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ASSESSMENT OF SOME HEAVY METALS CONCENTRATIONS IN SOIL AND GROUNDWATER AROUND REFUSE DUMPSITE IN IBADAN METROPOLIS, NIGERIA

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ABSTRACT
This study reports the determination of some heavy metals' concentration in soil and groundwater around refuse dumpsites in five locations in Ibadan Metropolis, Nigeria. Five samples were collected from each soil and ground water locations and analysed for heavy metals(Cd, Co, Pb, Cr, Zn, Mn and Ni)using Atomic Absorption Spectrophotometry. The soil samples were obtained in triplicates at 25cm depth intervals whereas the water samples were obtained from hand dug wells less than 10 m deep. The range of the values of heavy metal concentrations obtained in water is Co (0.01-0.04), Pb (0.01-0.02), Cr (0.02-0.05), Zn (0.40-0.70), Mn (0.02-0.05) and Ni (0.02-0.05), but Cadmium was not detected. The concentrations of Pb and Ni in ground water obtained from Arapaja, Aleshinloye and Alafara were higher than the World Health Organization (WHO) and Standard Organisation of Nigeria (SON) limits. The results obtained showed that the concentrations of Cd, Co, Pb, Ni and Cr in soil exceeded the WHO and SON permissible limits. However, Zn and Mn were below the limit.

Keywords: *Heavy metals, Dumpsite, Groundwater, Soil samples, Concentrations.*

1. INTRODUCTION

Nigeria is one of the developing countries in the world having most cities and towns with inapt waste management scheme including its largest city, Ibadan [1, 2]. Nowadays, high level of refuse produced in the cities daily as a result of human activities is detrimental to human health [1]. Most of these refuses generated as a result of expansion in agricultural and industrial sectors are not properly recycled. It was discovered that many Nigerians lack proper waste disposal and as a result of this, proper waste or refuse management has pose a major challenge to the country [3]. One of the major problems of refuse dumpsite is air pollution and this could have negative influence on people's health in rural and urban areas [4]. Improper management of organic and inorganic wastes materials in dumpsites could affect the soil composition and impact adversely on flora and fauna. Heavy metals which include Cadmium (Cd), Cobalt (Co), Lead (Pb), Chromium (Cr), Zinc (Zn), Manganese (Mn) and Nickel (Ni) are of major concern due to their potential to harm living organisms.

In Nigeria, refuse are littered and with heaps of illegal dumping sites which include refuse due to used cans, pins, used syringes from pharmaceuticals and so on. The particles of these materials are leached into nearby wells and rivers contributing significantly to their heavy metals' concentrations and thus harmful to human life and the environment. Heavy metals are natural components of the soil, but activities of human caused a big variation in their biochemical balances [5]. Also the uptake of these metals by plants is a means of entry into human food chain [6].

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The effects of these metals depend on the concentrations and pH level in the system for example its excesses in plants decreased growth.

Furthermore, as regard the increasing sensitivity of the imminent danger of refuse dumpsites to the environment, a lot have been invested immensely on research into refuse management in order to minimise the health danger it poses to human and the environment [1]. For instance, the quality assessment of groundwater in Pallavapuram municipal solid waste dumpsite in Chennai, India showed mild to high concentration of Fe and mild to high acidity of samples close to the dumpsite [7]. Olafisoye *et al.*, [8] examined the heavy metals contamination of water, soil, plants around an electronic waste dumpsite and concluded that the total mean concentrations of heavy metals decreased with depth in soil samples and distance from the dumpsite. Afolayan *et al.*, [9] studied the hydrological implication of solid waste disposal on ground water quality in urbanized area of Lagos state Nigeria and their study revealed that the water samples around the study area contain high level of heavy metals higher than WHO standard limit. Also, Agbede and Ojelabi [10] analysed the heavy metal concentrations of selected water sources in Ibadan and concluded that the concentrations of heavy metals in their samples including Lead, Zinc, Iron and Manganese were above the world health organization (WHO) and standard organization of Nigeria (SON) recommendations.

This work focuses on the assessment of heavy metals concentrations in refuse dumpsite in soil and groundwater in Ibadan metropolis, Nigeria with a view to relate the measured concentrations with WHO and SON standards and offer recommendations on better ways of managing refuse generated in this large metropolis hence, ensuring a safer environment.

2. STUDY AREA

Five dumpsites located within four local Government Areas in Ibadan with longitude and latitudes; Oluyole (Arapaja dumpsite on 7◦18'N and 3◦50'E), Akinyele (Moniya garage on 7°55'N and 3°91'E) and Iyana Apapaon (7° 32'N and 3°54'E), Ibadan South-West (Aleshinloyeon 7°39'N and 3°87'E) and Ido (Alafara on 7°26'N and 3°49'E) were selected for this study.

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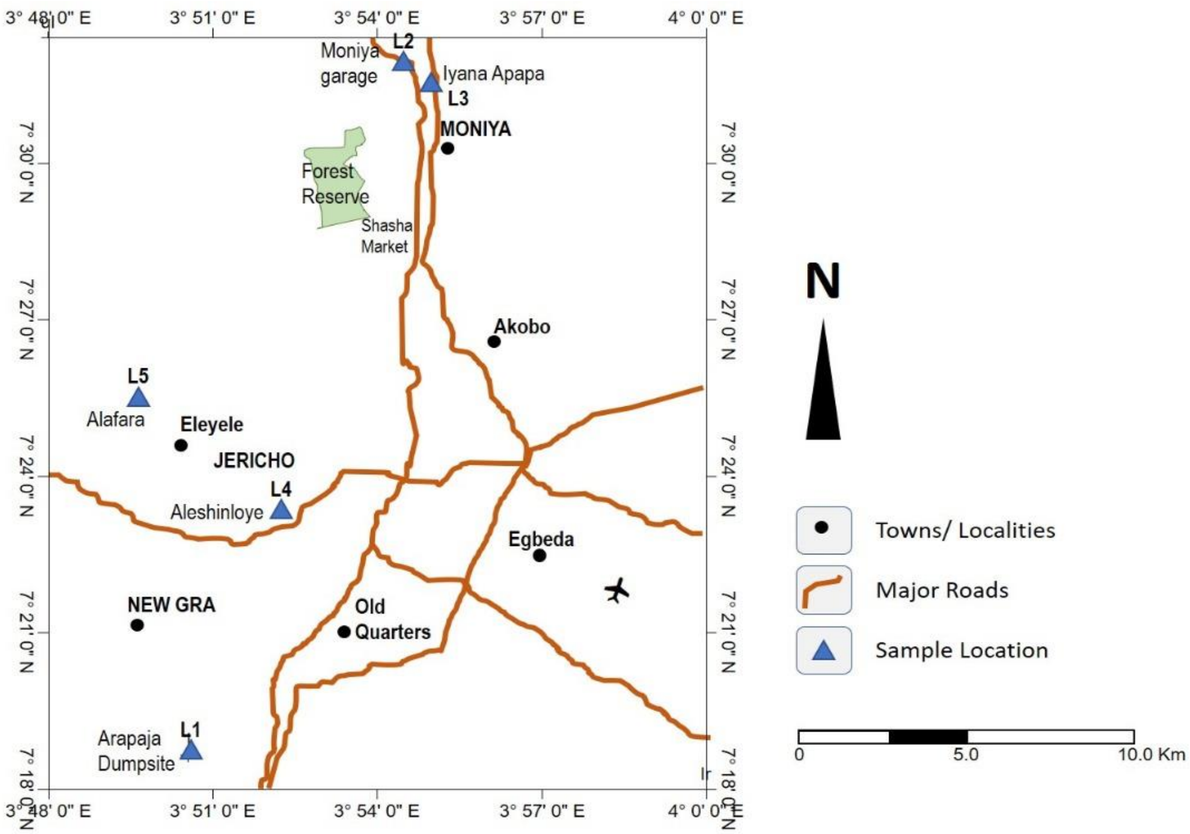

Fig. 1: Map showing location of samples in Ibadan Metropolis

3. MATERIALS AND METHODS

3.1. Soil and water sampling

A purposive sampling method was used based on the area of study. Five water samples and fifteen soil samples were collected at depth 5.0, 30.0 and 55.0cm using hand trowel and a measuring tape and were kept in a plastic container and properly labelled accordingly for Atomic Absorption Spectrophotometer (AAS) analysis using Buck Scientific Model 210VGP to determine the heavy metal concentrations including Co, Mn, Cd, Cr, Zn, Pb and Ni. The temperature, conductivity and pH of the water samples were taken in-situ using thermometer, conductometer and pocket digital pH meter respectively.

3.2. Soil analysis

The soil samples collected were air dried at room temperature for 48 hours, and then sieved using a 0.5 mm standard sieve to remove debris and other unwanted materials. Thereafter, 0.5 g of the sieved portion of each sample was placed into a conical flask and 5.0 mL of sulphuric acid was added and covered. Each of the flasks was then placed on a hotplate and heated to 95ºC in a fume cupboard for 1hour. The samples were removed on appearance of a light-coloured fume and cool for 10 minutes after which 2.0 mL of distilled water and 3.0 mL of 30% hydrogen peroxide were added to the sample. It was then filtered and the filtrates were analysed for Cd, Co, Pb, Cr, Zn, Mn and Ni using AAS.

3.3. Water sample analysis

The water samples were preserved by the addition of 5.0 mL nitric acid. It was then filtered and the filtrate was also analysed for heavy metal concentrations using AAS.

RESULTS PRESENTATION AND DISCUSSIONS

Table 1: Result of physico-chemical properties and heavy metals concentrations in water samples

Location	pH	Conductivity (µS/cm)	Zn (mg/L)	Mn (mg/L)	Pb (mg/L)	Ni (mg/L)	Cd (mg/L)	Co (mg/L)	Cr (mg/L)
L1	6.9	325	0.57	0.04	0.02	0.04	ND	0.03	0.05
L2	6.6	485	0.40	0.03	ND	0.02	ND	0.01	0.02
L3	6.8	424	0.50	0.02	ND	0.01	ND	0.02	0.03
L4	6.0	225	0.50	0.03	0.01	0.02	ND	0.02	0.03
L5	6.8	586	0.70	0.05	0.02	0.03	ND	0.04	0.02

Table 2: Result of physico-chemical properties and heavy metals concentrations in soil samples

Location	Depth (cm)	pH	Conductivity (µS/cm)	Zn (mg/L)	Mn (mg/L)	Pb (mg/L)	Ni (mg/L)	Cd (mg/L)	Co (mg/L)	Cr (mg/L)
L1	5	7.7	490	0.60	0.04	0.07	0.10	0.03	0.04	0.06
L1	30	8.0	445	0.57	0.06	0.07	0.06	0.03	0.05	0.08
L1	55	8.1	405	0.77	0.07	0.08	0.07	0.03	0.03	0.06
L2	5	8.3	309	7.33	0.05	0.04	0.10	0.04	0.06	0.06
L2	30	8.5	404	0.90	0.06	0.06	0.12	0.05	0.05	0.08
L2	55	8.2	641	0.53	0.05	0.07	0.12	0.05	0.04	0.08
L3	5	8.0	504	0.80	0.04	0.06	0.10	0.04	0.05	0.08
L3	30	8.3	309	0.57	0.05	0.05	0.09	0.03	0.03	0.08
L3	55	7.7	404	0.73	0.07	0.06	0.13	0.03	0.07	0.05
L4	5	8.0	506	0.87	0.06	0.08	0.14	0.05	0.07	0.04
L4	30	8.0	691	0.60	0.05	0.05	0.14	0.03	0.06	0.05
L4	55	7.3	305	0.47	0.04	0.08	0.07	0.05	0.05	0.04
L5	5	7.7	691	0.83	0.07	0.04	0.10	0.05	0.07	0.06
L5	30	8.1	504	0.80	0.08	0.06	0.10	0.04	0.04	0.06
L5	55	7.8	405	0.60	0.06	0.05	0.06	0.02	0.03	0.07

L1-Arapaja, L2-Moniya garage, L3-Iyana Apapa, L4-Aleshinloye, L5-Alafara

Table 3: WHO and SON standards for physico-chemical properties and heavy metals concentrations

	pH	Conductivity	Zn (mg/L)	Mn (mg/L)	Pb (mg/L)	Ni (mg/L)	Cd (mg/L)	Co (mg/L)	Cr (mg/L)
WHO	6.5-8.5	1400	3.0	0.05	0.01	0.02	0.003	0.05	0.05
SON	6.5-8.5	1000	3.0	0.05	0.01	0.02	0.003	0.05	0.05

The pH of the water samples indicated that it is slightly acidic and within the WHO/SON permissible limits except for L4 water that is below the permissible limit (Table I). The results correspond to that of Longe and Balogun [11] which reported that the water samples were generally acidic with a mean pH of 6.62 that falls within the permissible WHO standard. Lower pH aids the mobility of heavy metal ions. It was also observed that the pH of soil samples measured at three different depths were within the WHO permissible limits and moderately alkaline (Table II). In basic conditions, sorption of heavy metal ions by soil is high and the pH of soil can regulate the mobility of metals in soils [12]. The conductivities of the water samples range between 225-586µs/cm (Table I), which were within the WHO permissible limit [13-14]. Also, the soil samples conductivities range between 305-691µs/cm, which was below the WHO/SON permissible limit [13, 15] as shown in table II. The presence of these heavy metals' ions in both water and soils samples affects the electrical conductivities. The Pb and Ni concentrations in L1 and L5 samples were found to be higher than the WHO/SON threshold limits. Cd was not detected in all the water samples. Also, Pb was not detected in L2 and L3 samples. The presence of Pb and Ni in ground water is detrimental to human health; it is particularly dangerous metal with no biological role which adversely affects children in many ways [16]. The high Pb concentrations in other water samples can be traced to the various activities around water sources and improper refuse disposal. However, the concentration of Zn, Mn, Co and Cr in all the samples falls within the WHO/SON permissible limits for drinking water with Zn having the lowest concentration.

The Zn concentration (Table II) is lower than the WHO/SON threshold limit except for L2 sample at depth 5 cm with very high concentration. This can be linked to spent batteries deposition, pennies and die casting for cars present in the location as it is closer to a motor park. The observed values for Mn in the soil samples in L1 and L5 were higher as compared to the WHO/SON acceptable limits but the rest were within the limits.Pb concentrations in all the locations and depths exceeded the WHO/SON limit of 0.01mg/L. The increase in Pb concentrations is similar to the results of Adelekan and Abegunde, [17]. The presence of high Pb concentrations may be linked to the burning of fossil fuel, dumping of waste batteries, cosmetics, metal products, Pb-based paints and pipes at the refuse dumpsite that has leached into the soil [18]. Ni and Cd concentrations were above the WHO/SON permissible limits in all the locations and depth.The high level of Cd could be natural as a result of geological features of the area and leachate from agricultural land in the locations where the use of phosphate fertilizer may be common. The increase in Ni concentration in all the samples could be due to discharge of industrial effluent as a result of closeness of industries to these sites. Ni is toxic to man and might reach the food chain through plant uptake from contaminated soil [18-19]. Co concentration in all the sample area is within the WHO/SON acceptable limits. The Cr concentrations in all the soil samples are above the permissible limits of WHO and SON except for L3 and L4 (at 55.0 cm depth) which fall within the acceptable limits. The increased in Cr concentrations could be credited to deposited materials from water erosion of rocks, liquid fuels, and industrial and municipal wastes with high Cr contents [17].

4. CONCLUSION

It can be deduced from the results obtained within the study area that higher concentrations of heavy metals in soils and ground water around the refuse dumpsite could be as a result of improper disposal of refuse, as a result of human activities or by run-off or leaching that took place on the soil at the dumpsites. Drinking of ground water located around the dumpsites by the people poses a health risk. Therefore, it is suggested that there is an immediate need to construct a standard environmental sanitary dumpsite and encourage recycling of refuse around the dumpsites. Also, Ministries of Environment should make policies on groundwater monitoring, treatment and protection issues a great importance

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