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Evaluation of Physicochemical Properties and Heavy Metals Content For Medical HealthRisk Assessment in Soils from Selected Solid Waste Dumpsite in Al-Nasiriyah City, Iraq

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Discharging of untreated municipal solid wastes (MSW) to land is very common in developing countries. One of the serious problems is the enrichment of heavy metals in the nearest environment and various hazardous effects of toxic compounds contained in MSW have been reported on the humans. An assessment was conducted to evaluate the effect of discharged solid wastes on soil quality in two different seasons (summer and winter) within dumpsite of Al- Nasiriyah city, Iraq. In the study, different soil physicochemical parameters such as electrical conductivity, pH, and organic matter content including heavy metal content were considered. Sampling locations were selected by transect sampling method and soil samples were taken at distance of 10m, 30m and 60m from the periphery of the disposal sites at a depth of 0-20cm. Thesoils collected at different point in the Al-Nasiriyah dumpsite are silty loam in texture, low in organic matter with a high salinity content. There was seasonal variation in the level of chemical properties measured in the soil due to the effect of temperature increase on the soil capillarity force. The average soil pH recorded in the two seasons were slightly above neutral 7.26 and 7.18,respectively. The average EC recorded in the two seasons showed elevated salt level (4.80 and 5.4). Result of the soil heavy metal analysis indicates that vertical distribution of Pb, Cr, Cu and Cd increased in Al-Nasiriyah dumpsite which is a clear indication of the level of pollution in thearea. The study demonstrated contamination of the soil by heavy metals that will cause environmental and human risk through the food chain and possibly leaching into groundwater sources.

Keyword: Solid waste, physicochemical, heavy metal, soil samples, dumpsite, contamination.

1. Introduction

The solid waste disposal methods at a site can create serious environmental problems. Most adverse environmental impacts from solid waste are caused by inadequate collection and recovery of recyclable wastes; as well as, co-disposal of hazardous wastes and lack of properly designed landfills which have serious effects on air, ground water, soil, surface water, as well as the issues arising and odor produced from the solid waste transportation [1,2]. Open dumping is the most common method of Municipal solid waste disposalin many middle and lower-income countries. The indiscriminate and open disposal of waste can cause environmental degradation by introducing different toxicants including heavy metals.et al., Contaminations of soil by heavy metals are global concern and present a serious challenge [3,4]. According to Jayaprakash et al. [5], heavy metals occurrence in soil is an indication of the existence of natural or anthropogenic sources of pollution. Various types of wastes like an old computer, tin cans, and E-waste and old battery arefew examples that contribute heavy metals in a landfill. The waste disposal Municipal by incineration and landfills may in both effect the pollutants concentration directly from landfill leachates that may be polluting soil and groundwater source. This can influance the landfill gasesthat may pass to the nearby soils, producing a change in the environment of soil air. Soil scientists and land managers are facing a wide range of threats to soil quality, including those from Potentially toxic elements (pte) and pathogens in sewage sludge applied to agricultural landand forestry; Industrial sludges (e.g. pulp and paper mill wastewaters, saline process residues) and canal dredging applied to land as a means of waste disposal; Radioactive isotopes released following industrial accidents or from wastes disposal; gases deposited on soils following their aerial release from industrial processes; Residues from production chemicals used in agriculture (pesticides, fungicides, herbicides); Heavy metals (Pb, Hg, As) and organic contaminants (petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAH)) from historic land contamination [6]. Released leachate in the surrounding environment possess a risk to human health[7,8]. Residents in areas close to landfills and disposal sites may be exposed to harmful effects from contaminated soils, heavy

metals and pollutants may find their way into nearby streams and drinking water sources [9].

The physical and chemical characteristics of the soil system influence the transformation, retention, and movement of pollutants through the soil. Some metals tend to be relatively strongly adsorbed by soil constituents and their mobility and bioavailability depend on the soil condition, thus it is necessary to study soil condition as a means of determining the residual content of pollutants in the soil and possible remediation methods to be taken [10]. There is a dearth of studies on the content of heavy metals and properties of soil around solid waste disposal facilities in developing countries including Iraq. Most of the past studies conducted in the area were majorly on the quality of agricultural and terrestrial soils rather than urban soils. The present study focused on the evaluating the amount of Lead, Chromium and Cadmium contents and physicochemical properties of soil in Suq al-shyokh waste disposal site, and to determine the impact of human activities on it resulting in soil contamination.

2. Materials and Methods

2.1 Study location

The study was conducted in Suq al-shyokh city. Suq al-shyokh city is a district of the Dhi Qar Governorate, Iraq., south of Iraq. The city is situated between longitude 31º 08′ E and 31º 01′ E and latitude 46º 18′ N 46º and 08′ N. Suq al-shyokh city is located about 380 km to Baghdad and it is 214 km to Basra City. It is bordered to the north by west Governorate. Basra Governorate in the south, Governorate in the East, and A Muthanna governorate in the west. It is cotogarised as the largest home of Iraq marshlands with a total area about 1.048600 acres that takes 3.1% from the total Iraq area. The population of Suq al-shyokh is expected to rise in the upcoming decade as a result of the significant improvement in the security and economic conditions. Figure 1 shows the spatial location of the area. This city faced a serious challenge represented by solid waste and garbage dumping. The contamination of the sampling sites is mostly due to municipal and industrial waste dumping. It widely and harmfully spreads across most of the residential quarters, commercial and industrial districts, and streets. In Suq al-shyokh City, the total disposalof garbage and solid waste is about 900.000 and 600.000 metric tons respectively [11].

Several reasons led to this increasing problem, including the rise in the standard of living,population growth, inadequate cleanup, and popular unawareness.

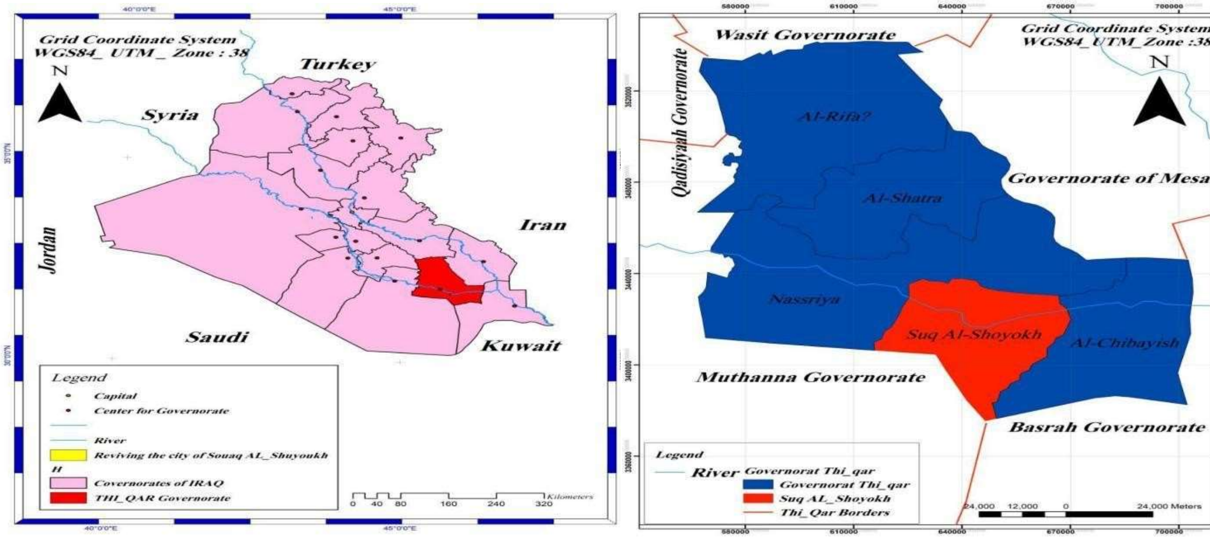

Figure 1. The spatial location of the study area.

2.2 Soil sampling and analysis.

Twelve soil samples (0 - 20 cm) were carefully collected from a dump site in two seasons i.e. summer and winter, using a stainless-steel auger. The collected soil was transferred into a plastic bag. The collection materials were thoroughly rinsed with a distilled water prior use. Collected samples were packed and transported to lab for subsequent analysis. The first stage of sample prepration is to dry the samples using air-dry in the laboratory, the samples were sieved and homogenized using 2 mm polyethene sieve to remove the large stones and debris pebbles, then they were disaggregated with a porcelain mortar and pestle. The prepared samples were stored using clean self- sealing plastic bags for subsequent investigation.

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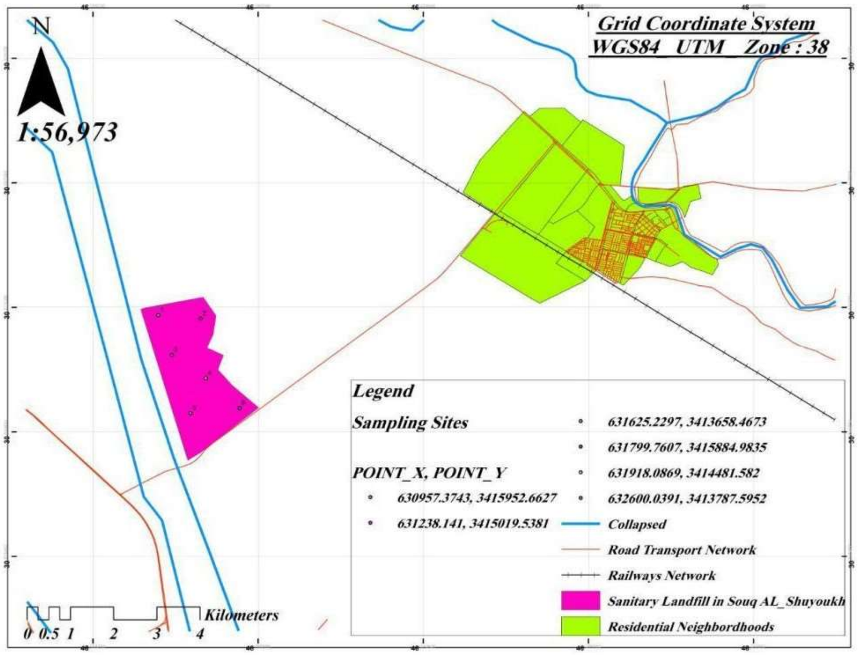

Figure 2. The soil sample location in the landfill

2.3 Soil Physico-chemical analysis.

The particle-size of soil determination and distribution is conducted using the pipette method. Soil pH is determined at the soil to water ratio 1:2.5. Electrical conductivity (EC) was measured at the soil to water ratio of 1:5. The soil CEC is determined using 1 M of the ammonium acetate with a of pH 7. A 100 mL of the1 M ammonium acetate with a pH 7 is used for the exchangeable cations extraction. The atomic absorption spectrophotometer (AAS) is usedto determine the Mg, K, Na and Ca concentration in the solutions. The dry combustion techniques is utulized to determine the total carbon in the soil using LECO CR-412 Carbon Analyser. The Kurtz II and Bray method is used to examin the available phosphorus (Landon, 2014). Exchangeable Al was extracted using 1 M KCl and the Al in the extract was measured by inductively coupled plasma-optical emission spectrometry (ICP-OES). Total micro heavy metals and nutrients content in the soil is removed using aqua regia technique [12,13]. The extracted elements were analysed using the inductively coupled plasma (ICP) spectrometry. Chlorides (Cl^{-}) was determined by titration with a solution of silver nitrates ($AgNO_3$), using potassium chromate ($K_2Cr_2O_7$) as an indicator. Bicarbonates (HCO_3^{-}) was estimated through the

pH-Alkalinity method. Sulfates ions (SO $^{-}$) was determined by Turbidimetric technique, using HITACHI spectrophotometer (U-1500) at the wavelength of 420.

3. Results and discussion.

The nature of the soil in the study area measured across two seasons (winter and summer) was sand silty in texture. This soil texture was believed to have formed by alluvial deposition due to the area belonging to the Mesopotamian floodplain. Thus the soil of this area has a largeproportion of silt and clay particles. High silt content of the soil results in intermediate soil permeability and a good infiltration rate. The somewhat high clay content of the soil in the area gives the soil very fine porosity, thus the soil retentive capacity is high

[14]. Table 1, 2 shows Particle-size distribution of soil in two season.

Table 1. Particle-size distribution of soil in Suq al-shyokh city, Iraq landfill site recorded during summer

ical size andtexture		S1	S2	S3	S4	S5	S6
Clay - <2 microns	%	33.56	42.79	21.41	17.86	33.54	21.46
Salt - <2-50 microns	%	64.88	56.29	76.10	79.12	65.77	77.14
Sand - <50 microns	%	1.56	0.92	2.94	3.02	0.69	1.40
Texture of Soil	Class	Silty Clay	Silty	Silty	Silty	Silty Clay	Silty
		Loam	Clay	Loam	Loam	Loam	Loam

Table 2. Particle-size distribution of soil in Suq al-shyokh city, Iraq landfill site recorded during winter

ical size andtexture	S1		S2	S3	S4	S5	S6
Clay - <2 microns	%	33.96	43.18	20.86	18.12	35.16	22.10
Salt - <2-50 microns	%	64.52	55.86	76.70	78.70	64.09	76.56
Sand - <50 microns	%	1.52	0.96	2.44	3.18	0.75	1.34
Texture of Soil	Class	Silty Clay	Silty	Silty	Silty	Silty Clay	Silty
	Loam		Clay	Loam	Loam	Loam	Loam

The results of soil physicochemical analysis at the studied area across the two seasons shows thatthere are slight variations in pH values during winter and summer in all the sampling location in the Suq al-shyokh dumpsite. Soil pH (log [H^+]) denotes the degree of acidity or alkalinity of soilsolution and the pH measured from all the sampling location in the study ranges from 7.6-7.8 in the winter to 7.7- 7.8 in the summer. The pH average is neutral 7.7 in winter and 7.8 in summer, however a slight increase in soil pH in summer may be due to the effects of chemical interactionsthat are activated because of increase in soil moisture during winter season in particular, as wellas the nature of mineral composition of the soils [15].

Table 3. chemical properties of soil collected at different location in Suq al-shyokh Landfill site in summer

Location (%)	pH	EC	Ca	Mg	K	Total C (%)	Total N (%)	Total S
			cmol.kg-1					
1	7.33	4.80	356.37	2.76	2.93	41.00	2.40	0.80
2	7.27	5.16	282.16	2.81	4.87	54.90	2.10	1.50
3	7.26	4.17	369.48	2.93	5.91	69.10	2.20	1.70
4	7.38	3.92	364.94	2.60	9.03	68.80	2.90	0.70
5	7.13	4.34	306.23	2.73	6.37	74.20	2.80	1.20
6	7.23	4.85	339.83	2.79	8.32	69.80	3.30	1.10
Average	7.26	4.80	336.50	2.77	6.23	62.96	2.61	1.45

Table 4. chemical properties of soil collected at different location in the Suq al-shyokh Landfill site in winter

Location	pH	EC	Ca	Mg	K	Total C (%)	Total N (%)	Total S(%)
			cmolckg-1					
1	7.17	5.83	356.20	2.68	3.00	40.10	1.40	0.80
2	7.21	5.27	282.16	2.84	4.86	55.40	1.80	1.10
3	7.18	5.38	369.48	2.78	5.90	69.70	2.90	2.00
4	7.24	5.36	364.94	2.56	9.01	69.60	2.60	0.70
5	7.14	5.24	306.23	2.78	6.41	75.70	2.80	1.60
6	7.17	5.32	339.83	2.74	8.29	69.40	1.30	0.90
Average	7.18	5.4	336.47	2.73	6.24	63.31	2.13	1.18
Reference	7.00	4.06	200	2.35	2.39	40.68	2.05	1.06

As shown in Table 1 and 2, the salinity of soil samples collected from different location in the dumpsite varies according to the season. The seasonal variations in the levels of EC in studied soil sample as seen by an increase in salinity during the summer compared to winter is a functionof temperature increase during summer that, in turn, increases the soil capillary force leading to an increase in the accumulation of salts on the soil surface.

The values of EC at the sample sites was significantly higher than the reference value. This was thought to result from human activities such as soil contamination by solid waste and garbage, which increases salinization in urban soils unlike in the wild soil used as reference. The soil salinization results in soluble salts that can increase salt content in soil profiles, land and water degradation. The salts also influencethe release and solubilization of heavy metals into solution, with potentially adverse impact on water quality and plant growth [16-20]

Soil solution consists of water and solutes that undergoes constant change because of processes such as decomposition, addition, transport, and loss of colloids. These cations and ions serve as amedium for many biochemical interactions that takes place in the soil. Cations and ions result in organic matter decomposition and salt dissolution within the soil profile, across the atmosphere, or in the groundwater, leading to elevated dissolved salts. As shown in Table 3 and 4, there are seasonal variations in values of cations and ions between the values recorded in the winter and the values recorded in the summer. During the winter, the values of cations recorded were as follows: Ca 282.16-369.48 $cmol_c kg^{-1}$, Mg values 2.60-2.93 $cmol_c kg^{-1}$, K concentration between 2.93-9.03 $cmol_c kg^{-1}$. The averages of cations values (Ca, Mg, and K) in all the sampling point atthe dumpsite are 336.50, 2.77, 6.23, $cmol_c kg^{-1}$ respectively. As regards the values of ions, Cl concentrations ranged from 0.27 to 1.33, HCO3 ranges from 0.34-0.66 and SO4 concentrations ranged from 2.10 to 2.22. The averages of ions values (Cl^-, HCO_3^-, and SO_4^-) in all sampling location at the Suq al-shyokh dumpsite were 0.70, 0.56, and 2.15 respectively. During summer, however, values of cations recorded in the dumpsite are as follows; Ca concentrations ranged from 306.23 - 369.45 $cmol_c kg^{-1}$, Mg concentrations ranged from 2.68 to 2.84 $cmol_c kg^{-1}$. K concentrations ranged from 3.00-9.01 $cmol_c kg^{-1}$. During the same season, averages values of cations (Ca, Mg, and K) in sampling sites were 336.48, 2.73, 6.24 and N respectively. Also, the value of ions recorded in the Suq al-shyokh dumpsite include 0.27-1.33 Cl^-. HCO_3^- concentrations between 0.34-0.66, SO4 concentrations ranged from 2.14-2.22. The averagesvalues of ions (Cl^-, HCO_3^-, and SO_4^-) in other sites were 0.70, 0.55 and 3.87 respectively.Generally, high concentrations of cations and ions in studied soil samples can be explained by a combined interaction of various anthropogenic and natural factors. Solid waste and garbage dumping in the disposal site results in direct and indirect contamination of soil. Also, soil contamination in the area can result from precipitation of gaseous residues from exhaust and combustion on the ground surface as well as soil contamination resulting from wastewater effluents. This observation was reported in similar research conducted by Adelekan and Abegunde [21], in their study on municipal disposal site in Ibadan. Soil contamination or pollution of soil in the Suq al-shyokh dumpsite may also arise due to the combination of natural factors such as increased air temperature and evaporation particularly during summer, capillary porosity effect, inherited poor structural properties of soils and elevated groundwater table, etc. Level of ions and heavy metals at the Suq al-shyokh disposal site in both season is presented in Table 3-4.

Table 5. Heavy metal content of soil collected at different location in the Suq al-shyokhLandfill site in summer

Location	HCO_3^-	$SO_4^{=}$	Cl^-	Cu	Cd	Cr	Pb	Mn	Zn	Fe
	mg/kg									
1	2.14	0.28	6.55	3.64	647.08	212.68	12.06	0.53	6.55	0.58
2	2.10	1.33	9.97	2.18	696.31	181.34	33.28	0.56	9.97	0.60
3	2.14	1.12	7.72	7.19	568.46	531.03	11.18	0.53	7.72	0.60
4	2.11	0.54	6.14	7.64	672.27	340.34	4.05	0.55	6.14	0.55
5	2.22	0.63	7.58	7.91	691.27	73.25	24.74	0.58	7.58	0.66
6	2.20	0.27	6.04	14.63	486.08	128.89	6.15	0.73	6.04	0.34
Average	2.15	11.09	7.33	7.19	629.91	244.65	15.23	0.58	7.33	0.55
Reference	1.18	0.38	0.14	0.89	78.00	56.00	2.00	-	4.50	0.28

Table 6. Heavy metal content of soil collected at different location in the Suq al-shyokhLandfill site in summer

Location	HCO3 -	Cl -	SO4 -	Cu	Cd	Cr	Pb	Mn	Zn	Fe
					mg/kg					
1	0.44	1.90	2.82	0.32	2.87	534.67	189.31	11.81	Trace	6.36
2	0.51	1.97	2.91	1.51	1.97	621.27	164.34	34.54	Trace	10.49
3	0.41	2.01	2.86	1.20	5.24	457.46	397.03	11.52	Trace	7.74
4	0.49	2.11	2.89	0.66	4.9	498.25	227.46	3.94	0.33	5.99
5	0.54	2.22	2.94	0.63	5.5	472.10	73.251	25.02	0.50	7.34
6	0.52	2.20	2.84	0.22	12.87	429.36	122.71	5.53	0.64	5.53
Average	0.48	2.06	2.87	0.75	5.56	502.18	195.68	15.39	0.82	7.24
Reference	0.28	1.46	0.38	0.14	0.89	78.00	56.00	2.00	-	4.50

The concentration of Pb, Cr and Cd were determined at different location in the site to indicate heavy metals burden on the soil around disposal sites and the concentrations of identified soil metals recorded in the two seasons were found to be above the permissible level. The highest metal contents were recorded in the winter season and the lowest in the summer season. Due to the lack of official Iraqi guidelines for healthy concentrations of metals in urban soils, metal concentrations are compared with soil quality standards of other country [22-29].

Several research have shown that urban soils are usually more contaminated than adjacent suburban regions due to the level of anthropogenic activities in metropolitan settlements [30-39]. This claim was also observed in the present study. Lead and Cd are anthropogenic metals, and without external interference, are usually not copious in topsoil [40-47] However, in this study, Lead (Pb) r.anged from 215.50to 624.50mg/kg in the top layer (0-20cm depth) of the soil (table 5 and 6). These values are

above the allowable limits of Pb of several countries (Table 7). Likewise, several of the heavy values obtained in this study were still higher than the criteria set by USEPA [26] and NEPCA [27] respectively.

The results showed elevated levels of Pb at the dumpsites, compared to the value of Pb in the reference site which is a non urban soil . Human exposure to heavy metals is essential via three main routes, i.e. inhalation, ingestion and skin absorption. Pb is a particularly dangerous metal which according to [48] have no biological function.

The concentrations of Cr in soil ranged between 457.46-621.27 in the winter and 486.08 to 691.27mg/kg in the summer, which was higher than that of the reference (6.25 to 19.75mg/kg). The limits of Cr concentrations vary widely with country, being 150mg/kg in France; 100mg/kg in Austria and Spain; 60mg/kg in Germany and Sweden; and 30mg/kg in Denmark and the Netherlands sa shown in Table 5.

Table 7 Allowable limits of Heavy Metals

Heavy metal	Austria	Germany	France	Denmark	Netherlands	Sweden	Spain
Cd	1-2	1	2	0.5	0.5	0.4	1
Cr	100	60	150	30	30	60	100
Co	50	-	-	-	-	-	-
Ni	50-70	50	15	15	15		30
Pb	100	70	40	40	40	40	50

Source:
ECDGE

Most of the values recorded in this study were greater than the standard limits of these countries. The elevated concentration of heavy metals recorded in the Suq al-shyokh dumpsite wereascribed to waste dumped in the landfill which contain high concentrations of Cr. Adelekan and Abegunde [30] , reported that an increase in concentration of Cr in the environment is mainlyas a result of industrial growth, particularly, in the metal, chemical and tanning industries. Sources of Cr in the soils could be due to waste consisting of lead-chromium batteries, plastic bags, and used paint containers [49]. The accumulation of chromium may also arise from the use of liquid fuels, and industrial and municipal waste. Despite that Cr hazards have rarely been recorded, it is essential to prevent its accumulation to a toxic level in the

nvironment as it poses some risks to human health. The accrual of chromium on skin, lungs, muscles, fat, liver, dorsal spine, hair, nails and placenta where it is traceable to various health conditions [50].

The values of Cd recorded in the soil were 0.91-76.47 in the winter and 0.5-12.87. Heavy metals such as Cadmium and Lead possess risks to animals and humans at relatively low concentrations and thus should receive close scrutiny in relation to the application of municipal solid waste composts to agricultural soil. The deposition of industrial waste, mining activities, incidental accumulations, atmospheric deposition, and agricultural chemicals are some sources for the pollution of soils with heavy metals [51]. The mobility of these metalsmakes them an imminent/potential source of risk as they may leach into groundwater and flows into nearby streams or finding their way into drinking water where it causes health hazards for human or animal that may consume such water [52]. Some human diseases have resulted from consumption of cadmium contaminated foods [53]. The threat that heavy metals pose to human and animal health is aggravated by their persistence in the soil over long period of time, even under high precipitations, and they often persist in the environment [54,55].

4. CONCLUSION

The results from the physiochemical analysis confirmed that soil quality in the study area is deteriorating, due to the impacts of pollution. This claim was supported by the obvious difference between values at the reference point which located outside the landfill area and those which located within the landfill (the other sites). This difference may explained by the profound effect of contamination due to human activities such as disposal of toxic waste in the landfill, while there is a little urban effect on the reference point. Elevated values of Pb, Cd, and Cr were found in soils at the refuse dumps when compared to reference value and established limits of several countries. It was found that Pb generally has the highest concentrations in the soil layers while Cd generally is least detected. The order observed for this study is Pb > Cr > Ni > Co > Cd.The values of Pb obtained from this study were above the allowable limits for soils, in several countries. This raises significant concern for safety of the environment and health impacts on the populace and calls for urgent attention and appropriate response. Soil samples from some dump

sites also exceeded the allowable limits in the cases of Cr and Cd. These refuse dumps should be relocated outside the city and some phyto-remediation measures of soil especially in respect ofPb should be initiated as a matter of urgency at these locations. The recommendations of the study include formulation and enforcement of a directive to prevent any form of farming on the dumpsites, relocation of the dumpsites out of the city and the enforcement of other environmental protection regulations to arrest the ongoing buildup of the heavy metals in those locations.

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References

1. Adelekan, B. A., & Abegunde, K. D. (2011). Heavy metals contamination of soil and groundwater at automobile mechanic villages in Ibadan, Nigeria. *International journal of physical sciences*, *6*(5), 1045-1058.
2. Al-Hassen, Sh. I. (2011). Environmental Pollution in Basra City, Ph. D Thesis, Coll. Arts, Univ. Basra: 232 pp
3. Alloway BJ, 1995. Cadmium. In, Heavy Metals in Soils, Second Edition (BJ Alloway, ed.). Blackie, New York, pp 122-151.
4. Alloway, B. J. (1990). Heavy Metal in Soils. (New York: Basic Books). Beyene, H. and Banerjee, S. (2011). Assessment of the Pollution Status of the Solid Waste Disposal Site of Addis Ababa City with Some Selected Trace Elements, Ethiopia. World Applied SciencesJournal, 14 (7), 1048-1057.
5. Al-Rubaiay, D. J. (1984). *Irrigation and Drainage Systems in Basrah Province* (Doctoral dissertation, Ph. D Thesis, Univ. Durham, UK: 320 p).
6. Al-Turki, A. I. and Branch, B. S. A. (2004). Mobilization of Pb, Zn, Cu and Cd, in pollutedsoil. *Pakistan Journal of Biological Sciences (Pakistan)*.
7. Charlesworth, S., Everett, M., McCarthy, R., Ordonez, A. and De Miguel, E. (2003). A comparative study of

heavy metal concentration and distribution in deposited street dusts in a large and a small urban area: Birmingham and Coventry, West Midlands, UK. *Environment International*, *29*(5), 563-573.

8. Chirenje, T., Ma, L. Q., Reeves, M., & Szulczewski, M. (2004). Lead distribution in near-surfacesoils of two Florida cities: Gainesville and Miami. *Geoderma*, *119*(1-2), 113-120.

9. Farghaly, O. A., & Ghandour, M. A. (2005). Square-wave stripping voltammetry for direct determination of eight heavy metals in soil and indoor-airborne particulatematter. *Environmental research*, *97*(3), 229-235.

10. Ferguson C. and Kasamas H (1999). Risk Assessment for Contaminated Sites in Europe. Volume Policy Framework, LQM Press Nottingham.

11. Jayaprakash, M., Nagarajan, R., Velmurugan, P. M., Sathiyamoorthy, J., Krishnamurthy, R. R.,& Urban, B. (2012). Assessment of trace metal contamination in a historical freshwater canal (Buckingham Canal), Chennai, India. *Environmental monitoring and assessment*, *184*(12), 7407-7424.

12. Komarnicki, G. J. (2005). Lead and cadmium in indoor air and the urban environment. *Environmental Pollution*, *136*(1), 47-61.

13. Landon, J. R. (2014). *Booker tropical soil manual: a handbook for soil survey and agricultural land evaluation in the tropics and subtropics*. Routledge.

14. Lee, C. S. L., Li, X., Shi, W., Cheung, S. C. N., & Thornton, I. (2006). Metal contamination in urban, suburban, and country park soils of Hong Kong: a study based on GIS and multivariate statistics. *Science of the Total Environment*, *356*(1-3), 45-61

15. Muniafu, M., and Otiato, E. (2010). Solid Waste Management in Nairobi, Kenya. A case for emerging economies. *Journal of Language, Technology & Entrepreneurship in Africa*, *2*(1), 342-350.

16. National Environment Protection Council of Australia, NEPCA, 2010. Limits of Heavy Metalsin Soils. Available online at www.newzealand.govt.nz

17. Panagos, P., Tomaž, V., Čustović , H. and Vrščaj B. (2011). Soil protection activities and soil quality monitoring in south Eastern Europe. Conference papers presented at the June 18th and 19th, on European Union's policies for the protection and sustainable development of the European and global environment, Luxembourg. Retrieved December 17, 2012, from http://europa.eu/.

18. Pollard, S. J. T., and Kibblewhite, M. G. (2006). Soils and land contamination. *An Introduction to Pollution Science, RSC Publishing, Cambridge*, 122-153.

19. Ren, H. M., Wang, J. D. and Zhang, X. L. (2006). Assessment of soil lead exposure in childrenin Shenyang, China. *Environmental Pollution*, *144*(1), 327-335.

20. Reyes-Gutiérrez, L. R., Romero-Guzmán, E. T., Cabral-Prieto, A., & Rodríguez-Castillo, R. (2007). Characterization of chromium in contaminated soil studied by SEM, EDS, XRD and Mössbauer Spectroscopy. *Journal of Minerals & Materials Characterization & Engineering*, *7*(1), 59-70.

21. Sparks, D. L. (2003). Environmental soil chemistry., 2nd edn (Academic Press: San Diego, CA).

22. United States Environmental Protection Agency, USEPA, 2008. Allowable Limits for Lead in Soil. www.epa.gov/lead/pubs/leadhaz.htm

23. Arao, T., Kawasaki, A., Baba, K., Mori, S., and Matsumoto, S. (2009). Effects of water management on cadmium and arsenic accumulation and dimethylarsinic acid concentrations in Japanese rice. Environmental Science & Technology, 43(24), 9361-9367.

24. World Health Organization (WHO) (1993). Standard maxima for metals in Agricultural soils.

25. National Environment Protection Council of Australia (NEPCA) (2010). Limits of heavy metals in soils. Available online at www.newzealand.govt.nz.

26. USAID (2009). Learn more about the Environmental Guidelines for Small-Scale Activities in Africa; Environmental Guidelines for Small-Scale Activities in Africa. Retrieved December 26, 2012, from: www.encapafrica.org. U. S. Environmental protection Agency (USEPA). (1989). Soil Sampling Quality Assurance User's Guide.2nd Ed. Retrieved December 29, 2013, from:

27. Jayaprakash, M., Nagarajan, R., Velmurugan, M. P., Sathiyamoorthy, J., Krishnamurthy, R. and Urban, B. (2012). Assessment of trace metal contamination in a historical freshwater canal Chennai, India. Environ Monit Assess, 184, 7407–7424.

28. Njoku, C. and Ngene, P.N. (2012). Content and Distribution of Heavy Metals in an Abandoned Mechanic and NonMechanic Sites in Abakaliki, Southeastern Nigeria. Greener Journal of Physical Sciences, 2(1), 016-019.

29. Muniafu, M. and Otiato, E. (2010). Solid Waste Management in Nairobi, Kenya. A case for emerging economies. The Journal of Language, Technology & Entrepreneurship in Africa, 2(1), 342-350.

30. Salvato, J. A., Nemerow, L. N. and Agardy, J. F. (2003). Environmental Engineering. (InG.Tchobanoglous 5 th ed), Solid Waste Managment. (Pp 755-888). New York: Wiley

31. Alloway, B. J. (1990). Heavy Metal in Soils. (New York: Basic Books). Beyene, H. and Banerjee, S. (2011). Assessment of the Pollution Status of the Solid Waste Disposal Site of Addis Ababa City with Some Selected Trace Elements, Ethiopia. World Applied SciencesJournal, 14 (7), 1048-1057.

32. Arif, A., Alameri, A. A., Tariq, U. B., Ansari, S. A., Sakr, H. I., Qasim, M. T., ... & Karampoor, S. (2023). The functions and molecular mechanisms of Tribbles homolog 3 (TRIB3) implicated in the pathophysiology of cancer. International Immunopharmacology, 114, 109581.

33. Lafta, H. A., AbdulHussein, A. H., Al-Shalah, S. A., Alnassar, Y. S., Mohammed, N. M., Akram, S. M., ... & Najafi, M. (2023). Tumor-associated macrophages (TAMs) in cancer resistance; modulation by natural products. Current topics in medicinal chemistry, 23(12), 1104-1122.

34. Qasim, M. T., Fenjan, M. N., & Thijail, H. A. (2022). Molecular identification of cystoisospora belli in patients infected with the virus human immunodeficiency. International Journal of Drug Delivery Technology, 12(2), 701-704.

35. Margiana, R., Alsaikhan, F., Al-Awsi, G. R. L., Patra, I., Sivaraman, R., Fadhil, A. A., ... & Hosseini-Fard, S. (2022). Functions and therapeutic interventions of non-coding RNAs associated with TLR signaling pathway in atherosclerosis. Cellular Signalling, 100, 110471.

36. Arif, A., Alameri, A. A., Tariq, U. B., Ansari, S. A., Sakr, H. I., Qasim, M. T., ... & Karampoor, S. (2023). The functions and molecular mechanisms of Tribbles homolog 3 (TRIB3) implicated in the pathophysiology of cancer. International Immunopharmacology, 114, 109581.

37. Lei, Z., Alwan, M., Alamir, H. T. A., Alkaaby, H. H. C., Farhan, S. S., Awadh, S. A., ... & Nekuei, A. (2022). Detection of abemaciclib, an anti-breast cancer agent, using a new electrochemical DNA biosensor. Frontiers in Chemistry, 10, 980162.

38. Bashar, B. S., Kareem, H. A., Hasan, Y. M., Ahmad, N., Alshehri, A. M., Al-Majdi, K., ... & Qasim, M. T. (2022). Application of novel Fe3O4/Zn-metal organic framework magnetic nanostructures as an antimicrobial agent and magnetic nanocatalyst in the synthesis of heterocyclic compounds. Frontiers in Chemistry, 10, 1014731.

39. Patel, A. A., Asma'a, H. M., Rizaev, J., Mallick, A. K., Qasim, M. T., Al Abdulmonem, W., ... & Ahmad, F. (2024). Application of mesenchymal stem cells derived from the umbilical cord or Wharton's jelly and their extracellular vesicles in the treatment of various diseases. Tissue and Cell, 102415.

40. Qasim, M. T., Mahdi Mohammed Alakkam, E., Mahdi Mohammed, M., Hachim, S. K., Sabah Jabr, H., Emad Izzat, S., ... & D Al-Dhalemi, M. (2022). Ovine Pasteurellosis Vaccine: Assessment of the Protective Antibody Titer and Recognition of the Prevailing Serotypes. Archives of Razi Institute, 77(3), 1207-1210.

41. Hjazi, A., Ahsan, M., Alghamdi, M. I., Kareem, A. K., Al-Saidi, D. N., Qasim, M. T., ... & Mirzaei, R. (2023). Unraveling the Impact of 27-Hydroxycholesterol in Autoimmune Diseases: Exploring Promising Therapeutic Approaches. Pathology-Research and Practice, 154737.

42. Hjazi, A., Nasir, F., Noor, R., Alsalamy, A., Zabibah, R. S., Romero-Parra, R. M., ... & Akram, S. V. (2023). The pathological role of CXC chemokine receptor type 4 (CXCR4) in colorectal cancer (CRC) progression; special focus on molecular mechanisms and possible therapeutics. Pathology-Research and Practice, 154616.

43. Gupta, J., Suliman, M., Ali, R., Margiana, R., Hjazi, A., Alsaab, H. O., ... & Ahmed, M. (2023). Double-edged sword role of miRNA-633 and miRNA-181 in human cancers. Pathology-Research and Practice, 154701.

44. Sane, S., Mahoori, A., Abdulabbas, H. S., Alshahrani, S. H., Qasim, M. T., Abosaooda, M., ... & Darvishzadehdaledari, S. (2023). Investigating the effect of pregabalin on postoperative pain in non-emergency craniotomy. Clinical Neurology and Neurosurgery, 226, 107599.

45. Al-dolaimy, F., Kzar, M.H., Hussein, S.A. et al. (2023). Incorporating of Cobalt into UiO-67 Metal–Organic Framework for Catalysis CO2 Transformations: An Efficient Bi-functional Approach for CO2 Insertion and Photocatalytic Reduction. J Inorg Organomet Polym. https://doi.org/10.1007/s10904-023-02860-0

46. Muzammil, K., Kzar, M. H., Mohammed, F., Mohammed, Z. I., Hamood, S. A., Hussein, T. K., ... & Alsalamy, A. (2023). Methanol extract of Iraqi Kurdistan Region Daphne mucronata as a potent source of antioxidant, antimicrobial, and anticancer agents for the synthesis of novel and bioactive polyvinylpyrrolidone nanofibers.

Frontiers in Chemistry, 11, 1287870.

47. Al-Safi, M. T., & Qasim, M. T. (2023). Study of some genetic and molecular markers for some rheumatoid arthritis patients in Iraq.

48. Ramaiah, P., Baljon, K. J., Hjazi, A., Qasim, M. T., Salih Al-ani, O. A., Imad, S., ... & Garousi, N. (2024). Dietary polyphenols and the risk of metabolic syndrome: a systematic review and meta-analysis. BMC Endocrine Disorders, 24(1), 26.

49. Hsu, C. Y., Ahmed, A. T., Bansal, P., Hjazi, A., Al-Hetty, H. R. A. K., Qasim, M. T., ... & Elawady, A. (2024). MicroRNA-enriched exosome as dazzling dancer between cancer and immune cells. Journal of Physiology and Biochemistry, 1-19.

50. Farhan, S. H., Jasim, S. A., Bansal, P., Kaur, H., Abed Jawad, M., Qasim, M. T., ... & Hadi, A. (2024). Exosomal Non-coding RNA Derived from Mesenchymal Stem Cells (MSCs) in Autoimmune Diseases Progression and Therapy; an Updated Review. Cell Biochemistry and Biophysics, 1-18.

51. Kumar, P., Singh, S., Gacem, A., Yadav, K. K., Bhutto, J. K., Alreshidi, M. A., ... & Alam, M. W. (2024). A review on e-waste contamination, toxicity, and sustainable clean-up approaches for its management. Toxicology, 153904.

52. Ul Hassan Shah, Z., Bashir, S., Sarfraz, R. M., Mahmood, A., Rehman, U., Ijaz, H., ... & Benguerba, Y. (2024). Development of antihyperlipidemic drug loaded β-CD-based microparticulate carrier systems: tuning and optimization. Polymer-Plastics Technology and Materials, 63(11), 1438-1463.

53. Hsu, C. Y., Jasim, S. A., Pallathadka, H., Kumar, A., Konnova, K., Qasim, M. T., ... & Abosaoda, M. K. (2024). A comprehensive insight into the contribution of epigenetics in male infertility; focusing on immunological modifications. Journal of Reproductive Immunology, 104274.

54. Zamanian, M. Y., Shahbazi, T., AL-Ghamdi, H. S., Hussien, B. M., Alghamdi, M. A., Qasim, M. T., ... & Golmohammadi, M. (2024). Chemopreventive and Anticancer Role of Resveratrol against non-melanoma skin cancer (NMSC): Focusing on cellular and molecular mechanisms and biochemistry. Authorea Preprints.

55. Hjazi, A., Jasim, S. A., Al-Dhalimy, A. M. B., Bansal, P., Kaur, H., Qasim, M. T., ... & Zwamel, A. H. (2024). HOXA9 versus HOXB9; particular focus on their controversial role in tumor pathogenesis. Journal of Applied Genetics, 1-20.