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Full Length Research Article

ASSESSMENTS OF HEAVY METAL CONTAMINATION IN SOILS FROM SELECTED SOLID WASTE DUMPSITES OF KAFANCHAN METROPOLIS, KADUNA STATE, NIGERIA

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ABSTRACT
Assessment of heavy metal contamination in soil from selected solid waste dumpsites in Kafanchan metropolis of Kaduna State, Nigeria, were determined and compared with control soil using standard analytical methods. The results, showed that; Heavy metals (Zn, Mn, Cu, Ni, Cd & Pb) mean- concentration (mg/kg) from the solid waste dumpsites were; 1095.4, 843.7, 124.0 32.7, 1.5 & 312.0 respectively. While, the concentrations obtained from the control site for, Zn, Mn, Cu, Ni, Cd & Pb were; 674.8, 941.7, 16.4, 39.4, 0.8 & 119.8 respectively. The trend of the heavy metals pollution status from the solid waste dumpsites, were; Cu > Pb > Cd > Zn > Mn > Ni. ANOVA at P > 0.05 showed that, there was no significant difference in the concentrations of Mn, Cu & Cd, while, the concentrations of Zn, Ni & Pb were significantly different.

Keywords: Assessment, Heavy metal, Contamination, Solid waste, Dumpsites & Metropolis

INTRODUCTION

United State Environmental Protection Agency, USEPA, (2006), defined waste as 'any useless unwanted or discarded materials with insufficient liquid content to be free flowing. Places with accumulated solid wastes are called refuse dumps, but a designed place for dumping of refuse is known as dumpsite. While, the Resource Conservation and Recovery Acts RCRA (2017) state, that, waste is any garbage or refuse sludge from a waste supply treatment plant, water supply, air pollution control facilities, resulting from industries, commercial, mining and agricultural operation or community activities.

In Nigeria just like in the rest of the world, rapid urbanization and population growth have brought about a proportion increase in the amount of solid waste that is generated (Anake et al, 2009). According to Kalausa, (2010), the total solid waste generated in Kaduna state per day is 12,227tons, that, every person in Kaduna state generates 2kg of waste every day. Many cities/ towns in Nigeria including Kafanchan have developed without proper planning and it has led to the pressure of open (informal) dumpsites within the built up areas inhibited by millions of people (Kalausa, 2010).

The manners of which solid wastes are generated and discarded in Kafanchan is very worrisome. Unorganized dumping of solid wastes is predominately in developing countries like Nigeria which result to adverse impacts to the environment. Municipal solid waste in Nigeria contain all sources of unsorted wastes such as commercial refuse, construction and demolition debris, garbage, electronic wastes and so on which are dumped indiscriminately on road and any available open pit in respective of health implication on people(Onwughara, *et al.,* 2011). Sources such as electronic goods, electronic plating wastes and used batteries and so on when dumped with municipal solid wastes, increases the heavy metals in the dumpsites, slow leaching of these heavy metals under acidic condition or environment during degradation process, results to leachates with high metal concentration (Esekku, *et al.*, 2003).

The environmental problems with heavy metals is that, they are unaffected during degradation of organic wastes and have toxic effect on living organism when exceeding certain condition(Esekku, *et al.*, 2003).

When the compost from municipal solid wastes (MSW) are used as manure, or leachate are drown into the surface or ground water, some heavy metals are being subjected to bio accumulated and may cause risk to human health when transferred to the food chain (Sholadoye and Nwoye, 2005). Exposure to heavy metals may cause blood and bone disorder, kidney damage, decrease in mental capacity and neurological damage (Duruibe *et al.,* 2007).

Therefore, monitoring of the concentration of heavy metals in the solid waste dumpsites, can facilitate to recommend suitable remediation measures. Thus, the aim of the study was to assess the level of heavy metals in soil from solid waste dumpsites of Kafanchan metropolis of Kaduna state, Nigeria.

MATERIALS AND METHODS

Sampling Sites

Kafanchan is a city found in southern Kaduna state in north central Nigeria. It is located at 9.58N latitude and 8.29E longitude and situated at 733meters above sea level. It is the 4th biggest city in Kaduna State (World atlas. Com). The three dumpsites, were selected within Kafanchan metropolis.

Sample Collection and Sample Preparation

Soil samples were collected from different parts of the selected dumpsites, with the aid of a stainless steel sampler using the quadrate crate sampling method. Samples were pooled together and homogenized to obtain the composite samples. The control samples were also collected from Government reserved areas away from the dumpsites. The samples were placed into appropriately labeled polyethene bags and taken to the laboratory, air dried grounded and sieved (< 2mm) for preparation and analysis.

Method of determination

For the heavy metals determination, 0.5g of each of the air dried sample were extracted by digestion using standard acid digestion method OMA of AOAC, (1990), 15TH ed. Method, 960:30, The metals concentration were determined using Atomic Absorption Spectrophotometer(AAS) Pg990

Quality Assurance Method

For the validation of the result, certified reference material of International Soil –Analytical Exchange (ISE 865) obtained from Wageningen Evaluating Programs for Analytical Laboratories (WEPAL) Switzerland was analyzed, % recovery study and blank analysis was also carried out.

The results of digestion of metals and precision showed that, the recoveries of metals varies from 84.61%-96.83% and the precisions were less than 10%. The results of the reference soil analysis show that, the concentration for the reference standard were within the certified values. These were verified with the t-test at 95% confidence limit as t- calculated was less than t-tabulated.

RESULTS AND DISCUSSION

Table1: Statistical summary of the heavy metal contents in soil from the dumpsites and control

Heavy	Dumpsite		Control		F-value
Metals	Ranged	Mean ± SD	Range	Mean ± SD	P>0.05
Zn mg/kg	67.70-1636.10	1095.40±1050.00	403.80-1112.80	674.75±306.70	90.71
Mn "	786.20-880.70	843.70±343.60	852.60-1010.80	941.65±51.61	0.85
Cu "	106.60-148.40	124.00±21.80	3.40-37.60	16.40±24.49	2.18
Ni "	1.00-47.40	32.70±15.79	5.44-27.80	39.36±45.35	20.34
Cd "	1.03-1.84	1.42±0.41	0.82-0.82	0.82±00.00	0.72
Pb "	251.40-379.10	312.6±64.01	101.2-126	119.8±2.4	2.36

Key: Zn-Zinc, Mn-Manganese, Cu-Copper, Ni-Nickel, Cd-Cadmium, Pb-Lead.

From table1, the concentration of Zn, Cu, Cd & Pb were higher at the dumpsites as compare with that of the control sites except that of Mn and Ni which were slightly higher at the control site. The increase in the concentration of these heavy metal at the dumpsite could be as a result of the decomposition of the solid waste which release the metals to the surrounding soil (Eaja and Lamiha, 2012).

Analysis of Variance (ANOVA) at 95% confidence limit as indicated with the F-value in table 1, shows that there was significant difference with the concentration of most of heavy metals within the dumpsites. The activities at the solid waste dumps under studied, varies from one dumpsite to another. In some dumpsites, there are industrial activities others is commercial activities while some are residential activities .These implies that, the types of the solid waste dumps in the dumpsites will also be varies. These variance could have been responsible for these differences in the concentration of the parameter in each dumpsite. Other factors that might have been responsible for these variation could be as a result of the location of the dumpsites or the economic status of the people within the dumpsites (Eaja and Lamiha, 2012).

The results of contamination index of most of the heavy metals using contamination factor index model (CF) (EL-Sayed, 2016) as indicates in table 2: range from 0.8 to 7.6, with their contamination status range from low contamination to highly contamination. The trend was; Cu > Pb > Cd >Zn > Mn > Ni. The metal with the highest contamination status was Cu fellow by Pb & Zn and the least is Ni. The higher values of contamination index of Cu Pb and Zn might have been attributed to refuse from the dumpsites which were mainly the alloys, plastic cables, used batteries, demolishing structures, and electric cables and so on. Ukpong, *et al.* (2013); Amadi, *et al.* (2015), also stated that, most of these solid waste dumpsites contain metal scraps, cans plastics, leathers, glasses and so on of which they are either component of copper, lead, Zinc, or other heavy metals. These might have contributed to the high contamination status in the soil of the solid wastes as a result of the decomposition of these solid wastes.

Table 2: Contamination Factors of Heavy Metals from Soil of Solid Waste Dumpsites

Metals	Concentration		Cf	Contamination Status
	Dumpsite	Control		
Zn	1095	675	1.6	Moderately contaminated
Mn	844	942	0.9	Low contamination
Cu	124	16	7.6	Highly contaminated
Ni	33	39	0.8	Low contamination
Cd	1.42	0.82	1.7	Moderately contaminated
Pb	313	120	2.6	Moderately contaminated

Key: Cf =Contamination Factor

The trend in contamination status of this study was in contrast with the trend, observed (Cd > Cr > Pb > Mn > Ni) by Getachew and Degefa, (2015). These variance might have been as a result of the different types of solid wastes found in dumpsites. Also, the differences in the location, age of the dumpsites and activities of the peoples within the dumpsites, affect the physicochemical content of the soil within the dumpsite (Essien and Hanson, 2013).

Conclusion

The solid waste increase the concentration of the heavy metals in the soil within the dumpsites. The concentration varies within the dumpsites which was suggested to be as a result of the heterogeneous nature of the solid wastes. The trace and heavy metals concentration was high and might leach out to contaminate both the surface and ground water. Also the use of these dumpsites as farmland could lead to transfer of the heavy metals to ecosystem that might be detrimental to human health.

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