

Arsenic Status at Different Depths in Some Soils of Bangladesh

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Abstract: A study was undertaken to determine the arsenic status of some selected soils in six thanas of three arsenic affected districts of Bangladesh. Eighteen soil samples taking three from each of 6 thanas representing 3 districts viz. Moulavibazar, Habiganj and Sylhet of Bangladesh were collected for the study. The soils were collected from 3 depths viz. 0-15, 15-30 and 30-45 cm from each location. The arsenic content in soils of Moulavibazar, Habiganj and Sylhet districts ranged from 1.32-31.89, 0-16.87 and 0.66-17.57 ppm, respectively. Out of 18 samples, arsenic content was noticed for 11 samples at 0-15 cm depth (1.98-25.76 ppm), 15 samples at 15-30 cm depth (3.96-30.68 ppm) and 14 samples at 30-45 cm depth (3.96-38.23 ppm). The highest arsenic content of 38.23 ppm was found at 30-45 cm depth in Sylhet district. Seven samples at 0-15 cm, 3 samples at 15-30 cm and 4 samples at 30-45 cm were free from arsenic contamination. Correlation study of arsenic contents of soils was done with some soil properties viz. sand, silt and clay contents, soil pH, EC and organic matter status. Results showed that arsenic content correlated significantly with different soil properties.

Key words: Arsenic, soil

Introduction

Arsenic poisoning has become a silent killer in Bangladesh. Millions of Bangladeshis have now been exposed to arsenic in the history's biggest mass poisoning. Give us safe water, save us from arsenic, cried peoples all over the world. At least 59 of the country's 64 districts are now affected with an estimated 1.12 million tubewells contaminated with arsenic. About 24 millions people are exposed to arsenic contamination and over 50 millions at some risk of exposure. Some 5,500 arsenic poisoned patients have already been registered, according to official statistics (Bakhtiar, 1999).

Arsenic, known as the king of poison, a natural element in the ground that seeps into groundwater and then into tube wells. Prolonged exposure to arsenic proves fatal to human beings. The maximum permissible level for human intake of arsenic in drinking water is 0.05 mg/l while the WHO limit is 0.01 mg/L. But testing samples collected from tubewells in parts of the country revealed that the water spilled contaminated arsenic in the range between 0.1 to 0.3 mg/L (Bakhtiar, 1999).

Arsenic is an element with metalloid characteristics having sometimes organic and sometimes inorganic substances. It occurs in all environmental media. It is widely distributed throughout the earth's crust. High arsenic contamination is associated with the following: volcanic deposits, deposits of alluvial lacustrine in semi and zones geothermal system and mining areas of gold and uranium. The problem is that once inside the body, although the arsenic will at first slowly pass out through the urine, hair, finger and toe-nails-and the skin-when the concentration in the body reaches a level where the body can no longer handle it, poisoning will takes place and reveal itself as melanosis, leucomelanosis, keratosis, hyperkeratosis, dorum, non-petting cedema, gangrene or skin cancer. (Mortoza, 1999).

In Bangladesh condition, it is believed to be the outcome of a natural process under the ground. Arsenic is widely distributed geologically as a component of hundred other minerals. One of the theories blames over drawing of ground water for the excessive presence of arsenic in water. Bangladesh has one of the world's highest concentration of wells to pump out ground water for drinking and irrigation. It has recently been reported in newspapers that over 1340 tons of toxic arsenic compound has entered Bangladesh soil through arsenic compound treated 25 lakh wooden electric poles imported from foreign countries for using in the rural electric supply system during the last two

decades. Atomic Energy Commission expert said that the arsenic compounds on the poles may cause serious hazards by contamination of the under ground water sources as well the soil of Bangladesh, particularly the upper layer of soil. However, this should be tested for confirmation. The arsenic contamination of ground water of West Bengal in India is from mineral sources and the depth of contamination is reported between 200 to 300 ft. Hence the depths of arsenic contamination of ground water in the western border districts of Bangladesh should be similar to the depths in West Bengal and the causes in Bangladesh might be due to overpumping of ground water for irrigation (Hoque, 1998a).

Arsenic enters the human body through drinking water, fish, meat, grains and vegetables. Arsenic poisoning occurs when its intake exceeds the limit of tolerance. It is chronic when small amount of arsenic enters the body repeatedly, through food and water over a prolonged period of time and it is acute when a large amount enters a body in a bolus.

During the last 6 years, hundreds of newspaper reports showed the arsenic contamination crisis in ground water in different areas of Bangladesh but very limited data are now available on soil environment of Bangladesh although soil is the mother reservoir of arsenic (Sattar, 2001). Thus, the present experiment has been planned to determine the arsenic status at different depths of some selected soils of Bangladesh and to find out the relationship between soil properties and arsenic content.

Materials and Methods

The experiment was carried out with the soils of 6 thanas representing 3 districts of Bangladesh. The selected thanas were Moulavibazar Sadar and Srimangal under Moulavibazar district; Habiganj Sadar and Nabiganj under Habiganj district and Sylhet Sadar and Golapgonj under Sylhet district. The soil sampling sites were selected with the help of the staffs of the Department of Soil Resources Development Institute (SRDI) of the respective area, the sites were selected on the basis of available records of high arsenic concentration in soils. Soil samples were collected from three locations of 6 thanas. Thus, a total of eighteen composite soil samples were collected from 6 thanas. The samples were collected at three different depths viz. 0-15, 15-30 and 30-45 cm. Each composite sample was a combination of three individual soil sample collected from different spots of the same field. The

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Table 1: General soil information of sampling sites

Thana	Location	AEZ	Land type	Soil series	General soil type
Moulavibazar Sadar	Sherpur	Eastern Surma Kushiya flood plain	High land	Kushiya	Non-calcareous Grey Floodplain Soil
	Gaosherpur	"	"	"	"
	Amorkona	"	"	"	"
Srimangal	Srimangal	Northern and Eastern Piedmont plain	Medium high land	Pritimpasa	"
	Kalighat	"	High land	Srimangal	"
	Kalapur	"	"	Biipur	"
Habiganj Sadar	Abdullapur	Old Meghna Estuarine flood plain	Medium low land	Madabpur	"
	Manikchak	"	"	"	"
	Shikarpur	"	"	"	"
Nabiganj	Pitua	"	"	"	"
	Mohammadpur	Eastern Surma Kushiya flood plain	High land	Goyainghat	Non-calcareous Brown Floodplain Soil
	Bhabanipur	"	"	Phagu	"
Sylhet Sadar	Khadimpura	Eastern Surma Kushiya flood plain	"	Biipur	"
	Sylhet	"	Medium low land	Ramgarh	"
	polytechnique area	"	"	"	"
Golapganj	Khadimnagar	"	"	Biipur	"
	Sherpur	Eastern Surma Kushiya flood plain	Medium high land	Balaganj	"
	Chandanbag	"	"	"	"
	Girdha	"	Medium low land	Goyainghat	Non-calcareous Grey Floodplain Soil

area from where one composite sample was taken ranged from 0.5 to 5 ha of land and the plant roots, leaves, gravels etc. were picked up and discarded. Finally, about one kg of each soil was put into the plastic bag labelled properly and then carried to the laboratory, of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh for subsequent physical and chemical analyses. The collected soil samples were dried at room temperature, ground and sieved through a 2-mm sieve. Then the entire amount of soil was thoroughly mixed. The prepared samples were preserved in polythene bags after proper labelling for laboratory analyses. The general soil information has been presented in Table 1.

The soil samples were analyzed for sand, silt and clay contents (Piper, 1950), Soil pH (Jackson, 1962) and organic carbon and electrical conductivity (EC) (Page *et al.*, 1982). Arsenic contents of the soils were determined by molybdenum heteropoly blue method as described by Allen (1974).

Results and Discussion

Arsenic Content in Soils:

Arsenic content at Moulavibazar district: Out of 18 samples, 17 gave variable amounts of arsenic ranging from 5.94-38.23 ppm at 6 locations of Moulavibazar district (Table 2). The arsenic was not detectable for D₁ at Kalighat. The maximum arsenic content in Sherpur was 38.23 ppm at D₃ depth and the minimum arsenic content in Amorkona and Kalapur was 5.94 ppm at D₂ and D₁ depths. Over all the depth of D₁, D₂ and D₃ arsenic content ranged from 5.94-25.76, 5.94-31.7 and 13.66-38.23 ppm, respectively. The average highest arsenic was found in Sherpur which was followed by Srimangal, Amorkona, Gaosherpur, Kalapur and Kalighat. However, in most of the soils the arsenic level did not exceed the maximum limit to 30 ppm. These results are in agreement with Alam and Sattar (1999).

The soil arsenic standards were classified by Thornton (1980) shown in Table 3. On the basis of this classification the soils at D₂ and D₃ of Sherpur were slightly contaminated.

Table 2: Arsenic content in selected soils of Moulavibazar district

Locations	Arsenic status in soil (ppm)			
	0-15 cm depth (D ₁)	15-30 cm depth (D ₂)	30-45 cm depth (D ₃)	Average value
Sherpur	25.76	31.7	38.23	31.89
Gaosherpur	7.93	11.89	21.79	13.87
Amorkona	25.76	5.94	17.83	16.51
Srimangal	19.81	29.72	29.72	25.09
Kalighat	ND	11.89	17.83	11.16
Kalapur	5.94	15.85	13.66	1.32

ND = Not detected

Table 3: Standard values (guidelines) for arsenic contaminated soils (Thornton, 1980)

Contamination status	Arsenic status (ppm)
Uncontaminated soil	0-30
Slight contaminated soil	30-50
Contaminated soil	50-100
Heavily contaminated soil	100-500
Usually heavy contamination	> 500

Arsenic content at Habiganj district: The arsenic was detectable in 11 samples out of 18 samples at Habiganj district at 5 locations (Table 4). The arsenic content was not detected in Abdullapur. The amount of arsenic was found in 3 depths viz. D₁, D₂ and D₃. The average value of arsenic at Manikchak, Shikarpur, Pitua, Mohammadpur, Bhabanipur were 5.94, 3.30, 16.17, 11.19 and 16.87 ppm, respectively (Table 4). The highest amount of arsenic in Pitua at D₂ was 30.68 ppm and the lowest in Shikarpur at D₂ was 3.96 ppm. Arsenic was not detectable in Abdullapur. The average highest arsenic content was found in Bhabanipur which was followed by Pitua, Mohammadpur, Manikchak, Shikarpur, Abdullapur. In general, surface soils contained slightly higher amount of arsenic. Similar results are found by Sattar (1997) in paddy soils and Sattar and Blume (1998) in general soils of Bangladesh. On the basis of arsenic contamination standards,

Table 4: Arsenic content in selected soils of Habiganj district

Locations	Arsenic status in soil (ppm)			
	0-15 cm depth (D ₁)	15-30 cm depth (D ₂)	30-45 cm depth (D ₃)	Average value
Abdullapur	ND	ND	ND	0.00
Manikchak	ND	11.89	5.94	5.94
Shikarpur	ND	3.96	5.94	3.30
Pitua	17.83	30.68	ND	16.17
Mohammadpur	ND	19.81	13.78	11.19
Bhabanipur	17.83	13.66	19.14	16.87

ND = Not detected

Table 5: Arsenic content in selected soils of Sylhet district

Locations	Arsenic status in soil (ppm)			
	0-15 cm depth (D ₁)	15-30 cm depth (D ₂)	30-45 cm depth (D ₃)	Average value
Khadimpura	15.37	19.72	17.64	17.57
Sylhet polytech-nique area	ND	7.81	9.7	5.83
Khadimnagar	11.89	7.93	5.94	8.58
Sherpur	5.38	5.38	ND	3.58
Chandanbag	1.98	ND	ND	0.66
Girdha	ND	ND	3.96	1.32

ND = Not detected

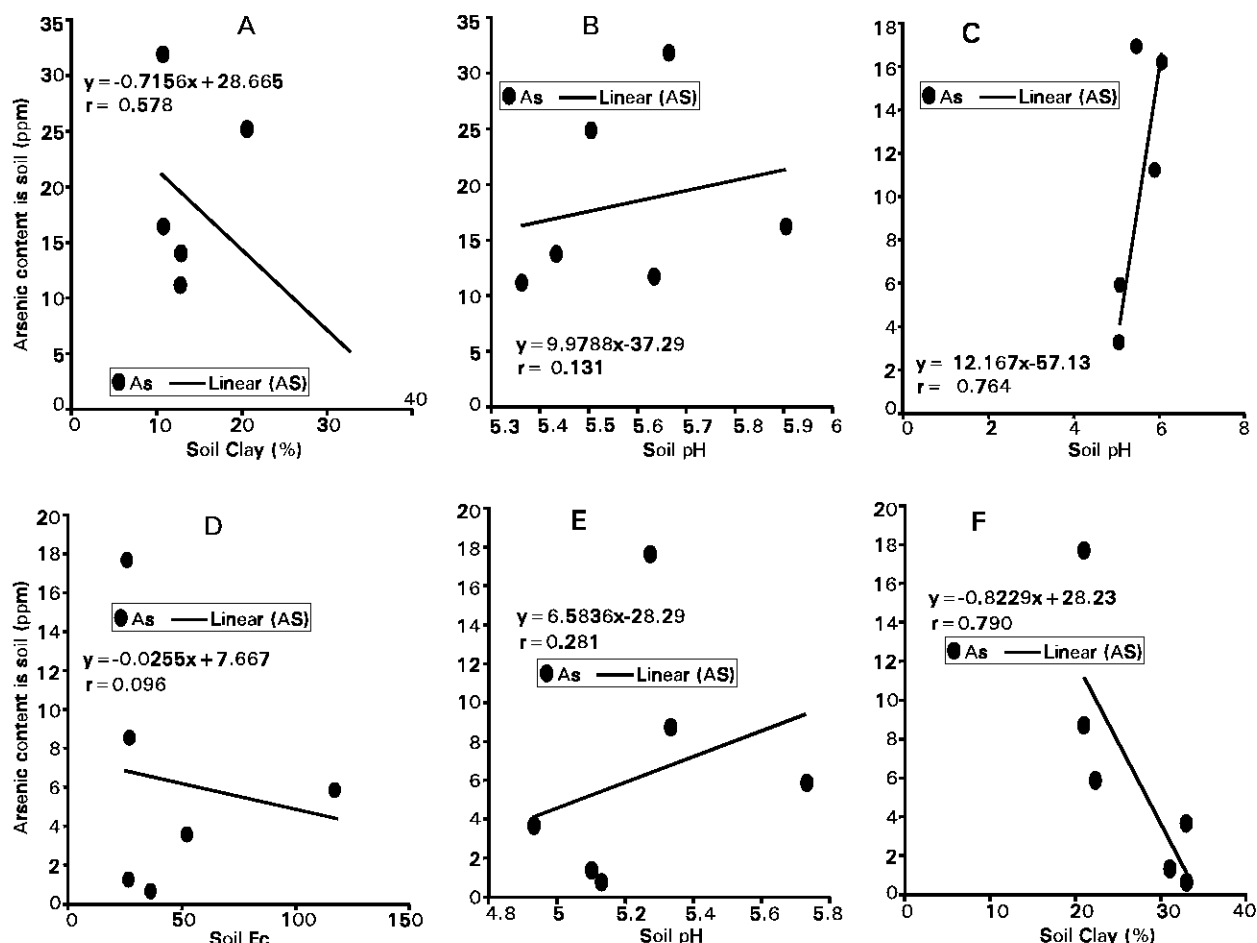


Fig. 1: Correlation of arsenic content in soils versus pH, clay, and EC content of selected districts (A & B = Moulavibazar, C & D = Habiganj, E & F = Sylhet District).

Table 6: Correlation of arsenic content in soils versus sand, silt, clay, pH, organic matter and EC content of selected districts

Districts	Correlation	No. of observations	r value
Moulavibazar	As in soil x % Sand	6	0.726
	As in soil x % Silt	6	0.368
	As in soil x % Clay	6	0.578
	As in soil x Soil pH	6	0.131
	As in soil x %Organic matter	6	0.059
	As in soil x Soil EC	6	0.194
Habiganj	As in soil x % Sand	6	0.451
	As in soil x % Silt	6	0.512
	As in soil x % Clay	6	0.258
	As in soil x Soil pH	6	0.764
	As in soil x %Organic matter	6	0.937
	As in soil x Soil EC	6	0.096
Sylhet	As in soil x % Sand	6	0.619
	As in soil x % Silt	6	0.164
	As in soil x % Clay	6	0.790
	As in soil x Soil pH	6	0.281
	As in soil x %Organic matter	6	0.778
	As in soil x Soil EC	6	0.145

D₂ of Pitua was slightly arsenic contaminated. In general, the surface soil of Habiganj was uncontaminated.

Arsenic content at Sylhet district: In Sylhet district arsenic was detectable at 12 out of 18 samples at D₁, D₂ and D₃ depths in 6 locations (Table 5). Arsenic was not detectable at 6 samples. The highest arsenic content (19.72ppm) in Khadimpura at D₂ and lowest (1.98ppm) in Chandanbag at D₁

depth were recorded. The average values of arsenic at Khadimpura, Sylhet Polytechnique area, Khadimnagar, Sherpur, Chandanbag and Girdha were 17.57, 5.83, 8.58, 3.58, 0.66 and 1.32 ppm, respectively. The average highest arsenic content was found in Khadimpura which was followed by Khadimnagar, Sylhet Polytechnique area, Sherpur, Girdha, Chandanbag. However, in most of the soils the arsenic level did not exceed the maximum limit of 20 ppm. These results are in agreement with Kabata-Pendius and Pendius (1992). On the basis of arsenic contamination standards the soils of Sylhet district were uncontaminated.

Correlation of arsenic contents of soils with some soil properties: The correlation between arsenic content and soil properties like sand, silt, clay, pH, organic matter and EC status has been shown in Table 6. Figure 1 illustrates the significant correlation between arsenic content of soils and selected soil properties. The soil pH (Fig 1B) and sand particles showed significant positive correlation and organic matter, silt, clay particles (Fig. 1A) and EC showed negative correlation with arsenic content in soils of Moulavibazar district. While arsenic status of Habiganj district was correlated with respective soil properties like sand, silt, clay, pH, organic matter and EC (Table 6). Soil organic matter and pH (Fig. 1C) indicated positive correlation with arsenic content in soil. Sand, silt, clay and EC (Fig. 1D) showed negative correlation

with arsenic content of soils. The arsenic levels of Sylhet district were correlated with sand, silt, clay, pH, organic matter and EC (Table 6). It was observed that the significant positive correlation existed with the arsenic content and pH (Fig. 1E) and negative correlation existed with arsenic content and clay particles (Fig. 1F) of the soils. These results are in agreement with Diddappa and Khan (1985) who found similar correlation.

From the aforesaid discussion and findings, it can be concluded that arsenic status in most of the selected soils were low except in few cases. In general, most of the surface soil, arsenic status was normal that is not harmful although a very few soils showed minor arsenic contamination. Further studies with most sensitive method (s) should be done to identify the arsenic contaminated soils all over Bangladesh.

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