

HORIZONTAL MOBILITY OF HEAVY METALS (Cd, Cr, Pb, and Ni) IN ONITSHA –OWERRI ROAD SEWAGE SLUDGE DUMPSITE, OWERRI IMO STATE

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ABSTRACT

This research was conducted to evaluate the mobility of Heavy metals Cadmium (Cd), Chromium (Cr), Nickel (Ni) and Lead (Pb) in a sewage sludge dumpsite situated at Owerri-Onitsha express road Owerri, Imo State Nigeria. With Dutch Auger, soil samples were randomly collected from the depth of 0-30cm from distances of 0ft, 2ft, 4ft, 6ft and 8ft away from dump site. The Heavy Metals mean value concentrations at different distances were: Cadmium 0ft= 1.19 mg/Kg⁻¹, 2ft=1.03 mg/Kg⁻¹, 4ft=0.80 mg/Kg⁻¹, 6ft=0.73 mg/Kg⁻¹, 8ft=0.81 mg/Kg⁻¹ and 0.74 mg/Kg⁻¹ for Control respectively. For lead, at 0ft=2.19 mg/Kg⁻¹, 2ft=1.31 mg/Kg⁻¹, 4ft=1.34 mg/Kg⁻¹, 6ft=1.32 mg/Kg⁻¹, 8ft=1.39 mg/Kg⁻¹ and 1.31 mg/Kg⁻¹ for control respectively. For Chromium: At 0ft=1.21 mg/Kg⁻¹, 2ft= 1.09mg/Kg⁻¹, 4ft=1.09 mg/Kg⁻¹, 6ft=1.08 mg/Kg⁻¹, 8ft=1.09 mg/Kg⁻¹ and 1.08 for control respectively. For Nickel: 0ft=21.9 mg/Kg⁻¹, 2ft=21.5mg/Kg⁻¹, 4ft=21.2mg/Kg⁻¹, 6ft=21.7 mg/Kg⁻¹, 8ft =21.3 mg/Kg⁻¹ and 21.4 mg/Kg⁻¹ control respectively. The mobility, though did not increase with increase in distance but were significantly different when compared with control. However, the concentration and mobility were not above the critical range in dumpsite at which toxicity may occur. The critical range is 3.0 -8.0 mg/Kg⁻¹ for Cadmium; Nickel 100-120 mg/Kg⁻¹; Lead 100 – 400 mg/Kg⁻¹; and 75.0 – 100 mg/Kg⁻¹ for Chromium. Results were discussed in line with concentrations and permissible limits.

Keywords: contamination, dumpsites, heavy metals, mobility, toxicity

INTRODUCTION

Land application of sewage sludge and other wastes has resulted to contamination of the environment through their effects on soil, ground water and plants. Sewage is the by-product(s) of domestic and, or municipal waste-water while sewage sludge is the solid of the by-product (Brandy and Weil, 1999). As reported by Harrison (1999), many trace organic elements can be found in these organic wastes. Heavy metals are examples of these trace elements, and are metals that have high specific gravity or densities of 5.0 mg/m or greater. They include Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Pb and Zn. Stehouwer (1998) further indicated that some of these compounds are toxic, carcinogenic and can cause reproductive or developmental defects in mammals.

Presently, problems resulting from industrial activities has become a global environmental and public health problem According to Yaashikaa *et al.* (2022), these activities have resulted into plant growth abnormalities, cancer induction and human multiple organ dysfunction (Guadie *et al.*, 2021). Industrial activities related to the petroleum industry has resulted to higher concentrations of several heavy metals (Miao *et al.*, 2020). Du et al., (2020) have shown that only small percentage of heavy metal in environmental media has migratory activity or can be absorbed and utilized by living organisms, which is known as heavy metal bioavailability.

In Imo State Owerri -Onitsha road is one of the areas where many industries are situated. Being an industrial area, arable crop lands within this axis are exposed to heavy metals which find their ways into humans (McGrath, 1998). Lack of effective waste management of these organic wastes originating from industrial activities affects the environment adversely (Lee and Samulis, 1999). This research was conducted to determine the presence of Lead (Pb), Chromium (Cr), Cadmium (Cd) and Nickel (Ni) in the sewage sludge dump sites in Onitsha-Owerri Road, Owerri

Imo State. The study seeks to address the heavy metals (Pb, Cr, Cd and Ni) mobility from dumpsites in comparison with adjacent soils.

MATERIALS AND METHOD

The study was carried out at major sewage sludge dumpsite in Owerri – Onitsha Road, Owerri Imo State Nigeria. Owerri is located geographically at latitude 5° 6'N and longitude 6° 7'E. It falls within the tropical rainforest zone of Nigeria. The region has a tropical climate with high humidity and bimodal rainfall peaking in April–July and September–November, exceeding 2,500 mm annually. Temperatures range between 25°C and 32°C, creating favorable conditions for agriculture and vegetation growth.

Study areas

Soil samples were collected from two location namely site currently under sewage dumpsite and the control site where there is no presence of sewage wastes.

Site1. Site currently under sewage sludge dumping:

This site consists of area currently under continuous dumping since three (3) years. The site was covered by a degraded secondary low-land rainforest and some voluntary trees and vegetables (Carica papaya, tomatoes, spinach, water-leaf etc).

Site 2. Control site: This was a non-dumped site with secondary re-growth forest. The control site was chosen at a distance of about 200feet away from the dump. This site was carefully examined during the survey visit to ensure that the areas have never been used as dumpsite before.

Sample collection

With the aid of Dutch auger, three (3) replicates of composite soil samples of the top-soil (0 – 30 cm) were randomly collected since previous work by Nyanagababo and Hamya (1986) showed that surface soils are better indicator for metallic burdens. In the site under dumping, fifteen (15) spots were randomly sampled (Sabbe and Marx, 1987) and distributed into three (3) replicates each. For control site, fifteen (15) samples were also randomly collected, bulked for three (3) composite replicates. This site was carefully examined not to have been dumped before.

Sampling for mobility

Samples were collected from a depth of 0-30cm from distances of zero feet (0ft -active dumpsite) and 2ft (2feet), 4ft (4feet), 6ft (6feet) and 8ft (8feet) away from the tip of the dump for composite soil samples.

Sample preparation and laboratory analysis

Soil samples were spread on clean and dry paper sheet for air drying. After air drying, the samples were crushed in clean ceramic mortar using a small ceramic piston. These samples were passed through 2-mm sieve for fine soil fraction (Nelson and Sommers, 1982). The fine soil fraction was used to extract heavy metals using the DTPA method. A 10 g of soil sample was mixed with 20 ml DTPA (0.05 M – adjusted to pH 7.3 with TEA), then shaken on a reciprocation shaker for 30 – 45 minutes before filtering through Whatman No 1 filter.

The concentrations of (Cd, Pb, Cr, Ni) were determined using Atomic Absorption Spectrophotometer (AAS), Perkin Elmer model 306. Soil pH was determined in distilled (deionised) water (1:2.5 soil-water ratio) using glass electrode

pH meter (Dewer model). Organic carbon was determined by the Walkley-Black wet oxidation method (Heanes, 1984).

Data analysis

Data were summed by simple statistical method, and mean values produced. These means were compared with control and established permissible (critical) limits.

RESULTS AND DISCUSSIONS

Table 1 showed the results of the concentrations of selected heavy metals and the Ph, organic matter and texture of the studied locations. The result showed presence of all studied heavy metals in the dumpsite. Within columns, the highest levels occurred in 0ft, though insignificant different between distances except when compared with control. Mobility of the heavy metals did not significantly increase with distance, and was also without a defined pattern of mobility. This was supported by Miller and Mcfee (1983), which showed vertical and horizontal movement of the metals in the sewage sludge deposited environment but without specific pattern of mobility. This was further supported by the work of Mulchi et al. (1987) which showed low mobility of heavy metals at low concentrations. Brookes *et al.* (1986). revealed that not all sewage sludges contains high concentrations of heavy metals. However, toxicity to both plants and mammals have occurred upon repeated application and mobility to adjoining areas (Krogmann and Boyles, 1999).

Table 1. Soil parameters, heavy metals concentrations and Mobility as affected by sewage sludge deposit

Parameters	Heavy Metals				Txt	pH (H ₂ O)	Organic Matter (%)
mg/Kg ⁻¹						
	Cd	Pb	Cr	Ni			
0ft	1.19	2.19	1.21	21.9	CL	5.67	3.98
2ft	1.03	1.31	1.09	21.5	CL	5.53	3.65
4ft	0.80	1.34	1.09	21.2	CL	5.52	3.74
6ft	0.73	1.32	1.08	21.7	CL	5.66	3.53
8ft	0.81	1.39	1.09	21.3	CL	5.63	3.71
Control	0.74	1.31	1.08	21.4	CL	5.71	3.75

Ft = feet, Txt = texture, Cd =Cadmium, Pb = Lead, Cr =Chromium and Ni=Nickel

Soil pH of the site was moderately acidic with highest acidity occurring in 2ft away from dumpsite. These levels were not significantly different when compared between distances and with control. The organic matter levels were all high and insignificantly different when compared between distances and control. The low mobility of the metals agrees with Bragato and Nobili-de (1998). that observed an increased availability and biotoxicity of metals occurrences in Volume 20(1): 3029-3033 2017

soils with less clay content, low pH and low organic matter content. And for all ecological considerations, the pH concentration and kind of heavy metal (species) in the soil, soil solution is of primary importance because metal mobility and availability are closely related to the composition of the liquid phase; thus, microbe(s) existence in the soil also depends on it (Holmgren *et al.*, 1993).

CONCLUSION AND RECOMMENDATIONS

Dumping of Sewage Sludge insignificantly increased the concentrations of the heavy metals, and their mobility were insignificantly low. The mobility did not increase with increase in distance away from dumpsite. Additionally, the mobility is not above permissible limit at which toxicity may occur. For Cadmium, the critical range is 3.0 -8.0 mg/Kg⁻¹; Nickel 100-120 mg/Kg⁻¹; Lead 100 – 400 mg/Kg⁻¹; and 75.0 – 100 mg/Kg⁻¹ for Chromium. The concentrations for all the heavy metals studied were within acceptable limits.

Behaviors of heavy metals in soils depends not only on the level of contamination as expressed by the total content, but also on the form and origin of the metal and the properties of the soils themselves. Soil pH, texture and organic matter content may be particularly important with respect to the form of the trace metal and its bioavailability. The heavy metals mobility of the studied dumpsite is low and insignificant. Where reduced heavy metals levels are required especially is highly acidic soil, treated sewage sludge can be land applied because it has heavy metal ranges of 1.26 -6.37 mg/Kg⁻¹ for Cadmium, 2.31-8.26 mg/Kg⁻¹ for Lead, 1.31-4.68 mg/Kg⁻¹ for Chromium and 18.5-38.94 mg/Kg⁻¹ for Nickel.

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