



To Determine the Arsenic Content in Water Samples Collected from Different Areas of Pune City

Running title: Determination of Arsenic content in water samples.

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Abstract: Arsenic, an element of the periodic table of elements has been deemed to be notorious for its tendency to act as a poison when consumed even in trace amounts. The poisoning occurs chronically with ingestion of trace amounts of arsenic, primarily through food and water.

Methodology: Water samples from 4 different areas of Pune city were collected and analyzed for their arsenic content. Standard arsenic solution dilutions were prepared using arsenic trioxide. The arsenic content in the water sample and standard was found by the colour reaction between potassium iodate and safranin o. The colour reaction was analyzed using UV spectrophotometer.

Results and Discussion: Arsenic content was found in water samples from Market yard, Singhgad road and Wagholi areas. This arsenic content was found to be outside the limits of World Health Organization. Whereas no arsenic content was found in the sample collected from Kothrud area of Pune city.

Conclusion: The arsenic content found in three areas of Pune city was out of limit as stated by WHO.

1. INTRODUCTION

Arsenic, an element of the periodic table of elements has been deemed to be notorious for its tendency to act as a poison when consumed even in trace amounts. The poisoning occurs chronically with ingestion of trace amounts of arsenic, primarily through food and water¹.

Arsenic was also called as the “king of poisons” with its role in many high-profile poisonings and fatal agent during the middle -ages. Its role as a poison was known and exploited without a standard concentration of activity².

Arsenic’s potency as a poison went unnoticed due to its inability to exhibit a colour or odour when present in water. Also, the common consequences of a poisoning could be confounding with symptoms of other diseases that include acute nausea, diarrhoea, etc³.

Apart from these, there’s also conjecture about Hippocrates using arsenic pastes to treat ailments of the stomach. Arsenic was also known to be a chemotherapy agent with use in skin and breast cancer.

Arsenic was widely used in the early eighteenth century in Fowler’s solution after which the Marsh test for Arsenic detection was developed. Fowler’s solution contains one per cent sodium arsenite. It served as an agent of treatment for diseases such as psoriasis, eczema, and malaria.

Eventually, after a deeper understanding of the consequential toxicity caused by Fowler’s solution, its ubiquitous use as a treatment agent declined and was replaced by other forms of therapy.

Salvarsan also contained arsenic that was used to treat syphilis which got eventually replaced by penicillin as the standard treatment. Marsh test could detect concentrations up to 0.02 mg, a feat at the time since standardised testing was not in place.

Historically arsenic had been used in various products for its lustre with little to no information about its possible adverse effect on the consumer. From 1786 to 1887, the element went unnoticed for almost a hundred years before its activity as a probable skin carcinogen was proposed by Hutchison.

Arsenic was widely used as a pigment due to its lustre and was present in products ranging from dyes, to wallpaper. Paris green, a pigment containing arsenic had gained popularity. Trimethyl arsine, a gas was considered to be poisonous, a notion that stands challenged as of recent times.

Paris green was also used as a pesticide, also lead arsenate. The use dwindled over the years when the health of orchard workers revealed severe side effects over a period of time.

Eventually the side effect in orchard workers were linked with arsenic and the incidence of cancer and over the course of the next five decades its use was completely banned. There is an estimated million acres of land that stands contaminated due to the use and residues of lead arsenate.

It is important to note that the pentavalent oxidation state arsenic is known to be far less toxic than trivalent. Organic arsenic compounds are less toxic than inorganic arsenic compounds due to their limited intrusion and metabolism in the cells.

The World Health Organisation cites irrigation, industrial processing and contaminated food and tobacco as possible sources if arsenic ingestion. The limit of arsenic in drinking water is 10µg/ml.

India is one of the countries listed by the World Health Organisation along with Chile, China, Mexico, Argentina, Bangladesh and the United States for having high levels of arsenic present in the ground water.

Apart from drinking water, diet forms another possible source of contamination. Processing industries, pharmaceuticals, hide tanning are high risk for arsenic content⁴.

2. OBJECTIVE

Arsenic has very toxic effects on the human body⁵. Arsenic present in the human body can create havoc in the long term and can have lethal effects. Water having arsenic greater than the limits stated by WHO can be lethal. Moreover, if the crops are irrigated with this water, the arsenic can enter the crops and finally come in

the human body. Looking at all of this our main objective of the project was to determine the arsenic content in water of different areas of Pune by UV spectrophotometer and to compare it with the WHO standards⁶.

3. MATERIAL AND METHODS

A Spectroscopic method developed by Pasha *et al.* for the determination of arsenic in environmental and biological samples was used. This method involves the reaction between Arsenic(III) with potassium iodate in an acidic medium. The reaction leads to the liberation of iodine which bleaches the pinkish-red color of safranin dye. This color reaction is measured by a decrease in absorbance at 532nm or 628nm⁸.

3.1 Instrumentation

The instrument used for analysis was the Jasco V-730 double-beam spectrophotometer. A full spectrum ranging from 200nm to 800nm was recorded for each of the dilutions. Following that the absorbance at 532nm and 628nm were noted.

3.2 Standards

Standard Arsenic(III) solution (1000 mg/L) was prepared using arsenic trioxide (As_2O_3). Arsenic trioxide is insoluble in distilled water so it is dissolved at a basic pH using NaOH. 0.132 grams of arsenic trioxide was taken and dissolved in 20% NaOH solution (quantity enough to dissolve arsenic trioxide) after which 1M HCl was added to half the volume and then the final volume was made up to 100ml using distilled water⁷.

3.3 Reagent preparation

The reagents are identical to those used by Pasha and Narayana. Distilled water was used for the preparation of the solutions.

(1) A 2% Potassium iodate (KIO_3) solution was prepared by dissolving potassium iodate equivalent to 2grams and making up the volume to 100ml.

(2) 1M HCl solution was prepared by diluting 8.5ml of concentrated hydrochloric acid in some distilled water and then making up the volume to 100ml.

(3) Acetate Buffer pH 4.0 was prepared by dissolving sodium acetate trihydrate equivalent to 13.6grams in 80ml of water. The pH was adjusted by acetic acid using a pH meter.

(4) 0.02% Safranin O solution was prepared by dissolving safranin equivalent to 0.02gms in distilled water and then making up the volume to 100ml.

3.4 Sample pre-treatment

Water samples from Singhgad road, Kothrud, Wagholi, and Market yard area of Pune city were collected in polythene bottles. Post-collection few drops of 10% potassium iodide (KI) were added to each sample bottle. This was mainly done to convert any Arsenic(V) to Arsenic(III).

3.5 Procedure

A series of dilutions ranging from 100 $\mu\text{g/ml}$ to 500 $\mu\text{g/ml}$ were prepared in 10ml volumetric flasks. This was done by taking 1ml, 2ml, 3ml, 4ml and 5ml standard arsenic solution (1000 mg/L). Potassium iodate 2%, 1ml, and hydrochloric acid 1M, 1ml was added to each of the volumetric flasks. This mixture was gently shaken until the appearance of yellow color indicating the liberation of iodine. Post this 0.5ml of 0.02% safranin o dye and 2ml acetate buffer was added to each of the volumetric flasks. Finally, the volume was made up to 10ml using distilled water.

Sample preparation was done by taking 1ml of sample from each area in different volumetric flasks of 10ml and the reagents were added in a similar manner as mentioned above.

A blank sample consisting only of the reagents was also prepared.

Finally, a full spectrum ranging from 200-800nm of the blank sample and then of all the standards and samples was taken.

The absorbance at 532nm for the standards was taken and a linear calibration graph was obtained. Using the equation of the graph and the absorbance of samples at 532nm the arsenic concentration was determined.

4. RESULTS

4.1 Spectra of standard arsenic solutions:

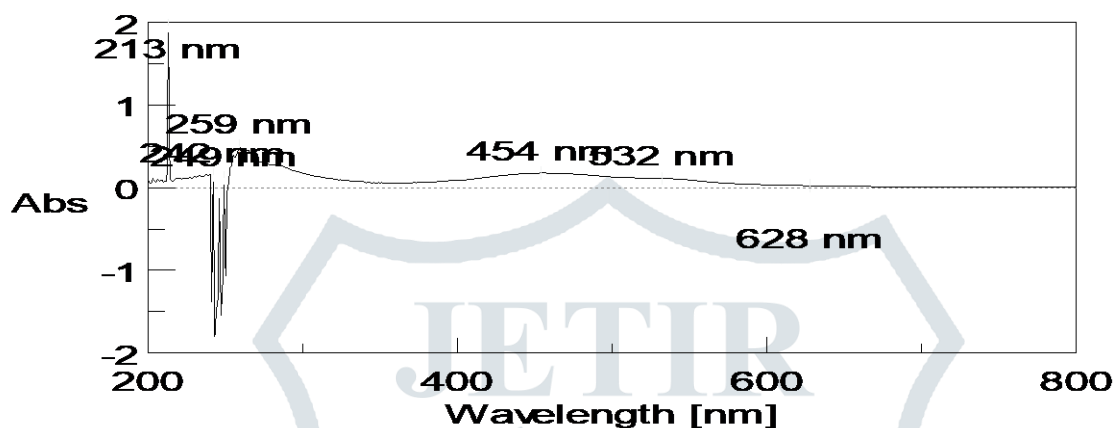


Figure 1. Spectra of 100µg/ml arsenic standard solution.

The 100µg/ml standard arsenic solution showed an absorbance of 0.1987 at 532 nm.

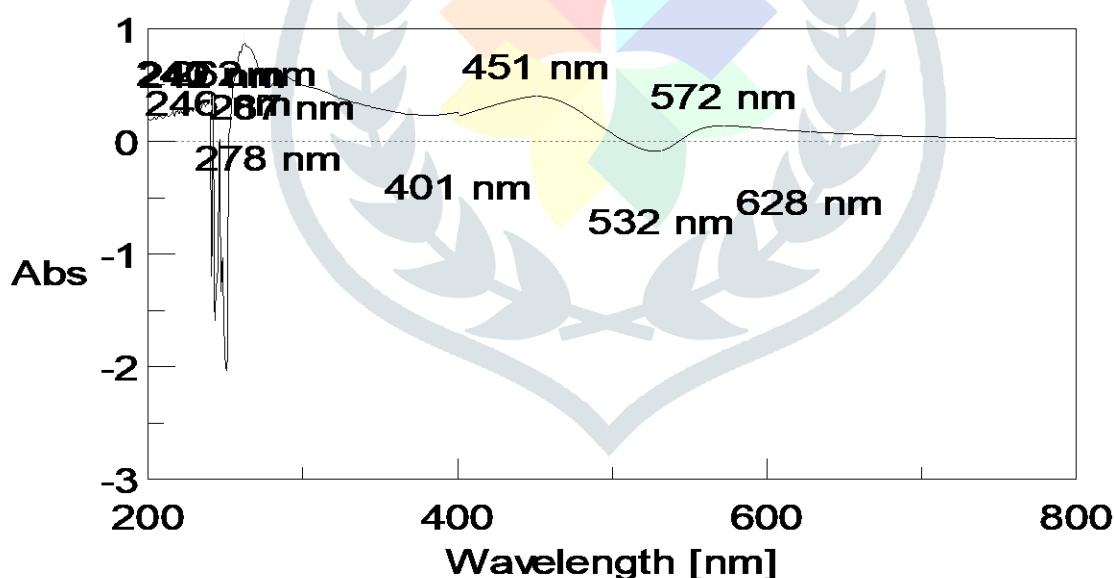


Figure 2. Spectra of 200µg/ml arsenic standard solution.

The 200µg/ml standard arsenic solution showed an absorbance of -0.0802 at 532nm.

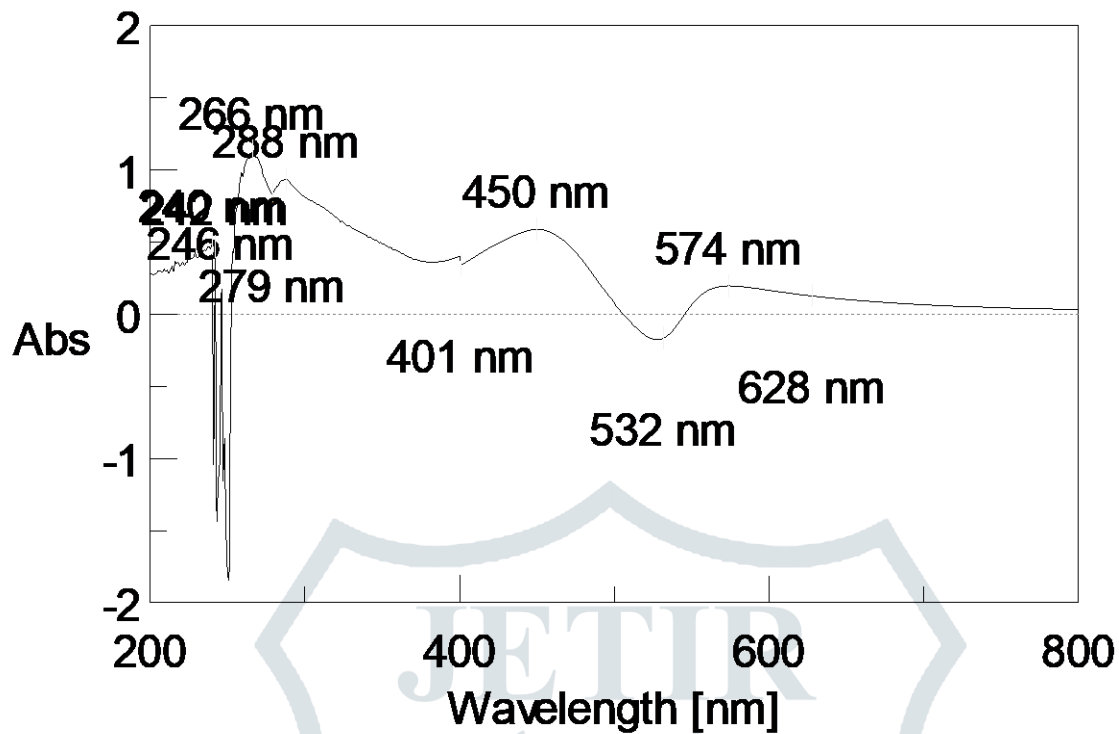


Figure 3. Spectra of 300µg/ml arsenic standard solution.

The 300µg/ml standard arsenic solution showed an absorbance of -0.1655 at 532nm.

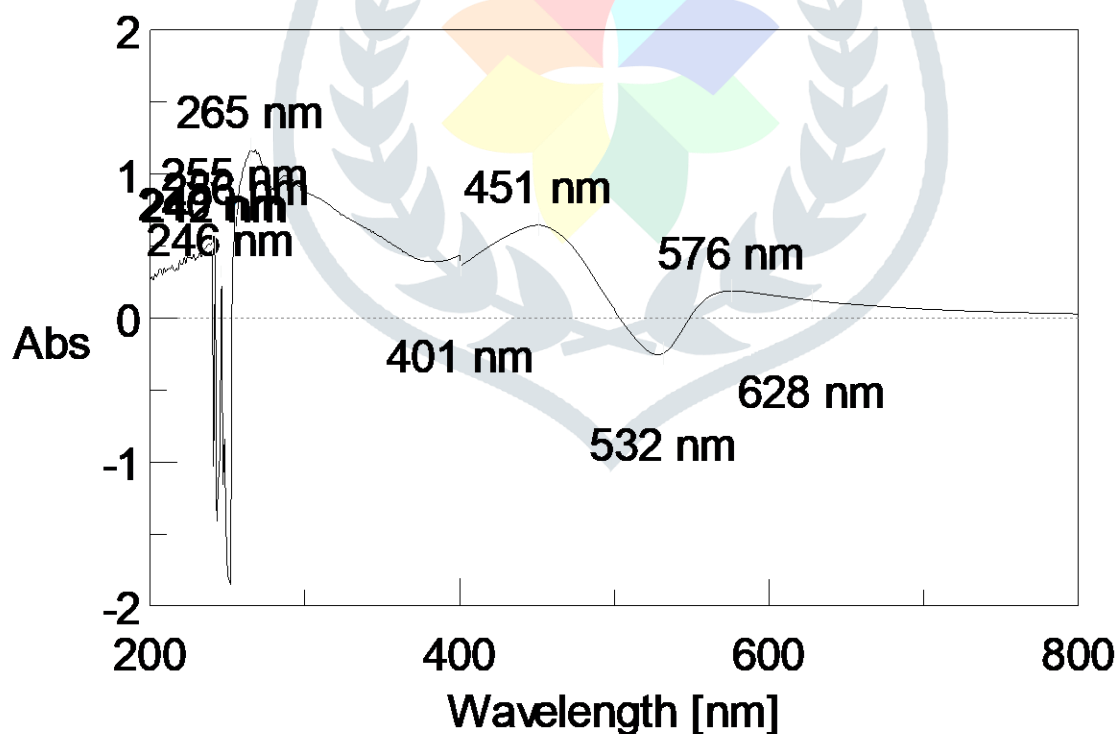


Figure 4. Spectra of 400µg/ml arsenic standard solution.

The 400µg/ml standard arsenic solution showed an absorbance of -0.2428 at 532nm.

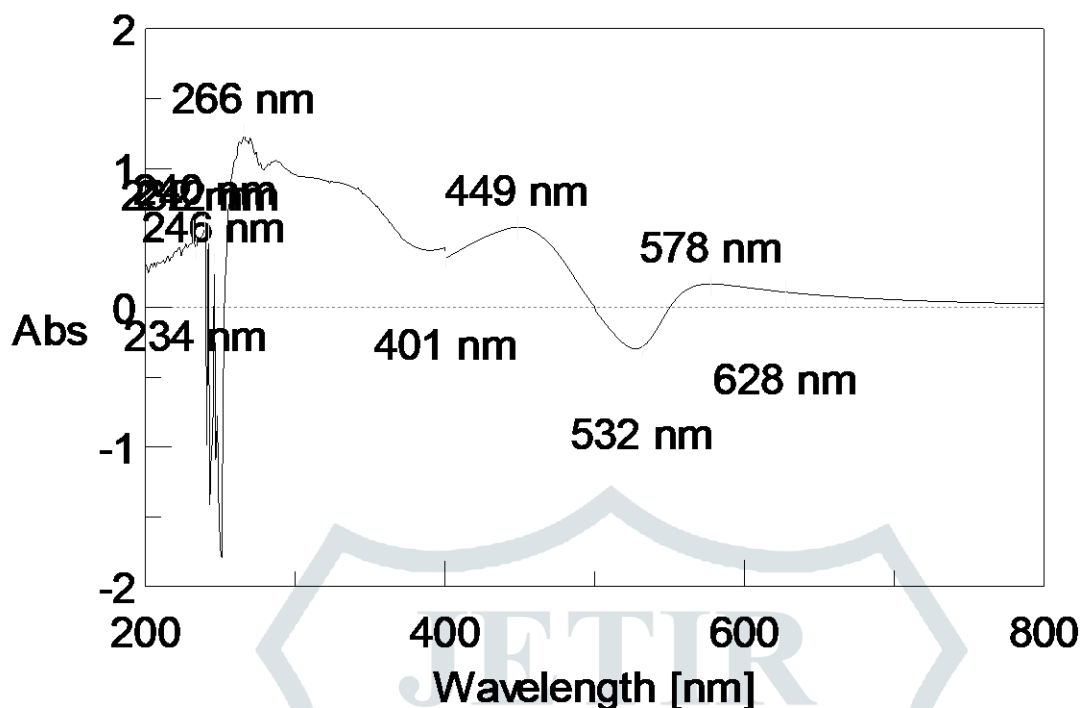


Figure 5. Spectra of 500µg/ml arsenic standard solution.

The 500µg/ml standard arsenic solution showed an absorbance of -0.279 at 532nm.

4.2 Spectra of water samples from different areas of Pune:

a) Market Yard:

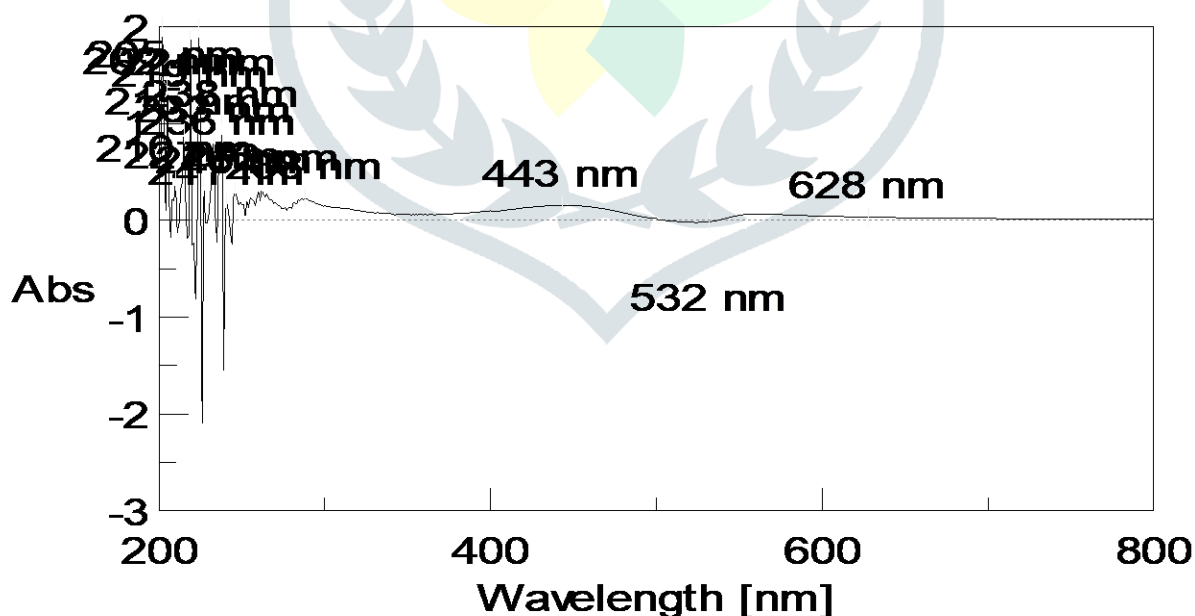


Figure 6. Spectra of water sample from Market Yard area.

This sample from Market Yard showed an absorbance of -0.0133 at 532nm.

b) Singhgad Road:

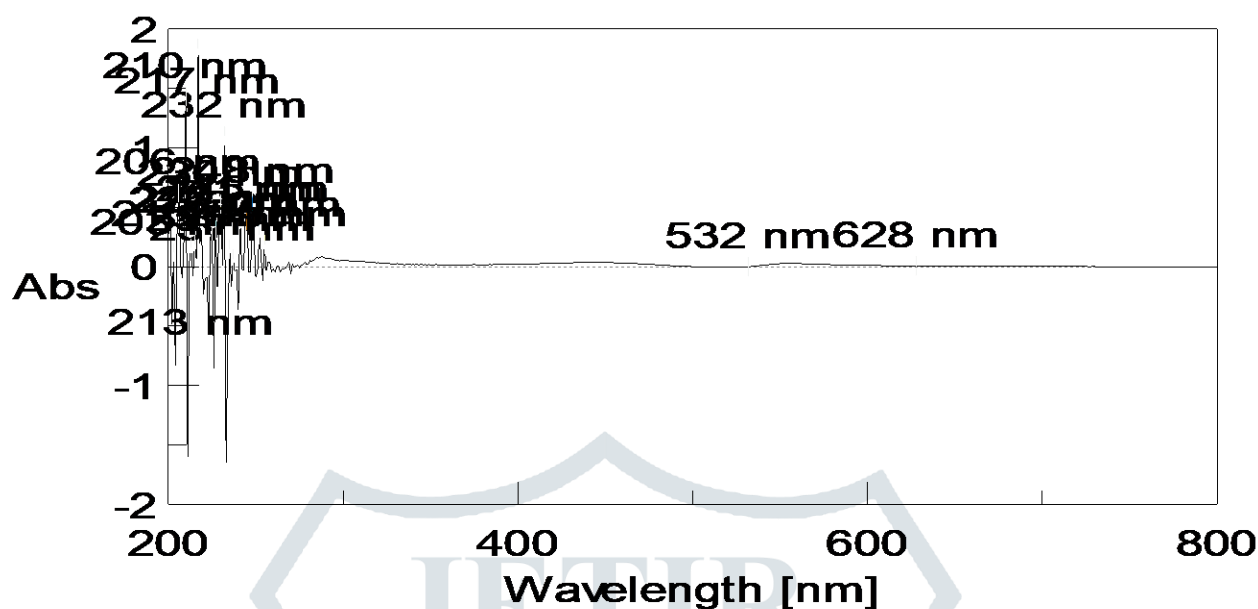


Figure 7. Spectra of water sample from Singhgad Road.

This sample from Singhgad Road showed an absorbance of 0.0000224 at 532nm.

4.3 Linear Calibration Graph:

Using the absorbance of the standard arsenic solutions a linear calibration graph of absorbance versus concentration was constructed. The equation of the graph was found to be $y = -0.0011x + 0.2216$.

Concentration (x) (µg/ml)	Absorbance at 532nm (y)
100	0.1987
200	-0.0802
300	-0.1655
400	-0.2428
500	-0.279

Table 1. Absorbance of the standard arsenic solutions.

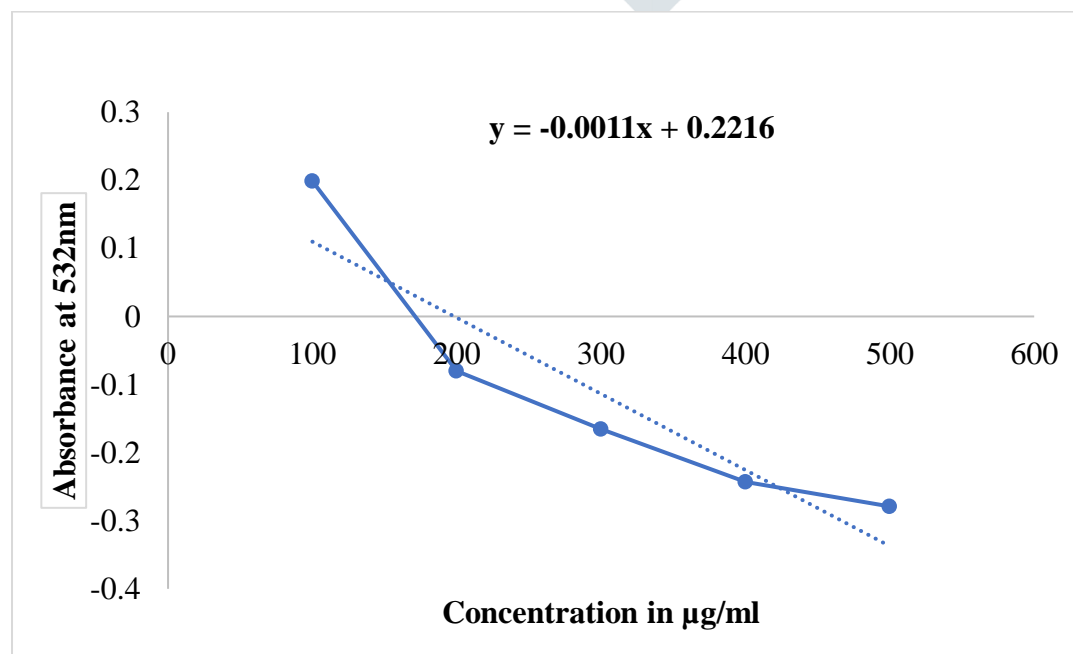


Figure 8. Linear Calibration curve for standard arsenic solutions.

4.4 Sample concentration:

Using the equation of the linear calibration graph,

$$y = -0.0011x + 0.2216$$

the concentration of arsenic per ml in the sample was found. The results are mentioned in Table 2.

Area	Absorbance at 532nm	Concentration of Arsenic (µg/ml)
Market Yard	-0.0133	213.5454
Singhad Road	2.24E-05	201.4341
Wagholi	0.1847	33.5454
Kothrud	0.3057	0

Table 2. Concentration of arsenic in the water samples collected.

The concentration of arsenic was found to be 213.5454 µg/ml in Market Yard sample, 201.4341 µg/ml in the Singhad Road sample, and 33.5454 µg/ml in the Wagholi area sample whereas zero arsenic was found in the Kothrud area sample.

5. CONCLUSION:

As stated by Pasha *et al.* a decrease in absorbance as the concentration of arsenic increases in the sample was observed. This shows an indirect relation between absorbance and concentration of arsenic.

The concentration of arsenic in water samples taken from Market yard (213.5454µg/ml), Singhad road (201.4341 µg/ml) and Wagholi (33.5454 µg/ml) was found to be very high. The limits of arsenic as per WHO is 10 µg/L. It can be clearly observed that the concentration has exceeded the limits as per WHO.

The sample from Kothrud area has shown zero arsenic content and the arsenic content is safe and within the limits of WHO.

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7. CONFLICTS OF INTEREST

The authors express no conflict of interest. There are no financial or other relationships that might lead to conflicts of interest.

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