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The cumulative capacity of some terrestrial plants spread in the Wadi Al-Tib - Maysan Governorate

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Abstract

Nowadays, pollution has become one of the biggest problems that the entire world suffers from, so this study sheds light on pollution with heavy elements and the importance of plants in reducing these risks and the amount of accumulation of these elements. Eight wild plants were collected: *Brassica tournifortii* Gouan., *Cakile arabica* Vel. & Bornm., *Capsella bursa – pastoris* (L.) Medic., *Carrichtera annua* (L.) DC., *Diplotaxis acris* (Forssk.) Boiss., *Diplotaxis harra* (Forssk.) Boiss., *Eruca sativa* Mill. and *Erucaria hispanica* (L.) Druce. belonging to the Brassicaceae family, which were collected from the Wadi al-Tib area in the northeast of Maysan Governorate, where 10 elements were estimated in them: Aluminum (Al), Silver (Ag), Arsenic (As), Boron (B), Barium (Ba), Molybdenum (Mo), Iron (Fe), Lithium (Li), Selenium (Se) and Tin (Sn). The concentrations of the elements were observed to vary in the studied plants. The highest accumulation of Al was 863.8 ppm in *E. sativa* and the lowest was 133 ppm in *D. acris*. As for arsenic, the highest rate was recorded at 1.5 ppm in *B. tournifortii* and the lowest rate was 0.1 ppm in *D. acris* and was not recorded in *C. arabica*, *D. harra* and *E. hispanica*. As for B and Ag, the highest concentration was 165.5 and 6.9 ppm, respectively, in *C. bursa-pastoris*, while the lowest concentration was recorded at 22.8 and 0.8 ppm, respectively, in *C. arabica*, as for the elements Br and Mo, the highest concentration reached 342.6 and 31.1 ppm in the *C. bursa-pastoris* plant, respectively, followed by 291.5 ppm in the *C. arabica* plant, and a significant decrease was observed, reaching 15.1 and 3.6 ppm in the *D. acris* plant, respectively. The statistical analysis was conducted using SPSS (version 26), applying a one-way ANOVA test at a 0.05 significance level.

Keyword: cumulative, Plants, pollution, element, heavy metals.

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Introduction

Soil and water pollution with heavy metals, which causes toxicity and stress, has become one of the important constraints that limit the productivity and quality of crops, as well as wild plants and others, the pollution situation has increased due to urban expansion and increasing population growth. Many studies have confirmed that reducing or neutralizing heavy metal toxicity requires complex mechanisms at the chemical, molecular, cellular, physiological, and anatomical levels of the plant, which may lead to improved plant growth and increased production. Recent developments in various biological sciences such as metabolomics, proteomics, transcriptomics, and others have helped in characterizing metabolites, transcription factors and proteins that can reduce stress and tolerate heavy metal toxicity (Singh *et al*., 2015; Angulo-Bejarano *et al*., 2021).

Soil is a complex medium that contains many different mineral elements, and the third most abundant element is aluminum, which is one of the important elements in promoting plant growth at moderate concentrations. Its presence also increases the efficiency of phosphorus absorption by plants, as well as reducing the toxicity of iron and manganese in acidic soils, the presence of aluminum in the soil also enhances the work of root bacteria (PGPR) and their interactions with plants by increasing organic secretions. (Muhammad *et al*., 2019).

Tuaih and Al-Asadi (2023) showed the effect of environmental factors and pollution with heavy elements on the distribution and spread of the *Artemisia scoparia* Waldst. et Kit. plant growing in the southern desert of Basrah Governorate, as the temperature, pH, relative humidity and soil salinity were studied, as well as the effect of heavy elements aluminum, iron, arsenic, zinc, cadmium, lead, copper and cobalt and the amount of their accumulation in the soil and plant, as the concentrations of these elements differed between the soil and the plant.

Al-Gizzi *et al*. (2024) studied the use of wild plant species as indicators of heavy metal accumulation, and showed that the wild plants selected in the study differed in their accumulation of elements, which are Cd, Pb, Ni, Cr, Hg, Cu, Mg, Zi, CO and V, as the concentrations of the elements differed according to the nature of the plant, whether it is perennial or annual.

Othman (2024) studied the monitoring of heavy metals in some desert plants south of Basra Governorate, Iraq. He found that the concentrations of heavy metals in desert plants vary according to the nature of the plant, as some plants showed the ability to accumulate metals, such as *Erodium glaucophyllum*, *Diplotaxis harra*, and *Astragalus spinosa*. Understanding the patterns of accumulation of heavy metals in the Iraqi desert vegetation supports conservation efforts and pollution reduction.

The aim of this study is to know the elements spread in the study area and what are the most common elements, also to know the best plants in accumulating of elements.

Material and Methods

Collection of plant samples

The botanical specimens were harvested from the Wadi Al-Tib region, situated in the northeastern part of Maysan Governorate, during the spring season. They were subsequently placed in designated bags and transported to the Environment Department at the College of Science, University of Basra. Following taxonomic classification based on the Flora of Iraq, the green tissues were desiccated at ambient temperature (25°C), ground utilizing a ceramic mortar, and stored in plastic containers. Each sample was labeled with pertinent information (species designation, sample number, collection site, date of collection, and purpose) before being dispatched to the laboratories of the University of Tehran, Islamic Republic of Iran, for the assessment of heavy metal concentrations.

Estimation of heavy elements in plants using the ICP-MS plasma device

Heavy metal quantification in plant samples was conducted via inductively coupled plasma mass spectrometry (ICP-MS) as per the methodology outlined by Masson et al. (2010). Specifically, 200 mg of each plant sample was subjected to digestion in a mixture of 7 ml concentrated nitric acid and 3 ml hydrochloric acid using a microwave digestion system for 20 minutes. The samples were enclosed in appropriate polymeric microwave vessels, sealed securely, and subjected to a temperature increase of 160 ± 5°C for no longer than 6 minutes to complete the digestion. Following digestion, the samples were allowed to cool, after which they underwent filtration and centrifugation prior to analysis with an ELAN 6100 DRC-e ICP-MS from Perkinelmer in the laboratories of the University of Tehran, Iran.

Statistical analysis: The statistical analysis was conducted using SPSS (version 26), applying a one-way ANOVA test at a 0.05 significance level.

Results and Discussion

Figure 1 shows the changes in the rate of accumulation of Al in some wild plants growing in Wadi Al-Tib, Maysan Governorate, where the highest rate of 863.8ppm was recorded in the *E. sativa* plant, followed by the *B. tournifortii* plant at a rate of 810.6 ppm, and the lowest rate was 133ppm in the *D. acris* plant, The results of the statistical analysis showed no significant differences among the plants with respect to the aluminum element(F=1.160; df= 7; p= 0.377) .the effect of the element on the plant depends on the type of plant, its age, the conditions in which it grows, and the time of exposure, Al can be beneficial to plants because it stimulates growth in alkaline soils, but it affects plant growth and productivity in acidic soils. It inhibits root growth and restricts the absorption of water and nutrients by the plant. (Ofoa *et al*., 2023).

As for As the highest rate was recorded at 1.5ppm in *B. tournifortii* and the lowest at 0.1ppm in *D. acris* and was not detected in *C. arabica*, *D. harra* and *E. hispanica*, (Figure 1) As is widely found in the environment through human activities and is found in plants in low concentrations, but its accumulation in plants, especially food or medicinal plants, poses a serious health risk to humans and animals, and its accumulation in them reduces the efficiency of the plant's photosynthesis process, and the accumulation of arsenic affects the work of reactive oxygen species (ROS) and the production of lipid peroxide and damage to cell membranes (Zhang *et al*., 2021).Figure 1 shows the changes in the concentration rates of B and Ag in the studied plants, as the highest recorded at 165.5 and 6.9 ppm, respectively, for *C. bursa-pastoris*, while the lowest recorded at 22.8 and 0.8 ppm, respectively, for *C. arabica*. Boron is a trace element in the soil and is needed by plants in photosynthesis and plant growth, and when it increases, it turns into a toxic element (Marschner, 2012). The results of the statistical analysis showed no significant differences among the plants (F=1.190; df= 7; p= 0.232).

Figure 1 shows the changes in the concentration rates of Br and Mo in the studied plants, as the highest reached 342.6 and 31.1 ppm in *C. bursa-pastoris*, respectively, followed by 291.5 ppm in *C. arabica*. It was noted that it decreased significantly, reaching 15.1 and 3.6 ppm in *D. acris*, respectively. Mo is an important element for plants in low concentrations, as it contributes to the nitrogen fixation process in the activity of rhizobia bacteria, converts nitrogen into amino acids, and reduces nitrogen to nitrates. However, if concentrations increase, it is toxic to plants (Tripathi *et al*., 2024). The results of the statistical analysis showed significant differences among the plants ((F=1.190; df= 7; p= 0.00).

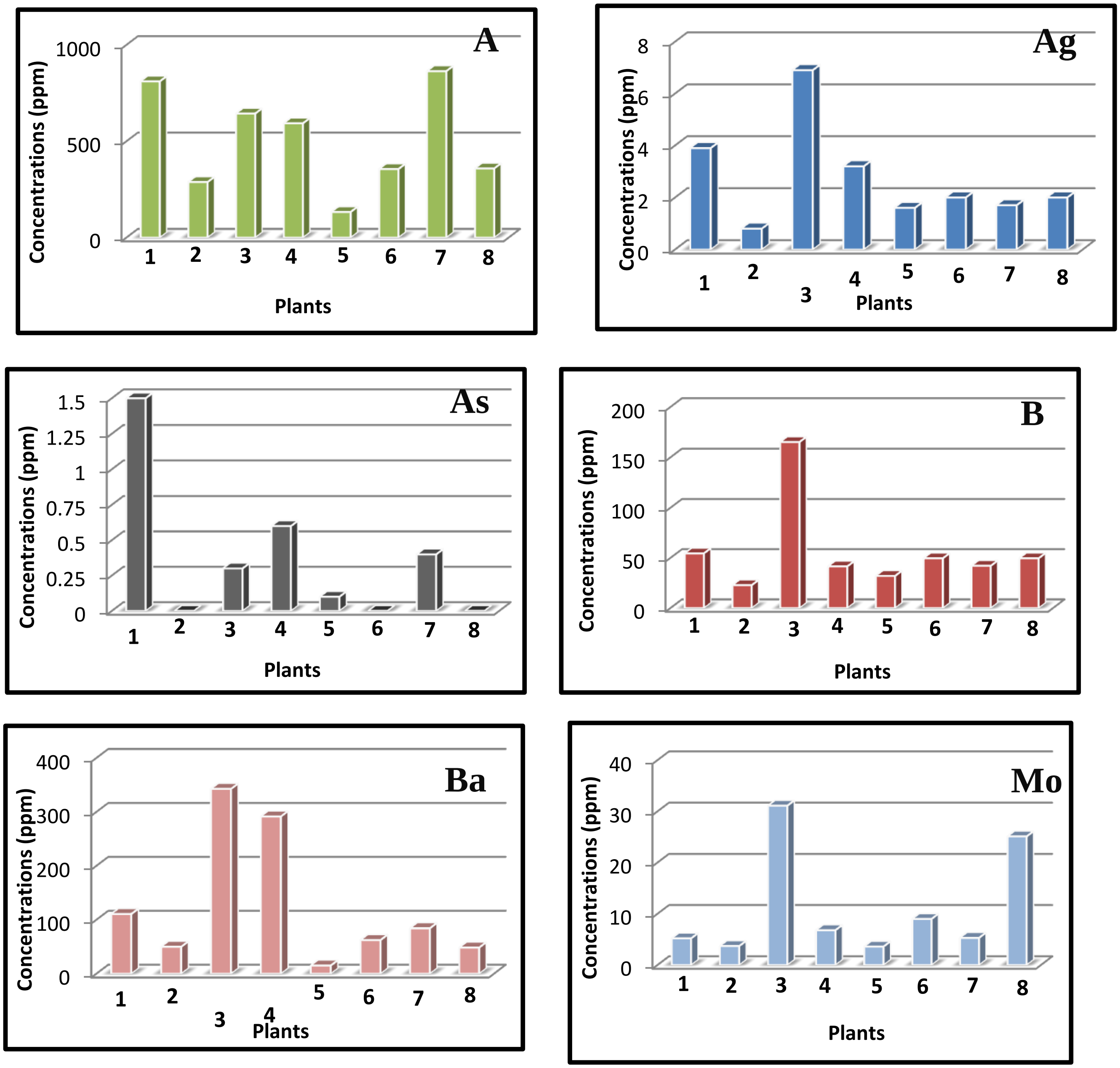

Figure 1: The ability to accumulate some heavy elements in the studied plants.

Figure 2 shows that the highest rate recorded for iron element is 1592 ppm followed by 1231 ppm in E. sativa and *B. tournifortii* respectively, and the lowest is 238 ppm in *D. acris*. Due to the potential toxicity associated with high iron levels, cells store iron using the specialized iron storage protein ferritin, which plays a key role in iron balance within plants and reduces stress on them (Proudhon *et al*., 1996). Figure 2 shows the changes in the rate of concentrations of Le and Se elements in the studied plants, as the highest concentration was recorded at 168 and 7.5 ppm, respectively, in *C. bursa-pastoris* plant and the lowest rate was 40 and 0.6 ppm in *C. arabica*, respectively. Selenium is an essential mineral, and it is important in the process of photosynthesis, but its increased concentration in the soil and plants turns into a toxic element that affects the growth and development of the plant. It has a vital role when present in small concentrations, as it is necessary for cellular functions in many organisms. The need for selenium varies between plant species, as some require high quantities, while its presence in the soil is not necessary for others (Ruyle, 2009; Al-Nabhan, 2022). The highest rate of Sn was recorded at 15.3 and 14.6 ppm in the plants *E. hispanica* and *C. bursa-pastoris*, respectively, and the lowest rate was 1.8 and 2.4 ppm in the plants *D. acris* and *E. sativa*, respectively. The results of the statistical analysis showed significant differences among the plants (F=1.187; df= 7; p= 0.00)

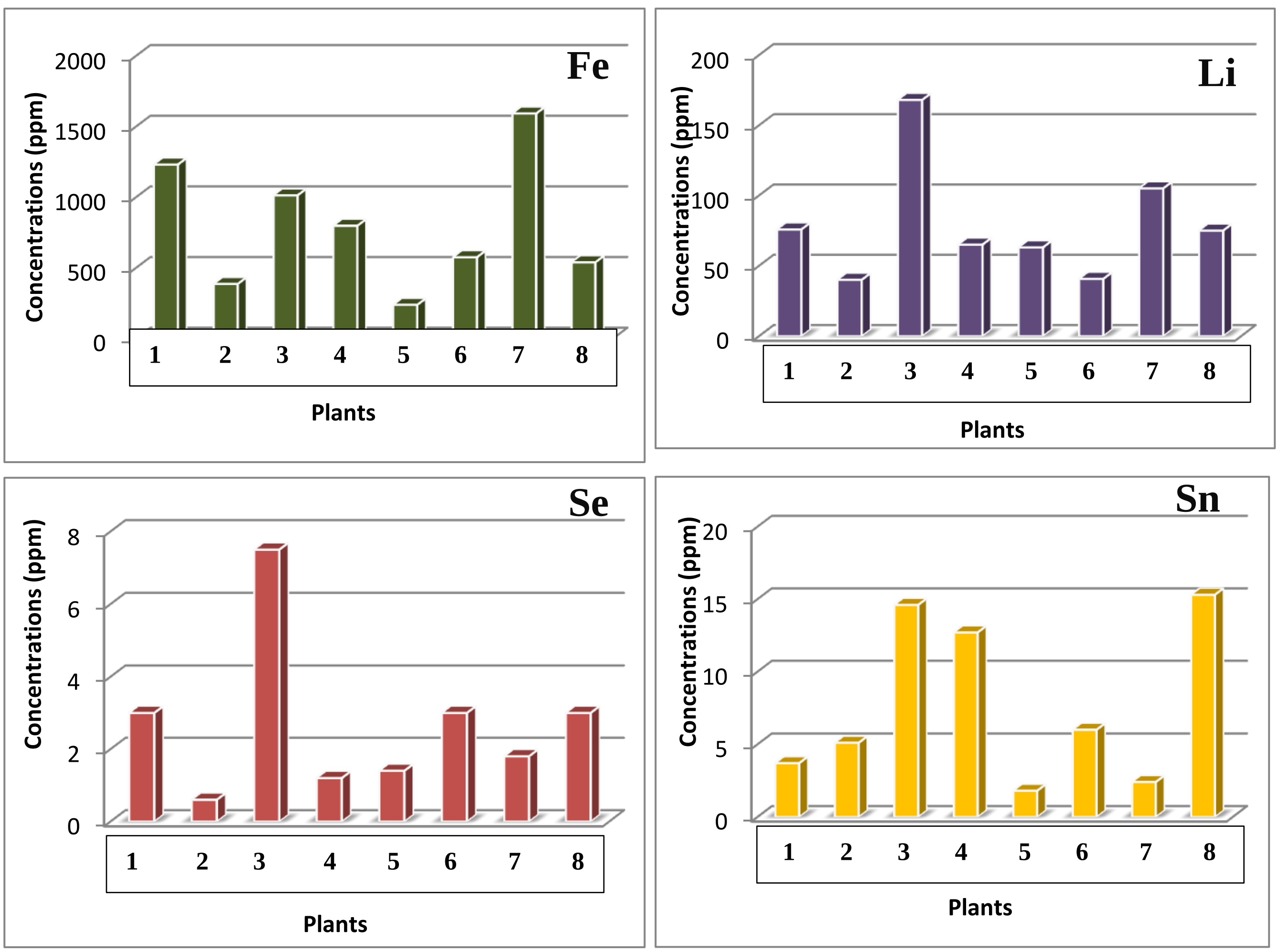

Figure 2: The ability to accumulate some heavy elements in the studied plants.

The average of the total heavy elements in the studied plants

The highest accumulation of elements in all the studied plants was Iron, which reached 796.5 ppm, followed by Aluminum, which reached 505.8125 ppm for all plants, and the least element present in the studied plants was Arsenic, which reached 0.3625, followed by Selenium, which reached 2.6875 ppm (Al-Hussein *et* al., 2024) Figure 3.

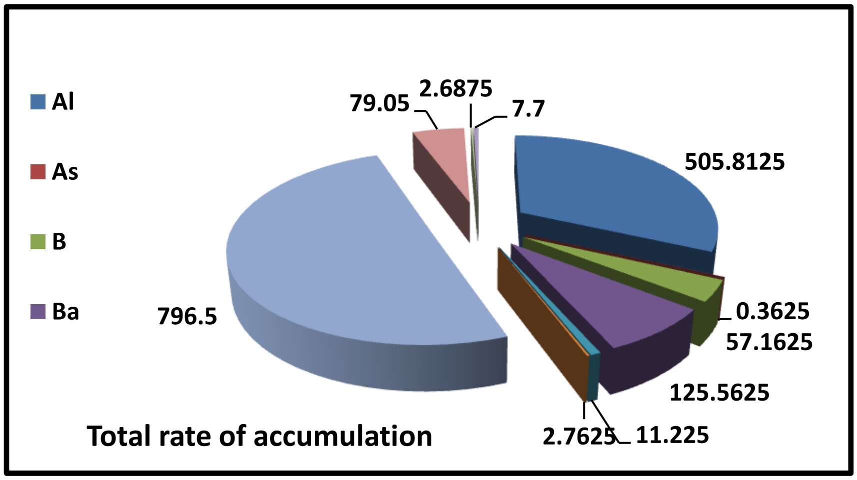

Figure 3: the total rate of accumulation of heavy elements in all studied plants.

Figure 4 shows the average total concentrations in, *E. sativa* was the plant that accumulated the most of all the studied elements, reaching 169.87 ppm, and the lowest was 48.96 ppm for *D. acris*.

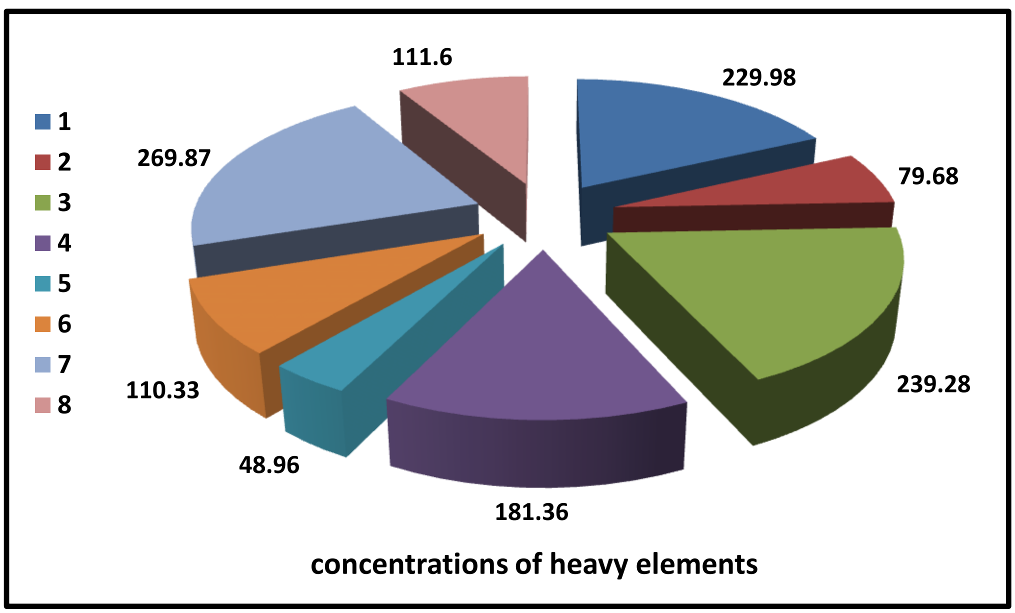

Figure 4: Average total concentrations of heavy elements for each plant

Conclusions

It has been observed that there is a discrepancy in the concentrations of the studied heavy elements, as it was concluded that the aluminum element is the most accumulated element and reached 863.8 ppm in the *E. sativa* plant, and the least accumulation of the element arsenic reached 0.1 ppm in *D. acris* and no accumulation was recorded in *D. harra*, C. *arabica*, *E. hispanica*. He also concluded that the most accumulated plant of the elements is the *E. sativa* plant, where it reached 863.8 ppm for aluminum and less plant-accumulating the elements is *C. arabica*.

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القدرة التراكمية لبعض النباتات الارضية المنتشرة في وادي الطيب – محافظة ميسان

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المستخلص

أصبح التلوث اليوم من أكبر المشاكل التي يعاني منها العالم أجمع، لذا تُلقي هذه الدراسة الضوء على التلوث بالعناصر الثقيلة وأهمية النباتات في الحد من هذه المخاطر وحجم تراكمها. جمعت ثماني نباتات برية هي: Brassica *tournifortii* Gouan.، *Cakile arabica* Vel. & Bornm.، *Capsella bursa – pastoris* (L.) Medic.، *Carrichtera annua* (L.) DC.، *Diplotaxis acris* (Forssk.) Boiss., *Diplotaxis harra* (Forssk.) Boiss., *Eruca sativa* Mill. and *Erucaria hispanica* (L.) Druce تنتمي الى العائلة الصليبية من منطقة واي الطيب شمال شرق محافظة العمارة حيث قُدِّرَت فيها عشرة عناصر: الألومنيوم(Al) ، والفضة(Ag) ، والزرنيخ(As) ، والبورون(B) ، والباريوم(Br) ، والموليبدينوم(Mo) ، والحديد(Fe) ، والليثيوم(Li) ، والسيلينيوم(Se) ، والقصدير .(Sn) ولوحظ تفاوت تراكيز هذه العناصر في النباتات المدروسة، حيث بلغ أعلى تراكم للألمنيوم 863.8جزء في المليون في نبات *E. sativa*، وأقلها 133جزء في المليون في نبات *D. acris*أما بالنسبة للزرنيخ فقد سُجِّل أعلى معدل له عند 1.5 جزء في المليون في نبات *B. tournifortii* وأقلها 0.1جزء في المليون في نبات *D. acris*ولم يُسجَّل اي تراكم له في نبات *C. arabica* ونبات *D. harra* ونبات *E. hispanica.* أما بالنسبة لعنصري البورون والفضة فقد بلغ أعلى تركيز 165.5 و 6.9جزء بالمليون على التوالي في نبات *C. bursa-pastoris*، بينما سجل أقل تركيز 22.8و0.8 جزء بالمليون على التوالي في نبات *C. arabica*، أما بالنسبة لعنصري البروم والموليبدينوم فقد بلغ أعلى تركيز 342.6و31.1 جزء بالمليون في نبات *C. bursa-pastoris*على التوالي ، يليهما 291.5 جزء بالمليون في نبات *C. arabica*، ولوحظ انخفاض معنوي ليصل إلى 15.1 و3.6 جزء بالمليون في نبات *D. acris* على التوالي. "أُجري التحليل الإحصائي باستخدام برنامج SPSS الإصدار 26، وباستخدام اختبار ANOVA أحادي العامل، عند مستوى معنوية 0.05.".