Alqalam Journal of Medical and Applied Sciences. 2025;8(2):816-826
https://doi.org/10.54361/ajmas.258238

Original article

Estimate of the Concentrations of Heavy Metals in Soil and Some Plant Samples Collected from (Near and Far away) of the Main Road between Al-Bayda City and Wadi Al-Kouf Region

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Abstract
This study was conducted on soli and the leafs and stem samples of Artemisia and Junipers plants collected from three areas located at west of the Al-Bayda city included (Farshita - Sidi Abdel Wahid - Wadi Al-Kouf regions) on the main road between Al-Bayda City and Wadi Al-Kouf region for estimate some of heavy metals in soil and some plants, as juniper and terabits plants samples collected during the fall and winter seasons. This study included five heavy metals: lead, cadmium, iron, chromium, and manganese. The results showed that the heavy metals detected in plants had different contents, where the highest concentration was recorded in the soil samples during the two seasons compared with their contents in leaves and stems. The concentration of cadmium showed lower concentrations in the leaves and stems in the third region, comparing to highest concentration of 19.669 ppm which observed in the stems in the area near the road, as well as chromium, recorded highest concentration of 231.014 ppm in the third region in the soil near the road, and its lowest concentration was 0.925 in the stems in the third region located far from the road, while for iron, the results showed highest concentration of 3516.9 ppm was the winter season for the soil sample of the area far from the road, and its lowest concentration was 67.665 ppm in the third region in the leaves of the *Juniperus* plant near the road. The highest concentration of lead was recorded in the first zone for the *Juniperus* plant, of 78,384 ppm near the road during the autumn, and the lowest concentration was recorded in the leaves in the third zone away from the road. The concentration of manganese in the first zone near the road in the soil was up to 2126 ppm in the winter in the *Artemisia* plant, and the lowest concentration was up to 9.862 ppm in the *juniper* plant in the third zone near the road in the stems.
Keywords: Heavy Metals, Artemisia, Junipers, Soli, Libya.

Introduction

Soil is an essential resource for life on planet Earth, supporting plant growth and affecting different ecosystems. However, heavy element pollution is one of the biggest environmental challenges that threaten soil quality and the health of living organisms [1]. Heavy metals result from natural sources, such as natural weathering of rocks, or from human activities, such as agriculture, industry, mining, and transportation [2]. Some metals, such as lead (Pb), cadmium (Cd), zinc (Zn), copper (Cu), nickel (Ni), and mercury (Hg) are among the most prevalent heavy metals in soil and plants. The accumulation of heavy metals in the soil may lead to negative effects on plant growth, as these minerals can lead to root poisoning, which weakens the absorption of water and nutrients [3].

The absorbability of these metals varies between different soil types, depending on several factors, such as pH, organic matter, and cationic exchange capacity (CEC) [4]. For example, increasing the acidity of the soil increases the solubility of heavy metals and makes them more available to plants, while alkaline soil reduces the absorption of these metals [2]. For plants, the accumulation of heavy metals in their tissues depends on factors such as the type of plant, the rate of absorption, and the presence of internal defense mechanisms that help reduce the toxic effects of these metals. Some plants can withstand high concentrations of heavy metals through mechanisms such as: soilation in cell walls, formation of complex compounds within the succulent vacuoles, or stimulation of antioxidant enzymes to reduce oxidative stress [5]. For example, some plants such as sunflower (Helianthus annuus) and mustard (Brassica juncea) have shown the ability to absorb and accumulate heavy metals, making them suitable for use in phytoremediation to remove pollution from the soil [6].

Studies indicate that industrial areas and sites near highways contain high concentrations of heavy metals due to emissions from vehicles and chemical industries [7]. The excessive use of phosphate fertilizers and pesticides in agriculture contributes to the accumulation of some heavy metals in the soil, which may lead to their entry into the food chain and their impact on human health [1]. Therefore, monitoring the levels of heavy metals in the soil has become an environmental necessity to protect ecosystems and ensure the safety of agricultural products. The study of concentrations of heavy metals in soil and plants is an important aspect of environmental and agricultural research, as it can help develop effective strategies to manage pollution and reduce its risks to the environment and public health. The application of bioremediation techniques, such as plant treatment using over-accumulated plants, can contribute to the removal of environmental pollution in a sustainable and environmentally friendly manner [8]. This study aims to determine the extent of knowledge of estimating the concentrations of heavy metals in the soil, and some plants (*Artemisia* and *juniper* plants) west of Al-Bayda city.

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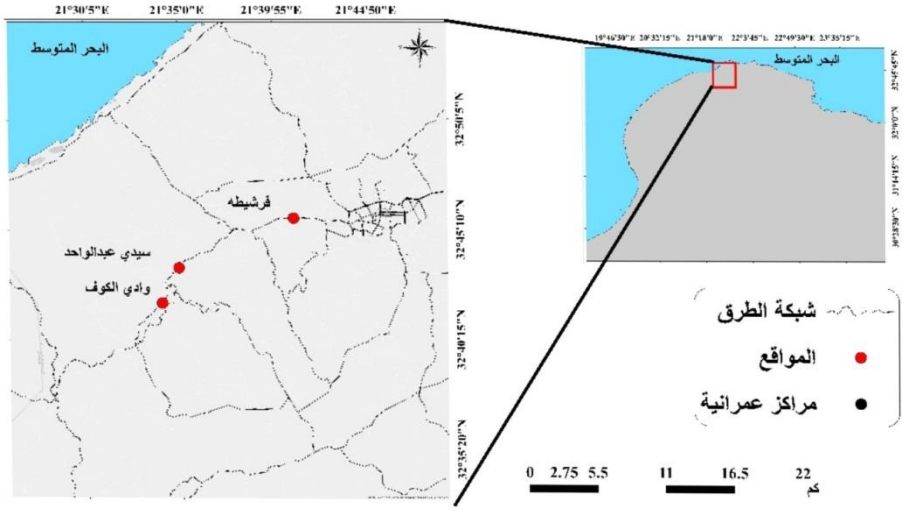
***Received**: 03-03-2025 - **Accepted**: 30-04-2025 - **Published**: 06-05-2025*

Methods

Study Areas

These areas were randomly selected based on agriculture and associated with the nearby city of Al-Bayda. Mountainous areas in Libya, such as Farshita, Sidi Abdel Wahid, and Wadi El Kouf, are part of the Green Mountain region in the northeast of the country. This region is characterized by its mountainous terrain and moderate climate, which makes it an important agricultural area. Farshita: It is a village west of the old corner of Al-Bayda city in Libya. Sidi Abdel Wahed: It is a village located about 15 km west of Al-Bayda city, northeast of Libya, and follows Al-Bayda center in the municipality of Jabal Al-Akhdar. Wadi Al-Kuf: Wadi Al-Kuf is located in the Green Mountain in eastern Libya, about 20 km west of the city of Al-Bayda. Map, 1.



Map 1. The area of study

Samples and Sampling

The leaves and stems of the *juniper* and the *Artemisia* plants and the soil surrounding the plant were selected in this study. The samples were collected from three different areas west of the city of Al-Bayda, namely (the area of Mesa, Sidi Abdel Wahed, and Wadi Al-Kouf). Seventy-two (72) samples were collected from the juniper Artemisia plants and the soil surrounding the plant over two seasons, autumn and winter of 2023, where 36 samples were collected in the autumn and 36 samples in the winter.

The samples were taken from three different areas, and samples were collected near the highway from Al-Bayda city to Wadi Al-Kuf, and other samples were far away (about 5 Km from the road), and these samples were left in the air away from pollution until dryness, then placed in the drying oven to make sure that they were dry. After drying, each sample was taken separately, and ground using the grinder to the desired degree of smoothness, then the samples were placed in sealed plastic boxes.

After drying and grinding the sample, the digestion process was carried out and about 0.5 grams were taken from each sample separately using the sensitive scale. About 5 ml of concentrated nitric acid was added with the addition of 25 ml of distilled water, and it is placed on a hot surface in the gas cupboard until near dryness and the sample is cooled, and it is filtered by the filtration paper, and it is completed to 100 ml of the sample. The metals were determined by atomic absorption spectrophotometer (AAS) at Omar Al Mukhtar University [9 -17].

Results

The results of this study were explained according to the type of each area and the location of collected samples and given in Tables of 1 -12 as follows:

The area of Farshita (near the road around the juniper plant)

For the concentrations of heavy metals of the first area which near the road , the results showed a different variation in the concentrations of heavy metals the juniper plant between the samples located at near and far from the road of leafs and soil in the juniper plant, where the concentration of cadmium in the leafs and stems is non-existent, the concentration of cadmium in the soil was 4.176 ppm, the concentration of cadmium in winter is 0.171 ppm in the leafs, the concentration of the stems is 19.669 ppm in the soil is 5.562 ppm , the concentration of iron is 354.553 ppm and in the stems is 362.665 ppm , and in the soil is 59487.35 ppm , so it was found that the concentration of iron in the soil is high in the autumn, as a result of the climate and the decline of the wind, the iron element in winter, so it is 227.28 ppm , and in the stems249.36, the soil is 36647.24 mg, so we can see that the concentration of iron in the soil element is higher than the leafs and branches.

As for the element chromium, its concentration in the autumn was 0.727 in the leaves, 0.474 ppm in the branches, and 105.498 ppm in the soil. Here, too, its concentration in the soil is higher than in other

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Received: *03-03-2025* - ***Accepted***: *30-04-2025* - ***Published***: *06-05-2025*

samples. As for its concentration in winter, it was in leafs 2.929 ppm, in stems3.009 ppm and in soil 137.724 ppm as well as in winter, the concentration of chromium was high in the soil due to rainfall on the branches, and this led to the fall of the concentration of metals and absorbed by the soil. The concentration of manganese was in leafs 50.815, in stems 40.8, and in soil 1401.36 ppm. In autumn, it was found that the element of manganese had a high concentration in the soil or in winter, so its concentrations in leafs were 49.967, in stems12.339, and in soil 1848.063, as well as the concentration of manganese was high in the soil, or the element of sorbent, so its concentration during autumn was in leafs 4.971, and in stems up to 2.148 ppm and in soil 43.067 ppm or the concentration of lead in winter in leafs is absent, and in stems was 3.781 ppm and in soil 39.869 ppm as well as we say here that the element is left in a high soil, Table 1.

Table 1. The concentrations of heavy metals in the leafs, stems, and soil of the area near the road of the juniper plant.

Near the road	Soil		Stems		leafs	
	Winter	**Autumn**	**Winter**	**Autumn**	**Winter**	**Autumn**
Cadmium	5.562	4.176	19.669	ND	0.171	ND
Iron	36647.24	59487.35	249.36	362.665	227.284	354.553
Chromium	137.724	10.4985	3.009	0.474	2.929	0.727
Manganese	1848.063	1401.36	12.339	40.8	49.967	50.815
Lead	39.869	43.067	3.781	2.148	ND	4.971

The area of Farshita (Far away area around the juniper plant)

The concentration of the first area far from the road of the juniper plant showed that the concentrations of lead in the fall in the leafs were 4.367 ppm in the stems 4.297 ppm and in the soil 44.93 ppm and it recorded the highest concentration in the soil or its concentration in the winter in the leafs and stems is non-existent, and in the soil 60.53, and here the vipers recorded that its concentration in the soil is high during the autumn and winter, and the cadmium element in the fall was 0.875 ppm in the leafs, and in the stems it was non-existent.

In the soil, the concentration of cadmium during the winter was 0.225 ppm in the leafs, in the stems it was absent, and in the soil, it was 7.507. Here, cadmium recorded the highest concentration in the soil during the quarter, and the concentration of cadmium was due to weather factors such as wind and rain. The iron element in the fall was 237.578 ppm in the leafs, 531.656 ppm in the branches, and 1031563 in the soil, while its concentration in the winter was 472.69 ppm in the leaves, and in the stems, it was 237.207, and in the soil 48428.77. Here is also the concentration of an element, Iron in soil is high. As for the element chromium, its concentrations during the autumn season in the leafs were 0.296, its concentration in the stems was 1.84 ppm, and its concentration in the soil was 104.478 ppm, while its concentration during the winter was in the leafs 3.387, in the stems3.037 and in the soil 189.398, as well as here the concentration of chromium in the soil is high during the two seasons. As for the element manganese, its concentration during the autumn was in leafs 61.902 ppm, and its concentration in stems was 41.377 ppm, and in soil 1480.45 ppm, and its concentration during the winter was in leaves 24.1 ppm, and in stems 16.062, and in soil 1757.757 ppm. It was also found here that the concentration of the element manganese is high in the soil during the two seasons, Table 2.

Table 2. The concentrations of heavy metals for the leafs, stems, and soil in the area of the juniper plant

Far from the road	Stems		Leafs		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	4.367	ND	4.297	ND	44.93	60.53
Cadmium	0.875	0.225	ND	ND	4.332	7.507
iron	531	2377.207	472.69	237	103156.3	48428.77
chromium	0.296	3.87	1.84	3.037	104.478	189.389
Manganese	61.902	24.1	41.377	16.062	1480.45	1757.757

The area of Sidi Abdel Wahid (near the road around the juniper plant)

Concentrations of the second area near the road for the juniper plant, the concentration of cadmium in the juniper plant was in the second area near by its ratio in autumn in leafs 15,931, and in stems it was non-existent, and in the soil it was 4.341, and its concentrations during winter were in leafs 0.248 ppm, and its concentration in stems0.372, and in soil 6.308, where the results showed that the concentration of cadmium in the soil during autumn is high in the leafs, and its concentration in winter is high in the soil. Lead was concentrated during autumn in leafs 3.692 ppm, in stems 4.648 ppm, and soil 39.573.

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*

As for its concentrations during the winter season, they were as follows: in the leafs there was no, in the stems it was 1.809, and in the soil, it was 41.949 ppm, and here it was found that the concentration of lead element is high in the soil during the autumn and winter seasons. As for the iron element, its concentrations during the autumn season were in leafs 177.772 ppm, in stems 451.15 ppm and in soil 10170.45 ppm, while its concentrations during the winter were in leafs 370.994 ppm, in stems459.498 ppm, and in the soil 44042.92 ppm, and here the results showed that the concentration of iron element was high in the soil during the winter or chromium element. Its concentration during the autumn season was in leafs 0.105, and its concentration in the stems was to 1.15 ppm, and in the soil 99.735 ppm or its concentrations during the winter was in leafs 5.165, and its concentration in stems5.18, and its concentration in the soil was 167.588 ppm, and here also the concentration of chromium element in the soil is high during the winter, due to rainfall and the absorption of rain by the roots, and the absorption process is carried out until it reaches the stems and leafs in small proportions.

As for the element manganese, its concentration during the autumn season was in leafs 40.2525, and its concentration in stems43.31, and in the soil 1351.568 ppm, while the concentrations of the element manganese during the winter season were 78.932 in the leafs, 21.54 in the branches, and 1656.067 in the soil, and here the results show that the concentrations of the element manganese are high in the soil during the winter, Table 3.

Table 3. The concentrations of heavy metals of the leafs, stems, and soil in the area near the road of the juniper plant.

Near the road	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Cadmium	15.931	0.248	ND	0.372	4.341	6.308
Lead	3.692	ND	2.648	1.809	39.573	41.949
iron	17.772	370.994	451.15	459.498	10170.45	44042.92
chromium	0.105	5.165	1.15	5.18	99.735	167.588
Manganese	40.2525	78.932	43.31	21.54	1351.568	1656.067

The area of Sidi Abdel Wahid (Far away the road around the juniper plant)

The concentration of the heavy metals of the juniper plant was studied, so that the ratio of the element of lead in the autumn in the leafs was 0.974 ppm, and its ratio in the stems was 3.988 ppm, and in the soil 41.669 ppm. As for the concentration of lead element in winter, it is 0.323 ppm in the leaves, and its concentration in the stems is zero, and in the soil, 30.319 ppm; it was found that the concentration of lead element in the soil is high during the two seasons. As for the element cadmium, its concentration during the autumn season in the leafs was zero, and its concentration in the stems was 0.186 ppm, while its concentration in the soil was 3.902 ppm, while its concentration in the winter season was 0.351, and in the stems, it was 0.177 ppm, and in the soil, it was 3.764 ppm, it was found that the concentration of cadmium element is zero in the leafs during the autumn, and high in the soil during two seasons. As for iron, its concentration during the autumn season was in leafs 235.93, and its concentration in stems586.109, and in soil 30869.07 ppm, while its concentration in winter was 337.87 ppm in leafs, and its concentration in stems 239.692 ppm, and its concentration in soil 26340.55 ppm, and here it was found that the concentration of iron in the soil is the highest concentration than in leafs and branches. As for the element chromium, its concentration during the autumn was as follows: in the leafs 0.411 ppm, its concentration in the stems 1.176 ppm, and the soil 100.803 ppm.

As for its concentrations during the winter in the leafs, it is 3.528, its concentration in the stems is 3.324, and its concentration in the soil is 95.88. Here, the concentration of chromium in the soil was found to be high during the two seasons. As for the element manganese, its concentration in autumn was in leafs 66.82 ppm, its concentration in stems 44.29 ppm, and its concentration in soil 1384.275 ppm. As for its concentration during the winter season, its concentration was in the leaves 65,249 ppm, its concentration in the stems was 27,139 ppm, and its concentration in the soil was 1482,096 ppm. Also, here the concentration of the manganese during the two seasons is high in the soil Table 4.

Table 4. Concentrations of heavy metals in the leafs, stems, and soil in the area far from the road of the juniper plant.

Far out of the way	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	0.974	0.323	3.988	ND	41.669	30.319
Cadmium	ND	0.351	0.186	0.177	3.902	3.764
iron	235.93	337.87	586.109	239.692	30869.07	26340.55
chromium	0.411	3.528	1.76	3.324	100.803	95.88
Manganese	66.82	65.249	44.29	27.139	1384.275	1482.096

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The area of Wadi Al Kouf: (near the road around juniper plant)

The concentrations of the third region (Wadi Al-Kouf region) are close to the road of the juniper plant. Samples of juniper were taken from this region, and the study proved that the concentration of lead in the leafs is 4.328, and its concentration in the stems is 2.954, and its concentration in the soil is 44.296 ppm, during the autumn.

As for winter, the concentration of lead in this region was 1.11, in the leafs, in the stems it was 1.235, and in the soil 47.225. Here, it was found that the concentration of lead in the soil is high during the two seasons. As for the element cadmium, its concentration in the autumn in the leafs was non-existent, as well as in the branches, while its concentration in the soil was 4.155 ppm. Its concentration in winter in the leafs is 0.548, and its concentration in the stems is 0.379, or in the soil is 8.955. Here, too, the concentration of lead in the soil is high in the two seasons. Its concentration during the autumn was 295.88 in the leafs, 422.06 ppm in the branches, and 41,260.53 ppm in the soil.

Its concentration during the winter was in folios 1156.367 ppm, and its concentration in stems was 323.216 and left in the soil 56864.18. It was found from the study that iron has a high concentration in the soil as well during the two seasons. As for the element chromium, its concentration during the autumn was 0.537 in the leafs, while the stems had a ratio of 2.996, while the soil had a concentration of 105.298. Its concentration during the winter season is 7,797 in the leafs, 1.847 in the branches, and 231.04 in the soil. Here, too, it is left high in thesoil during the first millennium. As for the element manganese, its concentration during the autumn was in leafs 57.53, and its concentration was in stems 42.995 and in soil 1279.88. The leafs reach 110,384and the stems are 9,862, while its concentration in the soil is 1693,154. Here, too, the study concluded that the element manganese has a high concentration in the soil during the two seasons, Table 5.

Table 5. The concentrations of heavy metals of the leafs, stems and soil in the area near the road of the juniper plant.

Near the road	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	4.328	1.11	2.954	1.235	44.296	47.225
Cadmium	ND	0.548	ND	0.379	4.155	8.955
iron	295.88	1156.367	422.06	323.216	41260.53	56864.18
chromium	0.537	7797	2.996	1.847	105.298	231.014
Manganese	57.53	110.384	42.995	9.862	1279.88	1693.154

The area of Wadi Al Kouf: (Far away from the road, around the juniper plant)

The study was conducted in this area to find out the concentrations of some heavy metals, and it was found that the element lead was left during the autumn in the leafs up to 3.673 and its concentration in the stems is 5.244, and its concentration in the soil is 4.979. As for its concentration during the winter, it was 2.775 ppm in the leafs and its concentration in the stems was 0.792 ppm, while its concentration in the soil was 23.314 ppm. The study proved that the soil has the highest concentration during the two seasons, the element of cadmium. Its concentration during the autumn season in the leafs was non-existent, as well as in the stems is non-existent, the concentration during the winter was 0.104, and in the stems0.4 and in the soil 4.416 ppm, and here also the concentration of cadmium is high in the soil during the two seasons, and this is due to the exhaust of cars or the element of iron. Its concentration during the autumn season in the leafs reaches 205.553, and in the stems, 325.34, the soil was 325.05 ppm, the concentration during the winter was 296.446, or its concentration in the stems, 663.839, the soil was 36656.09, here also the soil is the highest concentration during the two seasons.

As for the element chromium, its concentration during the autumn was 0.373 ppm in the leafs, 1.199 ppm in the branches, and 101.916 ppm in the soil. Its concentration during the winter in the leafs is 2.786, and its concentration in the stems is 4.804 ppm, while the concentration of the soil was 120.08. Here, the study also proved that the element chromium is high in the soil during the two seasons. As for the element of manganese, its concentration during the autumn season was in leafs 66.9175, and its concentration in stems was 29.13 ppm.

As for the soil 1331.028 ppm, its concentration during the winter season was in leafs 102.601 ppm, and its concentration in stems was 29.046, while its concentration in the soil was 826.323 ppm, and here, too, the concentration of manganese is high in the soil during the two seasons, Table 6.

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*

Table 6. The concentrations of heavy metals in the leafs, stems, and soil in the area of the juniper plant.

Far out of the way	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	3.673	2.975	5.244	0.792	40.979	23.314
Cadmium	ND	0.104	ND	0.4	4.121	4.416
iron	205.553	296.446	325.34	663.839	57382.05	36656.09
chromium	0.373	2.786	1.199	4.804	101.916	120.08
Manganese	66.9175	102.601	29.13	29.046	1331.028	826.323

The area of Farchita (Near Road around Artemisia Plant)

The study was conducted on the Artemisia plant. The results showed that the concentration of lead in the leafs reaches 3.028, in the stems 9.874, and in the soil reaches 78.384 during the autumn. Its concentration in winter was zero in the leafs, 0.105 in the stems, and 52.442 in the soil, and here it was found that the concentration of lead in the soil was high during the two seasons.

As for the element iron, its concentration during the autumn was in the leafs 67.665 ppm, in the stems 366.857, and in the soil 32389.59, and its concentration in the winter in the leafs reaches 408.764 and in the stems 481.986, and it reaches in the soil to 39763.23, and here its concentration in the stems and soil is high during the two seasons. As for the element chromium, its concentration during the autumn was zero in the leafs, in the stems 0.787 and in the soil 166.284 ppm, while its concentrations during the winter were in the leafs 5.696 ppm, in the stems 4.105 ppm, and in the soil 157.344 ppm. Here, its concentration in the soil was found to be high during the fall.

As for the element cadmium, its concentration was absent in the leafs and stems. Its concentration in the soil is 7.99 ppm, during the best of autumn. Its concentrations during the winter were in the leafs 0.279 ppm in the stems 0.186 ppm, and in the soil 8.915 ppm, and here it was found that the concentration of cadmium element is high in the soil during two seasons. As for the element manganese, its concentration during the autumn was 36.0875 ppm, while the stems were 40.635 ppm, and in the soil was 2589.46 ppm. As for its concentration during the winter season, it was in the leafs 28,537, and in the stems 24.807 ppm, but its concentration in the soil was 2126.781 ppm, and here it was also found that the concentration of the element manganese is very high during two seasons, Table 7.

Table 7. The concentrations of heavy metals of the leafs, stems and soil in the area near the road of the Artemisia plant

Near the road	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	3.028	ND	9.874	0.105	78.384	52.442
iron	67.665	408.764	366.857	481.986	32389.59	39763.23
chromium	ND	5.65	0.787	4.105	166.284	157.344
Cadmium	ND	0.279	ND	0.186	7.99	8.915
Manganese	36.0875	28.537	40.635	24.807	2589.46	2126.781

The area of Farchita (Far away, the road around Artemisia Plant)

In this region, the concentration of lead in the leafs was 3.815 ppm, in the stems 0.2 ppm, and in the soil 43.944 ppm, during the fall. As for its concentration during the winter, it was absent in the periods, while the stems were also absent, while the soil was 60.53. Here, the concentrations of lead were high in the soil during the winter. As for iron, its concentration during the autumn in the leafs was 164.203 ppm, and its concentration in the stems was 80,551 ppm, and in the soil 42,725.45. Its concentration during winter was in leafs 472.69, stems 239.207, and its concentration in soil 48498.77 ppm. Here, too, the concentration of iron was high in the soil during the two seasons.

The concentration of chromium during the autumn was 0.117 ppm in the leafs, 0.129 ppm in the stems, and 96.749 in the soil. Its concentration during the winter was 3.387 in the leafs, 3.037 in the stems, 189.398 in the soil, and 3.851 in the soil. Its concentration during the winter in the leafs is 0.225, in the stems it is non-existent, and in the soil, it is 7.507. Here, it was found that the concentration of cadmium is high in the soil during the winter season. As for the element of manganese, its concentration during the autumn was 43.0725, its concentration in the stems was 89.2925, its concentration in the soil was 1212.895, while its concentration during the winter was in the leafs was 24.1, and its concentration in the stems was 16.062 and its concentration in the soil was 1757.757, and here it was found that the concentration of the element of manganese is high in the soil during the two seasons, Table 8.

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*

Table 8. The concentrations of heavy metals in the off-road area of the Artemisia plant during the autumn and winter between the leafs, stems and soil

Far out of the way	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	3.815	ND	43.944	60.53	0.2	ND
iron	164.203	472.69	42725.45	48498.77	80.551	239.207
chromium	0.117	3.387	96.749	189.398	0.129	3.037
Cadmium	ND	0.225	3.851	7.507	ND	ND
Manganese	43.0725	24.1	1212.895	1757.757	89.2925	16.062

The area is Sidi Abdel Wahid (near the road around Artemisia plant)

In this study, the concentration of lead element during autumn in leafs was 4.154 ppm, its concentration in stems was 3.624 ppm, and in soil was 44.976 ppm. The concentration during the winter in the leafs and stems was absent, while the concentration in the soil was 32,537. the concentration of lead is high in the soil during the autumn season.

As for iron, its concentration during the autumn was in the leaves 132.331 ppm, its concentration in the stems 320.661 ppm, and its concentration in the soil 41578.4. Its concentration during winter is 317.761 ppm in leafs, 168.4 ppm in stems, and 25.145 ppm in soil. Here, it was found that the concentration of iron in the soil is high during the autumn season. The concentration of chromium during the autumn was 0.081 in the leaves, 0.68 in the stems, and 112.552 ppm in the soil; 3.608 ppm in the leafs, 3.744 ppm in the stems, and 92.622 ppm in the soil. Here, it was found that leaving chromium high in the soil during the winter.

As for the element cadmium, its concentration during the autumn in the leafs and stems was non-existent, while in the soil it reached 4.471. Its concentration during the winter is 0.209 in leafs, 0.109 ppm in stems, and 3.637 ppm in soil. Here, it was found that the element cadmium is high in the soil during the autumn.

As for the element of manganese, its concentration during the autumn was in the leafs 45.5875 ppm, and in the stems 37.4275 ppm, while in the soil it was 1447.405 ppm. Its concentrations during the winter were in leafs 58.356 ppm, in stems 13.284 ppm, and in soil 1429.817 ppm. The concentration of manganese was found to be high in the soil during the winter, Table 9.

Table 9. The concentrations of heavy metals the leafs, stems and soil of the second area near the road of the Artemisia plant

Near the road	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	4.154	ND	3.624	ND	44.976	32.537
iron	132.331	317.761	320.661	168.4	41528.4	25145.83
chromium	0.081	3.608	0.68	3 744	112.552	92.622
Cadmium	ND	0.209	ND	0.109	4.471	3.637
Manganese	45.5875	58.356	37.4275	13.284	1447.405	1429.817

The region of Sidi Abdel Wahid (Faraway of the road around Artemisia plant)

The concentration of lead element in this area during the autumn season in the leafs was 3.170, its concentration in the stems was 15.320 ppm, and its concentration in the soil was 60.14. Its concentrations during the winter in the leafs are non-existent, and in the stems, it was 0.556 ppm, but its concentration in the soil was 37.906, and here it was found that the element of lead has a high concentration during the autumn season in the soil.

As for the element iron, its concentration during the autumn season in the oqs was 899. 250 ppm, in stems 384.631 ppm, and its concentration in soil 63516.9 ppm or its concentrations during the winter in leafs 203.927 ppm, and in stems 135.084 ppm, or its concentration in soil 29162.9. Here, the concentration of iron was found to be high in the soil during the autumn. The concentration of chromium during the autumn was 0.187 in the leafs, 0.885 in the stalks, 122.23 in the soil, 4.54 in the leafs, 3.604 in the stalks, and 107.468 in the soil, and here it was found that the concentration of chromium is high in the soil during the autumn.

As for the element cadmium, its concentration during the autumn was in the leafs, in the stems, and in the soil, it was 5.211. Its concentrations during the winter were in the leafs 0.284, in the stems 10.078, or in the soil 4.096, and here it was found that the concentration of cadmium element is very small during the two seasons. As for the element of manganese, its concentration during the autumn season was in the leafs 47.7975, in the stems 43.0425, and in the soil 596.469 ppm, while its concentrations during the winter season were in the leafs 18.974, and in the stems 12.706, while its concentration in the soil was 1569.192 ppm and here it was found that the concentration of the element of manganese is high in the soil during the winter, Table 10.

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*

Table 10. The concentrations of heavy metals of the leafs, stems and soil in the second area of the Artemisia plant.

Far out of the way	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	3.170	ND	5.320	0.556	60.14	37.906
iron	250.899	203.927	384.631	135.084	63516.9	29162.9
chromium	0.187	4.54	0.885	3.604	122.23	107.468
Cadmium	ND	0.284	ND	0.078	5.211	4.096
Manganese	47.7975	18.974	43.0425	12.706	596.469	1569.192

The area of Wadi Al Kouf Region (near the road around Artemisia plant):

In this region, the concentration of lead during the autumn season was found in leafs 6.777 ppm in stems 2.991 ppm, and in soil 34.279 ppm. Its concentrations during the winter were absent in the leafs, as well as in the stems, while its concentration in the soil was 34,898. Here, it was found that the concentration of lead element in the soil is almost equal in the two seasons, and its concentration is absent in the leafs and stems.

As for the element iron, its concentration during the autumn was in the leafs 83.713 ppm ppm, in the stems 58.157 ppm, and in the soil 31882.43 ppm, while its concentrations in the winter were in the leafs 115.327, in the stems it was 160.84 ppm, and in the soil 30527.72 ppm. Here, the results showed that the concentration of iron element is high in the soil during the winter season. The concentration of chromium during the autumn was 0.272 in the leafs, 0.05 ppm in the stems, and 115.547 ppm in the soil. Its concentrations during the winter were 2.434 in the leafs, 4.141 ppm in the stems, and 113.409 in the soil. Here, too, the concentrations of chromium in the soil are similar in the two seasons, but in the stems, they are almost non-existent.

As for the element cadmium, its concentration in the leafs and stems was zero, and its concentration in the soil was 4.208 during the autumn. Its concentrations during the winter were in the leafs 0.1740 ppm, and in the stems 1590 ppm., and in soil 4.3. Here, it was found that the concentration of cadmium is absent in some places, and in small proportions in the leafs and stems during the fall. Manganese was concentrated during autumn in leafs 40.895 ppm, in stems 77.455 ppm, and in soil 1376.392. Its concentrations during the winter were in leafs 9.675, stems 20.88, and soil 1598.51 ppm. the manganese has a high concentration in the soil during the two seasons, Table 11.

Table 11. The concentrations of heavy metals for the leafs, stems and soil of the third area near the road for the Artemisia plant.

Near the road	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	6.777	ND	0.991	ND	> 279	.898
iron	713	327	0.157	.084	31.882	30527.72
chromium	0.272	0.434	0.05	0.141	0.547	4.09
Cadmium	ND	0.174	ND	0.159	0.208	0.43
Manganese	0.895	0.675	0.455	2.088	3.92	1.598

The area of Wadi Al Kouf Region (Far away from the road around Artemisia plant):

In this region, the concentration of lead during the autumn season in the leafs was 0.961 ppm, while its concentration in the stems was 3.358 and in the soil was 44.97 ppm. As for the concentrations of lead element during the winter of the leafs, 5.579 ppm, and in the stems, it was absent and its concentration in the soil was 34.279 ppm, and here it was found that the concentration of lead element is high in the soil during the autumn season.

As for the element iron, its concentration during the autumn was in the leafs 174.616 ppm, in the stems it was 138.889 ppm, and in the soil, it was 134.33 ppm. Its concentrations during the winter season in the leafs 122.742 ppm, and in the stems, 1152.802 ppm, while in the soil it was 31882, and here it was found that the concentration of iron element is high in the soil during the autumn season. As for the element cadmium, its concentration during the autumn in the leafs was 0.105 ppm, and in the stems and the soil was non-existent. Its concentrations during the winter were 0.18 ppm in the leafs, 0.313 ppm in the stems, and 4.208 ppm in the soil. Here, it was found that the cadmium element has a high concentration in the soil during the winter, and in small and non-existent proportions in the stems and leafs during the two seasons.

As for the element of chromium, its concentration during the autumn in the leafs, stems and soil was non-existent. Its concentrations during the winter were in the leafs 2.405 ppm and in the stems 7.807 ppm, while in the soil it was 115.547 ppm. Here, it was found that the concentration of chromium was high in leafs, stems, and soil during the winter, and absent during the autumn.

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*

As for the element of manganese, its concentration during the autumn season was in leafs 37.1, in stems it was 114.832 ppm, and in soil 89.895 ppm, while its concentrations during the winter season were in leafs 10.716 ppm and in stems 67.469 ppm, or its concentration in soil 1376.392 ppm. Here, it was found that the concentrations of the manganese are very high in the soil during the winter season, Table 12.

Table 12. The concentrations of heavy metals for the leafs, stems and soil. in the third area away from the road for the Artemisia plant.

Far out of the way	Leafs		Stems		Soil	
	Winter	Autumn	Winter	Autumn	Winter	Autumn
Lead	0.961	0.579	358	ND	44.97	279
iron	616	ND	889	0.802	134	31882
Cadmium	0.105	0.18	ND	0.313	ND	0.208
chromium	ND	0.405	ND	7.807	ND	0.547
Manganese	37.1	10.716	0.832	0.469	89.5	392

Discussion

This study was conducted on three areas west of the city of Al-Bayda (Farshisha – Sidi Abdel Wahid – Wadi Al-Kouf) on the highway in 2023. The estimation of the heavy metals in the soil, and some plants, and the selection of the juniper plant and the Artemisia plant, gathered on the highway during the autumn and winter seasons. Sampling these plants and the soil around them, this study included five heavy metals: lead, cadmium, iron, chromium, and manganese. These results showed that the heavy metals present in plants had a different ratio from one region to another, with the highest concentration in the soil during the two seasons being insignificant in the leafs and stems and zero or limited in the soil, stems, and leafs in some areas during the two seasons. The concentration of cadmium was limited in the leafs and stems in the third region, and its highest concentration was 19.669 ppm in the stems in the area near the road, as well as chromium, its highest concentration was 231.014 in the third region in the soil near the road, and its lowest concentration was 0.925 in the stems in the third region far from the road, and for iron, its highest concentration was 3516.9 ppm in the winter in the soil in the area far from the road, and its lowest concentration was 67.665 in the third region in the leafs of the Artemisia near the road. The highest concentration of lead was in the first zone in the soil of the Artemisia plant, reaching 78,384 near the road during the autumn, and the lowest concentration or lack of leafs in the third zone away from the road. The concentration of the element manganese in the first zone near the road in the soil was up to 2,126,781 in the winter in the Artemisia plant, and the lowest concentration was up to 9,862 in the juniper plant in the third zone near the road in the stems. The presence of these is mainly according to the human activities, especially from the car and fossil fuels, some of previous studies on the other plants were conducted, where five metals, of iron, copper, cadmium, and zinc on the soil and some leafy plants, namely thyme and chamomile [18].

The results of s study showed that there is a direct and inverse correlation between the concentration of heavy metals, and the strength of the correlation varies with the difference of the heavy metal, as well as there is a positive and negative relationship, both of which have a moral significance, and the lack of correlation may be due to a strong correlation between the concentration of heavy metals to the ability of the plant to get rid of some minerals.

Also, the other which carried out at the Wadi Al-Shati area in the south of Libya to study the concentrations of cadmium and lead in plants and soil in some farms scattered in the region. Soil and plant samples were taken from ten randomly selected farms, then samples were taken from plants in each farm that differed from one farm to another, and plant and soil analyses were conducted in these farms to reveal the presence of the concentration of the two mentioned metals, and the results showed a discrepancy in the results between the different farms, and the concentration of the thickener element in the studied soil exceeded the permissible limits in the World Health Organization, as the average value of the uncultivated soil of some farms also contained the element of lead, for the cadmium element whose concentration in some farms exceeded the globally permissible limits in plant samples for only two farms, and the plant samples in the rest of the farms were within the permissible limits. [19]

Another study was conducted in the area of Al-Hunyu in the city of Sirte to find out the content of soil in some heavy metals (cadmium, lead and manganese) Three sample collection sites were identified, and the samples were collected at each site from three depths (ground surface, 10cm depth, and 20cm depth). The content of cadmium, lead, and manganese in soil samples was estimated by wet digestion of the samples, using distilled water, and the use of atomic absorption spectrometers to analyze these samples. The results showed that the concentration of metals in all sites was within the permissible limits, while the surface samples had a concentration of those deeper, due to the internal movement of the metals and their high concentration on the surface due to pollution caused by traffic. However, these concentrations were within the permissible limits for natural soils. The results also showed that the first and second sites had a close

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*

evaluation of the concentrations of these metals because they were located at the same distance on the road. The third site had lower values, due to the distance from the paved road [20]**.**

Conclusion

Varying concentrations of heavy metals were detected in this study, where the results showed differences in the concentrations of heavy metals between areas near and far from the road, as the soil in nearby areas was more polluted than that far away, due to environmental factors, such as car exhaust and atmospheric deposits. High levels of iron and manganese in the soil: The study recorded very high levels of iron and manganese in the soil compared to leafs and stems, which indicates that the soil acts as a reservoir for these minerals, and may be the source of geological erosion or human activities. Lead and cadmium concentrations: High levels of lead and cadmium have been found in the soil, especially in areas near the road, indicating that these areas are affected by pollution from vehicles and industrial emissions. Effect of seasons on concentrations: There was a difference in the concentration of metals between the autumn and winter seasons, as it was noted that some metals rose in the soil during the winter season, perhaps due to washing processes as a result of rainfall.

Acknowledgement

Special thanks to the chemistry department staff members for their support during the establishment of the chemical analysis for this study.

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*

الملخص

اجريت هذه الدراسة على عينات من التربة وأوراق وسيقان نباتات البطوم والعرعر تم جمعها من ثلاث مناطق تقع غرب مدينة البيضاء شملت (مناطق فرشيطة - سيدي عبد الواحد - وادي الكوف) على الطريق الرئيسي بين مدينة البيضاء ومنطقة وادي الكوف وذلك لتقدير بعض المعادن الثقيلة في التربة وبعض النباتات، حيث تم جمع عينات من نباتات العرعر والبطوم والتربة خلال فصلي الخريف والشتاء لسنه 2023. وشملت هذه الدراسة خمسة معادن ثقيلة هي: الرصاص والكادميوم والحديد والكروم والمنجنيز. وأظهرت النتائج أن المعادن الثقيلة المكتشفة في النباتات كانت ذات محتوى مختلف، حيث تم تسجيل أعلى تركيز في عينات التربة خلال الموسمين مقارنة بمحتوياتها في الأوراق والسيقان. أظهر تركيز الكادميوم تراكيز أقل في الأوراق والسيقان في المنطقة الثالثة، مقارنةً بأعلى تركيز بلغ 19.669 جزء في المليون والذي لوحظ في السيقان في المنطقة القريبة من الطريق، وكذلك الكروم، حيث سجل أعلى تركيز بلغ 231.014 جزء في المليون في المنطقة الثالثة في التربة القريبة من الطريق، وكان أقل تركيز له 0.925 في السيقان في المنطقة الثالثة الواقعة بعيدًا عن الطريق، أما بالنسبة للحديد، فقد أظهرت النتائج أن أعلى تركيز بلغ 3516.9 جزء في المليون كان في فصل الشتاء لعينة التربة في المنطقة البعيدة عن الطريق، وكان أقل تركيز له 67.665 جزء في المليون في المنطقة الثالثة في أوراق نبات العرعر بالقرب من الطريق. تم تسجيل أعلى تركيز للرصاص في المنطقة الأولى لنبات العرعر، حيث بلغ 78384 جزءًا في المليون بالقرب من الطريق خلال فصل الخريف، وتم تسجيل أقل تركيز في الأوراق في المنطقة الثالثة البعيدة عن الطريق. بلغ تركيز المنجنيز في المنطقة الأولى بالقرب من الطريق في التربة حتى 2126 جزء في المليون في فصل الشتاء في نبات البطوم، وأقل تركيز حتى 9.862 جزء في المليون في نبات العرعر في المنطقة الثالثة بالقرب

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Received*: 03-03-2025 -* ***Accepted****: 30-04-2025 -* ***Published****: 06-05-2025*