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Effect of some Heavy Metals on Carbohydrates, Proteins and Phenolic Compounds Content in Olive and Oleander Leaves at Three Intersection of Tikrit Streets

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ABSTRACT

The study was conducted in the city of Tikrit. Three intersections of the city were chosen. Soil samples were taken from a depth of 30cm with olive and oleander leaves from each location from April to October 2021, to study the effect of heavy metals resulting from the crowded cars at the intersections of Tikrit city on the primary and secondary metabolic products of olive and oleander plants grown on the sides of the roads. The heavy metals were examined in the soil and plants of the study from the selected sites in which the highest rate of Lead (2.1) per part million in the soil of the first site. Iron concentration has part rates, within the permissible limits and reached to (13.9) per part million in the soil of the first site too. The analyses of olive have shown that Iron has been recorded the highest concentration reached (7.23) per part million in the third site. The primary metabolic compounds, such as: carbohydrates and total protein, of the plants have been identified. These compounds have been recorded low rates in olive and oleander leaves as a consequence of the exposure to pollutants, including heavy metals in traffic areas. Five phenolic compounds were diagnosed in olive and oleander leaves, where the highest concentration of the total phenolic content was recorded with a value of (5898.72, 8460.23) per part million, respectively. Meanwhile the phenolic compounds (Quercetin, Cinnamic acid) have recorded the highest values (1223.51, 1067.27) per part million in the both plants respectively.

Keywords: *Oleander, Metabolic products, Phenolic compounds.*

INTRODUCTION

The suffusion of pollutants into the soil depends on the concentration of those pollutants, the quality of pollution and its proximity to the sedimentation sites, as well as the amount of rain and air movement. Traffic activity is one of the largest industrial pollutants that cause chemical pollution to the soil in terms of organic compounds and heavy metals. The concentration of these pollutants decreases as the distance from the main roads increases. Air pollution is considered one of the basic sources of soil pollution as the pollutants loaded with dust deposit on the surface of the ground and on the soil, resulting in increased concentrations of materials and components, there is an overlap between the organic material in the soil with chemicals that are deposited from the air and therefore the physical and chemical properties of the soil change. Soil properties are affected by its use, the type of activity practiced on it, and the surrounding sources of pollution, such as the various means of transportation. (Hannah *et al.,* 2009). Soil is considered to be the most important part that receives toxic and heavy metals that come from different sources and it acts as a regulator that controls the movement of metals in to the plant (Ye *et al.,*2003; Farah, 2008).

Objectives of the Study:

Determination of the heavy metals content of the soil and plants and their effect on the primary and secondary metabolic products of those plants at the intersections of the streets of Tikrit through studying the crowdedness of cars at those intersections and its relationship with the concentrations of those metals in the study soils and plants.

MATERIALS AND METHODS

Description of the Area:

Olive and oleander are chosen in the present study as they are the most common plants in the city streets, which are evergreen shrubs and trees. The study includes three sites located in the center of Tikrit city, which is located 180 km north of Baghdad and 330 km south of Mosul. Astronomically, it is located at a longitude 43.35 degrees east of Greenwich, and at a latitude of 34.27 degrees north of the equator. The first location represents the intersection of Celebration Street, the second location represents the intersection of Al-Arbaeen (Forty) Street, and the third location represents the intersection of Al-Mohafaza (Governorate) Street.

Site. 3

Site. 2

Site. 1

Soil Heavy Metal

The concentrations of heavy metals (iron, copper, lead, zinc) are determined according to what is stated in (ICARDA, 2001)

The Solutions Used

Solution: is prepared by dissolving 1.97 grams of Diethylene Triamine Penta Acetic acid and 1.1 grams of calcium chloride $CaCl_2$ in distilled water. Then 14.92 gram of Triethanol amine is dissolved in distilled water. The volume has reached one liter after mixing the two solutions and adding distilled water to it.

10 grams of sifted and dry soil are taken previously. 20ml of solution A are added to the soil and shaken for two hours by a shake device. Next, the solution is filtered using filter paper (Whatman.no.42). Then the filtrate is used to measure the concentrations of the elements by means

of the atomic absorption device, and through the following equation the concentration of the ready elements of the plant is calculated:

heavy items PPm (Cu, Zn, Pb, Fe) = (Concentration of the element from the standard curve – Planck) X Total volume of extracted solution / weight of soil.

To plot the standard curve, a series of standard solutions of heavy elements in the extraction solution DTPA is prepared (ICARDA, 2001).

Plant Heavy Metal

The digestion method is used to determine the concentrations of the studied elements (Cu, Fe, Zn, Pb). In addition to the concentration of potassium in the leaves of plants, according to what is mentioned in (ICARDA, 2001).

The Solutions Used

Digestion solution is prepared from adding (500 ml) of $HCIO_3$ acid to (1 liter) of concentrated Nitric acid HNO_3.

Digestion Process

One gram of dry crushed plant is taken and placed in the digestion tube. Ten ml of digestion solution is added to it and the solution is left for a whole day. Then, the digestion tubes are put in the digestion device at a temperature of 150 C°. Next, the digestion process is stopped after 30 minutes at the appearance of the vapor of $HCIO_3$ inside the tube. The tube is removed from the device and left to cool. After that, the solution is filled with distilled water to reach 100ml and it is mixed well and left for a short time. Finally, the readings of the heavy metals are confirmed by an atomic absorption device. To calculate the concentrations of the heavy metals:

***(*Cu, Fe, Zn, Pb) ppm = (reading of the element from spectroscopy - Planck reading) x Total volume of the extract/the weight of the dry plant.**

Total Carbohydrate Content Estimation

Determination of the total carbohydrate content in the leaves of plants according to the method (Du Biois *et al.*, 1956).

The solutions used

Solution A: Phenol 5%.

Solution B: Concentrated sulfuric acid.

(0.1) gram of dry and crushed leaves by distilled water of the plants is taken and separated in a centrifuge at 3000 rpm for 20 minutes. After that, stuck materials and pieces of unbroken of the plant leaves are got rid of. The filtrate, then, is taken and filled with distilled water to reach 20ml. One ml is taken and added 1ml of solution A and 5ml of solution B to it. The mixture is shaken well and left for 15 minutes. The mixture is put in water bath at a temperature of 25-30 for 5 minutes. Then the absorbance is recorded at a wavelength of 490 nm.

Total Protein Content Estimation

Ebru’s method (2004) of calculating the value of the total protein in the leaves of the studied plants is depended on.

The Solutions Used:

Solution A is prepared by dissolving 2.859 grams of sodium hydroxide NaOH and 14,308 grams of sodium carbonate Na_2CO_3 in distilled water to complete the volume to 500 ml.

Solution B is prepared by dissolving 1.423 gram of aqueous copper sulfate $CuSO_4.H_2O$ with distilled water to complete the volume to 100 ml.

Solution C is prepared by dissolving 2.852 grams of potassium sodium tartrate with distilled `water to complete the volume to 100 ml.

Solution D is prepared by having the three solutions (A, B, C), above, mixed by 100,1,1.

Solution E is prepared by diluting Folin's reagent by distilled water with ratio of 1 Folin and 2 distilled waters.

0.5 gram of dry leaves of the plant is taken and crushed with 5-10 ml of distilled water, the suspended materials and the uncrushed parts of the leaves of the plant are removed using a centrifuge at 3000 rpm for 10 minutes. Then, the filtrate is taken in the amount of 0.1 ml and the volume is completed to 1 ml with distilled water. And 5 ml of solution D is added and left for 10 minutes. Next, 0.5 ml of diluted solution E and also left for 30 minutes in a dark cold place. The absorbance is read at a wavelength of 750 nm.

Secondary Metabolite Products

The phenolic compounds are investigated in the leaves of the two plants (olive, oleander) according to what is mentioned in (Obouayeba and Djyh, 2014). Where phenolic compounds are Extracted and identified from the samples using Fast Liquid Chromatographic (FLC) under optimal conditions for separation:

Separation Column: Phenomenex C-18, 3um Particle size (50x2.0 mm l. D)

Mobile Phase: linear gradient for the solvent A (0.1% trifuoro aceti acid) in distilled deionized water. Solvent B (acetonitrile), the gradient system from 0%B to 100%B for 10 minutes. Ultraviolet (UV) is diagnosed at 280 nm, flow rate1.3 ml/min. Ten mg of the extracted sample is taken and dissolved in 10 ml of methanol in glass tubes. The solution is exposed to Ultra sonication with a 60% operating cycle for 25 minutes at a temperature of 25 C°. Then, it is separated using a centrifuge at 7500 rpm for 15 minutes. The clear solution is taken, and the precipitate is neglected. Carbon is added to it to remove the pigments, then, it is dried using a vacuum device, and re-dissolving is performed in 1 ml of methanol, passing onto a 2.5 µm filter paper and the filtered solution is kept at $4C^{\circ}$. 20ul of the sample is taken and injected into the system of HPLC in the same optimum conditions for separation. The concentrations of phenolic compounds are extracted through the following equation:

Unknown phenolic concentration = sample package area / standard solution package area x standard solution concentration x number of dilutions

The number of dilutions for all solutions is 15, and the standard solutions used are 25 ug /ml. (Obouayeba and Djyh, 2014)

Statistical Analysis

Using the 9th edition of the statistical program SPSS, the results are statistically analyzed according to the analysis of variance ANOVA Table, and Duncan test at the level of ($p \leq 0.05$).

RESULTS AND DISCUSSION

Soil Heavy Metals

Lead (Pb)

Table (1) below shows the recorded values of Lead during the period of the study. It reveals the highest and the lowest values, depending on the date of sampling and sampling sites separately. The highest value of Lead is 2.7 ppm in the first site in July, and 0.3 ppm is the less in the third location in May. The high concentrations in the rates of this element in the first site, which is a very crowded street, is attributed to the high level of crowdedness of gasoline cars, because one of the most important sources of this element in the environment is gasoline that contains fourth ethylates Lead (Ediin *et al.*, 2000). While the third site has recorded the lowest concentrations because it is less crowded, and these results are higher than the values specified for lead in soil (pb>1.6 ppm) (Adriano, 2001). In comparison with the other results, it is less than the results obtained by (Tamem, 2017) for the pollution of roadsides with a group of heavy metals in the city of Erbil, which have reached 6.18 - 28.7 ppm. The results are higher than the results of (Bilal *et al.*, 2017), The impact of heavy metals that released from vehicles exhausts on some biochemical parameters in *Eucalyptus* sp. and *Ziziphus* sp. plants in street intersections of Baghdad city, which obtained lead concentration rates between 0.828-1.301 ppm. The results of the statistical analysis of the averages of Lead values, according to the sampling sites and the date of sampling, based on the analysis of variance test and Duncan test at a significant level ($p \leq 0.05$), show that there are significant spatial differences at the level (0.05) between the study sites and non-significant temporal differences. The reason for the significant differences between the study sites is due to the difference of crowdedness of the chosen sites.

Table 1: Concentrations of lead element for soil samples (ppm) in the sites of the study

Months / Sites	April	May	June	July	September	October	Sites rates
Site 1	1.4	1.9	2.5	<u>2.7</u>	2.0	2.3	a2.1
Site 2	0.8	0.9	1.2	1.4	1.1	1.4	b1.1
Site 3	0.5	<u>0.3</u>	0.8	0.6	1.0	0.9	c0.6
Months rates	a0.9	a1.0	a1.5	a1.5	a1.3	a1.5	

Iron (Fe)

The results of the current study, as shown in (Table 2), reveal that the highest value of Iron concentration reached 17.5 ppm in the first site in September, and the lowest value recorded is 6.7 ppm in the third site in June. The increase in the concentration of this element in the first site in September is attributed to the high organic content of precipitation in that site that may be equipped with iron when decomposing. In addition, the increase in the moisture content of the soil increases the abundance of the element. This is consistent with the results obtained before by (Al- Hammad, 2005). The results of the statistical analysis of averages of Iron values, according to the sampling sites and the date of sampling collection, based on the analysis of variance test and Duncan test at a significant level ($p \leq 0.05$), show that there are significant temporal differences at the level (0.01) and the presence of spatial significant differences at the level (0.05) between the study sites. The results of the current study of Iron within the specified values of heavy metals in the soil, which are 10-50 ppm million (Adriano, 2001).

Table 2: Concentrations of Iron element for soil samples (ppm) in the sites of the study

Months / Sites	April	May	June	July	September	October	Sites rates
Site 1	10.7	12.4	14.6	12.8	<u>17.5</u>	15.9	a13.9
Site 2	12.5	10.7	10.9	9.8	11.6	9.9	b10.9
Site 3	8.9	9.4	<u>6.7</u>	8.2	7.9	9.8	c8.4
Months rates	ab10.7	ab10.8	ab10.7	ab10.2	a12.3	b11.8	

Zinc (Zn)

Table (3) below shows the values of Zinc recorded during the period of the study. The table reveals the highest and lowest values depending on the date of sampling and their sites. The results of the current study have recorded the highest value of Zinc which reached 4.2 ppm in the first site in October. It also recorded the lowest value 0.9 ppm in the second site in June. The results of the current study of Zinc are within the specified values of heavy metals in the soil of 0.5 35 ppm (Adriano, 2001). The presence of Zinc in the soil is attributed to its use in the pad of the car brakes because of thermal conductivity properties. Thus, it is released during the mechanical wear process of vehicles and during the combustion of the car engine and tires. Therefore, it is existence on the sides of the street due to cars and other human activities (El-Gamal, 2000).

The results of the statistical analysis of the averages of Zinc values, according to the sampling sites based on the analysis of variance test and Duncan test at a significant level ($p \leq 0.05$), show that there are significant temporal differences at the level (0.05) and the presence of spatial significant differences at the level (0.01) between the study sites. The high levels of Zinc in the first site are due to the high traffic density and the high moisture content of the soil, which increased the rates of its fixation on the inorganic parts or components of the soil (FAO, 1972).

Table 3: Concentrations of Zinc element for soil samples (ppm) in the sites of the study

Months / Sites	April	May	June	July	September	October	Sites rates
Site 1	1.8	2.6	2.7	3.6	3.1	<u>4.2</u>	a3.0
Site 2	2.8	1.8	<u>0.9</u>	1.5	3.3	2.0	b2.0
Site 3	1.4	1.7	2.0	2.5	2.9	3.0	ab2.2
Months rates	b2.0	b 2.0	c1.8	b2.5	a3.1	a3.0	

Plant Heavy Metals

Lead (Pb)

Table (4) reveals the highest value of Lead in olives which reached 0.8 ppm in the first site in July. It also shows the lowest value in oleander which reached 0.1 ppm in the second site in June. It is noted through the statistical analysis, based on the date of sample collection and sampling sites, that there are significant temporal and spatial differences at the level of significance (0.05) between the study sites (FAO/WHO,1976). Compared with other results, the results of the current study are less than the results of (Sameera and Muhammed's, 2009) study for Lead in oleander 65.39 ppm. The content of plants of Lead is not related to its content in the soil, unlike other heavy metals (cobalt, nickel and cadmium). This may be due to the fact that Lead is toxic and it is not used by enzymes as an activating metal, whereas Iron, Copper and Zinc are micro-nutrient elements used by various enzymes in various metabolic activities (Rushdi, 2020). The reason of the increase of Lead in the content of the plants of the study may be due to the aerobic precipitation of the element resulting from the crowdedness and its accumulation on the leaves of the plants near the roads (Abdel-Sabour and Aly, 2000).

Table 4: Concentrations of lead in Olive and Oleander Leaves (ppm) at the study sites

Months / Sites	Plants	April	May	June	July	September	October	Sites rates
Site 1	Olive	0.4	0.2	0.5	0.8	0.4	0.3	a0.43
	Oleander	0.2	0.4	0.7	0.6	0.3	0.2	a0.40
Site 2	Olive	0.3	0.2	0.4	0.2	0.2	0.4	b0.28
	Oleander	0.2	0.3	0.1	0.2	0.2	0.3	b0.21
Site 3	Olive	0.3	0.5	0.2	0.6	0.2	0.4	ab 0.36
	Oleander	0.5	0.4	0.6	0.4	0.3	0.2	a0.40
Months rates	Olive	ab0.33	ab0.30	ab0.36	a0.58	b0.26	ab0.36	
	Oleander	b0.30	b0.36	a0.46	a0.40	c 0.26	c0.23	

Iron (Fe)

Table (5) shows the results of the study of iron concentrations in the two plants (olive and oleander). It is noted that the highest concentration in olives and oleander is (9.8 And 8.0 ppm) in the third location, whereas the lowest concentration recorded is (1.9 and 0.4 ppm) for olive and oleander in the first site, respectively. It is noted through the statistical analysis, based on the date of sample collection and sampling sites, that there are significant temporal and spatial differences at the level of significance (0.05) between the study sites. According to the recorded results of the concentration of the three heavy elements in olive leaves and oleander, Iron is the most concentrated element compared to the other elements. This is in agreement with the results of (Mohamed and Khairia, 2012) which indicate the high concentrations of Iron in the leaves of the plant because the leaves are the food factory in the plant. (Marchiol *et al.*, 2004) point out that the concentration of heavy elements in plant tissues increases at high levels of moisture because it improves the number of elements extracted from the soil. This is in complete agreement with the accumulation of heavy metals in the leaves of olive and oleander plants in the current study, as the highest concentrations of the three heavy metals are recorded in September.

Table 5: Concentrations of Iron in Olive and Oleander Leaves (ppm) at the study sites

Months / Sites	Plants	April	May	June	July	September	October	Sites rates
Site 1	Olive	2.1	3.0	2.7	3.7	2.3	1.9	e2.61
	Oleander	0.4	0.7	0.9	0.5	1.0	1.8	f0.88
Site 2	Olive	3.6	5.0	7.1	4.9	8.2	3.8	c5.43
	Oleander	3.8	4.1	2.9	2.4	5.8	4.0	d3.83
Site 3	Olive	6.8	4.6	5.2	7.8	9.8	9.2	a7.23
	Oleander	5.0	7.1	4.5	6.6	8.0	7.8	b6.50
Months rates	Olive	c4.16	c4.20	b5.00	ab5.46	a6.76	b4.96	
	Oleander	b 3.06	b3.96	c 2.76	b3.16	a4.93	a4.53	

Zinc (Zn)

The results of the study show the estimation of Zinc concentration in the two plants (olive and oleander) that the highest concentration in olive and oleander is (2.23 and 0.73 ppm) respectively in the second location in April, while the lowest concentration recorded is (0.06, ppm 0.07) for olive and oleander, respectively, in the first site in July. These results are within the permissible limits for Zinc in these plants, which amount to 20-100 ppm (FAO/WHO,1976). The means of transportation is considered one of the most important sources contributing to the spread of Zinc in the air as it enters the auto industry tires, during its friction with the ground, as well as it is one of the items of the asphalt (Winther and Slento, 2010). This is confirmed by the results of the current study. It is noted through the statistical analysis, based on the date of sample collection and sampling sites, that there are significant temporal and spatial differences in Zinc rates at the level of significance (0.05) between the sites of the study.

Table 6: Concentrations of Zinc in Olive and Oleander Leaves (ppm) at the study sites

Months / Sites	Plants	April	May	June	July	September	October	Sites rates
Site 1	Olive	0.20	0.33	0.08	0.06	0.35	0.71	c0.28
	Oleander	0.31	0.27	0.11	0.07	0.08	0.12	d0.16
Site 2	Olive	2.23	1.99	1.00	0.98	0.90	0.88	a1.33
	Oleander	0.73	0.62	0.66	0.42	0.40	0.37	b0.53
Site 3	Olive	0.52	0.36	0.32	0.19	0.15	0.18	c0.28
	Oleander	0.39	0.33	0.27	0.17	0.18	0.10	c0.24
Months rates	Olive	a 0.98	a0.89	c0.46	c0.41	c0.46	b0.59	
	Oleander	a 0.47	a0.40	b0.34	c0.22	c0.22	d0.19	

Total Carbohydrates Content

The results of the current study, as shown in (Table 7), reveal that the highest carbohydrate concentration value in the oleander is 60.2 ppm in the third location in July, whereas the lowest concentration value is 32.0 ppm in the first site in October, while the highest concentration value of carbohydrates in olive is 54.5 ppm in the third site in July, and the lowest value is 15.7 ppm million in the first site in October. It is noted that oleander is more efficient in the photosynthesis process than olives, as carbohydrates recorded the highest rate according to the sampling sites in the third site, with a value of 55.46 ppm for oleander, while the lowest rate is recorded in the first site with a value of 22.65 ppm for olive. It is also noted that the highest rate of carbohydrates, according to the date of sample collection, is recorded in July with a value of 48.90 ppm for oleander, and the lowest rate is 31.96 ppm for olive in April. A significant decrease in total carbohydrate concentrations is observed in olive and oleander leaves compared to the results of previous studies. This is attributed to the fact that the toxicity of Lead is due to their ability to bind with enzymes coenzyme as well as beta Aminolevulinic acid dehydratase (ALA- dehydratase) reductase that affects the content of chlorophyll, which leads to a defect in carbohydrate metabolism (Farah, 2012). The results of the statistical analysis of carbohydrate concentration rates, based on the analysis of variance test at a significant level of ($p \leq 0.05$), show that there are significant spatial and temporal differences at the level of significance (0.05) between the sites for both plants. The presence of significant differences between the sites and seasons is due to the difference in the physiological effectiveness of the plant and the sensitivity of plants to air pollution, respiratory rates, and carbon dioxide stabilization process.

Table 7: Concentrations of total carbohydrate content in Olive and Oleander Leaves (ppm)

Months / Sites	**Plants**	**April**	**May**	**June**	**July**	**September**	**October**	**Sites rates**
Site 1	Olive	20.8	22.4	26.0	31.4	19.6	15.7	d22.65
	Oleander	32.5	34.6	36.7	40.2	35.6	32.0	c35.26
Site 2	Olive	30.4	33.8	38.6	42.7	45.9	38.1	c38.25
	Oleander	34.7	37.0	41.2	46.3	38.6	39.0	c39.46
Site 3	Olive	44.7	41.9	50.3	54.5	47.1	52.0	b48.41
	Oleander	50.2	53.5	56.0	60.2	58.6	54.3	a55.46
Months rates	Olive	b31.96	b32.70	ab38.30	a42.86	ab37.53	b35.26	
	Oleander	a39.13	a41.70	a44.63	a48.90	a44.26	a41.76	

Total Protein Content

The results of the current study, as in (Table 8), show the highest value of the total protein concentration is in olives 3.2 mg/g in the third site in April, while the lowest value is in the oleander N 0.5 mg/g in the first site in July. It is noted through the statistical analysis, based on the date of sample collection, that the highest rate of protein concentration is recorded in the samples of April which are in olives with an average of 2.80 mg/g, and the lowest rate is 1.26 mg/g in the oleander in July samples. A negative correlation is found between the protein and carbohydrate content of the studied plants, and the decrease in protein in its recorded rates is caused by the plant's exposure to pollution in the same season as a result of crowdedness in the study site which lead the plant adopting a defensive behavior during the period of exposure to pollution and decomposing its tissue proteins (Agrawal and Deepak, 2003). The results of this study do not agree with the results of the local studies, including the study of (Bilal *et al.*, 2017), where the values of the protein content of olive plants are recorded between 0.036-26.101 mg/g. The result of the statistical analysis of the rates of protein concentration, based on of variance test at the level of significance ($p \leq 0.05$), reveal that there are significant spatial and temporal differences at the level of significance (0.05) between sites for both plants.

Table 8: Concentrations of total protein content in Olive and Oleander Leaves (ppm)

Months / Sites	Plants	April	May	June	July	September	October	Sites rates
Site 1	Olive	2.4	2.0	1.9	1.7	1.2	1.8	b1.83
	Oleander	1.5	1.2	0.8	0.5	0.9	1.0	c0.98
Site 2	Olive	2.8	2.6	2.0	2.2	2.5	2.1	a2.36
	Oleander	2.4	2.6	1.8	1.6	1.4	1.3	b1.85
Site 3	Olive	3.2	3.1	2.8	2.4	2.3	2.0	a2.63
	Oleander	2.9	2.7	1.9	1.7	2.0	2.3	a2.25
Months rates	Olive	a2.80	a2.56	ab2.23	ab2.10	ab2.00	b1.96	
	Oleander	a2.26	a2.16	b1.50	b1.26	b1.43	b1.53	

Phenolic Compounds in Olive and Oleander

Fig. (1) shows the Concentrations of phenolic compounds in Olive Leaves are ranged between the lowest value of (195.61 ppm) for the phenolic compound (Gallic acid) in the third site and the highest value is 1067.27 ppm for phenolic compound (Cinnamic acid) in the first site.

As the Fig. (2) shows concentrations of phenolic compounds in oleander samples is ranged between the lowest value, which is (115.76 ppm) for phenolic compound (Rutin) in the third position, and the highest value which is (1223.5 ppm) for phenolic compound (Quercetin) in the first site as well. For the most polluted with heavy metals site, it is noted that the most abundant phenolic compounds existed are (Cinnamic acid, Genistic acid) in olive and the phenolic compound (Quercetin) in oleander among the five compounds diagnosed in the olive and oleander. However, (Bilal, 2017) identifies seven types of phenolic compounds in olive, three of which are the most common ones (Tannins, Genistic acid, Eucalyptone) and he estimates the concentration of Genstic acid in olive leaves approximately 1362.022 ppm, and this content is higher than the concentration Genstic acid which is diagnosed in this study in olive sample which ranged (912.04 ppm). The metabolites vary according to the effect of the environmental condition and, thus, the sensitivity of plants to pollution varies just as the response of the plant to the surrounding environmental condition varies according to the type or plant organ (Bruno *et al.*, 2016). The defensive function of phenols accumulated in plant tissues makes it possess cellular resistance against environmental conditions or stress factors (Wittstoen and Gershenzon, 2002).

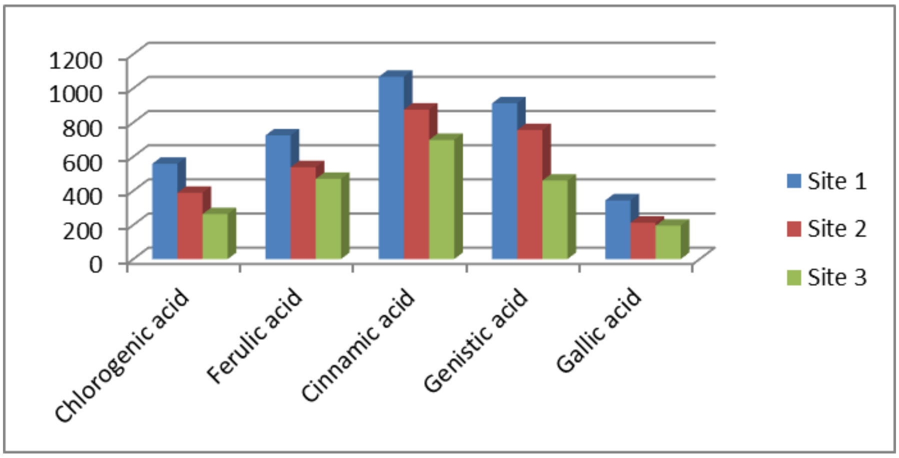

Fig. 1: Concentrations of phenolic compounds in Olive Leaves

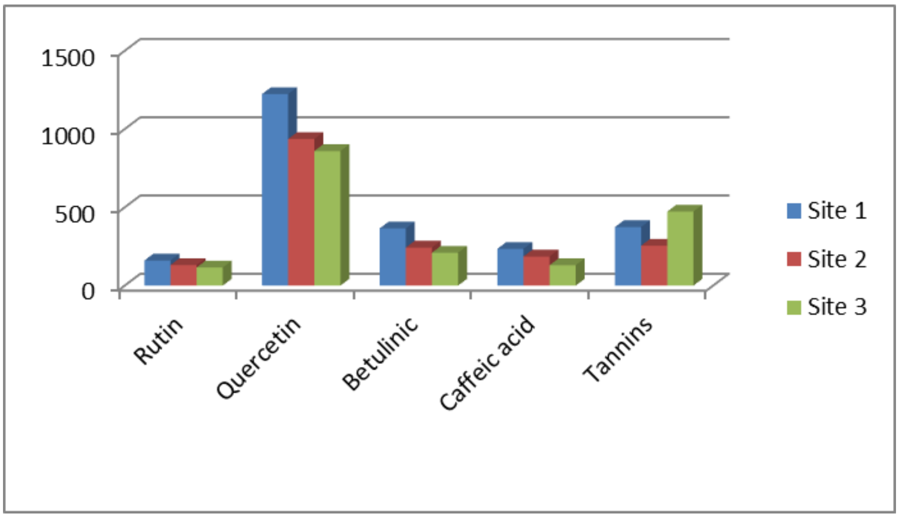

Fig. 2: Concentrations of phenolic compounds in Oleander Leaves

CONCLUSIONS

1- Olive is more efficient than oleander in accumulating heavy metals within its vegetative cells in the sites of the study.

2- The heavy metals: Lead, Iron and Zinc, in the soils and plants of the study, are all within the permissible limits except for Lead in the soils.

3- There are spatial and temporal differences between the study factors.

4-There is a positive correlation between the plant content of phenolic compounds, total carbohydrates, and Lead.

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تأثير بعض العناصر الثقيلة في محتوى السكريات والبروتينات وبعض المركبات الفينولية في أوراق نباتي الزيتون والدفلة في ثلاث تقاطعات للشوارع في تكريت

الملخص

أُجريت الدراسة في مدينة تكريت وحددت ثلاث تقاطعات في شوارع مدينة تكريت. وأُخذت نماذج من الترب من عمق 30 سم مع أوراق نباتي الزيتون والدفلة من كل موقع بدءاً من شهر نيسان لغاية شهر تشرين الاول من عام 2021، لدراسة تأثير العناصر الثقيلة الناتجة من زخم السيارات في تقاطعات مدينة تكريت على نواتج الأيض الأولي والثانوي لنباتي الزيتون والدفلة المزروعة على جوانب الطرق.

فحصت العناصر الثقيلة في ترب ونباتات الدراسة حيث سجل الرصاص معدلات عالية في المواقع والتي بلغت أعلى معدل لها (2.1) جزءاً بالمليون في تربة الموقع الاول. أما الحديد فقد سجل معدلات ضمن الحدود المسموحة والتي بلغت أعلى معدل لها (13.9) جزءاً بالمليون في تربة الموقع الاول، أما في النباتات (الزيتون والدفلة) فقد سجل الحديد معدلات عالية والتي بلغت أعلى معدل لها (7.23) جزءاً بالمليون في أوراق نبات الزيتون في الموقع الثالث. وحدد محتوى النبات من مركبات الأيض الأولية مثل: الكربوهيدرات والبروتين الكلي حيث سجلت تلك المركبات معدلات منخفضة في أوراق الزيتون والدفلة نتيجة تعرض تلك النباتات الى الملوثات منها العناصر الثقيلة في المناطق المرورية، وتم تشخيص خمس مركبات فينولية في أوراق الزيتون والدفلة حيث سجل أعلى تركيز للمحتوى الفينولي الكلي بقيمة (5898.72,8460.23) جزءاً بالمليون على التوالي، وكما سجلت المركبات الفينولية (Quercetin ,Cinnamic acid) أعلى القيم (1223.51,1067.27) جزءاً بالمليون في أوراق النباتين على التوالي.

الكلمات الدالة: الدفلة، نواتج الأيض، المركبات الفينولية.