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Determination of As, Cu, Sr, and Zn in some plant leaves grown in different places of Kalar city by ICP-OES

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Abstract

The research work was conducted to determine the concentration of Arsenic, Cupper, Strontum, and Zinc in some plant leaves (Dodoneae, Eucalyptus, Albizia Lebbeck) grown in different location in Kalar- Sulaymaneyah, Iraq to investigat contamination caused by traffic related pollutant. The samples were collected in (City Center, Industrial Area, Salih Agha village, and Garmian university campus). Concnetration of the selected elemnts were measured by inducively coupled plasma optical emission spectroscopy (ICP-OES) after wet digestion with acid mixture of (HNO_3:H_2O_2). The mean concentration ranges of heavy metals in different plant leaves samples were: As = ND – 0.9; Cu =0.4 – 1.9; Sr =15 – 797.7 Zn = ND - 20 mg/Kg. The highest concentrations of different heavy metals were found in the samples collected from heavy traffic. The study revealed that the concnetration ranges of Sr and Zn in samples collected in higher traffic intensities were several times higher than those collected from lower traffic intensities compared to Cu and As which the increase in thier concnetration is slight.

1. Introduction

Nowadays it is well known that cities suffer from considerable air pollution due to the release of different pollutants into the atmosphere whose levels can be toxic. Urbanization and various developmental projects embarked upon by developing countries have necessitated the issue of monitoring of pollutants in the environment. Soil and plant surface are major sink of these pollutants with the latter forming the basis of food chain by which biotoxic trace metals are transmitted to man [1].

Heavy metals are considered as one of the main pollutants responsible for environmental contamination [2] due to their high toxicity and persistency in the environment. Vehicular emissions, industrial discharge and other manmade activities are considered to be the main sources of heavy metals in the urban environment [3, 4]. Vehicular traffic is widely recognized to be a significant and increasing source of atmospheric and soil pollution in urban environments [5]. The number of automobiles has been dramatically increased with the rapid development of human civilization and industrialization that is responsible for air pollution with heavy metals and other pollutants. The pollution caused by traffic activities is a great threat to urban environment [6]. Heavy metals can be found generally at trace levels in soil and vegetation, and living organisms. However, these have a toxic effect on organisms at high concentrations. Heavy metal toxicity has an inhibitory effect on plant growth, enzymatic activity, stoma function, photosynthesis activity and accumulation of other nutrient elements, and also damages the root system[7] Entrance of metals via the foliage parts of plants has been noted to be one of the major pathways by which metals enter tree leaves, particularly in heavily polluted and industrial areas[8]. Plant species behave differently regarding trace metal uptake [9]. However, the availability of metal uptake depends on the total heavy metal content of the soil and the proportion of their mobile and bioavailable forms which are generally controlled by the texture and other physiochemical properties of soils [10].

The purpose of this study is to determine the concentrations of Arsenic, Copper, Strontium, and Zinc in some plant leaves grown in different places with different traffic intensities in Kalar – Sulamaneyah province / Iraq. To identify the effect of traffic intensity of the place on the accumulations of these trace metals.

2. Materials and Methods

2.1 Chemical Reagents

All of the reagents have been used in present study were of the analytical grades. Aqueous solutions prepared by using deionized water. Concentrated HNO_3 and $H2O_2$ (Merck, Darmstadt- Germany) solutions were used for the digesting the samples. Calibratin standard solutions prepared by diluting multi-element (1000µg/mL) ICP standard (Bernd Kraft der standard). Deionized water was obtained from (Thermos – Germany) water purification system. All glassware and plastic bottles that used in this work were washed by 10% (m/v) HNO_3 and rinsed three times with deionized water.

2.2 Sample Collection

The plant leaves (conocarpus erectus , Albizia Lebbeck, and Eucalyptus) samples were collected from four different points (City Center, Industrial Area, Salih Agha village, and Garmian university campus) in Kalar city. All samples were washed with tap and double distillated water to remove dust and any other impurities and then dried at 100°C to constant weight.

2.3 Sample Preparation

Digestion of samples was performed by using HNO_3–H_2O_2 (3:1). Ten milliliters of this acid mixture was used for a 0.5 g dried leaves sample. Then the mixture was heated up to130◦C for 4 h on a hot plate. Then, 5 milliliters of acid mixture were added again to avoid draining. After cooling, 10 mL of distilled water was added to the aliquot and mixed. Then the resulting mixture were filtered through blue band filter paper to remove any undissolved particles. Then the sample was diluted to 50 mL with deionized water. The blank solution was also prepared by the same way.

2.4 Operating Conditions for ICP – OES Instrument

An ICP – OES instrument (Spectro-Arcos – Germany) used for the analysis of elements under study. The conditions of the operation of ICP – OES instrument were as follows: 1400 watts of a RF power, 13 L/min coolant flow rate, 1 L/min auxiliary flow, 0.83 L/min nebulizer flow and 1.2 mL/min of sample uptake rate. Measurements of all of the elements were done in triplicate. Table 1 shows the characteristics data of the calibration curves of elements using ICP-OES.

Table 1. Characteristics data of the calibration curves of elements using ICP-OES

Elements	Equation	R2	Wave length(nm)	Linear range (mg. Kg -1)	DL(mg. Kg -1)
As	y = 9.0001x + 0.0804	0.99994	189.042	0.00264 - 2.4	0.00264
Cu	y = 169.69x + 2.0525	0.99995	324.754	0.00126 - 2.4	0.00126
Sr	y = 6.6695x + 0.0972	0.99978	407.771	9.63e-005 - 2.4	9.63e-005
Zn	y = 0.2307x + 0.0011	1.00000	213.856	0.000633 – 24	0.000633

3. Results and Discussion

İn this study concnetration of four elements (Arsenic, Cupper, Strontium, and Zinc) were determined in (Dodoneae, Eucalyptus, Albizia Lebbeck) grown in different location with different traffic intensities in Kalar-Sulaymaneyah-Iraq by ICP-OES. According to the obtained results the concentration trend of heavy metal in all three plant leaves were found to be as follows: Sr >Zn>Cu>As by the concentration range of 8.8-97.9, 9-20, 0.6-1.5, and ND-0.5 mg/ Kg for Sr, Zn, Cu, and As respectively for Dodoneae leaves, the concnetration range of measured heavy metals in Albizia Lebbeck leaves were 24.2-195.8, ND-4.2, 0.4-1.2 and ND-1 mg/ Kg for Sr, Zn, Cu, and As respectively, and Eucalyptus leaves contains 16.5-220.3, 2.4-20,

0.6-1.9, and ND-0.9 mg/ Kg for Sr, Zn, Cu, and As respectively, The analysis results of the plant leaves for the measured heavy metals are given in table 2 as mg/ Kg.

Comparing heavy metal content of different plant leaves in this study reveals that the Strontium content of Albizia Lebbeck leaves collected from were different location were higher than it's content in different Dodonaea leaves, and Eucalyptus leaves. Concnetration of Zinc and Cupper were higher in Dodoneae leaves while Eucalyptos leaves contains higher Arsenic than two other plants.

Table 2. Concentration (mean ± standard deviation) of elements in different plant leaves

Sample	Sampling Point	Concentration (mg/ Kg)			
		As	**Cu**	**Sr**	**Zn**
Dodonaea leaves	City Center	0.5 ±0.004	1.3 ±0.001	15 ±0.002	9 ±0.005
	Industrial Area	0.3 ±0.007	1.5 ±0.001	55.6 ±0.001	20 ±0.007
	Salih Agha	ND	0.6 ±0.001	8.8 ±0.001	5.3 ±0.002
	Garmian uni. campus	0.5 ±0.003	1.1 ±0.001	97.9 ±0.01	12.3 ±0.001
Albizia Lebbeck leaves	City Center	ND	0.5 ± 0.001	195.8 ±0.015	3.4 ±0.001
	Industrial Area	0.2 ±0.004	1.2 ±0.001	797.7 ±0.068	4.2 ±0.001
	Salih Agha	ND	0.4 ±0.001	24.2 ±0.004	ND
	Garmian uni. campus	1 ±0.011	1 ±0.002	177.1 ±0.013	2.7 ±0.001
Eucalyptus leaves	City Center	0.8 ±0.005	0.6 ±0.001	19.3 ±0.003	7.3 ±0.003
	Industrial Area	0.2 ±0.007	0.8 ±0.001	24.8 ±0.01	5.1 ±0.358
	Salih Agha	ND	0.6 ±0.002	16.5 ±0.003	2.4 ±0.002
	Garmian uni. campus	0.9 ±0.003	1.9 ±0.001	220.3 ±0.026	20 ±0.004

Concentrations of most of the measured elements found in the plant species collected from areas with higher traffic density were significantly higher than those collected from location of lower traffic intensities and a variation was also found among the plant species. İn this study concnetration of heavy metals wre higher in industrial area, city center main road, Garmian university campus also contains high amount of measured heavy metals due to the fact that the it is located near Kalar-Sulaymaneyah main road.

Ajasa et al.[11] noted in a study in Nigeria, using medicinal plants to check the level of trace metals in the environment, that the differences in macronutrients and other metals in plants from different sites are related to the condition such as vehicular emission and industrial inputs from where the samples were collected. Sites that were very close to the road or possibly in the urban centers witnessed an unusual increase in the concentration of macronutrients in the plants, which was exactly similar in the present study.

The results obtained for As, Cu, Sr, and Zn for leaves in all the sites indicated that the high concentrations of these metals is attributed to motore-vehicle exhausts. The concentration of all these metals was significantly higher in areas that are clearly associated with industrial areas followed by the high traffic density and university campus to the salih agha village in which the traffic density and other polution sources is lower. This shows the extent to which these automobiles and industries release these metals as pollutants into the environment. Our results are consistent with the notion that the main reason of high

concentration of heavy metals localized in industrial and in urban roadsides are either related to industrial activity or the density of the traffic [12]. The report from the study carried out by Fatoki and Ayodele [13] showed that high concentration of zinc in the vegetation of a roadside was as a result of motor vehicle emission because zinc additives are often used as lubricants in oils, while tire and break wear are the most important contributors to emissions of Zn, Cu, Pb [14] and others elements such as Sr or Sn [15]. Differences among the concentration of heavy metals in Dodoneae, Albizia Lebbeck, and Eucalyptus leaves samples are showed in Figure 1, 2, and 3 respectively.

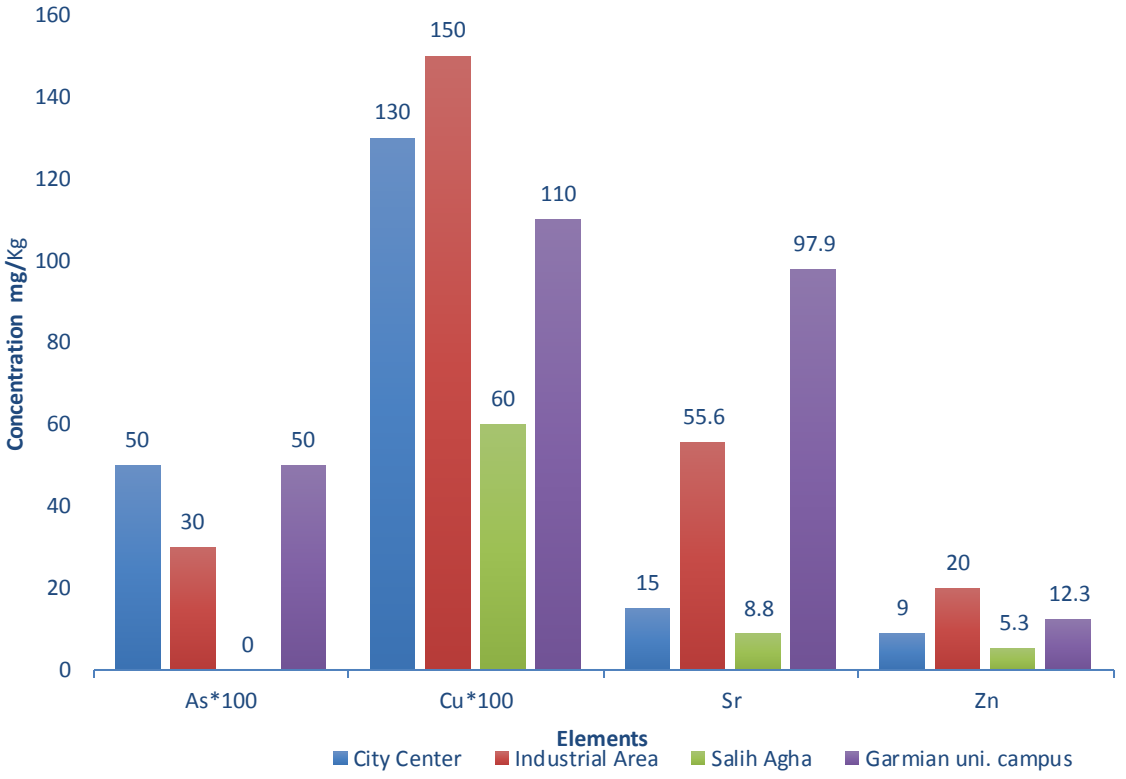

Figure 1. Comparison of concentration of elements in Dodoneae leaves grown in different places

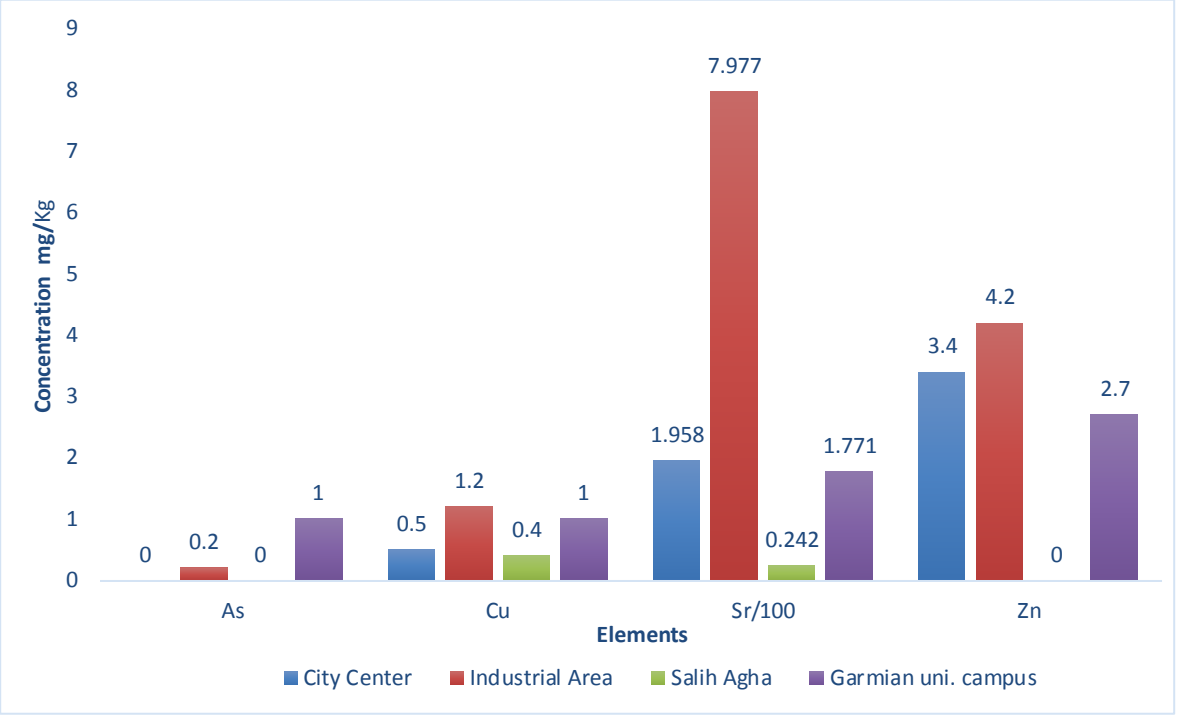

Figure 2. Comparison of concentration of elements in Albizia Lebbeck leaves grown in different places

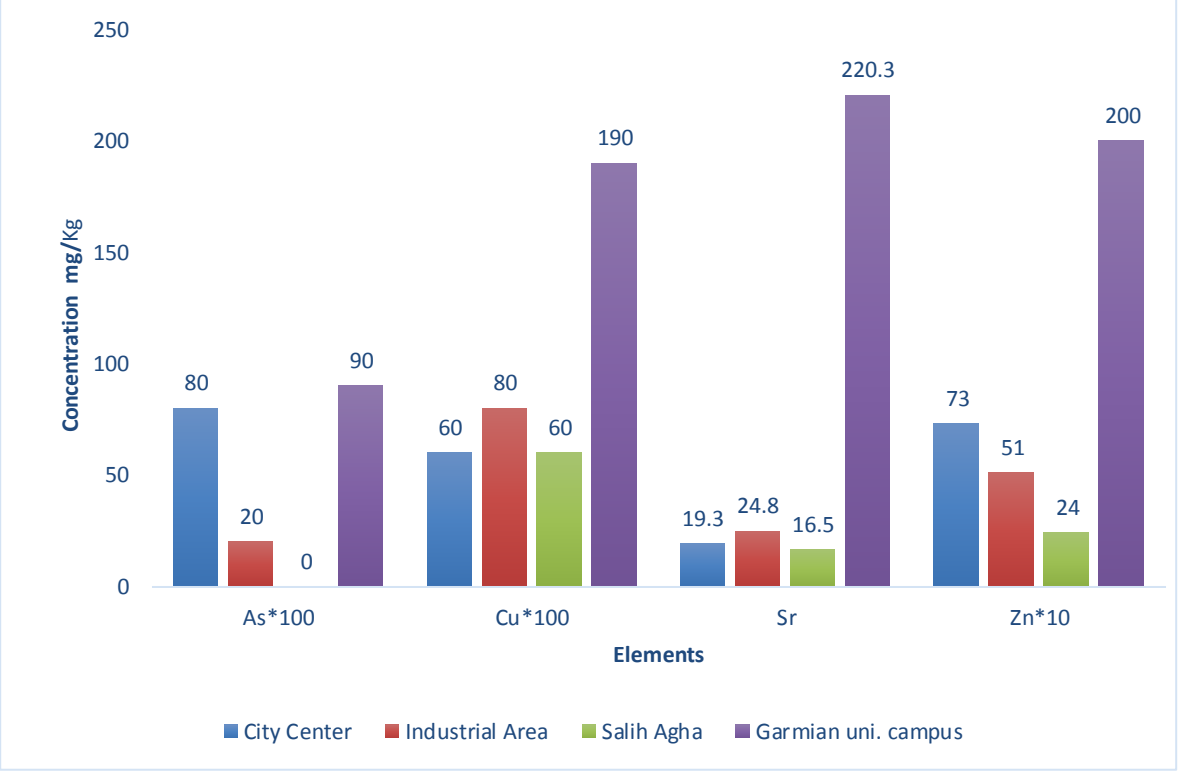

Figure 3. Comparison of concentration of elements in Eucalyptus leaves grown in different places

4. Conclusion

Different plant leaves grown in different areas in Kalar-Sulaymaneyah, Iraq were examined for As, Cu, Sr, and Zn. The rate of heavy metals contents in different plant leaves was found in the following order: Sr >Zn>Cu>As. The greater concentrations of heave metals in plant leaves grown near the roadside and industrial areas could represent long-term contamination of heavy metal from transport in a roadside environment and industrial activities that release heavy metals into the environment. This study has shown that the results of the concentration of heavy metals in plant leaves from the high traffic and industrial areas are indicative of anthropogenic pollution.

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