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Analysis of major heavy metals in the available fish species of the Dhaleshwari River, Tangail, Bangladesh

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Abstract
Dhaleshwari is one of the most important rivers in Bangladesh for multi-species fisheries production. In this study, concentrations of major heavy metals (Pb, Cd, Cr, Hg and As) in the six available fish species (*Channa punctatus*, *Mastacembelus armatus*, *Mystus vittatus*, *Puntius puntio*, *Amblyceps mangois* and *Metapenaeus spinulatus*) of the Dhaleshwari river collected from three selected locations (Porabari, Katuli and Mahmudnagar) during the months from March to May 2016 were quantified using Atomic Absorption Spectrophotometer in order to estimate the present heavy metals pollution index in the available fish species of the river. The concentration of heavy metals in fishes of the study area ranged as Pb 0.086-0.288 $mgkg^{-1}$, Cd 0.002-0.019 $mgkg^{-1}$, Cr 0.006-0.159 $mgkg^{-1}$, Hg 0.001-0.016 $mgkg^{-1}$, As <0.005-0.128 $mgkg^{-1}$. According to statistical analysis, heavy metals Cd, Cr, Hg and As in fishes show negative correlations among themselves and positive correlations with Pb. The level of these heavy metals in fishes of the river were found below the permissible limit. Thus, the study revealed that there is almost no heavy metal pollution in the Dhaleshwari river water fishes and the consumption of the available fish species of the river is not harmful to human beings.

Keywords: Dhaleshwari River, Fish species, Heavy metals, Bioaccumulation, Correlation and Aquatic biota

1. Introduction
Recent years have witnessed significant attention being paid to the problems of contamination of aquatic fish species by a wide variety of chemicals including the heavy metals. Metals from natural and anthropogenic sources continuously enter the aquatic ecosystem where they pose a serious threat because of their toxicity, long persistence, bioaccumulation and biomagnifications in the food chain [1]. As fishes are often at the top of aquatic food webs and may concentrate large amounts of metals from the water and sediments, heavy metals can enter into the human body very easily [2-4].
Non-essential heavy metals As, Cd, Pb and Hg affect human health through food chain [5]. Toxic effects of Pb, Cd and Hg have been reported even at trace concentrations and they are not essential for human body [6]. Heavy metals designated as a major group of aquatic pollutants as they can never be destroyed and can easily bio-accumulate to aquatic biota via food chain. Heavy metals toxicity in human body via fish consumption can cause several adverse effects including cardiovascular diseases, liver damage, renal failure and even death [7-9]. To assess the fish quality of the aquatic system for human consumption, many international monitoring programs have been established [10] and heavy metals concentrations in fish have been extensively studied [11]. Heavy metal pollution in fish has become an important worldwide concern, not only because of the threat to fish but also due to the health risks associated with fish consumption.
The Dhaleshwari River is an important distributary of the Jamuna River with a total length of about 290 km having average and maximum depth 37.19 m and 80.79 m respectively [12]. The river starts off the Jamuna near the north-western tip of Tangail district, Dhaka, Bangladesh with high potential for fisheries production in this area. Over exploitation of fisheries resources, river bank erosion and human activities are gradually damaging the aquatic life including fishes of the Dhaleshwari River. Bangladesh, as a developing country, is at a high risk of aquatic pollution [13]. The river systems may be contaminated with heavy metals released from domestic, industrial, mining and agricultural effluents. The overuse of fertilizers

and pesticides in the surrounding cultivable lands of the Dhaleswari river that washed out through surface runoff degrade the quality of the water [14] and ultimately affecting the aquatic biota. Moreover, the river embracing daily a huge amount of domestic sewage and industrial waste which results in the disruption of the aquatic ecosystem. As like other rivers of Bangladesh, Dhaleshwari River also have a high potential for fisheries production and the local peoples in this region consumed fishes mostly caught from this river and they depend on this river in many ways. Moreover, the river plays a vital role in the economy of the Tangail region of Bangladesh due to its geographical position. Preparation of current heavy metal profile of the Dhaleshwari River fish and water will, therefore, become very important for ecological purposes.

Heavy metal content in the tissues and organs of fishes indicates their accumulation in food chains. Since fishes are an integral component of the human diet, they need to carefully screen to ensure that unnecessary high level of heavy metals are not being transferred to human population via consumption of fish [9]. Therefore, it is important to observe the level of heavy metals in consumed fishes to get some ideas about the safety of fish protein supplied to the consumers and to understand its harmful effects on individuals, population or ecosystem. Moreover, for the existence and conservation of aquatic resources, it is essential to investigate the fish quality of the river. In the present study, six available fish species namely *Channa punctatus*, *Mastacembelus armatus*, *Mystus vittatus*, *Puntius puntio*, *Amblyceps mangois* and *Metapenaeus spinulatus* were collected from three selected locations: Porabari, Katuli and Mahmudnagar of the Dhaleshwari river during March to May 2016 and the concentrations of heavy metals *viz.* lead (Pb), cadmium (Cd), chromium (Cr), mercury (Hg) and arsenic (As) in the collected fish species were quantified using Atomic Absorption Spectrophotometer (AAS), aiming to evaluate the current heavy metal pollutions index of the Dhaleshwari river water fish and to assess the concentrations of metals in the selected available fish species of the river. It may be noted that, there is almost no information about the heavy metal concentrations in the selected fish species of the Dhaleshwari River [1, 15] and to the best of our knowledge, this is the first report regarding the heavy metal concentrations in the selected fish species of the river. Therefore, we emphasized the present study including available fish species of the Dhaleshwari River, Tangail, Bangladesh. The investigated fish qualities are compared with relevant standard levels to know the present status of the fish quality of the river. The study was also concluded consciousness to the concerned authority in regarding the present fish quality of the river and to make it environmentally sustainable.

2. Materials and Methods

2.1 Study Area

The Dhaleshwari River in the study starts off the Jamuna River near the north-western tip of Tangail district and then divided into two branches: the name Dhaleshwari retains in the northern branch which merges at the southern part of Manikgang district with the other branch of Kaligonga River. The merged flow then meets at the Shitalakshya River near of Narayanganj district. This combined flow finally merge into the Meghna river moving southwards [12]. For the study, three locations of the river namely Porabari (Location 1), Katuli (Location 2) and Mahmudnagar (Location 3) union at Tangail Sadar Upazilla of Tangail District, Bangladesh (Figure 1) were selected. The three sampling locations with their Latitude and Longitude is shown in Table 1. The exact location of each sampling point was determined using GPS. The three selected sampling sites has no significant pollution sources except some agricultural lands and were selected as a part of regular study. The almost whole of the lands surrounding the three sampling points is notable mainly for rice, jut, wheat, corn, mustard crops etc. cultivation.

Table 1: Sampling location with Latitude and Longitude

Station No.	Sampling Site	Latitude	Longitude
Location 1	Porabari	24º43 333N	89º81 667E
Location 2	Katuli	24º08 553N	89º93 385E
Location 3	Mahmudnagar	24º03 088N	89º89 364E

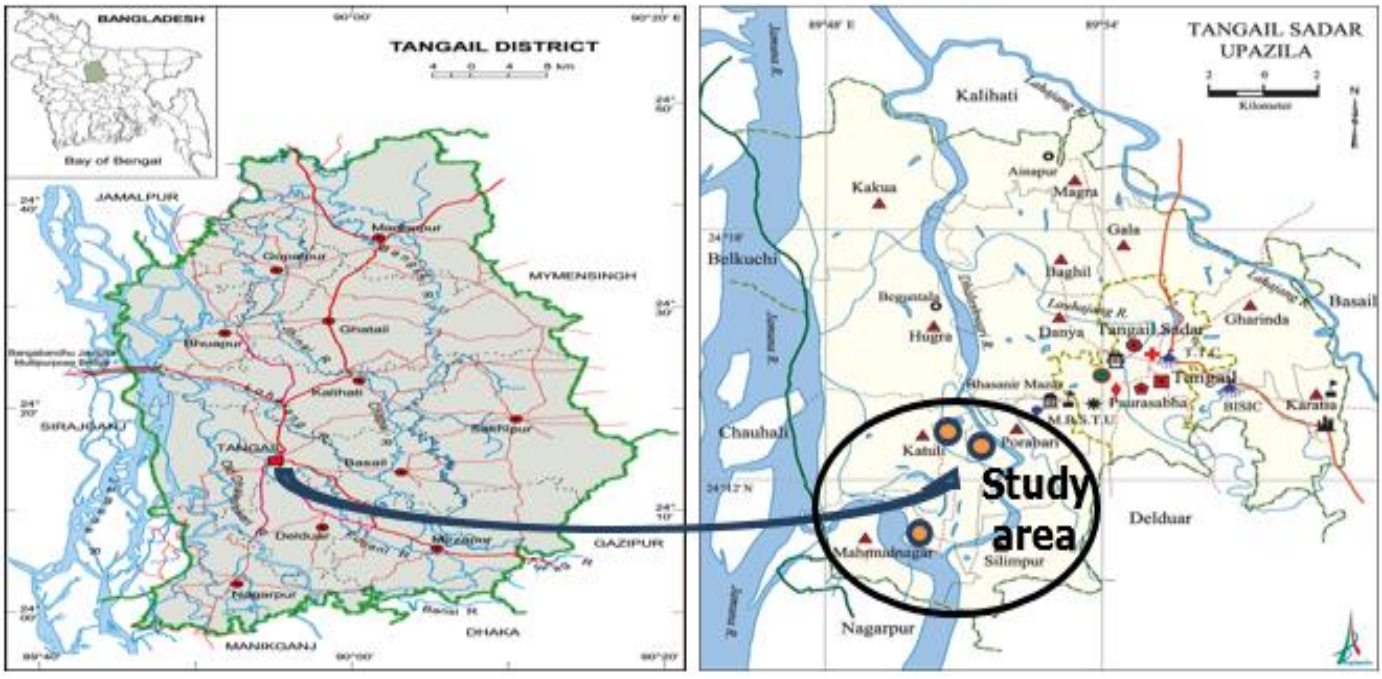

Fig 1: Map showing the three sampling sites (Study Area) of the Dhaleshwari River, Tangail, Bangladesh [17].

2.2 Sample collection

Fish samples were collected three times in each of the three months of March, April and May 2016 after 10 days interval from all the three locations for each of the six available species as shown in Table 2 and immediately put into isolated containers of ice-box. The collected samples were preserved with proper labels in a freezer at -20 °C [11, 16] until the analysis in Laboratory. Individual fishes of the same species were almost similar in size and weight.

Table 2: The collected fish samples with local and scientific names.

Species	Local Name	Scientific Name
Species 1	Taki	*Channa punctatus*
Species 2	Bain	*Mastacembelus armatus*
Species 3	Tengra	*Mystus vittatus*
Species 4	Puti	*Puntius puntio*
Species 5	Shing	*Amblyceps mangois*
Species 6	Chingri	*Metapenaeus spinulatus*

2.3 Sample analysis

The fish samples were analyzed at Institute of National Analytical Research and Service (INARS), BCSIR, Dhaka, Bangladesh which is an ISO/IEC 17025 accredited laboratory. Prior to analysis, all preserved samples were taken to the room temperature. The collected fish samples were analyzed for heavy metals *viz*. Pb, Cd, Cr, Hg and As using standard method [18] and finally, their average value was taken. During analysis, accuracy and precision were verified by using Certified Reference Materials (CRM) from Fluka Analytical, Sigma-Aldrich and spike recovery for all metals were 90-110% as calculated by the following equation.

$$\text{Recovery (\%)} = \frac{\text{Concentration of spike sample} - \text{Concentration of unspike sample}}{\text{Amount of spike}} * 100$$

A standard solution after five samples and a reagent method blank after ten samples were determined for analytical quality control. All reagents were Analytical Grade (AR) and purchased from Merck, Germany. A high precession calibrated electrical balance "GR-200", A&D Company Limited, Tokyo, Japan was used for weighing. All glassware including pipette and volumetric flask were also calibrated. They were soaked in10% (v/v) HNO_3 overnight and rinsed with deionized water and dried prior using. The deionized water with resistance greater than 18.2 MΩ-cm and conductivity less than 0.2 µS cm^{-1} was used throughout the whole experiment and prepared by RF ultrapure water system, Barnstead.

2.4 Analysis of heavy metals in fish samples by Atomic Absorption Spectrometer (AAS)

2.4.1 Sample preparation

At first, the fish samples were washed with deionized water and soaked with tissue paper in order to remove the adhered moister and then gutted and flesh was separated collecting in a watch glass for each sample. Then samples were prepared for heavy metal analysis in two different way. For the analysis of Pb, Cd and Cr, about 20g of samples were taken in previously cleaned and dried beakers. The samples were dried in an oven at 105 ºC overnight. After oven dry, the beaker containing samples were placed in muffle furnace covering with a watch glass remaining a slight gap at 150 °C for 1 h and then the temperature of the furnace was raised to 200 ºC, 300 ºC and 400 ºC gradually to avoid the loss of samples maintaining each temperature for one hour and finally the temperature was raised to 550 ºC keeping for 4-5 h to obtain ash that is white and free from carbon. After ashing, the sample beaker was removed from furnace and cooled. Then 1-3 mL of concentrated nitric acid and distilled water (1:1) were added in the beakers to wet the sample and for the complete removal of unwanted carbon particles which was then heated on a hot plate at about 150 ºC under a fume hood chamber until all the fumes removed or almost to dryness. Then the beakers were returned again to the furnace setting the temperature directly at 550 ºC for 2-3 h and cooled. The ash was then dissolved in 10 mL of concentrated nitric acid warming on a hot plate at 180-200 ºC for 5-10 min to aid in solution by keeping a watch glass on each beaker and heated until boiling. After complete dissolved of ash, the beakers containing sample were taken out from the hot plate and cooled at room temperature. Then the samples were taken in 50 mL calibrated volumetric flasks rinsing several times with deionized water and made up to the mark. The flasks were shaken well to uniform mixing the samples and then filtered to previously cleaned and labeled 100 mL non-transparent plastic bottles with Whatman™ qualitative 1 filter paper (125 mm dia.*100 circles) and preserved in the laboratory for heavy metal analysis.

For the analysis of Hg and As having a relatively low boiling point, about 20g of fish samples were taken in previously cleaned and dried beakers by weighing and then 20 mL of concentrated nitric acid and 10 mL of concentrated perchloric acid were added to each sample in beakers. The sample in beakers was boiled for digestion on the hot plate at 180-200 ºC covering with a watch glass under a fume hood chamber to almost dryness. The process was repeated until a colorless solution is obtained by evaporating the volatile organic matter after complete decomposition with oxidizing acids. Then the colorless samples solution were transferred into 50 mL calibrated volumetric flasks rinsing several times with deionized water after cooling at room temperature and made up to the mark. The samples solution was shaken well to uniform mixing and then filtered to previously cleaned 100 mL non-transparent plastic bottles with a label and preserved for analysis in the laboratory.

Three replicates were made for each fish sample preparation in both of the above process. A sample blank was also prepared in both processes following the same procedure as described for quality control.

2.4.2 Instrumental Analysis

Heavy metals were analyzed by AAS. The Pb, Cd and Cr concentrations of water and fish samples were analyzed using Zeeman Atomic Absorption Spectrometer (Model: GTA 120-AA240Z with PSD 120 auto sampler, Varian, Australia). Hg concentration of samples was analyzed using cold vapor hydride generation technique in AAS (Model: AA240 FS with VGA-77, Varian, Australia) and the concentration of Arsenic in the samples were determined using electric hydride vapor generation technique in AAS (Model: SpcetrAA 220 with an electrothermal temperature controller (ETC)-60 and VGA-77, Varian, Australia). The instrument uses specific Hollow Cathode Lamp (HCL) for each metal under the conditions as shown in Table 3. A calibration curve was prepared for all metals by running different concentrations of working standard solutions prepared from CRM obtained from Fluka Analytical, Sigma-Aldrich and concentrations of heavy metals of the samples were determined against the prepared

calibration curve. The stock standard solutions were 1000±4 mgL^{-1} as metals traceable to National institute of Standards and Technology (NIST) and measured against CRM produced and certified in accordance with ISO/IEC 17025 and ISO guide 34. During fish sample analysis, the samples were diluted for higher concentrations of heavy metals. Average values of three consecutive replicates were taken for each determination. The Method Detection Limit (MDL) for heavy metals: Pb, Cd, Cr, Hg and As were 4.3411, 0.1986, 1.7963, 0.8071 and 0.0799 μgL^{-1} respectively.

Table 3: HCL condition during heavy metal analysis by AAS

Heavy Metals	Hollow Cathode Lamp (HCL) Condition		
	Lamp Current (mA)	Wavelength (nm)	Slit Width (nm)
Pb	10.0	217.0	1.0
Cd	4.0	228.8	0.5
Cr	7.0	357.9	0.2
Hg	4.0	253.7	0.5
As	10.0	193.7	0.5

2.5 Statistical analysis
Pearson's correlation (r) matrix among the parameters was computed to show the association among the parameters. Descriptive statistics of the parameters were also computed to show their average behaviors and dispersions. All statistical analyses were performed using IBM SPSS Statistics, version 20 (IBM Corporation, Armonk, NY).

3. Results and Discussions
The concentrations of heavy metals in the available fish species of the Dhaleshwari River as determined in the months from March to May, 2016 are tabulated in Table 4. Descriptive statistics of heavy metals for the fish samples in Dhaleshwari river water is tabulated in Table 5 and Pearson's correlation (r) matrix among the heavy metals is shown in Table 6.

Table 4: Mean values of heavy metals in fish samples of wet weight at three different locations of the Dhaleshwari river during the months from March to May 2016 with measurement uncertainty (±) (k=2).

Species	Months	Pb $mgkg^{-1}$	Cd $mgkg^{-1}$	Cr $mgkg^{-1}$	Hg $mgkg^{-1}$	As $mgkg^{-1}$
Species 1 (*Mastacembelus armatus*)	March	0.086±0.027	0.010±0.002	0.007±0.001	0.001±0.000	<0.005±0.001
	April	0.100±0.031	0.004±0.001	0.154±0.032	0.010±0.001	0.022±0.004
	May	0.091±0.028	0.005±0.001	0.159±0.033	0.011±0.001	0.027±0.004
Species 2 (*Channa punctatus*)	March	0.124±0.038	0.019±0.003	0.046±0.010	0.002±0.000	0.011±0.002
	April	0.130±0.040	0.004±0.001	0.006±0.001	0.006±0.000	0.013±0.002
	May	0.133±0.041	0.011±0.002	0.032±0.007	0.005±0.000	0.016±0.003
Species 3 (*Mystus vittatus*)	March	0.242±0.075	0.011±0.002	0.083±0.017	0.008±0.000	<0.005±0.001
	April	0.178±0.055	0.010±0.002	0.116±0.024	0.003±0.000	0.033±0.005
	May	0.234±0.073	0.012±0.002	0.107±0.022	0.005±0.000	0.029±0.005
Species 4 (*Puntius puntio*)	March	0.168±0.052	0.002±0.000	0.113±0.024	0.008±0.000	0.063±0.010
	April	0.150±0.047	0.002±0.000	0.100±0.021	0.004±0.000	0.054±0.009
	May	0.174±0.054	0.002±0.000	0.124±0.026	0.006±0.000	0.061±0.010
Species 5 (*Amblyceps mangois*)	March	0.175±0.054	0.061±0.010	0.047±0.010	0.005±0.000	0.030±0.005
	April	0.177±0.055	0.060±0.010	0.078±0.016	0.005±0.000	0.028±0.004
	May	0.183±0.057	0.063±0.012	0.102±0.021	0.004±0.000	0.035±0.006
Species 6 (*Metapenaeus spinulatus*)	March	0.288±0.089	0.005±0.001	0.103±0.021	0.016±0.001	0.128±0.020
	April	0.265±0.082	0.004±0.001	0.098±0.020	0.011±0.001	0.110±0.018
	May	0.231±0.072	0.005±0.001	0.112±0.023	0.012±0.001	0.117±0.019
FAO standard value [19, 20]		0.5	0.05	0.15	0.5	0.1

Heavy metals have a great impact on the aquatic ecosystem. The concentration of Lead (Pb) in the fish of river ranged as: 0.086 to 0.288 $mgkg^{-1}$ and shows an insignificant positive correlations with Cd and Cr as r = 0.017 and r = 0.198 respectively while shows significant positive correlation with Hg (P<0.05) and As (P<0.01) as r = 0.503 and r = 0.680 respectively. The highest concentration of Pb was observed in *M. spinulatus* (Species 6) in all three months and then in *M. vittatus* (Species 3) in March and May which were below than the acceptable level in fish by FAO [19, 20] (0.5 $mgkg^{-1}$) and the lowest was in *M. armatus* (Species 1). Lead is a probable human carcinogen and can affect every organ and system in the body. Exposure to high lead levels can severely damage the brain, kidney and ultimately cause death [21]. Ahmed *et al.* [15] found the concentration (dry weight basis) of Pb in the fish species *Trypauchen vagina, Glossogobius giuris* and *Lamellidens marginalis* collected from three stations of the Dhaleshwari river, Bangladesh ranged from 6.14-8.03, 0.61-0.71and 7.03-59.21 $mgkg^{-1}$ respectively with seasonal variations (pre-monsoon, monsoon and post-monsoon). Ahmed *et al.* [1] recorded average bioaccumulation levels of Pb in a fresh water Ayre fish (*Sperata aor*) of the Dhaleshwari River which was 18.776 $mgkg^{-1}$ of dry weight.

Table 5: Descriptive statistics of the heavy metals in fish from the Dhaleswari river.

Heavy Metals	N	Range	Min.	Max.	Sum	Mean	SD
Pb	18	0.202	0.086	0.288	3.129	0.17383	0.059257
Cd	18	0.061	0.002	0.063	0.290	0.01611	0.021282
Cr	18	0.153	0.006	0.159	1.587	0.08817	0.044520
Hg	18	0.015	0.001	0.016	0.122	0.00678	0.003919
As	18	0.123	0.005	0.128	0.787	0.04372	0.038362

*Min. = Minimum, Max. = Maximum, SD = Standard Deviation.

Cadmium (Cd) concentration in the Dhaleshwari river fish ranged as: 0.002 to 0.063 mgkg^{-1} and shows an insignificant positive correlation with Pb as r = 0.017 and shows insignificant negative correlations with Cr, Hg and As as r = -0.209, r = -0.345 and r = -0.252 respectively. The highest concentration of Cd was observed in *A. mangois* (Species 5) in all three months which are slightly greater than the permissible level by FAO [19, 20] (0.05 mgkg^{-1}) and the lowest was in *P. puntio* (Species 4). Cadmium is known human carcinogens [21]. Ahmed *et al.* [15] found the concentration (dry weight basis) of Cd in the fish species *Trypauchen vagina*, *Glossogobius giuris* and *Lamellidens marginalis* collected from three stations of the Dhaleshwari river, Bangladesh ranged from 0.51-0.73, 4.25-8.17 and 0.56-7.23 mgkg^{-1} respectively with seasonal variations (pre-monsoon, monsoon and post-monsoon). Ahmed *et al.* [1] recorded average bioaccumulation levels of Cd in Ayre fish (*Sperata aor*) of the Dhaleshwari River which was 0.4873 mgkg^{-1} of dry weight.

Table 6: Pearson's Correlation matrix among the heavy metals in fish of the Dhaleswari River.

Heavy Metals	Pb	Cd	Cr	Hg	As
Pb	1	0.017	0.198	0.503*	0.680**
Cd	0.017	1	-0.209	-0.345	-0.252
Cr	0.198	-0.209	1	0.514*	0.382
Hg	0.503*	-0.345	0.514*	1	0.716**
As	0.680**	-0.252	0.382	0.716**	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

The concentration of Chromium (Cr) in the Dhaleshwari river water fish is in the range: 0.006 to 0.159 mgL^{-1} and shows insignificant positive correlations with Pb and As as r = 0.198 and r = 0.382 respectively and an insignificant negative correlation with Cd as r = -0.209. Besides, Cr shows significant positive correlations with Hg (P<0.05) as r = 0.514. The highest concentration of Cr was observed in *M. armatus* (Species 1) in April and May which were slightly greater than the acceptable level in fish by FAO [19] (0.15 mgkg^{-1}) and the lowest concentration (0.006±0.001 mgkg^{-1}) was in *C. punctatus* (Species 2) in April. Chromium (VI) compounds are toxins and known human carcinogens, whereas breathing high levels of chromium (III) can cause irritation to the lining of the nose, nose ulcers, runny nose, and breathing problems [21]. Ahmed *et al.* [15] found the concentration (dry weight basis) of Cr in the fish species *Trypauchen vagina*, *Glossogobius giuris* and *Lamellidens marginalis* collected from three stations of the Dhaleshwari river, Bangladesh ranged from 6.92-12.23, 7.15-11.92 and 9.38-501.11 mgkg^{-1} respectively with seasonal variations (pre-monsoon, monsoon and post-monsoon). Ahmed *et al.* [1] recorded average bioaccumulation levels of Cd in Ayre fish (*Sperata aor*) of the Dhaleshwari river which was 1.458 mgkg^{-1} of dry weight.

The Mercury (Hg) concentration in the Dhaleshwari River water fish ranged as: 0.001 to 0.016 mgkg^{-1} and shows strong positive correlation (P<0.01) with As as r = 0.716 and in addition to this, Hg shows significant positive correlations (P<0.05) with Pb and Cr as r = 0.503 and r = 0.514 respectively and an insignificant negative correlation with Cd as r = -0.345. The highest concentration (0.016±0.001 mgkg^{-1}) of Hg was observed in *M. spinulatus* (Species 6) in March which is far below the permissible level by FAO [19, 20] (0.5 mgkg^{-1}) and the lowest value (0.001 mgkg^{-1}) was in *M. armatus* (Species 1) in March. Mercuric chloride and methyl mercury are possible human carcinogens. Exposure to high levels can permanently damage the brain, kidneys, and developing fetuses [21]. Afrin *et al.* [22] found Hg levels in three fish species (Taki, Bain and Bele) of Turag river below the detection limit due to having no or a very little source of Hg containing pollutants in the Turag river.

The concentration of Arsenic (As) in the Dhaleshwari river fish was found to vary from less than 0.005 to 0.128 mgkg^{-1} and shows strong positive correlation (P<0.01) with Pb and Hg as r = 0.680 and r = 0.716 respectively and beside this, As shows significant positive correlations with Cr as r = 0.382 and an insignificant negative correlation with Cd as r = -0.252. The highest concentration of As was observed in *M. spinulatus* (Species 6) in all three months which is slightly higher than the permissible level by FAO [19] (0.1 mgkg^{-1}) and the lowest (<0.005 mgkg^{-1}) were in *M. armatus* (Species 1) and *M. vittatus* (Species 3) in March. Arsenic is a probable human carcinogen. Exposure to high levels of As may cause skin disease, kidney disease and coagulate proteins [20].

4. Conclusions

The research work reveals the present heavy metal concentrations level in the selected fish species collected from three different locations of the Dhaleshwari river during March to April 2016. The species *M. spinulatus* (Species 6) was the highest Pb, Hg and As contaminated species by 0.288 mgkg^{-1}, 0.016 mgkg^{-1} and 0.128 mgkg^{-1} respectively. The species *A. mangois* (Species 5) was found to Cd contaminated by 0.063 mgkg^{-1} and *M. armatus* (Species 1) was Cr contaminated by 0.159 mgkg^{-1}. The order of accumulations of the estimated heavy metals in fish found as Pb > As >Cr > Cd >Hg. The heavy metals Pb, Cd, Cr, Hg and As show positive correlations with each other and negative correlations among Cd, Cr, Hg and As for fish species. The heavy metals accumulated in the experimental fishes were found below the

permissible limit except the Cd concentration in *A. mangois* (Species 5), Cr in *M. armatus* (Species 1) and As in *M. spinulatus* (species 6) in which the values were slightly higher than the permissible level and this may be due the use of various agricultural insecticide and pesticide in the surrounding agricultural lands of the study area. Overall, the heavy metal concentrations level in the fish species were below the standard acceptable limits which may not pose threat on aquatic life. Therefore, the consumption of fishes from the studied region of the Dhaleshwari river by humans may not cause any detrimental or toxic effect in regard to estimated heavy metals and the consumption of the available fish species of the river is safe to human beings. The present status should be protected to save the aquatic biota of the river from pollution in near future and more adequate measures should be taken to ensure better fish quality and aquatic life of the Dhaleshwari river.

5. Competing interests
The authors have declared that no competing interests exist.

6. Author's contributions
Md. Younus Mia designed the experiment. Md. Abu Bakar Siddique and Mahbuba Akhter Munni carried out the sample preparation and analysis. Md. Abu Bakar Siddique and Ummey Hafsa Bithi wrote the manuscript with data interpretation and Md. Aminul Ahsan and Md. Ahedul Akbor revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript.

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