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Problems and solutions of the assessment contamination of Arsenic in drinking water from ground water of Agra district, U.P. (India)

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Abstract
The presence of arsenic in groundwater resources and the associated health hazards due to human consumption have been reported from various parts of India and the world during the past few years. Occurrence of arsenic in groundwater in general depends on the local geology, hydrology and geochemical characteristics of the aquifer materials. The toxicity of arsenic may vary from one species to another. The present paper describes in brief, occurrence, behaviour and speciation of arsenic in drinking water from ground water and also discusses an improved, simple and sensitive method for quick detection and estimation of as (III) and total arsenic in ground water of Agra district, U.P. (India). The method involves use of stannous chloride and an optimized amount of mercuric chloride as field test reagent Appearance of light to dark brown color precipitate after adding test reagent in water sample indicates presence of arsenic. The color chart is also provided for its quantitative estimation. The sensitivity limit of reagent for visual color observation is 0.05 mg/L., The test being rapid, economical and quantitative, can be incorporated in existing water testing field kits.

Keywords: Total arsenic, water sample, stannous chloride reagent, field test. Ground water Agra

Introduction

Groundwater, which is used for drinking and domestic purposes, must be free from contamination; but because of industrialization, urbanization and various other sources, it is being contaminated. About 2,20,000 inhabitants of India, particularly from west Bengal have symptoms of arsenic poisoning from groundwater [1, 2], In India, arsenic is found in groundwater in Uttar Pradesh, West Bengal, Orissa and Andhra Pradesh. Arsenic enriched groundwater is also found in other parts of the world, eg. Bangladesh, USA (Arizona) and Korea [3, 4, 5], Processes of arsenic mobilization from its source to groundwater are mainly either natural or anthropogenic. In general, it depends on hydro chemical characteristics of groundwater aquifers, presence of oxidized and reduced mineral phases and arsenic rich solid phases [6].

Arsenic Toxicology: A recent study [7-11] on cancer risks from arsenic in drinking water indicates that arsenic could cause liver, lung, kidney, bladder cancer other than skin cancer. The study showed that the lifetime risk of dying from cancer of the liver, lung, kidney on consumption of 1 L/day of water containing 50 µg/L, current drinking water limit as given by USEPA could be as high as 13 per 1000 persons.

A survey of 114 wells in Taiwan region of the south-west coast of Taiwan showed arsenic concentrations ranging from 0.6 to 2.0 mg/L. Black foot disease, a peripheral disorder characterized by gangrene of the extremities, especially the foot, was the cause of 244 deaths. A chemical factory manufacturing several chemicals. including the insecticide Paris green (aceto copper arsenite) was responsible for the contamination of wells in the southern parts of Kolkata [12], Over seven thousand people consuming the arsenic contaminated water for several years showed symptoms of arsenic poisoning. Water samples analysed for arsenic indicated extremely high levels of contamination, with total arsenic concentration ranging from as low as 0.002 to as high as 58 mg/L.

Guidelines for Arsenic in drinking water: Due to carcinogenicity of some arsenic compounds, the objective should be to reduce its exposure to a level as close to zero as possible, taking into consideration its health effects and toxicology, occurrence and human exposure, availability and cost of the treatment technology, the practical quantitation limit of analytical techniques and the estimated risk of cancer even at low concentrations. of arsenic found in drinking water. Based on these considerations, some regulatory agencies have revised the maximum contamination level (MCL) for arsenic in drinking water. Table-1 indicates the guideline values for arsenic in drinking water supplies by various regulatory agencies [13], Even though the toxicity of arsenic is largely dependent on its chemical form, the guideline values target only the total arsenic concentration.

Table 1: Guideline values for arsenic established by various regulatory agencies

Country/organization	MCL (µg/L)
Canada	25
USA	50
France	50
Federal republic of Germany	40
World Health Organization (WHO)	50
European Economic Community (EEC)	50
India	50
China	50
Taiwan	50

Treatment technologles: A number of treatment methods have been adopted to remove arsenic from drinking water under both laboratory and field conditions, namely: adsorption corecipitation using iron and aluminium salts,

adsorption on activated alumina activated carbon, activated bauxite, reverse osmosis, ion exchange, and oxidation followed by filteration [14, 15], The United States Environmental Protection Agency (USEPA) has summarized that coagulation with iron and aluminium salts, and lime softening are the most effective treatment processes for removing arsenic from water to meet the interim primary drinking water regulations standard of 0.05 mg/L.

Determination of Arsenic: Arsenic can be determined satisfactorily by instrumental like stabilized temperature platform furnace atomization atomic absorption spectrometry, STPF AAS or colorimetric methods. The instrumental methods are generally preferred because they are rapid and colorimetric methods are applicable when interferences are known to be within the capacity of the particular method. The only disadvantage associated with these techniques is that they are expensive, so they have not found much application in the home industry or in remote, areas. It must be appreciated that until and unless we develop indigenous technologies for rapid detection of Inorganic pollutants in field and provide them at affordable cost, the implementation of Rural Water Supply and sanitation Programmes cannot be made successful. The present study discusses indigenous colorimetric method for assessment of arsenic in drinking water from ground water of Agra district, U.P. (India). The method is simple and gives quantitative results within few minutes without compromising on the sensitivity and accuracy of test.

Materials and methods

Reagents: The following reagents in AR grade were used for detection of Arsenic in drinking water from ground water of Agra district U.P. (India) are as follows:

(a) Stannous chloride (AR)..... 0.8 g (2 ml conc. HCI).

(b) Mercuric chloride (AR)..... 0.01 g

Experimental Methods: In water (10 ml) sample, add stannous chloride reagent (2 ml) and traces of mercuric chloride. A stable light brown to dark brown color sprecipitate within 2-3 minutes i.e. 0.05 mg/L. The quantitative estimation can be done indicates that as (III) is present above permissible limit with the help of color chart.

Color chart: Standard arsenic trioxide (AR) solutions were prepared in different concentrations ranging from 0.05 to 10.0 mg/l. The colors developed at various concentrations of as (III) were taken as reference colors in the color chart as shown in Table- 2.

Table 2: Match of color produced with different concentrations of as (III)

Concentration of ARSENIC (mg/L)	Color developed
10.0	Dark brown-black ppt.
5.0	Dark brown ppt.
0.5	Brown ppt.
0.1	Yellow-brown ppt
0.05	Light yellow -brown ppt. color
<0.05	No color within 2-3 minutes

Estimation of Arsenic: Standard arsenic solutions were made from arsenic trioxide (AR) and estimation of arsenic (III) was done using atomic absorption spectrophotometric method (AAS) [16].

Results and discussion

The methods for estimation of arsenic [17-21] in drinking water from ground water of Agra district, U.P. (India) involve use of different reagents like silver nitrate, ammonium molybdate, starch iodine, stannous chloride etc. The results are given in Table-3,

It is clear from Table-3 that stannous chloride reagent is most suitable under field conditions because estimation of as (III) as well as total arsenic is also possible while others are not suitable due to their complexity, unstability and other limitations.

Comparative studies of standard methods like Atomic absorption spectrophotometric method and rapid field test undertaken on as (III) solutions have shown (Table-4) that the visual color test exhibited by this method is quite reliable under field conditions.

Laboratory and field trials on surface water, groundwater and irrigation water using this reagent have also been extensively conducted successfully. The test is simple. reliable, sensitive and quantitative too and can easily be performed by a person of normal scientific temper. So, the test will be a good addition in existing water testing field kits.

Table 3: Comparison of modified field test reagent with other standard reagents used for estimation of arsenic in drinking water from ground water, Agra (India)

Characterisation	Reagents				
	Silver nitrate	Ammonium molybdate	Starch - Iodine + $NaHCO_3$ + dil. H_2SO_4	Stannous Chloride	Stannous* Chloride+mercuric chloride
Medium	**Water**	**Acid**	**Water**	**Acid**	**Acid**
Number of ingredients	5	2	5	1	2
Sensitivity (mg/L)	10.0	5.0	0.05	0.05	0.05
Oxidation state of arsenic	As (III)	As (I II)	As (III)	As (III) and as (V)	As (III) and as (V)
Color & nature of complex	Red brown ppt. (Stable)	Dark yellow ppt. (Stable)	Blue color reappers (Stable)	Faint yellow ppt. (Stable)	Dark brown ppt./color (Stable)
Interferences	chromate and ferricyanide ions interfere	Many metal ions interfere	Iodine consuming substances like Cu interfere	Te, Se interfere	Cr, Co and Ni interfere
Remark	Liquid phase	Liquid Phase	Liquid Phase	Liquid Phase	Liquid Phase

Table 4: Comparative studies of rapid field test and standard method (AAS) using standard arsenic solutions

Parameters	**Standards samples having different concentration of As (III)**				
Sample number	**a**	**b**	**c**	**d**	**e**
Color produced after adding field test reagent	Light Yellow - brown ppt./color (Stable)	Yellow brown ppt.	Brown ppt.	Dark brown ppt.	Dark brown black ppt.
Concentration of arsenic using color chart in field test method (mg/L)	0.05	0.1	0.5	5.0	10.0
Concentration of arsenic estimated by standards AAS method (mg/L)	0.052	0.12	0.52	5.03	10.05

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