

Determination of Boron Concentration in Water Samples Using the Carmine Method

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ABSTRACT

Hazardous nonpathogenic contaminants, which are commonly found everywhere throughout the world in the waterways from which drinking water is derived, may pose serious health issues, hence it is important to assess the amount of Boron, (B), in water samples in the Al-Zubair area of Iraq. The water samples were collected from 13 different locations, and the measurements were conducted using the Carmine approach to look at them. Boron levels in the water samples analyzed ranged from Hayy Al-Asra 4.21 mg/L to Al-Moallemen District 0.88 mg/L. The results are presented and contrasted with those from other studies. The research might be used to help in the case of contamination and to aid in the establishment of water quality standards by the relevant authorities to protect the public's drinking water sources from radioactive contamination. The study also demonstrates that 13 surface water samples' boron concentrations are below the limit of detection. The drinking water sources in this area include naturally occurring boron. There might soon be major boron pollution concerns as a result.

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INTRODUCTION

Pollution is one of the main and important dangers that threaten the environment, and with societal progress, sources of environmental pollution began to increase in the field of industry, agriculture, and others, and the living and even non-living components and resources of the environment suffer from toxins, fumes, gases, and toxic compounds, and from hazardous waste, noise, radiation, and others. The increase in the number of the world's population and its concentration in limited areas, scientific and technological progress, the expansion of urban, industrial, and agricultural activity, and the

exploitation of natural resources without considering the environment around it has led to the emergence of several environmental problems such as pollution of air, water, and soil, and a decrease in vegetation cover and other natural resources. One of the most important traditional environmental risks is the lack of water suitable for drinking and human use, as well as indoor air pollution and natural disasters such as floods, droughts, earthquakes, and hurricanes.

The most important modern environmental risks are water pollution from overpopulation, industry, and others. Water is a medium for transporting other nutrients to cells, and it is also a means for excreting

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waste from the body. Accordingly, there must be a balance between what the human body takes in and what the human body excretes from water daily. As water is considered the carrier medium that spreads pollutants over large areas through its movement, especially since there is many different pollutants that are thrown to nature as they have radioactivity affecting the environment, and therefore they cause great risks to water users, especially drinking water. Therefore, studying the concentration of boron in water is necessary for human, animal, and plant life [1, 2].

Boron may be found naturally in water, soil, and rocks. It is classified as a non-metallic element [3]. It has an atomic weight of 10.81 and an atomic number of 5. Boron has two isotopes: boron-10, which is present in 19.8 percent of the abundance, and boron-11, which is abundant in 80.2 percent [4]. Although boron levels have been reported to reach up to 100 ppm in

places with greater boron levels, boron levels in the Earth's crust must not exceed 10 ppm [5]. The major aims are to investigate the detailed modifications and interactions with water flow, as well as to determine how many problems these fluids provide. Borates, boric acid, and per borates can be discharged into the environment since they are used in mild antiseptics, cosmetics, and pharmaceuticals [6].

Boron toxicity in the environment can be caused using borates and boric acid, which are used in the production of glass, soaps and detergents, flame retardants, and neutron absorbers for nuclear power plants. Because it is not carcinogenic to animals, borate is used in agriculture as a fertilizer, pesticide, and herbicide. Boron is found in the form of borosilicates in igneous, volcanic, and sedimentary rocks that are weatherproof and difficult for plants to access. Figure 1 depicts the chemical components of numerous boron compounds [7].



Fig. 1. Structures of certain boron compounds in three dimensions [8]

Elements of boron cannot be dissolved in water. The boiling point of decahydrate borax is zero. Borax begins to degrade around 75°C. It loses 5H₂O at 100°C, 9H₂O at 150°C, and becomes anhydrous at 320°C. Anhydrous borax has a melting point of over 700 degrees Celsius and a decomposition temperature of 1575 degrees Celsius [9]. Boric acid is a weak acid that occurs in physiological pH aqueous solutions as an undissociated acid (H₃BO₃). It has a pK_a of 9.2

and is ineffective. This article presents preliminary findings from boron concentration measurements taken in several areas in Al-Zubair. The major goal is to investigate the complicated exchanges and interactions that occur throughout the transit of water samples and evaluate how many hazards are introduced [10]. The research region is really inside the Al-Zubair, as seen in Figure 2.

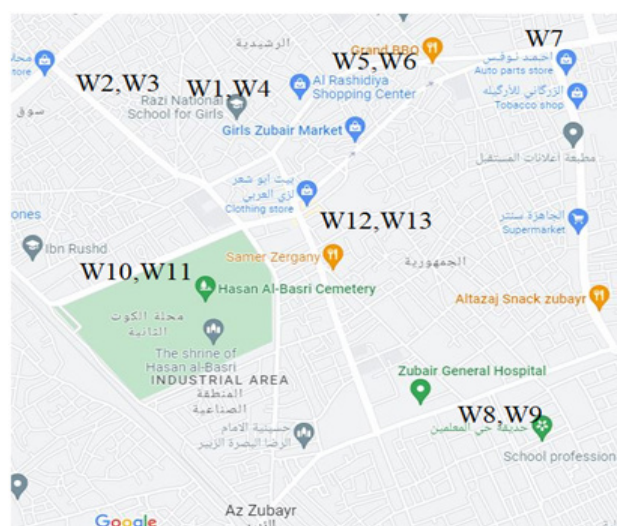


Fig. 2. Administrative units in Al-Zubair

Boron Toxicity

High doses of boron can be toxic. It has been proven that upon short or long-term exposure to boric acid (HBO) or borax in laboratory animals, the male reproductive system is a constant target for water, that the US Environmental Protection Agency has classified boron as an element of the fourth group, and this means There is insufficient evidence of human and animal carcinogenicity from boron. Korolev also found that when consuming 250 mg / L of boron in water, it may lead to structural changes in the thyroid gland tissue depending on the dose and that boron taken orally may cause several effects on humans, as symptoms range from mild to heavy up to until death.

The most important finding about the poisoning of newborns with boron was the result of accidental contamination or the addition of boron compounds to infant formula milk powder. Siegel and Wason showed that every (1-3 gm) of boric acid or (0.3-0.8 gm) of boron in the body is/are fatal to newborn babies. Every (5-6 gm) of borate is fatal for infants, and (15-20 gm) of boric acid (HBO) is fatal for adults. Symptoms of boron toxicity in humans include diarrhea, nausea, vomiting,

lethargy, dermatitis, poor appetite, weight loss, and decreased sexual activity. The toxicity of boron is relatively low for animals, but the high levels have a negative effect on the metabolism and phosphorus in cattle, as the lethal dose for cattle ranges from 200 mg/kg to 600 mg/kg of body weight.

Signs of development in cattle include inflammation and swelling in the legs, a decrease in feed consumption, a decrease in weight gain, a decrease in hemoglobin levels, depression, lethargy, twitching or fluttering of the eyelids, stiffness, and spasm when walking with ataxia and falling into lateral recumbency. In plants, boron deficiency may not significantly affect the green matter, but it negatively affects the fertility of flowers, as boron is concentrated in the reproductive organs of the plant such as stigmas, pollen, and ovaries [11].

Devices and Tools Used

Delicate Balance

It is a highly sensitive German-made scale of the type (SARTORIUS), its sensitivity is (0.001 grams), and its highest reading reaches (210 grams), as shown in Figure (3). This sensitive scale has been used to find the weight of cochineal and boric acid.

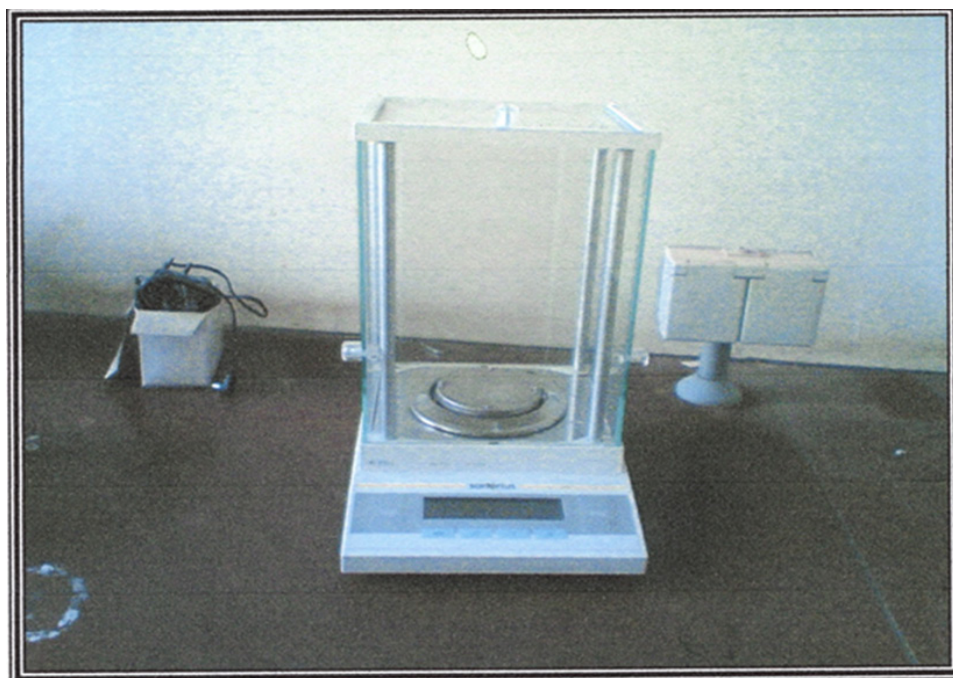


Fig. 3. Delicate balance

Spectrophotometer

The spectrophotometer is a device for measuring the amount of light from the material used by the wavelength that directs the device. Each material absorbs radiation at its own wavelength (if the wavelength in the field of visible light has a color

that we can see) (and in our experience, we directed the device to a wavelength equal to (585 nm)). The measurement of the optical absorption of the samples during this research was done using an analysis device CECIL Spectrophotometer Type 2021 CE manufactured by Aquarius, England, as shown in Figure (4).



Fig. 4. The spectrophotometer

Fechner Funnel or Buechner Funnel

The Fechner funnel or Buechner funnel is one of the practical tools in vacuum filtration. It is made of glass and plastic. On top of the funnel is a cylinder with a perforated plate separating it from the funnel.

As shown in Figure (5). The filter paper is placed on the filter, and after that, the material to be filtered is placed in the cylinder and passes through a hole in the conical flask by means of suction. This device was named after the Nobel Prize winner Edward Buechner.

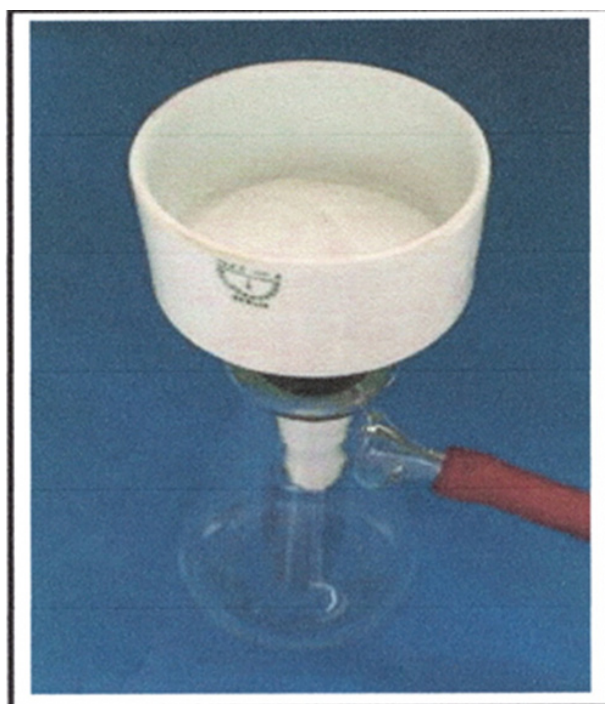


Fig. 5. The Fechner Funnel that was used to filter clay samples

MATERIALS & METHODS

Analytical Method

Boron content may be estimated using the Carmine procedure, which involves dissolving carmine or carminic acid, in sulphuric acid and measuring it photometrically. The carmine approach is effective for

determining boron levels ranging from 1 to 10 mg/L [12].

Carmine Method

Materials Used

(Hydrochloric acid, sulfuric acid, standard boric acid, pure carmine and distilled water)

Action Steps

- Hydrochloric acid (HCl): Add 48.6 ml of concentrated hydrochloric acid to 900 mL of distilled water.
- Carmine solution Add 0.92 gm of carmine to 1,000 mL of concentrated sulfuric acid (H₂SO₄) and shake until the carmine dissolves and store the solution in the dark.
- Standard boric acid solution (HBO₃): Dissolve 0.572 gm of uric acid in distilled water and bring the volume up to 1000 ml. Each milliliter of the solution contains 100 mg of boron.
- Preparation of the standard curve: Take different amounts of the boron standard solution mentioned in point (3) (0,2,4,6,8,10 mL) and put it in a container of (100 ml) capacity and complete the volume to 100 ml with distilled water to reach mg / ml 0,2,4,6,8,10 of boron, respectively.
- Procedure: We use a set of bottles with the number of water samples, put in each vial 2 mL of the sample under study, then add two drops of HCl, then add 10 ml of Sulfuric acid slowly. Then we add 10 ml of carmine solution and wait for 45

Min. Then we use the color spectrophotometer to estimate the absorbance at a wavelength (585 nm).

The Concentration of Boron in Water Samples

In November 2022, 13 water samples were collected from the Al-Zubair in Iraq. The optical absorbance values of the standard samples obtained by the optical spectrum analyzer were entered into the statistical program (MINITAB11), and we obtained the following equation:

$C = 0.118 + 2.79A$, as C is the concentration of boron (mg / L) and A represents the optical absorbance value of water samples at a wavelength of 585 nm, and the value of the amount of convergence between the points is $R^2 = 98.2\%$, after that, we entered the values Optical absorbance of aqueous samples measured by a spectrophotometer in the program (MINITAB11). We divided the above equation by 2, and we obtained the results of the boron concentration.

The following graph shows the statistical analysis used to derive the calibration equation related to absorbance and boron concentration.

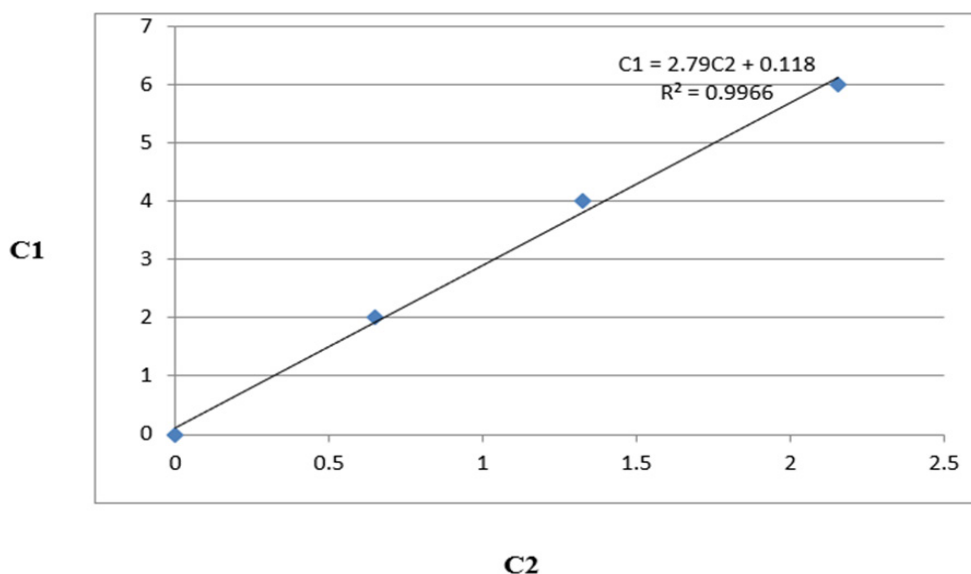


Fig. 6. Graph between absorbance and boron concentration

RESULTS & DISCUSSION

The carmine technique was used in the study to determine the amounts of boron in water samples collected from various locations in Al-Zubair. All stations in the present assessment of boron levels in Al-Zubair water have been determined to be within natural limits. Table 1 displays the findings for the 13 samples matching the 13 locations from W1 to W13. The greatest boron content identified is (4.21

mg/L) and the lowest concentration discovered is (0.88 mg/L), which belong to the Hayy Al-Asra and Al-Moallemen District, respectively. Many organizations published research on the magnitude of boron in the range of 1mg/L to 1.4mg/L for the best quality of water meant for human consumption in the European Union and New Zealand [13]. Herbicides, insecticides, and boron compound fertilizers are all frequently shifted to wastewater irrigation to prevent the risk of boron seeping under soils.

Table1

The carmine technique was used to determine the boron levels in water samples in Al-Zubair

Sites numbers	Sites	Absorption At 585 nm	Boron concentration (mg/L)
W1	Hayy Al-Asra	2.980	4.21
W2	The caravan city	0.994	1.44
W3	Safwan district	0.658	0.97
W4	Al-Durahimiya	0.691	1.02
W5	Al- Rashidiya 1	0.625	0.93
W6	Al- Rashidiya 2	0.611	0.91
W7	North Rumaila	0.659	0.97
W8	Sawadi market	0.617	0.91
W9	Petro	0.616	0.91
W10	Al-Askari district	0.618	0.92
W11	Al-Moallemen District	0595.	0.88
W12	Factories area	0.606	0.90
W13	Al Sahafieen District	0.620	0.92
	Average	0.837	1.222
	max	2.980	4.21
	min	0.595	0.88

CONCLUSION

This is the first study to employ the carmine method to assess boron amounts in water sources in Al-Zubair (Iraq). In general, the level of boron has been proven to be modest and within normal limits in all the water samples analyzed in the research locations. The correlation factor between the boron of the absorbance standard and the sample's absorbance in water is 95.7%. This is an extremely strong link. Correlation study in water samples revealed a strong positive relationship between boron and a few chemical components. Access to good soil samples is critical to human well-being, which is a major public health problem. Protecting

the raw soil sample supply and soil water treatment contributed to maintaining high-quality water samples. It is possible to protect raw water supplies by applying pollution control measures that prevent unwanted pollutants from contaminating the water and by following effective watershed management practices.

Data Availability

All data generated or analyzed during this study are included in this article.

Competing Interest

The authors had no competing interests.

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