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CARUM PETROSELINUM AND *PIPER NIGRUM* AS BIOLOGICAL AND GEOCHEMICAL INDICATORS OF POLLUTION WITH PB AND CD IN SOIL AND PLANTS ON ROADSIDE

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Abstract

In the research, two agricultural locations were chosen, the first was in Botanical garden of Biology Department in the College of Science/Al-Mustansiriyah University which considered as a control to the second location. The later was in Plantation Street near the College of Administration and Economics/Baghdad University. This location was divided into three sited (A, B, and C) along 750 m. Two plants were used, *Carum petroselinum*, and *Piper nigrum*, these plants were harvested after 45 days from agriculture. Each plant was divided into three parts; leaves, shoot, and root. In those parts, two heavy metals, Pb and Cd, were measured. The comparison in the concentration of Pb and Cd in each part of plants was obtained between plants which grow in the second location and the control area. The results present a significant increase in concentrations of Pb and Cd in all sites (A, B, and C) comparing with control plants in Botanical Garden. The averages of Pb in the second were 3.6, 3.4, and 5.7, while the Cd averages were 2.6, 2.3, and 5.4 for Root, Shoot, and Leaf respectively for the Piper. Those results were higher than the control in the Botanical Garden. The Carum showed the results 3.4, 2.5, and 5.0 in respect to Pb and 2.6, 2.3, and 5.2 for Cd for Root, Shoot, and Leaf respectively in opposite to the Botanical Garden which was relatively low values. On the other hand, the Soil geochemical analysis appeared high contamination by Pb and Cd in Plantation Street comparing with the control. The sites of interest indicate relatively high values particularly in site B in respect of Pb mean, while C show high values in Cd mean. Moreover, leaves showed the highest values in this study between the other parts of plants. Furthermore, all the resulted values presented high levels of Pb and Cd, higher than the levels of the World Health Organization (WHO), in soil and plants. The conclusion of this study, that second location was contaminated by high levels of these heavy metals (Pb and Cd). The Leaf was the highest among the other values due to the maximum concentration of contaminants located in this contacted area. As well as, the recommendation is not to utilize this area for agriculture, especially the crops, because of the contamination problem. This problem needs for later remediation studies to solve it, especially the area is prone to many vegetables and/or plants, which used for human nutrition.

***Keywords*:** Heavy Metals, Contamination of Soil and Plants, geochemical analysis, and Roadside Contamination.

Introduction

The contamination of heavy metals and pollutants has developed an ecological disaster in the last five decades (Abii, 2012) within the anthropogenic effect, which drew the attention of many researchers and environmental institutions. As well as, heavy metals contamination have considerable trouble and dangerous for human health when exceeding the maximum limits values in soil, plants, and animals (Abii and Okorie, 2011).

Heavy metals, such as lead and cadmium are very common in nature. These metals are spreading as results of industrial activities and burning of fuels that contaminate soil, plants, and human. These metals have the endurance for long periods in the environment and resistance to biodegradation (Yang *et al.,* 2011; Opaluwa *et al*., 2012; Habh, *et al*., 2015a, and Salih *et al*., 2018).

For these reasons, heavy metals such as lead and cadmium have widespread studied due to the effects of automobile exhaust contamination (Vodyanitskii, 2016). Russian Gost (State Norms and Standards) considers that Pb and Cd are very toxic and risky on the soil. The accumulation of Pb and Cd depends on their concentration in soil (Kanckenko and Singh 2004). The atmospheric precipitation of lead in soil and leaves of plants causing the accumulation of this element in plants, then transport to the food chain, or this heavy metal transporting from the soil, then to plant, and finally to food chain (Opaluwa *et al*., 2012) & (Curtis and Smith, 2008).

Lead and cadmium are the major metals pollutants of the roadside environments, which transported to soil and plants from the fuel burning that producing from cars, this contamination from automobile exhaust is a worldwide environmental problem (Zaidi *et al*., 2005), also (Dolan *et al*., 2006) reported that the vehicles resurrections are the main source of contamination by metals such as (Pb, Cd, Cu, and Zn). These elements transport from traffic road to the nearby soil and plants, which grow in this location (Dolan *et al*., 2006).

Many studies (Wilson *et al*., 2005) and (Khan *et al*., 2005) also reported the toxic effects of Pb and Cd on a living organism. These effects are dangerous on plants growth, animals' lives, and human health, for example, a low concentration of Pb damage the nerve system, liver, and bones. Moreover, high values of Pb and Cd in soil is phytotoxic (Bakidere and Yaman, 2008).

As these studies are considered as rare for Iraq, therefore the objective of the following study is to find out if there is contamination by Pb and Cd in the location of study, which occurs parallel to the traffic road.

Materials and Methods

Study Site

The following study includes two locations were chosen to sample. The first location was in the Botanical garden of Biology department / College of Science-Al-Mustansiriyiah University as a control location, which is far away from any contamination sources. The second location was at plantation street (along 750 m) besides the traffic road nearly to the College of Administration and Economics /Baghdad University, this location divided to three sites (A, B, and C), Figure 1, about 100 m between each site. The sampling comprises of soil and plants in March 2016.

Soil Samples and geochemical analysis

The collected samples were taken from the sites of study (second location), approximately each 50-75 m distance. The first is considered as control samples, Table 1, due to the distance from traffic jams or any other contamination sources. The second locations, samples from 1 to 9 represent the areas that extend over the traffic contamination and surrounding roads. These samples were divided into three samples for each location (A, B, and C) mentioned above. The samples were analyzed by the XRF instrument (SPECTRO XEPOS) in the University of Baghdad - College of Sciences - Department of Geology. The results were as metal oxides. The samples prepared as shown in (Yahya *et al*., 2014)

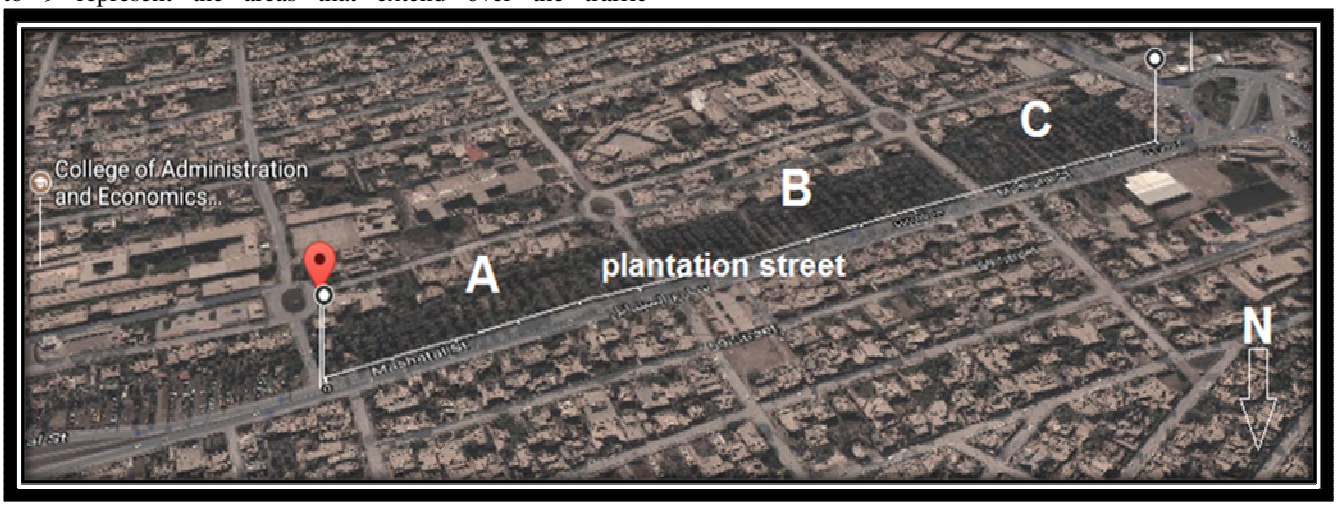

Fig. 1 : the second location of the study area, show A, B, and C sites in the Plantation Street (or Mashatel St. as an unofficial name) Baghdad, Iraq.

Agriculture of Plants

Two plants were used in this research, *Carum Petroselinum* (Carum) and *Piper nigrum* (Piper). The seeds of these two plants were sown in plastic pots with 3 kg weight; which got about six pots in each site for every plant.

A loamy soil was used after sieving about 2 mm and less, and then the soil is autoclaved before seeding. The seed was planted in March 2016 and harvested after 45 days. Later, on the Laboratory, plants were divided into three parts (leaves, shoot, and roots) for determining the concentrations of heavy metals in each part.

Measurement of Heavy Metals

The three parts of each plant were digested according to (Opaluwa *et al*., 2012), and then two heavy metals, Pb, and Cd were measured in each part of the plant by Atomic Absorption spectrometer (services laboratory in College of Iben-Al-Haitham / Baghdad University).

Statistical Analysis

The Least Significant Differences (L.S.D.) statistically analyzed the results of this search. This analysis utilized to show the difference in metals concentrations in the site of the study (IAEA, 1997).

Results and Discussion

The soil geochemical analysis showed evidently high results of Cd and Pb contamination in comparison to the control Table 1. As explained in figure 2, the higher of the high was in site B with respect to Pb whereas; C site was the highest in respect to Cd element. Whilst the control results (29.596 and 0.618ppm for Pb and Cd respectively) were also higher than the Maximal Permissible Addition (MPA) of heavy metals and metalloids in the soil as indicated by W.H.O., Table 5 (Salih *et al*., 2018).

The results of this research showed a significant increase in the concentration of Pb and Cd in all plants grown in the second location (Plantation Street); these results include both plants under study. The concentrations of Pb and Cd metals showed high levels in the all location (A, B, and C).

These levels were above than Maximum permission levels of Pb and Cd which recommended by Food and Agriculture Organization (FAO), (SAS., 2012) and were higher than maximum permissible limit of heavy metals in plants and soil which reported by World Health Organization (W.H.O.) (WHO. 1996).

The results in Table 2 showed high levels in concentrations of Pb and Cd in all three parts of Carum plants, which grow in the second location, and in all sites, Figure 3. These results considered high comparing with concentrations of Pb and Cd in the control.

The maximum values of this research present in site A. The highest concentrations of Pb and Cd appear in leaves of all plants in the two locations, then roots, and shoots descending. These results were agreement with another study (WHO, 1996) which mentioned that high levels of Pb element accumulated in leaves of plants more than other parts because the contamination maybe occurs through atmosphere transporting for gases, which produced from cars and other sources (Habh *et al*., 2015b).

In Table 3 also the concentrations of Pb and Cd recorded a significant increase in all parts of piper plants and in all sites A, B, C that grew in the second location, Figure 4, compared with the concentrations of metals in plants that grow in the first location.

The results were obtained from this experiment were higher, and above from the levels of Pb and Cd concentrations that recorded by (FAO/WHO) 1976, and (WHO) 1996, as mentioned in Tables (4) and (5). These results were obtained from this study agree with another study in some fields (FAO/WHO, 1976). This study presents

an accumulation in high levels of Pb and Cd in some herbs that grown parallel to the traffic road in north-central Nigeria. Also (Opaluwa *et al*., 2012) and (Chizzola *et al*., 2003) recorded those plants grown in four sites around mechanic workshops were polluted by high concentrations of heavy metals (Pb, Cd, and Cr). The study of (Yang *et al*., 2011) shown that heavy metals like Pb and Cd concentrated in high levels in crops grown around dumpsites (Habh *et al*., 2016).

The accumulation of heavy metals, Pb and Cd in plants grown in second locations, maybe occur from the pollution of the atmosphere by gases containing high levels of these metals (Ogundele *et al*., 2015), the main source for this gases coming from automobiles exhausts which passing on the highway road parallel to the second location (Habh *et al*., 2018).

Conclusions

The long-term exposure to the roadside gases was harmful to the second location (Plantation Street) that contaminated by high levels of Pb and Cd in terms of Plants and Soil of plantation. The concentration of the undertaken metals showed risky contamination in human food in the area of interest. In turn, Pb and Cd concentrations in the Botanical Garden (Control area) were higher than WHO maximum permission levels. This research comes to recommend to prevent the farmers to utilize this region (Plantation Street) agriculture especially the crops, due to contamination problem. Subsequently, the Bioremediations have to be taking on to purify these areas from any contamination by heavy metals.

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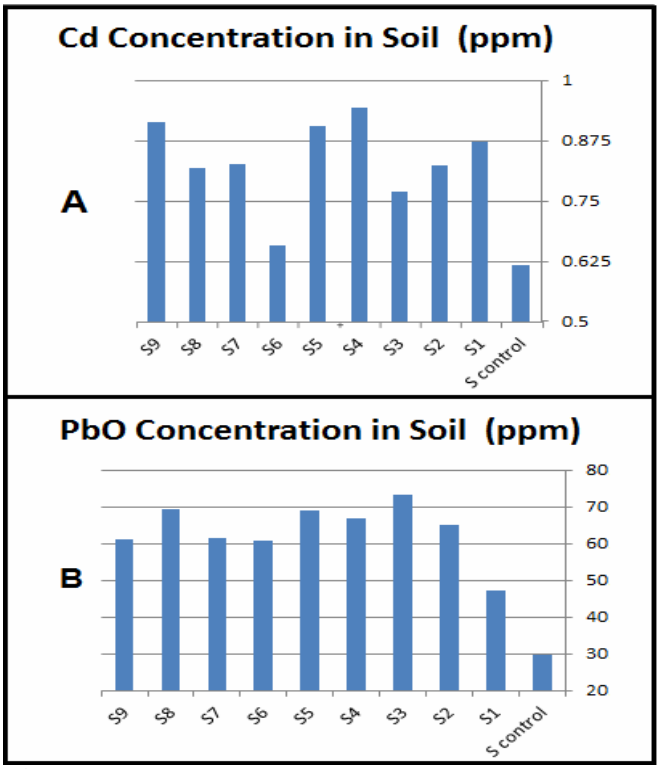

Fig. 2: The concentration of Cd and Pb of the soil samples in the study area in comparison with control.

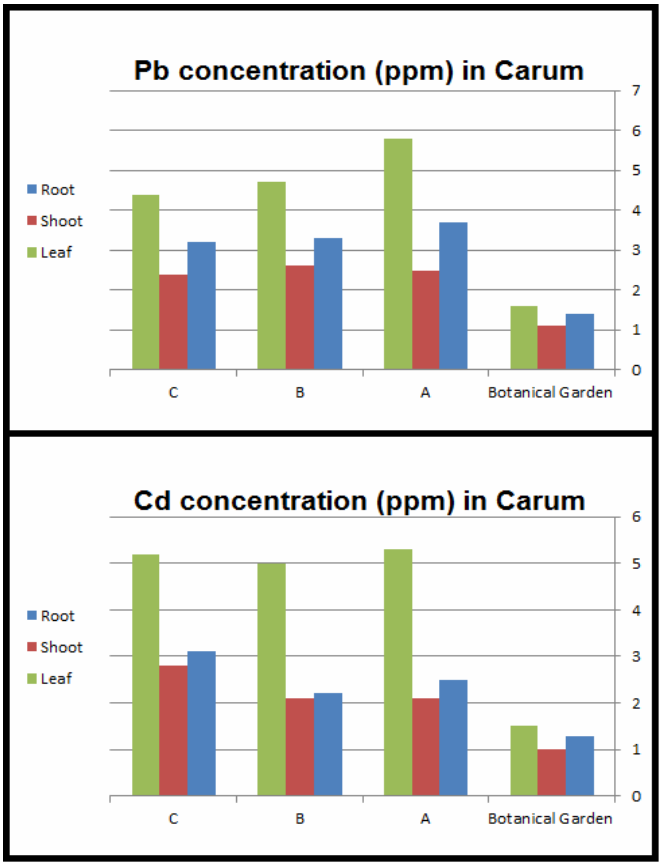

Fig. 3: the concentration of Pb and Cd in the Carum plants in terms of Root, Shoot, and Leaf, in the three study locations.

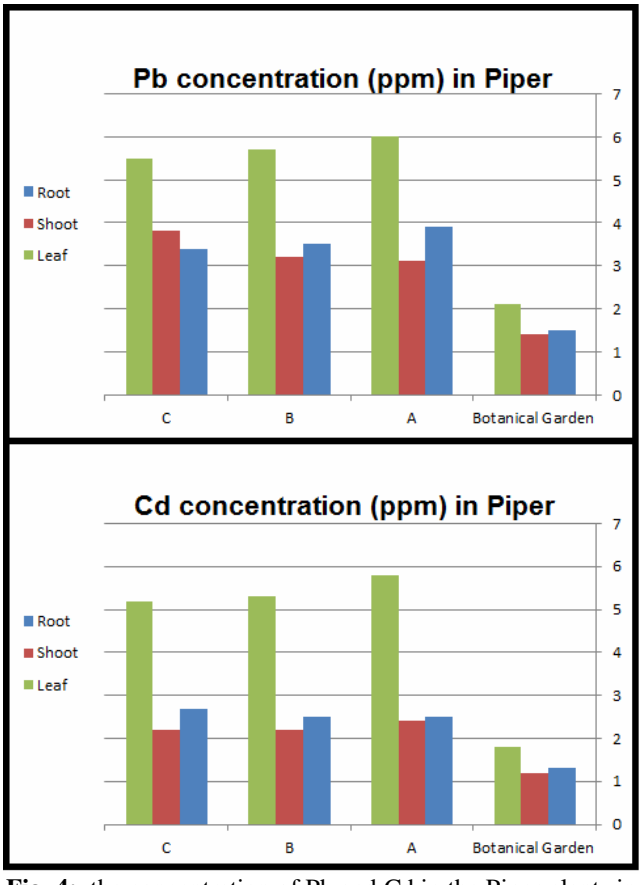

Fig. 4: the concentration of Pb and Cd in the Piper plants in terms of Root, Shoot and Leaf, in the three study locations.

Table 1: The concentration of Cd and Pb oxides in the Soil of study area.

Sample Name	Locations	Cd Concentration of ppm	Pb Concentration of ppm
S control	Botanical garden	0.618	29.596
S1	A	0.872	47.250
S2		0.823	64.935
S3		0.770	73.259
S4	B	0.944	66.981
S5		0.905	68.991
S6		0.657	60.805
S7	C	0.828	61.519
S8		0.818	69.315
S9		0.915	61.061

Table 2: Concentration of Pb and Cd in parts of *Carum petroselinum* plants.

Second Location Plantation Street Sites	The concentration of heavy metals (Mean)					
	Pb (ppm)			Cd (ppm)		
	Root	Shoot	Leaf	Root	Shoot	Leaf
A	3.7 ± 0.4	2.5 ± 0.3	5.8 ± 0.5	2.5 ± 0.3	2.1 ± 0.3	5.3 ± 0.5
B	3.3 ± 0.4	2.6 ± 0.3	4.7 ± 0.5	2.2 ± 0.3	2.1 ± 0.3	5.0 ± 0.5
C	3.2 ± 0.4	2.4 ± 0.3	4.4 ± 0.5	3.1 ± 0.4	2.8 ± 0.4	5.2 ± 0.5
First Location Control	1.4 ± 0.1	1.1 ± 0.1	1.6 ± 0.2	1.3 ± 0.1	1.0 ± 0.1	1.5 ± 0.2

- Significant under (0.05)

Table 3: Concentrations of Pb and Cd in parts of *Piper nigrum* plants.

Second Location Plantation Street Sites	The concentration of Heavy metals (Mean)					
	Pb (ppm)			Cd (ppm)		
	Root	Shoot	Leaf	Root	Shoot	Leaf
A	3.9 ± 0.4	3.1 ± 0.4	6.0 ± 0.5	2.5 ± 0.3	2.4 ± 0.3	5.8 ± 0.5
B	3.5 ± 0.4	3.2 ± 0.4	5.7 ± 0.5	2.5 ± 0.3	2.2 ± 0.3	5.3 ± 0.5
C	3.4 ± 0.4	3.8 ± 0.4	5.5 ± 0.5	2.7 ± 0.4	2.2 ± 0.3	5.2 ± 0.5
First Location Control	1.5 ± 0.2	1.4 ± 0.1	2.1 ± 0.2	1.3 ± 0.1	1.2 ± 0.1	1.8 ± 0.2

- Significant under (0.05)

Table 4 : FAO/WHO values for heavy metals in vegetable and plants. (1976).

Metal	WHO/FAO	Normal value in plants
Pb	2	0.5 – 3
Cd	1	≤ 2.4

Table 5 : WHO Maximum Permissible Limits for heavy metals in plants and soil

Elements	Maximum Permissible value of Plants (ppm)	Maximum Permissible value of Soil (ppm)
Pb	2	10
Cd	0.02	0.06

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