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Determination of Arsenic from the Atomic Absorption Spectroscopy

R. Tafesse[1]

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Abstract:

The toxicity of heavy metals (As, Hg, Cu, Zn, Cd etc.) has been made a major problem in these days because they give effect on the health of humans. In these metals, the quantity of arsenic is increasing in the drinking ground water due to the use of arsenic as pesticides, mining application, and wood preservation. Arsenic found in two forms: organic and inorganic. The level of inorganic arsenic in ground water is more compare to the organic arsenic form. Due to the exposure of arsenic, various types of health issue are produced such as cancer, cardiovascular disorder, neurological disorder, skin diseases and so on. So, there is need to reduce the quantity of arsenic in the water as well as from the environment. Different analytical techniques has been discovered for the identification of arsenic. But these techniques are low sensitive because of the low limit of detection (LOD). This review paper shows the current status of arsenic in the world and the disease caused by it. Also present the detection method for the arsenic in ground water with future perspective.

Keywords: *Arsenic, Groundwater, Detection Techniques, LOD*

Authors:

1. *University of South Africa, South Africa.*

Introduction

Metal 'Arsenic (As)' is toxic substance that gives health problems in humans. It is abundant element in the environment. It is generated mostly from the weathering of arsenic containing minerals while human activities produce less. The different types of health issues are caused by the exposure to arsenic. It is highly toxic in nature and carcinogenic due to which concern is raised. Its characteristics as steel grey, very brittle, crystalline in nature and it is oxidized on rapid heating and forms arsenous oxide, have the garlic smell. Arsenic toxicity depends on the chemical form as the inorganic form is less toxic compare to the organic form.

Chemical Forms of Arsenic element is already defined with their isotopic composition, electronic or oxidative state, inorganic and organic compounds, organometallic species and macromolecular compound. Generally, four oxidation states of arsenic, As^{3+}, As^{5+}, As^{0} and As^{3-} occur in the environment. Arsenite As (III) and Arsenate As (V) are the forms comes under inorganic arsenic. Monomethyl-Arsonic Acid (MMA) and Dimethylarsinic Acid (DMA) are the Organoarsenic that occur mostly in the environment.

Inorganic arsenic compound is formed when arsenic is combined with the oxygen, chlorine, and sulfur that are mainly used for the preservation of wood. Organic arsenic compounds are formed when combined with the carbon and hydrogen used as pesticides mainly for the cotton crop. Due to the use as pesticides, wood preservatives, mining activities and petroleum refining, arsenic can be released into environment.

Water and Arsenic

For the good human health, the safe and good quality drinking water is essential source. It provide some elements for the good health but when water is polluted it becomes dangerous to human health and develop various diseases such as cancers, adverse reproductive outcomes, cardiovascular disease, teeth decay and neurological diseases. The developing system in infant, and young population is very sensitive due to which they are more affected by the toxicity of arsenic. In case of children, they face difficulties in the learning, memory impairment, damage to nervous system and behavioral problems like aggressiveness and hyperactivity.

In the environment, most inorganic form of arsenic is present in water samples with less organic form such as MMA and DMA. The level of toxicity due to arsenic can be determined from its oxidative state. The form of arsenic is changed according the condition (biotic and abiotic) in water. Arsenic (III) and As (V) with the small amount of methyl and dimethyl arsenic compounds present in the ground water with <10µg/L concentration which is below the detection limit of analytical methods. The presence of arsenic in the groundwater pollutes the water. In recent time, this presence has been made a major environmental problem in various countries. The level of concentration is found to be above 3000 µg compare to recommended level (10µg/L) in many areas.

Diseases form Chronic Arsenic

Human health is affected by the chronic arsenic toxicity caused by prolonged exposure of arsenic in human is termed as arsenicosis. Different types of affects are seen in the human due to chronic toxicity of arsenic, these are followed as:

1. Skin Manifestation: specific skin disease such as Pigmentation and keratosis are due to the chronic arsenic toxicity. These diseases are strongly correlated with water arsenic levels.

2. Respiratory Disease: The chronic arsenic toxicity also produce the lung disease due to exposure of drinking water containing arsenic.

3. Gastrointestinal Disease: Dyspepsia, a case of chronic poisoning of arsenic is observed. The pain in the stomach that is similar to the common people. A source of chronic arsenic is in this case is the drinking water. Many symptoms are seen in chronic poisoning such as nausea, diarrhea, anorexia, and abdominal pain.

4. Liver Disease: Arsenic is used in the treatment as Fowler's solution that may cause liver damage. The features of portal hypertension with the sign of liver fibrosis are seen in the patients. Inorganic arsenic compounds give the result of liver cirrhosis after the use as a medicine.

5. Cardiovascular Disease: It is a peripheral vascular disease which is one of the most complication of chronic arsenic toxicity. This vascular disorders have several degree such as Raynaud's syndrome and acrocyanosis. Drinking arsenic contaminated water is also a source there.

6. Nervous System Diseases: Chronic exposure of arsenic by drinking water results as peripheral neuropathy disorder. Tingling,

numbness, limb weakness symptoms of paresthesia are the characteristics of peripheral neuritis. Sleep disturbances, weakness and cognitive and memory impairment are also caused by the chronic arsenic toxicity.

7. Hematological Effects: It can occur form both acute as well as chronic poisoning of arsenic. Anemia, leucopenia, thrombocytopenia are the characteristic pattern due to arsenic poisoning.

8. Diabetes: It is also a disease which is continuously increasing as a result of drinking arsenic contaminated water.

9. Pregnancy Outcome: During each pregnancy, arsenic exposure was assessed based on all water sources used.

10. DNA Damage, methylation of DNA and Genotoxicity are also the outcomes of chronic arsenic toxicity.

Analytical Method

Analytical chemistry is a part of science. In the field of arsenic research, analytical chemistry play a significant role. The interest of arsenic research is increased because of the carcinogenic and leukemic effects on humans due to the groundwater drinking. The determination of traces of arsenic and its chemical forms become very necessary because of the toxic effect and chemical behavior of arsenic. The detection limit should be very low (<1ppb) for the analysis of arsenic. This analysis can be attained by the use of state of the art equipment. Different analytical techniques are used for the detection of arsenic such as ion chromatography (IC), high performance liquid chromatography (HPLC) coupled with the hydride generation atomic absorption spectrometry (HGAAS), graphite furnace atomic absorption spectrometry (GFAAS) and inductively coupled plasma spectroscopy (ICP-MS). These techniques can provide the information of quantity as well as chemical forms of the arsenic compound.

Atomic Absorption Spectroscopy (AAS) is used for the determination of traces of arsenic. AAS can be used in various form such as Electrothermal Atomic Absorption Spectroscopy (ETAAS) and Hydride Generation Atomic Absorption Spectroscopy (HGAAS). Now, the problem with the ETAAS has been reduced by the improvement in the background correction techniques. The limit of detection of HGAAS for Arsenic (III) has 0.4 µg/L for the ground water sample.

Another method atomic emission spectroscopy (AES), inductively coupled plasma mass spectroscopy (ICP-MS), Atomic Fluorescence spectroscopy (AFS) are also used for the detection of arsenic in the ground water. A hyphenated techniques are best suitable for the detection of arsenic.

Review of Literature

According to Singh *et al.* (2010) Flame Atomic Absorption Spectroscopy is good technique because it is very rapid, reliable method for the analysis of arsenic and mercury. They also stated that cold vapor technique or vapor generation technique in AAS gives an accurate and sensitive result of arsenic and mercury in sample present in the atmospheric particulates matter.

Sarkar *et al.* (2011) compared the two techniques (AAS and Field kit) for the detection of arsenic and concluded that arsenic can be detection from field kit between the range 0.01 mg/L to 0.5 mg/L. Field test kit are able to give smaller values than AAS. According to them, the results obtained by field test kit is 20to 50% higher than AAS a sensitive laboratory technique.

Rajkumar, Thiagarajan and Chen (2011) stated that the detection of arsenic (III) by the use of electrochemically fabricated nano Au-CRV film is also a method that gives better result. The detection of arsenic in real drinking water samples such as river water, spring water and tap water from this technique is easy.

Tahir, Rasheed and Malana (2012) discussed that the determination of arsenic is done by the inexpensive instrument which should be cost effective and reliable technique. State of art equipment such as Atomic Absorption Spectroscopy (AAS) and Inductive Coupled Plasma Spectrometer (ICP-MS) are used by many laboratories for the analysis of arsenic at low detection levels.

Shahlaei and Pourhossein (2013) concluded that electrothermal atomic absorption spectroscopy is a fast, simple and economical method for the enrichment of arsenic from natural water samples. So, this method can be applied to the separation and determination of arsenic in water samples.

Rajakovic *et al.* (2013) stated that the analysis of the arsenic is very important in respect of human health. For the analysis, the complete characterization of arsenic is necessary because of the various types of toxic effects. They concluded that the best methods for the detection of arsenic are chromatographic separation coupled with the ICP-MS, AAS and HG-

AFS. The selection of suitable for the arsenic gives the reliable and accurate result.

Maria *et al.* (2013) proposed a technique atomic absorption spectroscopy with graphite furnace atomizer. The limit of detection was very low. Hence, the result was very precise. In future, this method can be used in toxicological studies because of very fast, efficient and environmental friendly.

Conclusion

The presence of arsenic in the groundwater is a worldwide problem and become a difficult task for the scientist. The method for the detection of arsenic from the groundwater as well as the quantification is also an important. Most of the researcher has been developed different techniques for the determination of arsenic in drinking water. Form the reviews of researcher, this paper concludes that the quantity of arsenic (III) is very low which cannot be detected easily. So, there is a need of technique with low limit of detection. In which, Atomic absorption Spectroscopy with their different sources such as Graphite furnace atomic absorption spectroscopy, Hydride generation atomic absorption spectroscopy and Electrothermal atomic absorption spectroscopy give accurate results with less time consumption.

References:

Bose, U., *et al.* "Arsenic Toxicity and Speciation Analysis in Ground Water Samples: A Review of Some Techniques." *International Journal of Chemical Technology,* vol. 3, no. 1, Jan. 2011, pp. 14–25.

Komorowicz, Izabela, and Danuta Barałkiewicz. "Determination of Total Arsenic and Arsenic Species in Drinking Water, Surface Water, Wastewater, and Snow from Wielkopolska, Kujawy-Pomerania, and Lower Silesia Provinces, Poland." *Environmental Monitoring and Assessment,* vol. 188, no. 9, Apr. 2016.

Maria, Guţu Claudia, *et al.* "Quantitative Determination of Arsenic in Bottled Drinking Water Using Atomic Absorption Spectroscopy." *Acta Medica Marisiensis,* vol. 59, no. 5, Jan. 2013.

Rajaković, Ljubinka V, *et al.* "Analytical Methods for Arsenic Speciation Analysis." *Journal of the Serbian Chemistry Society,* vol. 78, no. 10, 2013, pp. 1461–1469**.**

Rajkumar, Muniyandi, *et al.* "Electrochemical Detection of Arsenic in Various Water Samples." *International Journal of Electrochemical Science,* vol. 6, 2011, pp. 3164–3177.

Sarkar, B, *et al.* "Comparative Analysis of Arsenic Detection in Water by Field Test Kit and AAS Methods." *Journal of Experimental Sciences,* vol. 2, no. 1, 2011, pp. 38–41.

Shahlaei, Mohsen, and Alireza Pourhossein. "Determination of Arsenic in Drinking Water Samples by Electrothermal Atomic Absorption Spectrometry after Preconcentration Using the Biomass OfAspergillus NigerLoaded on Activated Charcoal." *Journal of Chemistry,* vol. 2014, 2014, pp. 1–6.

Singh, Nahar, *et al.* "Determination of Arsenic and Mercury Metals in Suspended Particulate Matter by Flame/Flameless Atomic Absorption Spectrometer." *Atmospheric Pollution Research,* vol. 1, no. 2, 2010, pp. 112–117.

Tahir, M. A., *et al.* "Method Development for Arsenic Analysis by Modification in Spectrophotometric Technique." *Drinking Water Engineering and Science,* vol. 5, no. 1, Apr. 2012, pp. 1–8.