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Detection of Heavy Metals Concentrations in Agriculture Plants Near Landfills: Case Study in Wadafiea, Sudan

Omer A. E. Abbass[1*], Abdelelah M. Elhassan[2], Abdelgadir E. Abdelgadir[1]

[1] Department of Environmental Science, Faculty of Science and Technology, Al-Neelain University, Khartoum 00000, Sudan
[2] College of Health Sciences, Abu Dhabi University, Abu Dhabi, UAE

Corresponding Author Email: elamin.omer6@gmail.com

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ABSTRACT

The study aimed to determine the levels of heavy metals in some selected plant samples near the Wadafiea Dumpsite in Khartoum North, Sudan, and compare the variations between dry and rainy seasons. Except for *Sudanese sorghum*, *Conocarpus lancifolius*, and *Leptadenia arborea*, zinc contents in all plant samples during the dry season were higher than WHO/FAO guideline value (5mg/kg). In the rainy season, Cd concentrations were generally lower than in the dry season due to rainfall dilution. According to the findings, an open landfill of solid waste could have a severe impact on the quality of plants in the research area and surrounding farms, perhaps causing future concerns for human health and the environment due to pollution.

1. INTRODUCTION

The rapid urban growth rate and economic growth have led to a significant increase in solid waste generation, which has had a significant impact on environmental parameters such as plants. Traditional waste management methods include collection and disposal, with different levels of processing depending on the type of waste and the area [1]. Depending on the type of waste and the location, a level of processing may occur after collection. This method aims to reduce waste hazards, recover material for recycling, generate energy from garbage, or reduce waste volume for more effective disposal. Over the years, managing various sorts of solid waste has been a difficult issue all over the world, including Sudan. Other waste management research findings revealed that levels of Knowledge, Attitudes, and Practices (KAP) influence waste management [2]. However, technological advancements and the resulting diversity of consumption have greatly altered the amount and character of municipal solid waste [3]. Millions of tons of solid garbage are produced every day, which is a persistent burden on human life, particularly in developing countries [4]. Different approaches in solid waste management lead to two destinations in big cities: recycling and disposal [5]. Landfilling is the most ancient technique of solid waste disposal and can be hazardous to both the environment and human health [6]. Landfills are the most extensively utilized method of municipal solid waste disposal in the world due to their ease of operation and low cost [7-9]. In buried solid waste, biological, physical, and chemical reactions occur, resulting in gas and leachate at landfill sites [10]. Although procedures like insulation and daily covering are employed to mitigate the environmental implications of landfilling, the features of leachate lead the landfill's environmental effects to be severe and diverse [11]. Leachate contains a variety of contaminants, including hazardous compounds and heavy metals, and has a high COD [12, 13]. Soil and water pollution in locations near landfills and places impacted by landfill leachate is a major concern in municipal solid waste management [14]. The decomposition of solid wastes releases chemicals that may alter the soil's nutrient composition and raise the concentration of heavy metals therein, changing the natural balance of nutrients available for plant growth and development and having an impact on the diversity of species and agricultural output. The main limiting factor dictating the course and character of biogeochemical development can be identified as heavy metals, which are the most prevalent pollutants in sewage sludge and trash. Heavy metals have a key role in the formation of soil and are taken up by vegetation [15]. The release of heavy metals into streams, lakes, rivers, and groundwater by acid rain that breaks down soils is another way that heavy metals can enter a water system [16]. Heavy metals are hazardous because they have a propensity to bio accumulate, which refers to an increase in chemical concentration over time within a biological organism relative to environmental concentration [17]. Metals such as Mn, Cu, Zn, Mo, and Ni are required or helpful micronutrients for microbes, plants, and animals. Their absence may result in deficiency disorders, but in high quantities, they all have substantial toxic effects and pose an environmental danger. Some heavy metals, such as Cd and Pb, are known to have little biological significance. Heavy metals have piqued the interest of scientists all around the world, owing to their detrimental impact on plants and other living organisms [18]. The heavy metal concentration of soils may be an important indicator for determining the dangers of trash dumps. Heavy metal deposition in soil may pose a major hazard to food safety and human health due to its toxicity, non-degradability, and persistence [19]. Because these contaminants have an impact on the environmental qualities in and around such open dumpsites, monitoring of soil qualities, particularly heavy metal concentration in dumpsites, becomes required, which may aid in the recommendation of appropriate remedial strategies [20]. The study's findings are anticipated to increase our understanding of the heavy metal toxicity hazards associated with solid waste dumps and, consequently, the viability of such locations for plant growth. It is well-recognized that heavy metals can lead to cancer and genetic abnormalities, among other health risks. They are among the main pollutants of leafy vegetables, ranking highly. They receive special attention globally due to their hazardous and mutagenic properties, even at very low doses [21]. The problem of solid waste extends beyond its creation or collection to include its disposal and the consequences it has on the surrounding ecosystem, including landfills, plants, soil, and nearby vegetation. In addition to being unsanitary and unsightly, the open dumping of solid waste fosters the growth of rodents, flies, mosquitoes, and other disease vectors. Among various solid waste disposal techniques, open waste dumping poses major issues and health dangers. Since the majority of these disposal locations aren't well considered, managed, or strategically placed, scavengers, animals, and vegetable growers frequently have access to them. The hazard to public health, the generation of methane gas (CH_4) from the decomposition of organic materials, and the toxicity to plants are some negative effects of dumpsites [22]. Therefore, the purpose of this study was to examine seasonal fluctuations in the concentration of heavy metals in plants (rainy and dry seasons) and to measure the contents of heavy metals in plants around solid waste dumpsites.

2. MATERIALS AND METHODS

2.1 Study area

This study was conducted during the period of (October 2019 to August 2020) in the landfill area and the surrounding areas in "Wadafiea landfill" located on the Eastern side of Kafoury, Norther side of Haj Youssef, and Southern of Napata, Khartoum North (Bahri), Khartoum State, Sudan. It lies between (Longitude 32° 603363 E and Latitude 15° 6762815 N) as shown in Figure 1.

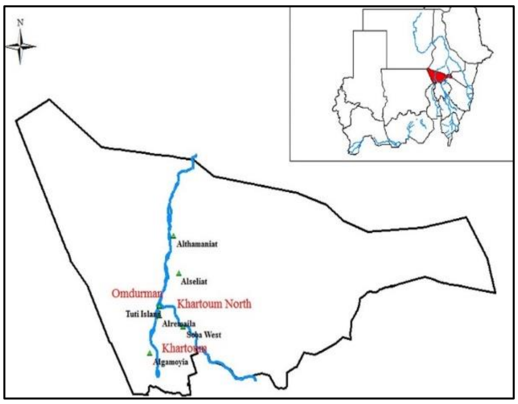

Figure 1. The study area in the Khartoum state map, Sudan

2.2 Laboratory tests

2.2.1 Collection and analysis of plant samples

Specialists from Al Neelain University's Faculty of Sciences and Technology gathered a total of twenty (20) plant samples called *Leptadenia arborea, Tamarix africana, Sudanese sorghum, Ricinus communis* and *Conocarpus lancifolius* from the dump and the surrounding area throughout two seasons, the dry season and the rainy season. Ten samples were taken from each season using random sampling. Plant samples were collected from farms on the dumpsite's south, west, and north edges at various sampling sites. All samples were packaged in bags and delivered to the laboratory of the Environmental and Natural Resources and Desertification Research Institute in Khartoum, Sudan, for analysis and testing.

2.2.2 Preparation of plant samples for Metal estimation

In a porcelain crucible, one gram of dried ground plant tissue was weighed and dried in a muffle furnace at 500°C. The ash was dissolved in 5 mL of 20% HCl, then filtered through acid-washed filter paper and diluted to volume with deionized water [23]. AAS was used to determine the heavy metals (Pb, Cd, Cr, Cu, Ni, and Zn) in the solution.

2.3 Data analysis

The data were analyzed with SPSS version (22) (univariate analysis of variance) to test the difference of variables.

3. RESULTS AND DISCUSSION

3.1 Level of heavy metals in *Leptadenia arborea* in the dry and rainy season

The levels of heavy metals in the plants that were tested varied from sample site to sampling site and from one species of plant to another. This may be due to the difference in the ability of plants to absorb some heavy metals through their roots and transport them to tissues. The content of heavy metals in the vegetation around the landfill was also measured during the dry and rainy seasons, and the results are shown in Table 1. The concentration results of (Cd, Cr, Cu, Ni, Pb and Zn) in the *Leptadenia arborea* at the southern side of the dumpsite during the dry season ranged from (0.115mg/kg), (2.075mg/kg), (2.915mg/kg), (0.125mg/kg), (1.225mg/kg) and (7.795mg/kg) respectively, while the concentration findings of (Cd, Cr, Cu, Ni, Pb, and Zn) in the *Leptadenia arborea* sample in the rainy season at the southern side were (0.11mg/kg), (0.22mg/kg), (2.00mg/kg), (0.26mg/kg), (0.61mg/kg) and (2.02mg/kg) respectively. The obtained results showed that the concentrations of (Cd, Cr, Cu, Ni, Pb and Zn) in *Leptadenia arborea* samples during the dry season at the western side (A), (B), and the northern side (A), (B) and the eastern side were ranged from (0.085mg/kg) to (7.27mg/kg), (0.06mg/kg) to (9.41mg/kg) and (0.06mg/kg) to (20.54mg/kg), (0.065mg/kg) to (0.505mg/kg) and (0.070mg/kg) to (6.505mg/kg) respectively, while those in the rainy season were ranged from (0.11mg/kg) to (2.08mg/kg) and (0.10mg/kg) to (4.63mg/kg) at the western (A) and (B) side respectively, (0.16mg/kg) to (2.51mg/kg) and (0.0 4mg/kg) to (2.15mg/kg) at the northern (A) and (B) side respectively and (0.07mg/kg) to (2.17mg/kg) at the eastern side. These results indicated that the concentrations of heavy metals in *Leptadenia arborea* samples during the dry and rainy seasons were higher than the controlled plant samples for (Cu) (0.44) and (Zn) (0.37mg/kg) except for Cu in the dry season which was found to be (0.435mg/kg) at the northern (B) side was lower than the controlled plant sample (0.44mg/kg). The concentrations of heavy metals (Cd, Cr, Cu, Ni, Pb and Zn) in all *Leptadenia arborea* samples were compared together in dry and rainy season, the sequence of concentration values in the dry season were (Zn > Cu > Cr > Pb > Ni > Cd) in the southern side, (Zn > Cu > Pb > Cr > Ni > Cd), (Zn > Cu > Cr > Pb > Cd > Ni) in the western (A) and (B) side, (Zn > Cu > Cr > Pb > Ni > Cd) and (Zn > Cu > Pb > Cr > Ni > Cd) in the northern (A) and (B) side while those sequence in the rainy season was (Zn > Cu > Pb > Ni > Cr > Cd) in the southern side , (Zn > Cu > Pb and Ni > Cd > Cr) in the western (A) side , (Zn > Cu > Pb > Cr > Cd > Ni) in the western (B) side and (Zn > Pb > Cu > Ni > Cr > Cd) , (Zn > Cu > Cd > Pb > Ni > Cr) in the northern (A) and (B) side and (Zn > Cu > Pb > Cd > Ni > Cr) in the eastern side. According to heavy metal findings for (Cd, Cr, Cu, Ni, Pb, and Zn) in *Leptadenia arborea* in the dry season, the concentration levels of (Cd, Cr, Cu, Ni, Pb, and Zn) were found to be higher than the concentration levels of (Cd, Cr, Cu, Ni, Pb and Zn) in the rainy season.

Table 1. The level of heavy metals (mg/kg) in *Leptadenia arborea* during the dry and rainy seasons

Parameters	*L. arborea* - South Dump		*L. arborea* West Dump (A)		*L. arborea* West Dump (B)		*L. arborea* North Dump (A)		*L. arborea* North Dump (B)		*L. arborea* East Dump		Control	WHO/FAO (2007)
	D	**R**	**D**	**R**	**D**	**R**	**D**	**R**	**D**	**R**	**D**	**R**		
Cd	0.115	0.11	0.085	0.120	0.08	0.110	0.06	0.160	0.065	0.220	0.07	0.190	ND	0.20
Cr	2.075	0.22	0.350	0.110	1.595	0.120	0.810	0.310	0.245	0.040	1.335	0.07	ND	-
Cu	0.915	2.00	2.825	2.030	4.06	2.710	20.54	2.210	0.435	2.150	2.89	2.140	0.44	40
Ni	0.125	0.26	0.105	0.160	0.06	0.10	0.120	0.340	0.230	0.150	0.180	0.18	ND	-
Pb	1.225	0.61	1.180	0.160	0.920	0.220	0.805	2.450	0.320	0.210	0.365	1.180	ND	60
Zn	7.795	2.02	7.270	2.080	9.410	4.630	9.290	2.510	0.505	2.090	6.505	2.170	0.37	5

ND: Not Detected; D: Dry season; R: Rainy season

Table 2. Heavy metal contents (mg/kg) in *Tamarix africana* in dry season and rainy season

Plant Species	Cd	Cr	Cu	Ni	Pb	Zn
Tamarix africana South dump / Dry season	0.415	0.435	1.810	0.155	0.415	7.395
Tamarix africana South dump / Rainy season	0.100	0.340	1.570	0.230	1.190	1.470
Tamarix africana	ND	ND	0.29	ND	ND	0.90
WHO/FAO (2007)	0.20	-	40	-	60	5

ND: Not Detected

Table 3. Heavy metal concentration (mg/kg) in *Sudanese sorghum* at dry season and rainy season

Plant Species	Cd	Cr	Cu	Ni	Pb	Zn
Sudanese sorghum South dump / Dry season	0.085	1.980	0.555	0.200	0.325	1.080
Sudanese sorghum South dump / Rainy season	0.130	0.130	0.510	0.150	1.160	0.420
Sudanese sorghum	ND	ND	0.040	ND	ND	0.930
WHO/FAO (2007)	0.20	-	40	-	60	5

ND: Not Detected

Table 4. Heavy metal concentration (mg/kg) in *Ricinus communis* at dry season and rainy season

Plant Species	Cd	Cr	Cu	Ni	Pb	Zn
Ricinus communis West dump / Dry season	0.055	0.865	2.840	0.115	0.835	8.460
Ricinus communis West dump / Rainy season	0.970	0.150	2.300	0.170	1.250	2.770
Ricinus communis	ND	ND	0.280	ND	ND	0.96
WHO/FAO (2007)	0.20	-	40	-	60	5

ND: Not Detected

Table 5. Heavy metal concentration (mg/kg) in *Conocarpus lancifolius* at dry season and rainy season

Plant Species	Cd	Cr	Cu	Ni	Pb	Zn
Conocarpus lancifolius Farm / Dry season	0.120	1.060	1.655	0.175	0.970	3.345
Conocarpus lancifolius Farm / Rainy season	0.130	1.190	1.690	0.250	0.450	1.380
Conocarpus lancifolius	ND	ND	0.430	ND	ND	0.100
WHO/FAO (2007)	0.20	-	40	-	60	5

ND: Not Detected

3.2 Heavy metal concentration in *Tamarix africana* During the dry season and rainy seasons

Tamarix africana sample at the southern side of the dump site area in the dry season ranged from (0.415mg/kg), (0.435mg/kg), (1.810mg/kg), (0.155mg/kg), (0.415mg/kg) and (7.395mg/kg) while the concentrations in the rainy season were (0.10mg/kg), (0.34mg/kg), (1.57mg/kg), (0.23mg/kg), (1.19mg/kg) and (1.47mg/kg) respectively. In *Tamarix africana* samples, heavy metals were found in the following order: Zn > Cu > Cr > Pb and Cd > Ni in the dry season, and Cu > Zn > Pb > Cr > Ni > Cd in the season of rainfall. Cu and Zn had the highest values in the *Tamarix africana* sample throughout both the dry and rainy seasons. The findings of *Tamarix africana* samples explained that the values of (Cd, Cr, Cu, Ni, Pb, and Zn) were lower than those of the controlled samples limits and the WHO / FAO guideline value [24] except the values of Zn (7.395mg/kg) and Cd (0.415mg/kg) were higher than the WHO/FAO guideline values [24] for Zn and (0.20mg/kg) for Cd respectively. In the controlled samples, no trace of Cd, Cr, Ni, or Pb was detectable Table 2.

3.3 Heavy metal concentration in *Sudanese sorghum* at dry season and rainy season

The results regarding heavy metal content in *Sudanese sorghum* samples collected on the southern side near the dumping area for solid waste during the dry and rainy periods are presented in Table 3. The obtained results confirmed that the values of (Cd, Cr, Cu, Ni, Pb, and Zn) in plant samples ranged from (0.085mg/kg), (1.980mg/kg), (0.555mg/kg), (0.200mg/kg), (0.325mg/kg) and (1.080mg/kg) respectively, while those in the rainy season were (0.13), (0.13), (0.51), (0.15), (1.16) and (0.42) respectively. The sequence of concentration values in *Sudanese sorghum* during the dry season was Cr > Zn > Cu > Pb > Ni > Cd, while the sequence in the rainy season was Pb > Zn > Cu > Ni > Cd and Cr. These results presented that the concentration levels of heavy metals in the dry season were greater than in the rainy season, except for the value of Pb (1.16) in the rainy season that exceeded the level of the dry season (0.325), all findings of (Cd, Cr, Cu, Ni, Pb, and Zn) in plant samples were far greater than the controlled samples and no trace of (Cd, Cr, Ni, and Pb) was detectable in the controlled plant samples except, the value of Zn (0.93) which was found to be higher than the plant samples in the rainy season (0.420) and the value of (Cd) (0.085) in the dry season was found to be lower than the sample in the rainy season (0.130). The plant sample concentration values in the dry and rainy periods were within the acceptable limits recommended by WHO / FAO guideline values [24].

3.4 Heavy metal concentration in *Ricinus communis* in dry season and rainy season

Table 4 shows the results of heavy metals in *Ricinus communis* on the western side of the dumping site during the dry and rainy seasons. In the dry season, the results were (0.055), (0.865), (2.840), (0.115), (0.835), and (8.460), while in the rainy period, the results were (0.97), (0.15), (2.30), (0.17), (1.25), and (2.77). According to these findings, the sequence of (Cd, Cr, Cu, Ni, Pb, and Zn) in *Ricinus communis* in the dry season was Zn > Cu > Cr > Pb > Ni > Cd, but in the rainy period, it was Zn > Cu > Pb > Cd > Ni > Cr. These results showed that the tested Zn and Cu had the greatest concentration levels in plant samples, and all dry season results were greater than rainy season results and fell within the permissible limits of control plant samples recommended by WHO/FAO guideline values [24].

3.5 Heavy metal concentration in *Conocarpus lancifolius* at dry season and rainy season

Table 5 shows the concentration levels of (Cd, Cr, Cu, Ni, Pb, and Zn) in *Conocarpus lancifolius* samples collected during the dry and wet seasons on the northern side of a solid waste dumping site. The illustrated results of the concentration values of the heavy metals in the dry season were (0.120), (1.060), (1.655), (0.175), (0.970), and (3.345), while in the rainy season they ranged from (0.13), (1.19), (1.69), (0.25), (0.45) and (1.38). The sequence of concentration of plant samples in the dry season was Zn > Cu > Cr >Pb > Ni > Cd, while in the rainy season it was Zn > Cu > Cr > Pb > Ni > Cd. The results in Table 5 demonstrated that no trace of Cd, Cr, Ni, or Pb was detected in plant control samples, and accumulation of Cd, Cr, Cu, Ni, Pb, and Zn was observed in plant samples, but none of them exceeded the standard levels of the WHO/FAO guideline values [24], but the level concentration values of plant samples exceeded the standard level of plant control samples.

The study found higher absorption and accumulation of metals in plants during the dry season. This may be due to organic matter decomposition, which releases toxic metals into the soil solution for plant uptake. These findings corroborated the findings of the study [25], who reported that the highest amounts of Cu, Pb, and Zn were found in dry season soil samples from Mokolo, probably due to much higher fertilizer and pesticide use in that area compared to the other three study sites. These findings lined up with those of the study [22], who claimed that the concentration of heavy metals in all samples cultivated near the dumping site was higher than in those from the control location. This fact suggests that the waste dump has had an impact on the quality of crops growing in the surrounding area. The results of the heavy metals in plants explained that the highest values were detected in samples. Although heavy metals are recognized as essential elements for plants, higher concentrations of these heavy metals may be toxic, and heavy metal accumulation in the plant will cause health problems for people living in the landfill, nearby residential areas, and farms adjacent to the dumping site. Also, these plants are commonly used to feed the residents' animals. The results found that, the plants absorbed large amounts of heavy metals from the soil around the dumping site, and this is also evident in the case of the higher concentration of soil which could be attributed to the mobility of metals from dumping sites to lands and plants around the dumping site through leaching and runoff. These findings were consistent with [26], who observed that the grass *Pennisetum purpureum* absorbed significantly more Cd and other HMs in the landfill than I. aquatica, possibly due to the deeper roots of the grass grown in soils, which increases its ability to absorb heavy metals.

3.6 The variation of total heavy metal concentration in plant samples in dry and rainy seasons

The mean variation between the total heavy metal concentrations in the dry and rainy seasons is presented in Table 6. The mentioned results of the concentration values of heavy metals n the dry season in all plant samples ranged from 2.416 mg/kg in *Leptadenia arborea*, 1.771 mg/kg in *Tamarix africana*, 0.704 mg/kg in *Sudanese sorghum*, 2.202 mg/kg in *Ricinus communis* and 1.221mg/kg in *Conocarpus lancifolius* while in the rainy season they ranged from 1.015mg/kg, (0.817 mg/kg), 0.417 mg/kg, (1.268 mg/kg) and 0.849 mg/kg, respectively. These findings could be explained by the considerable difference in average concentrations of heavy metals at the sampling location between the dry and rainy seasons, and in most cases, readily available minerals are absorbed by the plants in high quantities in the soil solution. While some metals are present in soluble forms for plant uptake, others appear as insoluble precipitates and are thus inaccessible to plants. According to these findings, the concentration of heavy metals in plant samples during the dry season was higher than the concentration of heavy metals during the rainy season.

Table 6. The variation of total heavy metal concentration (mg/kg) in plant samples in dry and rainy seasons

Season	Mean Value	Std. Deviation
	Leptadenia arborea	
Dry season	2.416	4.1360
Rainy season	1.015	1.1480
	Tamarix africana	
Dry season	1.771	2.8180
Rainy season	0.817	0.6660
	Sudanese Sorghum	
Dry season	0.704	0.6740
Rainy season	0.417	0.3760
	Ricinus communis	
Dry season	2.202	3.2260
Rainy season	1.268	1.0833
	Conocarpus lancifolius	
Dry season	1.221	1.1189
Rainy season	0.849	0.6141

Means in a column with superscript letters are significantly different ($P<0.05$).

3.7 The variation between total heavy metal concentrations in plant samples

The difference in total heavy metal concentrations Cd, Cr, Cu, Ni, Pb, and Zn (mg/kg) for plant samples from different sites was obtained in Table 7, demonstrating that the mean concentrations of total heavy metals Cd, Cu, Pb, and Zn (mg/kg) with respect to the WHO/FAO [24] standard are significantly different (P 0.05) in seasons. This outcome could have been impacted by the materials dropped at the site as well as the species' hyperaccumulation potentials at the location. These findings were reinforced by a study conducted by [27] in Nigeria, which found an overall reduction in heavy metal concentration in vegetable samples during the rainy season when compared to similar samples during the dry season. This could be because rainwater has the potential to leach away sections of the metals that have accumulated in the soil during the rainy season, limiting the amount of these metals available to plants in the soil. These findings were similar to those found by [28] in central Cameroon, where they noted that runoff may impair the removal ability of PTEs from agricultural land, resulting in increased concentrations of these elements during the dry season. During the dry season, evaporation is also more intensive, resulting in a larger concentration of soil solutions. Meanwhile, rainfall may dilute the soil solution, aiding in the leaching of PTEs from the soil into groundwater. Therefore, the general trends in the concentration of heavy metals in plant samples around "Wadafiea landfill" according to readings obtained for all plant samples were Zn > Cu > Pb > Cr > Ni > Cd (*Leptadenia arborea*), Zn > Cu > Pb > Cr > Cd > Ni (*Tamarix africana*), Cr > Pb> Ni > Zn > Cu > Cd (*Sudanese Sorghum*), Zn > Cu > Pb > Cd > Cr > Ni (*Ricinus communis*) and Zn > Cu > Cr > Pb > Ni > Cd (*Conocarpus lancifolius*). No abnormal total mean heavy metal concentration was observed in plant samples in Table 7. All the concentration values were within the acceptable range of WHO/FAO [24]. Therefore, the high concentration of Zn, Cu, and Pb in plant samples from the area around the landfill is a major concern. These high levels of Cu, Pb, and Zn in plant samples could be due to improper disposal of metal scraps or other metal-containing products like paints and cosmetics, or to medical wastes, factory wastes, and industrial wastes that are regularly deposited at the "Wadafiea landfill." These findings concurred with the findings of a study conducted by Dos Reis et al. [29], which stated that agrochemicals, heavy metals, and other waste residues leaching from surrounding residential areas and construction sites located at higher altitudes add these elements to the soils, and their presence can be found in the environment decades later, and also agreed with the findings of a study conducted by Nana et al. [28], which stated that heavy metal distribution was significant It could also come from different types of pollution, such as solid waste and e-waste, both of which are commonly burned near farms. Furthermore, because the locations are densely populated, they may be supplied with construction materials.

Table 7. The variation between total heavy metal concentrations (mg/kg) in plant samples

Heavy Metal	Mean Value	Std. Deviation
	Leptadenia arborea	
Cd^{e}	0.1154	0.05083
Cr^{d}	0.6067	0.65290
Cu^{b}	3.9082	5.30540
Ni^{f}	0.1676	0.07810
Pb^{c}	0.8041	0.65720
Zn^{a}	4.6896	3.19560
	Tamarix Africana	
Cd^{e}	0.2575	0.22274
Cr^{d}	0.3875	0.06718
Cu^{b}	1.6900	0.16971
Ni^{f}	0.1925	0.05303
Pb^{c}	0.8025	0.54801
Zn^{a}	4.4325	4.18961
	Sudanese sorghum	
Cd^{f}	0.1080	0.02450
Cr^{a}	1.0550	1.01330
Cu^{e}	0.5330	0.02560
Ni^{c}	0.1750	0.28110
Pb^{b}	0.7440	0.45920
Zn^{d}	0.5610	0.55710
	Ricinus communis	
Cd^{d}	0.5125	0.64700
Cr^{e}	0.5075	0.50558
Cu^{b}	2.5700	0.38184
Ni^{f}	0.1625	0.01061
Pb^{c}	1.0425	0.29345
Zn^{a}	5.6150	4.02344
	Conocarpus lancifolius	
Cd^{f}	0.1250	0.00840
Cr^{c}	1.1250	0.07180
Cu^{b}	1.6720	0.02020
Ni^{e}	0.2140	0.04280
Pb^{d}	0.7100	0.28500
Zn^{a}	2.3630	1.07630

Means in a column with superscript letters are significantly different ($P<0.05$).

4. CONCLUSIONS

Due to the rapid growth of the population, the amount of waste has increased, which puts more pressure on production to meet the needs of the population. The dumping of wastes into the environment will cause a large number of heavy metals and other pollutants to be released into the soil, causing serious damage to the ecosystem and harming the prosperity of populations and also plants that depend on soil nutrients for growth. The results of this study found that the plants absorbed a large number of heavy metals from the soil around the dumping site in the dry season, while in the rainy season, the possibility of rainwater leaching away some of these metals could accumulate in the soil, which reduced the amount of these metals available to plants in the soil and found that, the landfill affected the quality of any plants, such as crops grown around the area. The Wadafiea landfill is a multifaceted problem that affects soil and plant quality, causes environmental pollution and causes serious problems in terms of human health.

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NOMENCLATURE

Pb	Lead
Cd	Cadmium
Cr	Chromium
Cu	Copper
Ni	Nickel
Zn	Zinc
AAS	A flame Atomic Absorption Spectrophotometer
Mg/kg	Milligrams per liter
WHO	World Health Organization
FAO	Food and Agriculture Organization
COD	Chemical Oxygen Demand
Mn	Manganese
Mo	Molybdenum
SPSS	Statistical Package for the Social Sciences
E	East
N	North
HMs	Heavy metals
CH_4	methane gas
PTEs	Potentially Toxic Elements