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A Study of Cadmium and Cobalt in Agricultural and Non-Agricultural Soils Using Some Pollution Index in Baquba District, Diyala Governorate

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ABSTRACT

The current study is carried out from 01/Sep./2021 to 27/Sep./2021 in four sub-districts, namely Buhruz, Kanaan, Muhammad Sukran and Khan BaniSaad belonging to Baquba district inDiyala governorate. It is conducted by collecting three samples of Alhagi plant with its soil from agricultural and non-agricultural lands, and three compound soil samples from virgin, uncultivated lands for each site. The aim is todetect the concentrations of the heavy metals cadmium (Cd) and cobalt (Co)to determine some of the contamination criteria in the soil, namely the contamination factor (CF) and the enrichment factor (EF). The third site and the treatment of agricultural soil recorded the highest average pollution coefficient of cadmium, which amounted to 0.128 ± 1.066 and 0.090 ± 1.055, respectively, which indicates that the soil samples are moderately polluted. As for the coefficient of contamination for cobalt, the first site and the treatment of non-agricultural soil recorded the highest average It was 0.109 ± 1.593 and 0.077 ± 1.282, respectively. This indicates that the soil samples are moderately polluted. While the enrichment factor of cadmium was recorded as an average of the lack of abundance of agricultural and non-agricultural soils and soils of the study sites. The enrichment factor of the cobalt element in the first site recorded the highest average of 0.287 ± 2.278, which indicates that the soil samples have a slight abundance, and the results showed that there were no significant differences between the treatment of agricultural and non-agricultural soil, as the average of the treatment of non-agricultural soil and the treatment of agricultural soil 0.203 ±1.627 and 0.203 ±1.469, respectively. This indicates that the soil samples contain a slight abundance of the element cobalt.
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1. Introduction

Heavy metal pollution is one of the biggest environmental problems resulting from various human activities in the environment. Environmental pollution with heavy metals comes at the forefront of the problems. It is considered more toxic because heavy elements are not degradable and remain in the soil as long as possible without any

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occurring chemical change (Tahseen, 2019). Therefore, its danger and toxicity cannot be eliminated, so it accumulates in the environment. The pollution coefficient is defined as the ratio between the concentrations of elements in the samples to their concentration in the geochemical Background (Chen et al., 2015). Several methods and indicators for calculating the pollution coefficient have been shown, including the ground accumulation, to measure the degree of pollution concerning the soil (Hu et al., 2017).

The enrichment factor (EF) is an important identification tool for contamination levels and sources of heavy metals in soils and sediments (Khalilov and Mammadov, 2016). It is also a widely used measure to determine the extent to which the presence of a metal in samples increases relative to average natural abundance due to human activity. It is an indicator of human influence on soil or can give an insight into the distinction between anthropogenic and natural sources. It is one of the most widely applied indicators for assessing heavy metal concentrations due to anthropogenic influences (Taşpinaret al., 2021). In a study by Abdet al. (2017), certain sites in the city of Tikrit are chosen, namely Al-Bill, Al-QaraWardi, the Museum, Sheheen, Al-Mahzam hardware stores, and Al-Mahzam beach. They mention that zinc and copper recorded low contamination, while lead, cobalt, and chromium recorded moderate soil contamination. As for the contamination factor of nickel, it is recorded as being very high.

In another study by Said et al. (2019), 16 samples of agricultural soils with a depth of 0-30 cm were collected from the Girga area in Sohag Governorate in Egypt. They show that the contamination factor recorded low contamination for each of the cobalt, nickel, and lead metals, and the pollution index for the manganese metal recorded moderate pollution. Lermi and Sunkari (2021) have found in a study of the Polkar region in Turkey, that the value of the contaminationfactorhas ranged from low to relatively high contamination for each heavy metal, namely arsenic, cadmium, cobalt, nickel, zinc, and mercury. As for the areas remote from the Polkar region for non-agricultural soils, the contamination factor recorded low contamination of the same metals. The enrichment factor for soils in the Kirkuk governorate recorded the highest value for nickel compared to the values of the enrichment factor for lead, cobalt, chromium, and copper, respectively (Kadhimet al., 2017). As for Alrashdiet al. (2015), in their study of the enrichment factor, 57 samples of sediment were collected from an area in Abu Dhabi in the United Arab Emirates. They state that the enrichment factor is recorded for several heavy metals, including cadmium 0.6, cobalt 0.2, nickel 0.3, zinc 0.1 i.e.the area is not contaminated. Nicollet al. (2015) found in a study of acacia and eucalyptus soils where these trees are grown in an abandoned copper mine in South Australia that the enrichment factor recorded higher values for eucalyptus soils for heavy metals, namely copper, lead, and zinc compared to that with acacia soils.

2. Materials and Methods

First: Description of the Studied Area

Baquba district is one of the Iraqi districts with its center in the city of Baquba, and is regarded as the largest district in terms of population in the governorate. It consists of an area of 580 km2, and includes several sub-districts: Al-Abarrasub-district, Muhammad Sakransub-district, Buhruzsub-district, Kanaansub-district, Khan BaniSaadsub-district, and Ghalibiyasub-district. This study is conducted in Buhruz, Kanaan, Muhammad Sukran, and Khan BaniSaadsub-districts / Diyala governorate (Muhammad et al., 2021).

Second: Sampling Collection

The study samples are collected from four sites in Diyala Governorate / Baquba District, namely Buhruz, Kanaan, Muhammad Sukran, and Khan BaniSaad sub-districts from 01/Sep./2021 to 27/Sep./2021. They are three samples of the Alhagiplant with its soil from agricultural and non-agricultural lands and three compound samples from the soil of virgin lands. The samples are placed in polyethylene bags with the sample number and the site's name written on them. The plant is then washed.

The root is separated from the stem and dried aerobically. After that, the samples are grounded, passed through a 2 mm sieve, collected in plastic boxes, and weighed at 5 g for each sample. Finally, they are transferred to the Ministry of Science, Department of Environment and Water laboratories to estimate the concentrations of heavy metals, Co and Cd, by using a Japanese-origin spectrophotometer Apsorptio Atomic, model AA7000.

Third: Sample Preparation

1. Estimating elements in the soil:

An amount of 0.5 gm of dry, ground soil is taken, placed in a beaker glass, and 5 ml of concentrated nitric acid HNO3 of %70 is added to it. Then, the sample is placed on a hot plate for an hour at a temperature of 105 °C. After that, the sample is cooled, and 10 ml of distilled water is added. The sample is mixed well By a Rolex rotary device for 10 minutes, left to precipitate the solids, transferred to a centrifuge at a speed of 2000 rpm, and filtered with 0.45 Whatman filter paper. The volume is supplemented with distilled water up to 50 ml, and the sample is read using an atomic absorption spectrophotometer (Wodaje, 2017).

2. Pollution index

Some pollution indexes are calculated to determine the pollution status for each studied metal within the soil samples.

3. Contamination Factor (CF)

The contamination factor indicates the level of soil contamination with a heavy metal. Its high value indicates the state of contamination in that site, as it increases with its proximity to the source of contamination. The contamination factor is calculated according to the following equation (Abed et al., 2021):

CF = Cm Sample / Cm Background

Cm Sample = Concentration of the studied metal in the sample

Cm Background = Concentration of the studied metal in virgin lands

Table (1): Classification of soil contamination levels with heavy metals (Adamuet al., 2014)

Contamination Factors	Contamination Levels
$C_t \leq 1$	Low contamination
$<C_f \leq 31$	Moderate contamination
$\geq C_f < 63$	High contamination
$C_f > 6$	Very High contamination
EF>50	Very High contamination

4. Enrichment Factor

It is calculated according to the following equation (Alghamdiet al., 2022):

where,

CN is the concentration of iron in virgin lands.

CB is the studied metal in the sample.

Lv is the concentration of the studied metal in the virgin lands.

Table (2): The enrichment factor index for heavy metals (Issa and Al Jubouri, 2017)

Range of Enrichment Factor (EF)	
EF≤ 1	No abundance
1<EF≤3	Slight, low abundance
3<EF≤]5	Moderate abundance
5<EF≤10	Moderately intense abundance
10<EF≤25	extreme abundance
25<EF≤50	Very extreme abundance

3. Results and Discussion

First: Cd Contamination Factor

The results of Table (3) indicate that there are no significant differences between site treatments, agricultural and non-agricultural soil treatments, and the interaction between them. The third site recorded the highest average contamination factor amounting to 0.128± 1.066, which indicates that the soil samples for this site are moderately contaminated. The second site recorded the lowest average, which amounted to 0.128± 0.791, which indicates that the soil samples are of low contamination. (Mansur, 2017) As for the agricultural soil treatment recorded, a higher average was amounting to 0.090 ± 1.055 compared to the non-agricultural soil treatment, indicating that agricultural soils are moderately contaminated compared to non-agricultural soils. The results of this study are consistent with a previous study which indicated that soils are low in cadmium contamination (Abdet al., 2017). The use of chemicals in agriculture with irrational agricultural practices represented by chemical fertilizers containing impurities, heavy metals, and chemical pesticides may be the reason for this (Zaghloul, 2019).

Table (3): Cadmium contamination factor values of agricultural, non-agricultural, and study site soils

Average	Soil Treatment		Site
	Non-Agricultural	Agricultural	
0.128± 0.990	0.181± 0.800	0.181± 1.180	First
0.128± 0.791	0.181± 0.683	0.181± 0.898	Second
0.128± 1.066	0.181± 0.850	0.181± 1.283	Third
0.128±0.880	0.181± 0.900	0.181± 0.860	Fourth
---	0.090± 0.808	0.090± 1.055	Average
Site: 0.871, Treatment:N. M., interaction: N. M			LSD

Second: Co Contamination Factor

The results of Table (4) show that there are significant differences between the site treatments and the interaction between them. The first site recorded the highest average contamination factor amounting to 0.109± 1.593, which indicates that the soil samples for this site are moderately contaminated. The second site recorded the lowest average amounting to 0.109± 0.705, indicating that the soil samples for this site are moderately contaminated. The Table also shows no significant differences between agricultural and non-agricultural soil treatments, as the non-agricultural soil treatment recorded a higher average of 0.077 ± 1.282 compared to the agricultural soil treatment, which indicates that agricultural soils are moderately contaminated. These results are consistent with the study by Abdul et al. (2017). The use of chemical and organic fertilizers has a role in the accumulation of heavy metals in the soil (Salem and Al Waleed, 2019).

Table (4) values of pollution index of cobalt in agricultural and non-agricultural soils and soils of study sites

Average	Soil Treatment		Site
	Non-Agricultural	Agricultural	
1.593 0.109±	0.154± 1.777	0.154± 1.410	First
0.705 0.109±	0.154± 0.737	0.154± 0.67	Second
1.465 0.109±	0.154± 1.287	± 1.643 0.154	Third
± 1.066 0.109	± 1.328 0.154	± 0.804 0.154	Fourth
---	0.077± 1.282	± 1.113 0.077	Average
Site 0.329, Transaction: No. m, overlap: 0.466			LSD

Third: Cd Enrichment Factor (EF)

The results of Table (5) indicate that there are no significant differences between the site treatments, the agricultural and non-agricultural soil treatments, and the interaction between them. The fourth site recorded the highest average for the enrichment factor, which amounted to 0.117± 0.912. This indicates the absence of an abundance of cadmium in the soil samples. As for the third site, it recorded the lowest average of0.177± 0.685, which indicates the absence of an abundance of cadmium in the soil samples. Regarding the treatment of agricultural soils, it recorded the highest average of 0.125 ± 0.886 compared to the non-agricultural soils treatment. This indicates the absence of an abundance of cadmium in both agricultural and non-agricultural soils. The results of this study do not agree with the study by Rezapouret al. (2022). The reason for the lack of cadmium in the study samples is due to This is because the samples were contaminated with low levels of cadmium.

Table (5): Cadmium Enrichment Factor values of agricultural, non-agricultural, and study site soils

Average	Soil treatment		Site
	Non-Agricultural	Agricultural	
0.887 0.177±	0.250± 0.829	0.250 ± 0.944	First
0.822 0.177±	0.250± 0.518	0.250 ± 1.125	Second
0.685 0.177±	0.250± 0.727	0.250 ± 0.643	Third
±0.912 0.117	0.250 ±0.991	0.250 ±0.832	Fourth
---	0.125± 0.766	0.125 ± 0.886	Average
Site: G. M, treatment: N. M, interaction: N. M			LSD

Fourth: Co Enrichment Factor (EF)

The results of Table (6) indicate that there are significant differences between the site treatments. The first site recorded the highest average enrichment factor of 0.287 ± 2.278, indicating that the soil samples have a slight abundance. In contrast, the second site recorded the lowest average of 0.287 ± 0.685, which indicates the absence of an abundance of cobalt in the soil samples. Table (18) shows no significant differences between the agricultural and non-agricultural soil treatments, as the average of the non-agricultural soil treatment and the agricultural soil treatment amounted to 0.203 ± 1.627 and 0.203 ± 1.469, respectively. This indicates that the soil samples contain a slight abundance of the cobalt metal. These results agree with the study of Kadhimet. al. (2017). This is attributed to several reasons, the most important of which is the discrepancy in the intensity of traffic momentum (Issa and Al Jubouri, 2017). Referring to Table (3), the Table shows the presence of moderate contamination in the study samples. The concentrations of metals that fall within the category of slight abundance indicate that these metals are mainly derived from the rocks of the earth's crust (Abed et al., 2020).

Table (6): The cobalt enrichment factor values of the agricultural, non-agricultural, and study site soils

Average	Soil treatment		Site
	Non-Agricultural	Agricultural	
2.278 0.287±	0.406± 2.389	0.406 ± 2.167	First
0.658 0.287±	0.406± 0.792	0.406 ± 0.524	Second
2.000 0.287±	0.406± 1.750	0.406 ± 2.250	Third
±1.255 0.287	0.406 ±1.578	0.406 ±0.933	Fourth
---	0.203± 1.627	0.203 ± 1.469	Average
Site: 0.871, Treatment: N. M., interaction: N. M			LSD

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