International Journal of Environment and Pollution Research
Vol.10, No.1 pp.20-27, 2022
Print ISSN: 2056-7537(print),
Online ISSN: 2056-7545(online)

An appraisal of Heavy Metal Concentration in Soil and Selected Subterranean Animals in Olusosun Landfill, Ojota, Lagos State

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Citation: Iheanacho, J.N., Ejike-Okongwu, C., Idowu, S.A., Kabantiyok, D., Mkpuma, N.N, & Bala, N.M. (2022) An appraisal of Heavy Metal Concentration in Soil and Selected Subterranean Animals in Olusosun Landfill, Ojota, Lagos State, *International Journal of Environment and Pollution Research*, Vol.10, No.1 pp.20-27

ABSTARCT: *As a result of the global industrial activities, contamination of the ecosystem by heavy metals has given rise to one of the most important ecological and organismic challenges. An experimental study was performed to ascertain the levels of heavy metals in soil and selected subterranean animals in dumpsites in Lagos State. One (1) kg each of four composite soil samples at a depth of 0 -15cm from the soil surface within the landfill were collected using an auger. The level of parameters such as soil pH, temperature and soil moisture content were determined. Earthworm, Maggot and Spider from each sampled soil were washed in distill water to remove soil particles. The heavy metals (Zn, Cd, Cr, Cu and Pb) were then analyzed by Atomic Absorption Spectrophotometry (AAS). The result of the study showed that Pb and Cd had higher mean concentration (0.75mg/kg and 0.1mg/kg respectively) for the landfill soil sample compared to the control soil sample and subterranean animals. The result also showed that Maggot and Earthworm had higher means concentration of Zn (0.31mg/kg and 0.14mg/kg respectively) compared to the soil samples (landfill and control) and spider. The result was not statistically significant comparing the mean concentration of heavy metals on the landfill soil and the subterranean animals. Chromium (Cr) was not detected in the study. The study concluded that there is high anthropogenic influence and persistence of the heavy metals which accumulated in the environment and pose serious ecological and health challenges.*

KEYWORDS: heavy metals, soil, animals, subterranean, landfill, Lagos.

INTRODUCTION

Landfill is a major source of disposal of solid wastes in most cities of Nigeria in the last few decades [1]. This has posed major environmental and public health problems [2], and a source of worry for rural and urban planners [3]. Lagos state is the most populous city in Nigeria because of the explosive population growth and urbanization [4]. Most open dumpsites/landfills which were sited at the outskirts, are now within the heart of the mega city. Olusosun landfill, the biggest landfill in Lagos is a typical example. This landfill been in existence since 1978 and receives at least 25,000 tons of assorted waste per annum according [2]. A subterranean animal refers to animal species that are adapted to live in an underground environment [5]. Very few studies have been reported on the heavy metals content of subterranean animals and soil within the vicinity of the landfill [6]; [5]; [1]. A study by [7] noted bioaccumulation of heavy metals in subterranean animals. This underscores the need to regularly assess the levels of some toxic heavy metals in soil, subterranean animals and underground water samples from the vicinity of the landfill to assist in tracing the source (s) of these metals through correlation studies [8].

Several studies have shown that heavy metals such as lead, cadmium, nickel, manganese and chromium amongst others are responsible for certain diseases [9]. Metals found in waste dumpsite exist in various forms either as the pure metal or alloyed with various other metals. Heavy metals impairing the quality of the environment come from various sources that can be categorized into urban-industrial aerosols, liquid and solid wastes from animal and man, mining and industry and agricultural chemicals [10]. The disposals of materials contaminated with heavy metals such as in waste dumpsite are of concern and pose dangers to people in contact with the contaminated soils and plants. Research made it known that toxic metals arising from human activities are accumulated in soil. The quality and quantity of solid waste generated in Nigeria vary widely from day to day, season of the year and nature of the waste disposed due to improper waste management [8]. [11] Reported that concentrations of heavy metals in soil around waste dump site are influenced by types of wastes, topography, run-off and level of scavenging. The wastes at dumpsite are usually left over a long time to decompose naturally eaten by animals, picked by scavengers or washed away by floods when it rains into the larger creek and rivers thus affecting the surface water quality [3].

Recently, many studies have shown that heavy metals and metalloids with an atomic density >6 g/cm^3– from these wastes can accumulate and persist in soils at environmentally hazardous levels [12]. Most abandoned waste dumpsites in many towns in Nigeria attract people as fertile ground for cultivating varieties of crops. The cultivated plants take up the metals either as mobile ions presents in the soil solution through the root or through foliar adsorption. The uptake of the metals by crops results in the bioaccumulation of these elements in plant tissues. This is known to be influenced by the metal species, plant species and plant part [13]. Indeed, it has been reported that plants grown on soils possessing enhanced metal concentration due to pollution have increased heavy metal ion content. If the consumption of these metals through plant source is not carefully regulated, it may lead to accumulation in man with attendant health hazards [14].

Urban areas known for high level of industrial activities generate more pollutants and therefore subject to the menace of resultant indiscriminate disposal of both domestic and industrial wastes. A typical example of such urban centres is Port Harcourt city located in the heart of the oil-rich

Niger Delta of Nigeria. There are reports that its suburbs are loaded with toxic heavy metals and certain trace elements resulting from poor waste management programme [15].

In Nigeria at present, little data is available on the extent of soil-vertebrates-human pollution [16]. Clearly, there is a gap in knowledge related to dumpsite soil-water-animal-human pollution especially in Nigeria and empirical data are needed as the basis for wider modeling assessment. Lagos as an urban settlement with high industrial presence generates tremendous amount of waste which can be toxic to the environment. Most of the waste dumped in the landfills in Lagos is not treated at the point of generation before disposal and this exposes the environment especially the soil, underground water and soil organisms to direct contact with toxic substances.
Heavy metal content of soils is a critical measurement for assessing the risks of refuse dumpsites. Since these contaminants affect the environmental qualities in and around such open dumpsites, monitoring of soil qualities especially heavy metal content in dumpsite becomes necessary which can facilitate to recommend suitable remedial measures. The aim of the study was to assess heavy metal concentration in soil and selected subterranean animals in Olusosun Landfill, Ojota, Lagos State.

Description of study area
Olusosun landfill is located in Ojota area of Lagos State, Nigeria on latitude 60. 20' N and longitude 30. 20' E. It is a few kilometers from the Lagos lagoon and the Bight of Benin (Ogundiran and Afolabi, 2008). The landfill is surrounded by some factories, a gasoline filling station, a motor park, automobile repair workshop and road network which are sources that can release heavy metals especially Pb in addition to the assorted wastes that are discharged at the landfill everyday (Oyelola and Babatunde, 2008) . The Olusosun landfill is about 18 meters deep and covers an area of 42 hectares of land (LAWMA, 2004).

Characterization of wastes
Characterization wastes at the landfill followed the method of [14]. The groups used in the characterization of the waste includes: plastics, papers, metals, glass electronics, textiles, shoes, nylon and organic matter of plant and animal origin.

Characteristics used for identification of animals
The characteristics used in the identification of animals includes: presence of Tagmata (sections or segments), eight jointed legs, no wings or antennae, the presence of chelicerae and pedipalps and simple eyes. Cylindrical tube shape, presence of metameristems, presence of furrows, presence of bristle-like hairs called lateral setae and the presence of Prostomium were used in identification of the earthworms. White coloration, legless and canonical in shape and presence of mandibles were in identification of maggots.

Sample collection
About 1 kg each of four (4) composite soil samples at a depth of 0 -15cm from the soil surface within the landfill in such a manner that represented the entire landfill were collected. These samples were kept in a clean airtight polythene bag immediately after sampling and transported to

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the laboratory for further analysis. Earthworm, (*Eudrilus eugeniae*), Maggot (*M. domestica*), and jumping spiders (*Neatha*, *maxima*) from each sampled soil were washed in distilled water to remove soil particles from them. They were put in black polythene bags, tied and labeled accordingly. The soil and animal samples were taken to the laboratory further analysis.

Sample analysis
The soil and animal samples were air dried and sieved with a 0.5 mm mesh size sieve. The Temperature and pH of soil samples was determined by adopting the method by International Institute of Tropical Agriculture, Nigeria (IITA, 1979). The method involved taking the pH of 1:1 soil: deionized water extracts with a calibrated pH meter. Soil organic matter and moisture content was determined in line with the method of [17]. Environmentally available metals in soil samples were leached in the laboratory according to Miroslav and Vladimir [18]. This was carried out by accurately weighing 1g each of dried and sieved soil samples (≤ 0.5 mm) into a series of acid washed beakers covered with wash glass; 30 mL of 1:1 HNO3: deionized water were added to each of the beakers containing the soil. They were each boiled gently on a hot plate in the hood while stirring intermittently until the volume reduced to about 5 mL. Exactly 10 mL of 1:1 HNO3: deionized water was again added and the procedure was repeated. The second 5 mL for each case were diluted appropriately with standard flasks and preserved at 4 ^{0}C before for Atomic absorption spectrometric (AAS) analysis. all results were presented in mg/kg.

Data analysis
Data generated was analyzed using analysis of variance (ANOVA), mean separation was done using Duncan Multiple Range Test.

RESULTS

The result for the characterization of waste materials in the landfill showed that 33.3% of the waste materials consist of nylon and polythene bags, plastics accounted for 21.2%, paper materials were 19%, plant and animal debris were 5%, metals were 7.5% and the least occurring waste materials in the landfill were electronics 2.7% and shoes with 2.3%.

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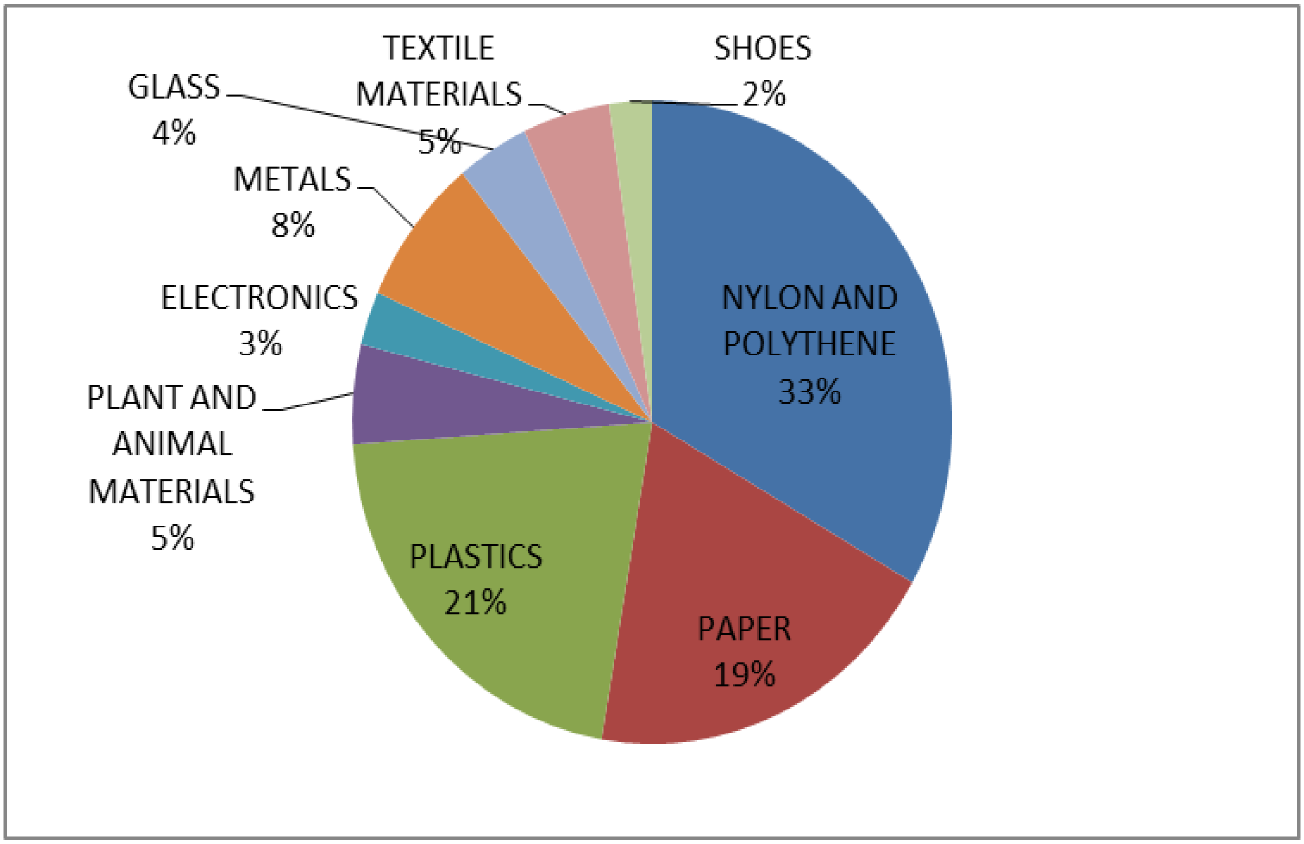

Figure 1: Characterization of waste materials

Physicochemical properties of the landfill soil

The result for the physicochemical analysis of the landfill soil is presented in figure 2. The results obtained showed that the mean pH of the landfill (8.1) was higher than that of the control (7.3) and below the FEPA permissible limit for dumpsite soil. Landfill soil organic matter content (49.5%) was observed to be FEPA recommended limit, while the control recorded 2.86%. the mean temperature of the control soil was higher than that of the landfill soil (29.70C as against 24.9 0C) and was found to be within FEPA permissible limit. The moisture content of the landfill soil had 15.6% while the control site recorded 25.8%.

Table 1: Physicochemical properties of the landfill soil

Parameters	Landfill	Control	FEPA Limit (2013)
pH	8.1	7.3	6-7
OM (%)	49.5	2.86	3
Tempt. (0C)	24.9	29.7	<40
MC (%)	15.6	25.8	-

Heavy metal concentration in soil and subterranean animals

Vol.10, No.1 pp.20-27, 2022
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Results of heavy metal concentration in landfill soil and selected subterranean animals are displayed in figure 2. The result showed that Pb had the highest mean value of 0.75 mg/kg while Cr was not detected; cadmium had 0.10mg/kg, zinc had 0.04mg/kg and copper 0.14mg/kg respectively. Results obtained showed that heavy metal concentration within the landfill was higher than the control values; however, the mean values were within FEPA permissible limit. The results further indicated presence of heavy metals among the subterranean animals assayed. From the result, Pb recorded the highest mean concentration of 0.36mg/kg; cadmium had 0.013mg/kg, zinc had 0.03mg/kg while copper and chromium where not detected. The result showed that Pb had the highest mean concentration of 0.38mg/kg while copper and chromium were not detected. The respective metal concentration was lower in earthworms than the landfill soil except zinc with mean value of 0.14mg/kg. Heavy metal concentration in maggot samples revealed that Pb recorded 0.17mg/kg; cadmium had 0.13mg/kg; zinc recorded 0.31mg/kg while chromium and copper had 0.3mg/kg and 0.23mg/kg respectively.

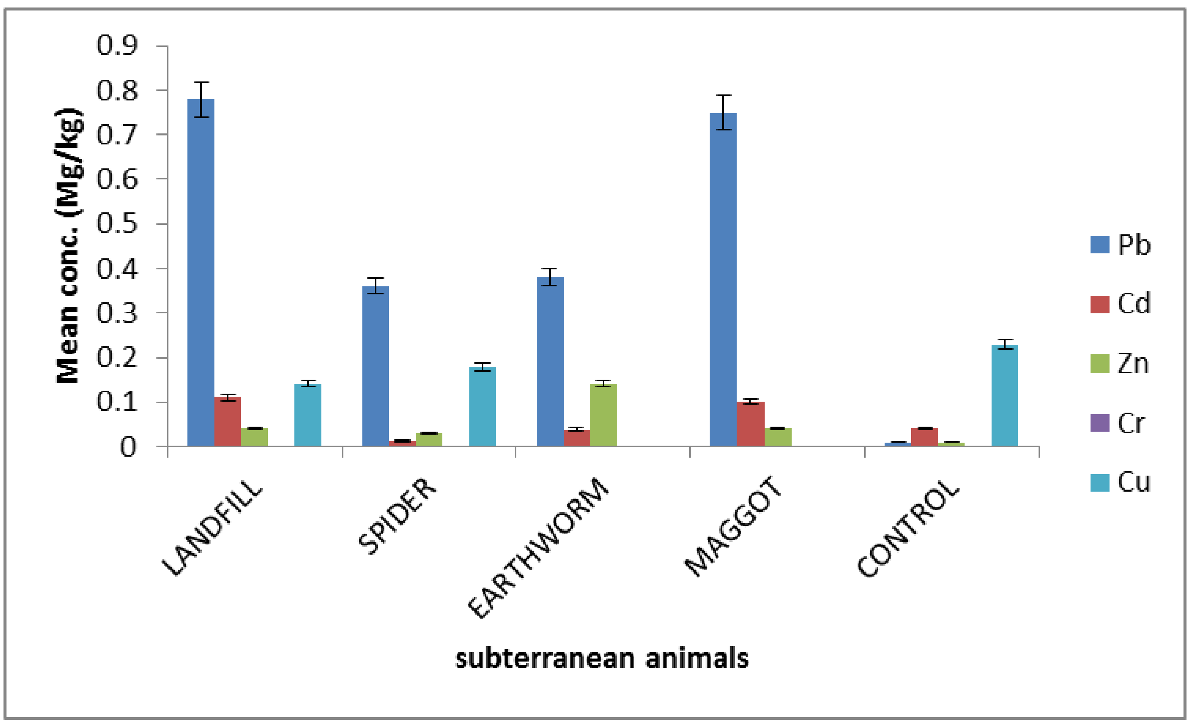

Figure 2: Heavy metal concentration in soil and subterranean animals

DISCUSSION

This study has established the bioaccumulation potentials of heavy metals in soil and three selected subterranean animals (spider, earthworm and maggot) collected from Olusosun Landfill, Ojota, Lagos State. It therefore gives background information on the extent of heavy metal pollution in the landfill and the possibility of alteration of the ecosystem integrity if nothing is done to remediate it. This knowledge can also help to explain certain phenomena and observations relevant

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Vol.10, No.1 pp.20-27, 2022

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to environmental health of particular locations such as bioaccumulation of chemical constituents [11]. A related study by [19] detailed the concentration of some heavy metals in subterranean animals. The results reported here would therefore be complimentary with those of [19].

The present study was based on the fact that there could be possibility of take-up of heavy metals through the food web. The results obtained indicate the high possibility of this suspected take-up since the heavy metals were detected in both the insects as well as the soil. This is consistent with the findings of [20] who reported that Cd, and Hg were detected in high concentration in the fresh and boiled leafy vegetables in the vicinity of landfill. The foregoing observation tends to support the suggestion of [21] that certain insects can be used as entomoremediators of soils polluted by heavy metals. Entomoremediators are described as insects capable of being used as agents of decontaminating polluted soil [20]. The results of this study show that (spider, earthworm and maggot) accumulated high quantities of heavy metals. This suggests that these species may be considered as candidates in decontaminating soils polluted by these heavy metals.

CONCLUSION

Assessment of the concentrations of Zn, Cd, Cr, Cu and Pb in soil and selected subterranean animals samples within the vicinity of Olusosun landfill in Ojota, Lagos, Nigeria was carried out. The concentrations of all metals for all soil samples collected from the vicinity of the landfill were far higher than those at background (collected from reserve area within the same geographical area) suggesting serious anthropogenic influence with respect to Zn, Cd, Cr, Cu and Pb. The dumping of wastes especially toxic waste on this landfill should be highly regulated and possible urgent fortification/ or evacuation of the landfill needs to be done. Awareness of the pollution statuses of soil, within the vicinity of the landfill needs to be urgently created especially among people living in the surrounding environment to avert health related problems from consuming plants from this vicinity. The three subterranean animals used in this study has demonstrated that they can be further used as entomoremediators of heavy metal polluted sites.

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