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Toxic metals monitoring in soil, water, vegetable and fish from Lakshmipur district in Bangladesh.

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Abstract: *The current study was carried out to assess the surface water quality, percentage of heavy metals such as lead, cadmium, chromium, manganese and nickel from Ramgonj, Raipur, Kamalnagor, Ramgoti and Lakshmipur. Water samples of the surface water resources were collected from different points of various areas. These were collected from ponds, lakes, tube wells in various zones of Lakshmipur district. The result showed that the concentrations Pb for 15 water samples were crossed the acceptable limit according to World Health Organization (WHO). Besides, the concentrations of Cd and Cr were also above the permissible level for each water sample. But the concentrations of Co and Ni in water samples were not above the standard values. The study was also carried out to measure the heavy metals in soil which were collected from different areas of Lakshmipur district. The investigation was revealed that in one soil sample, the quantity of Co, Pb, Cr, Ni were found as 5.51ppm, 2.26ppm, 11.07ppm and 15.46ppm respectively which were extremely high concentrations. The present study was also carried out to measure the heavy metals in vegetable and fish which were collected from different places of Lakshmipur district. In fish samples, Pb was found in F1 and F2 samples as 1.47ppm and 0.30ppm that were exceeded standard limit. Moreover, F1 and F2 were shown (1.44ppm and 1.01ppm respectively) the highest amount of chromium.*

Keywords: ***Heavy metals, Laxmipur, Soil, water, vegetable, fish, Bangladesh.***

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I. Introduction

Lakshmipur district is situated in Chattogram division of Bangladesh with an area of 1455.96 sq km. It is located in between 22°30' and 23°10' north latitudes and in between 90°38' and 90°01' east longitudes, bordered by Chandpur district to the north side, Bhola and Noakhali district to the south, Noakhali district to the east as well as Bhola and Barisal district to the west side. This district consists of five upazillas viz. Lakshmipur sadar, Raipur, Kamalnagar, Ramgati and Ramganj. Soil is an essential substance for human and any other living things as well as the main source of nutrients that is very necessary for plants, crops, vegetable etc. Water is a chemical thing having transparent, tasteless and odorless properties. It plays an important role to save the fauna and flora on the earth. About 70% of water is utilized for agricultural sector [1]. Vegetable is a good source of nutrition, vitamins, minerals and dietary fiber containing biochemical and antioxidant properties [2]. Now-a-days environmental pollution is the burning issue all over the world. Heavy is one of the major cause to pollute the environment occurs from different sources. Lead, cadmium, copper, iron, manganese, mercury, chromium etc. are the main hazardous elements to adulterate the vegetables in agriculture [3], [4], [5], [6]. These metals may also be severe toxic if it concentration is exceeded the acceptable limit. Lead can be entered and deposited in human body by different ways. It is existed in foods and aquatic lives due to dispose of wastes from various industries. Excess amount of lead is liable to damage the central nervous system, kidney, brain and even can cause death. On the other hand, cadmium is a metal can be occurred naturally and also manmade cause included using batteries, television screens, paint pigments etc. Another source of cadmium is assumed as the emission of smoke from cigarette by human [7]. Welding, clinical waste, drug industries are also the source of cadmium [8], [9]. Cadmium is responsible for cardiovascular diseases and cancer. It can cause headache, coughing and vomiting. Chromium is used in cement, rubber, metal alloys and paint's pigment [10]. It can be appeared automatically in nature. Nevertheless, approximately 40% of chromium is exposed in the environment through industrial waste as trivalent and hexavalent chromium. In the presence of manganese, trivalent chromium can be converted to hexavalent chromium in the soil [10]. Air borne and chromic acid spray are arisen by electroplating can cause the skin and lung cancer. Nickel is the metal used in the different types of industrial processing activities. It is an essential component for human body although excess amount may be harmful to living things [11], [12] & [13]. Cobalt is found in the environment, plays a vital role in human body as vitamin B_{12}. But many studies have revealed that, rarely cardiovascular disease may be occurred in human body due to toxicity of cobalt in the high concentration [14].

Figure: Map showing of Lakshmipur district

The present study was conducted to assess the concentration of heavy metals viz. lead, cadmium, chromium, cobalt and nickel in the soil, water, vegetable and fish sample in various region of Lakshmipur district using Flame Atomic Absorption Spectrometer (FAAS).

II. Materials and methods

Sample collection and preparation

a) Collection of soil samples and its preparation: A total of 10 soil samples were collected from ten different places viz. Chandipur, Kamarhat, Keroya, Sonapur, Rakhalia, Torabgonj, Hazirhat, Chandrogonj, Alakzender and Ramgoti in Lakhsmipur district. These samples were put into airtight polyethylene bags and transferred to the laboratory [15]. Then the samples were dried in an oven at 105°C for 6-7 hours [16]. The soil samples were ground and put into the plastic jars after drying [17]. About 25g of each sample was weighed in evaporating dish and placed in a muffle furnace. The samples were heated at 550°C for 6 hours and then digested with 10ml of nitric acid by heating. The mixture was filtered using filter paper (Whatman no 42) in a 100ml volumetric flask and diluted to the mark with distilled water.

b) Collection of water samples and its preparation: Water samples were collected from different places of Lakshmipur district such as Keroya, Chandipur, Vobanigonj, Hazirpara, Alekzender, Kalkini, Hazirhat, Chargazi, Karpara and Char Bahadur. Twenty one samples were stored in polyethylene bottles and added 2mL of concentrated nitric acid [18]. Then the samples were filtered through filter paper (Whatman 42).

c) Collected of vegetable samples and its preparation: Ten vegetable samples viz. carrot, tomato, green chilli, cauliflower, bean, brinjal, potato, radish conch, radish and calabash were collected from various zones of Lakshmipur district. Then were transferred to the laboratory and washed properly with distilled water and chopped with a knife. Then the samples dried in the Sun shine and crushed for analysis [19]. About 0.5g of powdered sample was weighed and put into crucible. Thereafter these samples were ignited at 450°C in a muffle furnace for 12 hours. These were cooled and contacted with 5mL of concentrated nitric acid. The mixture was filtered with filter paper (Whatman 42) in a 100mL volumetric flask and diluted to the mark with distilled water.

d) Collection of fish samples and its preparation: Fish samples were gathered from six different zones named Chandipur, Kamarhat, Kamalnagar, Lakshmipur, Keroya and Ramgonj. A total of six samples were randomly collected in the lakes, cannels and ponds. These were washed absolutely to remove dirt. The samples were put into polyethylene bags and brought the laboratory. Then the fish samples were cut with a knife to separate the liver and dried at 105°C for 8 hours. Each sample was ground with a morter and pastle after drying. About 1.0g

of sample was weighed and digested with 65% of concentrated nitric acid and 37% of concentrated sulphuric acid and perchloric acid at 80°C temperature [20]. Then the mixture was cooled to ambient temperature and filtered through filter paper (Whatman 42) in a 100mL volumetric flask and diluted to the mark with distilled water.

All of the prepared soil, water, vegetable and fish samples were analyzed using Flame Atomic Absorption Spectrometer (Thermo Scientific, iCE 3000, USA).

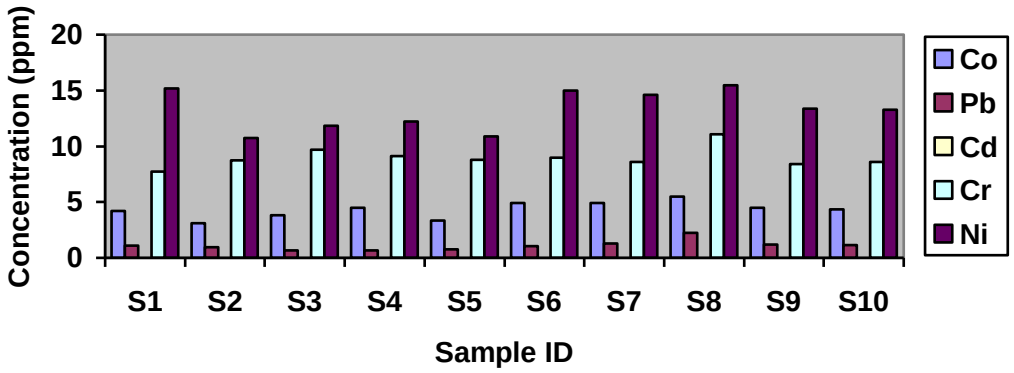
III. Results and discussion

The concentration of cobalt in soil sample was found in the range of (3.08 – 5.51)ppm followed by (0.66 – 2.26)ppm for lead, 0.00ppm for cadmium, (7.75 – 11.07)ppm for chromium and (10.72 – 15.46)ppm for nickel. The maximum as well as minimum concentration of heavy metal in soil sample were obtained from S 8 and S2, S8 and S4, S8 and S1, S8 and S2 samples for Co, Pb, Cr, Ni respectively. It was observed that samples S 8 was shown the highest concentration of all the assessed heavy metals [Table 1 & Figure 1]. According to World Health Organization (WHO) and Food and Agriculture Organization (FAO) guidelines no samples were shown the permissible level of Pb, Cd and Cr. But there is no guideline for acceptable limit of Co and Ni. The mean and SD values of heavy metal in soil were obtained as 4.30 ± 0.74, 1.11± 0.46, 0.00, 8.97 ± 0.89 and 13.25 ± 1.78 for Co, Pb, Cd, Cr and Ni respectively.

Table-1: Concentration of heavy metals (HMs) in soil from Lakshmipur district.

Sample ID	Collected areas	Concentration of HMs (ppm)				
		Co	Pb	Cd	Cr	Ni
S_1	Chandipur	4.2	1.02	ND	7.75	15.16
S_2	Kamarhat	3.08	0.94	ND	8.75	10.72
S_3	Keroya	3.81	0.67	ND	9.68	11.86
S_4	Sonapur	4.50	0.66	ND	9.10	12.22
S_5	Rakhaliya	3.32	0.78	ND	8.77	10.88
S_6	Torabgonj	4.92	1.05	ND	8.98	14.98
S_7	Hazirhat	4.91	1.28	ND	8.57	14.61
S_8	Chandrogonj	5.51	2.26	ND	11.07	15.46
S_9	Alekzender	4.47	1.17	ND	8.42	13.37
S_{10}	Ramgoti	4.32	1.14	ND	8.59	13.27
Mean ± SD		4.30 ± 0.74	1.11 ± 0.46	0.00	8.97 ± 0.89	13.25 ± 1.78

Figure 1: Concentration of HMs in soil



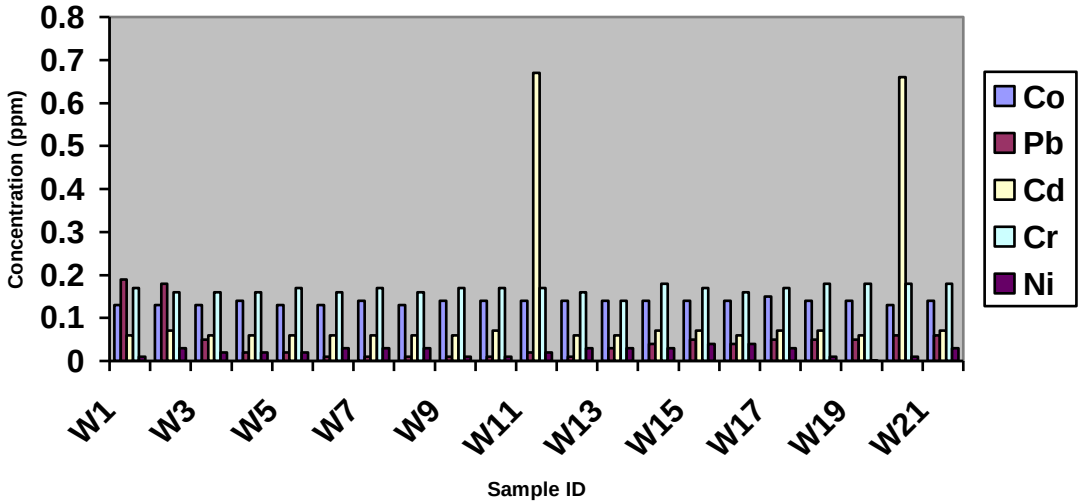
In surface water samples from different places, cobalt was measured in the range of (0.13 – 0.15) ppm followed by (0.01 – 0.19) ppm for Pb, (0.06 – 0.67) ppm for Cd, (0.16 – 0.18)ppm for Cr, and (0.01 – 0.04) ppm for Ni. The concentration of lead in 15 samples were above the acceptable limit (0.01ppm) of WHO except 6 samples viz. W6, W7, W8, W9, W10 and W12. On the other hand, all of the samples were crossed the standard values of chromium and cadmium (0.05ppm for Cr and 0.01ppm for Cd) in accordance with WHO/FAO 2007 guidelines [Table 2 & Figure 2].

Table-2: Concentration of heavy metals (HMs) in water from Lakshmipur district.

Sample ID	Collected areas	Concentration of HMs (ppm)				
		Co	Pb	Cd	Cr	Ni
W_1	Keroya	0.13	0.19	0.06	0.17	0.01
W_2	Keroya	0.13	0.18	0.07	0.16	0.03
W_3	Chandipur	0.13	0.05	0.06	0.16	0.02

W_4	Chandipur	0.14	0.02	0.06	0.16	0.02
W_5	Sonapur	0.13	0.02	0.06	0.17	0.02
W_6	Changirgaho	0.13	0.01	0.06	0.16	0.03
W_7	Torabgonj	0.14	0.01	0.06	0.17	0.03
W_8	Hazigonj	0.13	0.01	0.06	0.16	0.03
W_9	Purabgonj	0.14	0.01	0.06	0.17	0.01
W_{10}	Torabgonj	0.14	0.01	0.07	0.17	0.01
W_{11}	Chandrogonj	0.14	0.02	0.67	0.17	0.02
W_{12}	Vobanigonj	0.14	0.01	0.06	0.16	0.03
W_{13}	Hajipara	0.14	0.03	0.06	0.14	0.03
W_{14}	Alekzender	0.14	0.04	0.07	0.18	0.03
W_{15}	Alekzender	0.14	0.05	0.07	0.17	0.04
W_{16}	Kalkini	0.14	0.04	0.06	0.16	0.04
W_{17}	Hazirhat	0.15	0.05	0.07	0.17	0.03
W_{18}	Hazirhat	0.14	0.05	0.07	0.18	0.01
W_{19}	Chargazi	0.14	0.05	0.06	0.18	0.01
W_{20}	Kampara	0.13	0.06	0.66	0.18	0.01
W_{21}	Bahadur	0.14	0.06	0.07	0.18	0.03
Mean ± SD		1.14 ±0.006	0.05± 0.04	0.17 ± 0.01	0.12 ± 0.18	0.02± 0.01

Figure 2: Concentration of HMs in water

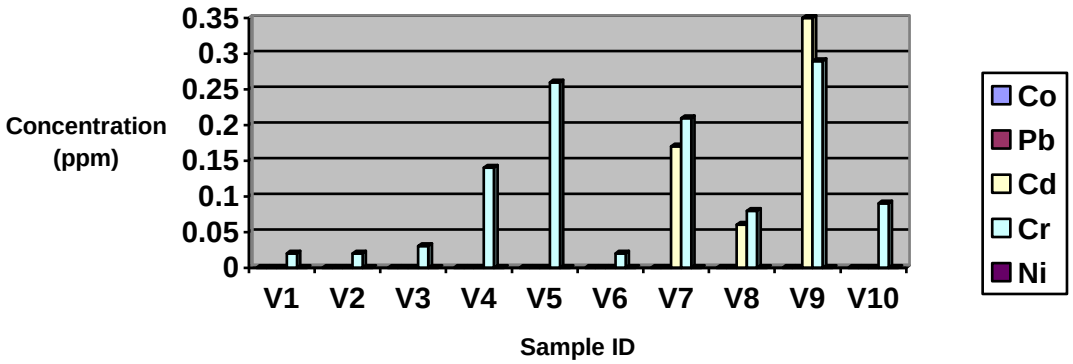


The concentration of heavy metals in 10 vegetable samples such as carrot, tomato, green chilli, cauliflower, bean, brinjal, potato, radish conch, radish and calabash were nothing found for Co, Pb and Ni whereas, the concentration of cadmium was found as 0.17ppm, 0.06ppm and 0.33ppm for potato, radish conch and radish respectively. According to WHO/FAO 2007, these values were exceeded the permissible limit (0.02ppm). However, chromium was found in vegetable samples in the range of (0.02 – 0.29)ppm. But no samples were crossed the acceptable level (2.3ppm) of chromium [Table 3 & Figure 3].

Table-3: Concentration of heavy metals (HMs) in vegetables from Lakshmipur district.

Sample ID	Collected areas	Sample Details	Concentration of HMs (ppm)				
			Co	Pb	Cd	Cr	Ni
V_1	Chandipur	Carrot	ND	ND	ND	0.02	ND
V_2	Kamarhat	Tomato	ND	ND	ND	0.02	ND
V_3	Keroya	Green Chilli	ND	ND	ND	0.03	ND
V_4	Sonapur	Cauliflower	ND	ND	ND	0.14	ND
V_5	Rakhaliya	Bean	ND	ND	ND	0.26	ND
V_6	Torabgonj	Brinjal	ND	ND	ND	0.02	ND
V_7	Hazirhat	Potato	ND	ND	0.17	0.21	ND
V_8	Chandrogonj	Radish Conch	ND	ND	0.06	0.08	ND
V_9	Alekzender	Radish	ND	ND	0.35	0.29	ND
V_{10}	Ramgoti	Calabash	ND	ND	ND	0.09	ND
Mean ± SD			0.00	0.00	0.19 ± 0.15	0.12 ± 0.10	0.00

Figure 3: Concentration of HMs in vegetables



In fish samples from 6 various places, Co, Pb, Cd, Cr and Ni were measured in the range of 0.00ppm, (0.00 – 1.47)ppm, 0.00ppm, (0.68 – 1.44)ppm and (0.00 – 0.13)ppm respectively. It was mentioned that two samples such as F2 and F3 for Pb were shown in the above concentration (1.4ppm for F2 and 0.30ppm for F3) of acceptable range (0.05ppm) of WHO or FAO. On the other hand, F1 (1.44ppm) and F2 (1.01ppm) were crossed the standard limit (1.0ppm) according to WHO/FAO 2007 guideline. It was observed that sample F2 was crossed the permissible level in case of the concentration of both lead and chromium [Table 4 & Figure 4].

Table-4: Concentration of heavy metals (HMs) in fish from Lakshmipur district.

Sample ID	Collected areas	Concentration of HMs (ppm)				
		Co	Pb	Cd	Cr	Ni
F_1	Chandipur	ND	ND	ND	1.44	0.13
F_2	Kamarhat	ND	1.47	ND	1.01	0.003
F_3	Kamalnagar	ND	0.30	ND	0.93	0.11
F_4	Lakshmipur	ND	ND	ND	0.69	0.01
F_5	Keroya	ND	ND	ND	0.85	ND
F_6	Ramgonj	ND	ND	ND	0.68	ND
Mean ± SD		0.00	0.89 ± 0.83	0.00	0.93 ± 0.28	0.06 ± 0.07

Figure 4: Concentration of HMs in fish

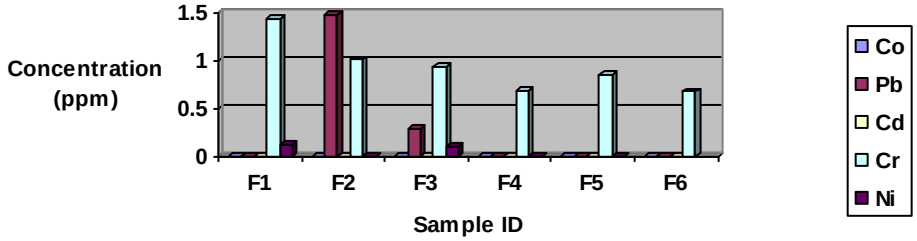
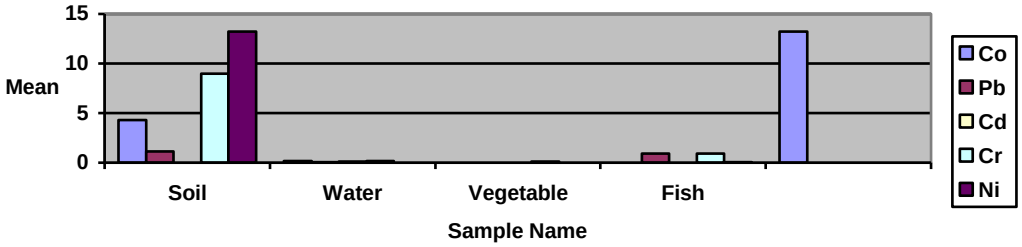


Table-5: Comparison of mean values in soil, water, vegetable and fish samples.

Sample	Concentration of HMs (ppm)				
	Co	Pb	Cd	Cr	Ni
Soil	4.30	1.11	0.00	8.97	13.25
Water	0.14	0.04	0.12	0.17	0.02
Vegetable	0.00	0.00	0.00	0.12	0.00
Fish	0.00	0.89	0.00	0.93	0.06

Figure 5: Mean value of HMs in Soil, Water, Vegetable & Fish



IV. Conclusion

Heavy metals contamination is a common issue in the world due to discharging of hazardous substances from various industries directly or indirectly. The current study was conducted to determine the heavy metals in soil, water, vegetable and fish samples. The final result was shown that almost all of the surface water samples from lake, cannel etc. contain excess amount of Pb, Cd, Cr and Ni. One vegetable sample out of ten from Alekzender contains maximum concentration of cadmium. Besides, two fish samples (F2 & F3) were shown excess quantity of lead. Moreover, the highest amount of chromium was also found in two (F1 & F2) fish samples. In this situation, public health risk may be increased day by day for consuming these heavy metals contaminated food stuffs. So, this study is recommended to take important steps for the reduction of heavy metals level in the environment by utilizing various technical processes in the different industries for the treatment of effluent before its discharging. Nevertheless, it is also essential to practice the use of chemicals, fertilizers, and pesticides which are contained poor amount of heavy metals.

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