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Evaluation of boron concentration in water samples of Al-Diwaniya Governorate (in Iraq) using ICP/OES Techniques

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ABSTRACT:

Boron is none uniformly distributed, ubiquitous essential micronutrient element for the plant as well as human beings. The aim of this study is to measure the Boron, $^{10}B_5$, concentration in water in Al-Diwaniya governorate (in Iraq). The measurements were performed by analyzing the water samples collected from 24 location using ICP/OES technique. The Boron concentration which is obtained ranged from 0.45ppm in (Al-dighara 4) to1.87ppm in (alhamza 6) in water. The present results are compared with other studies. The results could be utilized to make distinctive supplementary contributions when contamination event occurs and to implement water quality standards by concerned authorities to maintain radioactive contamination-free water samples which are needing for the people. The study further reveals that 24 surface water samples have boron more than detection limit.

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تقييم تركيز البورون في عينات المياه في محافظة الديوانية (في العراق) باستخدام تقنيات ICP / OES

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الكلمات المفتاحية:

بورون
عينات مياه
مطياف البلازما الانبعاث البصري المقترن حثيًا
محافظة الديوانية

الـــخُـــلاصـــة:

البورون غير موزعا بشكل متجانس، فهو يعتبر عنصر اساسي ومن المغذيات الدقيقة الأساسية للنبات وكذلك البشر. الهدف من هذه الدراسة هو قياس البورون ، $_5B^{10}$ ، تراكيز البورون في مياه محافظة الديوانية (في العراق). أجريت القياسات من خلال تحليل عينات المياه التي تم جمعها من 24 موقع باستخدام تقنية (ICP / OES). تراوح تراكيز البورون في مياه محافظة الديوانية الذي تم الحصول عليه حوالي (0.45 ppm) في منطقة (Al-dighara 4) إلى(1.87pmm) في منطقة (alhamza 6).. ويمكن استخدام النتائج لتقديم مساهمات تكميلية مميزة عند حدوث تلوث وتنفيذ معايير نوعية للمياه من قبل السلطات المعنية للحفاظ على عينات المياه المشعة الخالية من التلوث التي تحتاجها للناس. وتكشف الدراسة أيضًا أن 24 عينة من المياه السطحية تحتوي على البورون أكثر من حد الكشف.

1. INTRODUCTION

Boron is a nonmetallic element that belongs to Group IIIA of the periodic table and has an oxidation state of+3. I have an atomic number of 5 and atomic weight of (10.81 gm/mol). It is actually amixture of two stable isotopes, 10B (19.8%) and 11B (80.2%) [1]. It is a naturally-occurring element found in rocks, soil,and water. The concentration of boron in the earth's crust has been estimated to be <10 ppm, but concentrations as high as 100 ppm can be found in boron-rich areas [2]. It does not appear on the earth in elemental form but is found in combined state as borax, boric acid, tourmaline, colemanite, kernite, ulexite and borates [3-6].Boron deficiency is much more common in crops that are grown in soil that have higher amount of free Carbonates, low organic matter, and high pH [7]. Boric acid, borates and per borates can introduced to environment as these have been used in mild antiseptics, cosmetics, pharmaceuticals [8]. Boric acid and borates are used in glass manufacture, soaps and detergents, flame retardants, and neutron absorbers for nuclear installations can cause boron toxicity in environment. Borates have various agricultural uses as fertilizer, insecticide and herbicide because they are not carcinogenic to mammalian and lack of insect resistance compared with organic insecticides [9,10]. It occurs as borosilicate in igneous, metamorphic, sedimentary rocks which are resistant to weathering and not readily available to plants. The chemical structure of some boron compounds is found in Figure 1.

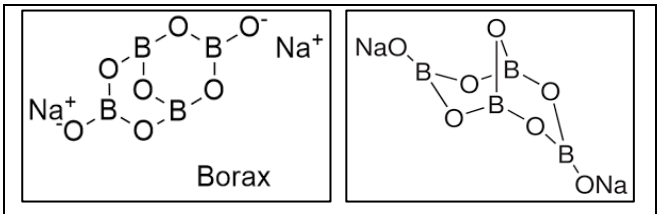

Figure 1: Chemical structures of some boron compounds [11].

Elemental boron is insoluble in water [12]. Borax (decahydrate) does not have a boiling point. Borax decomposes at 75°C, and loses $5H_2O$ at 100°C, $9H_2O$ at 150°C, and becomes anhydrous at 320°C. The melting point for anhydrous borax is above 700°C and it decomposes at 1575°C [11]. The purpose of this study is to investigate the complex interactions and exchanges with flow

of water, and to estimate how much hazards brought with water samples. In fact, the study area is located inside Al-Diwaniya Governorate which is located in the extreme southern part of Iraq, see Fig. 2.

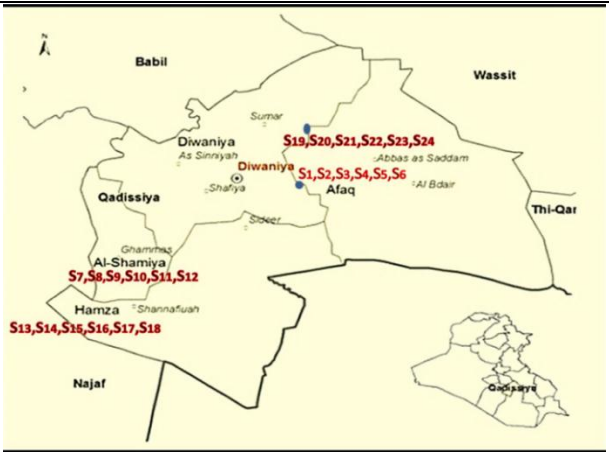

Figure 2: Diwaniya governorate, dots represent the places where samples taken from, numbering in station number (S).

In Al-Diwaniya governorate, the samples from 24 stations and locations were collected during July 2018.The measurements of Boron concentration soil samples were carried out by using ICP/OES method [13]: Inductively coupled plasma/optical emission spectrometry (ICP/OES) is a powerful tool for the determination of metals in a variety of different sample matrices. By using, liquid samples are injected into a radiofrequency- (RF) - induced argon plasma using one of a variety of nebulizers or sample introduction techniques. The sample mist reaching the plasma is quickly dried, vaporized, and energized through collisional excitation at high temperature. The atomic emission emanating from the plasma is viewed in either a radial or axial configuration, collected with a lens or mirror, and imaged on to the entrance slit of a wavelength selection

device. Single element measurements can be performed cost-effectively with a simple monochromator/ photomultiplier tube (PMT) combination, and simultaneous multielement determinations are performed for up to 24 elements with the combination of a polychromator and an array detector. The analytical performance of such systems is competitive with most other inorganic analysis techniques, especially with regards to sample throughput and sensitivity.

2. EXTRACTION OF BORON FROM WATER

The samples of water have been sampled which were estimated by ICP/OES method. For the calibration graph a stock solution of borate was used of which a calibration Solution was prepared by ICP/OES devices at 249.772 nm . A linear calibration was observed, followed by the calculation of the slope factor. The results are experimented in (mg/l). Regression equation Y=6793x + 286.62: R^2 = 0.9995 , Boron concentration was read directly from the standard curve see figure (3).

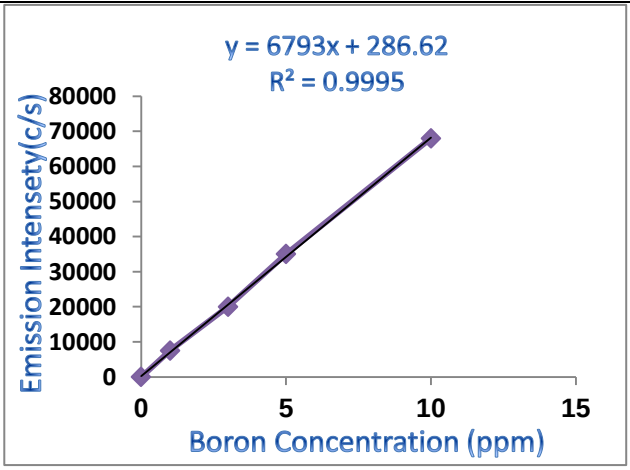

Figure 3: Calibration curve for boron concentration in water (ppm) vs Emission intensity (c/s).

3. RESULTS AND DISCUSSIONS

The results for Boron concentration in water samples in the present study are determined presented in Table 1.

which is collected from some areas in Al-Diwaniya Governorate, southern Iraq. For the measurement of boron concentration level water.

Table 1: Measurements of Boron concentration in water samples from different areas in Al-Diwaniya Governorate by using ICP-OES.

No. of site	Location of samples	Concentration of boron in water by ICP-OES (ppm)
S1	Nufer 1	1.33
S2	Nufer 2	1.09
S3	Nufer 3	0.71
S4	Nufer 4	0.67
S5	Nufer 5	1.07
S6	Nufer 6	0.7
S7	alshaamia 1	1.61
S8	alshaamia 2	0.7
S9	alshaamia 3	0.92
S10	alshaamia 4	0.84
S11	alshaamia 5	1.55
S12	alshaamia 6	1.21
S13	alhamza 1	0.79
S14	alhamza 2	1.33
S15	alhamza 3	0.77
S16	alhamza 4	1.78
S17	alhamza 5	1.14
S18	alhamza 6	1.87
S19	aldighara 1	1.21
S20	aldighara 2	0.66
S21	aldighara 3	0.48
S22	aldighara 4	0.45
S23	aldighara 5	0.53
S24	aldighara 6	1.55

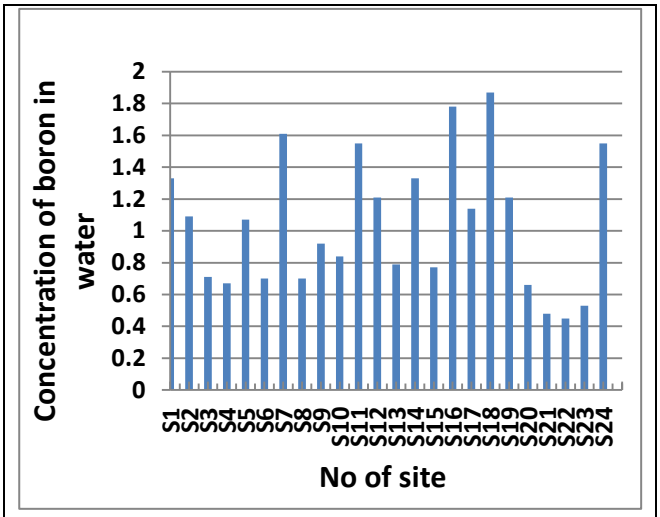

Figure4: Distribution of the results of the boron concentration in Diwaniya water analysis by ICP-OES.

For the measurement of boron concentration level water,.Table1 and Fig.4 reflect the fact that, there was some high level of boron concentration in this water higher than the most of public tap and washing surface water in the governorate. The results for these 24 samples categorized into 24 locations, in Al-Diwaniya Governorate region from **S1** to **S24**, shown in Fig. 4. Boron content found maximum (1.87ppm) in(Al-hamza 6) and minimum (0.45 ppm) was recorded in (Aldighara 4). Out of the 24 water samples 12 samples recorded higher which are beginning from 1.07 ppm to 1.87 ppm while the 12 water samples are beginning from 0.45 ppm to 0.92 ppm than the prescribed WHO limit (0.5 ppm). The World Health Organization (WHO) in 1993 the WHO established a health-based Guideline of 0.3 mg/L for boron. This value was raised to 0.5 mg/L in 1998 primarily. Furthermore, in 2000 it was decided to leave the guideline at 0.5 mg/L until data from ongoing research becomes available that may change the current view of boron toxicity or boron treatment technology [14,15].The European Union established a value of 1.0 mg/L for boron in 1998 for the quality of water intended for human consumption [16,17]. New Zealand has established a drinking water standard for boron of 1.4 mg/L [18,19]. Higher amount of Boron in water samples may be due to leaching of water boron as maximum amount of mobile boron is present in the acidic water in the study area. Moreover use of boron compounds as fertilizer, insecticide and herbicides at regular intervals are subjected to wastewater irrigation disposal hence possibility of boron leaching in under soil water. It may be due to higher leaching of boron during monsoon rains from surface water beyond the root zone. Thus, there is possibility of severe pollution problem with boron in near future. High concentrations of boron can be found in many parts of the world, particularly in highly mineralized, naturally carbonated ground waters. Mean boron concentrations in Italy and Spain ranged from 0.5 to 1.5 mg/l, and values ranged up to approximately 0.6 mg/l in the Netherlands and the United Kingdom[15].

4. CONCLUSION

This study is the first boron concentration measurement in water sources that is performed in the area for Al-Diwaniya Governorate (Iraq). In general, well water samples within the investigated areas, are highly mineralized. The correlation analysis revealed the strong positive association between boron and some chemical compounds in water samples. Access to safe water samples is essential to human well being and is a key public health issue. The maintenance of good quality of water samples were achieved both by protecting the raw water samples supply and water treatment. It is possible to protect the raw waters supply by means of pollution control measures that prevent undesirable constituents from entering the water and by good watershed management practices.

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