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Detection of Environmental risks Resulting from burning medical waste in Baghdad and its impact on Public Health

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Abstract
The research involved the investigation of PAHs in the air resulting from the incinerations of medical waste, and the determination the proportions of these aromatics in the air due to a importance as high-risk pollutants. It also identifies concentrations of some toxic heavy metals such as lead (Pb^{2+}), Cadmium (Cd^{2+}), mercury (Hg), Nickel (Ni^{2+}), and zinc (Zn^{2+}) in samples of air because of their negative effects on human health. Four air samples were collected from the hospital incinerator Al-alwea, 2020, and the HPLC technique was used to identify PAHs. The results showed that hydrocarbon ratios ranged between 0.720-1.789µg / m^3 and were within the permissible limits of WHO (1996). Heavy metals were ranged between (0.042-1436.6 µg/m^3). The zinc component was very high and its highest value was 1436.6 µg/m^3. The concentration of Nickel was also high and ranged from 0.087-1.078 µg/m^3. Mercury concentrations ranged between (0.042-0.0586µg/m^3) and these concentrations, although few, are considered to be contaminated with air. The study concluded by examining the association between the ambient air concentrations of PAHs and heavy metals, and it found excellent agreement.
This study has made significant progress in understanding this system in the study area and is an initial step toward the monitoring and Assessment for health purposes.

Keywords: Air pollution, medical waste, Poly Aromatic Hydrocarbons, Heavy metals, medical incinerators.

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1. Introduction

Health institutions are one of the most important sources of pollution in polyaromatic compounds and others if there is negligence in the application of preventive measures, so the cleanliness of the environment of institutions is necessary diseases for the health and safety of the community as a whole as it falls within the communities, the subject of environmental pollution at present is the world's major industrial and developing countries. Because pollution is a direct threat to human health, the pollution of polycyclic aromatic compounds is a recent "one of the most important contaminants of carcinogens (Grimmer, 1983; Chen et al.,2013).
It is also known that medical waste contains toxic heavy metals such as lead, cadmium, mercury, and others. These elements are usually emitted in very small minutes and can penetrate the human lung. The presence of these elements has been a concern for environmental protection agencies and health practitioners because of their negative effects (Cheng et al.,2017). On human health due to their toxicity and environmental stability (Carreras et al., 2009). There are more than 100 PAHs that affect humans by water, air inhalation or indirectly (Tfouni, 2007). The Occupational Health and Safety Association (OSHA) has set a limit for polyaromatic compounds in the air (0.2mg / m^3) (Hussain, 2003). The United States Environmental Protection Agency (USEPA) has selected a compound of poly aromatic hydrocarbon (PAHs) Due to their spread and presence in the environment more than others (ATSDR, 1995; Vera Samburova et al., 2017).
Azliyana (2012) conducted a study to determine the relationship between concentrations of

aromatic compounds in the air and plants and found a positive relationship between air and plants through the absorption of plant organic pollutants from the environment. The researcher also studied the distribution and spread of aromatic compounds (PAHs) and the heavy metals produced by the Kirkuk oil refinery products using the HPLC technology as well as the atomic absorption technique for determining concentrations of pollutants. The current research aims to measure the multi-ring aromatic compounds in air samples and determine the concentrations of heavy metals resulting from burning medical waste in Al-alwea Hospital in Baghdad and its impact on public health.

1.1. study area

The study area (Al-always Hospital) is located in the center of Baghdad, between 33.304047N and 44.459641E, Figure 1. In Iraq, there were 294 government hospitals, 49 private hospitals, 37 private hospitals, and 208 other health institutions. The medical services sector is in charge of providing health care to the citizens through the services it provides in diagnosis, examination, and treatment. This substantial and vital sector includes health institutions such as government and private hospitals, health centers, health laboratories, blood banks, etc. (Jaber et al., 2021).

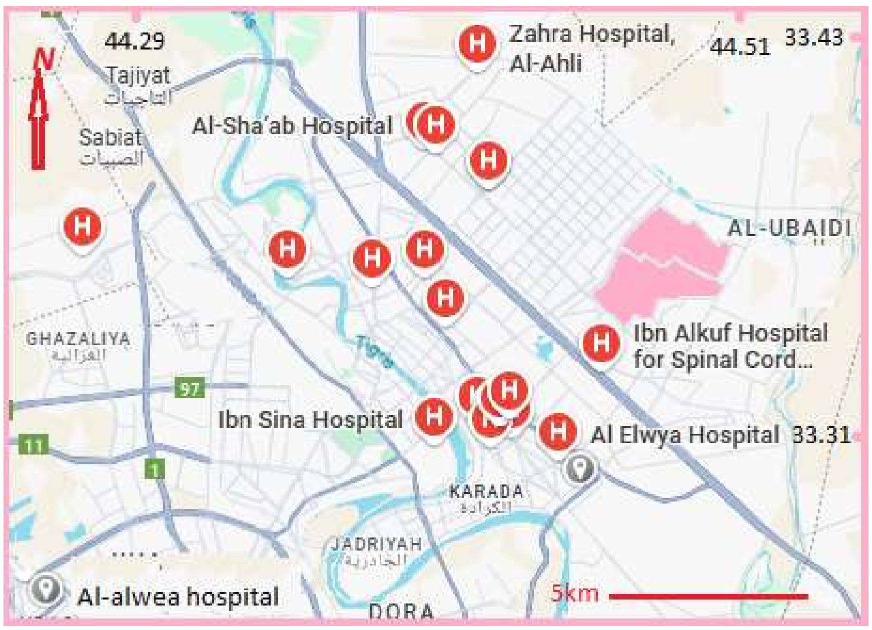


Figure 1. Location of study area with some medical services in Baghdad city.

2. Materials and methods

In July 2020, eight air samples were collected from four locations close to the Alawiya Hospital Incinerator in Baghdad, which is believed to be contaminated with polyaromatic compounds and Heavy metals. All the sample sites are shown in Table 1.

Table 1. The sites and the symbols of samples collected in the study area.

Sites	Symbol	Details
Site 1	S1	About 8m away from the waste incinerator/Right
Site 2	S2	About 16m away from the waste incinerator/Right
Site 3	S3	About 8m away from the waste incinerator/Left
Site 4	S4	About 16m away from the waste incinerator/Left

Preparation of standard solutions for polycyclic aromatic hydrocarbons:

1. The aromatic compounds were set using a German HPLC device of SYKUM-type origin.
2. Prepare a standard solution for each polycyclic aromatic compound with different concentrations (0.5,1,2,4,8,10ppm).

3-20µl of the standard solution is injected into the C18 column of the HPLC.

4 - Use an improvised phase (40% acetonitrile - 60% water) and flow rate (1.2ml / min) at the temperature of the column equal to (30C) and the wavelength of the detector was fixed at 254nm.

5. The time of arrest for each aromatic compound was determined and the peak of each aromatic compound was determined.
6. The concentrations of these standard polyaromatic compounds were determined against the peak height values of each compound obtained from the device.

2.1 Preparation of air samples:

Air models were collected by the Air Volume Sampler (Sniffer) air collection device to collect airborne minutes. Before starting to collect samples, the Cellulose Filters are dried at 80 ° C to remove the moisture. Then weigh it before placing it in the filter holder and record the weight, which represents (W1). When the sample collection process is started in the area to be studied, the filter is placed in the device (in the filter holder). The device is operated and calculated at start-up and the stability of the ball within the airflow size scale. The size of the air is indicated by the iron ball, which represents (V1) and the device is usually for half an hour, and after the time calculated the size of the new air, which is marked by the ball of iron, which represents (V2). Then the candidate is taken and weighed again, where the new weight (W2) is calculated.

Suspended particle $$SP = \frac{(W2-W1)}{Vt} \times 10^6$$

whereas:

SP: Concentration of suspended nuclei measured in µg / m^3.

W1: The weight of the filter before the withdrawal is measured in grams (g)

W2: The weight of the leak after the withdrawal is measured in grams (g)

Vt: Volume of drawn air in cubic meters (m3)

106: converting the gram into the microgram

The size of the drawn air Vt is calculated according to the following equation:

$$Vt = \frac{Qt}{1000}$$

whereas:

Q: Airflow rate in liters per minute

Total modeling time per minute

Q is calculated from the following equation

$$Q= \frac{V1+V2}{2}$$

whereas:

V1: The volume of air indicated by the iron ball at the start of the machine

V2: The air volume indicated by the iron ball at the end of the machine.

2.2 Method of extracting air samples:

The multi-ring aromatic compounds are extracted from the fiber filter by a separating funnel where it is placed with 10ml of methanol and dichloromethane mixture and 1: 1 after that, the shaker is applied to the shaker for 24hr Multivariate aromatic compounds in the solvent mix. After extraction, the models are concentrated.

Method of digesting air models to measure heavy elements:

1. Fold the air filter in contrast to the contents of the suspended minutes and then cut the filter into small pieces and put it in the Teflon Baker
2. Place 5ml of HNO_3 acid at 65% concentration in the baker, warming the baker gradually so that it stays approximately 1ml.
3. Add 3 ml of $HClO_4$ acid at 75% concentration to the baker container on the model and heat until the 1 ml remains in the form.
4. Add 3ml of HF acid with heating until 1ml remains. The sample is filtered in a 50ml volume vial and the model is ready for measurement.

2.3 Contamination Factor

The contamination factor (CF) is a simplistic and useful tool for observing the contamination of heavy metals (Said,2019). The CF is a geochemical indicator applied to define the contamination level from the heavy metals. The contamination factor (CF) is the ratio of metal concentration in the air sample and in the Earth's crust (background), respectively. The values of background were possessed by Kabata-pendis, (2010) as Follows: Table.

Table 2: Reference dose RFD (mg/kg-day) for each heavy metal within the dermal contact pathway.

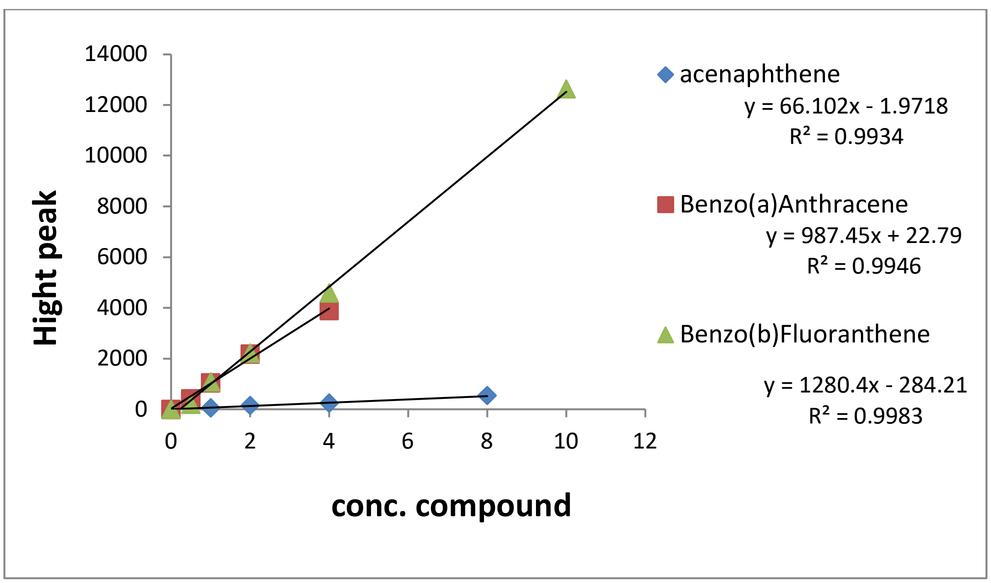
Heavy metals	(Pb^{2+})	(Cd^{2+}),	(Hg)	(Ni^{2+}),	(Zn^{2+})
Reference dose RFD (mg/kg-day)	0.15	15	0.08	8.40E-01	70

CF = Concentration of metals in dust sample /Concentration of metals in background.

CF values are categorized into 4 classes as follows (Gope et al.,2017): (i) Low contamination, CF < 1 (ii) Moderate contamination, 1 < CF < 3 (iii) Considerable contamination, 3 < CF< 6.

3. Results and discussion:

After the separation process, eight polyaromatic compounds were obtained for four Sites: Naphthalene, benzo (k) Fluantanthene, Fluantanthene, Benzo (a) Anthracene, Phenanthrene, Acenaphthene and Benzo (b) Fluoranthene. These compounds were concentrated after attending a standard solution of aromatic compounds (0,05,1,2,4,8,10ppm) and analyzed by HPLC, where the concentrations of these standard multichannel compounds were measured against peak height values for each compound obtained from the device as in Figuer.2.



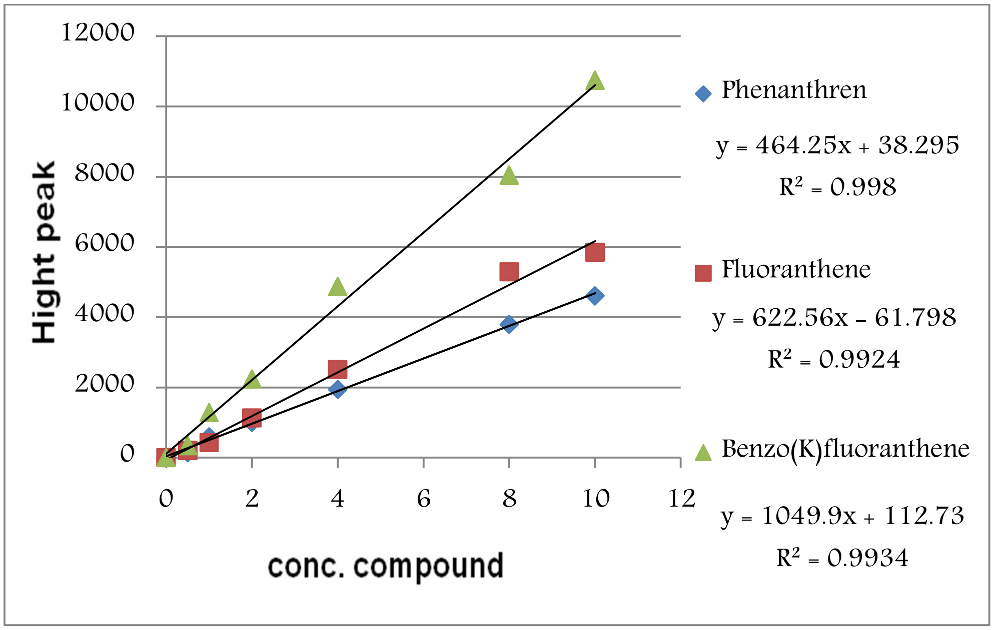


Figure 2. The linear relationship between high peaks and concentrations of the following polycyclic aromatic hydrocarbons: acenaphthene (z), naphthalene (o), benzo (a) anthracene, benzo (b) fluoranthene, benzo (k) Fluoranthen, Phenanthrene.

Table .3 shows that the concentrations of aromatic compounds from the separation process of the Sites are not high and that the total concentrations of aromatic compounds for each filter range from 0.720-1.789µg / m^3. The total (∑PAH) in the study area (minimum and maximum) is less than the permissible limit when compared with the permissible limit of 0.2 mg /m^3 (WHO,1996). These compounds are among the main causes of cancer and one in 100,000 people is diagnosed with cancer, even when the amount of these compounds is less than the permissible limit (Sitting M., 1985).

Table 3. Concentrations of Polyaromatic compounds in the air produced by the medical incinerator

PAHs	***Ambient air Concentration (µg/m^3)***			
	S1	S 2	S 3	S 4
Naphthalene	0.618	1.0393	-	-
Benzo (k) Fluoranthene	0.102	-	-	-
Phenanthrene	-	0.1599	-	-
Benzo(a)Anthracene	-	-	1.119	-
Acenaphthene	-	-	0.339	-
Fluoranthene	-	-	-	0.55
Benzo(b)Fluoranthene	-	-	-	1.239
Total	0.720	1.1992	1.458	1.789

In this study, Heavy metals were measured using the atomic absorption device after digesting the models of the air filters withdrawn from the medical incinerator of the hospital. Table 4, shows that there was contamination of the lead element and ranged between (0.989-1.9615µg/m^3) When compared with the 0.5 µg/m^3 limit (WHO, 1996).

Table .4. Concentrations of heavy metals in the air produced by the medical

Heavy metals	Ambient air Concentration (μg/m^3)			
	S1	S2	S3	S4
Hg	0.042	0.0443	0.0482	0.0586
Ni	0.087	0.0872	0.0896	1.078
Pb	0.989	1.26	1.78	1.9615
Zn	860.1	1038.6	1211.27	1436.6
Cd	BDL	BDL	BDL	BDL

The table above also, shows that there is also contamination of the nickel (Ni) element with a concentration range is 0.087-1.078μ g /m^3. This concentration is high when compared to the 0.2 μg /m^3 according to the World Health Organization (WHO, 1996), and mercury ranges between 0.042-0.0586 μg / m^3. There are no specific sources that determine the acceptable percentage of pollution in the air according to the recognized organizations, but there is a source (Scullmana, 1971). The value of mercury in the air is about 30.02μg / m^3. Zinc has a very high concentration, 1436.6μg / m^3 in the S4 camper with S1 Finally, all the measured values of Cadmium (Cd) below the detection limit which 0.01, Figure 3.

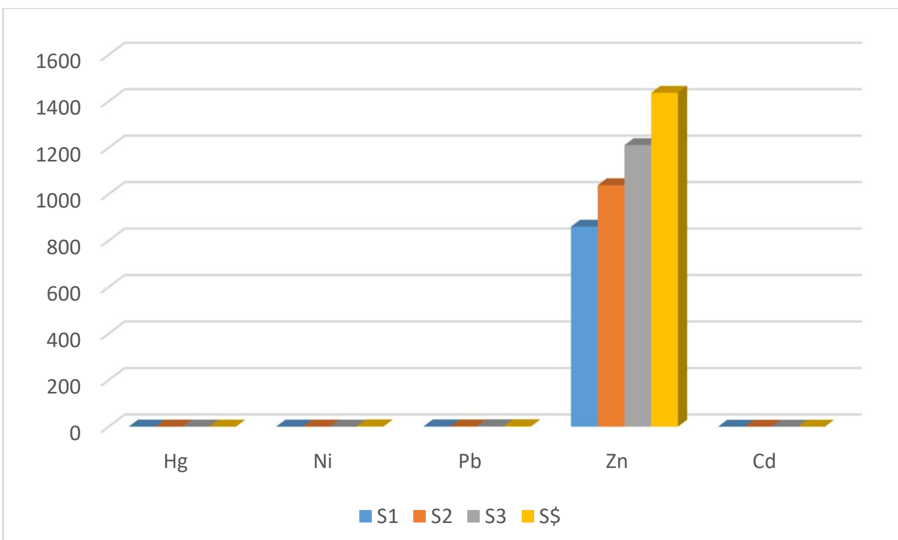


Figure 3. The concentration of heavy metals in all samples of the study area.

The heavy metal contamination in the air (all sites) was assessed with the determination of the CF (Table 5). The CF values illustrate the contamination varies between low and very high. The mean Pb and Zn values represent very high contamination while Ni and Hg are the low contamination. the very high contamination values are registered in the Pb and Zn. This is due to human activities and may also be waste emissions.

Table .5. The contamination factor (CF) calculated in the air for heavy metals in the study area.

Elements	CF S4	CF S3	CF S2	CF S1
Pb	8.4	6.593	13.07	11.86
Cd	0	0	0	0
Hg	0.525	0.6025	0.55375	0.85
Ni	0.00103	0.0011	0.0128	0.0010
Zn	12.28	14.83	20.522	17.30

Lastly, this study examined the association between the ambient air concentrations of heavy metals and PAHs. Figure 4. The results discovered a high degree of agreement. Since the overall pattern of changes in heavy metal concentrations was found to be rather similar to that of PAHs, it was possible to conclude that the two pollutants came from the same source.

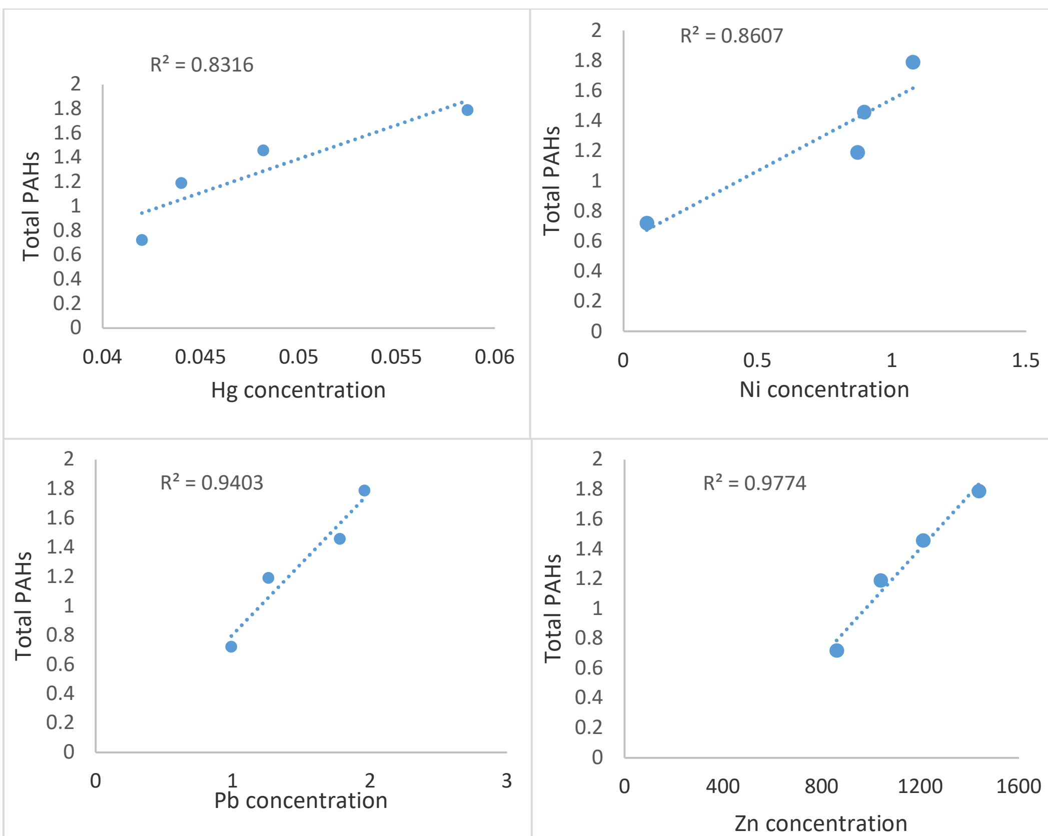


Figure .4. The relation between PAHs and Heavy metals (Hg, Ni, Pb and Zn) in the study area.

4. Conclusions

1- The results of the research show that the air in Baghdad is contaminated with polychromatic compounds resulting from the burning of medical waste.

2 - Medical Waste Air pollution with heavy elements and high rates.

3 - Hospitals and health centers have a significant role in environmental pollution in Baghdad.

4 - Lack of awareness of the seriousness of this pollution by workers in the field of medical waste management.

5 - The subject of the research needs to be studied more and more time and to pay great attention to the importance of this issue by officials in hospitals where we could not get many models to give comprehensive results with all details of environmental pollution.

6 - The lack of cooperation of the management of several hospitals in taking samples of medical waste offered except Alawi Hospital.

5. References:

Agency for Toxic Substance and Disease Registry (ATSDR), 1995. Toxicological profile for polycyclic Aromatic Hydrocarbons (PAHs), Atlanta, GA: U: S: Department of Health and Human Services, Public Health Service.

Ali, A, L.,2013. Environmental Impact Assessment of Kirkuk Oil Refinery. PhD. Theses, College of Science, University of Baghdad, (2013) 185p.

Azliyana B.A,2012. Polycyclic Aromatic Hydrocarbons (PAHs) in air and vegetation: a case study at three selected toll stations along the north-south expressway in Johor, Malaysia. M.Sc. Thesis, Technology Management, University of Hussein Onn Malaysia, (2012).

Carreras, H. A., Wannaz, E. D. and Pignata, M. L.,2009. Assessment of human health risk related to metals by the use of biomonitors in the province of Cordoba, Argentina. Environ Pollut; (2009) 157: 117-122.

Cheng Z, Chen LJ, Li HH, Lin JQ, Yang ZB, Yang YX, Xu XX, Xian JR, Shao JR and Zhu XM. 2017. Characteristics and health risk assessment of heavy metals exposure via household dust from the urban area in Chengdu, China. Sci Total Environment 2017; 619-620: 621–629. DOI: .1016/j.scitotenv.2017.11.144.

Chen M, Huang P and Chen L.2013. Polycyclic aromatic hydrocarbons in soils from Urumqi, China: distribution, source contributions, and potential health risks. Environ Monitoring Assessment 2013; 185(7): 5639–5651. DOI: 10.1007/s10661-012-2973-6.

Gope M, M., R. E, G. J, Hoque R. R and Balachandran S. 2017. Bioavailability and health risk of some potentially toxic elements (Cd, Cu, Pb, and Zn) in street dust of Asansol, India 138 231-41.

Grimmer G.,1983. "Environmental Carcinogens, Polycyclic Aromatic Hydrocarbons", CRC Press, Boca.

Husain K.I.,20003. Separation and Determination of PAHs in Iraq Environmental Samples. PhD. Thesis, College of Education-Ibn Al-Haitham, University of Baghdad. 104 p.

Jaber, S., A., Aldin A, Tudor P., and Elena P., 2021.The environmental situation of the ash medical waste in Baghdad city, Iraq. E3S Web of Conferences 286, 02017 (2021).

Kabata-Pendias A, 2010. Trace Elements in Soils and Plants (Boca Raton: CRC Press). P234.

Maree R.M., and Borrull F., 2000 Collection and Determination of Mercury in Air, International Journal of Environmental Analytical Chemistry. (1972) 2, 1, 29-36.

Said I, S. S and Elnazer A. A 2019. Multivariate statistics and contamination factor to identify trace elements pollution in the soil around Gerga City, Egypt Bulletin of the National Research Centre 43 4-9.

Scullman, J., & Widmark, G. (1971). Collection and Determination of Mercury in Air. International Journal of Environmental Analytical Chemistry, 1(2), 29-36.

Sitting., M., 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens Polynuclear Aromatic Hydrocarbons, 2nd.Ed., 1985.

Tfouni, S. A., Machado, R. M., Camargo, M. C., Vitorino, S. H., Vicente, E., & Toledo, M. C. F. (2007). Determination of polycyclic aromatic hydrocarbons in cachaça by HPLC with fluorescence detection. Food Chemistry, 101(1), 334-338.

Toledo M.C.F.2007. Determination of polycyclic aromatic Hydrocarbon sin cachaça by HPLC with fluorescence detection. Food Chem. (2007) 334,101.

Vera Samburova, Barbara Zielinska, and Andrey Khlystov, 2017. Do 16 Polycyclic Aromatic Hydrocarbons Representative PAH Air Toxicity.

World Health Organization (WHO). 1996. Air Quality Guidelines for Europe.

الكشف عن المخاطر البيئية الناجمة عن حرق النفايات الطبية في بغداد وتأثيرها على الصحة العامة

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المستخلص
تضمن البحث دراسة وجود الهيدروكربونات العطرية المتعددة الحلقات في الهواء الناتج عن حرق النفايات الطبية وتحديد نسب هذه العطريات في الهواء لأهميتها كملوثات عالية الخطورة. كما يحدد تراكيز بعض المعادن الثقيلة السامة مثل الرصاص (Pb2+) والكادميوم (Cd2+) والزئبق (Hg) والنيكل (Ni2+) والزنك (Zn2+) في عينات الهواء لما لها من آثار سلبية على صحة الإنسان. تم جمع أربع عينات هواء من محرقة مستشفى العلوية لعام 2020، وتم استخدام تقنية HPLC للتعرف على الهيدروكربونات العطرية متعددة الحلقات. أظهرت النتائج أن نسب الهيدروكربونات تراوحت بين 0.720 1.789-ميكروغرام/م3 وهي ضمن الحدود المسموح بها لمنظمة الصحة العالمية (1996). وتراوحت العناصر الثقيلة بين (0.042-1436.6 ميكروغرام/م3). وكان عنصر الزنك عالياً جداً وبلغت أعلى قيمة له 1436.6 ميكروغرام/م3. كما كان تركيز النيكل مرتفعاً أيضاً وتراوح بين 0.087-1.078 ميكروغرام/م3. وتراوحت تراكيز الزئبق بين (0.042-0.0586 ميكروجرام/م3) وهذه التراكيز وإن كانت قليلة إلا أنها تعتبر ملوثة للهواء. اختتمت الدراسة بفحص العلاقة بين تركيزات الهيدروكربونات العطرية المتعددة الحلقات والمعادن الثقيلة في الهواء المحيط، ووجدت توافقًا ممتازًا.

الكلمات المفتاحية: تلوث الهواء، النفايات الطبية، الهيدروكربونات العطرية المتعددة، المعادن الثقيلة، محارق النفايات الطبية.