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# HEAVY METAL CONCENTRATIONS AND HUMAN HEALTH RISK ASSESSMENT OF SELECTED WILD AND CULTURED FISHES OF BANGLADESH

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**Abstract:** This study was conducted to estimate the concentration of selected heavy metals such as chromium (Cr), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), and lead (Pb) as well as the possible risk to consumer health from the flesh of three wild and cultured fishes (*Labeo rohita*, *Mystus cavasius*, and *Heteropneustes fossilis*) collected from the Meghna river, Narayangonj and Rajoir fish farm, Madaripur district respectively. Heavy metal concentrations were determined using Atomic Absorption Spectrometric method. The average concentration of heavy metals were found in the wild fish samples in the range as Cr (0.295-1.647), Mn (0.900-1.294), Ni (0.063-0.198), Cu (0.179-0.529), Zn (5.487-8.343), Cd (0.004-0.009) and Pb (0.193-0.290) mg/kg dry weight while in the cultured fish samples in the range as Cr (0.043-0.315), Mn (0.975-2.36), Co (BDL), Ni (0.005-0.095), Cu (0.238-0.978), Zn (5.487-8.305), Cd (0.004-0.009), and Pb (0.238-0.286) mg/kg dry weight respectively. The hierarchy of mean concentration of heavy metals in wild fishes was Zn> Mn> Cu> Pb> Cr> Ni > Cd and in the cultured fishes, the order was found Zn> Mn> Cr> Pb> Cu> Ni > Cd. The present study showed that the wild fish accumulated higher concentration of heavy metals in their muscles than the cultured fish. The analyzed Ni, Cu, Zn, Cd, and Pb were below the allowable level specified by international agencies (FAO, WHO, EU, CE, USEP). In order to assess the human health risk, the Target Hazard Quotient (THQ), Hazard Index (HI), and Target carcinogenic Risk (TR) were calculated. The TR values suggested that the fishes posed low to moderate carcinogenic risk from Cr, Ni and Cd. Consequently, continuous and excessive consumption of these fish species over a lifetime will increase the possibility of causing cancer.

***Key words:*** Heavy metals, fish, Atomic Absorption Spectrometry**,** health risk

## INTRODUCTION

Bangladesh is regarded as one of the foremost suitable areas for harvesting

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fish and other aquatic life in the world. It has the world's largest submerged wetland and Asia's third largest aquatic biodiversity after China and India (Shamsuzzaman *et al.* 2017). The inland water resources of Bangladesh provide great potential for the expansion and development of freshwater fisheries and aquaculture (Hossain 2014). River pollution has been a serious issue in Bangladesh because of increasing industrialization, which has resulted in a rise in the usage of chemicals as raw material. In addition, anthropogenic human activities are increasing the availability of heavy metals in water reservoirs at an alarming rate, especially lakes, canals, rivers and aquatic organisms, which has become a global problem (Malik *et al.* 2010). Animal wastes like livestock, poultry, and cattle manures are utilized as food in aquaculture ponds and are normally provided to fish in the form of solids or semisolids. The manures produced by animals as a result of these diets include higher levels of copper, arsenic, and zinc and if fed to fish in a pond regularly, can result in a considerable accumulation of these metals over time in the sediment (Basta *et al.* 2005). In developed and developing countries like Bangladesh, heavy metal pollution is increasingly contaminating soil, sediment, vegetables, water and fish, which has become a worldwide concern (Ahmad *et al.* 2010 and Islam *et al.* 2014). Heavy metals cause a serious threat to the aquatic environment due to their toxicity, accumulation, and magnification in aquatic organisms (Roy 2010). Heavy metals are a concern not just to public water supplies, but also to human health when consumed in aquatic products, especially fish (Terra *et al.* 2008).

Fish has been known as a good accumulator of organic and inorganic pollutants (Gado *et al.* 2003). Human uptakes the pollutants through consumption of fish. Heavy metal toxicity in the human body can result in cardiovascular illness, liver damage, renal failure, and even death. (Castro *et al.* 2008 and Rahman *et al.* 2012). Furthermore, chronic lead exposure can cause sickness, mental impairment, and even death (Al-Busaidi *et al.* 2011). Cadmium damages the kidneys and causes chronic toxicity symptoms such as decreased renal function, decreased reproductive capacity, hypertension, tumors, and hepatic dysfunction (Al-Busaidi *et al.* 2011, Luckey and Venugopal 1977 and Rahman and Islam 2010). Other metals, such as chromium, zinc, and copper, can induce nephritis, anuria, and severe kidney lesions (Luckey and Venugopal 1977 and Rahman and Islam 2009). Heavy metal contamination has a detrimental impact on the ecological balance of the adoptive environment and the diversity of aquatic organisms (Vosyliene and Jankaite 2006). Therefore, the problem of heavy metal pollution in fish has drawn global attention.

As fish can metabolize xenobiotic and bio-accumulate pollutants directly from polluted water and sediment by diffusion through gill and skin, or they may ingest metals with their food, they provide a suitable model for assessing aquatic toxicity and wastewater quality (Al-Sabti *et al.* 1995, Minissi *et al.* 1996 and Frank *et al.* 1999). Fish are often used as biological indicators because they play multiple roles in the nutrient network, bio-accumulate toxic substances, and respond to low concentrations of pollutants (Klobucar *et al.* 2010). Furthermore, fish are known for their ability to accumulate heavy metals in their muscles while muscle is the main part of the absorption of metals and, since fish is an important part of the human diet. But it must be carefully examined to ensure that excessive levels of heavy metals are not being transferred to the human through fish consumption (Mahboob *et al.* 2014). The present study was aimed to analyze the heavy metal concentrations in three commonly consumed fish species of wild and cultured type and to estimate the health risk to human through dietary consumption.

## MATERIAL AND METHODS

*Sample collection:* The three commonly consumed fish species such as Rui (*Labeo rohita*), Gulsha (*Mystus cavasius)* and Shing (*Heteropnuestes fossilis*) of both wild and cultured type were studied to determine the heavy metal concentrations. Wild fish samples were collected directly from the fisherman of the Meghna River at Boidyer Bazar, Narayanganj District and cultured fish samples were collected from a culture pond of Rajoir fish farm, Rajoir upazila, Madaripur district, in November 2019 (Fig. 1). In case of Rui fish, ten fish samples were collected and incase of Gulsha and Shing, around three Kilogram fishes (55 Gulsha individuals and 45 Shing individuals) were collected. The samples were transported immediately to the fisheries laboratory of the department of Zoology, Jagannath University into a chill-box. Collected samples were identified by using the morphological characteristics, following Shafi and Quddus (1982), Rahman (2005) and Fish base (2014), and then stored in freezer at -20 °C in jip-locked plastic bags with proper labeling.

*Sample preparation:* The samples were taken out from the freezer and thaw at room temperature. The muscles of fishes were taken with the help of steam cleaned stainless steel knife and washed with distilled water. The cleaned fish muscles were homogenized by a blender. Three replicates of each grinded fish sample were analyzed. The determination of moisture and ash contents and digestion were carried out in the Basic Facilities and Sample Processing Laboratory of Centre for Advanced Research in Science (CARS), University of Dhaka, Bangladesh. The analysis of eight different heavy metals namely chromium (Cr), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), and lead (Pb) was carried out in BCSIR (Bangladesh Council of Scientific and Industrial Research), Dhaka.

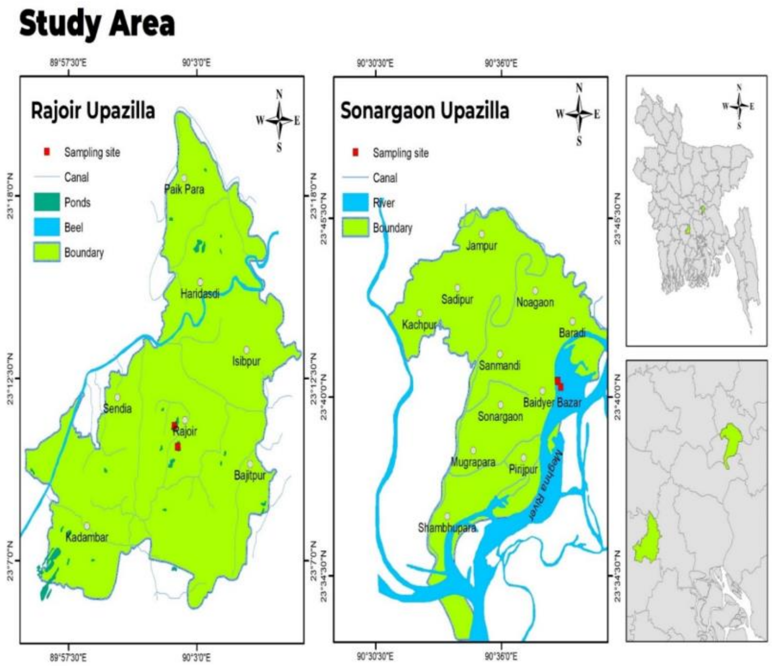


Fig 1. Location Map of study areas (Culture Pond of Rajoir upazilla, Madaripur and Meghna river of Boidyer Bazar, Sonargaon Upazila, Narayanganj)

*Determination of moisture content*: The weight of moisture free dried empty crucibles was taken, then 10 g blended fish sample were added in each crucible. The crucibles with samples were placed in an oven at 105 °C for 6 hours and then transferred into desiccators. The repeated weight was taken till constant weight was obtained and recorded.

*Determination of ash content*: The crucible 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 °C, 300 °C and 400 °C gradually to avoid the loss of sample. The temperature was raised to 600 °C, keeping for 8 hours to obtain ash that is white and free from carbon. Afterwards crucibles were transferred to the desiccators, weighting were repeated till constant weight was obtained and recorded.

*Digestion of fish samples:* For digestion, 0.2 g dried sample was taken in a beaker and 5 mL of conc. $HNO_3$ was added to the beaker. Then the samples were put on hot plate at 60 °C for digestion under fume hood. When the concentration drops, add 2 mL $H_2O_2$ to each sample. Finally, place the mixture on a hot plate at 100°C under a fume hood covering with a watch glass until it become transparent. The digests were allowed to cool and filtered with filter paper, then transferred to a different 50 mL volumetric flask and filled to the 25 mL mark with deionized water to obtain the final volume as a stock solution and kept ready for heavy metal analysis through Atomic Absorption Spectrometry (AAS).

*Standards:* Standard solutions of selected eight heavy metals such as Cr, Mn, Co, Ni, Cu, Zn, Cd, and Pb were provided by Fluka Analytical, Sigma-Aldrich (Germany). A calibration curve was prepared for all elements by running different concentrations of standard solutions prepared from certified reference materials (CRM) obtained from Fluka Analytical, Sigma-Aldrich. The standards were prepared from the individual 1000 mg/L standards (Merck) supplied in 0.1N HNO3. A series of working standards were prepared from these standard stock solutions.

*Analysis of heavy metal by AAS:* Eight heavy metal i.e. Cr, Mn, Co, Ni, Cu, Zn, Cd, Pb were determined by AAS using Zeeman Atomic Absorption Spectrophotometer (GTA 120-AA240Z with PSD 120 auto sampler, Varian, Australia). Measurements were carried out using standard hollow cathode lamps for Cr, Mn, Co, Ni, Cu, Zn, Cd, and Pb. The standard operating conditions for the analysis of heavy metals using AAS used in the experiments are given in Table-1. The results were shown as mg/kg or ppm of dry weight. The glassware and containers used in the study were cleaned thoroughly then rinsed with double distilled water for 3-4 times and dried in air prior to use.

**Table 1. Standard operating conditions for metal analysis using AAS**

| Element | Lamp current (mA) | Wavelength (nm) | Flame | Slit setting (nm) |
|---|---|---|---|---|
| Zn | 5.0 | 213.9 | Air-acetylene | 1.o |
| Cr | 7.0 | 357.9 | | 0.2 |
| Pb | 10.0 | 279.5 | | 1.0 |
| Cu | 4.0 | 324.8 | | 0.5 |
| Mn | 5.0 | 217.0 | | 0.2 |
| Ni | 10.0 | 232.0 | | 0.2 |
| Cd | 4.0 | 228.8 | | 0.5 |

*Health Risk assessment:* The values of heavy metal concentration were used to calculate the estimated target hazard quotients (THQ), hazard index (HI), and target cancer risk (TR) of individuals.

*Target Hazard Quotient:* The Target Hazard Quotient (THQ) is a measure of the level of non-cancer risk associated with exposure to contaminants. THQ is evaluated using the US Environmental Protection Agency Risk-Based concentration Table-III to estimate the risk to human health from the consumption of metal-contaminated fish (US EPA 2011). The formula used for calculating the THQ is as follows:

$$\mathbf{THQ} = \frac{\mathbf{EF \times ED \times FIR \times CF \times CM}}{\mathbf{WAB \times ATn \times RfD}} \times \mathbf{10^{-3}}$$

where THQ is the target hazard quotient, EF is the exposure frequency (365 days/year), ED is the exposure duration (30 years for non-cancer risk as used by USEPA 2011), FIR is the fish ingestion rate (49.5 g/person/day; BBS 2011), Cf is the conversion factor (00.208) to convert fresh weight (Fw) to dry weight (Dw) considering 79 % of moisture content in fish, CM is the heavy metal concentration in fish (mg/kg d.w), WAB is the average body weight (bw) (70 kg), ATn is the average exposure time for non-carcinogens (EF×ED) (365 days/year for 30 years (i.e., ATn=10,950 days) as used in characterizing non-cancer risk (USEPA 2011), and RfD is the reference dose for metals where, Cr=0.003, Mn =0.14, Co= 0.0003, Ni=0.14 Cu=0.03, Zn=0.3, Cd=0.001 and Pb=0.2 (USEPA 2011, 2012).

*Hazard index:* To assess the overall potential health risks of more than one metal, the THQ of each metal is added together called the Hazard Index (HI). HI can be calculated by summing the target risk ratio of each metal (USEPA 2011).

Here, HI =THQ (Zn) + THQ (Pb) + THQ (Mn) + THQ (Ni) + THQ (Cu) + THQ (Cr) + THQ (Cd)

*Target cancer risk:* Target cancer risk (TR) is used to indicate cancer risk. The US Environmental Protection Agency's Zone III Hazard-Based Concentration Table (USEPA 2011) also provides a method for estimating TR. The model to calculate TR is the following:

$$\mathrm{TR} = \frac{\mathrm{EF \times ED \times FIR \times CF \times CM \times CPSo}}{\mathrm{WAB \times ATc}} \times 10^{-3}$$

Where TR is the target cancer risk, CPSo is the carcinogenic potency slope, oral (mg/kg bw/day), and ATc is the averaging time, carcinogens (365 days/year for 70 years as used by USEPA 2011). Since CPSo values of Cr (0.5), Ni (1.7) (USEPA, 2011), Cd (0.6) and Pb (0.009) (Alam *et. al.* 2015 and Oehha 2011) were only known. Therefore, the TR value of the intake of these metals was calculated.

## RESULTS AND DISCUSSION

*Moisture content:* The moisture content in the studies fishes ranged between 74.61% (cultured *H. fossilis*) to 84.64 % (wild *H. fossilis*) (Table 2). The

**Table 2. Heavy metal concentrations in the experimental wild and cultured fish (Values expressed as mean ± SD in mg/kg in dw and n=3)**

| Fish | Type | Residual level of heavy metals in mg/kg unit | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Cr** | **Mn** | **Co** | **Ni** | **Cu** | **Zn** | **Cd** | **Pb** |
| | Wild | 0.295±0.0002 | 1.294±0.006 | BDL | 0.198±0.008 | 0.266±0.004 | 5.668±0.0003 | 0.004±0.0006 | 0.290±0.004 |
| Rui | Cultured | 0.315±0.005 | 2.36±0.004 | BDL | 0.095±0.05 | 0.238±0.006 | 8.305±0008 | 0.005±0.0062 | 0.238±0.02 |
| | Wild | 0.164±0.0002 | 0.900±0.0003 | BDL | 0.072±0.0004 | 0.529± 0.0006 | 8.343±0.001 | 0.009±0.0003 | 0.288±0.005 |
| Gulsha | Cultured | 0.146±0.0007 | 0.975±0.006 | BDL | 0.018±0.0004 | 0.511±0.0007 | 8.292± 0.009 | 0.009±0.0006 | 0.284±0.09 |
| | Wild | 1.647±0.007 | 1.061±0.06 | BDL | 0.063±0.0007 | 0.179±0.001 | 5.487±0.003 | 0.094±0.0003 | 0.193±0.003 |
| Shing | Cultured | 0.043±0.004 | 1.837± 0.0005 | BDL | 0.005± 0.0009 | 0.978± 0.0003 | 5.487±0.0005 | 0.005± 0.0064 | 0.286±0.004 |
| FSG (mg/kg) | | (1.0) (WHO 1989) | 1.0 (WHO 1995) | | 80 (USFDA 1993) | 30 (WHO 1995) | 100 (WHO (2010) | 0.5 (FAO 1983) | 2.0 (WHO 1995) |

*dw-dry weight, n= replicate number, BDL-Below Detection Limit and FSG-Food Safety guide mean concentrations of moisture content were analyzed in the sequences of 78.68% (*M. cavasius*) <83.09% (*H. fossilis*) <84.64% (*L. rohita*) in the wild samples and 74.61% (*H. fossilis*) < 76.83% (*L. rohita*) < 80.28`% (*M. cavasius*) in cultured samples respectively.

*Ash content:* The ash content in the experimental fishes ranged between 1.28% (cultured *L. rohita*) to 2.76 % (cultured *M. cavasius*) (Table 2). The mean concentrations of ash contents were found in the ranking order of 1.67% (*M. cavasius*) <1.769% (*H. fossilis*) <1.92% (*L. rohita*) in wild fish and 1.28% (*L. rohita*) < 1.67% (*H. fossilis*) < 2.76`% (*M. cavasius*) in cultured fish respectively. The moisture and ash contents varied considerably might be due to differences in species, trophic position and habitat etc.

*Heavy metals:* The concentrations of eight heavy metals such as Cr, Mn, Co, Ni, Cu, Zn, Cd, and Pb in the wild and cultured fish species were observed (Table 2).

*Chromium (Cr)*: The mean concentration of Cr in the fishes was in the range of 0.043 (cultured *H. fossilis*) to 1.647 (wild *H. fossilis*) *mg/kg dry-wt basis*. It *was analyzed in the order of* 0.164 (*M. cavasius*) < 1.647 (*H. fossilis*) < 0.295 (*L. rohita*) mg /kg dw in wild fishes and 0.043 (*H. fossilis)* < 0.146 (*M. cavasius)* < 0.315 *(L. rohita*) 0.164 (*M. cavasius*) mg /kg dw in cultured fishes. The concentration in wild *H. fossilis* was above the recommended maximum permissible limit 1.0 mg/kg (WHO, 1989).

*Manganese (Mn):* The range of the average concentration of Mn in fishes was 0.900 (wild *M. cavasius*) to 2.36 (cultured *L. rohita*) mg /kg dw. While the ascending orders of this content are as follows: 0.900 (*M. cavasius*) < 1.061 (*H. fossilis*) < 1.294 (*L. rohita*) mg /kg dw in wild fishes and 0.975 (*M. cavasius*) < 1.837 *(H. fossilis*) < 2.36 (*L. rohita*) mg /kg dw in cultured fishes. The Mn concentrations in four samples out of six, namely wild and cultured *L.rohita* and *H. fossilis* were higher than the recommended maximum permissible limit 1.0 mg/kg (WHO, 1995).

*Cobalt (Co):* Co was analyzed as below detected limit in all the six samples.

*Nickel (Ni)*: Ni content varied between 0.018 (cultured *M. cavasius*) to 0.198 (wild *L. rohita*) mg /kg dw. This metal was distributed according to the chronologies: 0.063 (*H. fossilis*) < 0.072 (*M. cavasius*) < 0.198 (*L. rohita*) mg /kg dw in wild fishes and 0.004 (*H. fossilis*) < 0.018 (*M. cavasius*) < 0.095 (*L. rohita*) mg /kg dw in cultured fishes.

*Copper (Cu)*: Copper was detected at mean concentrations between 0.179 (wild *H. fossilis*) to 0.978 (cultured *H. fossilis*) mg /kg dw. The metal was distributed as 0.179 (*H. fossilis*) < 0.266 (*L. rohita*) < 0.529 (*M. cavasius*) mg /kg dw in the wild fishes and 0.238 (*L. rohita*) <0.511(*M. cavasius*) <0.978 (*H. fossilis*) mg /kg dw in cultured fishes.

*Zinc (Zn):* The mean concentration of Zn was in the range of 5.487 (wild *H. fossilis) to* 8.343 (wild *M. cavasius)* mg /kg dw. It was distributed according to the chronologies: 5.487 (*H. fossilis*) <5.668 (*L. rohita*) <8.292 (*M. cavasius*) and 5.487 (*H. fossilis*) <8.291 (*M. cavasius*) <8.305(*L. rohita*) mg /kg dw in wild and cultured fishes respectively.

*Cadmium (Cd)*: The highest Cd concentration was found in wild *H. fossilis* (0.094 mg/kg) and the lowest was in wild *L. rohita* (0.004 mg/kg). It was analyzed in the order of 0.004 (*M. cavasius*) <0.009 (*L. rohita*) <0.094 (*H. fossilis*) mg /kg dw in wild fishes and 0.004 (*H. fossilis*) <0.005 (*L. rohita*) <0.009 (*M. cavasius*) mg /kg dw in the cultured fishes.

*Lead (Pb)*: Lead was varied between 0.193 (wild *H. fossilis*) to 0.290 (wild *L. rohita*) mg/kg dry-wt. This metal was detected in the orders of 0.193 (*H. fossilis*) <0.288 (*M. cavasius*) <0.290 (*L. rohita*) and 0.238 (*L. rohita*) <0.284 (*M. cavasius*) <0.286 (*H. fossilis*) mg /kg dw in wild and cultured fishes respectively.

The analysis showed that the heavy metals detected in fishes varied considerably among different species and also the same species of different habitats. The variation might be due to the fact that accumulation of heavy metals in the fish muscles depends on several factors such as metal concentration, ways of metal uptake, trophic position of fish, physico-chemical condition of the surrounding environment and intrinsic factors (fish age, trophic position, metabolic rate etc.) (Jezierska and Witeska 2006). The result from the comparison with other reported values showed that the degree of contamination in fishes of the study area was found lower from Buriganga and Turag river (Baki *et al.* 2019 and Ahmad *et al.* 2016), Bay of Bengal (Jothi *et al.* 2018) of the country while higher from the Dhaleshwari river (Ahsan *et al.* 2018). The heavy metal concentrations in fishes from Kelanta river, Malaysia (Hashim *et al.* 2014), Bay of Bengal, India (Mitra *et al.* 2011), river Niger, Nigeria (Ujah *et al.* 2017) were also higher than the present study.

*Comparison between wild and cultured fish sample:* The wild *M. cavasius* fish contained higher amount of all detected heavy metals expect Mn than the cultured *M. cavasius*. Wild *H. fossilis* contained higher amount of four heavy metals (Cr, Ni, Zn and Cd) than the cultured one. The wild *L. rohita* contained higher amount of three metals (Ni, Cu and Pb) than cultured sample. The result revealed that the wild fishes were comparatively contaminated with higher accumulation of the analysed heavy metals than cultured species, and it may be attributed to the pollution in the water and sediment of Meghna river (Hassan *et al.* 2015).

*Health risk assessment:* Risk assessment for bio-accumulated heavy metals was estimated using target hazard quotient (THQ), hazard index (HI) and target cancer risk (TR). These parameters depend not only on intake amount of contaminant but also deal with exposure frequency and duration, average body weight and oral reference dose (RfD).

*THQ:* The THQ value has been acknowledged as one of the acceptable parameters for assessing the risk of metals related to contaminated fish consumption (Li *et al.* 2013). The THQ was used to estimate non-carcinogenic risk, and the acceptable threshold level was set at 1, as suggested by the USEPA (2011). If the THQ value is 1, it indicates that there is a little or no non-carcinogenic risk for consumers, however, if it exceeds the specified limits, it may have negative consequences for consumers. The THQ values of heavy metals obtained by consuming the muscles of wild and cultured *L. rohita, H. fossilis*, and *M. cavasius* were showed in Table. 3. THQ values for all individual heavy metals were less than 1 in all three fish species, indicating that ingesting a single heavy metal through the diet of these fish has no non-carcinogenic health risk.

*Hazard Index (HI):* If the value of HI exceeds 1 indicating the metal is toxic cause health hazard to human (Li *et al.* 2013). The values of HI in all the samples were below the tolerable limit 1.

**Table 3. Target hazard quotient (THQ) and Hazard index (HI) for different heavy metals and their hazard index (HI) in the experimental wild and cultured fish**

| | Wild fish species | | | Cultured fish species | | |
|---|---|---|---|---|---|---|
| **Metal** | ***L. rohita*** | ***M. cavasius*** | ***H. fossilis*** | ***L. rohita*** | ***M. cavasius*** | ***H. fossilis*** |
| Cr | 0.002770 | 0.004090 | 0.002690 | 0.001542 | 0.007192 | 0.002690 |
| Mn | 0.012187 | 0.012103 | 0.008110 | 0.007546 | 0.003117 | 0.012019 |
| Ni | 0.004138 | 0.002678 | 0.003392 | 0.000100 | 0.000019 | 0.005874 |
| Cu | 0.001959 | 0.003894 | 0.001317 | 0.001752 | 0.003759 | 0.007135 |
| Zn | 0.001446 | 0.000799 | 0.000804 | 0.004071 | 0.004065 | 0.002103 |
| Cd | 0.000208 | 0.000075 | 0.000065 | 0.000691 | 0.001382 | 0.000004 |
| Pb | 0.000706 | 0.001382 | 0.01382 | 0.001001 | 0.011934 | 0.000691 |
| HI | 0.023414 | 0.025021 | 0.030198 | 0.023414 | 0.025021 | 0.030198 |

*HI=Hazard Index

*Target Cancer Risk (TR):* According to the New York State Department of Health (USEPA, 1989), the TR category is described as if TR ≤ $10^{-6}$ = low; $10^{-4}$ to $10^{-3}$ = medium; $10^{-3}$ to $10^{-1}$ = high; ≥$10^{-1}$ = Very high probability of causing cancer. Like THQ, estimated lifetime cancer risk (TR) is not a specific estimate of expected cancer. Rather, it appears to be the upper limit of the chance that an individual may develop cancer at some point in the consumer's life after exposure to the toxicant (NYSDOH 2007). The values of TR for Cr, Ni, Cd and Pb of the studied fishes were shown in the Table 4. The both wild and cultured *L. rohita* and *M. cavasius* as well as wild *H. fossilis* fish samples had TR in the order of $10^{-4}$ in terms of Cr metal. The present study found that total of five fish samples out of six had a moderate carcinogenic risk from Cr as these fish have carcinogenic slope potency in $10^{-4}$ order. All the six fish samples posed a low cancer risk from Ni consumption as these fish have TR value in the range of E-5 to E-6 order. On the other hand, wild *H. fossilis* samples had E-6 order value for metal Cd consumption; therefore, this fish had a low carcinogenic risk from Cd consumption. In addition, none of fish species were in cancer risk in terms of lead consumption as they have TR value E-7 order.

**Table 4. TR values for Cr, Ni, Cd and Pb of the experimental wild and cultured fish samples**

| Heavy metal | Wild fish species | | | Cultured fish species | | |
|---|---|---|---|---|---|---|
| | *L. rohita* | *M. cavasius* | *H. fossilis* | *L. rohita* | *M. cavasius* | *H. fossilis* |
| Cr | 6.51E-04 | 3.63E-04 | 3.68E-04 | 6.95E-04 | 3.22E-04 | 9.49E-05 |
| Ni | 4.97E-05 | 1.18E-05 | 1.57E-05 | 2.38E-05 | 4.73E-06 | 1.18E-06 |
| Cd | 4.23E-07 | 8.29E-07 | 8.26E-06 | 4.14E-07 | 8.29E-07 | 4.14E-07 |
| Pb | 3.83E-07 | 3.81E-07 | 2.55E-07 | 3.15E-07 | 3.75E-07 | 3.78E-07 |

In the present study, the concentration of only eight heavy metals were analyzed although many others metals persist in the environment. From the results of THQ and HI on the basis of these eight metals, it could be said that the studied fishes have no health hazard. Whereas there may be possibility of health hazard from the fishes considering all metals persist in the environment. Moreover, the TR values of Cr, Ni and Cd of the studied fishes indicated that fishes had moderated and low cancer risk for those metals respectively. So continuous consumption of these fishes through diet over life time may cause serious health hazard to human.

## CONCLUSION

The study was conducted to determine the concentrations of eight selected trace metals such as Cr, Mn, Co, Ni, Cu, Zn, Cd, and Pb in three commonly consumed wild and cultured fish species from Meghna river and cultured pond of Madaripur district respectively. The seven metals except Co were detected in all studied fishes in various concentrations. Among all the studied fishes, wild species were observed more metals concentration than cultured one. The values of Hazard Index (HI) indicated the fishes are safe to eat but the continuous and excessive consumption with the significant amount of toxicants may be regarded a possible cancer risk to human in the lifetime considering the target cancer risk assessment of the study.

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