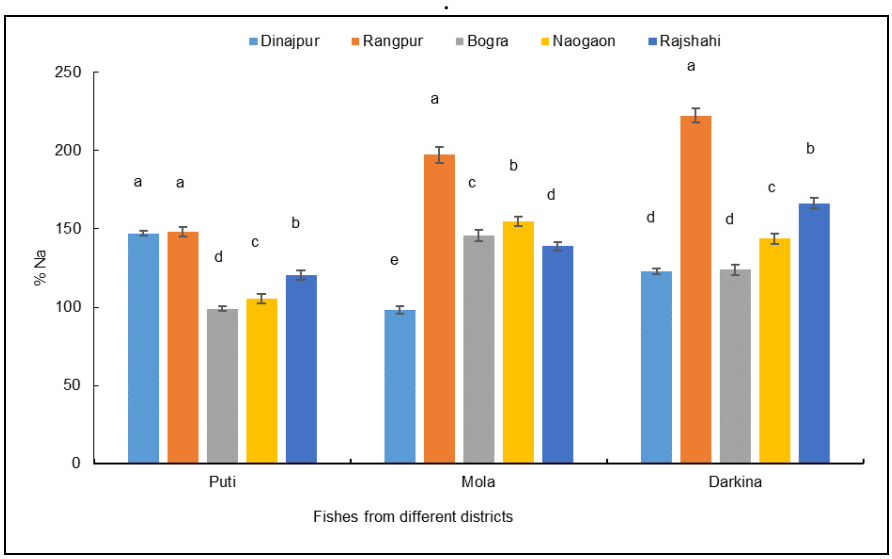

Fig 8: Sodium content for *Puti* (*Puntius sophore*), *Mola* (*Amblypharyngodon mola*) and *Darkina* (*Esomus danricus*) fish from different districts in the northern region of Bangladesh.

3.4 Total sugar content

The total sugar content of were estimated ranged from 1.61% to 1.88% in *Puti*, 2.65% to 1.64% in *Mola* and 1.97% to 2.35% in *Darkina* fish. From the data it was showed that Naogaon and Rajshahi were statistically non-significant. On the other hand, Dinajpur, Rangpur and Bogura were statistically significant for total sugar content of *Puti*.

Figure 3 showed that the total sugar content of *Mola* fish in Rangpur and Naogaon were same and statistically non-significant. Bogura and Rajshahi were statistically same. Similar result were found between Bogura and Rajshahi district but Dinajpur was statistically significant from other districts. However, In case of *Darkina* the graph showed that only Bogura showed statistical variation.

3.5. Fibre content

Figure 4 showed the fibre content of three fish species. It was ranged from 3.43% to 8.74% in different districts for *Puti* fish. The fibre content of *Mola* was ranged from 2.17% to 5.97% and for *Darkina* it was 3.97% to 7.31%. There was no statistical difference found in Rangpur and Bogura for *Puti* fish. In *Mola* fish fiber percentage was statistically different in Dinajpur and Rangpur district but other three districts did not show any statistical difference. All the districts showed statistical difference of fiber content in *Darkina* fish.

3.6. Fat content

The fat contents of *Puti*, *Mola* and *Darkina* in different districts on the northern region of Bangladesh showed in the figure 5 sequentially. The highest value of fat content was recorded in Dinajpur (7.77%) and the lowest value was in Bogura (6.08%) for *Puti* fish. The fat content of Bogura and Rajshai were found to be statistically non-significant because they are equal value and the rest of the values were statistically significant.

The highest value of fat content among the five districts was recorded in Rangpur 5.97% and the lowest was in Dinajpur (2.17%) in case of *Mola*. All the values were statistically significant in *Mola* fish. The highest fat content of *Darkina* fish was found in Dinajpur and the lowest content was found in Rangpur. It was showed that the contribution of fat content in Dinajpur and Bogura were same and statistically non-significant and Rangpur, Naogaon and Rajshahi were also statistically same result.

3.7 Phosphorus content

The mineral elements such as phosphorus contents of *Puti* (*Puntius sophore*) fish in different districts in the northern region of Bangladesh showed in the figure 6. The highest value of phosphorus content was recorded in Bogura district (414.95 mg/100g). On the other hand the lowest was in Dinajpur district (134.89 mg/100g). The phosphorus content of Dinajpur, Rangpur and Bogura found to be very significant.

The highest phosphorus content of *Mola* fish was found in Bogura and the lowest content was found in Noagaon. It was showed from graph that the percentage of phosphorus content in Dinajpur and Bogura district was statistically non-significant and others were statistically significant.

The highest phosphorus content of *Darkina* fish was found in Dinajpur and the lowest content was found in Rangpur. Bogura and Rajshahi were statistically non-significant. Interestingly Rangpur and Naogoan did not show any statistical difference.

3.8. Sulfur content

The mineral elements such as sulfur contents of *Puti* (*Puntius sophore*) fish in different districts in the northern region of Bangladesh showed in the figure 7. The highest value of sulfur content was recorded in Dinajpur both for *Puti* and *Mola* fish. The highest sulfur content of *Darkina* fish was found in Bogura and the lowest content was found in Rajshahi.

3.9. Sodium (Na) content

Figure 8 shows the mineral elements such as sodium contents of *Puti* (*Puntius sophore*) fish in different districts in the northern region of Bangladesh. The highest value of sodium content was recorded in Rangpur (148.22 mg/100g). On the other hand the lowest was in Bogura (99.06 mg/100g). The Na content of Bogura, Naogaon and Rajshahi were found to be very significant. Similarly that figure indicated that the values of Dinajpur and Rangpur were same and for that they were statistically non-significant.

The highest value of Na content was recorded in Rangpur (197.36mg/100g) in case of *Mola* fish. On the other hand the lowest was in Dinajpur (98.29mg/100g). The figure indicated that all the values were different and so they were statistically significant.

The highest value of Na content was recorded in Rangpur (222.33mg/100g) and the lowest value was in Rangpur (122.33mg/100g) for *Darkina*. The Na content of Dinajpur and Bogura were found to be statistically non-significant because they were equal value and the rest of the values were statistically significant.

4. Discussion

The concentration of protein, lipid, ash and minerals (calcium and phosphorus) are extremely variable among the small indigenous species (SIS). Research work on the evaluation of proximate composition of SIS of Bangladesh have not so far been undertaken in detail. Only a few species are reported to subject to analysis of vitamin A and minerals such as calcium, magnesium and iron.

4.1 Ash content

The ash content of *Puti* (*Puntius sophore*) fish among the five districts in the present study ranged between (14.30 to 17.85)%. The highest ash content was found in Sample 1 which is very higher than the values reported previously in *Puti* [23]. The ash content of the *Mola* fish among the selected districts in the present study ranged between 15.76 to 18.50%. The highest ash content was found in Rangpur (18.50%) which is slightly higher than the values reported by previous study in *Mola* [24]. The ash content of the *Darkina* fish among the five districts in the present study ranged between 15.26 to 18.65%. The highest ash content was found in Dinajpur (18.65%) which is very higher than the values of previous report in *Esomus danricus* [23]. CSIR (1962) reported that the ash content of some selected fish species in India ranged between 1.53-2.60%. In the present study, the ash content is found different due to it might the values are taken in dry weight basis, environmental parameters, climatic change, region, water quality etc.

4.2. Protein content

In the present study the protein content of the *Puti* fish ranged between 44.55% to 54.53%. The highest protein content was observed in Rajshahi (54.53%) while lowest in Dinajpur. The highest protein content was found in Rajshahi (54.53%) which is very higher than the values reported previously in *Puntius sophore* [25]. The protein content of the *Mola* fish among the five districts in the present study ranged between 41.88% to 61.96%. The highest protein content was found in Bogura (61.96%) which is very higher than the values reported by previous authors in *Amblypharyngodon mola* [25]. In the present study the protein content of the *Darkina* fish ranged between 41.59% to 56.64%. The highest protein content was observed in Bogura while lowest in Naogaon. The highest protein content was found in Bogura (56.64%) which is very higher than the values reported by previous researcher in *Esomus danricus* [25]. CSIR (1962) reported the protein content of some selected fish species in India to be 14.32 to 19.8%. In the present study, the protein content is found slightly different due to it might be the values are taken in dry weight basis, for environmental parameters, for climatic change, for regions, water quality etc.

4.3 Total Sugar Content

In the present study, the total sugar content of *Puti* fish is high in sample collected from Bogura which is lower than the previous values in *Puntius sophore* [25]. Higher levels of carbohydrate in *Puti* fish in Bogura might be due to over-activeness for reproduction with the approach of monsoon.

In the present study, the total sugar content of *Mola* fish is high in sample Naogaon which is lower than the values reported previous *Puntius sophore* [25]. Lower levels of carbohydrate in *Mola* fish in sample Naogaon might be due to over-activeness for reproduction with the approach of monsoon, species from different region, climatic change etc.

The protein content of the fish among the five districts in the present study ranged between 1.97% to 2.35% in case of *Darkina*. The highest total sugar content in *Darkina* fish was found in sample Rangpur which is lower than the values reported in previous study [25]. Lower levels of total sugar content in *Darkina* fish is found in the present study it might be the environmental parameters, seasonal variation, climate change etc.

4.4. Fibre Content

In the present study, the fibre content of *Puti* and *Mola* fish is high in sample collected from Rangpur (8.74%) which is higher than the values from other districts. Fibre content of *Darkina* fish is high in sample collected from Bogura (6.42%)

which is higher than the values from other districts. This may happened due to the different environment, seasonal variation, climatic change etc.

4.5 Fat Content

The lipid or fat content of SIS in the present study ranged between 6.08 to 7.77%. The carcass fat content was inversely correlated with moisture contents. Such inverse relationship between lipid and moisture has also been reported earlier that crude fat content in *Puntius sophore* was 13.33% which are higher to the values obtained in the present study [25].

In case of *Mola* highest value of lipid or fat content is recorded in sample Rangpur (5.97%) and the lowest is in sample Dinajpur (2.17%). The highest fat content recorded in Rangpur was higher to the result of previous report [24].

The lipid or fat content of SIS in the present study ranged between 5.51 to 6.38%. It was reported that crude fat content in *Esomus danricus* was 5.33% which is lower to the values obtained in the present study [23]. The fat content for *Darkina* fish is estimated lower than previous report [23] due to it might be seasonal variation, climatic change, environmental factors etc.

4.6. Phosphorus Content

Minerals such as Ca and P are closely related to metabolism especially in bone formation and the maintenance of acid-base equilibrium in fish. Almost the entire store of calcium (99%) and most of the phosphorus (80%) in the body are in the form of bones, teeth and scales. The phosphorus content of the *Puti* fish in the present study ranged between 134.96 mg/100g to 414.95 mg/100g. The highest value was obtained in Bogura (414.95 mg/100g) which was lower than the reported value in *Puntius sophore* [27]. Such low concentration of phosphorus might be due to the removing of head, bones and scales from the fish body.

The phosphorus content of the *Mola* fish in the present study ranged between 487.14 mg/100g to 535.35 mg/100g. The highest value was obtained in Bogura (535.35 mg/100g) which is higher than the reported value by previous author [24]. Such low concentration of phosphorus might be due to the removing of head, bones and scales from the fish body.

The phosphorus content of the *Darkina* fish in the present study ranged between 342.11mg/100g to 443.64 mg/100g. The highest value was obtained in Dinajpur (443.64 mg/100g) which is higher than the reported value [24]. Such low concentration of phosphorus might be due to the removing of head, bones and scales from the fish body.

4.7. Sulfur Content

The sulfur content of the *Puti* fish in the present study ranged between 500.50 mg/100g to 422.34 mg/100g. The highest value was obtained in Dinajpur (500.56 mg/100g) which is higher than the reported value in previous study[25]. Sulfur content ranged from 160 to 300mg/100 g and is higher than results reported in the FAO/INFOODS global database, although consistent with results reported elsewhere in the literature. Such high concentration of sulfur might be due to the removing of head, bones and scales from the fish body.

The sulfur content of the *Mola* fish in the present study ranged between 5.59 mg/100g to 9.67 mg/100g. The highest value was obtained in Dinajpur. The sulfur content of the *Darkina* fish in the present study ranged between 409.84 mg/100g to 456.13 mg/100g.

4.8 Sodium (Na) Content

The Na content of the *Puti* fish in the present study ranged between 99.06mg/100g to 148.22mg/100g. The highest value was obtained in Rangpur (148.22mg/100g) which is higher than the previous reported value [28]. The Na content of the *Mola* fish in the present study ranged between 98.29mg/100g to 197.36mg/100g. The highest value was obtained in Rangpur (197.36mg/100g) which is higher than the reported value of previous study [27]. The Na content of the *Darkina* fish in the present study ranged between 122.85mg/100g to 222.33mg/100g. The highest value was obtained in Rangpur (222.33mg/100g) which is higher than the reported value of previous study [27]. Sodium (26–110mg/100 g) and potassium (58–350mg/100g) content were broadly consistent with ranges for other fish and seafood reported elsewhere. Such high concentration of Na might be due to climatic change, the removing of head, bones and scales from the fish body, different regions etc.

5. Conclusions

The result of the present study implies that despite of some little variations, SIS in Bangladesh exhibited adequate quantities of protein, fat, ash, total sugar and minerals. The enormous number of people in Bangladesh is poor and unable to afford large fish to their daily diet due to hickey price. In Bangladesh, fish is an important source of protein as well as mineral and vitamins. Some SIS fish are very small (<10 cm) and they are typically eaten whole. All small fish contain large amounts of calcium and phosphorous. Big fish like silver carp (*Hypophthalmichthys molitrix*) and rohu (*Labeo rohita*), which are promoted in aquaculture do not contribute significantly to calcium and phosphorous input since the bones are not eaten. However, the result of the present investigation states that the proximate composition of different small indigenous fish more or equal to other larger carp species, though the price of SIS is very lower than larger species of fish. Therefore, small indigenous fishes can play a significant role to fulfill the nutrient demand of poorer sections of people of the country. Variation in proximate composition of fish flesh may vary with species variation, season, age and the feeding habit of fish. Here the differences may be due to the difference in the fish species used. It has been shown in present study that small indigenous fish do not differ significantly in their nutrient and biochemical compositions.

6. Acknowledgement

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