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Arsenic Contamination in Hizla, Bangladesh: Sources, Effects and Remedies

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ABSTRACT Various natural (high arsenic bearing strata and pyrite oxidation) and anthropogenic (agricultural, coal mining, metal smelting, and refining industry) sources are involved in arsenic pollution of water. Water, soil, and biological samples (vegetables, fish, and meat) were collected from potentially arsenic affected area - Hizla, Bangladesh - and analyzed to find the source of arsenic contamination. All analyses excluding water were carried out by X-Ray Fluorescence method. Total arsenic determination of groundwater was conducted by field kit and cross-checked by Total Reflection X-Ray Fluorescence method. About 80% of shallow tubewell (10-30 m) water was contaminated (71 out of 89 samples), but none of the 35 deep tubewell (more than 200 m) water samples. Hair samples from patients, who have been drinking arsenic tainted water for several years and have been suffering with preliminary skin lesions, showed significant results (5.5 to 11.1 mg kg^{-1}). Reasonable concentrations have not yet been investigated in biological and soil samples, as a source of arsenic pollution in Hizla. Arsenic in groundwater was found to be increased proportionally with iron but decreased inversely with the well depth. Analysis of borehole soil samples in different depths from arsenic contaminated area, initially confirmed by As test kit, will certainly identify the source of arsenic contamination in the study area.

KEYWORDS: Groundwater contamination, arsenic, carcinogen, source of arsenic, effects of arsenic.

INTRODUCTION

Arsenic (As) contamination in water has been reported from Argentina, Chile, China, Taiwan, Thailand, Mongolia, Ghana, the United States of America, and India. Arsenic contamination includes contamination of groundwater and surface water by natural and anthropogenic sources. Millions of people have been exposed to arsenic contamination through drinking water. Well-documented cases of health disorders due to arsenic are 'Kai Dam' in Thailand, 'Black Foot Diseases' in Taiwan, and 'Bell Ville Disease' in Argentina.

It is indeed a matter of great concern that the environmental impact of arsenic has been causing widespread disquiet in Bangladesh. The problem was first identified in 1993 by the Department of Public Health Engineering (DPHE). Arsenic contamination in the groundwater has been increasing quantitatively and qualitatively with time. Groundwater arsenic contamination was detected in seven districts in 1996. By the middle of 1997, the number had shot up to 48, and by March 1999 tubewell water of 59 districts has been contaminated. Within this short period, about 24 million people have been potentially exposed and 7,000 people have been affected by arsenic related diseases ranging from melanosis to skin cancer.[1, 2] Among them, 2027 are seriously affected[1] and sixteen have already died by September 1997 at the village of Samta in the district of Jessore.[3] It has been estimated that 40 million people are at risk for arsenic poisoning through groundwater contamination.[4] Arsenic contamination has been creating serious social problems for affected people. The provisional concentration of As in drinking water is 0.05 mg l^{-1} in Bangladesh[5], whereas the World Health Organization (WHO) guideline is 0.01 mg l^{-1}.

Hizla, the study area, which occupies an area of 515.36 sq. km including 63.97 sq. km rivers is the largest thana (sub-district) in Barishal district.[6] With a population of 166,225 people and population density 322 people per sq. km[6], Hizla is surrounded by Lakshmipur, Chadpur, and Sariatpur districts. The average arsenic contamination of groundwater in these contiguous districts is more than 0.05 mg l^{-1}. Among them, Lakshmipur is the most contaminated district in Bangladesh.[7, 8] Seven people have already died in Barishal Sadar (town).[9] Therefore, the incidence of arsenic contamination in Hizla cannot be ignored.

Arsenic is a dietary constituent, which is present in many foodstuffs such as meat, fish, poultry, grain, and cereals. The organic forms of arsenic in these foods are less toxic than inorganic forms.[10-13] At present, people have been affected by drinking arsenic tainted groundwater, and the number of arsenic affected patients is increasing. However, no study has yet been done to explore the source of arsenic contamination other than groundwater in Bangladesh. Therefore, the present study is performed with the following objectives: (1) to determine As concentration in water, soil, and biological samples to explore the source of its contamination; (2) to assess the potential risk of arsenic contaminated area in Hizla; and (3) to correlate arsenic in hair samples of suspected arsenicosis patients with initial skin lesions for arsenicosis severity.

Materials and Methods

Sampling and sample preparation

Water

Water samples were collected from tubewells of various locations in 250 ml new polyethylene bottles, which were soaked in 20% nitric acid solution, washed with tap water followed by distilled deionized water. 1.25 ml of supra pure concentrated hydrochloric acid was poured into the dry and cleaned bottles, and filled with water after purging the well for five minutes.[14] Acidified samples were stored in a refrigerator to prevent changes due to chemical or biological activity as well as loss due to evaporation.[15]

Soil

About 100 g of each sample was collected from depths of 0-15 cm from the surface close to the contaminated tubewells and from the crop, vegetables, and rice fields. A portion of each sample (about 5 g) was spread to remove roots and external contaminants, air-dried and oven-dried at 80 ± 5 °C for 12 hrs, and ground to fine powder with an agate mortar, and preserved in desiccator for subsequent analysis.

Biological samples

The kitchen vegetables (sweet gourd, red amaranth, tomato, bean, bitter gourd, grass, lady's finger, and grass pea) were collected from house yards or house adjacent fields. About 200 g of each sample was cut into small pieces, washed, air-dried and oven-dried at 80 ± 5 °C for 2 days, and finally ground to fine powder.[16] Large prawn (*Macrobrachium rosenbergii*) and small prawn (*Macrobrachium lamarrei*) of fresh water, and meat and liver from cow that grazed in the field were collected, and cut into small pieces and washed by distilled water, followed by distilled deionized water, dried at 105 ± 5 °C for 2 days, and ground as per the recommendation of Khan [16] and Tarafdar.[17]

Hair

About 5 g of hair sample was cut with stainless steel scissors from the closest distance of the scalp and from different sites around the head of suspected arsenicosis patients with early skin lesions.[18, 19] To remove the external contaminants, 1 g of sample was washed twice by acetone, three times by distilled deionized water and finally once with acetone again as recommended by International Atomic Energy Agency (IAEA).[20] After that the samples were air-dried and oven-dried at 105 ± 5 °C for 2 days and at 180 ± 5 °C for 1 hr, and ground into powder.[19]

Analytical methods

Total Reflection X-Ray Fluorescence (TXRF) technique for water samples

To measure the level of arsenic, 6 ml of water sample was taken into a clean plastic vial to which 6 ml of 1000 $\mu g\ l^{-1}$ Yttrium (Y) standard solution was added as an internal standard. To prepare the sample in the form of a thin film 6 µl of the sample was placed in the center of a quartz reflector and evaporated to dryness under an Infra Red (IR) lamp at 70 °C. The dry sample was irradiated with the primary X-ray beam under the total reflection.[21]

In the TXRF technique, the primary beam coming from the line focus of an X-ray tube is collimated by passing through the slit of a collimation unit. The beam under total reflection conditions impinges on the reflector and excites the sample to emit fluorescent radiation. The emitted secondary radiation is detected by a Si(Li) detector and the spectrum is collected by a multi-channel analyzer.[22] The spectral processing was performed using the QXAS software program. The internal standardization in quantitative TXRF analysis of thin film samples is performed throughout.[21] A calibration curve was established by means of six multi-element standard solutions containing Y as the internal standard solution. Each standard solution was made by mixing five different commercially available single element standard solutions (suprapure stock solution from E Merck).

X-Ray Fluorescence (XRF) technique for soil, hair, and biological samples

About 100 mg of homogenous sample was pressed into 1 mm thick and 10 mm diameter pellet with the stainless steel pellet maker for X-ray analysis and preserved in desiccator. Similar procedure was followed for the standard, where orchard leaf (NIST-SRM-1571) and IAEA-Soil-7 was used for biological and soil sample analysis, respectively.

A radioisotope induced X-ray fluorescence system was applied for XRF analysis, where a 10 mCi ^{109} Cd annular source was used for excitation. All samples including standard were irradiated for 3,000 seconds by the X-ray source with close sample-source-detector geometry. The characteristic X-rays were detected with the Si(Li) detector and the pulses after amplification were analyzed with multi-channel analyzer. The spectrum obtained gave explicit information about the quality and quantity of the elements present in the sample. All peak areas were integrated using the software AXIL on a Redstone (IBM) professional computer. IAEA and National Institute of Standardization (NIST) standard reference materials were used for concentration calibration in all analyses. Standards were used as such without any further treatment. The concentration of each element in biological samples was calculated by comparison with the calibration curve constructed from the standards. For fish, meat, and vegetables, the IAEA standard MA-A-2 (fish-flesh homogenate), NIST bovine liver (SRM-1577), and NIST orchard leaf (SRM-1571) were used, respectively, for concentration calibration. Concentration calibration curves were constructed from the average peak areas obtained from the irradiation of 100 mg standard pellets.

Field test kit

Detection of arsenic in water by an improved field test kit offers a cheap, user friendly, and simple way of testing a large number of samples at the community level to screen for contamination of tubewell water. There are several kits that can be used to determine As in water eg E Mark from Germany, Aqua kit from India, AAN kit from Japan, and AIIH&PH kit from India. The Asia Arsenic Network (AAN) field test kit, modified by National Institute of Preventive and Social Medicine (NIPSOM), Mohakhali, Dhaka, Bangladesh was used for the overall survey of tubewell water. Ahmad et al[23] discussed the materials and chemicals required, and procedures for the determination of total arsenic level in water.

Other parameters

The levels of Fe and Cl^- were also measured by TXRF method to observe their relationships with that of arsenic. Electrical conductivity and pH were measured to study the characteristics of high arsenic containing water using Lazar Model 1671 Dual Display Conductivity meter and Lazar Model PHN-368 with pH electrode 15-cm body, respectively.

Arsenic-safe drinking water

To provide arsenic-safe drinking water as remedies among the villagers in the study area, available arsenic removal techniques and alternative sources for safe drinking water were reviewed.

RESULTS

Most shallow tubewell water from all the unions (sub-thana) of Hizla is tainted by arsenic, except for that from Memania and Hizla-Gourabdi unions. The observed variations may be due to the differences in geology and hydrogeology among the unions since the two arsenic-free unions are separated from the main land by the Dharmaganj river and were formed as islands 25 years ago. Also it was not possible to survey the Kuchaipattee union because it is in a remote area. Right now, no deep tubewell water was found to be tainted with arsenic in Hizla. Therefore, the total area containing As-affected shallow tubewell water in Hizla is 224.46 sq. km (43.55 % of Hizla) with a population of about 113,000 people (67.73 % of the total population of Hizla) (Table 1). This does not indicate that at present all 113,000 people have been drinking arsenic contaminated water and that the whole area of 225 sq. km is contaminated by arsenic. The possibility of arsenic contamination in the whole area, however, cannot be ruled out in the long run. Figure 1 shows the arsenic status of groundwater in Hizla. Most shallow tubewell water in Khunna-Gobindapur village of Barazalia union is arsenic free. Mostly all shallow and deep tubewell water of Barazalia village in Barazalia union has been tested, and all tested shallow but not deep tubewell water was contaminated in that village.

To verify the field test kit results, water samples were cross-checked by the TXRF method and more than 70% accuracy was observed. Figure 2 shows the correlation between the two methods. To check reagents, an internal standard was executed frequently using standard solution of arsenic and distilled water. The kit results were 100% reproducible.

In the contaminated region of Hizla, arsenic concentration in shallow aquifer is much higher than

Table 1. Arsenic status of different unions in Hizla thana.

No.	Union	Population	Area (km^2)	Tubewell tested			Tubewell contaminated	
				Total	Shallow (10~30 m)	Deep (>200 m)	Shallow	Deep
1	Barazalia	32,345	55.12	77	52	25	38	ND
2	Guabaria	31,499	47.60	10	8	2	8	ND
3	Harinathpur	26,645	76.65	20	16	4	16	ND
4	Memania	17,122	54.81	6	4	2	ND	ND
5	Hizla-Gourabdi	21,530	45.35	2	1	1	ND	ND
6	Dhulkhola	22,121	45.09	9	6	3	5	ND
7	Kuchaipattee	15,003	90.36	-	-	-	-	-
Total	**Seven**	**166,265**	**515.36**	**124**	**87**	**37**	**67**	**ND**

Contaminated: Arsenic concentration in drinking water is more than 0.05 mg l^{-1}
ND: Not detectable
-: Information is not available

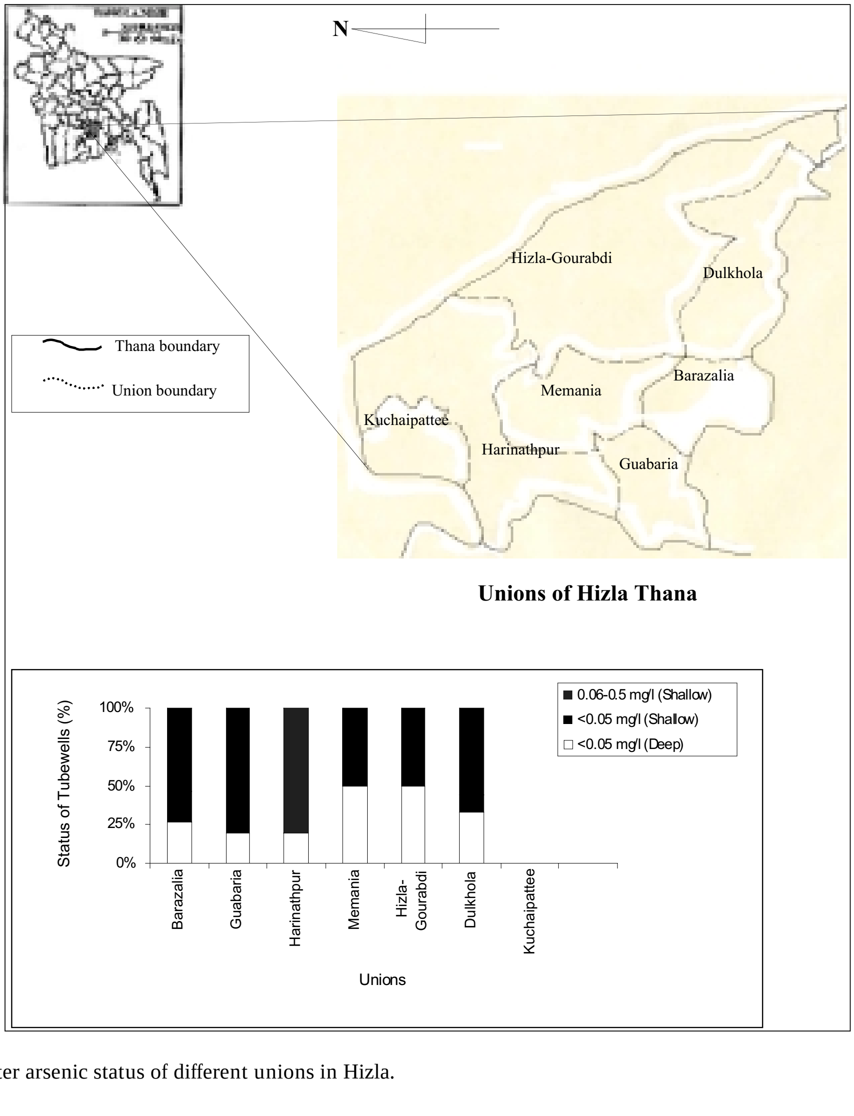

Fig 1. Groundwater arsenic status of different unions in Hizla.

that of in deep aquifer. All but one of the water samples exceed the WHO Fe standard (1 mg l^{-1} of Fe) (Table 3). Iron concentration in deep aquifers is generally much lower, than that in shallow aquifers. Therefore, there is a significant correlation between arsenic and iron concentration (Figure 3).

Table 2. Characteristics of groundwater [33] containing high levels of arsenic.

Parameters	Range
pH	6.5 to 7.5
Electrical conductivity (µS cm^{-1})	> 700
Total iron (mg 1^{-1})	> 10
Chloride (mg 1^{-1})	> 25

Electrical conductivity (E C) of groundwater varies from 496 to 1716 µS cm^{-1} at pH 7.16 to 7.86, indicating that total dissolved solids (TDS) in water is within the limit. In the exterior of the coastal zone, groundwater is generally fresh (E C < 2000 µS cm^{-1}). Although the study area is next to the coastal region, its groundwater is still fresh.

Arsenic may leach down from the surface soil and contaminate the groundwater. All but two of

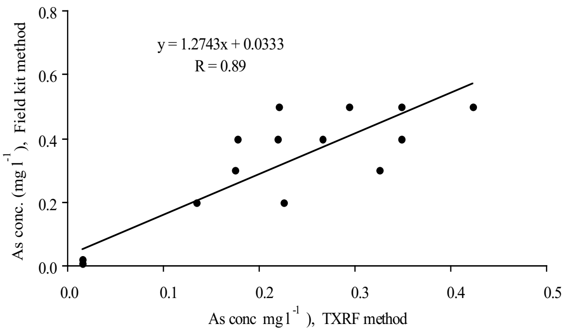

Fig 2. Correlation between the field kit and the TXRF method.

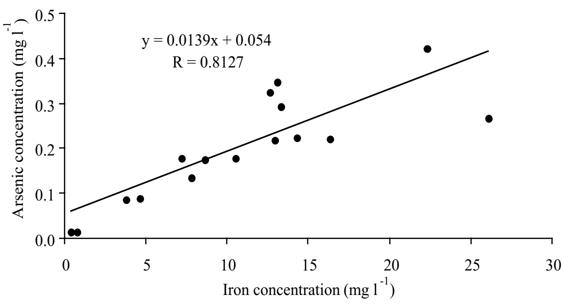

Fig 3. Correlation between the concentrations of arsenic and iron in ground water samples taken from Hizla.

Table 3. Characteristics of water samples collected from Hizla, Bangladesh.

As level (mg l^{-1})	Conc. of As (by test kit) (mg l^{-1})	Depth (m)	By TXRF Method			Electrical Conductivity (E.C) (µS cm^{-1})	pH
			As (mg l^{-1})	Fe (mg l^{-1})	Cl (mg l^{-1})		
Low <0.05	ND	260	<0.015	0.356 ± 0.032	62.7 ± 1.63	747	7.16
	0.02	275	<0.015	0.751 ± 0.046	120 ± 1.60	901	7.50
	0.02	12	<0.015	1.14 ± 0.05	58.8 ± 1.20	496	7.61
	0.02	17	<0.015	1.85 ± 0.10	98.4 ± 3.02	522	7.65
	0.02	12	<0.015	3.02 ± 0.02	133 ± 2.4	763	7.54
Medium 0.05~0.30	0.3	12	0.085 ± 0.016	3.75 ± 0.110	161 ± 2.55	929	7.35
	0.3	12	0.088 ± 0.017	4.58 ± 0.158	228 ± 2.89	1,358	7.40
	0.3	16	0.175 ± 0.015	8.62 ± 0.163	148 ± 2.79	831	7.50
	0.2-0.3	19	0.225 ± 0.015	14.3 ± 0.20	208 ± 2.48	1,294	7.44
	0.2	19	0.134 ± 0.016	7.8 ± 0.18	125 ± 2.37	1,180	7.26
	0.3	15	0.325 ± 0.036	12.6 ± 0.27	263 ± 14.0	1,522	7.52
High >0.30	0.4	12	0.348 ± 0.019	13.1 ± 0.157	279 ± 3.23	1,391	7.55
	0.4	19	0.177 ± 0.014	7.21 ± 0.101	147 ± 1.79	807	7.59
	0.5	14	0.348 ± 0.016	13.09 ± 0.144	252 ± 3.12	1,221	7.45
	0.5	12	0.423 ± 0.074	22.3 ± 0.514	-	956	7.46
	0.4	19	0.266 ± 0.019	26.1 ± 0.280	174 ± 2.72	858	7.46
	0.5	22	0.22 ± 0.02	16.3 ± 0.20	252 ± 4.3	1,306	7.33
	0.5	15	0.294 ± 0.033	13.3 ± 0.22	172 ± 2.88	1,716	7.34
	0.4	15	0.177 ± 0.015	10.5 ± 0.17	168 ± 2.5	786	7.86
	0.4	12	0.219 ± 0.037	12.9 ± 0.40	184 ± 3.86	1,115	7.46

ND: Not detectable

soil samples tested did not show notable arsenic concentrations. Soil which is composed of silt (KS8) and sand (KS6), contains more arsenic concentrations than others (Table 4). Arsenic uptake by plants depends on types of soils and species of plants. Arsenic concentrations in biological samples (vegetables, fish, and meat) are too low to be considered as a source of As contamination in the study area.

Hair samples were collected from the suspected arsenic patients with skin lesions from the study area to screen out arsenic exposure as chronic. A relationship between arsenic concentration in drinking water and in hair samples of the patients who have been drinking tubewell water containing more than 0.05 mg l^{-1} arsenic for several years was studied. All cases show different stages of chronic arsenism – black spots on gums, conjunctivitis, diffused keratosis, black spots on soles and palms, and gangrene. In most cases, diffused keratosis is the common symptom.[24] The clinical manifestations of some of the affected villagers are shown in Figures 4 and 5. The As concentrations in hair samples and background information of the patients are shown in Table 5. Several hair samples showed significant arsenic concentrations (more than 3.0 mg kg^{-1}).

Table 4. Arsenic concentration in soil samples.

Sample no.	KS1	KS2	KS3	KS4	KS5	KS6	KS7	KS8
As conc. (mg kg^{-1})	BDL	BDL	BDL	BDL	BDL	17.7 ± 6.00	BDL	19.1 ± 7.86

BDL: Below detection limit

Fig 4. Gangrene (skin lesions on fingers and toes) in a patient who has been drinking water containing 0.3 mg l^{-1} arsenic.

Fig 5. keratosis on the soles of a patient who has been drinking water containing 0.4 mg l^{-1} arsenic.

Discussion

Sinha-Ray[25] considered arsenic–rich pyrite detected in borehole samples at various locations to be the major source of arsenic. From the surveyed results of West Bengal and Bangladesh[26], the arsenic contaminated region falls under the Younger Deltaic Deposits of the Ganges Basin.

The gutzeit procedure has been modified to develop many field kits.[15] The field kit of AAN is one of such kinds.[27]

Usually arsenic concentration decreases sharply with the depth of earth.[28-29] There is a high level of arsenic in one particular layer under the earth's surface, which varies from area to area and does not have any relationship with the water table.[30] Although arsenic concentration was found to be high with tubewell depth in Tungipara, Faridpur, and Manikgonj districts[31], it is not so with tubewell depth in Hizla (Table 3).

AAN[32] and MML[31] reported that the concentration of arsenic is likely to increase with the increase of iron concentration. Nickson[30] and Talukdar[28] observed the identical correlation in the water samples from various locations in Bangladesh.

NRECA[33] detected the general characteristics of groundwater with high arsenic content (Table 2). Water samples from the study area show similar characteristics (Table 3) as those detected by NRECA.

NRECA[33] reported that arsenic concentration in extracts of silt and sandy soil are higher (0.06 to 0.13 mg kg^{-1}), compared to those of other soils. If the As level in soil exceeds 200 to 500 mg kg^{-1}, it will be 1 mg kg^{-1} As in plants on fresh weight basis.[34] Some crops can accumulate high levels of As, even though there is much lower level of As in the soil. For example, grass and alfalfa accumulate up to 14 mg kg^{-1} of As when growing in soils containing 60 mg kg^{-1} of As.[34]

Biswas et al[3] have shown that patients, who have been drinking arsenic contaminated water for a long time, possess high concentration of arsenic in their hair samples.

Table 5. Arsenic concentrations in hair samples and pertinent characteristics of arsenicosis patients.

Sample No	As conc in drinking water (mg l^{-1})	Occupa-tion	Income per year (Taka)	Daily diets	Addiction	Chronic Arsenicosis Symptoms	Duration of drinking As contaminated water (yr)	As conc in hair (g kg^{-1})
KH1	0.3	Service owner	25,000	Rice, bread, patato, milk	Betel-nut, tobacco	Hyper keratosis on feet	12	MDL (<3.0)
KH2	0.4	Farmer	15,000	Rice, dal, vegetb	Smoking, betel-nut, tobacco	Melanosis on skin	3	MDL
KH3	0.4	Farmer	8,000	Rice, dal, vegetb	Smoking, betel-nut, tobacco	Black spots on gum	3	7.34 ± 2.94
KH4	0.4	Farmer	20,000	Rice, dal, fish, vegetb	Smoking, betel-nut, tobacco	Conjunctivitis and keratosis on feet	3	MDL
KH5	0.5	House wife	70,000	Rice, fish, dal, vegetb	Betel-nut, tobacco	Melonosis on skin	4	11.1 ± 2.82
KH6	0.02	Student	No income	Rice, dal, fish, vegetb	Not addicted to special thing	Black spot on face	Drinking As free water	MDL
KH7	0.02	Land owner	25,000	Rice, dal, fish, vegetb	Betel-nut, tobacco	Melanosis on skin	Drinking As free water	MDL
KH8	0.3	House wife	12,000	Rice, dal, fish,	Betel-nut, tobacco	Gangrene	20	7.19 ± 2.73
KH9	0.02	Land owner	25,000	Rice, dal, fish, vegetb	Betel-nut, tobacco	Diffused keratosis on palm and feet	At present drinking As free water	MDL
KH10	0.5	Land owner	15,000	Rice, dal, vegetb	Betel-nut, tobacco	Diffused Keratosis on Palm	8	5.55 ± 2.29
KH11	0.3	Farmer	12,000	Rice, dal,	Betel-nut, tobacco	Melanosis on skin	6	MDL

1 US$ = 54 Taka

Nowadays, various methods are available for removal of arsenic from water. Available chemical methods are coprecipitation, activated alumina, ion exchange, membrane process, and microbiological processes. Alternative options for arsenic free water include rainwater harvesting, ring well, household mini sand filter and pond sand filter. At present, arsenic removal techniques used in Bangladesh include alum method, chemical-packed method, and Shafi filter. Each method has its negative effects, such as high cost, complex operation, production of highly concentrated arsenic waste, and corrosion problem. In view of the overwhelming dependence of the population on groundwater as the source of drinking water, there is an urgent need to develop suitable methods for removal of arsenic from groundwater. Socioeconomic conditions of Bangladesh demands low cost as well as small-scale treatment systems that could be implemented in the rural areas at household or community level.

The high levels of arsenic in shallow tubewell water also mean high level of iron. Therefore, people can practice keeping the tubewell water in a covered vessel undisturbed for 12 hrs or overnight. The upper two-thirds of water, after filtering through clean cloth, is taken into another vessel. This filtered water is about 70% arsenic free and relatively safe for drinking.

The lower one-third of water after gravitational settling is arsenic rich, and is to be disposed into a surface hole containing cow-dung, so that the arsenic can be detoxified by biomethylation.[35] Nikolidis's[36] research shows that arsenic contaminated tubewell water can be purified by passing the groundwater through the filter attached with tubewell. Professor Shafiullah of Jahangirnagar University, Bangladesh has also been pursuing similar research.[37] He has designed special tubewell strains attached with the tubewell, which may keep arsenic concentration of the tubewell water within permissible limits.

A community-based solution for arsenic safe water is a pond sand filter (PSF), if both types of tubewell – shallow and deep – are contaminated. Rainwater harvesting is a good practice for arsenic safe drinking water for the people, who live in the coastal or hilly areas and have shortage of safe groundwater or safe surface water.

The structure and method of using PSF was described by Yokota et al.[38] Meng and Karfiatis proposed PSF[39] as an alternative source for arsenic free water. Considering the annual rainfall and financial conditions of the villagers, the scientists of Asia Arsenic Network (AAN) group have recommended the process of rainwater harvesting[32] in Samta village of Jessore district, which is one of the most arsenic contaminated region in Bangladesh.

Conclusions

Most shallow tubewell water, but not deep tubewell water, has been found to be arsenic tainted in Hizla. Hair sample test confirmed the relationship between arsenic patients and the drinking of arsenic contaminated water for several years. Reasonable concentrations of arsenic have not yet been reported in biological and soil samples, negating the possibility of it being a source of arsenic contamination. Therefore, it can be concluded that so far groundwater is the only major source of arsenic contamination in Hizla.

Most of the affected people are poor. Indeed most people of Hizla have been living below the poverty line. It is noticeable that drinking of arsenic contaminated water (more than 0.05 mg l^{-1}), malnutrition (balanced diet), food habits, addiction of special food items, poor socio-economic conditions, and illiteracy are main reasons for chronic arsenic toxicity in Hizla as well as rest of the country.

Arsenic tainted water with high iron concentration can be used safely by keeping the water overnight. It is necessary to know the arsenic status of each tubewell to safeguard people from arsenic mutilation. To provide arsenic safe drinking water for long term, some alternative approaches, such as household mini sand filter, rainwater harvesting, and pond sand filter, have been recommended for the As contaminated area, considering the availability of surface water, economic conditions, social acceptance, and environmental sustainability.

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