Study of arsenic in drinking water and food in three different districts of Bihar, India

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ABSTRACT: Arsenic contamination in groundwater is a serious and widespread global public health problem and India is one of the highly arsenic exposed countries with maximum impact in the Ganga Meghna Brahmaputra plains. A total of 18 districts out of 38 districts of the state of Bihar are highly affected with groundwater arsenic poisoning. In the present study, three arsenic affected districts were taken selected for survey. The study deals with the survey of the affected village in the district, with groundwater arsenic quantification with special attention to determine the concentration of arsenic in food material. The maximum arsenic contamination in water sample was 107.1 $\mu\text{g L}^{-1}$ in Saran while 1257 $\mu\text{g kg}^{-1}$ in rice in Bhagalpur, 567.5 $\mu\text{g kg}^{-1}$.

1 INTRODUCTION

Arsenic in the recent times has caused health hazards in a huge population inhabiting Ganga-Meghna-Brahmaputra basin. The entire Ganga-Meghna Brahmaputra (GMB) plains has high arsenic concentrations ($> 10 \mu\text{g L}^{-1}$) in groundwater. Populations residing in these plains are exposed to arsenic which has led to many health-related problems like keratosis, melanosis and even cancer (Ahamed *et al.*, 2006).

There is no effectively remedial action of chronic arsenicosis. An assessment of As and other elements in the food components was conducted to understand the actual disease burden caused by ingestion of food in people residing in the middle Gangetic plain (Kumar *et al.*, 2016).

In Bihar, presently 18 districts out of a total of 38 are affected by arsenic and it is assumed that a population of about 5 million are consuming arsenic contaminated water with more than 50 $\mu\text{g L}^{-1}$ (Singh *et al.*, 2014). Bhojpur, Buxer and Bhagalpur was the worst affected district among others. The highest value of arsenic (1861 $\mu\text{g L}^{-1}$) was detected in the water of the tube-well at the Bhojpur area. All three confirmed sources of arsenic; water, soil and food with elevated arsenic level is posing a serious threat to the residing communities and hence their health is at risk (Singh *et al.*, 2011).

2 METHODS

2.1 Study area

Samples were collected from three different arsenic affected district of Bihar, namely Bhagalpur (located

on southern bank of Ganges river), Saran (situated near the junction of Ghaghara and Ganga river) and Patna (located on southern bank of Ganges river). These districts were selected as a part of our ongoing NUTRI-SAM project supported by DST-UKIERI.

2.2 Sample collection and arsenic estimation

Water sample and three types of food samples like raw rice, wheat and potato were collected in a sterile polyethylene bag. Arsenic was estimated by atomic absorption spectroscopy (Perkin Elmer PinAAcle 900T) after processing and digestion.

2.3 Statistical analysis

To determine the significant mean, correlation between the various data, standard deviation SPSS software (IBM, version 22) was used.

3 RESULTS AND DISCUSSION

3.1 Arsenic profile in water samples

The arsenic concentration (Table 1) in drinking water was elevated in some of the tested samples. The maximum arsenic concentration in groundwater sample reported was 107.10 $\mu\text{g L}^{-1}$ in Saran District with the mean value 44.13 $\mu\text{g L}^{-1}$ and standard deviation 38.07 and the lowest arsenic concentration in groundwater reported was 50.60 $\mu\text{g L}^{-1}$ in Patna district with the mean value is 26.87 $\mu\text{g L}^{-1}$ and the standard deviation is 19.13.

Table 1. Arsenic in water samples.

District	Maximum ($\mu\text{g L}^{-1}$)	Mean ($\mu\text{g L}^{-1}$)	Standard deviation
Bhagalpur (N = 14)	99.5	30.5	43.2
Saran (N = 14)	107.1	44.1	38.1
Patna (N = 14)	50.6	26.9	19.1

Table 2. Arsenic in raw rice samples.

District	Maximum ($\mu\text{g kg}^{-1}$)	Mean ($\mu\text{g kg}^{-1}$)	Standard deviation
Bhagalpur (N = 13)	1257.5	108.3	345.8
Patna (N = 14)	66.3	48.7	10.5

3.2 Arsenic profile in food samples

For the total arsenic in analyzed samples of raw rice (Table 2), the highest arsenic concentration was in $1257.5 \mu\text{g kg}^{-1}$ in Bhagalpur district with mean value $108.34 \mu\text{g kg}^{-1}$ and the standard deviation is 345.78. In Patna district arsenic in raw rice was in very low concentration, maximum value was found was $66.30 \mu\text{g kg}^{-1}$ with mean value $48.68 \mu\text{g kg}^{-1}$ and the standard deviation is 10.49.

In total analyzed wheat samples (Table 3) the highest arsenic concentration was $567.5 \mu\text{g kg}^{-1}$ in Bhagalpur district with mean value $340.6 \mu\text{g kg}^{-1}$ and standard deviation 161.4 In Patna district arsenic in wheat was in moderate concentration, maximum value was $215.5 \mu\text{g kg}^{-1}$ with mean value $135.3 \mu\text{g kg}^{-1}$ and standard deviation 46.32 The lowest arsenic concentration in wheat is in Saran district i.e. $175 \mu\text{g kg}^{-1}$ with the mean value 57.9 and standard deviation 57.8.

In total analyzed potato samples (Table 4) the highest arsenic concentration was in $826 \mu\text{g kg}^{-1}$ in Bhagalpur district with the mean value $558.7 \mu\text{g/kg}$ and standard deviation 127.40 In Saran district arsenic in wheat is in moderate concentration, maximum value was $195.7 \mu\text{g kg}^{-1}$ with mean value $123.0 \mu\text{g kg}^{-1}$ and the standard deviation is 37.98. The lowest arsenic concentration in wheat is in Patna district i.e. $170.1 \mu\text{g kg}^{-1}$ with the mean value 143.6 and standard deviation 28.6.

Arsenic in food items (Rice, Wheat and Potato) was not correlated with the concentration in drinking water. This was due to the fact that the food procured is not grown locally. The water used for irrigation is different from the water used for the drinking.

4 CONCLUSIONS

The mean arsenic concentration in water samples of three entire selected region was not so much. Most of

Table 3. Arsenic in wheat.

District	Maximum ($\mu\text{g kg}^{-1}$)	Mean ($\mu\text{g kg}^{-1}$)	Standard deviation
Bhagalpur (N = 11)	567.5	340.6	161.4
Saran (N = 12)	175.0	57.9	57.8
Patna (N = 10)	215.5	135.3	46.3

Table 4. Arsenic in Potato samples.

District	Maximum ($\mu\text{g kg}^{-1}$)	Mean ($\mu\text{g kg}^{-1}$)	Standard deviation
Bhagalpur (N = 9)	826.0	558.6	127.4
Saran (N = 14)	195.7	123.0	38.0
Patna (N = 10)	170.1	143.6	28.6

the samples were within the range ($<50 \mu\text{g L}^{-1}$). The arsenic concentration in food samples (rice, wheat and potato) of Bhagalpur was found to be high in comparison to Patna and Saran district. The arsenic content in our wheat samples were within the range of $490\text{--}1150 \mu\text{g kg}^{-1}$. No correlation was observed in food and drinking water samples of the study area.

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