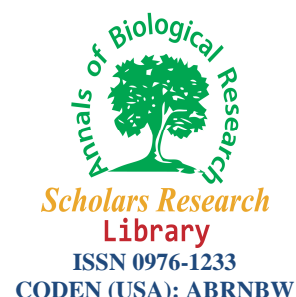




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Annals of Biological Research, 2014, 5 (3):105-109
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Highly sensitive & low cost colorimetric method for quantifying arsenic metal in drinking water of Malwa Punjab and comparison with ICAP-AES

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ABSTRACT

Our work was aimed at analysis of arsenic metal in drinking water in Malwa region Punjab, which is known to be cancer belt. We have developed a highly sensitive & cost effective colorimetric method for quantifying Arsenic metal in drinking water of and the result of sample analysis has been compared with ICAP-AES method. In addition to this we have observed some new location in Malwa region of Punjab, having high Arsenic in drinking water. Our modified colorimetric method of arsenic determination is sensitive up to 0.0167 mg/L without any interference at 515nm.

Key words: ICAP-AES, BOD, DO, EPA, Malwa

INTRODUCTION

Water is one of the most essential component of life but polluted, water has now becoming one of the major challenge since many undesirable substances are now part of this which are hazardous not only to humans but also to animals. The major undesirable substances found in water include viruses, bacteria and heavy metals. Present concern is much connected to the chemical pollutants (heavy metals) in water and their undesirable health effects on prolonged exposure [1]. These contaminants are the major concern throughout the world [2]. The accumulation of heavy metals in water and soil is of increasing concern due to the safety issues of drinking water and food. It is imposing potential health risks as well as it is unfavourable for the ecosystem also [3]. The most commonly reported heavy metal contaminants are arsenic, phosphate and fluoride [4]. Increasing Arsenic content in water, has become as one of the major challenge in the world. Humans and other fauna and flora are coming in contact regularly because of contaminated ground water by industrial and agrochemical waste products. Grazing farm animals may also come in contact by eating grasses and crops contaminated with arsenic pesticides [5]. The ingested arsenic is absorbed through intestinal track and lung and then flow into the blood stream thus effecting directly various organs of human body [6]. The toxicity of arsenic is subject to its oxidation state for example Arsenites is ten times more toxic than arsenate [7, 8]. Arsenic is reported to be mutagenic and carcinogenic [9] and is now has been reported from ground water table of Bangladesh, West Bengal, Punjab, and some part of Delhi where their concentrations have been exceeded beyond the recommended value WHO [10,1,7,8].

Our sample assessment of ground water in various parts of Punjab specially Malwa region, shows high concentration of Arsenic as compared to permissible limit of WHO and EPA (As : 0.010 mg/ L) [11,12,13].

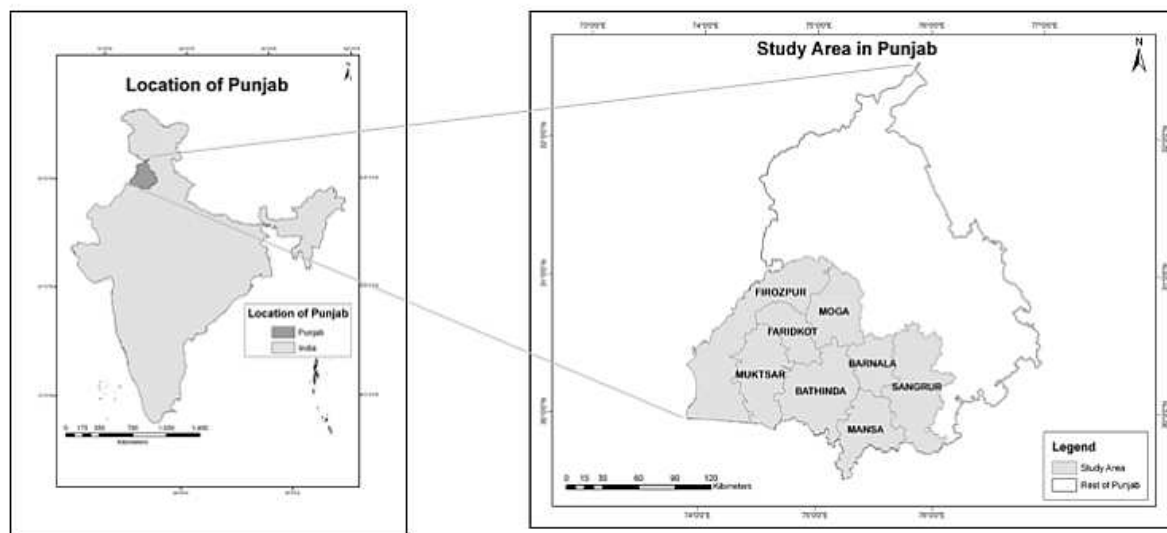
Heavy metal pollution in ground water not only affects the production and eminence of crops, rather extended influence over the quality of the atmosphere and water bodies have been reported in various literature. Thus, the ill effect over health and life of all living beings including humans is because of the food chain [14] and thus various symptoms of arsenic is in form of skin lesions and cancer of brain, liver, kidney and stomach [13].

Determination of arsenic in drinking water can be done by various techniques which include; atomic absorption spectroscopy (AAS), atomic fluorescence spectrometry, inductively coupled plasma (ICP), ICP/mass spectrometry (MS), and LC/MS/MS. These techniques being expensive and time consuming, are not suitable for routine monitoring of large numbers of samples [15].

Selection of area

PUNJAB: The state of Punjab located in North West India, bordering Pakistan, extends from 29°32′ to 32°32′ North and 73°55′ to 76°50′ East. It is surrounded by the Indian states of Jammu and Kashmir in the north; the hilly state of Himachal Pradesh in the east; and by the state of Haryana and Rajasthan in the south.

STUDY AREA: Malwa, the region south of river Satluj includes eight districts namely, Sangrur, Barnala, Moga, Firozpur, Faridkot, Muktsar, Bathinda and Mansa. [16]



MATERIALS AND METHODS

Water samples were randomly collected from three districts (Bathinda, Moga and Faridkot) at Malwa region of Punjab. Eighteen villages of these regions were randomly chosen and from each village six water samples (250ml) was collected in pre-sterilized bottles and stored at 4⁰ C till further analysis. pH estimation was done followed by addition of 1ml of HCl for preservation.

Method of water collection from hand pump

To collect sterile water, a piece of paper was burnt and flame was kept near the mouth of the hand pump for few seconds. After pumping for 3-4 minutes, water sample was collected in pre-sterilized bottle (80%-90%). The bottle was then labeled properly with location, date and time.

Physical Properties of Water

Total dissolved solids (TDS) and Dissolved Oxygen (DO) was measured as per the procedure given by Aneja, (2003). [6]

Determination of Arsenic

All chemicals used were of analytical grade and distilled water was used for dilution of reagents and samples. Standard arsenic stock solution (1mg/mL) was prepared by dissolving 0.1732g of NaAsO₂ in 100 mL of water. Working standard solution was prepared by dilution of stock solution. sulphuric acid, 0.1M, potassium iodate, 2% v/v, carbon tetrachloride, 7%, EDTA, 0.01%. An aliquot of sample solution containing 0.2-14 µg/mL of arsenic was transferred into series of test tubes. Then potassium iodide (2%, w/v) (1mL) and sulphuric acid (0.1M), (1 mL) were added and mixture was gently shaken. EDTA (0.01%), (1 mL) was added and mixture was gently shaken. This was followed by addition of CCl₄ (7%, w/v), (1mL). The solution was kept for 5 min and made 10 mL by adding distilled water. The absorbance of pink colour was measured at 515 nm. This method involves the liberation of iodine by the reaction of arsenic with potassium iodate in acidic medium. The liberated iodine selectively oxidizes CCl₄ to form pink color which have maximum absorbance at 515 nm [10].

Water sample detection by ICAP-AES:

Water samples which were collected from various regions and were send to Punjab Agriculture University, Ludhiana for accurate measurement of arsenic by ICAP-AES (Inductively Coupled Argon Plasma-Atomic Emission Spectroscopy).

RESULTS

A total 18 samples were analyzed and data presented here is mean and SD of 10 samples which shows significant arsenic concentration samples from each specified region was collected for the study and based on present detection . *these are the new places where arsenic in high concentration was not reported. Most the sample here are above allowed limit >0.01 mg/L.

Table 1: Comparative Arsenic content in water samples of Bathinda, Moga* and Faridkot* district

| Sr No. | Location (Bathinda) | Arsenic ICAP-AES (mg/L) | Arsenic UV-Vis. Spectro (mg/L) |
|--------|------------------------------|-------------------------|--------------------------------|
| 1 | Jassi Pauwali | 0.031±0.08 | 0.041±0.98 |
| 2 | Gehri Bhagi | 0.056±.06 | 0.033±0.89 |
| 3 | Gulabgarh | 0.001±0.05 | 0.000±0.89 |
| 4 | Kartar Singh Wala | 0.073±0.07 | 0.044±0.98 |
| 5 | Bir Talab | 0.049±0.08 | 0.037±0.88 |
| 6 | Phuss Mandi | 0.003±0.06 | 0.000±0.78 |
| | Location (Moga)* | | |
| 7 | Podkot | 0.004±0.076 | 0.000 |
| 8 | Bahona | 0.004±0.067 | 0.000 |
| 9 | Dhala | 0.033±.08 | 0.021±.87 |
| 10 | Longi Vind | 0.002±0.067 | 0.000 |
| 11 | Bughipura | 0.005±0.84 | 0.000 |
| 12 | Manava | 0.003±0.056 | 0.000 |
| | Location * (Faridkot) | | |
| 13 | Rattirori | 0.043±0.003 | 0.035±0.5 |
| 14 | Phidde Khurd | 0.016±0.004 | 0.017±0.6 |
| 15 | Sandhawn | 0.008±0.002 | 0.000 |
| 16 | Tehna | 0.049±0.01 | 0.035±0.4 |
| 17 | Tibbi Bharian | 0.076±0.02 | 0.044±0.3 |
| 18 | Sukhanwala | 0.023±0.01 | 0.021±0.3 |

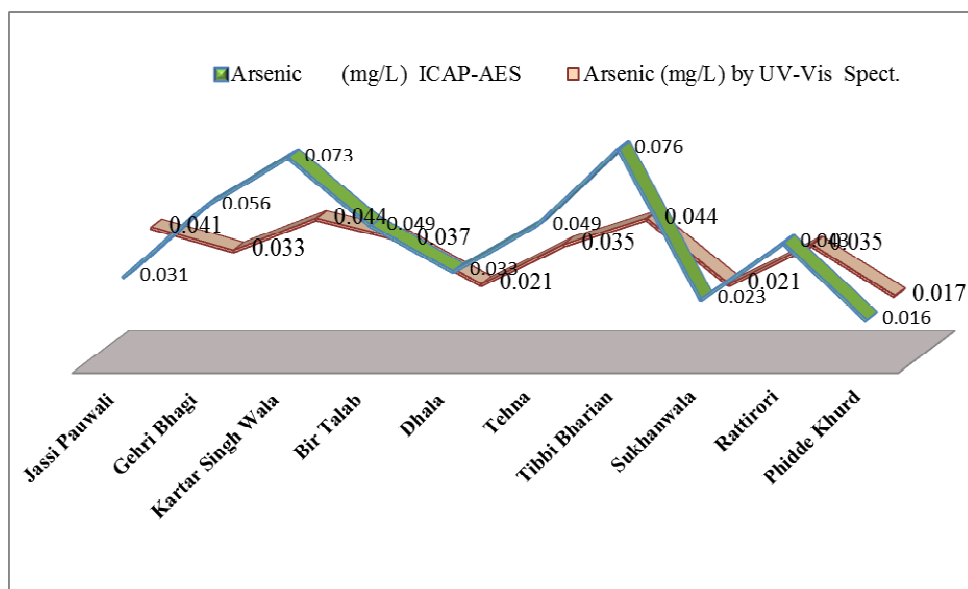
**Fig. 1 Comparative analysis of data obtained by Atomic absorption spectroscopy and UV-VIS spectrophotometer (515 nm)**

Table 2 Laboratory analysis of drinking water quality (pH, TDS, DO) in different region of Punjab
The marked region shows high quantity of arsenic

| S.No | Samples | pH | TDS (mg/L) | DO (mg/L) |
|------|-------------------|------|------------|-----------|
| 1 | Jassi Pau Wali | 7.73 | 500 | 9.8 |
| 2 | Gehri Bhagi | 8.26 | 543 | 10.57 |
| 3 | Gulabgarh | 7.69 | 522 | 9.83 |
| 4 | Kartar Singh Wala | 7.93 | 500 | 11.3 |
| 5 | Bid Talab | 7.58 | 530 | 9.79 |
| 6 | Phoos Mandi | 8.03 | 580 | 10.33 |
| 7 | Podkot | 7.6 | 500 | 8.6 |
| 8 | Bohana | 7.3 | 480 | 9.2 |
| 9 | Dhala | 7.4 | 586 | 7.65 |
| 10 | Longi Vind | 7.7 | 500 | 9.67 |
| 11 | Bhagipur | 8.0 | 550 | 11.4 |
| 12 | Manava | 7.87 | 470 | 10.71 |

Note: Level of TDS (milligrams per litre) < 300, Excellent; >300, Good; >600, Fair; >900, Poor; >1,200, Unacceptable
 (www.who.int/water_sanitation_health/dwq/chemicals/tds.pdf) [17] [18]

DISCUSSION

The study from different areas of Punjab, specifically Malwa region was carried out to investigate the concentration of Arsenic. From 18 different samples studied, 10 samples show high arsenic concentration as compared to the maximum limit of 0.01mg/L (USEPA). These regions are Jassi Pau Wali , Gehri Bhagi, Kartar Singh Wala, Bir Talab, Dhala Rattirori, Phidde Khurd, Tehna, Tibbi Bharian, Sukhanwala. The pH of these samples was found in range of 7.2-8.2. The reason may be formation of carbonic acid which is responsible for leaching of metals. Total dissolved solids (TDS) is measured which describes the inorganic salts and small amounts of organic matter present in water. TDS of water samples were found to be in the range of 460 - 590 mg/L which was higher as compared to recommended value. The amount of dissolved oxygen in the water samples were found in range of 9.3 – 11.4 mg/L.

CONCLUSION

Thus we can conclude from the experiment that arsenic level was not so much high that it should cause any cancer instead there is large variations in pH & TDS which may be due to various reasons. The newly developed modified colorimetric method for arsenic detection may be an alternative and cheap method for quick analysis of arsenic.

Acknowledgements

Author is acknowledging the support of PAU, Chandigarh for ICAP analysis and Biotechnology department for providing chemicals for developing methods, and thankful to Miss Shilpa bhatt, Assistant professor in Biotechnology for editing and finalising the manuscript. Author declares no conflict of interest.

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