Science Journal of Chemistry
2023; 11(2): 51-55
http://www.sciencepublishinggroup.com/j/sjc
doi: 10.11648/j.sjc.20231102.12
ISSN: 2330-0981 (Print); ISSN: 2330-099X (Online)

Determination of Toxic and Trace Heavy Metals in the Soil of Two Different Dumpsites: A Case Study of Ojota and Oko Filling Dumpsites, Lagos State

Moronkola Bridget Adekeni*, Alegbe Monday John, Okpala-Chunonso Angela, Adewusi Anuoluwapo

Chemistry Department, Lagos State University Ojo Campus, Lagos Badagry Expressway, Lagos, Nigeria

Email address:
moronkolaab@gmail.com (Moronkola Bridget Adekeni)
*Corresponding author

To cite this article:
Moronkola Bridget Adekeni, Alegbe Monday John, Okpala-Chunonso Angela, Adewusi Anuoluwapo. Determination of Toxic and Trace Heavy Metals in the Soil of Two Different Dumpsites: A Case Study of Ojota and Oko Filling Dumpsites, Lagos State. *Science Journal of Chemistry*. Vol. 11, No. 2, 2023, pp. 51-55. doi: 10.11648/j.sjc.20231102.12

Received: January 26, 2023; **Accepted**: March 8, 2023; **Published**: April 13, 2023

Abstract: Heavy metals are metallic elements with a relatively high density that are dangerous or hazardous at low concentrations and pose a serious threat to people and the environment. The purpose of this research is to ascertain the concentrations of heavy and trace metals in the Lagos State communities of Ojota and Oko Filling. The soil samples taken from the dumpsites were treated using the digestion process. After being placed into a sampling vial, the mixed solution from the digestion process was then taken for measurement using inductively coupled plasma optical emission spectroscopy (ICP-OES). Samples taken from the dumpsites at Ojota and Igando contained 12.52% and 4.44% of moisture, respectively. The analysis's findings showed that the average concentrations of Fe (42.429 mg/L), Zn (2.070 mg/L), Ca (7.140 mg/L), P (9.06 mg/L), Cd (0.022 mg/L), Cr (0.042 mg/L), Cu (0.135 mg/L), Pb (1.280 mg/L), and Ni (0.123 mg/L) at the Ojota dumpsite were all within the WHO/FAO standards' tolerable limits and did not pose any risk. While, Fe (94.784 mg/L), Zn (11.564 mg/L), Ca (45.243 mg/L), Cd (2.838 mg/L), Cr (0.046 mg/L), Cu (0.215 mg/L), and Ni (0.22 mg/L) are the mean concentrations, respectively. In conclusion, the results from the Oko – filling dumpsites shows that the heavy metals from the soil is highly toxic and are such harmful to the environment and detrimental to human life than Ojota dumpsites.

Keywords: Dumpsites, Soil, Heavy Metals, Digestion, ICP-OES

1. Introduction

Heavy metals are inert, naturally occurring elements of the crust of the Earth [1]. They sporadically get into our systems through food, water, and air. Certain heavy metals, such as copper, selenium, and zinc, are necessary as trace elements to keep the human body's metabolism running smoothly. High ambient air concentrations near emission sources, ingestion through the food chain, drinking water, or sewage disposal are all scenarios where exposure at higher concentrations can result in poisoning. Examples include Pb, As, Hg, Cd, Zn, Ag, Cu, Fe, Cr, Ni, Pd, and Pt. The mines emit the heavy metals into the environment through a variety of anthropogenic and natural sources, including mining, industrial discharge, cars, and exhaust [3, 4]. Heavy metals are non-biodegradable and have a propensity to accumulate in living things, in contrast to organic contaminants. In fact, the majority of them have been linked to cancer in the past. Long-term and ongoing exposure to heavy metals is recognized to pose a number of negative health risks [2, 3, 4]. Appropriate techniques must be created for their efficient removal from the environment because they are non-degradable and have a propensity to bio accumulate. As it is made up of both inorganic and organic materials, soil is the top layer of the ground. In addition to providing structural support, it also serves as a supply of water and nutrients for plants [5]. Minerals, soil organic matter, living organisms, gas, water, and water and water body included water, fish, and plants are the five primary components of soil [6]. The parent materials of the soil and numerous anthropogenic sources, the majority of which involve several metals, are the sources of heavy metals found in soils [7]. Both agricultural and urban soils can get contaminated with heavy metals from a variety of anthropogenic sources [7, 8]. The health of the local people may also be significantly impacted by localized contamination from a dominant single source, such as a metal smelter, especially in nations with insufficient emission controls and requirements for soil quality.. In general, different categories of heavy metal pollutants can be found in soils at industrial sites, depending on the relevant industries and their raw materials and outputs [9, 10]. All metropolitan areas typically include lead (Pb), zinc (Zn), cadmium (Cd), and copper (Cu) contamination of the soil due to traffic, paint, and numerous other non-specific urban factors. Although the parent material tends to have a stronger influence on the heavy metal composition of agricultural soils, other inputs from sources like the application of organic materials, contaminants in fertilizers, and the deposition of long-distance, atmospherically transported aerosol particles from fossil fuel combustion and other sources can also be significant. Humans and the environment have been very concerned about heavy metal contamination in soil [11]. In addition to negatively affecting several aspects of plant quality and yield, heavy metal pollution also alters the microbial community's size, composition, and activity [12]. As a result, heavy metals are one of the main causes of soil pollution. Several metals, including Cu, Ni, Cd, Zn, Cr, and Pb, are the main culprits for heavy metal contamination of the soil [13]. Heavy metals have been shown to negatively affect soil biological and biochemical characteristics [14, 15, 16, 17]. The purpose of this research is to ascertain the levels of heavy metals in the Lagos State, Nigeria, areas of Ojota Dumpsite and Oko Filling Dumpsite.

2. Materials and Methods

Lagos, Nigeria's Oko-filling, Igando, and Ojo are the study locations for this research. Along Lagos's Lagos Isheri Road is where the dump is located. This landfill is known as Solous Dumpsite, and according to a consulting company with experience in waste-to-energy and biomass energy, Olusosun Dump Site in Lagos' Ojota neighborhood is the largest landfill in Lagos and Nigeria, spanning over 43 hectares of land. Igando Dump is ranked as the second-largest landfill in Nigeria, occupying about 8 hectares of land.

2.1. Sampling Area

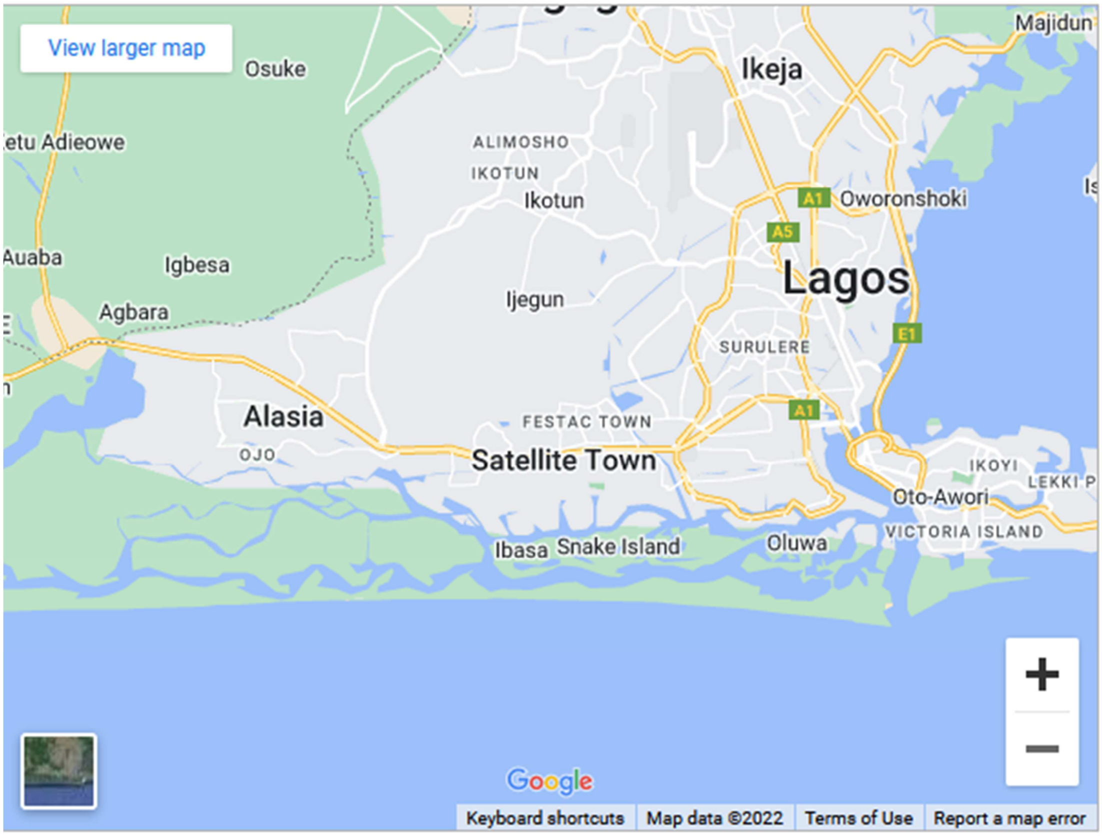

Figure 1. *Map of dumpsite locations.*

2.2. Sample Collection and Preparation

Samples of soil were taken from landfills in the cities of Ojota and Igando. Six (6) different locations on the dumpsite were used to collect the samples. With the aid of a soil auger, these samples were obtained at a depth of 14 cm. The samples were then packaged in polyethene bags and transported to the lab for analysis. The samples were pulverized using a mortar and pestle to pass through a 2 mm sieve after being air dried, and the leftover particles were thrown away. The powdered form was then kept in storage for later digestion and analysis.

2.3. Sample Digestion

A hot plate in a fume cupboard was used to digest 5.0 g of dried, sieved soil samples in 12 ml of aqua regia (HCl/HNO_3 v/v, ratio 3:1) until white vapors were visible. The sample was diluted with 20 ml of 2% nitric acid (v/v) after being allowed to cool to room temperature. After filtering the liquid through Whatman No. 42 filter paper and making it mark with distilled water, the mixture was then put into a sample vial. For both samples, the experiment was run a second time. Using an inductively coupled plasma optical emission spectrometer, heavy metal concentrations in the digested soil waste samples were determined (ICP – OES).

3. Results

3.1. Moisture Content

When soil samples from Ojota and Igando dumpsites were examined for moisture, it was discovered that the dry season values were 8.56 and 6.97, respectively, while the wet season values were 13.75 and 10.7, respectively. The rainy season had a larger moisture content than the dry season, and both seasons' Ojota moisture contents were greater than those of the dry season. Figure 2 displays the amount of moisture in the soil samples taken from the dumpsite.

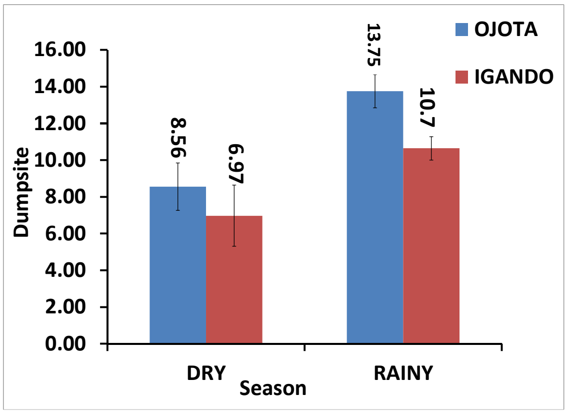

Figure 2. *Moisture content of soil samples obtained from Igando and Ojota dumpsites.*

3.2. Dumpsites

The samples were taken from two dumpsites in the Lagos State communities of Igando and Ojota throughout both the rainy and dry seasons. Toxic heavy metals and hazardous trace metals were analyzed in both samples for the two seasons, and high and low quantities of each were discovered, as shown in Figures 3 and 4 for the respective Igando and Ojota locations.

3.2.1. Ojota Dumpsite

Toxic and Trace Heavy Metals

Figure 3a revealed the concentrations of some of the toxic heavy metals found in the sample which includes Barium (Ba) and Manganese (Mn) and lead (Pb) which has higher concentration than chromium (Cr) and cadmium (Cd) and the Figure 3 also shows that concentration of toxic heavy metals are higher during the rainy days than the sunny days, e.g Barium has the concentration of 0.41mg/L during the rainy days and has concentration of 0.293 mg/L during the sunny days. Zinc (Zn) and magnesium (Mg), which were found in the soil of the dump site in the highest concentrations both during the rainy and dry seasons, are shown in Figure 3b. Zn has a higher concentration of trace metals both during the rainy and dry seasons than calcium. Concentrations of Zn during the dry and raining seasons are 21.24 mg/L and 14.85 mg/L respectively while the concentrations of Cupper during the dry and raining seasons are 2.01 mg/L and 7.01 mg/L respectively.

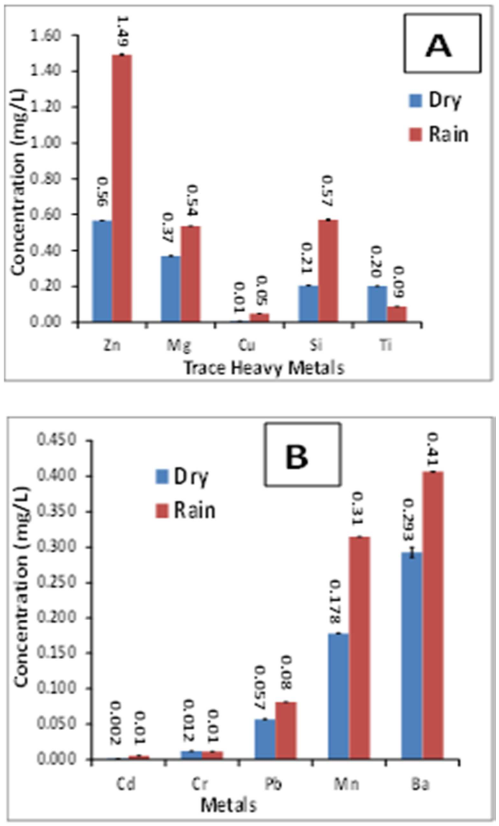

Figure 3. *Concentration of toxic (a) and trace (b) heavy metals in dumpsite soils during rainy and dry seasons.*

3.2.2. Igando Dumpsite

Toxic and Trace Heavy Metals

The results from the samples taken from the Ojota dumpsite showed that the mean concentrations (mg/L) for hazardous heavy metals were as follows: Th (0.005 mg/L), U (0.149 mg/L), As (0.012 mg/L), Hg (0.003 mg/L), and Cd (0.022 mg/L) are the toxic heavy metals that are within the WHO/acceptable FAO's limits and do not represent a major concern. The WHO/FAO have set acceptable limits for the mean concentrations of trace heavy metals for Cu (0.13 mg/L), Fe (40.43 mg/L), Ni (0.12 mg/L), Zn (6.48 mg/L), and Mo (0.01 mg/L) as indicated in Figure 3. Iron (Fe) and calcium (Ca), which were found in the soil at the dump site in the highest concentrations during both the rainy and the dry seasons, are shown in Figure 4b. Iron has a higher concentration of trace metals than calcium both during the rainy and the dry seasons. Whereas calcium concentrations are 2.01 mg/L and 7.01 mg/L during the dry and rainy seasons, respectively, respectively, the concentrations of iron are 21.24 mg/L and 14.85 mg/L.

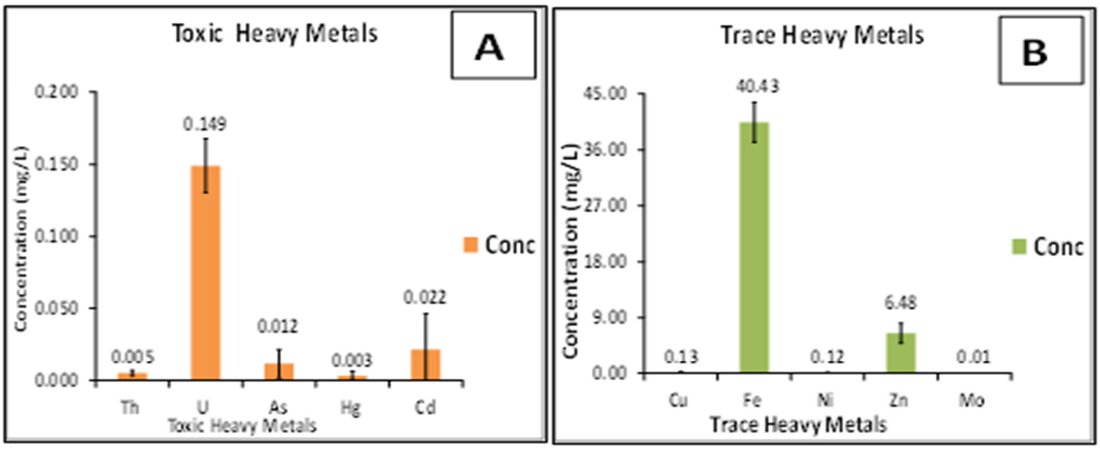

Figure 4. *Concentration of toxic (a) and trace (b) heavy metals in dumpsite soils during rain and dry season.*

4. Conclusion

Conclusively, the results of the hazardous and trace heavy metals found in both dumpsites showed that they did not include the same types of metals. The heavy metals in their soil are extremely poisonous, destructive to the environment, and deleterious to human life, as demonstrated by the Ojota and Igando dumpsites. The Ojota dumpsites location is surrounded by residents who have provided evidence that the level of heavy metals from the dumpsites is below EPA guidelines and that the pH from the six sites is essentially neutral, meaning that neither man nor agricultural products are being endangered.

Acknowledgements

The authors would like to thank Mrs Omowonuola, A. A for editing and reviewing this research write up and Mr Onifade Olayinka for carrying out the ICP analysis of the samples.

References

[1] Jarup, L. (2003). Hazards of heavy metal contamination: A review. Journal of British Medical Bulletin, 68 (2), 167-182.

[2] Duffs, J. H. (2002). “Heavy metals”- A meaningless term: International Union of Pure and Applied Chemistry, 74, 793-807.

[3] Vajargah, M. F. (2021). A review: on the effects of heavy metals on aquatic animals. Journal of Biomedical research and environment science, 5 (5), 22-26.

[4] International agency for research on cancer (2012). Monographs on the evaluation of carcinogenic risks to humans: Arsenic, metals, fibers and dust. A review of human carcinogens, 100.

[5] Koller, M. and Saleh, H. M. (2018). Lide, D. R. CRC Handbook of Chemistry and Physics. Introductory Chapter: Introducing heavy metals in H. E. M. Saleh, and R. F. Aglan (Eds.). CRC Press, Florida. 2004.

[6] Koller, M. and Saleh, H. M. (2018). Introductory Chapter: Introducing heavy metals. In. Saleh, H. E. M. and Aglan, R. F. (eds) Heavy metals, pp 1-11.

[7] Porz, L., Zhang, W., Hanebuth, T. J. and Schrum, C. (2021). Physical processes controlling mud depocenter development on continental shelves–Geological, oceanographic and modeling concepts. Marine Geology, 43, 106-402.

[8] Ali, H. and Khan, E. (2018). Bioaccumulation of non-essential hazardous heavy metals and metalloids in freshwater fish. Risk to human health. Environmental chemistry letters, 16 (3), 903-917.

[9] Brad, H. B. (2018). Heavy Metals in the Environment; Journal of Interface science and technology, 6, 142-144.

[10] Azizi, G., Akodad, M., Baghour, M., Layachi, M. and Moumen, A. (2018). The use of Mytilusspp mussels as bioindicators of heavy metal pollution in the coastal environment. A review; Journal of Mater Environmental Science, 9 (4), 1170-1181.

[11] Abdullsalam, N. (2009). Assessment of Heavy metals pollution in dumpsites in Ilorin metropolis. Ethopian Journal of Environment Studies and Management, 2 (2), 51-55.

[12] Wajahat, N., Sajida, P. and Syed A. S. (2006). Evaluation of Irrigation Water For Heavy Metals Of Akbarpura Area Journal of Agricultural and Biological Science, 1, 51 -54.

[13] Akaeze, C. S. (2001). Solid waste analysis, A research project of Chemistry/Biochemistry University of Uyo, Nigeria, 4, 150-156.

[14] Akwa, V. L., Binbol, N. C., Samaila, K. I. and Markus, N. D. (2007). Geographical perspective on Nasarawa State, A publication of Geography Department, Nasarawa State University, Keffi, Nigeria.

[15] Ali, N., Oniye, S. J., Balarabe, M. L. and Auta, J. (2005). Concentrations of: Fe, Cu, Cr, Zn, and Pb in Makera–Drain, Kaduna, Nigeria. Chemical Class Journal, 2, 69-73.

[16] Anake, W. U., Adie, G. U. and Osibanjo, O. (2009). Heavy metals pollution at municipal solid waste dumpsites in Kano and Kaduna States in Nigeria, Bulletin of the Chemical Society of Ethiopia, 23 (1).

[17] Udosen, E. D. (2000). Level of Toxic Metals in Achantina from Parts of Akwa-Ibom State, Nigeria. Journal of Environmental science, Beijing, China, 12 (1), 68-74.