

Arsenic in Tube Well Water in Six Blocks of Supaul District, Bihar

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Abstract: An experimental estimation of arsenic in a large number of samples by Field Test Kits and by Hydride Generation Atomic Absorption Spectrophotometer (HGAAS) was done. Water samples were collected from the following blocks of Supaul district, viz., Raghapur, Basantpur, Supaul, Nirmali, Saraigarh-Bhaptiyahi and Triveniganj. The aim of this study was to analyze the total arsenic concentration in tube well water of these regions at different locations. Twenty water samples were randomly selected from each block (n=120) for the determination of Arsenic concentration, using Field Test Kits. Few samples (n=11) found with higher concentration of arsenic, were also estimated and confirmed by HGAAS method for comparative observation. The maximum concentration of arsenic was found to be 0.10 mg/l by using Field Test Kits method and the average concentration of arsenic of the selected samples was 0.02 mg/l, whereas around 20% of these tube wells had arsenic concentration above 0.05 mg/l. It was observed that the results obtained by using Field Test Kits showed less measurement as compared to those obtained by HGAAS method for the same samples, when the arsenic concentration measured ≤ 0.10 mg/l. Arsenic concentration was significantly ($p < 0.0001$) higher in HGAAS results than the value obtained by Field Test Kit method.

Keywords: Arsenic, Tube well water, Field Test Kit, HGAAS

I. Introduction

Environmental pollution has become one of the most serious concerns these days. Arsenic (As) is among the top 20 most toxic known substances, which have become serious concerns for the human health. Arsenic is described as a metalloid and a ubiquitous element in the environment. Toxicity of arsenic depends on the form in which it is present. Inorganic arsenic, typical in drinking water, is much more toxic than organic arsenic. The toxicity of arsenic is determined by its oxidation state, thus the toxicity of different As species changes depending on the biotic and abiotic conditions in water [1]. Incidences of arsenic in groundwater have been reported in many countries of the world [2,3,4,5,&6]. In 1984, ground water arsenic contamination was identified in lower Gangetic plains of West Bengal [7]. Arsenic contamination in the middle Gangetic plain of Bihar was first reported in June 2002 [8&9]. It was reported that the Ganga-Meghan-Brahmaputra (GMB) plain, which had an area of approximately 500,000 km² and the population over 500 million, was at risk from ground water arsenic contamination. According to Public Health Engineering Department, Government of Bihar and UNICEF - Bihar, arsenic contamination of ground water was found in several districts of Bihar, viz. Patna, Saran, Vaishali, Katihar, Purnea, Araria, Supaul, Kishanganj, Madhubani, Sitamarhi, East and West Champaran, Khagaria, Begusarai and Bhagalpur. Extensive exposure to high level of arsenic in drinking water may cause serious health hazard [10, 11, 12, 13 & 14]. Hydride Generation Atomic Absorption Spectrophotometer (HGAAS) is widely used technique for trace metal analysis. With the help of this HGAAS technique, metal toxicity in water, soil and other biological samples can be examined easily. The aim of the present work was to make comparative study of existing methods for detection of arsenic in water samples of the selected region by Field Test Kits and by Hydride Generation Atomic Absorption Spectrophotometer (HGAAS).

II. Materials And Methods

Sample containers were cleaned scrupulously with 1% HCl.

2.1 Materials and reagents of Test Kit:

Field Test Kit (Merck, Germany) contained two test bottles, One red spoon, One green Spoon, reagent 1st (As-1), Reagent 2nd (As-2), Reagent 3rd (As-3) and arsenic test strips.

2.2 Method for detection of arsenic using test kit:

60 ml water sample was taken in the test bottle. Thereafter two drops of As-1 reagent was mixed with the sample water collected in the testing bottle. After that, one red spoon As-2 reagent was added and vigorously swirled. Then one green spoon As-3 reagent was mixed with the sample. Thereafter, one As-test strip was

inserted into the test bottle to develop the color. Thereafter it was kept at room temperature for 20 minutes. After 20 minutes the strip was matched with arsenic color chart.

2.3 Reagents of AAS:

3% (w/v) NaBH₄ in 1% (w/v) NaOH, 3% (w/v) KI in 5% ascorbic acid, Conc. HCl, Conc. HNO₃ and Distilled water

2.4 Digestion of water samples:

100 ml water sample was taken in a Griffin beaker and 5 ml HNO₃ was added into it. Then the sample was covered with watch glass and it was placed on a hot plate at 90 °C for evaporation to allow volume to reduce to up to 5ml. After that, the sample was cooled at room temperature and volume made up to 50 ml with 2% HNO₃. Finally, that solution was filtered by using filter paper.

2.5 Preparation of water sample for AAS:

10 ml digested sample was taken in a 50 ml volumetric flasks and 5 ml conc. HNO₃ was added, after that 5 ml prepared KI with ascorbic acid solution was added. Thereafter the solution was kept for 45 minutes at room temperature. After 45 minutes the volume of solution was made up to 50 ml by adding DI water.

2.6 Instrument Used:

In this study model number PinAAde900T Atomic Absorption Spectrophotometer (AAS) with Hydride Generation was used.

III. Results And Discussion

Arsenic concentration range in water (mg/l) of different blocks of Supaul district was found as following: Raghapur block from 0.02-0.10, Basantpur block from 0.01 - 0.10, Supaul block from 0.01-0.10, Nirmali block from 0.005-0.05, Saraigadh-Bhaptiyahi block from 0.005-0.05 and of Triveniganj block from 0.005-0.025 mg/l (Table 1).

Table-1. Mean, SD and SEM Values of Arsenic Concentration

Name of Blocks	Range(mg/l)	Arsenic Level(mg/l)		
		Mean	SD	SEM
Raghapur	0.02-0.10	0.04275	0.03397	0.00760
Basantpur	0.01-0.10	0.04575	0.03661	0.00819
Supaul	0.01-0.10	0.03275	0.03374	0.00754
Nirmali	0.005-0.05	0.01950	0.01799	0.00402
Saraigadh-Bhaptiyahi	0.005-0.05	0.01925	0.01823	0.00408
Triveniganj	0.005-0.025	0.00975	0.00881	0.00197

Seventeen out of twenty water samples from Raghapur, sixteen out of twenty water samples from Basantpur, fifteen out of twenty water samples from Supaul, fourteen out of twenty water samples from Nirmali, thirteen out of twenty water samples from Saraigadh-Bhaptiyahi and eleven out of twenty water samples from Triveniganj blocks crossed the permissible limit of arsenic in drinking water (0.01mg/l = 10 ppb) as prescribed by WHO (1999) [21], which are shown in Table - 2.

Table-2. Summary of Arsenic concentration in the six blocks of Supaul district

Name of Blocks	No. of Samples	≤0.01mg/l		>0.01-0.2 mg/l		0.025-0.1 mg/l	
		Numbers	%	Numbers	%	Numbers	%
Raghapur	20	03	15	04	20	13	65
Basantpur	20	03	15	05	25	11	55
Supaul	20	05	25	06	30	09	45
Nirmali	20	06	30	6	30	08	40
Saraigadh-Bhaptiyahi	20	07	35	06	30	07	35
Triveniganj	20	09	45	08	40	03	15

There may be various explanations for such arsenic concentration in ground water in blocks of Supaul district. The four geochemical mechanisms of natural arsenic pollution are reductive dissolution; alkali desorption; sulphide oxidation and geothermal activity [15]. Nickson et al., (2000) [16] have suggested anoxic reduction of arseniferous iron-oxyhydroxides as the promising source of arsenic in ground water. According to another theory [17,5 & 18], on the basis of sediment analysis high volume pulling out of ground water favours the oxidation of arsenic rich iron sulphide and mobilization of arsenic to the aquifer. River Koshi originates from the Himalayas and crosses Tibet reaching plains at Chatra in Nepal and in India on the border of

Madhubani and Darbhanga. It flows through Supaul, Saharsa and Madhepura and joins the river Ganga near Kursela. Supaul was one of the districts that were affected by Koshi flood in 2008. McArthur et al. (2004) and Ravenscroft et al. (2005) [19&20] have reported that arsenic contained in relatively unweathered alluvial sediments are imitative of igneous and metamorphic rocks in the Himalayas and associated young mountain chains. The variation of arsenic concentration in ground water of six blocks under Supaul district is to be related to regional and local variations of the amount of organic matter in aquifer sediments. Weathering of rocks from Himalayas in Koshi River and the widespread use of rodenticides and pesticides might be other aspects accountable for arsenic contamination in ground water of the study area.

Eleven samples out of one hundred twenty samples having the highest concentration were further observed by Hydride Generation Atomic Absorption Spectrophotometer (HGAAS) for the comparison of results, which are shown in Table-3, Table-4 and Fig.-1

Table-3. Water sample of tube wells detected with high concentration of Arsenic

Sample ID	Owner of the Tube well	Locality of Block	Depth of Tube well (ft.)
R03	Sajjan Pandit	Raghopur	20
R10	LalBahadur Mehta	Raghopur	35
R17	Jaynarayan Mandal	Raghopur	25
R20	Lalit Sada	Raghopur	25
B06	Nagendra Mishra	Basantpur	15
B09	Santosh Singh	Basantpur	15
B18	Dularchandra Sada	Basantpur	20
B19	India-Nepal Border	Basantpur	25
S07	Amal Sada	Supaul	45
S15	Ganesh Mandal	Supaul	35
S20	Anirudh Chopal	Supaul	35

The highly concentrated water samples from eleven different tube wells (Table-3) were collected in separate sample container (glass) of 250 ml capacity for further observation under Hydride Generation Atomic Absorption Spectrophotometer (HGAAS) at Mahavir Cancer Institute & Research Center, Patna in the DST Lab. When the samples were analyzed for arsenic content by HGAAS, it was found that there were differences in values as compared to the Field Test Kit method values. Differences in the values have been shown in Fig.-1 and Table-4.

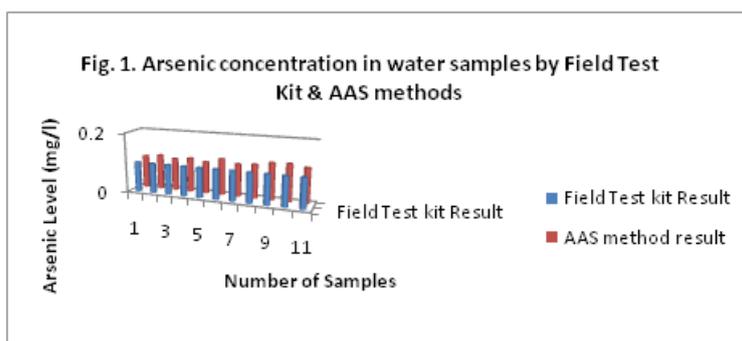


Table-4. Mean, Std. Deviation (SD) & Std. Error of Mean (SEM) of Fig. 1

Sample ID	Mean	SD	SEM
R03	0.1050	0.0071	0.0050
R10	0.1085	0.0120	0.0085
R17	0.1045	0.0063	0.0045
R20	0.1075	0.0106	0.0075
B06	0.1030	0.0042	0.0030
B09	0.1105	0.0148	0.0105
B18	0.1045	0.0063	0.0045
B19	0.1060	0.0084	0.0060
S07	0.1115	0.0162	0.0115
S15	0.1120	0.1696	0.1200
S20	0.1080	0.0113	0.0080

IV. Conclusion

Nowadays, Arsenic content in water is measured by either of the two methods: Laboratory based instrumental method like AAS or by Field Test Kit method at the site. In this work, a comparative study of Field Test Kit method with HGAAS has been done. It was observed that the results obtained by using Field Test Kit

showed less measurement as compared to that by AAS method ($p < 0.0001$). The water samples having arsenic concentration ≤ 0.10 mg/l were further analysed by AAS. 86 samples out of 120 samples collected from the different blocks of Supaul district were found to have arsenic concentration more than the permissible limit of 0.01mg/l as recommended by WHO (1999).

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