Leachate Characteristics and Pollution Index Assessment of an Active Dumpsite in Ibadan, Southwestern Nigeria

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ABSTRACT

The study assessed the characteristics of the leachates from an active dumpsite as well as the extent of the leachate contamination using leachate pollution index (LPI). Monthly samples collected from three different leachate locations were subjected to physical and chemical tests using standard methods. Mean values of the determined parameters of the leachates from the three locations were significantly different ($p<0.05$).

High pH, low chloride, BOD, COD and BOD/COD ratio values of the leachate samples suggest the age of the dumpsite, stability, and methanogenic phase. Significant and linear relationship that exists between the leachates characteristics and month of collection of samples indicated the influence of precipitation on the waste decomposition. The LPI (7.33) value of the dumpsite is lower when compared with previous studies. Results of study has thus shown that the dumpsite can pose a significant threat to the environment through percolation of contaminants from leachates into the soil, which in turn can infiltrate into the groundwater. Thus, remedial actions such as rehabilitation of the dumpsite are needed to reduce and control the environmental hazards.

(Keywords: leachates, active dumpsite, Leachates Pollution Index, LPI, remediation, environmental hazards)

INTRODUCTION

Solid waste, heterogeneous in nature, consists of biodegradable waste such as cellulose, starch, lignin, proteins, lipids and diverse chemicals such as detergents, metals, organic and inorganic chemicals that are toxic and dangerous to the environment (Engle et al., 1993; Akintola, 2014). Under favorable conditions such as temperature, moisture, presence or absence of oxygen, dumpsite/landfill accommodates numerous numbers of microorganisms which can perform myriad reactions resulting to chemical and biological decomposition and degeneration of solid wastes (Engle et al., 1993; Akintola, 2014).

This decomposition eventually releases more toxic elements or compounds that are absent in a free or reactive form in the waste, degraded into organic chemicals as well as forming a liquid-rich organic constituents that can dissolve many heavy metals such as Pb, Cu, Zn, Mn, Cr, As, Hg, Cd and Ni among others into the environment (Alimba et al., 2006; Abu- Daabes et al., 2013; Akintola, 2014; Talalaj and Biedka, 2016; Boateng et al., 2019). This liquid–rich organic constituent is one of the most dangerous chemical and biological substances generated from municipal solid waste dumpsite especially from an un engineered landfill and can be a momentum risk to the environment as it may infiltrate into the soil and percolate into the groundwater as well as surface water through surface run off from rain (Bhalla et al., 2012; Ashraf et al., 2013; Naveen and Malik, 2017).

The characteristics of leachate, organic liquid-rich constituents formed as a result of diverse chemical and biological reactions within the waste dumpsite depends on the mixture and composition of waste, climatic and geographical location of the sites, particle size of the soils, degree of compaction, hydrology of the site, moisture content as well as state of the decomposition of wastes and the age of the dumpsite or landfill (Kjeldsen et al., 2002; Jones et al., 2006; Manimekalai and Vijayalakshmi, 2012; Arunbabu et al., 2017, Hussein et al., 2019). Leachate from an un-engineered landfill like the study area is of great concern because the processes such as landfill monitoring, leachate treatment and collection are not put into the consideration due to their complexity and costly nature (Tyrel et al., 2002; Arunbabu et al., 2017). Thus, there is need for assessment of leachate to ascertain its contamination potential using Leachate Pollution Index (LPI) as proposed by Kumar and Alappat (2005).

The LPI which is formulated as an environmental index using the Rand Corporation Delphi Technique acts as a quantitative means of calculating overall contamination potential of leachate as well as an information tool for decision making for a remediation process (Kurmar and Alappat, 2005; Lake et al., 2010, Tamru and Chakma, 2015; Lothe and Sinha, 2017). The study assessed the characteristics of the leachates from an active dumpsite and as well the extent of the leachate contamination using leachate pollution index (LPI).

MATERIALS AND METHODS

Study Area Description

Ajakanga dumpsite, established in 1998 is one of a major open waste disposal site belonging to Oyo state waste management authority. It is located between 7˚18´41.32˝ N (latitude) and 3˚50´29.34˝ E (Longitude) within Oluyole local government, Ibadan south-western Nigeria (Figure 1). Increase in population and rapid urbanization has opened the dumpsite to build up areas (Ewemoje et al., 2017). The study area is characterized by tropical rain forest with thick undergrowth and is drained by River Ona with dendritic drainage pattern (Akintola et al., 2020).

The topography of the area is undulating, and the dumpsite is on high elevation. Tones of wastes which includes industrial, medical, agricultural, and domestic generated and collected from different locations around Ibadan city are deposited and strewn on daily basis all over the dumpsite. Three leachate points were located within the dumpsite. Geologically, the study area is underlain by biotite- hornblende gneiss, quartzite and migmatite gneiss (Figure 2). The rocks are mainly lying low and highly foliated (Ogunseiju et al., 2015). Isolated quartizite ridges and inselbergs of gneisses were found in some locations.

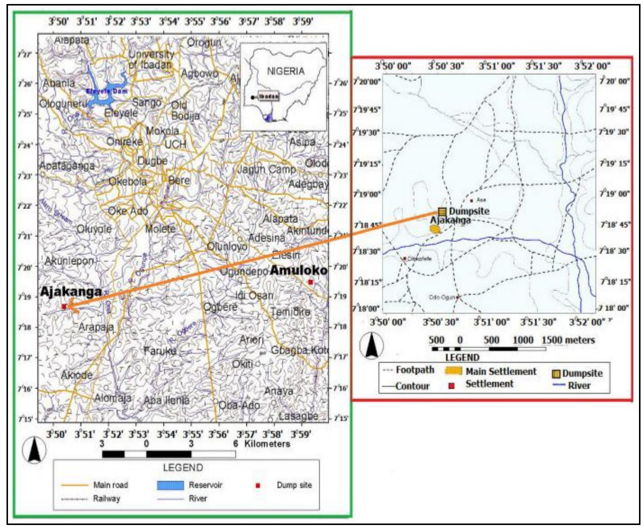

Figure 1: Location Map of the Study Area (Ewemoje et al., 2017).

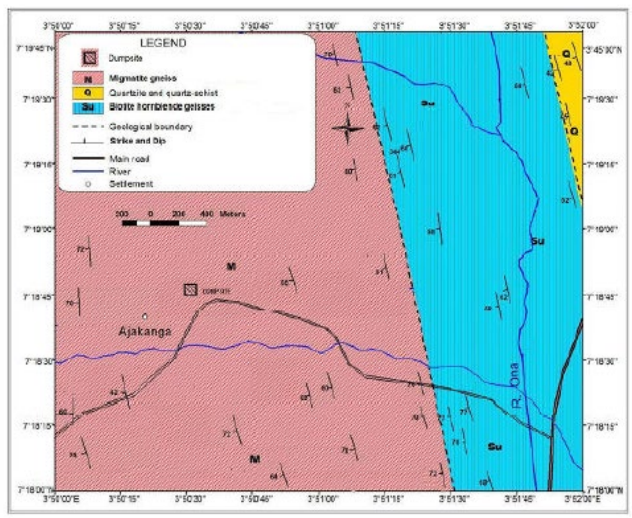

Figure 2: Geological Map of the Study Area. (Ogunseiju et al., 2015).

Sampling Collection and Preservation

Monthly samples were collected from the three different leachate points located within the dumpsite. The collection of samples was done from the month of March to October (8 months) to cover up for the peak of drying and rainy seasons. This was done to know if there will be any variation in the characteristics of the leachate within the periods of collection. All samples were collected by rinsing the bottles with de-ionized water and the leachate samples before finally filled with the samples. Leachate samples were collected into two different 250ml and 1-liter bottles from three different sampling points each for a period of 8 months. The samples in 250ml (for heavy metal analysis) were acidified with two drops of nitric acid for stabilization and to prevent the hydrolysis and precipitation of heavy metals while the other 1-liter bottles were left un-acidified.

The samples were put in cool chest box to reduce biological and chemical reaction; and transported to the laboratory for analysis. The parameters such as pH, total dissolved solids (TDS) and electrical conductivity (EC) were measured in-situ using a DIGITAL SATO SK-632 pH/ Temperature and Conductivity meter MODEL CM-1K. The collection, preservation and measurements of samples were done in accordance with Standard Methods for Examination of Water and Wastewater (APHA. 2005).

Analytical Procedure

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) test were analyzed over a five-day period using the respective methods of 5210B and 5220C. Leachates samples were digested using microwave digestion with nitric acid for easy quantification and dissolution of heavy metals [24]. Heavy metals (Fe, Cu. Zn, Pb, As, Hg, Cr and Ni) were analyzed using an Atomic Absorption Spectrophotometer (AAS, Perkin-Elmer Instruments USA) and in accordance with American Public Health Association (APHA. 2005). Titration method was used for the determination of Cl^-, SO_4^{2-} and NO_3^- in the leachate samples.

Statistical Analysis

The statistical analyses were done using SPSS for window version 20. The analyses of leachate samples were done in triplicates and data were done using one-way analysis of variance (ANOVA), the difference between the mean were compared using Duncan's multiple range and the mean values were represented graphically. Regression analysis was used to reveal the linear relationship between the leachate characteristics (y) and the months of sample collection (x) and Pearson's correlation coefficient was determined to reveal relationship among the determined parameters.

Calculation of Leachate Pollution Index (LPI)

The parameters used for assessing the LPI in this study were pH, TDS, BOD, COD, Cl^-, Fe, Cu, Zn, Pb, As, Hg, Cr and Ni. The LPI was calculated according to the equation given by Kumar and Alappat (2005) and out of 18 parameters used by Kumar and Alappat (2005) for the calculation, only 5 parameters (phenolic compounds, cyanide, total coliform bacteria, TKN and ammonia nitrogen were not analyzed in this study. The LPI was calculated according to Kumar and Alappat (2005) as follows:

Leachate pollution index when all the 18 parameters were determined:

$$LPI = \sum_{i=1}^{n} \text{wipi} \qquad \text{Equation 1}$$

Where n is the number of leachate pollutant parameters, wi is the weight for the ith pollutant variable and pi is the sub-index values of the ith leachate pollutant variable as stated by Kumar and Alappat (2005). The Equation 1 is used when all the 18 selected variables according to Kumar and Alappat (2005) are known.

However, in this study, since not all the eighteen pollutant variables were determined, the equation 2 was used.

$$LPI = \frac{\sum_{i=1}^{m} \text{wipi}}{\sum_{i=1}^{m} \text{wi}} \qquad \text{Equation 2}$$

Where m is less than 18 and ∑wi is less than 1

RESULTS AND DISCUSSION

Leachate characteristics

The characteristics of the leachate samples collected monthly from the three location points were presented in Figure 3a-p, the mean values of the monthly determined parameters from the three leachates locations were presented in Table 1 and a comparison between this study and those obtained from other landfill sites were presented in Table 2.

Physiochemical Parameters

The physiochemical parameters considered in this study were pH, electrical conductivity (EC) and total dissolved solids (TDS). The mean values of the leachate samples collected monthly from the three location points differ significantly from each other at $p < 0.05$ (Figure 3a). It was observed that the mean pH values of the leachate increase with the month of sampling collection. The mean values of pH for location 1 (7.47), location 2 (6.98) and location 3 (6.63) were significantly different and alkaline in nature (Table 1).

The pH value of leachates samples in this study (Table 2) is higher than the value obtained by Asibor and Edjere (2016) and within those values obtained by Kumar and Alappat (2005) and Naveen and Malik, 2017). Leachate pH is usually ranged from 4.5 to 9.0 (Christensen et al., 2001). The pH of leachate increases steadily with time from acidic nature at the initial deposition of wastes to the alkaline nature as the landfills become mature, stable and older (Kumar and Alappat, 2005; Abass et al 2009; Singh et al., 2017). The change from acidic to alkaline nature of leachates is due to the conversion of high concentration of volatile fatty acids at the initial generation of leachates to methane and carbondioxide during methanogenic phase as the age of the landfill increases (Singh et al., 2017). Thus, the alkaline nature of the leachates is due to the age of the dumpsite (22 years as at the date of data collection).

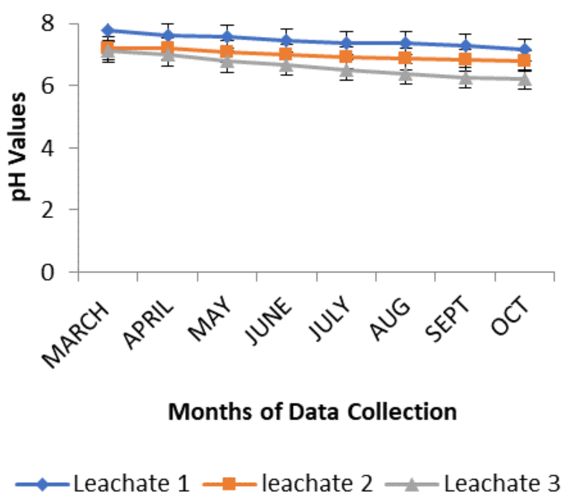

Figure 3a: Monthly Mean pH Values of Leachate Samples.

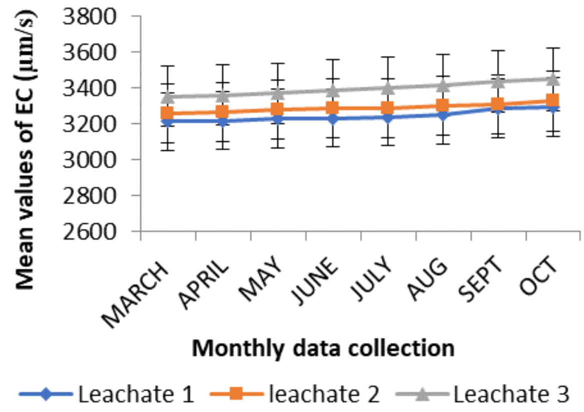

Figure 3b: Monthly Mean EC Values of Leachate Samples.

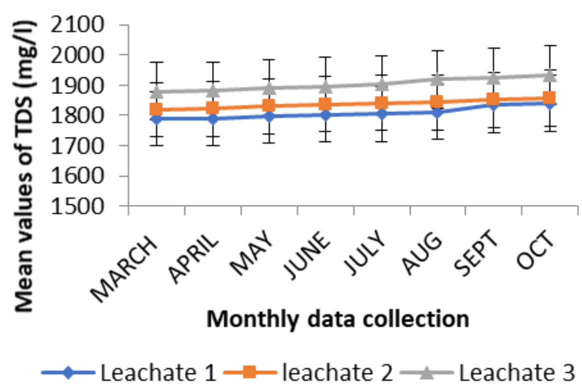

Figure 3c: Monthly Mean TDS Values of Leachate Samples.

Electrical conductivity is an indication of presence of dissolved solids and other chemical elements especially electrolytes (Akintola, 2014). The mean monthly values of both EC and TDS from the three location points were significantly different (Figure 3 b and c). The higher mean values of EC (3397.47 µm/s) were recorded in location 3 with corresponding high value of TDS (1904.33mg/l) while the lowest mean values of EC (3245.62 µm/s) and TDS (1808.61 mg/l) were recorded in location 3 (Table 2). The significant difference obtained in the mean values of EC and TDS of the leachate samples from the three locations is attributed to the topographic nature of the dumpsite as the location 1 is on higher elevation, followed by 2 and 3. The EC and TDS values of the leachate samples studied were lower than those from landfill of previous studies (Kumar and Alappat, 2005; Kale et al., 2010;

Naveen and Malik, 2017; Hussein et al., 2019). The lower EC values recorded in studied leachate may be corresponded to the methanogenic phase of waste decomposition since in the acetogenic phase (early deposition of leachate), the leachate is more concentrated and characterized by a high EC (Kmet and McGinley, 1982; Andreottola and Cannes, 1992).

Organic Materials

The organic materials such as biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were determined in this study to assess the potency of the leachate from the decomposition of wastes from the dumpsite. BOD is used to measure the quantity of organic contaminants in water/ wastewater exhausted by microorganisms while COD measures the oxygen needed by organic waste to utterly change into in inorganic compounds, contaminants, and lethal chemicals (Hussein et al., 2019; Enitan et al., 2018). Significant difference was observed in the mean monthly values of BOD and COD of the leachates from the three locations in the dumpsite (Figures 3d and e). The mean values of the leachates (Table 2) from the three locations significantly different from each other with location 3 having the highest BOD (129.70 mg/l) with corresponding high COD (335.12mg/l) while location 1 which is on high elevation has the lowest values of BOD (96.60 mg/l) and COD (203.01mg/l).

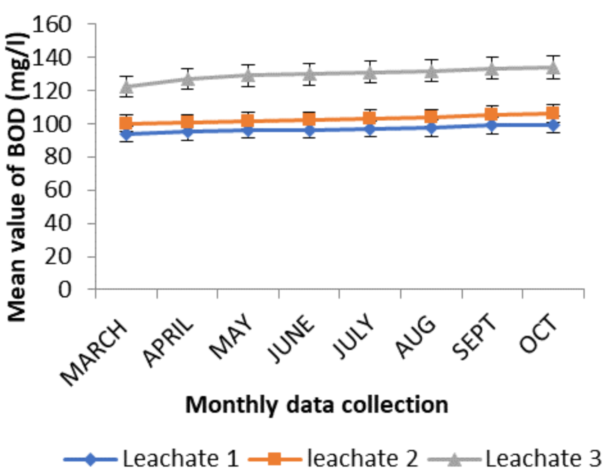

Figure 3D: Monthly Mean BOD Values of Leachate Samples.

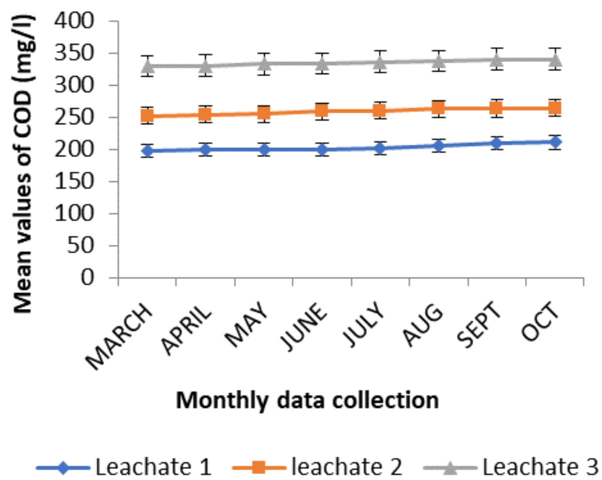

Figure 3e: Monthly Mean COD Values of Leachate Samples.

The ratio of BOD and COD which is the proportions of biodegradable organic constituents (Kumar and Alappat, 2005) was calculated and the mean value (0.38) was shown in Table 2. Leachate is characterized by high BOD and COD as well as high BOD/COD in acetogenic phase (rich in higher degradable organic compounds) at early age of the dumpsite as well as deposition of leachate and become reasonably lower in methanogenic phase as the age of the dumpsite increases (Christensen et al., 2001; Tatsi and Zoboulis, 2002; Foo and Hameed, 2009). The concentrations of BOD and COD of leachates samples in this study (Table 2) is lower than the value obtained by (Asibor and Edjere, 2016) and lower than those values obtained by (Kumar and Alappat, 2005; Naveen and Malik, 2017). Thus, the lower in the studied leachate are primarily due the increase in the age of the dumpsite.

Anion Concentrations

The mean monthly concentrations of Cl^- , NO_3^- and SO_4^{2-} of the leachate showed a significant different from each other (Figure 3f to 3h). It was observed that the mean values of the anion concentrations at the three locations differ significantly from each other (Table 1). The mean concentrations of the Cl^- , NO_3^- and SO_4^{2-} in the study area were 54.74, 15.26 and 5.95 respectively (Table 2). The concentration of Cl^- in the studied leachate was lower than other landfill studies (Kumar and Alappat, 2005).

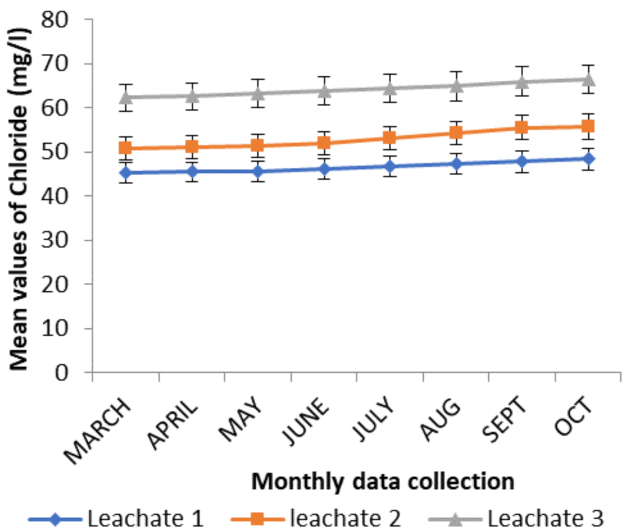

Figure 3f: Monthly Mean Cl^- Concentrations of Leachate Samples.

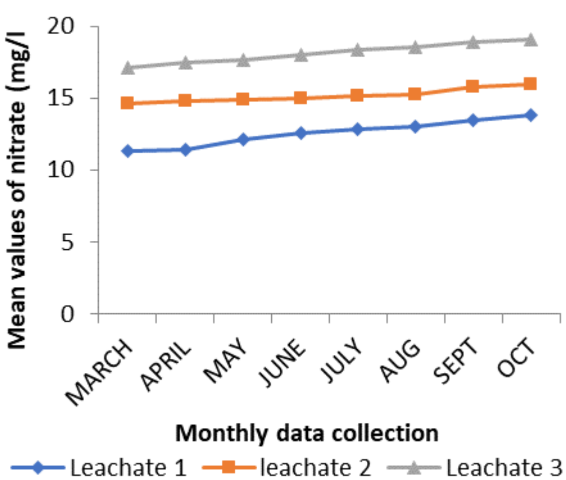

Figure 3g: Monthly Mean NO_3^- Concentrations of Leachate Samples.

Heavy Metal Concentrations

Heavy metals (Fe, Cu, Zn, Pb, As, Hg, Cr and Ni) concentration of the leachate samples were determined to assess the extent of pollution in the leachate. The mean monthly concentrations of the heavy metals indicated a significant different among the months of collection at the three sampling locations (Figure 3i to 3p). The mean concentrations of the heavy metals from the three different locations were significantly different from each other (Table 1).

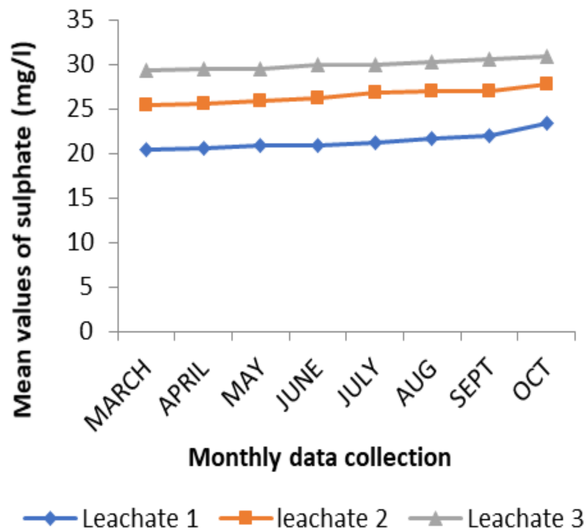

Figure 3h: Monthly Mean SO_4^{2-} Concentrations of Leachate Samples.

This is attributed to the topographic condition of the study area as location 1 is on high elevation while location 3 is on lower elevation. The mean concentration values of heavy metals (Table 2) were Fe (17.33mg/l), Cu (1.43mg/l), Zn (1.08mg/l), Pb (1.2mg/l), As (0.29mg/l), Hg (0.03mg/l), Cr (0.45mg/l) and Ni (0.61mg/l). These values were higher than those of landfills studied by other researchers with the exception of Fe and Cr that are within their range (Kumar and Alappat, 2005; Asibor and Edjere, 2016. Naveen and Malik, 2017; Hussein et al., 2019). The heavy metal concentrations are in the order of Fe>Cu>Pb> Zn> Ni>Cr>As>Hg.

Generally, leachate will have higher concentrations of heavy metals at the early stage of deposition due high metal solubility rate resulting from low pH of organic acid production and low heavy metals concentration as the age of the landfills increase and methanogenic phases occur due to precipitation and adsorption reactions as well as increase in pH (Kulikowska and Klimiuk, 2008). Thus, the concentrations of determined heavy metals in this study suggest the age of the dumpsite and improper sorting of wastes before dumping.

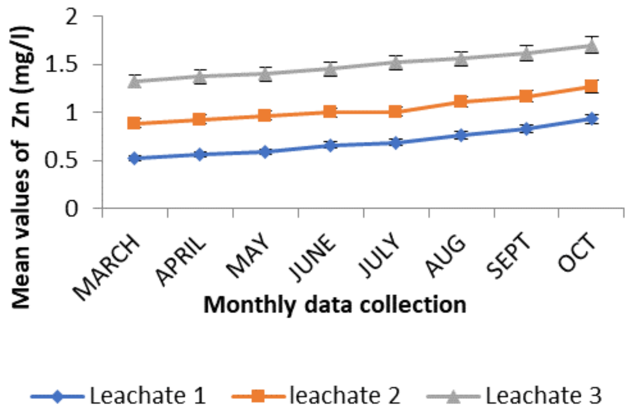

Figure 3i: Monthly Mean Zn Concentrations of Leachate Samples.

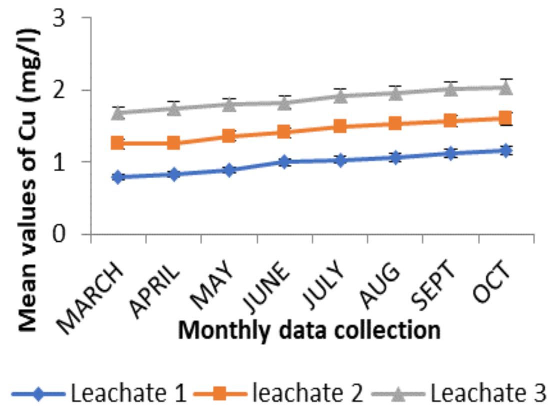

Figure 3l: Monthly Mean Cu Concentrations of Leachates Samples.

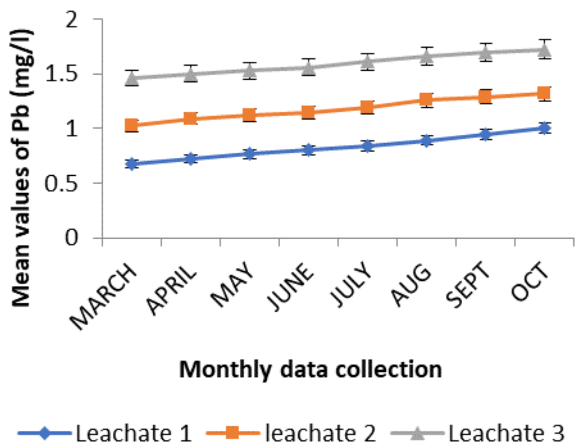

Figure 3j: Monthly Mean Pb Concentrations of Leachate Samples.

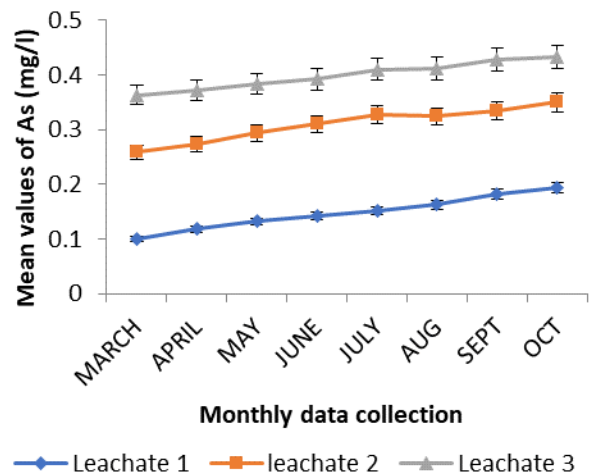

Figure 3m: Monthly Mean As Concentrations of Leachates Samples.

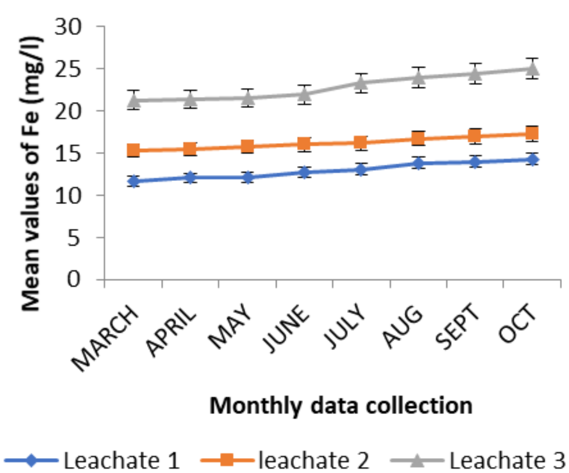

Figure 3k: Monthly Mean Fe Concentrations of Leachate Samples.

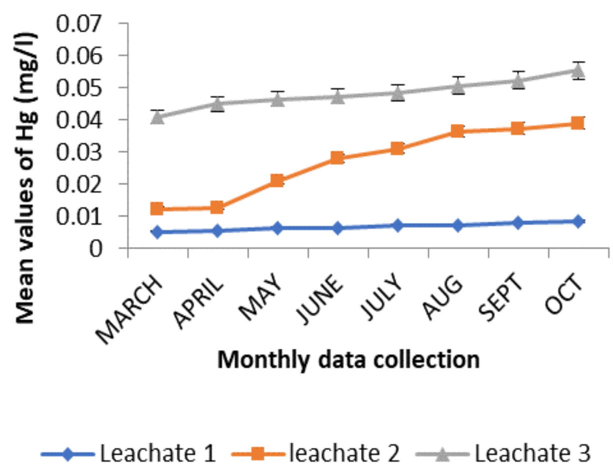

Figure 3n: Monthly Mean Hg Concentrations of Leachate Samples.

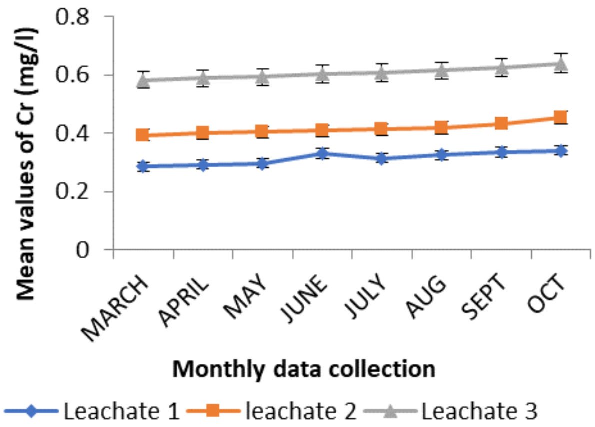

Figure 3o: Monthly Mean Cr Concentrations of Leachate Samples.

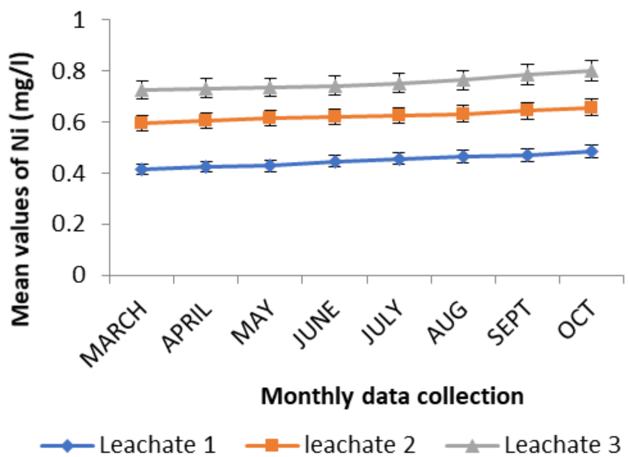

Figure 3p: Monthly Mean Ni Concentrations of Leachate Samples.

Regression and Correlation Analyses of the Determined Parameters

Linear and significant relationships were established between the concentrations of the determined parameters and the months of leachate collection from the three locations where the values of R^2 ranging from 0.91 to 0.99 (Table 1). This relationship indicated increase in concentrations of the determined parameters in the leachate samples with the months of sampling collection (dry to rainy seasons).

These can be attributed to the influence of precipitation on the waste decomposition as formation of leachates depends on several factors such as rainfall, waste disposal method, waste types, chemical and biological reactions taking place within the dumpsite (Akintola, 2014). Also, a negative, strong and significant correlation (0.908 - 0.999) exist between leachate pH and other determined parameters. This further buttressed the reports of previous researchers that the higher the leachate pH, the lower the concentrations of other parameters determined from the leachate samples due to the increase in the dumpsite/ landfill age which has changes the leachate from acidic to alkaline nature (acetogenic to methanogenic phase). Also, the positive, strong and significant correlation coefficient (0.903 -0.999) established among the other determined parameters indicated that they are from the same source (dumpsite).

Leachate Pollution Index (LPI)

Leachate pollution index is an index used in evaluating the pollution potential of landfill sites. Table 4 showed the parameters used in rating the contamination potential. The mean value of the parameters determined in the three leachate location points was used for the calculation of LPI in this study. The calculated LPI is 7.33 (Table 4). This is higher than the LPI (5.696) for standard leachate discharge (Hussein et al, 2019).

The calculated LPI from this study is lower than those reported from previous researchers (Kumar and Alappat, 2005; Aziz et al , 2010, Salami et al., 2015; Asibor and Edjere, 2016; Naveen and Malik, 2017; Hussein et al., 2019) and higher than those calculated from other landfills in Nigeria (Agbozu et al., 2015; Asibor and Edjere, 2016). The lower LPI from the study when compared with previous works may be due to the relatively low concentration of parameters such as BOD, COD, TDS and chloride which resulted into lower individual pollution ratings. The LPI value from this study is an indication that leachate generated from the dumpsite can percolate in the soil, infiltrate into the ground water and through the surface run off can get into the surface water around the vicinity of the study area.

Table 1: Mean and Regression Analysis of the Determined Parameters in the Samples from the Three Leachate Locations.

PARAMETERS	Leachate 1		Leachate 2		Leachate 3	
	Regression Equation	Mean	Equation	Mean	Equation	Mean
pH	$y = -0.064x + 6.66$ $R^2 = 0.908$	7.47[a]	$y = -0.063x + 6.216$ $R^2 = 0.912$	6.98[b]	$y = -0.127x + 6.157$ $R^2 = 0.980$	6.63[c]
EC (µm/s)	$y = 11.24x + 3195$ $R^2 = 0.901$	3245.62[c]	$y = 9.244x + 3249.$ $R^2 = 0.966$	3290.67[b]	$y = 13.92x + 3334.$ $R^2 = 0.987$	3397.47[a]
TDS (mg/l)	$y = 7.470x + 1775.0$ $R^2 = 0.907$	1808.61[c]	$y = 5.340x + 1813.7$ $R^2 = 0.986$	1837.82[b]	$y = 8.125x + 1867.7$ $R^2 = 0.972$	1904.33[a]
BOD (mg/l)	$y = 0.724x + 93.38$ $R^2 = 0.971$	96.60[c]	$y = 0.856x + 99.03$ $R^2 = 0.968$	102.90[b]	$y = 1.49x + 122.9$ $R^2 = 0.897$	129.70[a]
COD (mg/l)	$y = 1.918x + 194.3$ $R^2 = 0.892$	203.01[c]	$y = 1.828x + 250.6$ $R^2 = 0.979$	258.91[b]	$y = 1.629x + 327.7$ $R^2 = 0.988$	335.12[a]
Cl^- (mg/l)	$y = 0.457x + 44.48$ $R^2 = 0.976$	46.55[c]	$y = 0.58x + 51.06$ $R^2 = 0.354$	53.67[b]	$y = 0.615x + 61.39$ $R^2 = 0.989$	64.17[a]
NO_3^- (mg/l)	$y = 0.369x + 10.90$ $R^2 = 0.978$	12.57[c]	$y = 0.185x + 14.34$ $R^2 = 0.930$	15.18[b]	$y = 0.284x + 16.86$ $R^2 = 0.992$	18.14[a]
SO_4^{2-} (mg/l)	$y = 0.370x + 19.72$ $R^2 = 0.840$	21.39[c]	$y = 0.330x + 24.96$ $R^2 = 0.969$	26.45[b]	$y = 0.229x + 28.97$ $R^2 = 0.957$	30.01[a]
Fe (mg/l)	$y = 0.403x + 11.15$ $R^2 = 0.976$	12.97[c]	$y = 0.297x + 14.85$ $R^2 = 0.983$	16.19[b]	$y = 0.595x + 20.15$ $R^2 = 0.936$	22.83[c]
Cu (mg/l)	$y = 0.054x + 0.739$ $R^2 = 0.978$	0.99[c]	$y = 0.053x + 1.185$ $R^2 = 0.976$	1.43[b]	$y = 0.051x + 1.636$ $R^2 = 0.993$	1.87[a]
Zn (mg/l)	$y = 0.057x + 0.438$ $R^2 = 0.972$	0.69[c]	$y = 0.051x + 0.812$ $R^2 = 0.940$	1.04[b]	$y = 0.052x + 1.257$ $R^2 = 0.985$	1.50[a]
Pb (mg/l)	$y = 0.046x + 0.623$ $R^2 = 0.993$	0.83[c]	$y = 0.041x + 0.992$ $R^2 = 0.987$	1.18[b]	$y = 0.036x + 1.425$ $R^2 = 0.980$	1.59[a]
As (mg/l)	$y = 0.012x + 0.090$ $R^2 = 0.991$	0.15[c]	$y = 0.012x + 0.252$ $R^2 = 0.954$	0.31[b]	$y = 0.010x + 0.351$ $R^2 = 0.986$	0.40[a]
Hg (mg/l)	$y = 0.000x + 0.004$ $R^2 = 0.965$	0.007[b]	$y = 0.004x + 0.007$ $R^2 = 0.945$	0.027[b]	$y = 0.001x + 0.040$ $R^2 = 0.967$	0.065[a]
Cr (mg/l)	$y = 0.008x + 0.278$ $R^2 = 0.855$	0.32[c]	$y = 0.007x + 0.380$ $R^2 = 0.908$	0.42[b]	$y = 0.007x + 0.571$ $R^2 = 0.966$	0.61[a]
Ni (mg/l)	$y = 0.010x + 0.402$ $R^2 = 0.987$	0.45[c]	$y = 0.007x + 0.588$ $R^2 = 0.978$	0.62[b]	$y = 0.010x + 0.706$ $R^2 = 0.939$	0.75[a]

Table 2: Comparison of this Study with Leachate Samples from Other Researchers.

Parameters	This study	Asibor and Edjere (2016) Warri, Nigeria	Hussein et al (2019) Pajam, Malaysia)	Naveen and Malik (2017) Delhi, India	Kumar and Alappat (2005) Hong Kong
pH	7.02	5.78-6.02	7.88-9.74	7.6 - 8.1	7.80 - 9.00
TDS (mg/l)	1850.25	1090-2330	7290-11100	9636 - 11284	480 - 2000
EC (µm/s)	3311.25	1880-4194	$(1.18 - 1.79) \times 10^6$	ND	ND
BOD (mg/l)	109.73	35.3-55.01	37-322	2757 - 3330	81 - 22,000
COD (mg/l)	265.68	88.25-150.80	2880- 3953	440 - 5840	750 - 50,000
BOD/COD	0.38	0.36-0.40	0.09-0.11	38.40 – 56.80	ND
Cl^- (mg/l)	54.74	ND	ND	ND	170 - 30000
NO_3^- (mg/l)	15.26	18.11-28.8	ND	ND	ND
SO_4^{2-} (mg/l)	25.95	98.8-110.43	ND	ND	ND
Fe (mg/l)	17.33	9.77-28.8	5.87-7.85	7.5 - 41.6	ND
Cu (mg/l)	1.43	ND	0.02	0.54 - 0.95	0.08 – 0.10
Zn (mg/l)	1.08	ND	0.12-0.16	0.40 – 1.35	0.29 - 0.30
Pb (mg/l)	1.2	0.45-0.84	0.012-0.014	0.40 – 0.56	0.06 – 0.10
As (mg/l)	0.29	0.03-0.08	0.003-0.007	ND	ND
Hg (mg/l)	0.033	<0.001	ND	ND	ND
Cr (mg/l)	0.45	2.76-3.04	ND	0.40 – 1.84	0.35 - 5.30
Ni (mg/l)	0.61	0.19-0.22	0.07-0.12	0.25 – 0.45	ND

ND- not determined

Table 3: Correlation Analysis.

Parameters	pH	EC	TDS	BOD	COD	Cl^-	NO_3^-	SO_4^{2-}	Fe	Cu	Zn	Pb	As	Hg	Cr	Ni
pH	1															
EC	-0.937	1														
TDS	-0.952	0.999	1													
BOD	-0.908	0.997	0.993	1												
COD	-0.984	0.984	0.991	0.968	1											
Cl^-	-0.981	0.987	0.994	0.973	0.999	1										
NO_3^-	-0.992	0.973	0.983	0.953	0.999	0.997	1									
SO_4^{2-}	-0.999	0.933	0.949	0.903	0.982	0.978	0.991	1								
Fe	-0.959	0.997	0.999	0.989	0.994	0.996	0.987	0.956	1							
Cu	-0.996	0.964	0.976	0.942	0.996	0.994	0.999	0.995	0.981	1						
Zn	-0.986	0.982	0.99	0.965	0.999	0.999	0.999	0.984	0.993	0.997	1					
Pb	-0.991	0.975	0.985	0.956	0.999	0.998	0.999	0.989	0.988	0.999	0.999	1				
As	-0.997	0.909	0.928	0.876	0.969	0.964	0.981	0.998	0.937	0.987	0.972	0.979	1			
Hg	-0.965	0.996	0.999	0.986	0.996	0.998	0.999	0.962	0.999	0.984	0.995	0.991	0.944	1		
Cr	-0.965	0.996	0.999	0.986	0.996	0.998	0.999	0.962	0.999	0.984	0.995	0.991	0.944	1	1	
Ni	-0.999	0.941	0.956	0.913	0.986	0.983	0.994	0.999	0.963	0.997	0.988	0.993	0.997	0.968	0.968	1

Correlation is significant at 0.005

Table 3: Leachate Pollution Index (LPI) of the studied Dumpsite.

Parameters	Contaminant concentrations	Sub index value p_1	Pollution weight w_1	Over all pollution rating
pH	5.96	5	0.055	0.275
TDS	1850.25	15	0.050	0.75
BOD	109.73	10	0.065	0.65
COD	265.68	10	0.062	0.62
Cl^-	54.74	5	0.048	0.225
Fe	17.33	5	0.045	0.275
Cu	1.43	8	0.050	0.40
Zn	1.08	5	0.056	0.28
Pb	1.2	10	0.063	0.63
As	0.29	5	0.061	0.325
Hg	0.033	5	0.062	0.31
Cr	0.45	5	0.064	0.32
Ni	0.61	5	0.052	0.26
Total			**0.726**	**5.31**
LPI Values = $\sum_{i=1}^{m} wipi / \sum_{i=1}^{m} wi$				**7.33**

Pollutant weight (wi) and sub-index value (pi) were adapted from Kumar and Alappat (2005a)

CONCLUSION

The study showed the influence of precipitation on the waste decomposition as the concentrations of the determined parameters increase with the month of sampling collection. High concentrations of toxic heavy metals recorded in the leachate samples suggests the improper sorting of wastes before dumping. High pH, low chloride, BOD, COD and BOD/COD ratio values of the leachate samples suggest that the age of the dumpsite and it is in a stable methanogenic phase. The significant correlation coefficients among the determined parameters indicated that wastes are decomposed into organic materials and inorganic elements.

The LPI value is an indication that leachate generated from the dumpsite can percolate in the soil, infiltrate into the ground water and through the surface run off can get into the surface water around the vicinity of the study area. Thus, urgent preventive measures such as sorting of wastes before disposal should be encouraged and conversion of the dumpsite to modern landfill must be considered to reduce its impact on soil, plant and water resource in the study area.

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