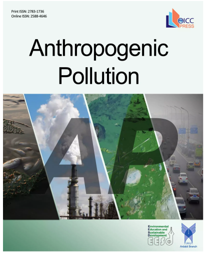

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Pb heavy metal monitoring using biological indicators, *Prosopis juliflora*, *Eucalyptus microtheca*, and *Ziziphus spina-christi* in Ahvaz city (Iran)

Azadeh Ghorbani Talkhoncheh, Maryam Mohammadi Rouzbahani*

Department of Environment, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.

*Corresponding author: mmohammadiroozbahani@yahoo.com

Original Research

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Abstract:

Lead is one of the toxic and dangerous elements of the environment and has no biological role in the body of living organisms. Three plant species *Prosopis juliflora*, *Eucalyptus microtheca*, and *Ziziphus spina-christi* were considered as investigated plants in Ahvaz city of Iran.The highest amount of lead in the unwashed leaf samples of Algaroba trees at the low traffic station was 72.56±0.01 mg/kg. The lowest amount of lead in leaf samples related to washed leaves of Lotus trees in low traffic station was 60.13±0.25 mg/kg. The pattern of lead accumulation in the washed and unwashed leaves of the studied trees in high traffic and low traffic areas was obtained as Algaroba>Eucalyptus>Lotusand in the vicinity of the gas station as Eucalyptus>Lotus>Algaroba. The highest and lowest concentrations of lead in the soil were obtained 40.4 mg/kg and 18.33 mg/kg, respectively. The results of this study on the accumulation of lead in all species and stations showed that the accumulation of lead was more than the WHO limit of 2 mg/kg. The BCF of the leaves of the *Prosopis juliflora*, *Eucalyptus microtheca*, and *Ziziphus spina-christi* in Ahvaz city was higher than 1, so it can be concluded that these trees have the ability to accumulate lead in their leaves, and they can be classified as hyperaccumulator plants.

Keywords: Pb; Bio-accumulation; BCF; *Prosopis juliflora*; *Eucalyptus microtheca*; *Ziziphus spina-christi*

1. Introduction

Heavy metals cause serious and dangerous environmental problems, limit the growth of animals and plants and threaten human health (Fouladi et al., 2021; Fataei et al., 2010). Heavy metals enter the food chain due to absorption and accumulation by plants and agricultural products (Nagajyoti et al., 2010). Heavy metals such as cadmium, lead, and mercury are pollutants that have no biological significance (Ezeofor et al., 2019; Bayrami et al., 2020)and are associated with diseases such as brain damage, cardiovascular, renal, blood, neurological, and bone diseases (Ogutucu et al., 2021).

Lead is the second most toxic metal that makes up 0.002% of the earth's crust and is naturally found in a very limited amount, but it is mostly produced due to human industrial activities and vehicle traffic, so humans and their environment affected by lead pollution (Tripathy et al., 2022). Lead is known as a carcinogenic compound for humans, because it absorbs a high percentage of lead from the environment (Ristic et al., 2013). Lead poisoning may occur in repeated exposure (Mishra et al., 2022; Mostofie et al., 2014). Lead can be transported and magnified through food chains and can pose a major threat to living organisms (Raj and Das, 2023). The permissible level of lead in the environment is in the range of 0.3-0.1 micrograms per cubic meter. The air in India was polluted with a concentration of 1 microgram per cubic meter of lead in winter, which is several times higher than the permissible limit. The rate of acceptance of various types of metal absorbers in soil and plants is supported by independent biological factors or in sequence with geochemical factors. Soil pH is the main factor controlling Pb availability to plants (Choudhari et al., 2010; Roomiani and Jalilzadeh Yengejeh, 2016).

Lead in soil is toxic (Fataei et al., 2010) and harmful to the environment, and the availability of lead in soil is mostly absorbed by plants, the flexibility and solubility of lead is limited by specific biogeochemical factors that include pH, microbial conditions, and the type of plant species included (Mohanty et al., 2017; Nas and Ali, 2018; Ogutucu et al., 2021). Lead is considered an unnecessary element for plants and accumulates in different parts of the plant and has a negative effect on various physiological processes including photosynthesis, respiration, mineral nutrition, membrane structure and properties, and gene expression (Islam et al., 2008). Accumulation of lead in the soil prevents the germination of seeds and delays the growth of seedlings, reduces the percentage of germination, germination index, root and stem length, tolerance index and dry mass of roots and shoots. Therefore, the control of heavy metal pollution, especially lead, is essential and very important (Nas and Ali, 2018; Javanmardi et al., 2018).

In several studies and researches, a number of plant species have been identified that can tolerate and accumulate high amounts of lead metal in their tissues and can be used in phytoremediation of soils contaminated with metals. These plant species have special mechanisms to deal with higher levels of metals in their growing environment (Sulaiman and Hamzah, 2018; Kumar et al., 2020; Usman et al., 2020; Hussain et al., 2021). In a study in the vicinity of a steel factory in Khuzestan province, it has been reported that the leaves of Lotus(Ziziphus spina-christi) and Algaroba (Prosopis cineraria) have the ability to accumulate cadmium, lead and iron and they can be used in polluted areas. Industrial and urban use as a hyperaccumulator species in phytoextraction (Abbaszadeh et al., 2019). The results of another research in Saudi Arabia showed that two species of Ziziphus spina-christi and Conocarpus erectus have a high ability to accumulate lead in their roots and leaves compared to other plants (Alsihany et al., 2019).In a study on the plant (Althea officinalis), the researchers showed that the maximum amount of lead absorption in the control sample treatment was 47.82 micrograms/kg in the leaves, and this plant has a high ability to accumulate lead in its leaves and roots. Therefore, marshmallow plant can be a good absorber for lead (Kolah Kaj and Mohammadi Rozbahani, 2017).The researchers reported that the accumulation of lead and nickel heavy metals in the leaves of Burhan tree (Albizia lebbeck) and Conocarpus erectus can extract nickel and cadmium from the soil, that Conocarpus has a greater ability to absorb nickel than Burhan and can to be used in plant treatment projects in similar areas (Torkashvand et al., 2018; Rafati et al., 2021). total pollution produced by heavy metals, so more attention should be focused on the evaluation and effectiveness of monitoring methods (Collin et al., 2022). This research was conducted with the aim of monitoring the amount of lead heavy metal using plant tracers (Eucalyptus, LotusandAlgaroba) in Ahvaz city. Also, another goal of this research was to know the situation of lead pollution in Ahvaz urban area in the autumn season and compare in areas with high and low traffic.

2. Materials and Methods

Ahvaz city, the center of Khuzestan province from Iran, and with an average height of 16 meters above sea level, is located between 31° 31′ to 31° 23′ North and 48° 32′ to 47° 48′ East, which includes eight urban divisions and the area of the project area Its total area is 295 km^2. The annual average temperature of Ahvaz city is 25 °C, the average maximum temperature is 32.8 °C, and the average minimum temperature is 17.2 °C. The annual rainfall is reported to be around 205 mm, which is located in the dry region due to the climate of Dumarten.

In order to take samples of tree plants in the stations, leaves were harvested between 1 and 2 meters in 3 different directions using garden shears in the fall of 1401. Sampling was done from each tree with 3 repetitions and they were placed in nylon bags to be transported to the laboratory. To determine the sampling stations, the comprehensive and basic map of Ahvaz city was examined first, and then the stations were determined by considering the prevalence of plants and traffic in different areas.In general, 6 stations including 2 stations as high traffic areas, 2 stations as low traffic areas, 2 stations as gas stations and one control area were selected as sampling areas (Table 1). After selecting the stations, the exact location of sampling was determined and recorded in terms of latitude and longitude of the area using GPS device. To prepare the plant samples, first half of the leaves collected in each station were washed 4 times with deionized distilled water, then the leaves were divided into smaller pieces using scissors and placed in paper envelopes. The species were selected in such a way that they are present in all the studied stations and are part of the dominant urban species. Also, regarding the side species, this tree is one of the native species of the region. And they were placed in the oven at a temperature of 80 °C for 48 hours to dry. After the samples were dried, the leaves were ground into powder with a Chinese mortar and passed through a 0.063 micron sieve, and then 0.5 g of the powdered plant was weighed using a scale. Digestion of plant samples was done using Jackson 1980 method.In this method, to digest the plant samples, 0.5 g of the powdered plant sample was transferred to a 100 cc Erlenmeyer flask, and then 5 cc of concentrated nitric acid was added to each of the samples and by placing a watch glass on the Erlenmeyer flasks for It was placed under the hood for 24 hours. Then, the Erlenmeyer flasks are placed on a heater with a temperature of 80 to 90 °C and the heating process starts gently so that dark brown steam is emitted from all the samples. After 10 minutes, 2 cc of 30% hydrogen peroxide was added to each of the flasks and the heating process became more intense until the oxidation of the plant material was completed. This process continued until the sample volume was reduced to 2-3 cc and the sample became completely colorless. After the sample became completely colorless and its volume decreased after the container cooled down, some distilled water was added to it and the volume was brought to 50 cc by passing through Whatman 40 paper. Then it was transferred into a polyethylene container with a lid and then the amount of lead in the samples was read by an atomic absorption device.

Table 1. : Longitude and latitude location of sampling stations

Station No.	Name	Type	N	E
1	Zand Street	full of traffic	31° 19’ 86”	48° 41’77”
2	Kianpars Square	full of traffic	31° 20’484”	48° 41’ 31”
3	Eastern Worker Blvd.	Low traffic	31° 18’ 251”	48° 38’ 71”
4	Quds Blvd.	Low traffic	31° 19’954”	48° 40’242”
5	Saat Square	Gas station	31° 19’353”	48° 41’74”
6	Kianpars	Gas station	31° 21’265”	48° 41’ 311”

The BCF (Bioaccumulation Coefficient Factor) of lead metal in tree leaves was calculated using equation 1. CL is the concentration of lead in plant leaves and CS is the amount of lead in the soil (Vidali, 2001).

$$\mathrm{BCF} = \mathrm{CL} \div \mathrm{CS} \tag{1}$$

SPSS version 20 and Excel software were used for data analysis and drawing graphs. Before performing the statistical analysis, in order to choose the appropriate type of statistical tests and logical deduction of the data, the distribution of the data was examined using the Shapiro-Wilk test. After it was determined that the data is normal, using ANOVA analysis, it was found that there is a significant difference in some parameters, and then using post hoc tests (LSD), the data were compared two by two.

3. Results

In stations 1 and 2, which are high-traffic areas of Ahvaz, there was no significant difference in the concentration of lead metal between the washed and unwashed leaves of Eucalyptus tree (*Eucalyptus microtheca*) and Algaroba tree (*Prosopis juliflora*) (P>0.05, P Value= 0.43). In stations 3 and 4, which are low traffic areas of Ahvaz city, there was no significant difference in lead metal concentration between washed and unwashed Eucalyptus, Algaroba and Lotusleaves (P>0.05, P Value= 0.33). In stations 5 and 6 of Ahvaz city, there was no significant difference in lead metal concentration between washed and unwashed Eucalyptus, Algaroba and Lotus leaves (P>0.05, P Value= 0.43). In station 1, there was a significant difference (P<0.05, P Value= 0.03) in the concentration of lead metal between the washed and unwashed leaves of the Lotustree (*Ziziphus spina-christi*), but in station 2, the lead values between the washed and unwashed leaves of the tree No significant difference was observed in Lotus (P>0.05, P Value= 0.44) (Table 2).

There was no significant difference in the lead metal concentration of washed Eucalyptus leaves in high-traffic and low-traffic areas (P>0.05, P Value= 0.43), but there was a significant difference in the lead metal concentration of washed Eucalyptus leaves in low-traffic areas and near gas stations (P<0.05, P Value= 0.00). Also, there was no significant difference in lead metal concentration of unwashed Eucalyptus leaves in high traffic, low traffic and gas station areas (P>0.05, P Value= 0.43). The highest amount of lead in Eucalyptus leaves was observed in washed leaves and gas station stations, and the lowest amount of lead in washed

Table 2. Comparison of the average concentration of Lead (mg/kg) in plans Species of Ahvaz city

Plant type	Station No.	Name	Type	Washed Sample	Unwashed Sample
	1	Zand Street	Full traffic	61.08±0.02a	63.28±0.01a
Eucalyptus microtheca	2	Kianpars Square	Full traffic	61.03±0.45a	63.26±0.75a
	3	Eastern Worker Blvd.	Low traffic	60.68±0.02a	62.36±0.02a
	4	Quds Blvd	Low traffic	60.66±0.28a	62.33±0.35a
	5	Saat Square	Gas station	60.26±0.32a	62.46±0.35a
	6	Kianpars	Gas station	60.21±0.03a	62.44±0.04a
	1	Zand Street	Full traffic	71.6±0.17a	72.43±0.35a
Prosopis juliflora	2	Kianpars Square	Full traffic	62.23±0.02a	65.83±0.66a
	3	Eastern Worker Blvd	Low traffic	71.16±0.04a	72.56±0.01a
	4	Quds Blvd	Low traffic	71.6±0.35a	72.43±0.4a
	5	Saat Square	Gas station	60.16±0.01a	62.65±0.01a
	6	Kianpars	Gas station	60.50± 0.4a	62.53±0.20a
	1	Zand Street	Full traffic	60.73±0.2b	72.23±0.15a
Ziziphus spina-christi	2	Kianpars Square	Full traffic	60.73±0.3a	63.46±0.3a
	3	Eastern Worker Blvd.	Low traffic	60.13± 0.25a	62.33±0.4a
	4	Quds Blvd.	Low traffic	60.14± 0.04a	62.34± 0.4a
	5	Saat Square	Gas station	62.66±0.47a	71.3±0.25a
	6	Kianpars	Gas station	62.68±0.02a	71.5±0.2a

Similar letters in each row indicate no significant difference between the means (P<0.05).

leaves was observed in low traffic stations (Table 3). There was no significant difference in the lead metal concentration of washed Lotusleaves in high-traffic, low-traffic areas, and gas stations (P<0.05, P Value= 0.00), but there was a significant difference in the lead metal concentration of unwashed Lotusleaves in high-traffic, low-traffic areas, and gas stations (P>0.05, P Value= 0.33). The highest amount of lead in Lotusleaves was observed in unwashed leaves and in gas stations, and the lowest amount of lead in washed leaves was observed in low traffic stations. The lead metal concentration of washed Algaroba leaves in low and high traffic areas and gas stations and the lead metal concentration of unwashed mesotheli leaves in low and high traffic areas and gas stations had a significant difference (P<0.05, P Value= 0.00) (Table 3).
Comparison of the average concentration of lead metal in the washed leaves of the studied trees in high traffic areas of Ahvaz city shows that the highest concentration of heavy lead metal is related to Algaroba tree and the lowest is related to Lotustree. The statistical analysis and comparison between the lead values in the leaves of the studied trees showed that there is a significant difference between the lead levels in the leaves of Algaroba, Lotus and Eucalyptus (P<0.05, P Value= 0.00), but there is no significant difference between the average lead levels in the leaves of Lotus and Eucalyptus (P>0.05, P Value= 0.43). The pattern of the average amount of lead in the leaves of washed trees in high traffic areas is as follows: Algaroba>Eucalyptus> cedar. The highest concentration of the heavy metal lead in the leaves of the studied trees in the low traffic areas of Ahvaz city was related to the Algaroba tree and the lowest was related to the Lotustree. The statistical analysis and comparison between the lead values in the leaves of the studied trees showed that there was a significant difference between the lead levels in the leaves of Algaroba, Lotusand Eucalyptus (P<0.05, P Value= 0.01), but there was no significance (P>0.05, P Value= 0.44). difference between the average lead levels in Lotusand Eucalyptus leaves. The average pattern of lead content in the leaves of washed trees in low traffic areas is as follows: Algaroba>Eucalyptus>Lotus.In the gas station areas of Ahvaz city, the highest concentration of lead heavy metal was found in the Eucalyptus tree and the lowest in the Algaroba tree. The statistical analysis and comparison between the lead values in the leaves of the studied trees showed that there was a significant difference between the lead levels in the leaves of Algaroba and Eucalyptus (P<0.05, P Value= 0.01). The pattern of the average amount of lead in the leaves of the washed trees in the vicinity of the gas station is as follows: Eucalyptus>Lotus>Algaroba (Figure 1).
Comparing the average concentration of lead metal in the unwashed leaves of the studied trees in high traffic areas of Ahvaz city shows that the highest concentration of heavy lead metal was related to Algaroba tree and the lowest was related to Eucalyptus tree. The statistical analysis and comparison between the lead values in the leaves of the studied trees showed that there was a significant difference between the lead levels in the leaves of Algaroba, Lotusand Eucalyptus (P<0.05, P Value= 0.01), but between the average lead levels in the leaves of Lotusand Eucalyptus. Also, there is no significant difference between Lotusand Algaroba (P>0.05, P Value= 0.42). The pattern of average amount of lead in the leaves of unwashed trees in high traffic areas is as follows: Algaroba>Lotus>Eucalyptus. In the low traffic areas of Ahvaz city, comparing the average concentration of lead metal in the unwashed leaves of the studied trees showed that the highest concentration of heavy lead metal was obtained from the Algaroba tree and the lowest from the Lotustree. There was a significant difference in the amount of lead between the leaves of Algaroba, Lotus and Eucalyptus (P<0.05, P Value= 0.00), but there was no significant difference between the average amount of lead in the leaves of Lotus and Eucalyptus (P>0.05, P Value= 0.42). The average pattern of lead content in the leaves of unwashed trees in low traffic areas is as follows: Algaroba>Eucalyptus> cedar. The highest concentration of the heavy metal lead in the vicinity of the Ahvaz gas station is related to the Lotustree and the lowest is related to the Eucalyptus tree. The comparison between the amounts of lead in the leaves of the studied trees showed that there was a significant difference between the amount of lead in the leaves of Lotusand Eucalyptus and Algaroba (P<0.05, P Value= 0.01), but there was not a significant difference between the average amount of lead in the leaves of Algaroba and Eucalyptus (P>0.05, P Value= 0.43). The pattern of the average amount of lead in the leaves of washed trees in the vicinity of the gas station

Table 3. Statistical comparison of Pb (mg/kg) in leaves plants of low traffic, full traffic and gas station from Ahvaz city.

plants Species	Leaves Location	Washed Sample	Unwashed Sample
EucalyptusMicrotheca	Full traffic	61.05±0.42a	63.27±0.38a
	Low traffic	60.67±0.15a	62.35±0.19a
	Gas station	65.26±0.18b	62.45±0.20b
Prosopis juliflora	Full traffic	66.91±0.09a	69.13±0.50a
	Low traffic	71.38±0.19b	72.49±0.20b
	Gas station	60.33±0.20c	62.76±0.10c
Ziziphus spina-christi	Full traffic	60.73±0.25a	67.84±0.22b
	Low traffic	60.14±0.14a	62.33±0.22a
	Gas station	62.67±0.24a	71.40±0.22c

Similar letters in each column indicate no significant difference between the means (P<0.05).

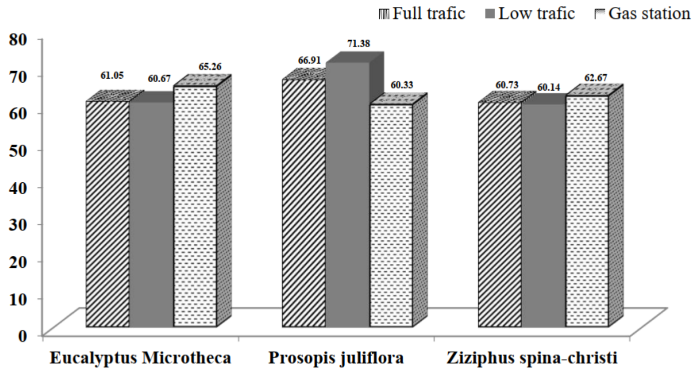

Figure 1. Comparison of Lead concentration in washed leaves of trees in full traffic, low-traffic and near gas stations areas in Ahvaz city.

is as follows: Lotus>Algaroba>Eucalyptus (Figure 2). The highest and lowest concentrations of lead in the soil were obtained *Ziziphus spina-christi* 40.4 mg/kg and *Prosopis juliflora* 18.33 mg/kg, respectively.The concentration of lead in the soil under the *Prosopis juliflora, Eucalyptus microtheca and Ziziphus spina-christi* of station 5 was higher than other studied stations. In station 4, the concentration of lead in the soil at the base of the *Prosopis juliflora, Eucalyptus microtheca and Ziziphus spina-christi* was the lowest. (Table 4). The BCF values in the unwashed leaves of the trees (*Prosopis juliflora, Eucalyptus microtheca and Ziziphus spina-christi*) were higher than the washed leaves. In the washed leaves of the trees, the highest and lowest BCF values were 33.3 and 1.55 respectively in *Prosopis juliflora and Ziziphus spina-christi.* For unwashed leaves of trees, also the highest value of BCF in Prosopis juliflora 3.40 and the lowest BCF of *Eucalyptus microtheca*, 1.66 respectively (Table 5).

4. Discussion

One of the conventional methods of reducing and removing toxic metals is the phytoremediation method (Rigoletto et al., 2020), which uses tree plants to remove or reduce pollutants in the environment (Sun et al., 2017). Plants with bioremediation capacity have been studied for lead-contaminated soils and water bodies, which can absorb large amounts of the heavy metal as an environmental remediation strategy (Sulaiman and Hamzah, 2018; Kumar et al., 2020; Usman et al., 2020; Hussain et al., 2021). The advantages of using the bioremediation method to remove toxic pollutants from the environment is that it is a completely natural process (Sun et al., 2017), this method can eliminate pollutants in the environment itself instead of transferring the contaminated environment to other sections or to extract. Most importantly, compared to other techniques, it is a cheaper technology for this specific purpose, also the need to transport pollutants can be completely eliminated by choosing this technique, and thus the risk of threats to health and the environment. reduced (Vidali, 2001).

The results of this research, which was conducted in the studied areas in 6 stations of Ahvaz city, showed that the highest average lead content of unwashed leaves of Algaroba trees in low traffic station is 72.56±0.01 mg/kg, also with difference was very small in the high-traffic station,

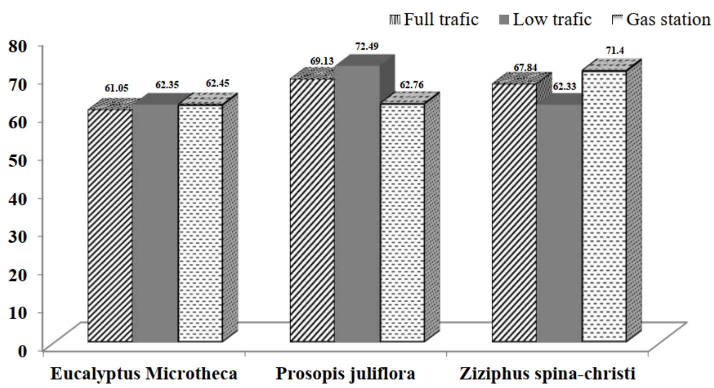

Figure 2. Comparison of Lead concentration in unwashed leaves of trees in full traffic, low-traffic and near gas stations areas in Ahvaz city.

Table 4. Comparison of the average concentration of Lead (mg/kg) in Soil of Ahvaz city.

Station No.	Name	*Eucalyptus microtheca*	*Prosopis juliflora*	*Ziziphus spina-christi*
1	Zand Street	33±0.81	32.3±0.94	34.8±0.62
2	Kianpars Square	28.66±1.24	33.6±0.47	30.8±0.62
3	Eastern Worker Blvd.	23.33±1.24	21.33±1.7	26.3±0.94
4	Quds Blvd.	19±1.41	18.33±0.47	19±0.81
5	Saat Square	37.5±1.08	38.5±0.40	40.4±0.41
6	Kianpars	28.66±1.24	32.5±0.40	30.6±1.24

unwashed Algaroba leaves had the value of 72.43±0.35 mg/kg, and unwashed Lotusleaves had 72.23±0.15 mg/kg. Also, the lowest amount of lead in leaf samples related to washed leaves of Lotustrees in low traffic station was 60.13±0.25 mg/kg. The highest concentration of lead in washed Eucalyptus leaves is 70.26±0.03 mg/kg in the vicinity of Kianpars gas station and in unwashed Eucalyptus leaves in Zand street area with 63.28±0.01 mg/kg had the highest concentration. In Algaroba tree leaves, washed leaves - Eastern Kargar Boulevard as a low traffic area with 71.16±0.04 mg/kg and in unwashed leaves - Algaroba trees in this area with 72.56±0.01 mg/kg had the highest concentration of lead metal. In the washed Lotusleaves the highest concentration of lead was 62.68±0.02 mg/kg in the Kianpars gas station area, and in the unwashed Lotusleaf, the highest concentration was 72.23±0.15 in the Zand Street area. Lead accumulation is one of the primary health concerns worldwide, affecting millions of people and ecosystems (Bakirdere and Yaman, 2008). Lead is a natural heavy metal that may accumulate in plant soil through waste materials and exhaust gases (Marcotte et al., 2017). The results of this study on the accumulation of lead in all species and stations showed that the accumulation of lead was more than the WHO limit of 2 mg/kg (Ogutucu et al., 2021), Because there are many polluting sources in Ahvaz city. Traffic, car traffic, numerous factories and industries, industrial workshops, oil and gas and steel industries are among the sources of pollution in Ahvaz city. The tolerance level threshold of lead in plants is reported to be 43 mg/kg (Celik et al., 2005) that lead had the ability to bioaccumulate in the leaves of Algaroba, Lotusand Eucalyptus, in other words, high amounts of lead in all the studied samples. was observed. Abbaszadeh et al. (2019) reported that Lotus and Algaroba species have the ability to accumulate heavy metals and can be harvested and extracted from these plant species, especially in polluted industrial and urban areas. Therefore, the plants used, the results confirm the results of this research.

Other research regarding the investigation of heavy metals such as lead, iron, nickel and cadmium in Lotus(Ziziphus spina-christi) and Algaroba (Prosopis cineraria) species (Abbaszadeh et al., 2019), khamti plant (Althea officinalis) (Kolah Kaj and Mohammadi Rozbahani, 2017), Burhan (Albizia lebbeck) and Conocarpus erectus (Torkashvand et al., 2018; Rafati et al., 2021), Ziziphus spina-christi and Conocarpus erectus (Alsihany et al., 2019) The results of this research confirmed the accumulation of lead metal in the leaves of Eucalyptus (Eucalyptusmicrotheca), Lotus(Ziziphus spina-christi) and Algaroba (Prosopis juliflora). Eucalyptus is a tree native to Australia that is

Table 5. The results of BCF in the trees of Ahvaz city.

Plant type	Station No.	Name	Washed Sample	Unwashed Sample
Eucalyptus microtheca	1	Zand Street	1.85	1.91
	2	Kianpars Square	2.12	2.20
	3	Eastern Worker Blvd.	2.60	2.67
	4	Quds Blvd.	3.19	3.28
	5	Saat Square	1.60	1.66
	6	Kianpars	2.10	2.17
Prosopis juliflora	1	Zand Street	2.21	2.24
	2	Kianpars Square	1.85	1.95
	3	Eastern Worker Blvd.	3.33	3.40
	4	Quds Blvd.	3.90	3.95
	5	Saat Square	1.56	1.62
	6	Kianpars	1.86	1.92
Ziziphus spina-christi	1	Zand Street	1.74	2.07
	2	Kianpars Square	1.97	2.06
	3	Eastern Worker Blvd.	2.28	2.36
	4	Quds Blvd.	3.16	3.28
	5	Saat Square	1.55	1.76
	6	Kianpars	2.04	2.33

widely planted around the world. It belongs to a genus of the Myrtaceae family with about 800 species, all of which are limited to Australia. They are evergreen trees, fast growing, rooted, resistant to poor soil conditions, drought and moderate salinity (Turnbull and Booth, 2002). Eucalyptus species have been proposed for phyto-stabilization of contaminated soils, because of the moderate to low accumulation of heavy metals in belowground biomass, thereby reducing the risk of contaminant transfer to the food web (Arriagada et al., 2007; King et al., 2008). However, some Eucalyptus trees can accumulate a certain amountof heavy metals in their leaves under experimental conditions. The suitability of the selected species should be evaluated for specific conditions and types of pollutants (Fine et al., 2013; Mok et al., 2013). Based on the different ability of tree species to accumulate lead, two plant groups are distinguished (Wierzbicka, 1987; Morel et al., 1986). The plants of the first group remove lead and keep it in their roots, and the other group of plants are hyper-accumulators that absorb and accumulate large amounts of lead in the leaves without damaging the metabolism (Miles et al., 1972; Tu and Brouillette, 1986). Algaroba is a tree native to dry and tropical regions of South and Central America, which was introduced to many desert environments, including the Persian Gulf countries, mainly to reduce the effect of desertification and is considered one of the biological indicators of environmental pollution. Algaroba has a good capacity to accumulate heavy metals, including lead, and hence it is suitable for plant stabilization of lead in metal-forming soil (Usman et al., 2019). The Lotustree is from the Rhamnaceae tree family, which can absorb and accumulate trace elements in its leaves, roots, and stems (Saied et al., 2008). The Lotustree has been used as a pollution indicator in studies and the reported results state that the Lotustree is considered a metal-tolerant species (Rafati et al., 2020; Al-Naimi et al., 2023).
In this research, the amount of BCF in the leaves of the *Prosopis juliflora*, *Eucalyptus microtheca*, and *Ziziphus spina-christi* were higher than 1, so all three species of trees are considered as plants for extracting plants. Researchers reported that bioaccumulation of lead in Eucalyptus tree is better than Burhan and small-leaved fig trees, and Eucalyptus tree absorbs and accumulates these metals with a suitable capacity in its leaves (Torkashvand et al., 2018), which confirms the results of this research. . Also, in a research, it was shown that lead and cadmium metals are absorbed from the environment by two species of eucalyptus, Eucalyptus tereticornis and Eucalyptus grandis, and these trees have a suitable phytoremediation ability, which is consistent with the results of this research. Different species of trees and plants are divided into two groups based on the absorption and accumulation of lead metal (Morel et al., 1986; Wierzbicka, 1987), accumulate in their leaves, which plants are too accumulating (Miles et al., 1972; Tu and Brouillette, 1986).

5. Conclusions

The comparison of the studied species showed that there was a significant difference between the amount of lead in the plant samples of the two species at some stations ($P<0.05$, P Value= 0.01), but there was no significant difference in some species. Also, there was no definite significant difference between the amount of lead metal accumulation of any plant in the areas with different traffic ($P>0.05$, P Value= 0.44), which indicates that there is no relationship between different intensities of lead accumulation in plant species with high traffic. In general, it is concluded that in the case of some species, even the highest value is observed in low traffic areas.This shows that the direction of the wind and the transfer of pollutants are probably influential in different urban areas. On the other hand, there was no significant difference between washed and unwashed leaves of Algaroba and Eucalyptus ($P>0.05$, P Value= 0.51), but there was a significant difference between washed and unwashed Lotusleaves ($P<0.05$, P Value= 0.00).This is justified considering the shape of Lotusleaves and the presence of hairs on the underside of Lotusleaves. Regarding the ability to use species as biological indicators of lead metal, considering that the amount of lead in all species is higher than the standard limit, these species can be used as monitors, but in order to express a definitive opinion in this field, it is necessary to calculate Bioaccumulation coefficient is essential. The BCF of the leaves of the *Prosopis juliflora*, *Eucalyptus microtheca*, and *Ziziphus spina-christi* in Ahvaz city was higher than 1, so it can be concluded that these trees have the ability to accumulate lead in their leaves, and they can be classified as strong accumulator. In order to find out how much lead accumulation in the leaves of the trees was due to atmospheric precipitation, only a significant difference was observed in this research, which is due to the hairs on the leaves of this tree.
One of the limitations of the research is the absence of some species equally in all the studied areas. Also, the simultaneous effect of lead absorption through soil and through atmospheric dry precipitation are things that may not be easily separated. Due to the time limitation and lack of financial resources to measure other heavy metals and petroleum hydrocarbons in other plant species, it is suggested that other researchers conduct research in this field in future studies.

Ethics Statement
This research was approved at the Islamic Azad University, Ahvaz Branch, Ahvaz, Iran with thesis code 10652924131980721001516262357.

Authors Contributions
Maryam Mohammadi Rouzbahani: prposed the plan, authored or revised drafts of the paper, approved the final draft; Azadeh Ghorbani Talkhoncheh: Conceived the experiments, analyzed the data.

Availability of Data and Materials
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interests
The authors declare that they have no conflict of interest.

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