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Evaluation of Heavy Metals in Soils from Different Dumpsites

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Abstract: *Open dumps are a source of various environmental and health hazards. The decomposition of organic materials produces methane, which may cause explosions and produce leachates, which pollute surface and ground water. The main objective of the study is to assess the heavy metals present in dumpsites in Ile Ife, Osun State. Soil samples were collected from three different dumpsites using sterile polythene bag. 2.0g of the sieved soil samples was digested for 3hours at 85ºC in 12ml of aqua regia (3:1 HCl-HNO_3v/v) using a hot plate in a fume cupboard until white fumes are observed. Digested soil waste samples were analyzed for the heavy materials; Cd, Pb, Co, Cr, Ni; using Atomic Absorption Spectrophotometer (AAS: iCE 3000 series). The results of the findings reveals that soil sample from SAMPLE A had 0.09±0.006, 0.28±0.06, 1.98±0.04, 0.19±0.008 and 0.02±0.006 of cadmium, lead, cobalt, chromium and nickel. SAMPLE B soil sample had cadmium, lead, cobalt, and chromium and nickel concentrations of 0.02±0.006, 1.56±0.24, 1.81±0.01, 0.15±0.01 and 0.01±0.006 respectively. Soil sample collected from SAMPLE C had 0.09±0.006, 0.68±0.08, 1.10±0.07, 0.22±0.08 and 0.02±0.006. The study showed that all the dumpsites soil samples collected contained Cadmium, Lead, Cobalt, Chromium and Nickel but are within permissible standards by WHO and SON.*

Keywords: Dumpsites, Heavy metals, Soil, Atomic Absorption Spectrophotometer

1. INTRODUCTION

In terms of materials usage and waste, man is best described as a chemical factory in terms of resource and energy demands on the environment, as well as the internal pollution that man inflicts on himself through inhalation and ingestion of alien chemical substances. Heavy metals are the most prevalent contaminants detected in landfills (Anzene, 2019). Natural and manmade sources both contribute to the presence of these metals in our environment. Soils, unlike other organic pollutants that are converted to carbon (IV) oxide by microbial action, are the principal sinks of heavy metals released into the environment through waste disposals; municipal, medical/pharmaceutical wastes, and so on (Anzene, 2019).

Heavy metals, often known as "trace elements," are usually divided into two categories: essential and non-essential metals. At certain concentrations, essential heavy metals are advantageous to living things. Iron, Manganese, Copper, Zinc, and Chromium are just a few of the significant heavy metals. The presence of high concentrations of critical metals in biological systems may cause toxicity in the species exposed. Others, such as lead, cadmium, mercury, and arsenic, are exceedingly dangerous even at low concentrations since they have no known purpose in living creatures (Sylvester *et al*., 2017).

Heavy metals are found in abundance in the ecosystem, with a wide range of amounts. Anthropogenic activities have also brought some of these heavy metals into the biosphere in modern times (Vareda *et al*., 2019). Inhalation of contaminated dust, ingestion, and skin contact are all ways that humans are exposed to heavy metal contaminated soils. Improper waste management practices may cause groundwater pollution or cause the majority of metal contaminants to be washed away by runoff into streams and rivers, polluting the aquatic ecosystem. As a result, these metals can build up in fish and other aquatic species, putting consumers' health at risk (Ezemonye *et al*., 2019; Liu *et al*., 2019).

Typically, abandoned dump sites are converted to other land uses such as crop cultivation, recreational areas, or the construction of human dwellings. Because of the rich mineral and organic content, the soil is sometimes dug for soil amendments elsewhere, but without considering the health concerns to organisms and the environment (Burns *et al*., 2019). Despite their extensive existence and importance in the country, dump sites have received little research, particularly in terms of mineral and hazardous composition. Large landfills (Jafaru *et al*., 2015), dump sites near light industrial hubs (Kodom *et al*., 2012), and e-waste recycling facilities have been the focus of the few research undertaken thus far (Cao *et al*., 2019; Yang *et al*., 2020).

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Agyarko and his colleagues (2010) compared the concentrations of a variety of metals (including As, Cd, Co, Cr, Cu, Fe, Hg, Mo, Ni, Pb, and Zn) in an urban dump site to those in a rural community in Ghana, concluding that metals loading in the urban dump site exceeded the threshold, posing health risks. A investigation of the impact of heavy metals on soil physicochemical parameters at another dump site (Agbeshie *et al*., 2020) found that heavy metal contamination was within FAO/WHO permitted levels.
Stakeholders need to know how many metals waste receptacles (including landfills) discharge into the general environment in order to make educated judgments and policies around heavy metal contamination. Heavy metal concentrations (cadmium, lead, cobalt, chrome, and nickel) in soils from dumpsites in Ile-Ife, Osun State, were determined in this study.

2. METHODOLOGY

2.1 Sample collection and preparation

Topsoil (0-12cm) samples (wastes) were obtained from dumpsites. They were combined into composite samples in a plastic bag and delivered to the lab for analysis. The materials were air dried before being pulverized with a mortar and pestle to pass through a 2mm sieve.

2.2 Digestion of samples

Using a hot plate in a fume cupboard, 2.0g of sieved soil samples were digested for 3 hours at 85oC in 12ml of aqua regia (3:1 HCl-HNO3v/v) until white fumes were seen. Allow the sample to cool to room temperature before diluting with 20ml of 2% Nitric Acid (v/v). After filtering with Whatman No. 42 filter paper and marking with distilled water, the mixture was placed into a 100ml volumetric flask. Using an Atomic Absorption Spectrophotometer, the extracts (digested soil waste samples) were tested for heavy metals such as Cd, Pb, Co, Cr, and Ni (AAS: iCE 3000 series).

2.3 Samples Analysis by Atomic Absorption Spectroscopy

Atomic Absorption is a term that refers to the process of The metal determinations were done with a spectrophotometer, which used a Hollow Cathode Lamp (HCL) for each of the elements. The examination was carried out at the Advanced Chemical Laboratory of the Sheda Science and Technology Complex (SHESTCO), using a Thermo Scientific SOLAAR S spectrometer. The actual metal content in each sample was calculated using the equation below, based on the results of the spectrometry study.

$$\text{Metal content (mg/g)} = \frac{\text{Concentration in solution from AAS result (mg/L)} \times \text{vol of dilution (L)}}{\text{Weight of sample (g)} \times 1000}$$

3. RESULT AND DISCUSSION

3.1 Result

3.1.1 Concentration of Cadmium in soil samples from dumpsites

Figure 1 shows the cadmium levels in soil samples collected from various dumping sites (SAMPLE A, SAMPLE B, and SAMPLE C). SAMPLE A and SAMPLE C soil samples had the greatest cadmium concentrations (0.0090.006 mg/kg). Soil samples taken from SAMPLE B had the lowest cadmium levels (0.020.006 mg/kg) (Figure 1).

3.1.2 Concentration of Lead in soil samples from dumpsites

The concentrations of lead in the three soil samples collected from separate dumping sites (SAMPLE A, SAMPLE B, and SAMPLE C) were all different. The highest concentration of lead was found in SAMPLE B (1.560.24 mg/kg), followed by SAMPLE C (0.680.008 mg/kg). A sample taken from SAMPLE A had a low concentration (0.280.006 mg/kg) (Figure 2).

3.1.3 Concentration of Cobalt in soil samples from dumpsites

Cobalt concentrations were variable in soil samples taken from three distinct sources. SAMPLE A soil sample had the greatest concentration of cobalt (1.980.04 mg/kg), followed by SAMPLE B soil sample with a concentration of 1.810.01 mg/kg. SAMPLE C soil sample had the lowest content of 1.1.00.07 mg/kg (Figure 3).

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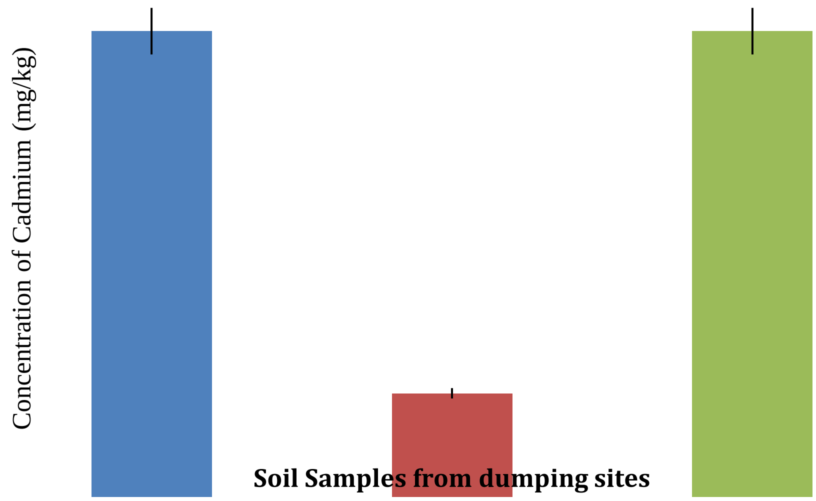

Figure 1: Concentration of Cadmium in soil samples collected from dumpsites in Ile-Ife, Osun State

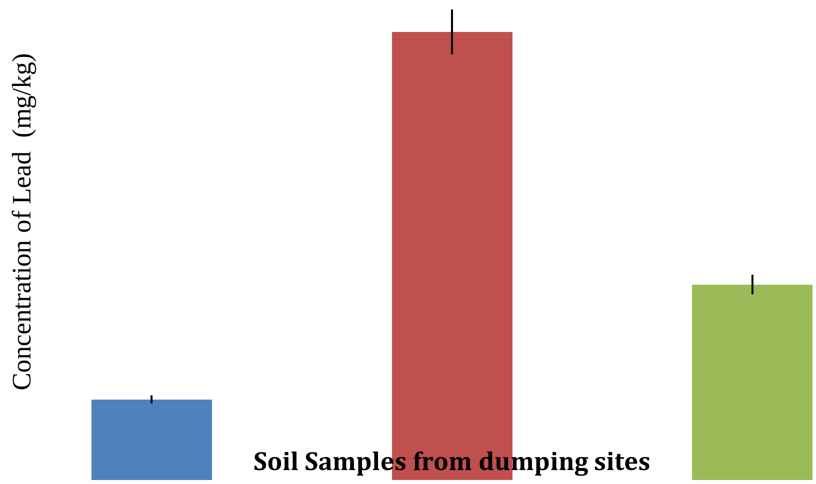

Figure 2: Concentration of Lead in soil samples collected from dumpsites in Ile-Ife, Osun State

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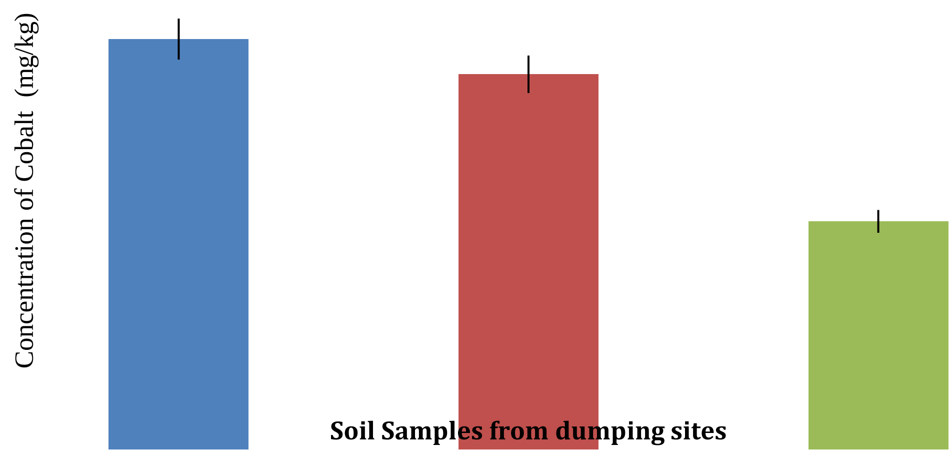

Figure 3: Concentration of Cobalt in soil samples collected from dumpsites in Ile-Ife, Osun State

3.1.4 Concentration of Chromium in soil samples from dumpsites

The amount of chromium in the soil samples above varies. Cobalt concentrations were variable in soil samples taken from three distinct sources. The highest concentration of chromium was found in a soil sample from SAMPLE C (0.220.008 mg/kg), followed by a sample from SAMPLE A (0.190.008 mg/kg), and a soil sample from SAMPLE B (0.150.01 mg/kg) (Figure 4).

3.1.5 Concentration of Nickel in soil samples from dumpsites

Soil sample from SAMPLE A and SAMPLE C had the same concentration of nickel (0.02±0.006 mg/kg) while the concentration of nickel from SAMPLE B soil sample is 0.01±0.006 mg/kg (Figure 5).

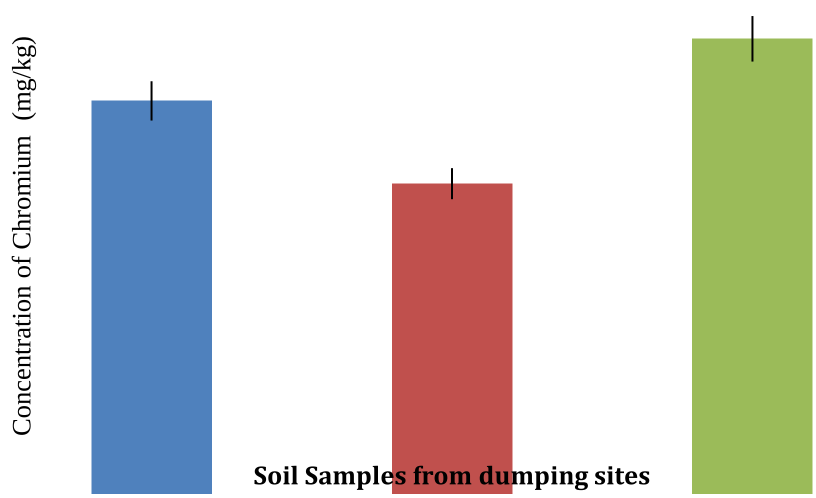

Figure 4: Concentration of Chromium in soil samples collected from dumpsites in Ile -Ife, Osun State

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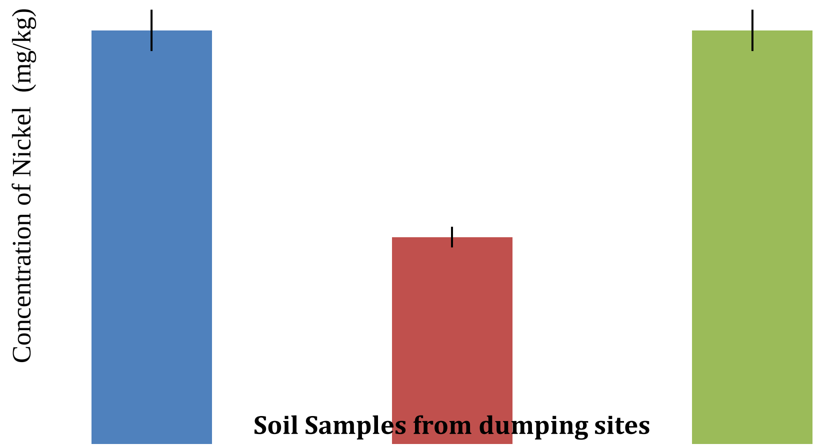

Figure 5: Concentration of Nickel in soil samples collected from dumpsites in Ile Ife, Osun State

3.2 Discussion

Three separate dumping sites in Ilesha, Osun State, were sampled for soil. Cadmium, lead, cobalt, chromium, and nickel were among the heavy metals considered. Soil samples collected from dumpsites were used to determine the amounts of the above heavy metals. Cadmium is a rare heavy metal that is often regarded as one of the most harmful to human health (Cranor, 2011; Kumar *et al*., 2015). The findings of this investigation revealed that cadmium contents varied significantly between sampling stations. Both SAMPLE A and SAMPLE C soil samples had the highest quantity of cadmium. The amounts of cadmium in the three test sites, however, were below the acceptable limits, according to Bowen (1979) (10–100 mg kg-1), FAO/WHO (FAO/WHO, 2001) (3 mg kg-1) and AEP (2016). (3.8 mg kg-1). Low inputs of cadmium materials from sludge, batteries, PVC materials, coatings, and motor oils may be linked to the research site's low Cadmium metal concentration (Twumasi et al., 2016).

When lead (Pb) is ingested into the body, it is considered a fatal heavy metal (Olayiwola *et al*., 2017; Yilmax, 2005). Lead disrupts water balances, enzyme activities, and mineral nutrition at higher amounts. The concentrations of lead in the various sampling locations varied significantly, ranging from 0.28 to 1.56 mg kg-1. The presence of lead at the study location is due to the disposal of batteries, food packaging material, PVC materials, and insecticides in waste materials (Twumasi et al., 2016). SAMPLE B soil sample had the highest lead levels (1.560.24 mg/kg). Awokunmi et al. (2010) reported similar mobility of Pb away from the dumpsite center down the slope in a study on heavy metal leaching at several chosen dumpsites in Nigeria. However, the lead concentration at the various sampling locations was within the permissible limits of Bowen (1979) (2–200 mg kg^{-1}), FAO/WHO (2001) (50 mg kg^{-1}) and AEP (2016) (70 mg kg^{-1}).

Cobalt concentration in three sampling points is varied. The highest concentration of cobalt was found in SAMPLE A soil sample (1.98±0.04 mg/kg). However, the cobalt concentration at the various sampling locations was within the permissible limits of World Health Organization (10.0 mg/kg)

The Chromium concentrations in the various soil samples given in the aforementioned study are within the acceptable range. All of the soil samples had chromium contents that were within WHO and SON's allowed and recommended standards (70 mg/kg). Chromium concentrations could be attributed to deposited materials from water erosion of rocks, liquid fuels, and high-Chromium-content industrial and municipal wastes.

Nickel concentrations in three soil samples were found to be varied. SAMPLE A and SAMPLE C soil samples, on the other hand, had larger concentrations. Nickel levels in all of the soils tested are under the WHO and SON permissible limits (35 mg/kg).

4. CONCLUSION

All of the dumpsite soil samples collected from various dumping locations contained Cd, Pb, Co, Cr, and Ni, according to the study. Some dumpsites contained larger concentrations of these metals than others, which might be related to the presence of garbage containing higher levels of these heavy metals as well as the geological formation of the locations. Because the concentrations of these metals are now within the WHO permitted level, the dumpsites are not considered a health hazard.

Planting edible fruits and other agricultural goods on dumpsites is a harmful practice, and eating such food products puts one's health at risk. Farming near the dumpsite should be avoided because farm products are prone to absorbing heavy metals.

There is the need for regular monitoring and awareness creation by the EPA to ensure segregation of waste before dumping to reduce increased levels of the contaminants (heavy metals) at the dumpsite, which may pose serious health risks. Alternatively, remediation technologies (e.g. phytoremediation) could be introduced at the site to help decontaminate the dumpsite.

Developing and implementing an efficient waste management plan is the most effective way to reduce/eliminate the environmental impact of these heavy metals. Plans to identify and manage the materials and wastes at a specific location. Rather than indiscriminately labeling dumpsites as is the case now, designated areas should be used as dumpsites. Before using dumpsites for cultivation, they need be treated. People who live near these dumpsites should also stop farming on or around them. As a result, it is advised that a standard environmental sanitary dumpsite be built as soon as possible, with recycling of garbage encouraged surrounding the dumpsites. Ministry of the Environment policy on groundwater monitoring, treatment, and protection should also be prioritized.

REFERENCES

J.P. Vareda, A.J.M. Valente, L.(2019). Durães, Assessment of heavy metal pollution from anthropogenic activities and remediation strategies: a review, J. Envi- ron. Manage. 246 (2019) 101–118 https://doi.org/10.1016/j.jenvman.2019.05.126 .

L.I. Ezemonye, P.O. Adebayo, A .A . Enuneku, I. Tongo, E. Ogbomida,(2019). Potential health risk consequences of heavy metal concentrations in surface water, shrimp (Macrobrachium macrobrachion) and fish (Brycinus longipinnis) from Benin River, Nigeria, Toxicol. Reports. 6 (2019) 1–9 https://doi.org/10. 1016/j.toxrep.2018.11.010 .

H. Liu, G. Liu, Z. Yuan, M. Ge, S. Wang, Y. Liu, C. Da, Occurrence, potential health risk of heavy metals in aquatic organisms from Laizhou Bay, China, Mar. Pollut. Bull. 140 (2019) 388–394 https://doi.org/10.1016/j.marpolbul.2019.01.067.

K.N. Burns, S.K. Sayler, R.L. Neitzel, Stress, health, noise exposures, and injuries among electronic waste recycling workers in Ghana, J. Occup. Med. Toxicol. 14 (2019) 1–11 https://doi.org/10.1186/s12995-018-0222-9 .

H.M. Jafaru, G.N.N. Dowuona, T.A. Adjadeh, E.K. Nartey, P.M. Nude, D. Neina, Geochemical assessment of heavy metal pollution as impacted by munic- ipal solid waste at Abloradjei waste dump site, Accra-Ghana, Res. J. Environ. Earth Sci. 7 (2015) 50–59 https://doi.org/10.19026/rjees.7.1695 .

K. Kodom, K. Preko, D. Boamah, X-ray Fluorescence, XRF) analysis of soil heavy metal pollution from an industrial area in Kumasi, Ghana, Soil Sediment Contam, An Int. J. 21 (2012) 1006–1021 https://doi.org/10.1080/15320383.2012.712073 .

P. Cao, T. Fujimori, A. Juhasz, M. Takaoka, K. Oshita, Bioaccessibility and human health risk assessment of metal(loid)s in soil from an e-waste open burning site in Agbogbloshie, Accra, Ghana, Chemosphere 240 (2020) 124909 https://doi.org/10.1016/j.chemosphere.2019.124909 .

J. Yang, J. Bertram, T. Schettgen, P. Heitland, D. Fischer, F. Seidu, M. Felten, T. Kraus, J.N. Fobil, A. Kaifie, Arsenic burden in e-waste recycling workers –a cross-sectional study at the Agbogbloshie e-waste recycling site, Ghana, Chemosphere 261 (2020) 127712 https://doi.org/10.1016/j.chemosphere. 2020.127712 .

A .A . Agbeshie, R. Adjei, J. Anokye, A. Banunle,(2020) Municipal waste dumpsite: Impact on soil properties and heavy metal concentrations, Sunyani, Ghana, Sci. African. 8 (2020) e00390 https://doi.org/10.1016/j.sciaf.2020.e00390 .

G. Darko, M. Dodd, M.A. Nkansah, Y. Aduse-Poku, E. Ansah, D.D. Wemegah, L.S. Borquaye, Distribution and ecological risks of toxic metals in the topsoils in the Kumasi metropolis, Ghana, Cogent Environ. Sci. (2017) 3 https://doi.org/10.1080/23311843.2017.1354965.

K. Agyarko, E. Darteh, B. Berlinger, Metal levels in some refuse dump soils and plants in Ghana, Plant, Soil Environ 56 (2010) 244–251 https://doi.org/ 10.17221/13/2010-PSE .

Sylvester, C. I; Sunday, E.B. and Elijah , I. O (2017); Assessment of pollution load indices of Heavy Metals in cassava mill Effluents of contaminated Soil: A case study of small-scale processors in a rural community in the Niger Delta; Nigeria. *Bioscience Methods Vol.8 (1), 1-17*.

Solomon J. Anzene (2019). Determination of Heavy Metals in Waste Dumpsites in Lafia Town and Environs International Journal of Engineering Research & Technology (IJERT), Vol. 8 (6): 1541-1545

AB Yilmax, Comparison of heavy metal levels of grey mullet (Mugil cephalus L.) and sea bream (Sparus aurata L.) caught in Iskenderun Bay (Turkey), Turkish J. Veterinary Animal Sci. 29 (2005) 257–262 .

EE Awokunmi , SS Asaolu , KO Ipinmoroti , Effect of leaching on heavy metals concentration of soil in some dumpsites, Afr. J. Environ. Sci. Technol. 4 (2010) 4 95–4 99 .

P Twumasi , MA Tandoh , MA Borbi , AR Ajoke , E Owusu-Tenkorang , R Okoro , RM Dumevi , Assessment of the levels of cadmium and lead in soil and vegetable samples from selected dumpsites in the Kumasi Metropolis of Ghana, Afr. J. Agric. Res. 11 (2016) 1608–1616

HJM Bowen, in: Environmental Chemistry of the Elements, Academic Press, London, 1979, pp. 212–246. CF Cranor , Legally Poisoned, Harvard University Press, 2011

HA Olayiwola , L Abudulawal , GK Adewuyi , MO Azeez , Heavy metal contents in soil and plants at dumpsites: A case study of Awotan and Ajakanga dumpsite Ibadan, Oyo State, Nigeria, J. Environ. Earth Sci. 7 (2017) 11–24 .