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Heavy Metals' Concentration in Textile and Garments Industries' Wastewater of Bhaluka Industrial Area, Mymensingh, Bangladesh

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ABSTRACT

An investigation was made to ascertain heavy metals' concentration in effluent samples collected from different textile and garments industries located in Bhaluka industrial area, Mymensingh, Bangladesh during August to November, 2013. Atomic Absorption Spectrometer (AAS) was used to evaluate concentration of Zinc (Zn), Copper (Cu), Nickel (Ni), Cadmium (Cd), Chromium (Cr) and Lead (Pb) in the samples. The study revealed that heavy metals were present in variable amounts, where concentrations of Cu (0.0405 ppm) and Pb (0.0003 ppm) were found lower than recommended level for industrial wastewater. Among the present trace metals, the highest concentration (0.2-1.0 ppm) was found in Zn. Although the concentration was suitable for irrigation, it was unsafe for aquaculture. Besides, all of the wastewater samples possessed no Cr, Cd and Ni, which indicated no possibility of contamination by these metals. However, comparing findings of this study with the safe limits for industrial wastewater, it was concluded that the wastewater of the whole study area except that of some sampling sites could be used for irrigation and aquaculture.

Key words: Atomic Absorption Spectroscopy (AAS), Contamination, Discharge, Heavy metals, Industrial wastewater.

INTRODUCTION

In the modern world, environmental pollution has been recognized as one of the major problems. The activities of human society influence biogeochemical cycles via industries and have led to various irreversible changes in our environment[1,2]. As a result, undesirable effects of poor environmental circumstances on human health are mostly manifested in environment, predominantly in developing countries where urbanization, industrialization and rapid population growth are taking place on an unprecedented scale[3-5].

The irregular disposal of industrial wastes has created pollution problems since this waste is disseminated in the environment or is accumulated in sediments, aquatic organisms, and water[6]. Majority of manufacturing processes are water based and a considerable volume of effluent is ejected to the environment in either treated or inadequately treated form, leading to surface and groundwater

pollution[7]. Industries have contributed to serious and widespread deterioration in the quality of water, land and air in Bangladesh[8]. Textile is the most important sector of Bangladesh's economy that utilizes a large quantity of water in production process and consequently highly polluted and toxic wastewaters are discharged into sewers and drains without any kind of treatment[9]. Textile and Garments' washing & dyeing sections have been condemned as being one of the world's most offenders in terms of pollution[10]. Textile industries are major sources of pollution and contributors of metal contaminants to the environment. Although most of the industries are supposed to have effluent treatment plant, however, so far only a few industries have implemented it, although treatment alternatives are either; complex, energy consuming, expensive or applicable to an indisputable portion of the world due to proficient work force requirement[7]. A large number of factories are operating without the ETPs, violating existing laws[11]. Heavy metals are natural components of the earth's crust. They cannot be degraded or destroyed. Today, contamination of water by toxic heavy metals in the form of effluents from industries is a worldwide environmental problem. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. lead, chromium, copper, mercury, manganese, selenium, zinc etc) are essential to maintain metabolism of human body. However, at higher concentrations they can lead to poisoning[12]. Effluents discharged from textiles contain a higher amount of metals. These effluents are released on the land as well as discharged into the surface water which ultimately end up in groundwater by leaching and lead to contamination of it due to accumulation of toxic metallic components[13]. Thus industrial effluents induce a wide range of environmental problems, more complex and critical health hazards in developing countries like Bangladesh as well as other developed countries. Industrial effluent is a major source of direct and often continuous input of pollutants into aquatic ecosystems with long-term implications on ecosystem functioning[14-17]. Keeping these facts in mind, therefore, the present study was undertaken to assess heavy metal concentrations of wastewater dumping site in Bhaluka industrial area, Mymensingh, Bangladesh.

MATERIALS AND METHODS

Study Area

Textile and garments industries, situated in Habirbari union of Bhaluka upazila, "Mymensingh district" located approximately within latitude at 24.3750ºN and longitude at 90.3778°E (Fig. 1) were selected to evaluate heavy metal concentration in effluents.

Sample collection

The industrial effluent's samples (E1-E12) were collected during September 2013 from effluent discharging drains originated from six different industries' outlet. The sampling points (S1-S12) were designed in relation to industries as depicted by Fig. 2. Samples were preserved for laboratory analysis maintaining with proper direction.

Analytical procedures: determination of heavy metals

Determination of different heavy metals viz. Zn, Cu, Ni, Cd, Cr and Pb in water samples was done by an Atomic Absorption Spectrophotometer (AAS) (Varian Spectra AA55B, Australia) as suggested by APHA[19]. A standard line was prepared by plotting the absorbance reading on Y-axis versus the concentration of each standard solution of metal on X-axis. The concentration of metal was calculated by putting AAS reading on the standard line.

Data analysis

Descriptive statistical parameters were calculated with SPSS software package and Microsoft Office Excel. Various descriptive statistical measures such as range, number, percentage, mean, standard deviation (SD), etc were used for categorization and describing the variables.

RESULTS AND DISCUSSION

Heavy metal concentrations

Descriptive statistics of the data including wastewater parameters of six metal concentrations are shown in Table 1. Among the studied heavy metals the most dominant metal was Zn followed by Cu, Cd, Pb, Cr and Ni. Distinct variation was observed among heavy metal contents in the effluent samples. The amount of Cu varied from 0 to 0.356

ppm (Table 1), with an average value of 0.0405 ppm, which indicated that this effluent could be safely used for irrigation as well as other purposes in respect of Cu concentration. Among all samples, 11 samples were found within the recommended limit except E6, for irrigation where its acceptable limit is 0.20 ppm[20].

Concentration of Zn varied from 0.2 to 1 ppm where the mean was 0.512 ppm (Table 1) and standard deviation was 0.208. The highest concentration (1.0 ppm) was found at the point E6 and the lowest concentration (0.2 ppm) was observed at E12. A nearly similar Zn concentration was recorded at E5 (0.65 ppm), E9 (0.64 ppm) and E11 (0.65 ppm) and same (0.34 ppm) in E4 and E8. According to Ayers and Westcot[20], the maximum permissible limit of Zn in irrigation water is 2.00 ppm. Comparing to standard limits, in respect of Zn, all effluent samples were found as suitable for

Table 1: Available concentration of the heavy metals in samples (E_1-E_{12}) where, n =12

Metals	Descriptive statistics		
	Minimum*	Maximum*	Mean* ± SD
Cadmium (Cd)	0.00	0.00	0.00±0.00
Copper (Cu)	0.00	0.356	0.0405±0.10
Chromium (Cr)	0.00	0.00	0.00±0.00
Lead (Pb)	0.00	0.002	0.0003±0.0006
Zinc (Zn)	0.20	1.00	0.512±0.208
Nickel (Ni)	0.00	0.00	0.00±0.00

Note: SD= Standard deviation; *= ppm

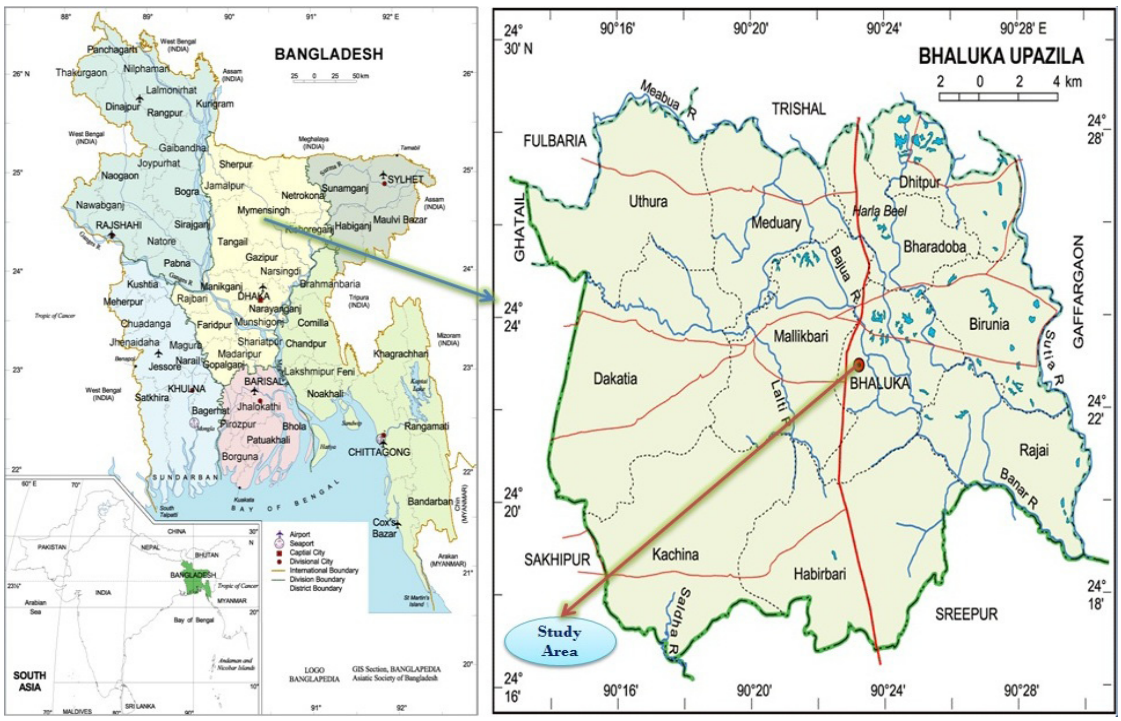

Fig. 1: Map showing the study area[18]

irrigation[21] but exceeded the standard value for aquaculture[22]. Therefore, the water was harmful for aquatic life and thus unsuitable for aquaculture. The degree of relationship between available Zn content and Cu (Fig. 3) of the samples revealed that the strongest positive correlation existed between Zn and Cu at 5% level (2-tailed) of significance where the correlation value (r) = 0.707*.

Concentration of Pb, ranging from 0 to 0.002 ppm with an average value of 0.0003 ppm and standard deviation of 0.00065 indicated that the analyzed effluents were free from lead (Pb) contamination[20] and thus suitable for irrigation[21] and aquaculture[22]. Correlation between concentration of available Cu, Pb (Fig. 4) and Zn, Pb (Fig. 5) of the water samples had a negative relationship where the correlation values (r) were 0.158 and 0.0447, respectively.

Experimental result also revealed that Cr, Cd and Ni were found as trace amount in effluent samples (Table 1), leading to the decision that the samples were free from Chromium, Cadmium[23] and

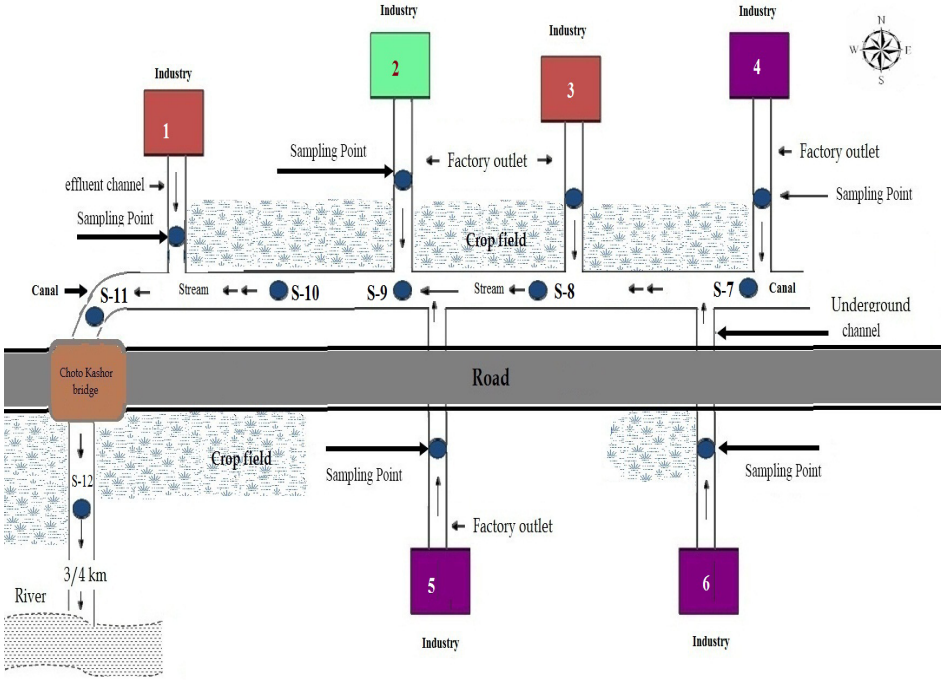

Fig. 2: A sketch map representation of the selected sampling sites

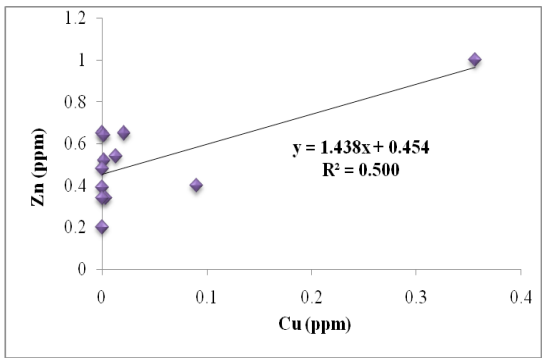

Fig. 3: Correlation between Zn and Cu

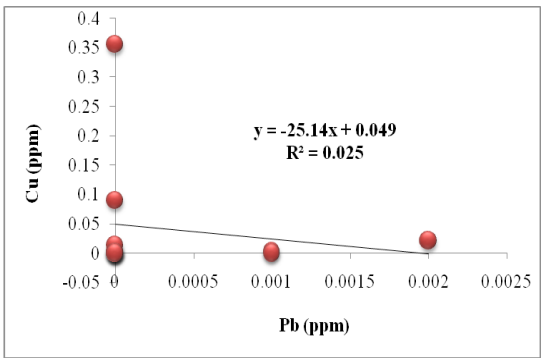

Fig. 4: Correlation between Cu and Pb

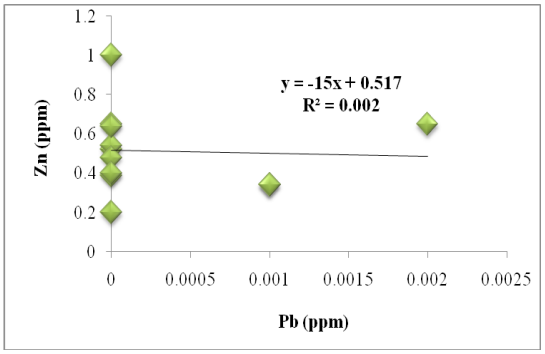

Fig. 5: Correlation between Zn and Pb

Nickel contamination.

CONCLUSION

On the basis of results of the experiment it can be stated that level of heavy metal contamination in collected wastewaters from textile and garments industries was generally low and showed an acceptable limit. The objectionable appearance of canal water could be attributed to the discharge of untreated industrial wastewaters. Though some of the chemical elements were beneficial for agriculture and aquaculture up to a certain limit, it might be potentially detrimental beyond that.

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