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Analysis Of Hazardous Level Of Arsenic Metal Ion In Boro Rice And Wheat Available In Endemic Areas Of Nadia District; West Bengal, India

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Abstract

Background: Research over past two decades has indicated the presence of Arsenic with consumption f rice and wheat. The present research was conducted on human health effects, including chronic toxicity of arsenic in West Bengal, India.
Results: Arsenic content in the Haringhata region samples were found as 55 ug/l in Ground water, 41 ug/l in Soil sample, 30 ug/l in Boro Rice, 20 ug/l in Wheat, 24 ug/l in Potato. Arsenic content in the Chakdaha region samples were found as 50 ug/l in Ground water, 44 ug/l in Soil sample, 35 ug/l in Boro Rice, 19 ug/l in Wheat, 25 ug/l in Potato. Arsenic content in the Ranaghat region samples were found as 56 ug/l in Ground water, 39 ug/l in Soil sample, 30 ug/l in Boro Rice, 20 ug/l in Wheat, 25 ug/l in Potato. Arsenic content in the Shantipur region samples were 55 ug/l in Ground water, 45 ug/l in Soil sample, 34 ug/l in Boro Rice, 25 ug/l in Wheat, 27 ug/l in Potato. Arsenic content in the Krishna Nagar region samples were found as 54 ug/l in Ground water, 43 ug/l in Soil sample, 32 ug/l in Boro Rice, 21 ug/l in Wheat, 24 ug/l in Potato.
Conclusion: This research reveals that Levels of arsenic content were highest in the groundwater compared to soil, in all the selected regions. The arsenic content in groundwater increases the arsenic contamination which affects serious threats to human health.

Keywords: Arsenic; toxicity; health effects; analysis

Introduction

Arsenic-contaminated groundwater is not only used for drinking and cooking but also used to grow rice and wheat during the drought. Moreover, cooking rice with arsenic-contaminated water makes it even more arsenic content in rice, leading to serious health hazards (1). The people of arsenic hot spot areas, especially in Bangladesh and West Bengal (India), consume an average of 450g rice per day. As a result, in addition to drinking water, dietary arsenic ingestion from rice is thought to represent a new source of exposure and a new calamity for the people (2). Cooked rice has a greater concentration of arsenic heavy metal than raw rice, ranging from 227 to 1642 μg/kg. The arsenic speciation in rice was unaffected by the cooking process. Cooked rice is responsible for 41% of inorganic arsenic ingestion on a daily basis.
The Arsenic is a naturally occurring metalloid that poses a significant risk of cancer to humans. The bulk of arsenic exposure comes through water consumption; millions of people are exposed to arsenic through naturally occurring levels of arsenic in grains, vegetables, meats, and seafood, as well as products cooked with arsenic-contaminated water (5). Chronic exposure to high amount of arsenic is related to adverse health effects in multiple organ systems including keratosis, skin, bladder and lung carcinoma, impaired intellectual function, bronchiectasis, coronary heart disease, and diabetes.
Therefore, it affects the glucose metabolism leading to insulin dependent diabetes mellitus.

Materials & Methods:

Analysis of arsenic was carried out in Haringhata, Chakdaha, Ranaghat, Shantipur, and Krishnanagar towns of Nadia district, West Bengal, India.

Preparation of reagents:

Vanillin-2-amino nicotinic acid (VANA)

Vanillin (1.5g, 0.0098 mol) in 60 ml of methanol, 2-aminonicotinic acid (1.36 g, 0.0098 mol) dissolved with 60 ml of methanol and were kept into 250ml Round Bottom flask. To the reaction mixture, a suitable quantity (1ml) of 1molar sodium acetate and 2 or 3 drops of conc. H2SO4 were added and refluxed for 8 hours. The ash-colored product was separated from the reaction mixture after it was cooled. Water and ethyl acetate were used to clean it. It was filtered and rinsed numerous times with hot water before being exposed to n-hexane.

Arsenic (III) Standard solution

The stock solution ($1.0x10^2$M) of 50 ml was actually prepared by dissolving 0.1520gm of Sodium arsenate hepta hydrate in de-ionized water. The Arsenic of 1000 ppm stock solution was produced by dissolving 0.416gm of Sodium arsenate heptahydrate in100ml distilled water.

Potassium permanganate solution

A 1% potassium permanganate solution was prepared by dissolving in deionized water.

Buffer Solution

1M Sodium acetate + 0.1M hydrochloric acid (0.5 – 3.0), 0.2M Sodium acetate + 0.2M acetic acid (3.5 – 6.0), 1M Sodium acetate + 0.2 Macetic acid (6.5–7.5), 2M Ammonia + 2M ammonium chloride (8.0–12.0) buffer solutions were prepared in distilled water. Suitable portions of these solutions are properly mixed to obtain the required pH.

Aqueous ammonia solution

A 100 ml solution of aqueous ammonia was prepared by adding 10ml concentrated NH3 (28–30%, ACS grade) to100 ml with the help of de-ionized water. After proper dilution the solution was poured and kept in a polypropylene bottle.

A known a liquot of the sample solution was taken in a 25ml standard flask containing constant volume of 10ml of buffer solution (pH = 5), 1.0 ml of 1x10-3 M VANA and finally, distilled water was used to make up the final required volume. Absorbance value of the solution was measured at 350 nm against the blank solution. The reading of absorbance values were referred to the established calibration plot to evaluate the arsenic content.

Tartrate solution

A tartrate (0.01%w/v) stock solution of 100 ml was obtained by dissolving 10 mg of potassium sodium tartrate tetrahydrate in 100 ml of deionized water.

Results & Discussion

Calibration curve of arsenic content:

The calibration curve is prepared by taking the absorbance of the solution containing varied concentration of the metal ions by measuring at 350 nm using photospectrometer. The linear plot in the graphical representation between the concentration of As (III) and absorbance is obtained. The straight line was obtained as according to equation =mx+c. (Beer'^s Lambert law is followed in the range of 10-50 µg/l).

Table 1. Calibration curve of arsenic using UV-spectrophotometry

S. No.	**Absorbance**	**Arsenic Concentration(ug/l)**
1.	0.09	10
2.	0.20	20
3.	0.31	30
4.	0.40	40
5.	0.50	50
6.	0.62	60
7.	0.70	70
8.	0.80	80

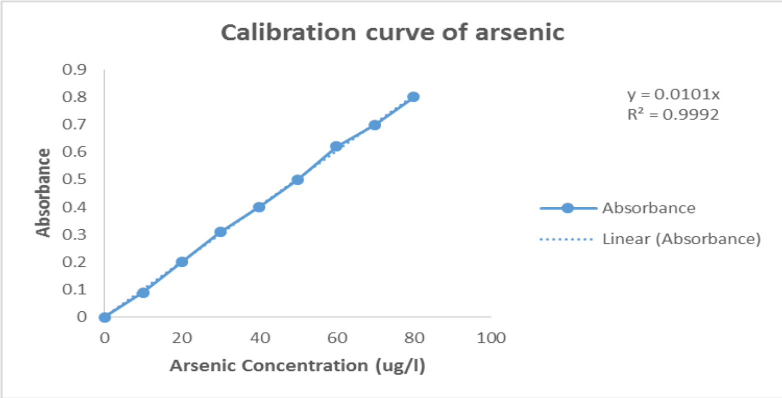

Figure 1. Absorbance vs arsenic concentration Calibration curve of arsenic using UV-spectro-photometry.

Table No. 2 shows arsenic content in the Haringhata region. According to this in Haringhata region 5 types of samples were taken as Ground water, Soil sample, Boro Rice, Wheat, Potato (vegetable), Brinjal (vegetable) and Cabbage (vegetable) then we determined arsenic content in these samples. Arsenic content in these samples were 55 ug/l in Ground water, 41 ug/l in Soil sample, 30 ug/l in Boro Rice, 20 ug/l in Wheat, 24 ug/l in Potato.

Table: 2 Determination of arsenic content in the Haringhata region.

S. No.	**Sample Type**	**Haringhata region**	
		Absorbance	**Amount of arsenic(ug/l)**
1.	Ground water	0.55	55
2.	Soil sample	0.41	41
3.	Boro Rice	0.30	30
4.	Wheat	0.20	20
5.	Potato (vegetable)	0.24	24

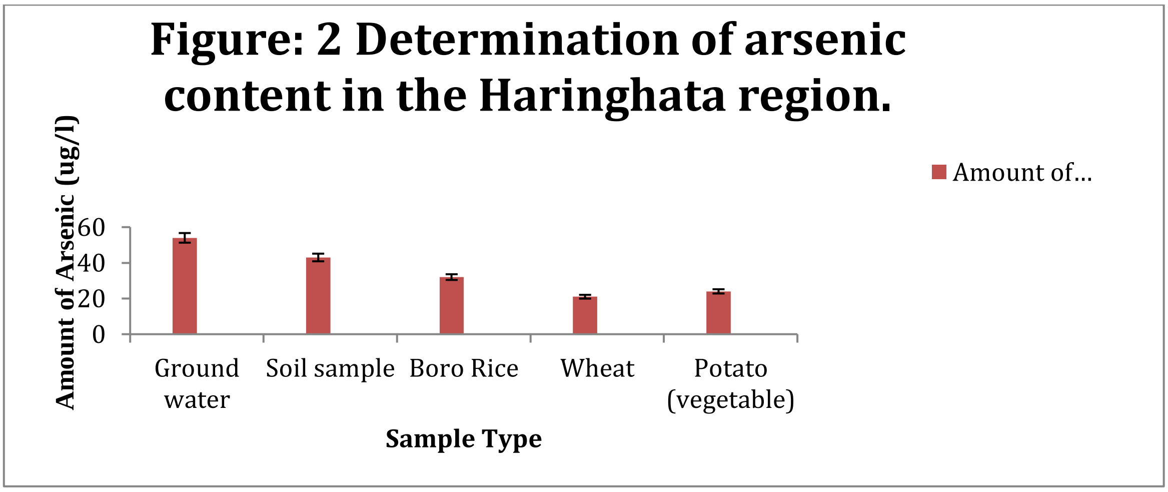

Table No. 3 shows arsenic content in the Chakdaha region. According to this in Chakdaha region 7 types of samples were taken as Ground water, Soil sample, Boro Rice, Wheat, Potato (vegetable), Brinjal (vegetable) and Cabbage (vegetable) then we determined arsenic content in these samples. Arsenic content in these samples were 50 ug/l in Ground water, 44 ug/l in Soil sample, 35 ug/l in Boro Rice, 19 ug/l in Wheat, 25 ug/l in Potato.

Table:3 Determination of arsenic content in the Chakdaha region.

S. No.	**Sample Type**	**Chakdaha region**	
		Absorbance	**Amount of arsenic(ug/l)**
1.	Ground water	0.50	50
2.	Soil sample	0.44	44
3.	Boro Rice	0.35	35
4.	Wheat	0.19	19
5.	Potato (vegetable)	0.25	25

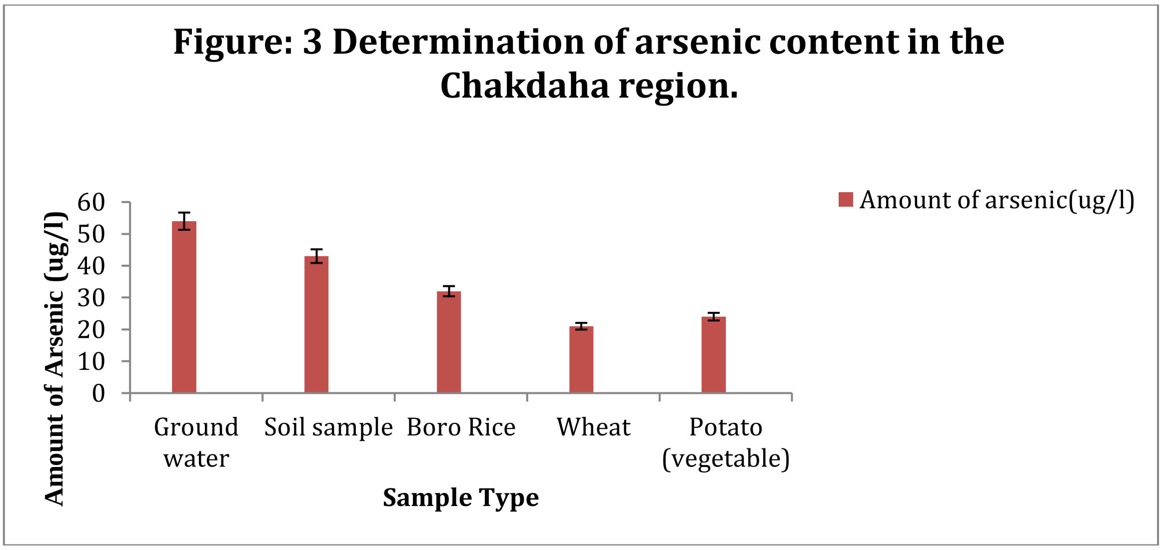

Table No. 3 shows arsenic content in the Ranaghat region. According to this in Ranaghat region 7 types of samples were taken as Ground water, Soil sample, Boro Rice, Wheat, Potato (vegetable), Brinjal (vegetable) and Cabbage (vegetable) then we determined arsenic content in these samples. Arsenic content in these samples were 56 ug/l in Ground water, 39 ug/l in Soil sample, 30 ug/l in Boro Rice, 20 ug/l in Wheat, 25 ug/l in Potato.

Table:4 Determination of arsenic content in the Ranaghat region.

S. No.	**Sample Type**	**Ranaghat region**	
		Absorbance	**Amount of arsenic(ug/l)**
1.	Ground water	0.56	56
2.	Soil sample	0.39	39
3.	Boro Rice	0.30	30
4.	Wheat	0.20	20
5.	Potato (vegetable)	0.25	25

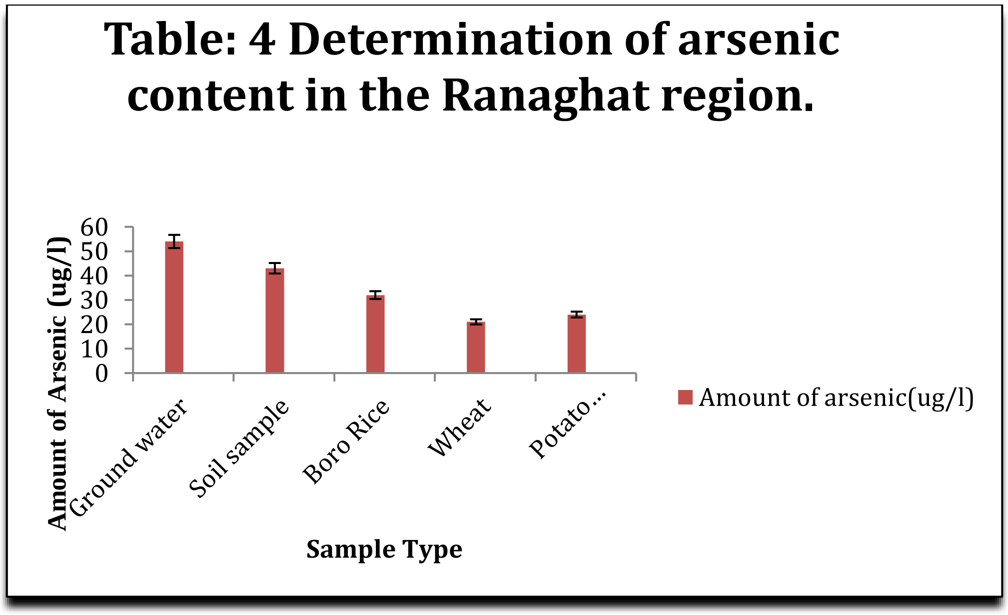

Table No. 3 shows arsenic content in the Shantipur region. According to this in Shantipur region 7 types of samples were taken as Ground water, Soil sample, Boro Rice, Wheat, Potato (vegetable), Brinjal (vegetable) and Cabbage (vegetable) then we determined arsenic content in these samples. Arsenic content in these samples were 55 ug/l in Ground water, 45 ug/l in Soil sample, 34 ug/l in Boro Rice, 25 ug/l in Wheat, 27 ug/l in Potato.

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Table: 5 Determination of arsenic content in the Shantipur region.

S. No.	Sample Type	Shantipur region	
		Absorbance	**Amount of arsenic (ug/l)**
1.	Groundwater	0.55	55
2.	Soil sample	0.45	45
3.	Boro Rice	0.34	34
4.	wheat	0.25	25
5.	Potato (vegetable)	0.27	27

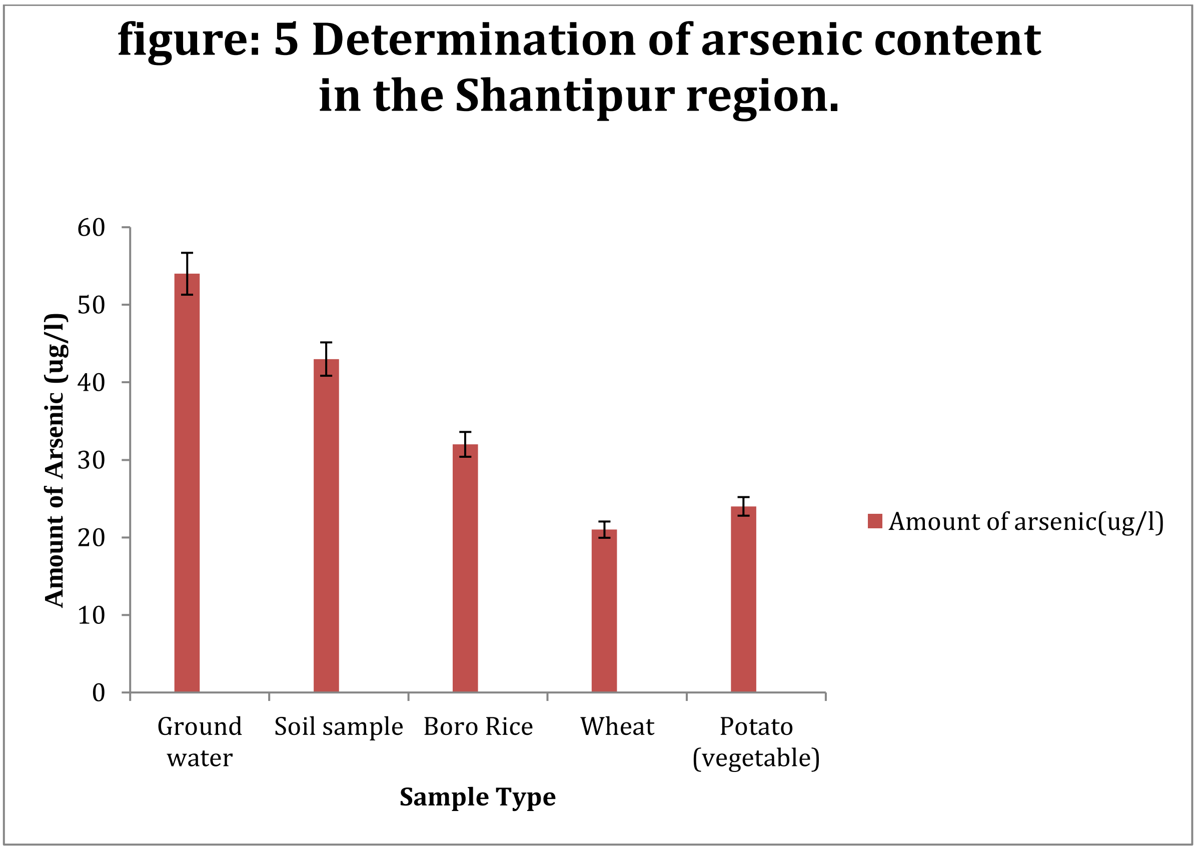
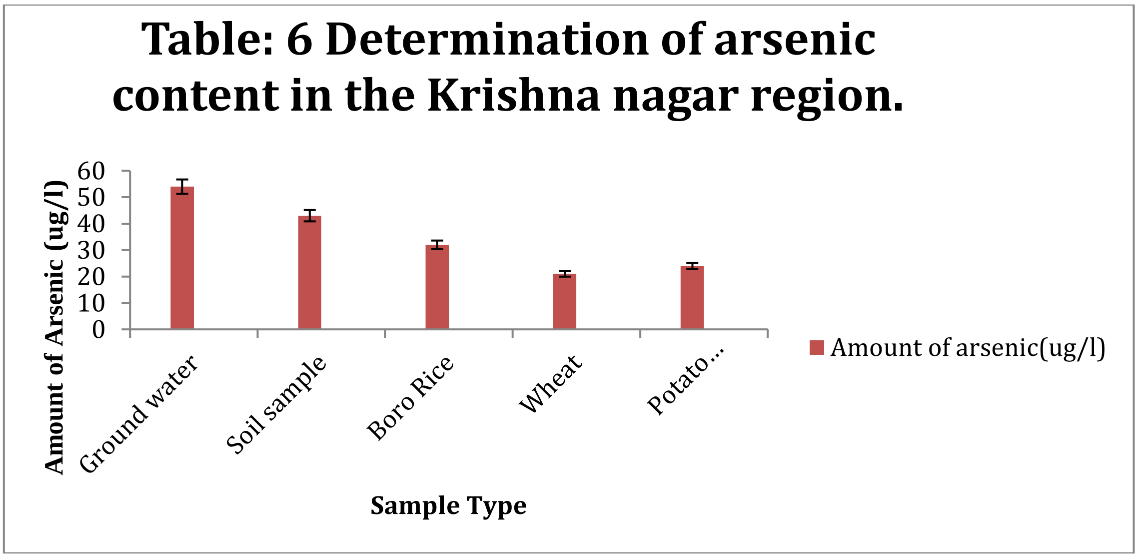


Table No. 3 shows arsenic contentin the Krishna nagar region. According to this in Krishna nagar region 7 types of samples were taken as Ground water, Soil sample, Boro Rice, Wheat, Potato (vegetable), Brinjal (vegetable) and Cabbage (vegetable) then we determined arsenic content in these samples. Arsenic content in these samples were 54 ug/l in Ground water, 43 ug/l in Soil sample, 32 ug/l in Boro Rice, 21 ug/l in Wheat, 24 ug/l in Potato, 23 ug/l in Brinjal and 21 ug/l in Cabbage.

Table: 6 Determination of arsenic content in the Krishna nagar region.

S. No.	Sample Type	Krishna nagar region	
		Absorbance	**Amount of arsenic(ug/l)**
1.	Groundwater	0.54	54
2.	Soil sample	0.43	43
3.	Boro Rice	0.32	32
4.	Wheat	0.21	21
5.	Potato(vegetable)	0.24	24



Discussion : Absorbance of arsenic ion was measured using different solutions. Surprisingly, in all the selected regions level of Arsenic is highest in the groundwater as compared to soil. As compared to all the samples of wheat, rice showed highest absorbance values depicting greater amount of arsenic content. Absorbance values of wheat and cabbage are least followed by brinjal and potato.

The present research showed that that rice accumulates toxic amount of arsenic, particularly when it was grown in arsenic-contaminated soil. Rice had highest absorbance values than other samples depicting greater amount of arsenic content. Arsenic content in the Haringhata region samples were found as 55 ug/l in Ground water, 41 ug/l in Soil sample, 30 ug/l in Boro Rice, 20 ug/l in Wheat, 24 ug/l in Potato. Arsenic content in the Chakdaha region samples were found as 50 ug/l in Ground water, 44 ug/l in Soil sample, 35 ug/l in Boro Rice, 19 ug/l in Wheat, 25 ug/l in Potato. Arsenic content in the Ranaghat region samples were found as 56 ug/l in Ground water, 39 ug/l in Soil sample, 30 ug/l in Boro Rice, 20 ug/l in Wheat, 25 ug/l in Potato. Arsenic content in the Shantipur region samples were 55 ug/l in Ground water, 45 ug/l in Soil sample, 34 ug/l in Boro Rice, 25 ug/l in Wheat, 27 ug/l in Potato. Arsenic content in the Krishna Nagar region samples were found as 54 ug/l in Ground water, 43 ug/l in Soil sample, 32 ug/l in Boro Rice, 21 ug/l in Wheat, 24 ug/l in Potato, 23 ug/l in Brinjal and 21 ug/l in Cabbage. Absorbance values of wheat and cabbage were least followed by brinjal and potato. Hence we could say that arsenic content in the food was also correlated to the health condition of the individual.

However, there are currently insufficient data to determine toxic arsenic concentrations that can induce arsenicosis. Present study data suggest that arsenic toxicity is produced by eating boro rice and wheat that can sometimes increases the daily limit of arsenic consumption.

Toxicity of arsenic in boro rice and wheat is highly dependent on the soil in which it is grown. Arsenic compounds that are inorganic are generally more poisonous than those that are organic. The more dangerous inorganic form of arsenic predominates in West Bangal rice grain. In boro rice grain, the percentage of inorganic arsenic different from sample to sample. Arsenic was entered in the plants through irrigation water or a section of the soil where arsenic is soluble in water. According to present information, individuals can get toxic level of arsenic by drinking water and also through the food materials. Food materials that are irrigated with arsenic-contaminated water that absorbed by intestine. However, the toxic arsenic that enters directly into the body and produces arsenicosis must be determined. The bioavailability of arsenic in various food items has to be investigated further, as well as a screening of plants with unusually high levels of arsenic. We must eat food that is free of arsenic. Present research showed that a clear picture of toxic level of arsenic in the residents of West Bengal. Our findings showed to the need for more research and development of ways to reduce arsenic transmission from water to soil to plants.

Conclusion: This research reveals that Levels of arsenic content is highest in the groundwater compared to soil, in all the selected regions. The arsenic content in groundwater increases the arsenic contamination which affects serious threats to human health. Therefore methods are to be taken to decrease the arsenic content in both food and water. Investigations should be carried out to decrease the arsenic poisoning in all the selected regions after consumption. It has been hypothesized that thorough washing could help reduce arsenic levels. As rice is one of the more consumed foods in India, the availability of toxic levels of arsenic in boro rice and wheat is a hazardous human health concern. It has been proven that cultivating the boro rice with contaminated water increases the danger of exposure. Other foods, like juices, veggies, marine food, have been known to contain toxic level of arsenic, which, when combined with boro rice and contaminated drinking water, can result in very high toxic arsenic concentrations. This could have serious consequences for person health, particularly in the presence of diabetes mellitus in that person. It has been hypothesized that thorough washing could help reduce arsenic levels. Arsenic concentration in rice can be lowered by lowering rice grain absorption.

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