Toxic Heavy Metals in Soil and Some Plants in Baghdad, Iraq

Habib R. Habib, Salih M. Awadh* and Muhanad Z. Muslim
Department of Earth Sciences, College of Science, University of Baghdad, Baghdad-Iraq.
*E-mial:salihauad2000@yahoo.com.

Abstract

In purpose to know the distribution and concentration of heavy metals (Fe, Pb, Cd, Ni and Co) in the soil and both the plant leaves and the fruits of Rutaceae Family (*Citrus aurantifolia, Citrus sinensis, Citrus reticulate, Citrus aurantium, Citrus grandis*) as well as the leaves and dates of *Phoinix dactylifera* (palm) in Baghdad city, they are measured in both of soil and plant samples which have been collected from 25 sites in Baghdad city. This study was carried on 25 samples of soil, 47 plant leaf samples, 29 fruit samples as well as 22 palm leaf samples with 5 samples of dates. The concentration of heavy metals in the soil appeared to be higher than of the natural distribution, so in the leaves and fruits of plants are also likely. The heavy metals in the plants mainly tend to be preferentially accumulated within the leaf fraction greater than of the fruits. Heavy metals in the Baghdad soil, especially Pb, Cd and Co had strongly correlated together and distributed in similar patterns which may be originated from source of diesel and gasoline fuel.

Keywords: Heavy metals, Pollution, Soil, Plant, Baghdad.

Introduction

Generally, nutritional metals do occur naturally in fruits and vegetables as essential trace elements needed for good health, but they could be toxic when their concentrations exceed limits of safe exposure; sixteen chemical elements are known to be important to a plant's growth and survival. The sixteen chemical elements are divided into two main groups: non-mineral and mineral. The Non-Mineral Nutrients are hydrogen (H), oxygen (O), and carbon (C), these nutrients are found in the air and water. The 13 mineral nutrients, which come from the soil, are dissolved in water and absorbed through a plant's roots. These are divided into two groups; macronutrients and micronutrients. Macronutrients can be broken into two more groups; these are primary and secondary nutrients. The primary nutrients are nitrogen (N), phosphorus (P), and potassium (K). These major nutrients usually are lacking from the soil first because plants use large amounts for their growth and survival. The secondary nutrients are calcium (Ca), magnesium (Mg), and sulfur (S). Micronutrients are those elements essential for plant growth which needed in only very small in micro quantities. These elements are sometimes called minor elements or trace elements. The micronutrients are boron (B), copper (Cu), iron (Fe), chloride (Cl), manganese (Mn), molybdenum (Mo) and zinc (Zn) [1].

Heavy metals are that elements having specific gravity that is at least five times the specific gravity of water which is expressed as 1 at 4°C and refers to metallic elements with an atomic weight greater than iron (55.8 g/mol) [2]. These elements are stable and highly toxic, because they cannot be metabolized, and are bio-accumulative passed up the food chain to humans. Generally, the trace quantities of heavy metals are nutritionally essential for a healthy life; they are commonly found naturally in plants, therefore plants are considered as multivitamin products. Heavy metals are also common in the manufacture of pesticides, batteries, alloys, chemical laboratories, Medical Industries and their wastes, electroplated metal parts, textile dyes , steel, tanning in tannery, transportation setting, electrical generation stations, refining oil stations, and hazardous waste sites. Like these factories are found in Baghdad. Chronic exposure to heavy metals leads to chronic toxicity resulting from repeated or continuous exposure, causing an accumulation of the toxic metals in the body, also chronic exposure may results from contaminated food, air, water; living near a hazardous waste site. The sudden or unexpected exposure to a high level of the heavy metal caused acute toxicity [3].

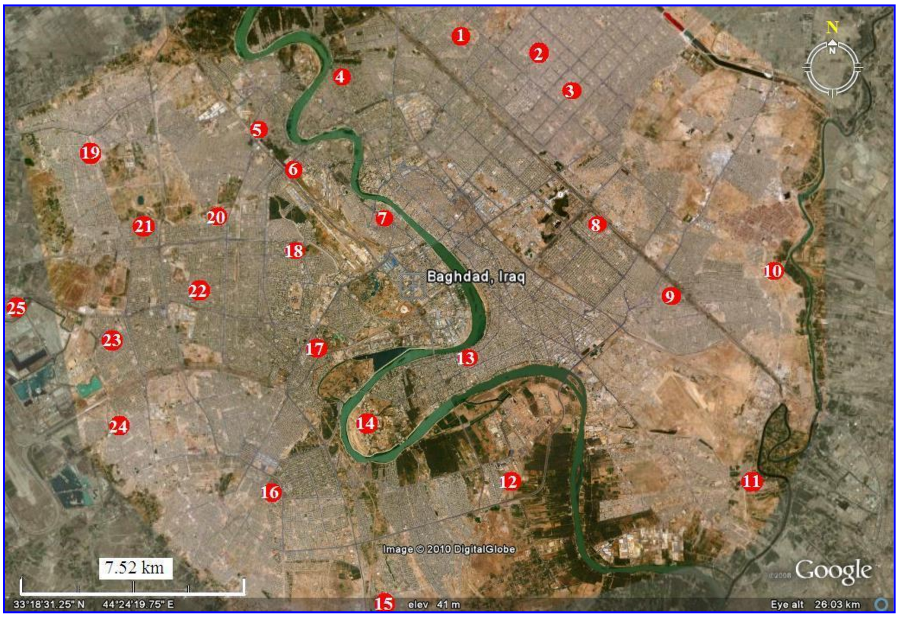
Many researchers who studied soil water and plants in Baghdad have detected high heavy metals concentration in different sampling media. Khalid and Salih [4] found high Pb concentration in soil of some highly populated areas at Baghdad. Hana and Al-Bassam [5] found much higher Pb concentration in plants of Baghdad than those of other less populated Iraqi cites. Al-Bassam et al., [6] found less than 10 ppm of Pb within soil of Western Desert. Haqus and hammed [7]; Hana and Al-Hilali [8] and [9] found high Pb concentration in plants collected from Baghdad and other selected areas the highways and cement plants. AL-Sayegh and Al-Yazichi [10] attributed the high concentration of Pb, Cd, Cu and Zn to the car exhausts in Mosul city. Kuwaidem [11] found high concentration of heavy metals in Basra soil which were mainly attributed to the drilling and oil production. Ameen [12] studied the biological effects of Pb poisoning in Baghdad, then he deduced that the children are at greater risk than adults due to lower body weight and increasing incidence of cancer and blood poisoning. Awadh [13] through his study of atmospheric pollution of Baghdad city found the anthropogenic activities are main responsible sources of pollution.

This study was carried out on twenty five sites within Baghdad (Fig.(1)) and (Table (1)), from these sites soil and some types of plants (Citrus aurantifolia, Citrus sinensis, Citrus grandis, Citrus reticulate, Citrus aurantium and phoenix dactylifera) which are growing in were studied. This soil is a part of the Mesopotamian Plain sediments which has mainly exposed of wide variety of contaminants like suspended particulates originated from different sources. Baghdad is a densely populated and highly agricultural and industrialized site. Generally, the climate of Mesopotamia is semi-arid with maximum temperature up to 53ºC in July- August and minimum temperature of -7ºC in January [14]. The annual precipitation is 150 mm/year (monthly occurring from November to March).

This work is expressed as geochemical and biogeochemical study for further contribution of the local environmental pollution; it is going to discuss the concentration and distribution of the heavy metals in Baghdad soil in comparison with their accumulation in both of the leaf and fruit parts in attempt for revealing the source of heavy metals existing in high level.

Samples Collection and Analyses

Twenty nine composite surface samples at A_0 soil zone were collected from 25 locations at Baghdad (Fig.(1)) and (Table (1)); as well as 47 leaf samples and 29 fruit samples were also collected from Citrus aurantifolia, Citrus sinensis, Citrus grandis, Citrus reticulate, Citrus aurantium and phoenix dactylifera. Generally, soil samples are agricultural soil composed of clayey silt belong to Tigris River sediments within the Mesopotamian Plain. Heavy metals (Fe, Pb, Cd, Ni, and Co) in both of soil and plant samples were analyzed by using Atomoc Absorption spectrophotometry in Biology Department of College of Science at University of Baghdad. The composite soil samples were dried to constant weight at 50ºC; then passed through a 1 mm sieve to remove stones, roots and other larger particles. Each composite soil sample was manually finely ground using an agate mortar, thereafter 0.5 gm for each was transferred into 100 ml Pyrex beaker. 20 ml of Aqua Regia (1:3 HNO_3: HCl) was added to digest the sample. The solution was evaporated to near dryness on a hot plate at a temperature of 105ºC. After cooling, 15 ml of 5% HCl acid was added. The solution was warmed on the hot pate to dissolve the salts; then allowed to cool. The solution was transferred to a 50 ml volumetric flask and made up to volume using 5% HCl. The solution was kept for 24 hours to allow sandy grains to settle. The solution became ready for the analyses by Atomic Absorption Spectrophotometry. Fruits and leaves also were dissolved and analyzed according to [15].



Legend:		8	Zayuna	17	Qadisiya
		9	Baghdad jadeda	18	Mansor
1	Shaab	10	Mashtal	19	Qazaliya
2	Talbiya	11	Zufaraniya	20	Al jameaa
3	Jamela	12	Dora	21	Kadhraa
4	Adhmiya	13	Karada	22	Nafaq shurta
5	Al-Salam	14	Jaderiya	23	Amriya
6	Ataifia	15	Abu Dsheer	24	Jehad
7	Haifa	16	Saidiya	25	Furat

Fig.(1) Arial photo showing the sites of study areas in Baghdad city; their coordination are described in the Table (1).

Table (1)
The names and coordination of sampling sites.

Sample no.	*Area name*	*Lat.*	*Long.*	*Sample no.*	*Area name*	*Lat.*	*Long.*
1	Shaab	33.2324	44.2429	**14**	Jaderiya	33.1633	44.2238
2	Talbiya	33.231	44.2614	**15**	Abu Dsheer	33.1334	44.2326
3	Jamela	33.2224	44.2657	**16**	Saidiya	33.1575	44.2029
4	Adhmiya	33.2239	44.2153	**17**	Qadisiya	33.1746	44.2134
5	Al-Salam	33.2141	44.2014	**18**	Mansor	33.1935	44.2046
6	Ataifia	33.2177	44.2051	**19**	Qazaliya	33.2118	44.1631
7	Haifa	33.2011	44.2253	**20**	Al jameaa	33.201	44.1925
8	Zayuna	33.1958	44.2732	**21**	Kadhraa	33.2	44.1742
9	Baghdad jadeda	33.1854	44.2849	**22**	Nafaq shurta	33.1854	44.185
10	Mashtal	33.1911	44.3115	**23**	Amriya	33.1757	44.1655
11	Zufaraniya	33.1521	44.3044	**24**	Jehad	33.1626	44.1772
12	Dora	33.1529	44.2542	**25**	Furat	33.1753	44.1381
13	Karada	33.1733	44.2442				

Heavy Metals in Soil

The statistical distribution (median, 25%-75%, non outlier range, outliers and extremes) of heavy metals is illustrated in Fig.(2). Iron (Fe) appears to be found in wide range from 0.003% in Qazaliya to 3.26% in Zufaraniya with average 1.55%; it is less than of global value (Table (2)). Nickel (Ni) recorded high values which were ranging from 105 ppm in Dora to 208 ppm in Al-Jameaa and Al-Jehad, with average of 172 (Table (2)). Lead (Pb) was recorded ranging from 29 ppm in Khadhraa to 138 ppm in Haifa with average of 43 ppm; Nickel and lead are four times higher than the global value (Table-2). Cobalt (Co) ranges from 31 ppm in Nafaq shurta to 58 ppm in Haifa with average of 39 ppm; it is nearly approach of five times higher than the global (Table (2)). Cadmium (Cd) concentration ranges from 11 to 41 ppm with average 19 ppm; the lowest value was recorded in Adhamiya, while the highest value was found in Haifa; in comparison with the global value, it is very high and nineteenth times greater (Table (2)). Heavy metals concentration in soil of Baghdad could be descending ordered as Fe> Ni> Pb> Co> Cd. Obviously, there is no iron pollution, but the others heavy metals (Ni, Pb, Cd and Co) are higher than the natural distribution. In Baghdad Jadeda, Abu Disher and Haifa and the heavy metals (Ni, Pb, Cd and Co) clearly displayed increasing all together; despite of the thousand tons of the emitted gases from Dora chimneys annually, Dora has no display the highest heavy metals concentration; but the area which are locating south and east of Dora (Baghdad Jadeda Zufaraniya and Abu Dsheer) displayed high concentration (Fig.(3)); this may be attributed to the arial transportation of pollutants and this hypothesis be a fact especially when the preferred wind direction (south east) is taken in consideration. Figs.(4,5,6,7 and 8) are displaying how the heavy metals distribute in Baghdad soil. Burning fuel in automobile and local electrical generators may contribute the rise content of these heavy metals; Al-Qaraghuli found high concentrations of Pb, Ni and Co in Iraqi oil.

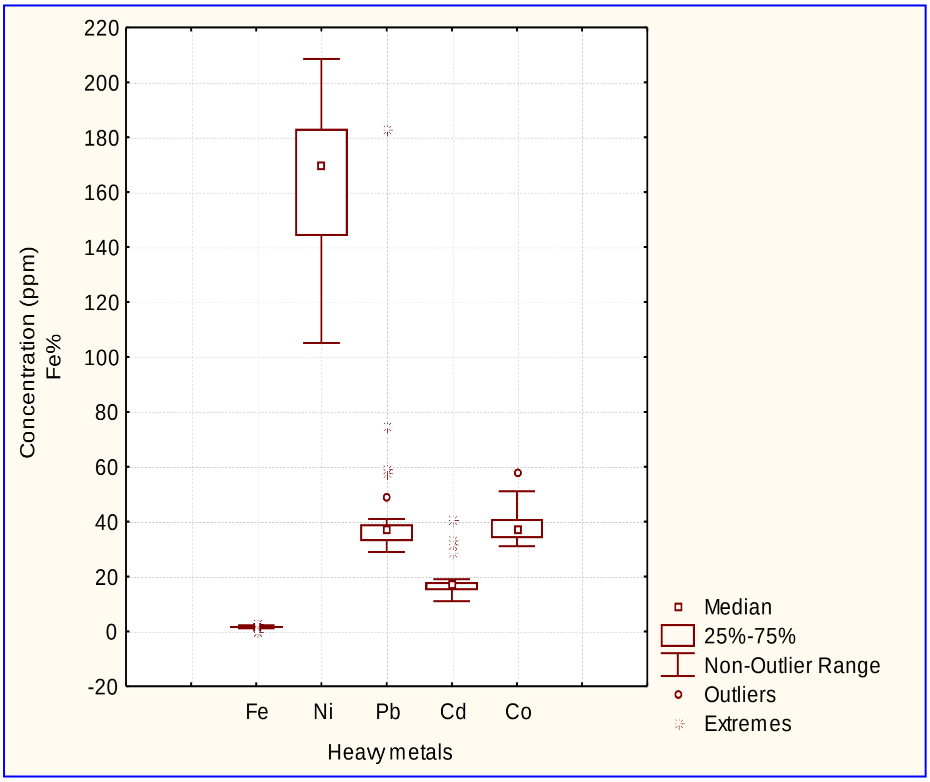


Fig.(2) Statistical distribution of the heavy metals in the Baghdad soil.

Table (2)
Chemical results, ranges and averages of heavy metals in the soil samples of Baghdad compared with the global average.

Sample no.	*Area name*	*Lat.*	*Long.*	*Fe %*	*Ni ppm*	*Pb ppm*	*Cd ppm*	*Co ppm*
1	Shaab	33.2324	44.2429	1.84	144	39	19	41
2	Talbiya	33.231	44.2614	1.12	169	33	15	37
3	Jamela	33.2224	44.2657	1.79	181	41	18	44
4	Adhmiya	33.2239	44.2153	1.46	183	32	11	36
5	Al-Salam	33.2141	44.2014	1.77	183	38	18	38
6	Ataifia	33.2177	44.2051	1.58	156	34	13	41
7	Haifa	33.2011	44.2253	1.79	180	183	41	58
8	Zayuna	33.1958	44.2732	1.86	156	36	17	32
9	Baghdad jadeda	33.1854	44.2849	1.35	138	58	33	48
10	Mashtal	33.1911	44.3115	3.14	130	36	15	36
11	Zufaraniya	33.1521	44.3044	3.26	208	39	13	34
12	Dora	33.1529	44.2542	1.63	105	37	17	33
13	Karada	33.1733	44.2442	1.63	186	39	16	35
14	Jaderiya	33.1633	44.2238	1.6	195	49	14	37
15	Abu Dsheer	33.1334	44.2326	1.7	169	75	32	51
16	Saidiya	33.1575	44.2029	2.23	169	38	18	38
17	Qadisiya	33.1746	44.2134	1.33	156	59	29	44
18	Mansor	33.1935	44.2046	1.86	181	36	14	38
19	Qazaliya	33.2118	44.1631	0.003	129	33	14	39
20	Al jameaa	33.201	44.1925	1.81	208	31	17	38
21	Khadhraa	33.2	44.1742	0.17	157	29	15	33
22	Nafaq shurta	33.1854	44.185	0.16	144	37	16	31
23	Amriya	33.1757	44.1655	1.44	156	29	17	33
24	Jehad	33.1626	44.1772	2	208	37	19	40
25	Furat	33.1753	44.1381	1.49	130	33	17	31
Range				0.003-3.26	105-208	29-183	11-41	31-58
Average				1.55	172	43	19	39
*Globally average in the world soil				3.8	40	10	1	8

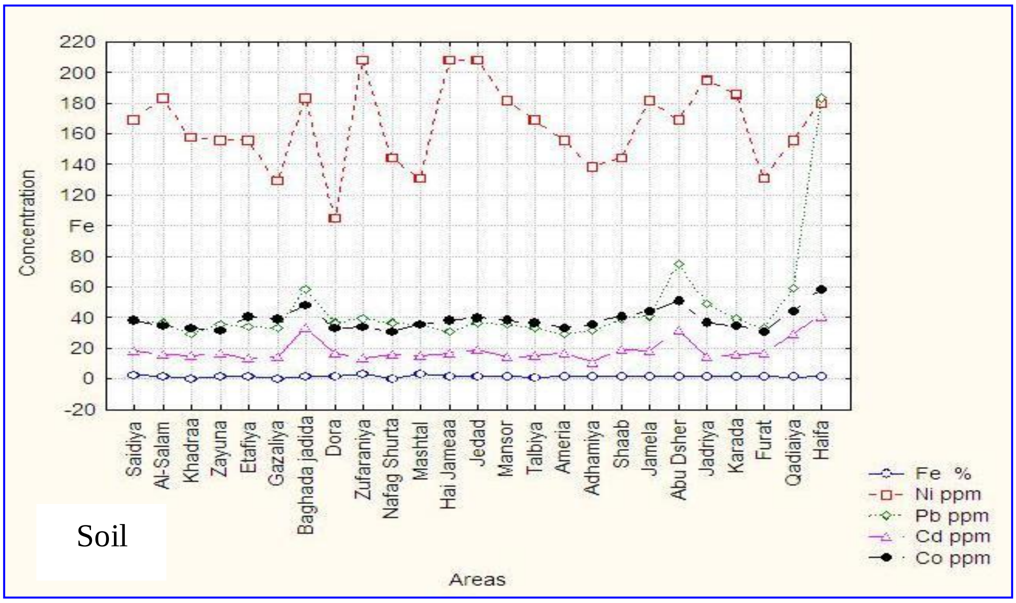


Fig.(3) Distribution of heavy metal concentrations in the soils of different site of Baghdad.

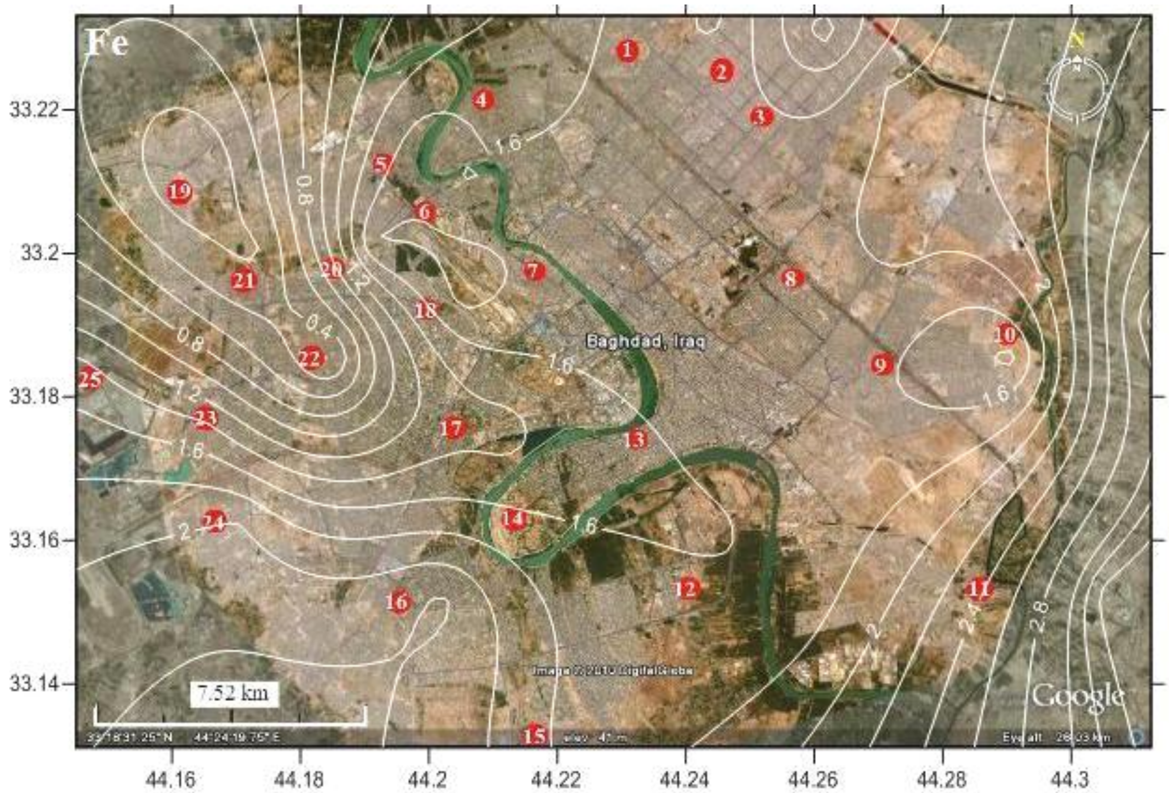


Fig.(4) Contour map shows the Fe distribution in Baghdad.

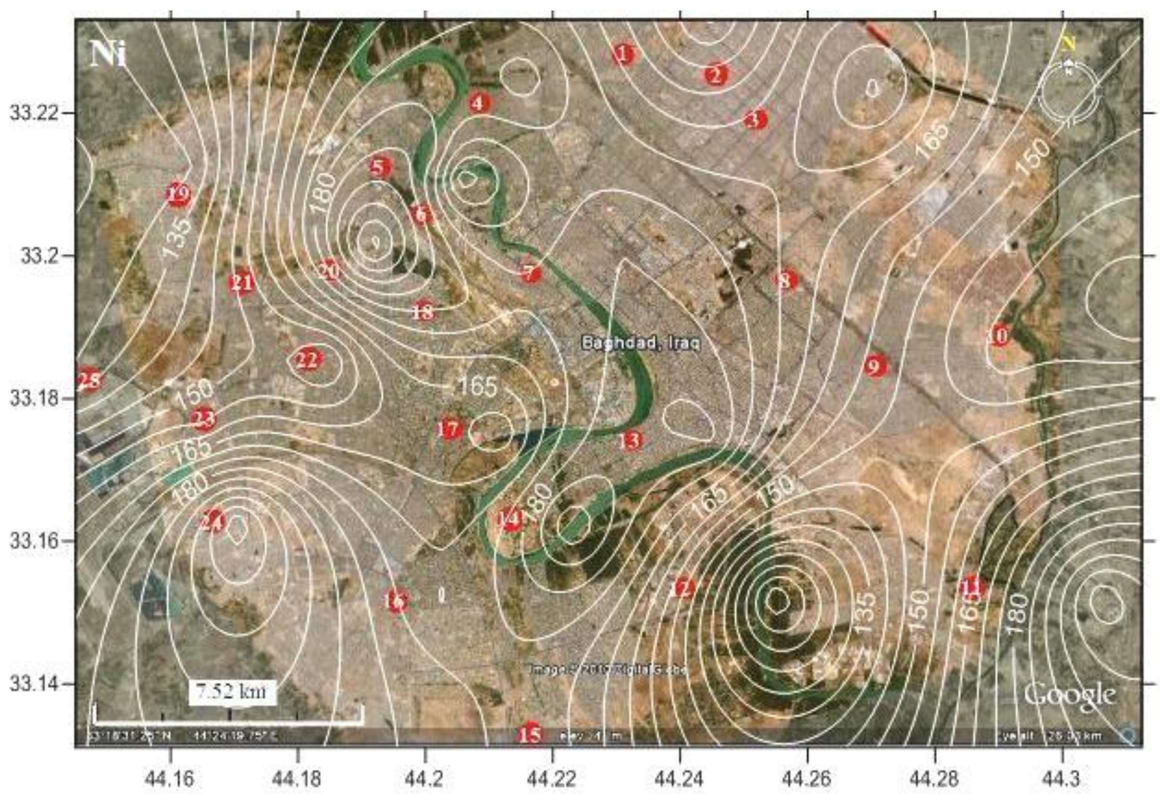


Fig.(5) Contour map shows the Ni distribution in Baghdad.

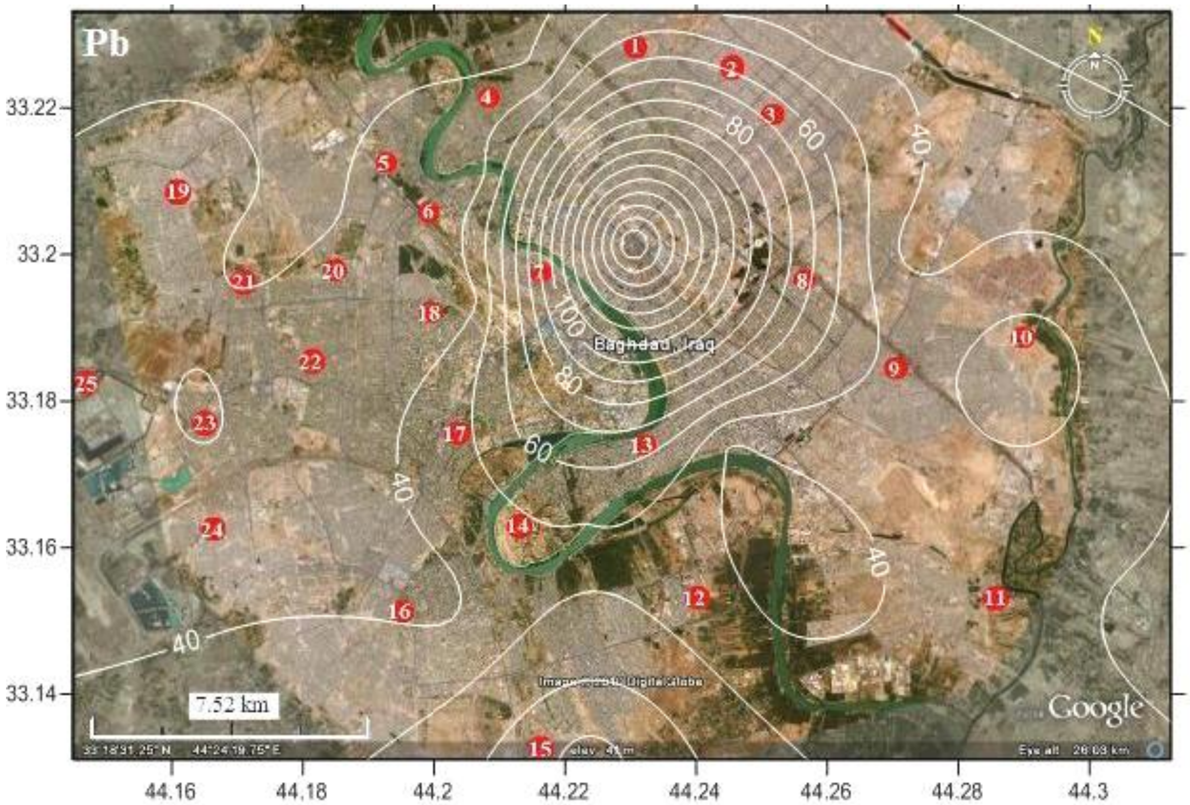


Fig.(6) Contour map shows the Pb distribution in Baghdad.

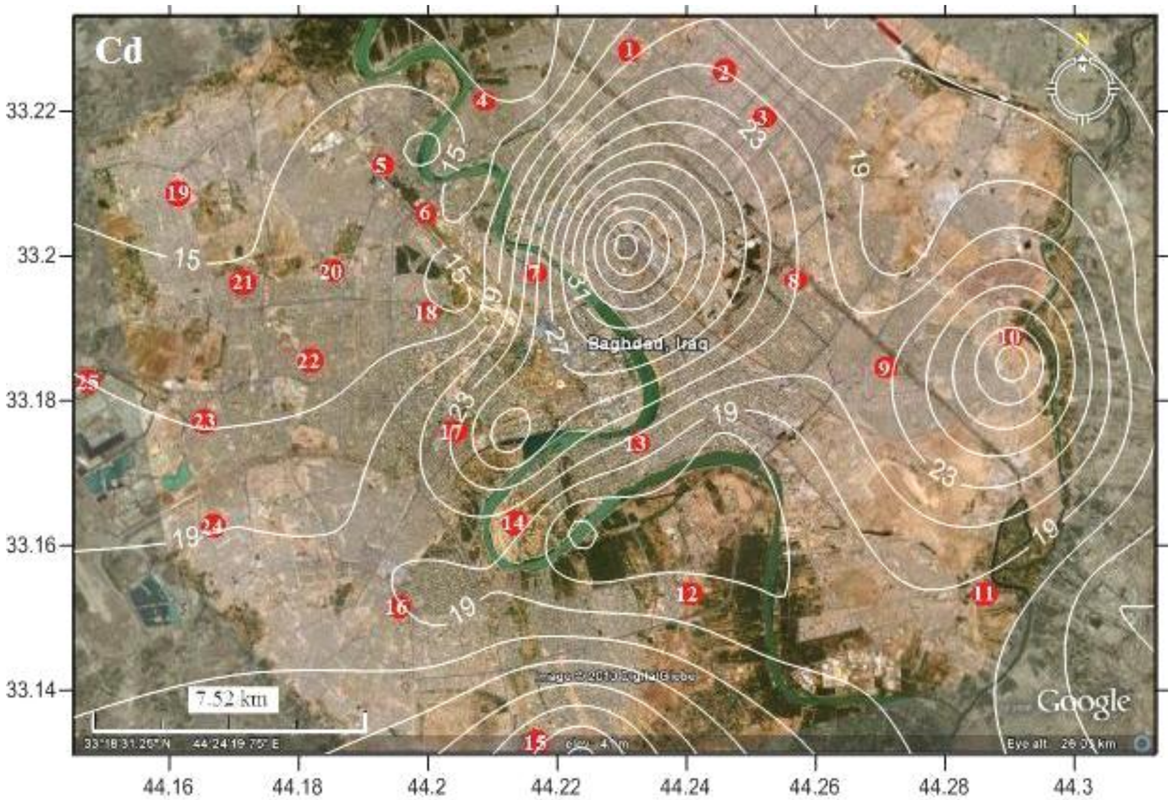


Fig.(7) Contour map shows the Cd distribution in Baghdad.

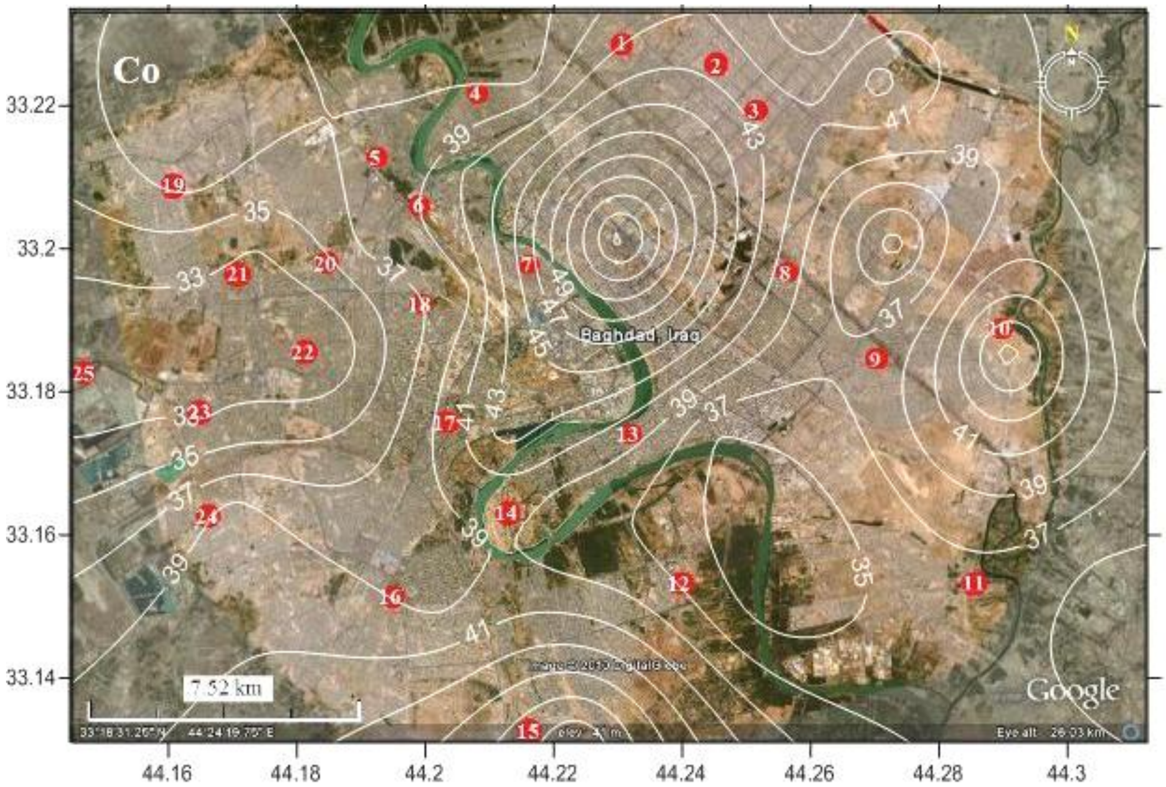


Fig.(8) Contour map shows the Co distribution in Baghdad.

Heavy Metals in Plants

Plants are collectors for all air pollutants, and their chemical composition may be a good indicator for contaminated-areas [17] and [18]. Trace elements that are essential for plant growth are micronutrients which are Boron (B), Chlorine (Cl), Iron (Fe), Molybdenum (Mo), Sodium (Na), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickle (Ni) and Zinc (Zn) [1]. Iron (Fe) has a number of roles in plants, often related to the transition Fe^{2+}, Fe^{3+}, such as electron transport, protein structure (hemeproteins and iron-sulfur proteins), enzymes involved in nitrogen and sulfur metabolism. Iron prevents anaemia, and zinc is a co-factor in over one hundred enzyme reactions [3]. Pb and Cd are non essential nutrient for plant and toxic; it is effectively absorbed by both the root and leaf systems, and is also highly accumulated in soil organisms [19]. Nickel (Ni) is rarely deficient in nature. Nickel deficiency causes disruptions in nitrogen metabolism. Nickel catalyzes urease. Osha, 2004 in [20] considered that the 20 ppm of Cd in soil as pollutant. A great proportion of the Cd is known to be accumulated in root tissues [21]. The mean Cd content in orange fruit tissue ranges from 0.002 ppm – 0.14 ppm [22] and [23].

Cobalt (Co) is not needed by plants in general. However it is needed by the nitrogen fixation complex in the bacteroids in legumes. Heavy metals in both of the leaves (Table (3)) and the fruits (Table (4)) recorded values higher than of global value; and appeared to be descending ordered as Fe> Ni> Pb> Co> Cd (Fig.(9) and (10)). Clearly, leaves contained higher concentration of heavy metals than fruits (Fig.(11)). In the leaves of Phoenix *datylifera* (palm), the concentration of iron ranged from 93 to 225 ppm with average 211 ppm; Ni ranged from 30 to 60 ppm with average 45 ppm; Pb ranged from 20 to 40 ppm with average 30 ppm; Cd ranged from 12 to 20 ppm with average 16 ppm and Co ranged from 15-31 ppm which forms of 23 ppm in average (Table (5)), whereas in the dates of Phoenix *datylifera* (palm), the range and average of iron is 93-205 (138) ppm; Ni recorded 27-60 (47) ppm; Pb recorded 20-39 (31) ppm; Cd recorded 11-17 (13) ppm whereas the 13-29 (19) for Co (Table (5)). From the information above, the leaf palms contained higher concentration of Fe, Cd and Co than the dates, but the Ni and Pb concentrations are slightly higher in the dates (Table (5)).

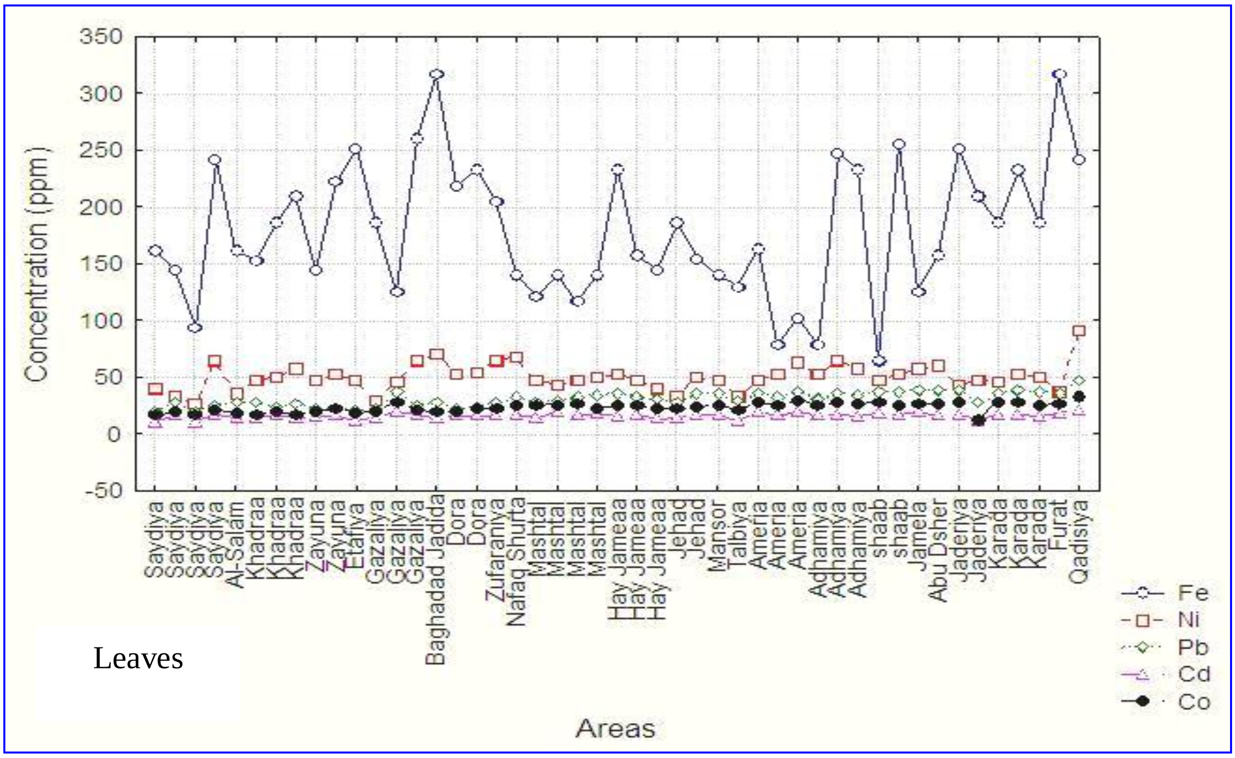


Fig.(9) Heavy metals distribution in plant leaves of different site of Baghdad.

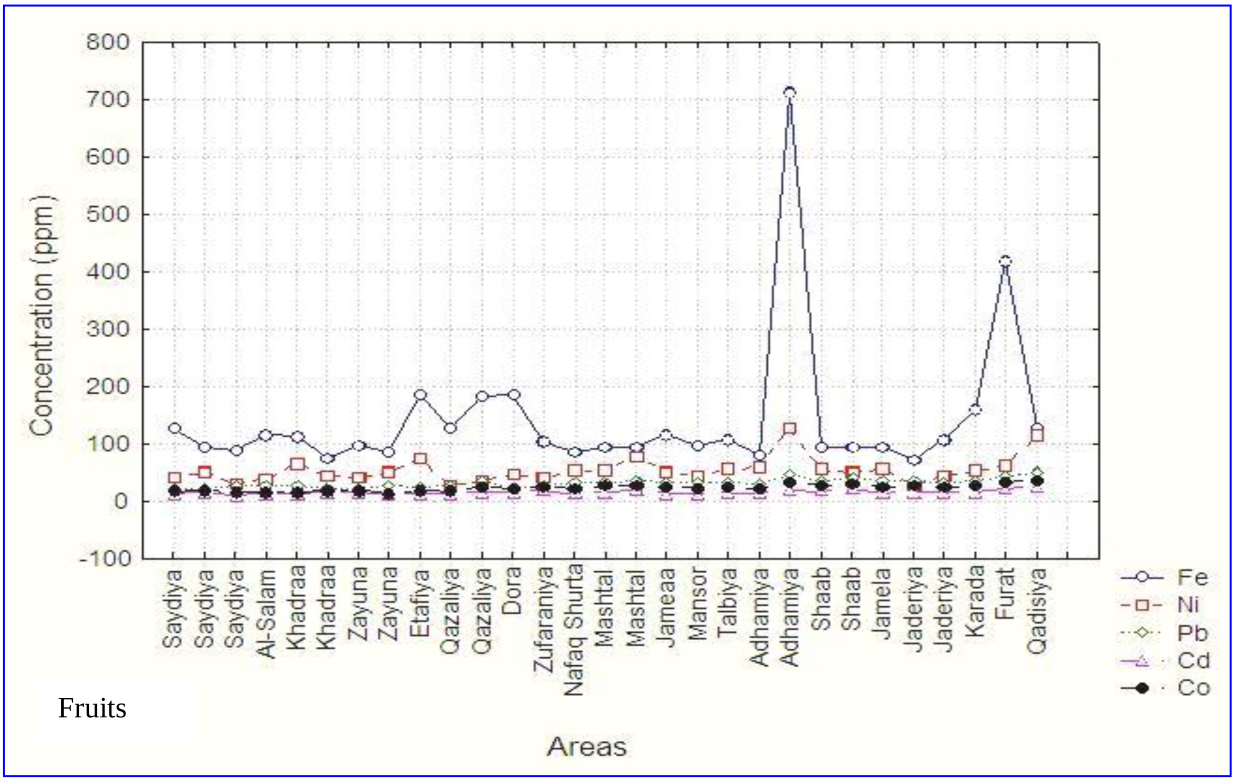


Fig.(10) Heavy metals distribution in plant fruits of different site of Baghdad.

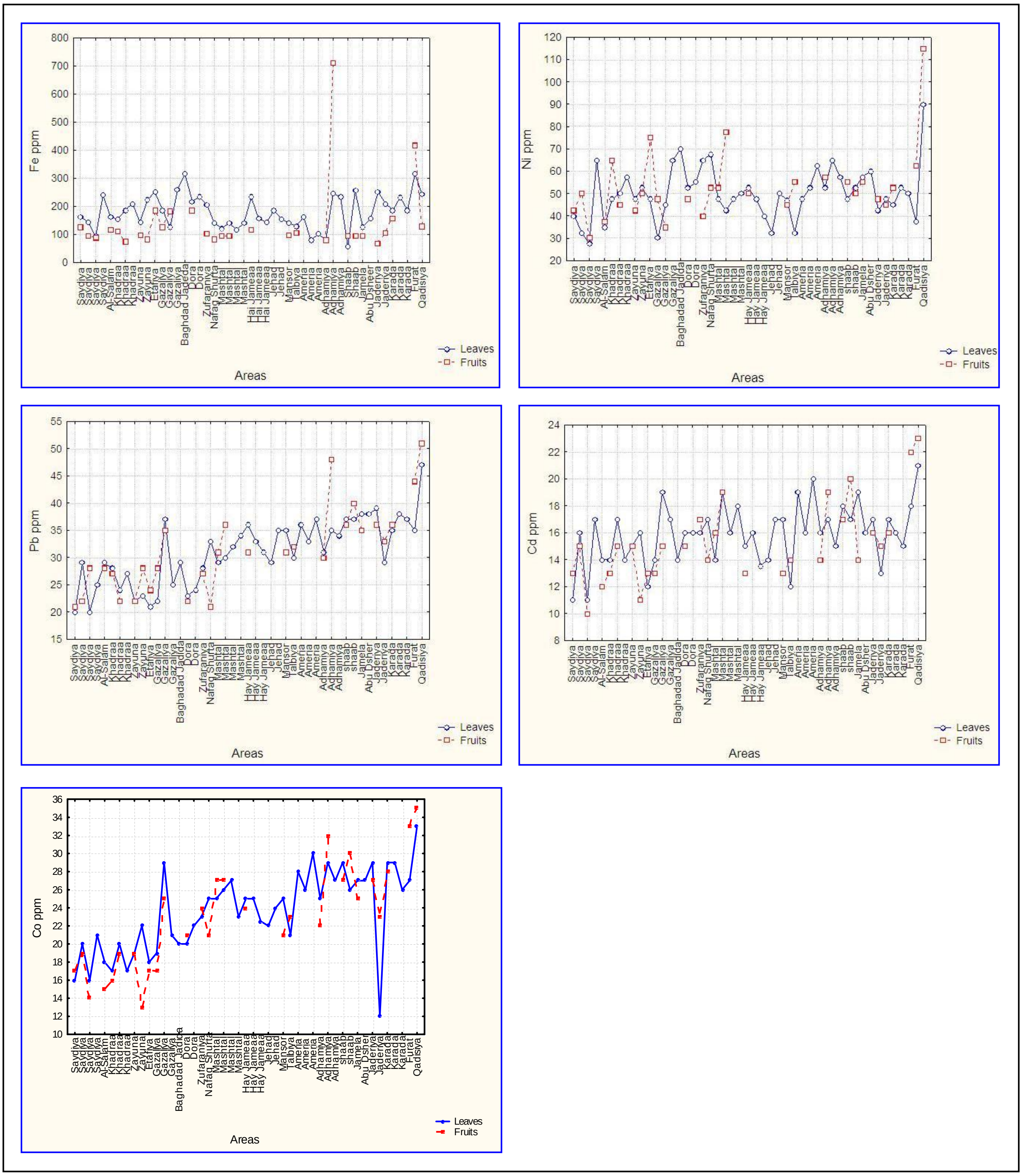


Fig.(11) Contrast of heavy metals in plant leaves and fruits of different site of Baghdad.

Table (3)
Heavy metals concentration in different of plant leaves.

Sample no.	Area name	Type of plant leaves	Fe (ppm)	Ni (ppm)	Pb (ppm)	Cd (ppm)	Co (ppm)
1SH-L	Shaab	Citrus aurantifolia	56	475	37	18	29
2SH-L		Citrus aurantifolia	256	52	37	17	26
3T-L	Talbiya	Citrus aurantifolia	130	32	30	12	21
4J-L	Jamela	Citrus aurantifolia	126	57	38	19	27
5A-L	Adhmiya	Citrus aurantifolia	79	52	31	16	25
6A-L		Citrus aurantifolia	247	65	35	17	29
7A-L		Citrus sinensis	233	57	34	15	24
8S-L	Al-Salam	Citrus aurantifolia	162	35	29	14	18
9AT-L	Ataifia	Citrus aurantifolia	251	47	21	12	18
10H-L	**Haifa**	---	---	---	---	---	---
11Z-L	Zayuna	Citrus sinensis	144	47	22	15	19
12Z-L		Citrus aurantifolia	223	52	23	16	22
13B-L	Baghdad jadeda	Citrus aurantifolia	316	70	29	14	20
14M-L	Mashtal	Citrus aurantifolia	121	47	29	14	25
15M-L		Citrus aurantifolia	140	50	34	18	23
16M-L		Citrus reticulate	140	42	30	19	26
17M-L		Citrus aurantium	116	47	32	16	27
18Zf-L	Zufaraniya	Citrus aurantifolia	205	65	28	16	23
19D-L	Dora	Citrus aurantifolia	218	52	23	16	20
20D-L		Citrus reticulate	233	55	24	16	22
21K-L	Karada	Citrus aurantifolia	186	45	35	17	29
22K-L		Citrus sinensis	232	52	38	16	29
23K-L		Citrus aurantium	186	50	37	15	26
24J-L	Jaderiya	Citrus aurantifolia	251	42	39	17	29
25J-L		Citrus sinensis	210	47	29	13	21
26AD-L	Abu Dsheer	Citrus aurantifolia	158	60	38	16	27
27SD-L	Saidiya	Citrus aurantifolia	144	32	29	16	20
28SD-L		Citrus sinensis	162	40	20	11	16
29SD-L		Citrus sinensis	93	27	20	11	16
30SD-L		Citrus reticulate	241	65	25	17	21
31Q-L	Qadisiya	Citrus aurantifolia	242	90	47	21	33
32M-L	Mansor	Citrus aurantifolia	140	47	35	17	25
33QZ-L	Qazaliya	Citrus aurantifolia	186	30	22	14	19
34QZ-L		Citrus aurantifolia	125	45	37	19	29
35QZ-L		Citric (Lamon)	260	65	25	17	21
36AJ-L	Al jameaa	Citrus aurantifolia	233	52	36	15	25
37AJ-L		Citrus aurantifolia	158	47	33	16	25
38AJ-L		Citrus reticulate	144	40	31	13	22
39KH-L	Khadhraa	Citrus aurantifolia	186	50	24	17	20
40KH-L		Citrus aurantifolia	210	57	27	14	17
41KH-L		Citrus sinensis	153	47	28	14	17
42NS-L	Nafaq shurta	Citrus aurantifolia	140	67	33	17	25
43AM-L	Amriya	Citrus aurantifolia	163	47	36	19	28
44AM-L		Citric grandis	79	52	33	16	30
45AM-L		Citrus reticulate	102	62	37	20	30
46J-L	Jehad	Citrus aurantifolia	168	32	29	14	22
47J-L		Citrus aurantifolia	154	50	35	17	24
48F-L	Furat	Citrus aurantifolia	316	37	35	18	27
***global concentration in dry matter of plant**			**100**	**0.05**	**30**	**4.3**	**0.1**

Table (4)
Heavy metals concentration in the fruits in the different sites of Baghdad.

Sample no.	*Area name*	*Type of fruits*	*Fe*	*Ni*	*Pb*	*Cd*	*Co*
			ppm				
1SH-F	Shaab	Citrus aurantifolia	93	55	36	17	27
2SH-F		Citrus aurantifolia	93	50	40	20	30
3T-F	Talbiya	Citrus aurantifolia	107	55	32	14	23
4J-F	Jamela	Citrus aurantifolia	93	55	35	14	25
5A-F	Adhmiya	Citrus aurantifolia	79	57	30	14	22
6A-F		Citrus aurantifolia	711	127	48	19	32
7S-F	Al-Salam	Citrus aurantifolia	116	37	28	12	15
8AT-F	Ataifia	Citrus aurantifolia	186	75	24	13	17
9Z-F	Zayuna	Citrus sinensis	97	42	22	15	19
10Z-F		Citrus aurantifolia	84	50	28	11	13
11M-F	Mashtal	Citrus aurantifolia	93	52	31	16	27
12M-F		Citrus aurantifolia	93	77	36	19	27
13ZF-F	Zufaraniya	Citrus aurantifolia	102	40	27	17	24
14D-F	Dora	Citrus aurantifolia	186	47	22	15	21
15K-F	Karada	Citrus aurantifolia	158	52	36	16	28
16J-F	Jaderiya	Citrus aurantifolia	70	47	36	16	27
17J-F		Citrus sinensis	107	45	33	15	23
18SD-F	Saidiya	Citrus aurantifolia	93	50	22	15	19
19SD-F		Citrus sinensis	126	42	21	13	17
20SD-F		Citrus sinensis	88	30	28	10	14
21Q-F	Qadisiya	Citrus aurantifolia	128	115	51	23	35
22M-F	Mansor	Citrus aurantifolia	97	45	31	13	21
23QZ-F	Qazaliya	Citrus aurantifolia	126	47	28	13	17
24QZ-F		Citrus aurantifolia	183	35	35	15	25
25AJ-F	Al jameaa	Citrus reticulate	116	50	31	13	24
26KH-F	Khadhraa	Citrus aurantifolia	75	45	22	15	19
27KH-F		Citrus sinensis	112	65	27	13	16
28NS-F	Nafaq shurta	Citrus aurantifolia	84	52	31	14	21
29F-F	Furat	Citrus aurantifolia	418	62	44	22	33
Range			**75-711**	**30-127**	**21-48**	**10-22**	**13-35**
Average			**142**	**55**	**33**	**15**	**23**
Average in one piece of Citrus aurantifolia			1736	653	370	178	270
Average in one piece of Citrus sinensis			1253	529	619	156	210

Table (5)
Heavy metals concentration in the leaves and dates of phoenix dactylifera in the different sites of Baghdad.

Sample no.	Area name	Sample type (phoenix dactylifera)	Fe	Ni	Pb	Cd	Co
			ppm				
1J-PL	Jamela	Palm leaves	186	52	37	14	23
2J-PD		Dates	205	50	39	17	26
3A-PL	Adhmiya	Palm leaves	135	55	33	17	26
4A-PL		Palm leaves	233	35	33	13	23
5S-PL	Al-Salam	Palm leaves	251	30	20	13	17
6H-PL	Haifa	Palm leaves	219	47	35	19	25
7H-PL		Palm leaves	353	60	38	18	29
8Z-PL	Zayuna	Palm leaves	140	37	21	14	17
9B-PL	Baghdad jadeda	Palm leaves	256	57	25	13	19
10Zf-PL	Zufaraniya	Palm leaves	158	42	25	15	21
11D-PL	Dora	Palm leaves	218	47	30	14	24
12K-PL	Karada	Palm leaves	325	47	40	20	31
13K-PD		Dates	149	52	38	17	29
14J-PL	Jaderiya	Palm leaves	288	50	33	17	26
15AD-PL	Abu Dsheer	Palm leaves	205	50	40	18	31
16SD-PL	Saidiya	Palm leaves	242	42	22	15	17
17SD-PD		Dates	102	27	28	11	14
18Q-PL	Qadisiya	Palm leaves	219	47	35	19	25
19QZ-PL	Qazaliya	Palm leaves	167	42	21	13	16
20QZ-PL		Palm leaves	153	47	34	16	28
21QZ-PD		Dates	144	60	20	11	15
22QZ-PD		Dates	93	45	29	11	13
23KH-PL	Khadhraa	Palm leaves	190	32	20	13	19
24KH-PL		Palm leaves	161	45	27	12	15
25AM-PL	Amriya	Palm leaves	251	55	37	17	27
26J-PL	Jehad	Palm leaves	93	45	34	16	27
Range		**Palm leaves**	**93-325**	**30-60**	**20-40**	**12-20**	**15-31**
Average		**Palm leaves**	**211**	**45**	**30**	**16**	**23**
Range		**Dates**	**93-205**	**27-60**	**20-39**	**11-17**	**13-29**
Average		**Dates**	**138**	**47**	**31**	**13**	**19**

Discussion and Conclusions

Markedly, the accumulation of heavy metals with high concentration in the Baghdad soil in comparison with the global values is attributable to the pollution of Baghdad soil. The descending order of heavy elements in the soil as well as the both types of plant tissues; leaves and fruits as Fe> Ni> Pb> Co> Cd indicate a systematic uptake of trace elements from soil. On the basis of plants are able to accumulate trace elements (especially heavy metals) above established background concentrations in or on their tissues [2]; they were considered as intermediate reservoirs through which heavy metals from soils move to food chain. Obviously, the leaf plant tissues store the greater quantity of heavy metals, while the lower quantity is stored in fruit tissues (Fig.(11)); however, the heavy metals (Ni, Pb, Co, and Cd) accumulated within both of leaves and fruits having concentration higher than of the global values (Table (3)). From the average concentration in the different type Citrus fruit, author have inferred that the average concentration of heavy metals in one piece of Citrus fruit which have about 120 gm is Fe (2800 ppm), Ni (1100 ppm), Pb (660 ppm), Cd (300 ppm) and Co (460 ppm); this means the total concentration of these elements is 0.5% approximately. Iron concentration tend to be less than of the average of global value and has distribution pattern increases toward SE of Baghdad (Fig.(3)); in concordance with the prevailing wind direction which considered as an active redistributor. Nickel in general occurs in high values in Baghdad soil but concentrated around Al-Salam, Autaifiya, Jameaa, Jehad, Saidiyas, Zufaraniya, Dora and Jadriya (Fig.(3)); Nickel (Ni) can be found in high concentration around areas contained nickel-cadmium batteries and as product of diesel fuel.

The vehicle exhausts in heavy traffic are the main source of Pb and Cd [25]; contour maps (Figs. (6, 7 and 8)) display the distribution of Pb, Cd and Co in Baghdad soil has similar pattern and concentrated maily in Al-Rasafa side around Garage of Bab Al-Muaadham in which the gases from automobiles are continuously emitting; this led to suggest that the garages and crowded traffic area were a point and non point source respectively.

These heavy metals could come from many different sources. The authors believed that leaded gasoline was the major pollutant; lead is used manufacture of batteries, fuel additives (Leaded gasoline), in painted surfaces, in PVC plastics, crystal glass production, and pesticides. Cadmium is a by-product of smelting of lead and zinc; it can be found in nickel-cadmium batteries, diesel fuel, Tires, cigarettes, PVC plastics, and paint pigments, in soils because insecticides, fungicides, cadmium. Nickel (Ni) can be found in nickel-cadmium batteries, diesel fuel. Cobalt (Co) can be found in diesel and gasoline fuel; in sludge, and commercial fertilizers that use addition to that many industrial sites occurring in Baghdad like Dore electrical station; Dora oil refining; Factory of liquid batteries in Al-Wazeria; The general company for wool industries in Khadhumiya; The state company for vegetable oils industry (Al-Rasheed factory and Al-Amen factory; The company of light industry; Al-Haditha painting company. All these industrial sites add heavy metals into environment, but they were partially polluted source.

In both leaves of Citrus and Phoenix (palm), good correlation arose among Pb, Cd and Co (Tables (6) and (7)); whereas, in the Citrus fruits Ni also correlated with Pb, Cd and Co (Table (8)), but Cd tend to be well correlated with Co (Table (9)). However, those heavy metals have highly correlation in the Iraqi fuel, therefore, the increasing of Pb, Cd and Co attributed to the burning of fuels in the automobiles which uses the leaded gasoline and diesel. Accordingly, the vehicles electrical generators exhausts are therefore suggested to be a main source of pollution.

Table (6)
Correlation coefficient of heavy metals in 48 samples of plant leaves, (Significant Level= 0.46).

	Fe	*Ni*	*Pb*	*Cd*	*Co*
Fe	**1.00**				
Ni	**0.67**	**1.00**			
Pb	**0.80**	**0.77**	**1.00**		
Cd	0.43	**0.58**	**0.60**	**1.00**	
Co	0.44	0.54	**0.71**	**0.91**	**1.00**

Table (7)
Correlation coefficient of heavy metals in 29 samples of fruits, (Significant Level =0.55).

	Fe	*Ni*	*Pb*	*Cd*	*Co*
Fe	**1.00**				
Ni	0.33	**1.00**			
Pb	-0.03	0.36	**1.00**		
Cd	-0.01	**0.48**	**0.64**	**1.00**	
Co	-0.04	0.38	**0.88**	**0.75**	**1.00**

Table (8)
Correlation coefficient of heavy metals in 22 samples of palm leaves, (Significant Level=0.63).

	Fe	*Ni*	*Pb*	*Cd*	*Co*
Fe	**1.00**				
Ni	0.22	**1.00**			
Pb	0.28	**0.63**	**1.00**		
Cd	0.41	0.46	**0.73**	**1.00**	
Co	0.52	0.49	**0.88**	**0.84**	**1.00**

Table (9)
Correlation coefficient of heavy metals in 5 samples of palm's dates. (Significant Level = 0.95).

	Fe	*Ni*	*Pb*	*Cd*	*Co*
Fe	**1.00**				
Ni	0.52	**1.00**			
Pb	0.53	-0.05	**1.00**		
Cd	**0.79**	0.32	**0.89**	**1.00**	
Co	0.75	0.37	0.48	**0.99**	**1.00**

References

[1] Ajmalkhan, M. U.; Showalter, A. M.; "Effect of salinity on growth, ion contact, and osmotic relation"; Stapf. Journal of Plant Nutration, 22, 1, 191-204, **1999**.

[2] Kabata, A.; Pendias, H.;" Trace Elements in Soils and Plants"; (3rd ed.), CRC press, Washington, D.C., 550 p. **2001**.

[3] Komatina, M. "Medical Geology, Effects of Geological Environmental on Human Health-Development in Earth and Environment Sciences-2"; Oxford, UK, 482p, **2004**.

[4] Khalid, B. Y.; Salih, B. M.;"Lead contamination of soil in Baghdad city"; Iraqi Bull. Environ. Contam. Toxical, 27, 634-638, **1981**.

[5] Hanna, A.; Al-Bassam, K. S. ;" Survey of lead pollution in Baghdad"; Water, Air and Soil Pollution Journal, 19, 3-14, **1983**.

[6] Al-Bassam, K. S.; Hann, A.; Al-Hilali, M.; "Concentration of some heavy elements in Iraqi soil"; Procceding of the Conference on Environmental Protection from Industrial Pollution. Ministry of Industry and Minerals. Habbaniya , Iraq; pp.12-15, **1985**.

[7] Haqus, M. D.; Hammed, H. A. ;"Lead content of green forage growing adjacent to express ways and road connecting Arbil city (N Iraq)". Jour. Bio. Sci. Res.;17, 153-164, **1986**.

[8] Hanna, A. ; Al-Hilali, M.;" Investigation of some environmental aspects in Baghdad", Geoserv, Int.Rep. 1529, 1-34, **1986**.

[9] Al-Hamadani, R.;"Industrial Pollution by Heavy Metals on Soil and Plant" M.Sc. Thesis, College of Medicine. University of Baghdad (Arabic), Iraq, pp100-111, **1987**.

[10] AL-Sayegh, A.; Al-Yazichi, K.;"Car exhausts pollution in Mosul city", Rafidain Journal of Science, College of Science, University of Mosul, (in Arabic); 12, 2, 122-123, **2001**.

[11] Kuwaidem, K. H. "Study of Environmental Situation in Al-Basra Governorate", (Unpublished Ph.D. Thesis); College of Science, University of Baghdad, Iraq, pp 90-94p, **2007**.

[12] Ameen, N. H.;"Biological effects of lead poisoning in Baghdad city"; Iraqi J. Biotech; 8, 1, pp. 242-251, **2009**.

[13] Awadh, S.M.;"Atmospheric pollution of Baghdad city, Iraq"; Proceeding of 3rd Scientific Conference of College of Science, University of Baghdad; vol.1, pp.1727-1740, **2009**.

[14] jassim, S. Z. ; Goff, J. C. ; "Geology of Iraq', First edition, Dolin, Praque and Moravian Museum, Brno, Czech Republic; pp 90-122, **2006**.

[15] Haswell, S. J.;"Atomic Absorption Spectrophotometry"; Theory Design and Application" Elsevier, Amsterdam, The Nether Land; pp400-45-406, **1991.**

[16] Al-Qaraghuli, N. A. ;"Trace elements and organic matter contents in the Cretaceous sediments of the Rumaila oil field"; Bull. Col. Soi.; 12,13 217-241, **1973**.

[17] Rühling, A.; Rasmussen, L.; Pilegaard, K. Mäkinen, A.; Steinnes, E.;"Survey of Atmospheric Heavy Metal Deposition in Nordic Countries in 1985"; Report for Nordic Council of Ministers, Kobenhavn, Norway; pp150-165, **1987.**

[18] Jenkis, D. K. ;"Trace Elements in Saxicolous Lichens in Pollutant Transport and Fate in Ecosystems, Blackwell Sci., Oxford, London; pp240-249, **1987**.

[19] McGrath, S. P. ;"Soil Quality in Relation to Agricultural Uses", In Integrated Soil and Sediment Research: A Basis for Proper Protection, Eijsackers, H. J. P. ; Hamers, T. (Eds.),Kluwer Academic, The Netherlands; pp 99-105, **1993.**

[20] H. A. Hamza,"Pollution of some soils and water of Diyala river with Cadimium", M. Sc. (Unpublished Thesis), College of Agriculture, University of Baghdad. Iraq, pp. 25-36, **2005**.

[21]Kabata, P. A. ;"Effects of Inorganic Air Pollutants on the Chemical Balance of Agricultural Ecosystems", paper presented at United Nations-ECE Symposium on Effects of Air-borne Pollution on Vegetation, Warsaw; 20, pp93-134, August, **1979**.

[22] Shacklette, H. T.;"Cadmium in plants"; U. S. Geol. Surv. Bull.; 28, 13, pp.1292-1314, 28, **1972**.

[23] Shacklette, H. T.;"Elements in fruits, and vegetable from areas of commercial production in the Conterminous United States", U. S. Geol. Surv. Prof. Paper, 1178, 149, **1980**.

[24] Rose, A. W. ; Hawkes, H. E.; Webb, J. S.;"Geochemistry in Mineral Exploration"; (2^{nd} edition). Acadimic Press. London, 657, **1981.**

[25] Mohammed, F. A.;"Pollution caused by vehicle exhaustes and oil trash burning in Kirkuk city", Iraqi Journal of Earth Sciences; 9, 2, 39-48, **2009**.

الخلاصة

لغرض معرفة توزيع تراكيز العناصر الفلزية الثقيلة السامة (الحديد والرصاص والكادميوم والنيكل والكوبالت) في التربة واوراق وثمار بعض النباتات (النارنج والبرتقال واللالنكي والسندي والليمون الحامض) بالاضافة الى سعف النخيل والتمور في مدينة بغداد: فقد تم قياسها في عينات التربة والنباتات التي جمعت من 25 موقعاً. أجريت هذه الدراسة على 25 عينة تربة و 47 عينة أوراق نباتية و29 عينة ثمار و 5 عينات تمور. بينت هذه الدراسة ان تركيز العناصر الفلزية الثقيلة في التربة والاوراق والنباتات يكون أعلى من التوزيع الطبيعي, وان هذه الفلزات تميل للتراكم في أوراق النباتات أكثر من تراكمها في الثمار، كما تبين أن الفلزات الثقيلة وخاصة الرصاص والكادميوم والكوبالت في تربة مدينة بغداد تكون ذات ارتباط موجب قوي وتتوزع بانماط متشابهه ويعزى السبب في ذلك الى انها من اصل واحد وان مصدرها هو احتراق وقود الديزل والبنزين.