Original Article

Cu, Pb, Zn,Cr and Cd concentrations in indoor dust in HadithaCity, Western Iraq, measured by washing with EDTANa2 - organic acid

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Abstract

In recent years, society's awareness of the presence of heavy metals in home dust has increased. Many cities have various levels of metal in their dust as a result of different regional pollution sources. Heavy metals are generated by both natural and man-made processes. The amount of heavy metals and minerals in the atmosphere is influenced by natural processes such as soil erosion, forest fires, volcanic eruptions, rock fracturing, dust, and forest fires. The sources of heavy metals in household dust include anything that people use or do in their houses, such as heaters, consumer products, building materials, and furniture. They also include activities like indoor smoking and incense burning, the color of the wall paint, as well as the entry of outside pollutants.In order to measure the levels of heavy metals ,the artificial chelating substance ethylenediaminetetraacetic acid disodium (EDTA) and low-molecular-weight organic acids (citric acid, oxalic acid, and tartaric acid) were chosen as the washing reagents. The washing solution utilized in the current study is made up of a mixture of (0.4 M) tartaric, oxyalic, and cetric organic acids and (0.2 M) EDTA. In accordance with the findings, the average amounts of these heavy metals in indoor dust were as follows: Zn (24.10± 15.93 mg/kg), Pb (19.52 ±14.74 mg/kg), Cr(8.73± 3.00 mg/kg), Cu (5.95 ±3.46 mg/kg), and Cd (3.25± 1.24 mg/kg).

Keywords: heavy metals; indoor dust; chelating; EDTA-organic acids.

1. INTRODUCTION

Soil washing, which has gained a lot of attention over the past 10 to 15 years, is one of the cutting-edge technologies that combines physical and chemical processes[1]. The method is widely employed to treat polluted soils and separates the most contaminated component of the soil for disposal[2].Different washing chemicals and HM removal techniques have been used[3]. The washing process is significantly impacted by the washing agent that is selected. To remove dangerous heavy metals from polluted soil, chelating chemicals, inorganic acids, and organic acids are typically utilized as washing agents. Particularly, it is known that both organic and inorganic acids considerably improve the extraction of heavy metals from contaminated soils[4]. Chelating agents and organic acids are frequently suggested as alternatives to mineral acid for washing that is less damaging[5]. Low-molecular-weight organic acids (LMWOAs) include acids like citric, tartaric, and oxalic, and a synthetic chelating molecule was selected[6]. Chelating chemicals are widely employed to enhance metal removal from soil. In this context, it is strongly recommended to use a biodegradable chelating agent with a high level of metal-specific selective coordination[7]. Some researchers have favored (LMWOAs) that include citric acid (CA). [8]. oxalic acid (OA)[9]. tartaric acid (TA)[10]. Previous research has mostly focused on the use of mixed washing reagents to eliminate soil pollutants at lower levels[11].

2. Materials and methods

2.1. Chemicals

Ethylenediaminetetraacetic acid disodium, used in this experiment was purchased from BDH company. Citric, oxalic and tartaric, were bought from Merck company, The Cu, Pb, and Zn (1000 mg.L−1) aqueous metal standard solutions made by the BDH company.

2.2. Sample Collection and Analysis

Indoor dust was sampled from the various indoor locations (including houses, schools, offices and mosques) in Haditha Center, west Iraq, throughout 2 months (October to November, 2021). 25 of the samples were collected from indoor locations, including furniture surfaces including desks, window sills ,chairs, lockers, and bookshelves. Sealable plastic bags were used to store the dust samples until their analysis in the lab. All samples were prepared by being dried in an oven at 80 degrees for 24 hours, and then they were sifted through stainless steel sieves measuring 53µm to exclude visible extraneous particles like hairs. About 2 g of dust samples were put in a series of 50 ml centrifuge tubes. The experimental groups' reagents were prepared by mixing 0.2 M EDTANa2and 0.4 M (tartaric, oxalic, and citric acids) in equal amounts. The pH of the combined reagent solutions was regulated to 7.0. Following that, 20 ml of the combined reagent solutions were applied to dust samples in 50 mL polyethylene centrifuge tubes. A horizontal shaker was used to shake tubes at 180 rpm for three hours at room temperature. Afterward, they were passed through a 0.45-m cellulose acetate disk filter[12]. FAAS (Model AA-Phoenix-986, American), was used to estimate the concentrations of heavy metals in the filtrate.

3. Results and discussion

Table (1) indicated that the values of copper concentrations obtained by the washing of soil technique for indoor dust ranged between (2.05 - 14.21) mg.Kg-1 and at a rate of (5.95) mg.Kg-1.In Figure(1), the spatial distribution of Cu content in samples of interior dust is displayed. It demonstrates that the site (8) of the interior dust sample had the lowest concentration while the highest concentration was at site (4).

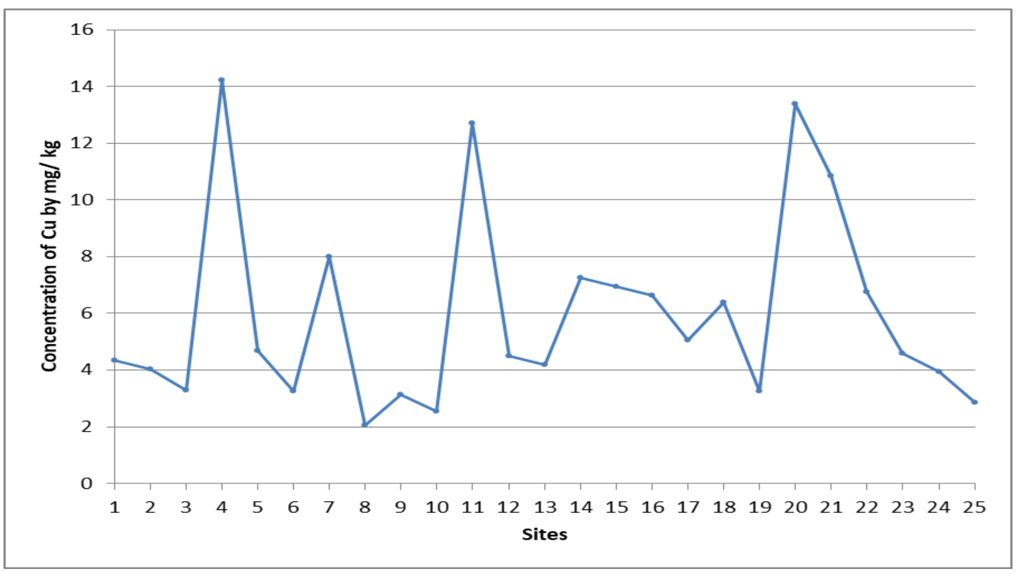

Figure 1: Spatial distribution of Cu concentration in indoor dust samples

The results indicated as shown in Table 1 that the values of lead concentrations in the internal dust ranged between (5.66-59.75) mg .Kg-1 and with average of (19.52) mg. Kg-1. Spatial distribution of Pb concentration in indoor dust samples is shown in Figure (2). It shows that the sample with the lowest concentration was located at the site (11) while the sample with the highest concentration was located in site (7).

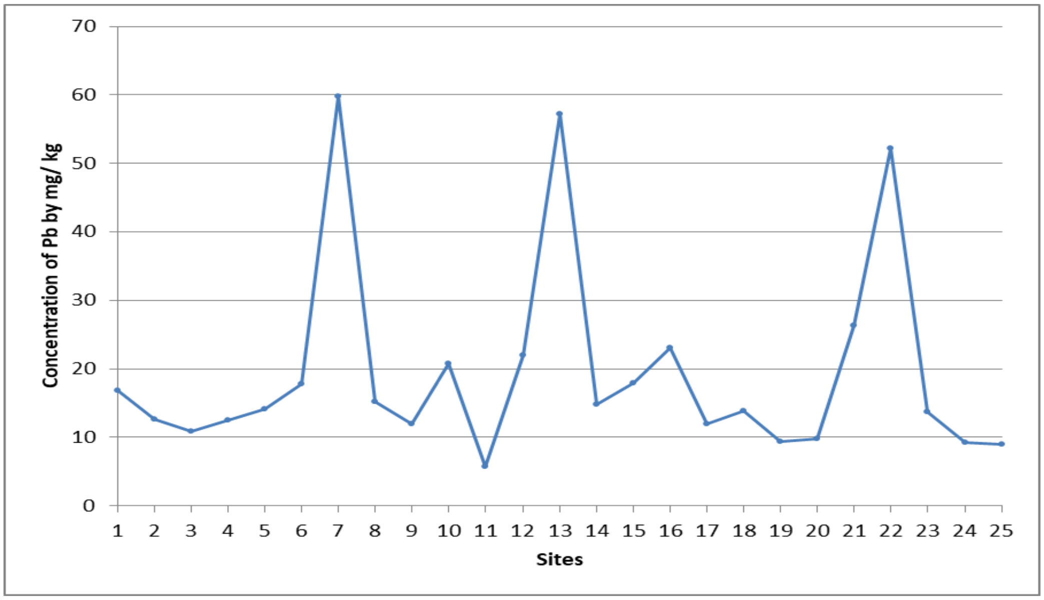

Figure 2: Spatial distribution of Pb concentration in indoor dust samples

According to the findings, which are shown in Table 1, The concentrations of zinc in the indoordust range from 6.02 to 66.45 mg.kg-1.with a rate of 24.10 mg.Kg-1.

Figure(3) illustrates the spatial distribution of the Zn concentration in interior dust samples. It shows that the concentration was lowest at site (17) and greatest at site (15), respectively.

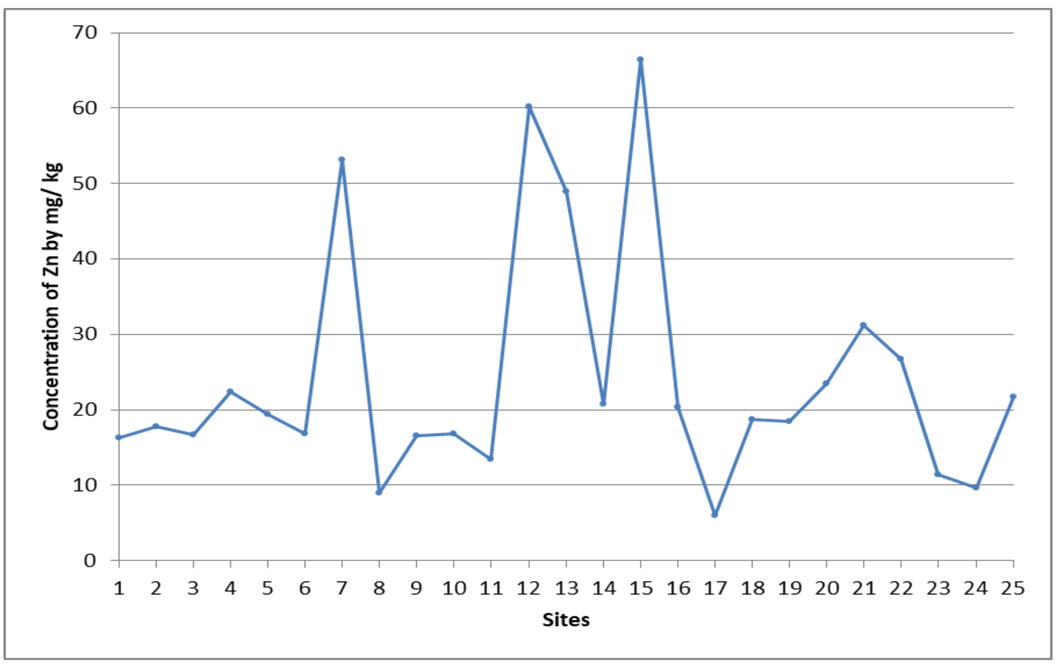

Figure 3: Spatial distribution of Zn concentration in indoor dust samples

According to the results displayed in Table 1, chromium concentrations in indoor dust ranged from 0.40 to 13.95 mg. Kg-1, with an average of 8.73 mg. Kg-1. Figure (4) displays the spatial distribution of the Cr concentration in samples of indoor dust It demonstrates that site (16) had the highest concentration of interior dust, whereas site (8) had the lowest.

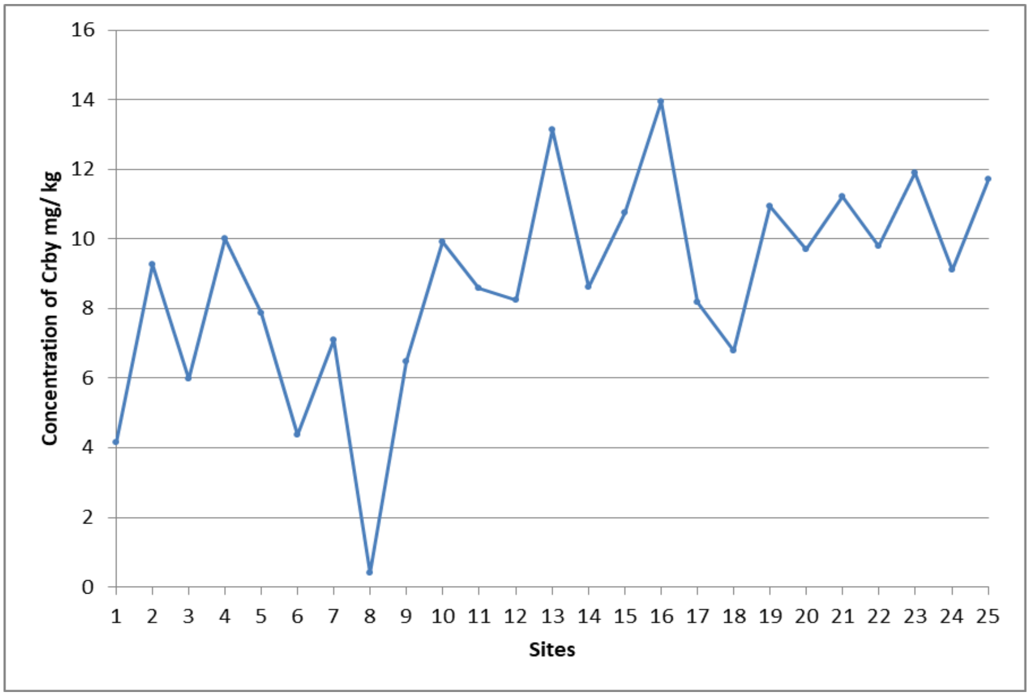

Figure 4: Spatial distribution of Cr concentration in indoor dust samples

Table 1 shows that the range of Cd levels in indoor dust after washing with EDTA-organic acid was (0.88 - 6.71) m.g Kg-1 and at a rate of (3.25) mg. Kg-1. The spatial distribution of Cd concentration in interior dust sample samples is shown in Figure (5). It reveals that the site with the highest concentration of Cd was at site(13), whereas the indoor dust sample site(8) had the lowest concentration of Cd.

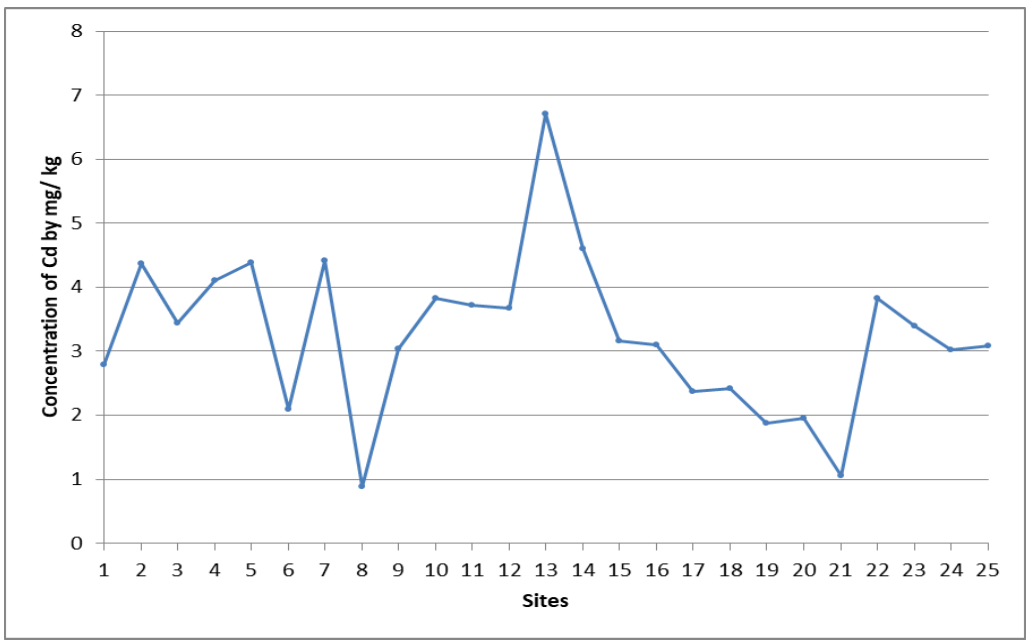

Figure 5: Spatial distribution of Cd concentration in indoor dust samples

The outcomes above can be summed up as shown in Table (1), Figures(6).

TABLE 1: Descriptive statistics for heavy metals in indoor dusts in different sites in Haditha city, mg/kg by washing with EDTA-organic acid

Indoor dust					
Heavy metals	**Cu**	**Pb**	**Zn**	**Cr**	**Cd**
Mean	**5.95**	**19.52**	**24.10**	**8.73**	**3.25**
Minimum	**2.05**	**5.66**	**6.02**	**0.40**	**0.88**
Maximum	**14.21**	**59.75**	**66.45**	**13.95**	**6.71**
Standard deviation	**3.46**	**14.74**	**15.93**	**3.00**	**1.24**

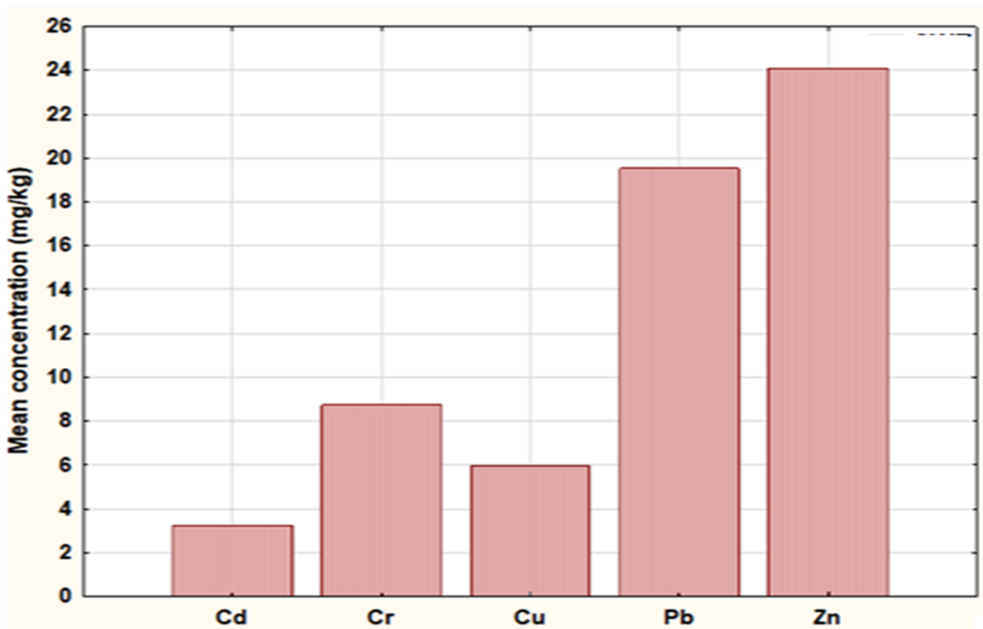

Figure 6 : The concentrations mean values of heavy metal in indoor dust in the study area measured by washing with EDTA-organic acid

The washing solution used in the current study consist of a mixture of (0.4 M Tartaric, Oxalic, and Cetric organic acids) with 0.2M EDTANa2 extracted concentrations (Cu, Pb, Zn) in the indoor dust. In order to enhance the ability of the combined reagents to chelate heavy metals, EDTA should be added. Heavy metal ions are released after the organic acids release hydrogen ions that dissolve carbonates, oxides, and hydroxides of metals. These heavy metal ions then expand with the negative ions of the organic acids to form single complexes[13].

4. Conclusions

According to the findings of the experiment, it has been shown that heavy metal extraction from polluted dust using a mixture of organic chelate and EDTANa2 is effective and has significantly fewer negative side effects than the majority of heavy metal extraction techniques. The outcomes revealed the mean concentrations of heavy metals in indoor dust were ranged in an descending order as follows: Zn (24.10 mg/kg) > Pb (19.52 mg/kg) > Cr(8.73 mg/kg) > Cu (5.95 mg/kg) > Cd (3.25 mg/kg)

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