Chapter 7

Estimation of Arsenic (III) in Ground Water by Spectrophotometric Technique

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Abstract

In the present study, a newly designed Schiff base has been successfully utilized as an analytical probe for micro level spectrophotometric determination of As (III) at pH 3.7. The Schiff base was synthesized from the reaction of 6-methoxy pyrrole-2-carboxaldehyde and thiosemicarbazide in DMF by stirring for about 3 hrs. Here, it is observed that the As-complex showed maximum absorbance at λ_{max} 368 nm for As (III) ions. The standard straight-line curve was use for determination of molar extinction coefficients where absorption vs. concentration of arsenic is plotted. Using the data, concentration of arsenic in the tested water has been determined. This proposed method has been successfully applied to the determination of arsenic in the drinking water samples of Bhupatinagar, in the district of Purba Medinipur, West Bengal, India. The results show that the concentration of arsenic in the ground water of said region is 0.34 µg/L which is below danger level and supports to the recognition of free arsenic zone for the concerned area.

Keywords: Arsenic-Schiff base Complex, Drinking Water Samples, Spectrophotometric determination

7.1 Introduction

The twentieth abundant element in earth crust found to be in the range of 1.5 -2 ppm in form of Realgar (AsS), Arsenolite (AsS_4O_6), Arsenic pentaoxide (As_2O_5). Arsenopyrite (FeAsS) and in marine samples pyrite be the dominating one. The predominant species of arsenic as As (III) and As(V) be the main cause for increasing level of arsenic in water samples. The uptake of arsenic at the level of 100 mg can lead to chronic poisoning. Some past literature reports

covering the countries of Asia and south America fighting with increasing level of arsenic causing a great threat towards the risk of lungs, liver, bladder and kidney cancer. The permissible limit of arsenic as recommended by WHO is 0.05mg/L. In Asian countries, it crosses the limit of 1 mg/mL while US public health service recommended that it has to be 10 μg/lit. The source of arsenic in ground water is mostly due to the leaching of geological materials, minerals precipitation, and dissolution of unstable arsenic minerals, pesticides and fertilizers. Apart from the above sources, it is also released into the environment through burning fossil fuels, cement manufacturing and mining activities [1-6]. Arsenic compounds are widely used in pigments, rodent poisons, insecticides, fungicides, fertilizers, medicine, glass industry, tanning, also in differ sources like fish, meat, different ecological sources, that can behave as toxicant even if it is present in very micro level. Hence, the former sources can release arsenic in ionic form (mostly in III & V) to water resources like river, pond water, nearby cultivation field etc. and consequently the drinking water resources. Adverse effect of arsenic present in metallic form are not so pronounced yet trace amount of arsenic (in form of III & V) exerts very severe health hazards like gastrointestinal problem, cardiac damage etc. Arsenic and its different forms which are carcinogenic, mutagenic, tetratogenic can also causes vascular disorder like black foot disease. Thus, it is important to assess the presence of arsenic in micro trace and ultra-trace levels in biological resources most importantly here ground water directly consumable. The presence of arsenic can be determined using different analytical methods like atomic absorption spectroscopy (AAS), polarography separation, hydride generatively couple plasma atomic absorption spectroscopy, cathode stripping voltammetry, disperse x-ray fluorescence spectroscopy etc. But these instrumental methods are expensive for detection of arsenic in remotest areas. Many reports suggest that the easy and rapid detection of arsenic using UV-VIS spectrophometer by complexation with different chelating agents are employed in this respect. Ammonium pyrrolidinedithiocarbamate (APDC), silver dithiocarbamate, sodium diethyldithiocarbamate (NaDDc), azure-B are found to behave good chelating agent in extractive determination of arsenic. It is also found that chelating agents with sulphur atom have a great affinity to bind with arsenic in extraction of arsenic in water resources.

In the present work, we have tried to design a sulphur containing Schiff base chelating agent, 6-methoxy pyrrole-2-carboxaldehyde found to be very effective to selectively determine the trace amount of arsenic in ground water. This ligand was synthesized in DMF solvent and on the complexation of this ligand with arsenic in DMF, the absorbance has been checked by UV-VIS spectroscopy.

7.2 Materials and Methods

7.2.1 Chemical Reagents: All the reagents were purchased in pure form of AR grade from Sigma Aldrich. For the synthesis of ligand, 6- methoxy pyridine 2-carboxyaldehyde and thiosemicarbazide were used and for complexation $AsCl_3$ was used. DMF was used as solvent.

7.2.2 Instrument: All the absorption measurement for ligand, complex and free 'As' ion were performed using Systronics 2202 UV- Vis spectrophometer under room temperature. All the solutions were prepared with proper mixing of the solvent by magnetic stirrer.

7.2.3 Preparations of Solutions

7.2.3.1 Stock As (III) Solution of 0.011mg /mL: 10 mg $AsCl_3$ was taken and mixed with 10 ml of conc. HCl in 100 ml volumetric flask and diluted up to 100 mL. Distilled water was used for preparation of solution.

7.2.3.2 Water for Arsenic Estimation: The arsenic estimation using spectrophotometric method was done for tap water collected in Bhupatinagar, Purba Medinipur, India. Tap water was collected in a plastic bottle and kept for one week. Then 5 ml of it was taken for investigation at the time of experiment.

7.2.4 Synthesis of Ligand: The chelating ligand 6- methoxy pyridine -2- carboxyaldehyde semicarbazone synthesized by mixing 0.5 mmol of 5 mL of 6- methoxy pyridine -2- carboxyaldehyde in DMF with 0.5 mmol of 5 mL of semicarbazide in DMF, followed by reflux at 50°C for 2 hours. The pale yellow colour ligand was obtained. It was cooled for 30 mints and kept for further uses.

7.2.5 Analytical Procedure: From the stock solution of Arsenic three standard dilute solutions of Arsenic were prepared from 4×10^{-5} to 12×10^{-5} mg/mL. To each solution, 0.05 mL of ligand was added and consequently the complexation occurs. In UV -Vis spectrophotometer, 5 ml complex solution was taken in 1 cm quartz cell and absorption was measured at λ_{max} 368 nm. The standard straight-line curve was used for determination of molar extinction coefficients and absorption vs. concentration of arsenic is plotted to obtain the standard curve whose slope provide molar extinction coefficients. To find the concentration of arsenic in the tested water, 0.05 mL of water was mixed with 0.05 mL of ligand in 5 mL of DMF solvent and absorption was measured at 368 nm. Then by using the following equation, concentration has been determined.

Concentration of arsenic = Slope / Absorption of the solution   (1)

7.3 Result and Discussion

The standard plot, absorption vs. concentration of arsenic is straight line with slope 10612 mL mg^{-1}cm^{-1} (Figure 7.1). Using this data of slope and absorption (0.182) of the tested samples, concentration of arsenic is determined with the help of above equation 1. It is found that the concentration of arsenic in the tested water collected from Bhupatinagar block is 0.34 µg/L which clearly gives support to the recognition of free arsenic zone given to concerned area.
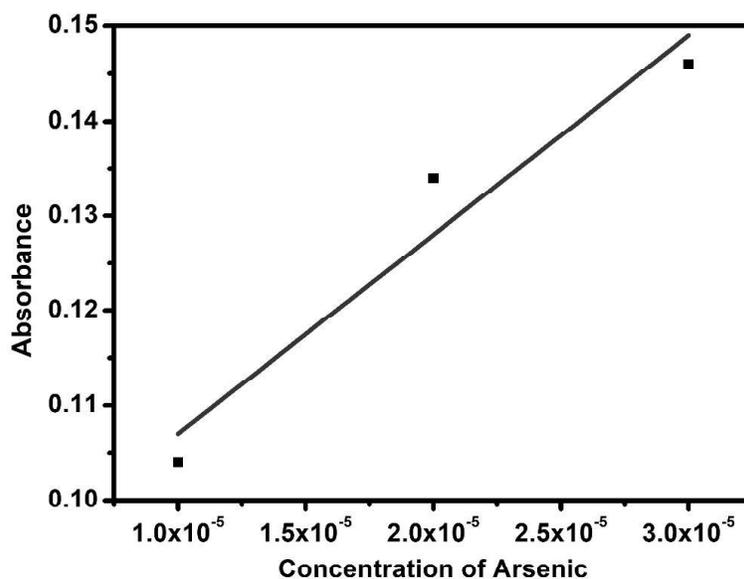

Figure 7.1 Absorption vs. concentration of arsenic

7.5 References

[1] Behpour, Mohsen; Ghoreishi, S.M., and Salehi, Sakineh, Acta Chim. Solv. 2005, 52, 323-327.

[2] Kumar, R. Kishore; Venkatesarlu, S; Reddy K. Vijaya, Kumar; Tulasammam, P.; Govinda, V.; Jyothi, N.V.V.; and Venkateswarlu, P., J. Chem. Pharm. Res.; 2011; 3(3), 626-634.

[3] Singh, Seema; Harjit, Jeena; Kataria, H.C.; and Amlathe, Sulbah, IOSR Journal of Applied Chemistry (IOSR-JAC), 2014, 7(4), pp.57-64.

[4] Rahman, M.F.; Chakraborty, A., and Das, T., IOSR Journal of Applied Chemistry (IOSRJAC), 2015, 1, pp.14-20.

[5] Rahman, Md. Faridur; Chakraborty, Aniruddha; and Das, Tanmoy, Material Sc. Res. India, 2015, 12(2).

[6] Rehman, F.; and Mairaj, Samya, Orient. J.Chem., 2012, 28(2), pg. 881-885.