Exploration of lead , cadmium and copper in street dust of Baghdad city.

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Abstract

This research study examines streets dust pollution in Baghdad city by heavy metals Pb, Cd, and Cu. In this study it has been taking 69 dust specimen 52 from Karkh and 17 from Rusafa regions including crowded general streets, bystreets, and from some street nearer to main electrical generators and from some housetops or terraces and gardens of some houses. This study included 25 region in Karkh and Rusafa in Baghdad city. The levels of heavy metals concentration were determined using flame atomic absorption spectrophotometer (AAS) after digestion of dust samples using aqua regia. The study was conducted to include the effects of accumulation of heavy metals derivatives on soil surface as a result of emissions of such heavy metal and to include the effects on the environments. It was found that the highest concentration level of lead in dust of abo-greib (AGBt) sample in Karkh site equal to 139.52 ppm and the maximum level of lead in dust of Karkh site equal to 27.78 ppm for street near electric generator in gent sample and comparing to level 29.32 ppm was found for lead in dust of housetop in Rusafa site in Ht sample. The highest concentration level of copper in dust of Karkh site was found in St1 sample equal to 9.96 ppm comparing to level 23.82 ppm of copper in general street of Rusafa site in St sample, whereas the highest concentration level of cadmium in dust of Karkh site was found in gent sample equal to 0.29 ppm comparing to level 0.15 ppm of cadmium in St sample of Rusafa site. Whereas the lowest level of lead in dust in Rusafa site was found in branch street of St1 sample equal to 15.1 ppm compared to lowest level of lead in dust in Karkh site equal to 11.71 ppm .

Key Words: Heavy metals, Baghdad city street dust, atomic absorption spectrometry.

الخلاصة

يتناول البحث الحالي قياس تلوث تراب شوارع مدينة بغداد بالعناصر الثقيلة Pb و Cd و Cu حيث تم أخذ 69 عينة. 52 عينة في جانب الكرخ و 17 عينة في جانب الرصافة شملت الشوارع العامة المزدحمة والفرعية ومن بعض الشوارع الفرعية قرب مولدات الكهرباء ومن تراب سطوح وحدائق بعض المنازل فشملت الدراسة البحثية الحالية 25 منطقة في الكرخ والرصافة في مدينة بغداد وحسبت تراكيز العناصر بجهاز مطياف الأمتصاص الذري اللهبي AAS بعد هضم العينات مختبرياً بأستخدام خلطة الحوامض المركزة وجرى دراسة تأثير هذه

العناصر على البيئة وبالخصوص نتيجة أنبعاث مشتقات الرصاص من حرق وقود مركبات النقل الخاصة والعامة. فوجد أن أعلى تركيز Pb في عينة تراب أبوغريب AGBt في جانب الكرخ يساوي 139.52 جزيء بالمليون ثم أن أعلى تركيز Pb في جانب الكرخ في شارع قرب مولدة كهربائية عينة تراب gent حيث بلغ 27.78 جزيء بالمليون وبالمقارنة وجد أن أعلى تركيز Pb في جانب الرصافة في عينة تراب سطح المنزل Ht يساوي 29.32 ملغم/لتر. بينما وجد أن أعلى تركيز للنحاس في جانب الكرخ في عينة شارع فرعي St1 يساوي 9.96 جزيء بالمليون. وبالمقارنة وجد تركيز النحاس في جانب الرصافة في عينة شارع عام St يساوي 23.82 جزيء بالمليون بينما أعلى تركيز للكادميوم في جانب الكرخ في شارع قرب مولدة كهربائية عينة تراب gent حيث بلغ 0.29 جزيء بالمليون بالمقارنة مع تركيز الكادميوم في جانب الرصافة في عينة شارع عام St يساوي 0.15 جزيء بالمليون. بينما بالمقارنة وجد أن أدنى تركيز Pb في جانب الرصافة في عينة تراب St1 حيث بلغ 15.1 ملغم/لتر وأدنى تركيز Pb في جانب الكرخ في عينة تراب St1 أيضاً حيث بلغ 11.71 ملغم/لتر.

الكلمات المفتاحية: العناصر الثقيلة ، تراب شوارع مدينة بغداد، مطياف الأمتصاص الذري.

Introduction

The street dust is defined in some recent studies [1,2,3] as the product of the interaction of solid, liquid and gaseous materials produced from different sources on the roads and may contain pollutants such as heavy metals and dangerous organic compounds, becoming a growing concern in recent years because it is a continuous contact with the habitants of cities [3]. However, scarce information exist in developing countries limiting the appropriate evaluation of the levels of risk of the people who lives in the most important cities [2]. Street dust has been identified as a potential source of lead exposure to human. This heavy metal is released from the combustion of leaded gasoline. The heavy metal and other contaminants present in the soil surrounding the roads can reach the road via rain water, also the dry and wet atmospheric deposition of vehicle wear, tear vehicular fluids and particular emissions all add to the level of the pollutants [4,5,6]. In general urban system is regarded as complex matter and the polluted dust by lead, cupper and cadmium at the surface of roads gives variety of indications to the urban environment pollution [7,8,9]. Lead continues to be an important element for environmental monitoring due the health effects so assessment of potential hazards and monitoring of remediation efforts are essential to providing a safe environment [10,11]. For this reason concentrations of lead in street dust was recorded in some cities [12] and appears it has values ranging between 85 to 5060 µg/g, and as a result of preventing leaded gasoline fuel that contained compounds $Pb(CH_3)_4$, $Pb(CH_3)_3(C_2H_5)$, $Pb(CH_3)_2(C_2H_5)_2$, $Pb(CH_3)(C_2H_5)_3$, or $Pb(C_2H_5)_2$ or even that contained lead halides such as $PbBr_2$, PbBrCl, Pb(OH)Br, $(PbO)_2PbBr_2$ or $(PbO)_2PbBrCl$ as well

as lead ammonium halides such as $PbBrCl.NH_4Cl$ [13]. In many local regimen the unleaded gasoline has been used which cause a reduce in lead concentrations in street dust for example, in Caracas city was recorded level between 5 and 13 µg/g and in Maracay city (1) recorded level between 2.0 and 4.0 µg/g especially in dust of resident area. In recent research study [14] was recorded a diversity in concentration levels of lead in dust of crowded roads while other study [15] was found that lead in main streets ranging from 800 to 1000 µg/g. The matter of pollution by heavy metals was attained great concern for their toxicity and hazards on human health, environment and on agricultural crops near to roads [16]. It is known that lead is health endangering metal for human and its effects include blood enzyme changes, anemia, hyperactivity, and neurological disorder [17]. Excessive Cd exposure may give rise to renal, pulmonary, hepatic, skeletal, reproductive effects [18]. It is known that Cu is essential element yet it may be toxic to both human and animals when its concentration exceeds the safe limits in some human tissues such as thyroid[19].

Obviously, the monitoring of lead cadmium and copper levels in the environment has a high importance. The Word Health Organization (WHO) reported tolerable weekly intake of Cd and Pb as 0.007 and 0.025 mg/kg body weight respectively, for all human groups [16]. Particularly in light of the impact of high blood Pb levels in children living in urban area and likelihood of this being caused by unintentional hand mouth contamination while children play in a city street [20-24].

The aim of this research study was firstly to determine the average concentrations of three metals (Pb, Cd, Cu) in street dusts sampled from several region in Karkh and Rusafa districts in Baghdad city and to generate information for the level of traffic related to metal pollutants in these districts of Baghdad.

Experimental

Samples digestion:

The dust sample digestion methods were found in many literatures that specializing in analysis of heavy metals differed when work with it using one of the following concentrated acids: HCl, HNO_3, $HClO_4$, HF or a mixture of some of them and sometimes using hydrogen peroxide H_2O_2 [25-28], each time 1 gm from the dust sample was subjected to acid digestion using different temperature conditions [14,29,30] especially using 8 molar nitric acid alone. Some of the methods a 95° C digestion temperature was used for 2 hr [29] others digestion at 80° C for 3 hr [31] and sometimes with reflux [16,32]. In the past century the concentrated acid solution which is consisted from three volumes of HCl mixed with one volume of HNO_3 that it so called aqua regia was commonly used for digestion, this concentrated acid solution was recently used for digestion of dried 1 gm dust sample

using temperature above boiling with reflux [1,16,33] and also using kieldahl [34] in digestion. But recently [35] a digestion with lower temperature at 95° C and for a period approximately 1 hr using a modified acid mixture which consisted of $2HCl+2HNO_3+2H_2O$.

Apparatus, materials and reagents:

In this work 20 ml of aqua regia has been used for digestion of dried 1.0 gm of dust sample, this acid solution was prepared from concentrated (37%) HCl and concentrated (69%) HNO_3 both obtained from AppliChem-company-GmbH Germany, the mixture was shacked for 24 hr then filtered and the filtrate was further centrifuged then the supernatant was diluted using volumetric flask by distilled deionized water to a 50 ml. A set of suitable standard solutions were prepared from 1000 mg/L stock solutions of Pb type HC813336, of Cd type HC813220 and of Cu type HC804298 all these stock were obtained form MERK company-Germany. A SHIMADZU AA-7000 flame atomic absorption spectrometer was used for the determination of analytes. The apparatus optimum conditions for AAS are given in Table 1.

Table 1 apparatus operating parameters for AAS .

Parameters	Pb	Cd	Cu
Wavelength, nm	283.3	228.8	324.8
HCL current, mA	10	8	8
Acetylene flow rate, L /min	2.0	1.8	1.8
Air flow rate, L /min	15	15	15
Slit, nm	0.7	0.7	0.7

Samples collection:

The number of dust sample according its type was 8 dust sample type, and in this work each type was given appropriate name as follows: (1) St for general street, (2) St1 for branch street, (3) gent for street near to electric generator (4) Mt for highway street, (5) AGBt for street of abogreib battery factory, (6)AGC for street abogreib agriculture college, (7) Ht for dust at housetop, (8) G for house garden.

In this work the number of the residential areas were 16 area including 25 samples in these areas at both sides of Baghdad city; Karkh and Rusafa and they are nominated as follows: (1) alsaidai including C1-K, C2-K, C3-K and C4-K. (2) aldura including D1-K, D2-K, D3-K and D4-K. (3) alyousfai including Al-yous-K. (4) alruthwanai including Ruth1-K and Ruth2-K. (5) abomaalef including Abo-maa-K. (6) haialaml including Al-aml 1-K and Al-aml 2-K. (7) hialmansoor including Hi.mans-K. (8) abogreib including AGBt and AGC. (9) hialjehaad including Hi-Ji-K. (10) including Hi-Ja-K. (11) palestein street including Pal-St.-R. (12) almashtel including Al-mash-R. (13) alkarrada including Kar-R. (14) hialsaadon including Al-saad-R. (15) alatmia including Al-atm-R. (16) hialshaab including Al-shaab-R. Whereas the letters K and R denoting for Karkh and Rusafa respectively.

The place symbols from which samples have been collected are clarified in Table 2 that shows a total

of 69 dust samples distributed on 52 specimens in Karkh sites plus 17 specimens in Rusafa sites, also the sampling points from which the specimens have been collected are shown on overview map of Baghdad city in Figure 1.

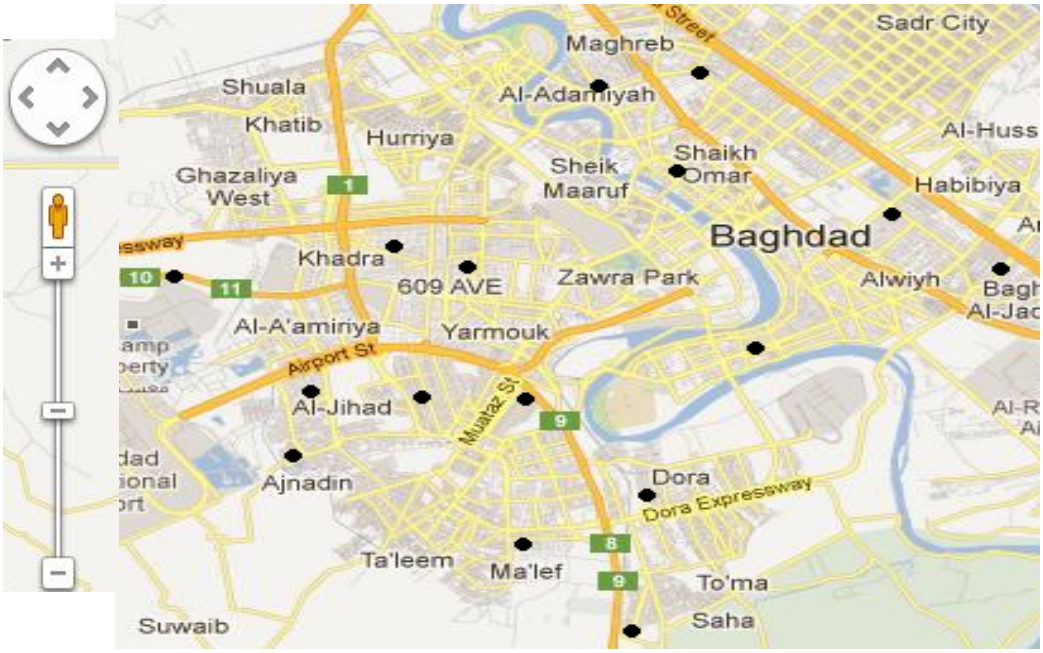

Figure 1 location map of studied area in Karkh and Rusafa sites of Baghdad city.

Table 2 symbols of samples collection at both sides of Baghdad city; Karkh and Rusafa.

place	symbol of specimen	No	place	symbol of specimen	No	place	symbol of specimen	No
St	Pal-St.-R1	1	St	C 1-K1	28	St	Abo-maa -K2	1
St	Al-atm-R1	2	St	C 2-K1	29	gent	Abo-maa-K1	2
Ht	Pal-St.-R3	3	St	C 3-K1	30	St1	Abo-maa -K3	3
Ht	Al-atm-R3	4	St	C 4-K1	31	St	Ruth1 –K1	4
G	Pal-St.-R2	5	gent	C 3-K3	32	St1	Ruth2-K1	5
G	Al-atm-R2	6	gent	C 4-K3	33	St	Al-aml 2-K1	6
St	Al-saad-R1	7	St1	C 2-K2	34	St1	Al-aml 2-K2	7
St1	Al-saad-R2	8	St1	C 3-K2	35	St	Al-aml 1-K1	8
Ht	Al-saad-R3	9	St1	C 4-K2	36	AGBt	Abo-Gr.1	9
St	Al-mash-R1	10	Mt	Al-yous- K1	37	AGC	Abo-Gr.2	10
St	Kar-R1	11	St	Al-yous-K2	38	St	Hi-Ja-K1	11

St	Al-shaab-R1	12	St	D 1-K1	39	gent	Hi-Ja- K3	12
St1	Al-mash-R2	13	St	D 2- K1	40	St	Hi-Ji-K1	13
St1	Al-shaab-R2	14	St	D 3-K1	41	gent	Hi-Ji-K3	14
Ht	Al-mash-R3	15	St	D 4-K1	42	St1	Hi-Ji-K2	15
Ht	Kar-R2	16	St1	D 1-K2	43	St	Hi.mans-K1	16
Ht	Al-shaab-R3	17	St1	D 3-K2	44	Ht	C 1-K3	17
			St1	D 4-K2	45	Ht	C 2-K3	18
			gent	D 3-K3	46	Ht	D 1-K3	19
			G	C 1-K2	47	Ht	D 2- K3	20
			G	D 2- K2	48	Ht	C 4-K4	21
			G	Al-aml 1-K2	49	Ht	D 4-K3	22
			G	Ruth1 –K2	50	Ht	Ruth1-K3	23
			Ht	Hi-Ja-K2	51	Ht	Ruth2-K2	24
			Ht	Hi.mans-K2	52	Ht	Al-yous-K3	25
						Ht	Al-aml 1-K3	26
						Ht	Al-aml 2-K3	27

Sample Preparation:

Dust samples were collected from demographic places of crowded population density in Baghdad city that encompassed roads, footpaths and housetops during intervals that no fall of rain happened. Samples were grinded using porcelain mortar, each specimen was divided into four parts (13): First part for test of humidity that measured using gravimetric method by heating at 105° C for 24 hrs. Second part for test of organic materials that measured muffle furnace (Type Carbolite CWF1200 was used) used at 450° C for 4 hrs. Third part for test of pH that measured using (HANNA pH 211Microprocessor was used) a mixture prepared from 1 portion of dust with 2 portion of 0.01M aqueous solution of calcium chloride well shakes for 1 min then settled for 15 min and then the pH reading was taking to the supernatant. And finally fourth part test of heavy metals Pb, Cd and Cu .

Results and Discussion

Calibration curves for Pb, Cd and Cu were obtained by using suitable standard solutions prepared from stock solutions. The graphs obtained were rectilinear in the concentration ranges and equations of the curves were found as follow:

$$\mathbf{Y = 0.01371\,X + 16.57\times10^{-7}} \qquad \mathbf{R^2 = 0.9999\ for\ Pb}$$

$$\mathbf{Y = 0.4393\,X + 0.0290} \qquad \mathbf{R^2 = 0.9995\ for\ Cd}$$

$$\mathbf{Y = 0.1609\,X + 15.3\times10^{-4}} \qquad \mathbf{R^2 = 0.9971\ for\ Cu}$$

Where Y is absorption reading Abs, X is concentration in ppm, mg/L this unit

by definition is also equal to the following units mg/Kg and µg/g .
The higher concentration of Pb was found in dust specimen of AGBt, equal to 139.52 ppm as in Table 3 Figure 2 whereas in Rusafa was found equal to 29.32 ppm for Ht specimen as in Table 4 Figure 3. Whereas the higher concentration of Pb was found in dust sample was in gent specimen in Karkh equal to 27.78 ppm as in Table 3 Figure 2, in Rusafa site 15.1 ppm found for St1 specimen as in Table 4 Figure 3, and the minimum concentration of Pb in Karkh site was found equal to 11.71 ppm for St1 specimen in Table 3 Figure 2, Besides, Figure 4 shows outright values for the average concentrations of Pb in comparison with Pb concentration in AGBt dust specimen.

Table 3 average concentrations of Pb, Cu and Cd in ppm, and average percent of organic materials in Karkh site.

No	place	Cd ppm	Cu ppm	Pb ppm	organic materials %
1	St	0.14	5.52	19.71	8.36
2	St1	0.43	9.96	11.71	10.47
3	Ht	0.13	6.32	15.04	5.8
4	gent	0.29	5.32	27.78	16.4
5	Mt	0.01	4.70	15.89	6.4
6	AGBt	0.01	5.49	139.52	19.0
7	AGC	0.10	4.78	18.48	5.2
8	G	0.06	4.45	13.68	14.6

Note: (1) St for general street, (2) St1 for branch street, (3) gent for street near to electric generator (4) Mt for
highway street, (5) AGBt for street of abogreib battery factory, (6)AGC for street abogreib agriculture college, (7) Ht for dust at housetop, (8) G for house garden.

Table 4 average concentrations of Pb, Cu and Cd in ppm, and average percentages of organic materials in Rusafa site

No	place	Cd ppm	Cu ppm	Pb ppm	organic materials %
1	St	0.15	23.82	27.77	5.9
2	St1	0.13	6.49	15.10	6.1
3	Ht	0.11	7.71	29.32	6.2
4	G	0.08	5.96	17.65	9.3

Note: (1) St for general street, (2) St1 for branch street, (3) Ht for dust at housetop, (4) G for house garden.

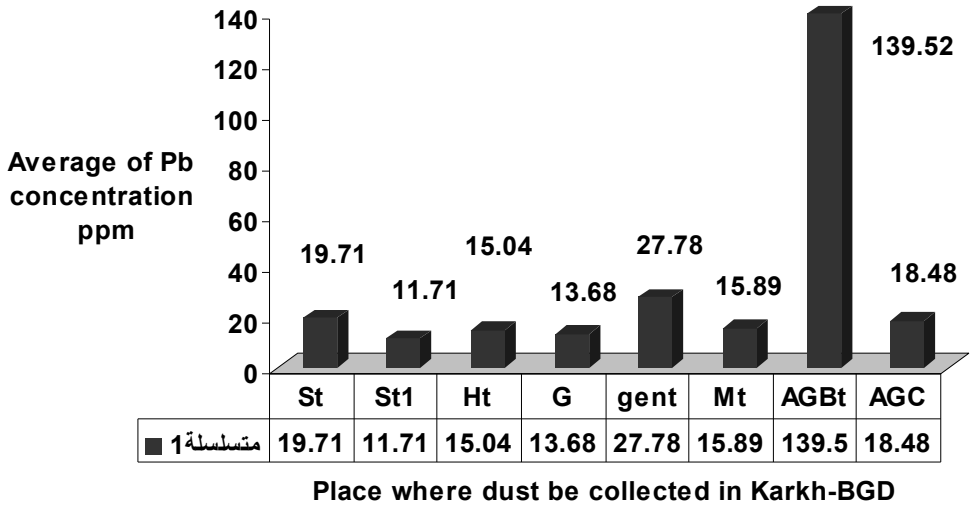

Figure 2 average concentration of Pb ppm of dust specimen in Karkh site of Baghdad city.

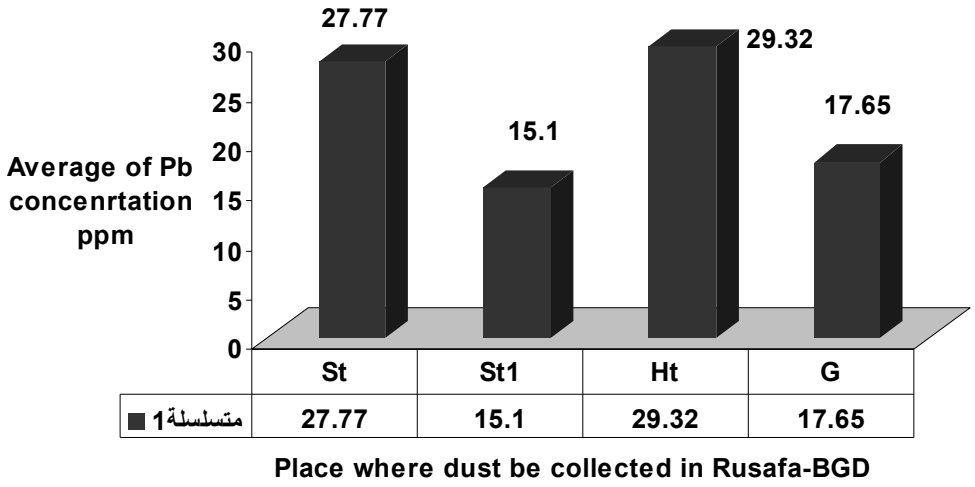

Figure 3 average concentration of Pb ppm of dust specimen in Rusafa site of Baghdad city.

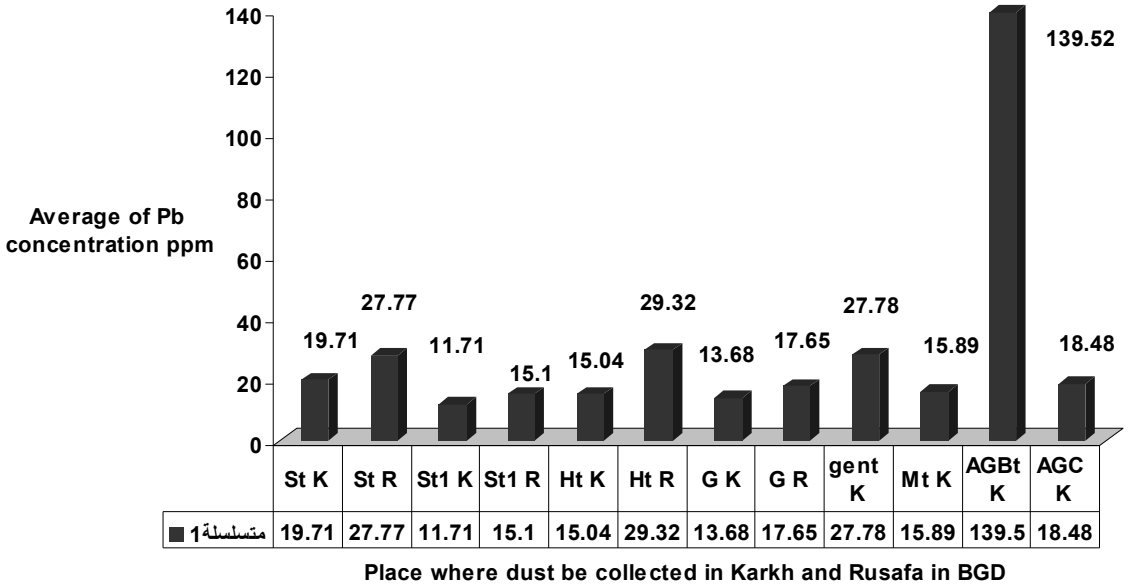

Figure 4 outright values for the average concentrations of Pb ppm in Karkh and Rusafa sites in comparison with Pb concentration in AGBt dust specimen.

According to Environmental Policy Alert, U.S. EPA (6,24) the safe concentration level of Pb of dust in urban residential areas is 5 ppm, although, in Malaysia (35) it was recorded a level of Pb 35 ppm in dust of main street, and Jordon (7) it was recorded a level of Pb 115 ppm in dust of main street, whereas in Istanbul (29) it was recorded a level of Pb 165 ppm in dust of main street, and in Europe (34) it was recorded a level of Pb 400 ppm in dust of main street.

From sited studies (29) Table 5 shows a comparison results of concentration levels for Pb, Cd and Cu in ppm of dust in urban residential areas in major cities.

Table 5 global studies of individual Pb, Cu and Cd metals concentration of dust in urban residential areas in major cities and places (29) .

No	place / city	Cd ppm	Cu ppm	Pb ppm
1	New York [*]	8	355	2582
2	London [*]	6250	61	413
3	Hong Kong [*]	0.01	92	208
4	Madrid [*]	0.01	188	192
5	Amman [*]	2.5	69	219
6	Oslo [*]	1.4	123	180
7	Bahrain [*]	72	0.01	152
8	Lancaster [*]	3.6	75	1090
9	Seoul [*]	3	101	245
10	Taejon, Korea [*]	0.01	47	60
11	Jordan [*]	0.01	1.8	115
12	Istanbul [*]	0.21	136	165

[*] Not : this table was elicited from references (29 for year 2008) and (34 for year 2009)

In this work Tables 3 and 4 are shown values of concentration levels for Pb higher than EPA standard specification. For this reason it is recommended that attention must be taken into account and the community looking forwards to solve this problem, mainly by regulate the cases of vehicle jam in main streets in Baghdad city, and to clean the streets using cleaning automotive vehicles to reduce further pollution.

Conclusion

Heavy metal contamination in the street dust verges in the study area was relatively high. The concentration of lead, cadmium and copper, however were below the critical maximum level above which toxicity is possible. The highest concentrations were detected in samples collected from abo-greib AGBt and from samples collected near electric generator, and there was trend of a decrease in metal contents with the increasing distance from street paving. These concentration levels indicate that street dust contamination by heavy metals originated from a common anthropogenic source with probably automobiles as a major common source which are including gasoline, engines and tires. So to reduce human health risks this metals pollution lead free gasoline must be available in every gas station and people should be encouraged to using unlead gasoline and compel automobile manufacturer companies to use platinum of catalytic silencers.

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