Heavy Metal Contamination in Pond, Tube Well and Tap Water of Mymensingh Town

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Abstract
Heavy metals are highly toxic, persistent, and accumulative, making them significant environmental pollutants. This study aimed to assess the heavy metal content in pond, tube well, and tap water from five locations in Mymensingh Sadar. A total of 15 composite water samples were collected from the Bangladesh Agricultural University (BAU) campus, Bridge Moor, Maskanda, Town Hall, and Ganginar Par and analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) following standard methods. The results were compared with WHO drinking water standards. In pond water, arsenic (As), cadmium (Cd), cobalt (Co), lead (Pb), chromium (Cr), nickel (Ni), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) were detected across all sites, except Cr in Maskanda, BAU campus, and Town Hall, and Ni in Bridge Moor and Ganginar Par. Pb exceeded the WHO limit (11.6 ppb) in Town Hall pond water. In tube well water, Fe (500.5 ppb) and Mn (165 ppb) surpassed WHO limits in Ganginar Par and BAU campus, respectively, while other metals remained within safe levels. In tap water, Fe (448.8 ppb) in Ganginar Par and Mn (129.8 ppb) in Bridge Moor exceeded WHO limits. Cr was found only in Ganginar Par tap water, while BAU tap water contained no Ni. However, Town Hall tap water had the highest Ni concentration (7.7 ppb). Given the elevated levels of certain heavy metals, purification measures should be prioritized before using the contaminated water for drinking purposes.

Keywords: Heavy metal, ICP-MS, Water contamination

Introduction

One of the elements that make up the earth is water. Human life and their activities cannot be completed without using water. It's the most significant natural resource that exists, and water quality is crucial to human welfare. Nowadays, due to human activity the water resource is contaminated and being dangerous for both onshore and offshore life (Kumar, 2004). On the other hand, quality water is also important for drinking, irrigation, fish culture, etc. In human life, an uncontaminated source of pure drinking water is one of the most important things (Hossain and Patra, 2020). Heavy metals as an environmental pollutant, occurrence in waters from natural (such as chemical weathering of minerals and soil leaching) or anthropogenic sources (such as industrial and domestic effluents, urban storms, water runoff, landfill leachate, mining activities, atmospheric sources, etc.). Both naturally occurring and man-made sources introduce heavy metals into water systems. Over the past two centuries, the amount of heavy metals released by human activity has surpassed that of natural sources (Lohani *et al.*, 2008).

Water pollution is a global issue that has a detrimental impact on life. Heavy metals are among the most significant types of pollutants. The metals classified as heavy have a higher density (relatively) and are toxic in small amounts. As (arsenic), Cr (chromium), Cd (cadmium), Hg (mercury), Tl (thallium), and Pb (lead) are a few common heavy metals. This list also includes a few trace elements, such as copper (Cu), selenium (Se), and zinc (Zn). All of these components are necessary for a healthy metabolism, but as their concentration rises, they may also become hazardous (Lenntech, 2012).

Recent researches reveal excess heavy metal residues in water sources (rivers, canals, ponds, oceans, etc.) which adversely affect human health and the environmental components. Contamination in water decreases its quality and for this reason, the people of underdeveloped and developing countries suffer from health problems associated with either lack of quality water or due to the presence of contamination in water (Myers *et al.*, 2011). Heavy metals from the water bodies directly or indirectly pass through the food chain and eventually cause harm to humans and other aquatic or terrestrial organisms. Researchers reported that river/pond water and fish are contaminated by pesticides and antibiotics as well as heavy metals (Saha *et al.*, 2017; Biswas *et al.*, 2017). Today heavy metals pollution of the groundwater is one of the serious environmental problems. Some of the heavy metals considered micronutrients can cause adverse effects on human health when their contents exceed the permissible limit in drinking water (Prasanna *et al.*, 2011, Prasad *et al.*, 2014). Thus, heavy metals assessment in water bodies is very significant from the human health viewpoint.

Limited information has been reported on heavy metal contamination in water bodies at Mymensingh. The study was conducted to determine the heavy metal contents in water sources of selected areas of Mymensingh and their amount regarding the permissible limits. The objective was to detect the heavy metals concentration in the selected water samples and compare them with the permissible limit provided by WHO. This research would be helpful in monitoring the

future changes in heavy metal content in different water bodies and to assess their impact on that certain area.

Materials and Methods

Experimental Site

Water samples of three sources (pond, tube well, and supply water for drinking) were collected from 5 places in Mymensingh Sadar (BAU Campus, Bridge mor, Maskanda, Town hall, Ganginar par).

Sample collection and preparation

Each sample was collected thrice. A total of 45 samples were collected in plastic bottles weighing 500 ml. The plastic bottles were rinsed thrice with sampled water each time before sampling, filled to their brim, and wrapped tightly by corks to avoid any air bubbles. 15 composite samples were prepared by these 45 samples based on sources and the places of sample collection. Then the bottles were labeled and carried to the laboratory quickly using an ice box.

Water samples were filtered by the Whatman no. 42 filter paper for any impurities. The samples were preserved using 10 ml 2% HNO_3 and the volume was made up to 100 ml with sample water. Finally, the prepared samples were refrigerated for heavy metal analysis.

Laboratory analysis

The water samples were analyzed in the Professor Muhammed Hussain Central Laboratory (PMHCL) of Bangladesh Agricultural University, Mymensingh. As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, and Zn were analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) according to standard methods.

Data analysis and presentation

Descriptive statistical parameters were calculated and presented using Microsoft Office Excel.

Results and Discussion

Heavy metal status in water

Pond water

Among the toxic heavy metals, As, Cd, Co, and Pb were found in all five sampling areas. The concentrations of Pb and As ranged from 2.5-11.6 ppb, and 1.9-5.5 ppb, respectively, and were relatively higher than the other two metals. The highest concentration of Pb was observed at the Town Hall area (11.6 ppb) which exceeded the permissible limit, whereas As was the lowest at the site (1.9 ppb). Cr was detected in the water samples of Bridge Moor and Ganginar par at a deficient concentration, on the other hand, Ni was not present in those areas (**Fig. 1**). Besides, the presence of four essential micronutrients viz. Cu, Fe, Mn, and Zn were detected in all the sampling areas within the ranges of 17.7-24 ppb, 50.4-178.2 ppb, 28.6-53.2 ppb, and 7.7-38.1 ppb, respectively (**Fig. 2**). The relative dominance of heavy metals in pond water samples was observed in the following order: Fe> Mn> Zn> Cu> Pb> As> Co> Cd> Ni> Cr. The values of all metals were within acceptable limits excluding Pb according to WHO (2008).

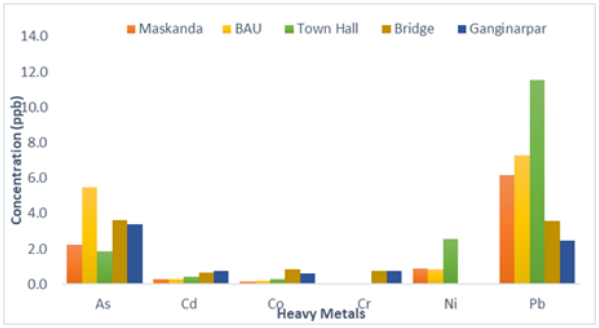

Fig. 1. Concentration of As, Cd, Co, Cr, Ni, and Pb in pond water samples

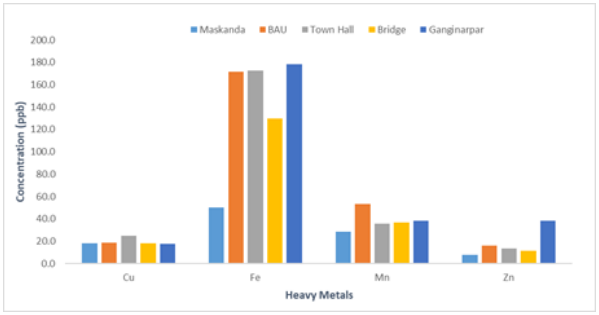

Fig. 2. Concentration of Cu, Fe, Mn, and Zn in pond water samples

Levels of copper (Cu), zinc (Zn), led (Pb), cadmium (Cd), and chromium (Cr) were found in the waters of a fish farm in Mymensingh district, Bangladesh in varied concentrations: Cu (20-100 ppb), Zn (55-72 ppb), Pb (39-66 ppb). The heavy metals ranked in order of Cr > Pb > Cu > Zn > Cd (Sultana *et al.*, 2017). Islam *et al.* (2022) reported the mean concentrations of As, Cd, Pb, Cr, Ni, Cu, Fe, Mn, and Zn in pond water were 59, 33, 67, 136, 133, 280, 733, 127 and 266 ppb. Sarker *et al.* (2019) in their study found the presence of heavy metals and the concentration varied from Pb 1.8 to 3.5 ppb, Nickel 4.5 to 6.9 ppb, Mercury 0.001 to 1.6 ppb, Chromium 2.0 to 2.2 ppb and Manganese 0.03 to 0.8 ppb, respectively. Some of them exceeded the Bangladesh Standard which portrays the pollution problem of these water bodies implying the necessity of proper action.

Tube well water

In tube well water except for Fe and Mn the concentrations of all the metals were within the safe limit. The water of Ganginarpar tubewell contained Fe (500 ppb) much higher than the acceptable limit. As, Cd, Ni, and Pb were found in the samples of all five areas in the ranges of 0.1-1.2, 0.3-0.7, 0.4-5.5, and 1.4-7.8 ppb, respectively, whereas Cr was found in Ganginarpar only with the value of 0.6 ppb (**Fig. 3**). The concentration of Mn exceeded the permissible limit in Maskanda, BAU, Townhall, and Bridge moor except Ganginarpar (**Fig. 4**). BAU campus was free of Co, Cr, and Cu. Dhar *et al.* (2020) reported the concentration of the investigated heavy metals ranging from Fe (18.5−861.6 ppb), Mn (0.020−0.564 ppb), Zn (8.8−96.1 ppb), Cu (5.6−52.9 ppb), and As (<0.5−105.3 ppb). Similar to the present

study, the drinking water samples surpassed the WHO and BDS permissible limit of 100 ppb for Mn, but for Fe it was the opposite. The descriptive statistics results showed that the mean concentrations of iron (Fe), manganese (Mn), and barium (Ba) have exceeded the permissible limits and those concentrations are alarming to human health and their surrounding environments (Islam *et al.*, 2017).

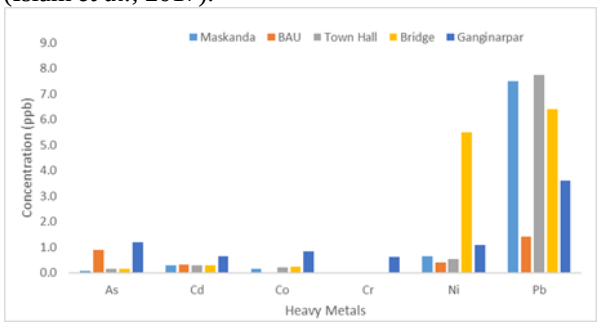

Fig. 3. Concentration of As, Cd, Co, Cr, Ni, and Pb in tube well water samples

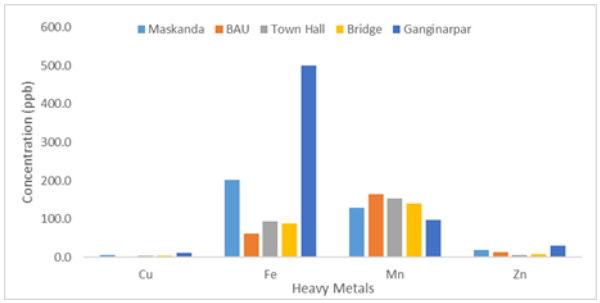

Fig. 4. Concentration of Cu, Fe, Mn, and Zn in tubewell water samples

Tap water

Tap water was also contaminated with heavy metals in the study areas. Apart from Co, Cr, and Ni, other selected heavy metals were found in each of the five areas. Ni was found highest in Townhall with a value of 7.7 ppb but absent in BAU. Similarly, Co was not detected in BAU, and Ganginarpar was the only site where Cr was present. Pb was found within the acceptable limit and the value ranged from 2.5 to 6.7 ppb (**Fig. 5**). From **Fig. 6** it can be seen that only Fe and Mn of Ganginarpar and Bridge moor exceeded permissible limits, respectively. Cu and Zn were found in a very small amount. the concentrations of the potentially toxic elements such as Cr, Mn, Fe, Co, Ni, Zn, As, Cd, and Pb vary from 1.54 to 5.32, 7.00–196, 2.00–450, 0.04–1.45, 8.23–24.4, 0.10–813, 0.10–10.5, 0.002–0.212, and 1.55–15.8 ppb, respectively. Similarly, the values of Fe and Mn in some samples were above the permissible limit (Abedin *et al.*, 2023). Mn and Fe these two elements may not be of completely geogenic origin, but their occurrence may be due to other artificial sources such as corrosion from galvanized iron pipes (Trueman *et al.*, 2017) and the potential intrusion from surface water pollutants (IWM, 2014).

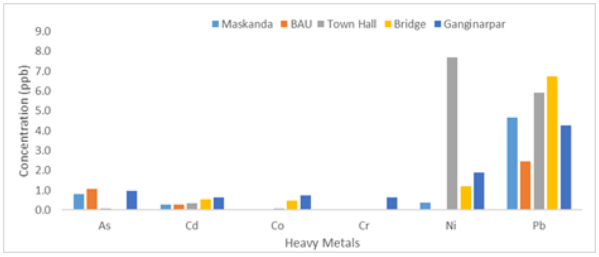

Fig. 5. Concentration of As, Cd, Co, Cr, Ni, and Pb in tap water samples

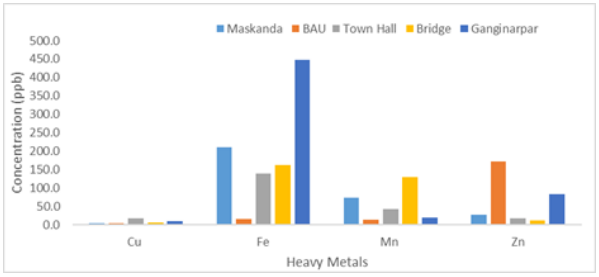

Fig. 6. Concentration of Cu, Fe, Mn, and Zn in tap water samples

Conclusions

This study revealed the heavy metal content in ponds, tube wells, and supply water for drinking of Mymensingh Sadar area. The tube well and tap water of Ganginar par contained higher level of Fe which is not safe to drink and Cr was found in tap water of Ganginar par. On the other hand, Mn level of BAU tube well water and bridge moor tap water exceeded the WHO standard limit which is also alarming for us. In townhall pond water Pb content exceeded the WHO permissible limit. This situation is very alarming for us and other organisms habiting there. Heavy metals are causing severe damage in human body as well as the other living organisms of the nature. Though the other heavy metals are within acceptable limit but measures should be taken not to increase the present concentration of the metals and those exceeded the permissible limit would be used with proper treatment.

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