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Indication Cadmium in leaf *Eucalyptus camaldulensis* plant at Samarra city/Iraq

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Abstract: The concentrations and main sources of Cd elements were determined seasonally in leaf plant species *Eucalyptus camaldulensis* and soil surrounding it at three stations near the Tigris River Samarra city/Iraq during the period from January 2022 to July 2022 . The results showed that the highest mean concentration of Cd in leaf at was (3.013 ng/g dry weight) in *E. camaldulensis* and it was (4.906 ng/g in soil . Seasonal variation of Cd concentration showed that the highest mean concentrations were recorded in Spring (3.004 ng/g dry weight) at *E. camaldulensis* ,while the lowest mean concentrations were recorded in January (1.99 ng/g dry weight) in soil . According to Cd indices evaluating the potential ecological risks resulting from soil and plant pollution with cadmium and determining pollution levels was using enrichment, pollution and geochemical accumulation factors to determine ecological risks using the factors of potential and unilateral environmental risk factor.

Keywords: Indication Pollution, *Eucalyptus camaldulensis,*Soil

1- Introduction

Human activities associated with urbanization and industrialization is important sources of soil and plant pollution, and the mechanism of their transmission from adjacent waters with minerals (Wu *et al*, 2014). As the sources of metal pollution include airborne particles from industry or vehicle emissions, water run-off, fires, and others, with private sites contaminated with garden soil as a result of the use of fertilizers and pesticides, and building gardens infected with pollution (Alloway, 2004; Douay *et al*, 2007). Soils receive a lot of heavy metals from agriculture and applications of pesticides over a long period of time, organic and inorganic manures and other soil conditioners and contaminated irrigation water that may lead to mineral buildup, atmospheric deposits, paint particles, and landfilling of metal-containing waste activities. Entertainment such as air rifle shooting (Szolnoki *et al*, 2013). Smelting, plating, and battery manufacturing are the industrial activities that produce large quantities of heavy metals (Foucault *et al.*, 2013). Cadmium is one of the nonessential heavy metals that are toxic to humans, animals and plants. Generally, the concentration of cadmium in the earth's crust is (0.2mg/kg) and in the topsoil is 0.53 mg/kg) (Kabata-Pendias and Pendias, 2001). There is a growing environmental concern About the presence of cadmium because it is one of the most toxic ecological metals, as it has negative effects on the biological activity of the soil, plant metabolism, public health and the animal kingdom (Koza *et al.*, 2011).The sources of cadmium in the environment are either natural or human or both, human sources may be from Fuel combustion, use of phosphate fertilizers, smelting operations, mining, sewage irrigation, urban traffic, and nickel-cadmium batteries (Liu *et al*, 2015). Cadmium is considered a major pollutant in roads because it is used as a stabilizer in car tires. The mineral phosphorous fertilizers contain a large amount of cadmium, which causes pollution to agricultural areas (Clarke *et al*, 2015). The products of combustion of plastic materials are one of the most important sources of cadmium pollution, as they increase its concentration in the atmosphere and then deposit it in the soil (Al-Maliki, 2006). The natural sources of cadmium are mainly from volcanic activities, weathering processes of mother rocks, forest fires and decomposition of radioactive materials (Liu *et al*, 2015). Cadmium enters into many industries, including the manufacture of alloys, welding materials, and the manufacture of batteries (Lu *et al.*, 2007).

Due to the overlapping of a group of factors, the most important of which is the increase in the population in the city and the consequent environmental problems resulting from the depletion of natural resources, the increase in factory waste and garbage dumps, the increase in the number of vehicles and other factors that lead to the release of many pollutants to the soil and their transmission to plants through the food chain, affecting this negatively on ecosystems and even human health, so some areas were chosen to conduct this study for the purpose of evaluating the potential ecological risks resulting from soil and plant pollution with cadmium and determining pollution levels using enrichment, pollution and geochemical accumulation factors to determine ecological risks using the factors of potential and unilateral environmental risk factor.

2. Experimental

2.1 Description study site

Three main areas close to the Tigris River were selected in the city of Samarra, Salah al-Din Governorate, as it is located in the northern part of the sedimentary plain with flat land between latitudes 34° 11′45″N 43° 53′08″E. The Tigris River penetrates the area from north to the South. The study area is also distinguished by the presence of industrial sites, communities and agricultural land, with an area of inhabited land, including the boundaries of industrial establishments (30%), while the area of the land is uninhabited, including agricultural land (50%) .

The soil of the region is characterized by a silty, sandy, varying and irregular nature. It is also characterized by being basic, as the Ph value reaches more than (7), and the percentage of total dissolved salts (T.P.S.) is relatively low, and the relative values of natural moisture (% W) range between (18-34) %) and to different depths of the soil .The main industries polluting soil in the city of Baghdad are: petrochemicals, oil industries, power stations, textile industries, chemical industries, engineering industries, extractive industries, construction industry (Ajmi , 2006).

2-2 Sampling Procedure

Digestion of soil and plant leaves:

After the soil samples and leaves of *Eucalyptus camaldulensis* were collected as a first step, then dried at room temperature, and then passed through a sieve (2mm sieve) to get rid of the impurities that may accompany the soil with the collection process and to get a soil sample with a grain size of less than (2mm). The usual digestion process is according to the standard methods used, converting it to a solution that is dealt with according to this method of analysis and according to the method (Lamble and Steve, 1998) and the samples are prepared for examination by an atomic absorption spectrometer.

After filtration, it is diluted to 50ml using deionized water, digestion was carried out by treating it with a mixture of nitric acid and per chloric acid (1:4), respectively (HNO_3:$HClO_4$) with continuous heating at a temperature of (60 Co) for five hours until the solution became clear. Then the sample is filtered and placed in a volumetric bottle of 50 ml capacity and the volume is completed to the standard volume by ionic water. Then the measurement process is carried out, taking into account the preparation of a chelating solution (Blank Solution) under the same conditions for the treatment of samples (APHA, 1998), then the process of automatic analysis of the elements is carried out using the Flame Atomic Absorption Spectrophotometry in the laboratories of the Department of Chemistry - Environmental Safety Center - Department of Hazardous Materials and Environmental Research /The Ministry of Science and Technology. Then the cadmium concentration was calculated.

Table (1) Grades of ecological risk of Cd metals

E^i_r value	Grades of ecological risk of metals
$E^i_r < 40$	Low risk
$40 \le E^i_r < 80$	Moderate risk
$80 \le E^i_r < 160$	Considerable risk
$160 \le E^i_r < 320$	High risk
$320 \le E^i_r$	Very high risk

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2.4 Laboratory Analysis

Assessment polluted of plant leaves and soil

To assess soil pollution, three factors, the Enrichment Factor (EF), the Integrated Pollution Load Index (IPLI) and the geoaccumulation Index (Igeo) were used.

Geoaccumulation index (Igeo)

The enrichment of metal concentration above base concentration was calculated using the method proposed by Muller (1969). He described the coefficient of geochemical accumulation (Igeo). The coefficient of geochemical accumulation was expressed as follows:

Igeo = log2 (Cn/Bn . 1.5)

where (Cn) is the measured concentration of the mineral ((n) in the sediment sample and (Bn) the basic geochemical value . A factor of 1.5 was introduced to include the possible differences in the basic values due to the lithogenic effect, as suggested by Muller (1981). (7) Categories of geochemical accumulation index

Table (2) Coefficients and degrees of the potential monolithic ecological risk factor (Eir)

RI value	Grades of the environment
RI < 110	Low risk
110 ≤ RI < 200	Moderate risk
200 ≤ RI < 400	Considerable risk
400 ≤ RI	Very high risk

3. Results and Discussion

The levels of cadmium concentrations for soils and leaf plant were determined and statistics were conducted for them. The results were compared with the values of international, American and Canadian soils for soil quality and pollution factors and ecological risks were calculated, as follows:

From the results obtained and shown in Table (3), which show that the general average of cadmium concentration in the soil and plants of the study area ranges between (12-24 µg/g) in the soil (18.6 µg/g) in the plant. When comparing the average cadmium concentration recorded in the soils of the study area with the global value and the Canadian and American standards. We find that the average value of the cadmium concentration for the soils of the studied region has exceeded the value of its concentration in the global soils (0.4), the Canadian standards and the American standards (0.6) for the quality of the soils, and this indicates that the region contaminated with cadmium. The average cadmium concentration of plant leaves was also compared with the average cadmium concentrations recorded for a number of studies in Iraqi cities for the urban soils of Baghdad city, also higher than the average concentration recorded by (Liu, *et al*, 2015) for the soils of the gardens of the city of Erbil, which averaged (0.34). And due to the lack of study that was obtained for garden soils in Iraq, the results of the studied soils were compared with international soils, where it was found that the average concentration of cadmium for the soils of the studied gardens is higher than the average concentration of cadmium recorded by (WHO,, 2013) for (Szeged) gardens, which is (5.55). It is also higher than the average cadmium concentration recorded by (Alamgir *et al*, 2015) for urban soils of the city of Chittagong, which amounted to (2.43). We note from the results obtained that the average cadmium concentration for the studied soils is higher than the average concentration for all Iraqi and international soils, as well as We find that all the concentrations of the study soils have exceeded the permissible concentrations of the international, Canadian and American soils. The high concentration of cadmium is related to the traffic and its proximity to public roads that have high traffic density, which may increase the cadmium pollution of the soil of the study area as mentioned. The presence of cadmium in soil is related to the wear of car tires, as well as it may be due to traffic, and this fact was confirmed by (Reyam *et al.*, 2018 b) , the increase in cadmium concentration in soils may be due to human activities and the combustion of fossil fuels. Adriano, 2001 mentioned that human activities can contribute to an increase in the level of cadmium as a result of industrial activity in urban areas or agricultural practices. Phosphate fertilizer applications and sediments may also contribute. And from the spatial distribution of cadmium concentrations for the soil and plant of the study area, we find that the highest mean concentration of Cd in leaf at was (3.013 ng/g dry weight) in *E. camaldulensis* and it was (4.906 ng/g in water. As shown in Table 3 and Figure 1.

Table (3) Concentration average cadmium concentrations in urban soils and leaf plants of different cities of Iraq

Sample	Cd in soil	Cd in leaf plant	References
Baghdad (Iraq)	11.45	----	*Rahi et al,2012*
Baghdad (Iraq)	0.54	-----	*Al- Obaidy et al. (2013)*
Babylon(Iraq)	-----	4.6	*Manii , 2014*
Baghdad (Iraq)	4.18	8.85	*Al-Anbari et al,(2015)*
Erbil (Iraq)	0.34	-----	*Kafoor and Kasra,(2014)*
Baghdad (Iraq)	19	-----	*Habib et al,2012*
Baghdad (Iraq)	11.7	7.25	*Tawfic et al,2015*
Baghdad (Iraq)	18.642	3.67	This Study

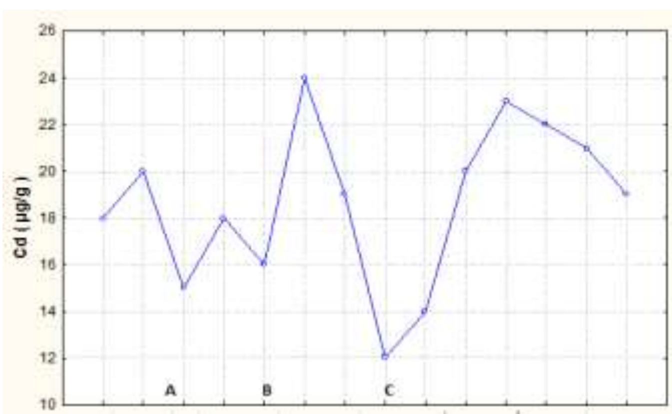

Figure (1) The spatial change of cadmium concentration (Cd) in the soils and plants of the study area

Analysis of the correlation coefficient between soil parameters and leaf plant . The relationship between the element cadmium can provide important information about the source of the mineral and its pathways. The results obtained for soil and plant leaves in an area to study Table (3) showed that there is a positive correlation between cadmium between soil and plant by 0.56, and this means that this mineral may originate from one source. They may be human or natural sources, thus increasing the organic content increases the adsorption of cadmium from the soil, affecting the common physiological effect between soil and plants.

Enrichment Factor (EF) , input of cadmium in soil and plants from human sources can be estimated by enrichment factor. Enrichment factor (EF) The values were calculated in order to assess pollution levels in the study area, the enrichment factor is used to distinguish between the concentrations of elements of natural origin from those that consist of human sources, as the values of the enrichment factor between (0-1.5) indicate that the mineral It is entirely of crustal materials or of natural origin, while (EF>1.5) indicates that the sources are likely to be man-made, including emissions from vehicles, industrial discharges, etc., and basically the higher

the value of the enrichment factor, the greater the contribution of human resources (Liu, *et al,* 2015). The results of the enrichment coefficient for the metal shown in Table (1-2) showed that the value of the enrichment coefficient for cadmium ranged between 120.63-541.18 for soil and plant leaves, a value of 231.35.
The results show that the enrichment coefficient is more than (5) for cadmium, while we find that the average values of the enrichment coefficient for the rest of the elements are less than (5). Where we find that the soils are minimally enriched with EF<2) and highly enriched with cadmium (EF>40). (Szolnoki *et al*, 2013) confirmed that cadmium can be released into the atmosphere from tire corrosion and fuel combustion. However, enrichment coefficients that are less than (5) are not considered significant even though they are indicative of mineral accumulation because such small enrichment may arise from differences in the composition of local soil materials and the reference value used in (EF) calculations (Reyam *et al,* 2018). However, industrial discharge, waste, exhaust gases and traffic emissions that contain heavy metals and are released to the environment lead to an increase in the accumulation of heavy metals in urban soils (WHO, 2012).The following table shows the enrichment factor for the soil and plants of the study area. Pollution Load Index results of the (PLI) values for cadmium metal showed that the average pollution load factor (PLI) values for cadmium (46.57) in the soil and in the plant (0.05), where the results showed that the soils of the study area had high cadmium pollution (PLI>3)), while they had low pollution in The leaves of the plant were all values (PLI<1).
Results integrated Pollution Load Index (IPLI) values ranged between (5.21 - 10.23) in the soil and plant leaves amounted to (8.01) and we note that all values were greater than (2), which means that the study area with High cadmium pollution. Geoaccumulation index (Igeo) used to assess the degree of metal contamination in soil and plant leaves, where the obtained results showed that the average values of the geochemical accumulation coefficient of cadmium (4.92), (1.89) for the soil and plant leaves reached (0.9 0.1) a. This means that the soil of the study area High to very high polluted with cadmium (Igeo = 4-5) and this is due to the influence of various human activities in the soil, while it is not polluted with the other element (Igeo ≤ 0). The Potential ecological risk assessment chemical pollutants in soil can have serious effects on the ecological system and human health. It is necessary to assess the extent of the risks to potential receptors, as many types of assessments of metal contamination in soil or sediments transferred from the surrounding water including (enrichment factor, factor Pollution load, geochemical) All of these methods are based on pollutant content and the potential ecological hazard index (Ri) is a method used to assess the environmental quality of soil pollution and its transfer to plants according to their environmental behavior. It affects not only the level of minerals in the soil, but also the environmental and ecological effects with toxins. In (Hakanson's) method, various potential toxicological response factors to different heavy metals and element concentrations are taken into consideration. Therefore, (Hakanson) method is more comprehensive in this study. The single-order potential ecological risk factor (Ei) and the ecological potential risk factor (Ri) can be calculated to assess the potential environmental risks of cadmium and its transfer from soil to plants.

4. Conclusion

Through the results of the study that was reached from the content of cadmium in plant leaves and the surrounding water. In addition to evaluating the level of pollution in terms of environmental indicators such as the geochemical accumulation factor (Igeo), the enrichment factor (EF), the pollution load factor (PLI) and the integrated pollution load factor. IPLI) and the potential ecological risk factor (Ri) The conclusions in this work can be summarized as follows:
1- The soil samples showed a significant increase in cadmium content and based on comparing the concentrations of the studied heavy metals with the standards of the US, Canadian and international Environmental Protection Agency for soil quality. It is heavily polluted with cadmium.
2- The results of the analysis of the correlation between soil and plant treatments showed that there are positive correlations between the mineral, which indicates that it may arise from the same source of pollution, and there are similar spatial distribution patterns for the mineral shown by the spatial distribution maps, and this indicates that there is a common origin of pollution with these elements.

4- The human influence has a clear relationship in the field of study by calculating the results of the enrichment coefficient values (EF) showing the soil of the studied area with high enrichment to the maximum extent (in cadmium), and this indicates the possibility of increasing the concentration of elements in urban soil due to human activities. According to the values of the indicators of potential environmental risks (Ri), it was found that the soils of the gardens of the study areas are of high environmental risks

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