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Metals composition of leachate in the vicinity of solid waste dumpsites of Maiduguri metropolis, Borno state, Nigeria

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Abstract
Assessment of Leachate was carried out at five dumpsites within Maiduguri Metropolis, Nigeria. These include; Bulunkutu (BLKT), Railway (RLWY), State Low-cost (STLC), Infectious Disease Hospital (IDH) and Nigerian National Petroleum Corporation (NNPC) depot. The Leachate samples were collected at each site and analysed for metals using AAS Perkin Elmer 1000 Model. The metals assessed are Cadmium (Cd), Chromium (Cr), Lead (Pb) and Copper (Cu). The results of analyses showed that the leachate from the five dumpsites have the following ranges of mean concentrations 0.08 – 0.22 mg/cm^3 Cd, 0.01 – 0.13 mg/cm^3 Cr, 1.87- 2.84 mg/cm^3 Pb and 1.99 – 1.99 mg/cm^3 Cu. These metals are present in the leachate in low amount. Their presence however suggested that solid wastes dumpsites contribute to metals contamination of the environment.

Keywords: Maiduguri, bulunkutu, AAS perkin elmer 1000 model, contamination and leachate

Introduction

The final disposition of solid wastes is a practice that still brings serious impacts to the environment generating pollution by-products such as leachate, a dark-coloured, strong-smelling highly toxic solution. Leachate originates from the decomposition of organic matter, the intensity of pluvial waters and other liquids derived from wastes (Bertazzoli and Pelegrini, 2002). The toxicity and impact provoked for the leachate on microflora and microfauna is very strong and they are influenced by various factors such as organic matter, heavy metals and nitrogen concentrations as well as mass flux of contaminations being transported, (Isidori *et al*., 2003) [12].

Studies have shown that leachate at refuse dumpsites contain different kinds and concentrations of heavy metals, depending on the age, contents and location (Odukoya *et al*., 2009) [14]. In recent times, it has been reported that metals from waste dumpsites can be accumulated and persist in leachate at an environmentally hazardous level (Amusan *et al*., 2005) [5]. In Nigeria, leachate from refuse dumpsites constitutes a source of metals pollution to aquatic environment (Ande *et al*., 2009) [6]. Identifying compounds that cause the toxicity in the leachate is not easy because the physicochemical characteristics of leachate is highly variable and dependant on the following factors; local environmental conditions, time elapsed after wastes disposal and landfill characteristics as well (Bertazzoli, Pelegrini 2002).

Leachate from dumpsites varies widely in composition depending on the age of the landfill and the types of wastes that it contains (Henry *et al* 1996) [11]. Additional leachate volume is produced during the decomposition of carbonaceous materials, producing a range of other materials including methane, carbon dioxide and a complex mixture of organic acids, aldehydes alcohols and simple sugars. Pollution of ground water by leachate from dumpsites has been organized (Hem *et al*., 1989) [10].

The practice of dumpsites system as method of wastes disposal in many countries is usually far from standard recommendations (Adewale 2009) [1] standardized dumpsites system involves carefully selected locations and is usually constructed and maintained by means of engineering techniques, ensuring minimized pollution of air, water, soil and risk to man and animals. Dumpsites practice involves placing wastes in one area with the aim of controlling pollution (Alloway and Ayres, 1997) [3]. Dumpsites in developing countries context is usually an unlined shallow hollow (often) not deeper than (50cm) (Zurbrugg *et al*, 2003) [19] referred to it as “dumps” receives solid wastes in a more or less uncontrolled manner, making uneconomical use of the available space which allows free access to waste pickers, animals and flies and often produce unpleasant and hazardous smoke from slow-burning fire.

Hence leachate of diverse composition are produced, depending on sites construction and operational practice, age of the dumpsites, climatic and hydrological conditions and surface water ingress into the dumpsites (Cambell, 1993).

Leachate therefore migrates vertically and laterally into the environment by direct discharge into streams and bodies of water around the dumpsites. The realization of the polluting effect of dumpsites leachate on the environment has prompted a number of studies. These include studies on domestic wastes (Sridhar *et al*, 1985) and Leachate quality (Aluko *et al*, 2000) [4]. At the study, leachate is discharged into the environmental media without treatment. This has resulted in low farm produce, release of obnoxious gases into the environment, contamination of the domestic water sources (Tairu, 1998) [16].

Materials and Method

Study Areas and Site Location

The study was conducted on five dumpsites in Maiduguri metropolis *viz*:- Bulunkutu (BLKT), Railway (RALWY), State Lowcost (STLC), Infectious Disease Hospital (IDH) and Nigerian National Petroleum Corporation (NNPC) respectively.

Sample Collection

Leachate samples were collected from vicinities of the municipal solid waste (MSW) dumpsites by digging a hole about 0- 30 cm deep, water was poured on the solid wastes and allowed to drain into the hole. The leachate was collected and filtered through a 250 mm Whatman filter paper and then stored in plastic bottles. These samples were collected between November 2019 and January 2020. The leachate analyses were done in accordance with standard procedure and guidelines by WHO (1996) for heavy metals.

Experimental Procedures

Analyst Perkin Elmer 1000 model AAS was used to carry out the metals analysis of the pre – treated leachate samples. Standards were prepared for metals under consideration, the machine was calibrated and calibration curves plotted automatically. Concentrations of the different metals were read from the computer screen and tabulated.

Results and Discussion

Table 1: Metals Composition of Leachate at Municipal Dumpsites in (mg/cm^3)

Sites	Cu	Cd	Cr	Pb
BLKT	1.99±0.00	0.24±0.01	0.08±0.01	2.72±0.02
RAWY	1.41±0.01	0.10±0.01	0.02±0.00	1.93±0.01
STLC	1.44±0.03	0.11±0.01	0.11±0.00	1.87±0.01
IDH	1.28±0.02	0.07±0.00	0.10±0.01	1.95±0.04
NNPC	1.22±0.01	0.13±0.03	0.13±0.00	2.84±0.10

BLKT →Bulunkutu, RLWY →Railway Area, STLC →State Low – Cost,
IDH→ Infection Disease Hospital, NNPC →NNPC Depot.

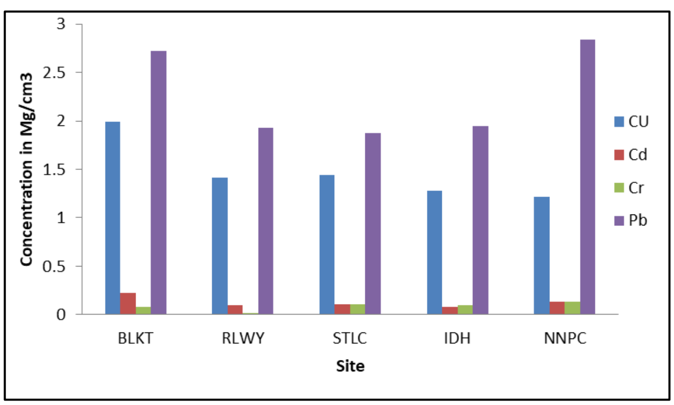

Fig 1: Showing Concentrations of Metals Composition of Leachate at Municipal Dumpsites in (mg/cm^3)

Discussion

Cadmium is a toxic metal having functions neither in human body nor in animals or plants. It is present in fossil fuel such as coal and oil. This present study indicates the mean concentrations range of 0.08 – 0.22 mg/cm3 for cadmium in the dumpsites leachates. These range of concentrations were within the range ascertained by Oviasogie *et al*., 2010 (0.14 – 0.90 mg/dm^3). Furthermore these concentrations were also within the permissible limit of 1.00 mg/dm3 by FEPA, (1991) and WHO, (1997). The concentration level of contaminants in these dumpsites accounts for the low concentrations of these metals in the leachate.

Chromium is a toxic heavy metal. It occurs naturally in leachate at a normal range of 5 – 15000 mg/cm3. In this study the mean concentrations of chromium in the dumpsites leachate were found to range from 0.02 – 0.13 mg/cm^3. These concentrations were lower than those reported by (Ande *et al*., 2010) i.e13.00 – 24.20 mg/dm^3 and by (Oviasogie *et al*., 2009) as 3.50 – 9.00 mg/dm^3. The permissible limit of Chromium in dumpsite leachate is 1.00 mg/dm^3 as reported by FEPA, 1991 and WHO, 1997.

Increase lead concentration in leachate is usually attributed to industrial activities (Eddy *et al*., 2006) [8]. Lead is mostly found in automobile battery in sufficient amount. The results of this study showed mean lead concentrations of leachate at the dumpsites as 1.87 – 2.84 mg/cm^3. These concentrations were below the permissible lead concentrations of 15 – 25 mg/dm^3 as reported by (Eddy *et al*., 2006) [8] and below the concentrations reported by (Agyarko *et al*., 2010) as 8.59 – 9.20 mg/cm^3. The concentrations of lead obtained in this study indicate that the leachate at these dumpsites exceed the permissible limit of 1.00 mg/dm^3 by FEPA, 1991 and WHO, 1997. This is due to anthropogenic and auto mobile activities at the sites.

Copper is an essential micronutrient required by plants for their healthy growth. The normal range of copper falls within 7- 8.0 mg/dm^3 (Eddy *et al*., 2006) [8], the concentrations of copper for the dumpsites studied for leachate ranged from 1.22 – 1.99 mg/cm^3. These concentrations were lower than those reported by David *et al*, 2009 (16.41-76.18 mg/dm^3). The lower concentrations of copper obtain in this study as compared with those of literatures suggested that the leachate at the dumpsites is not polluted.

Conclusion

We may conclude that analyses of the dumpsites leachates samples showed low concentrations of Cd (0.08 – 0.22 mg/cm^3), Cr (0.02 – 0.13 mg/cm^3), Pb (1.87 – 2.84 mg/cm^3), and Cu (1.22 – 1.99 mg/cm^3). The dumpsites may not be classified as contaminated since these metals concentrations were within FEPA 1991 (1.0 mg/dm^3) and WHO1997 ((2.0 mg/dm^3)) permissible limits respectively.

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