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Microbial Load and Heavy Metals Properties of Leachates from Solid Wastes Dumpsites in the Niger Delta, Nigeria

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Abstract

Waste management is a challenge to sustainable development. In Nigeria most wastes are discharged into the environment with little or no treatment. Due to activities of microbes, some of these wastes undergo degradation releasing leachates. The study assessed the microbial population and heavy metals characteristics of leachate from solid waste dumpsites aligning water bodies in the Niger Delta, Nigeria. Analyses were carried out following standard procedure. Microbial population results showed that Total heterotrophic bacteria, total fungi, total coliform and faecal coliform ranged from 8.23 – 10.79 Log cfu/ml, 6.25 – 8.64 Log cfu/ml, 2.42 – 2.66 Log MPN/100 ml, and 1.97 – 2.34 Log MPN/100 ml respectively, while the heavy metals such as Cd, Cr, Cu, Mn, Hg, Fe, Pb and Zn ranged from 0.00 – 0.17 mg/l, 0.00 – 0.46mg/l, 0.00 – 0.70mg/l, 0.20 – 0.60mg/l, 0.00 – 0.27 mg/l, 0.20 – 8.41mg/l, 0.27 – 2.77 mg/l and 0.00 – 4.10 mg/l respectively. The heavy metals are in the order Fe>Pb>Zn>Mn>Cu>Cr>Hg>Cd. Analysis of variance showed that there were significance difference ($P<0.05$) in the microbial populations, and heavy metals apart from Cadmium and Zinc. The levels of contamination amongst the leachates indicated that continuous and precarious dumping of solid waste in areas aligning the coastal areas of the Niger Delta should be discouraged due to their associated health impacts.

Keywords: Niger Delta, dumpsite, leachate, contaminants

1 Introduction

Inadequate waste management is a threat to sustainable development in developing country like Nigeria [1, 2]. Wastes are generated in nearly all sector of the economy as well as all human activities such as hospitals, agriculture, market, workshops, food processing etc. In sector like hospital, hazardous wastes are generated and they are discharged into the environment without treatment [3]. This waste include pathological, hazardous chemicals, radioactive, stock cultures, blood and blood products, animal carcasses, pharmaceutical, pressurized containers, batteries, plastics, low level radioactive materials, disposable needles, syringes, scalpels, clinical bandages, gauze, cotton and other sharp items [4]. Poor waste management poses a great challenge to the well-being of inhabitants of such area, particularly those living adjacent to the dumpsites [5]. Typically, the types of wastes generated depend on the activities being carried out. The quantity of wastes depend on population and size of the sector. Due to urbanization, industrialization, and population growth, rural-urban migration, unplanned development, industrial and technological expansion, energy utilization [6 - 8], affluence and consumption pattern, the wastes generated in the country has been in increase [1]. These has rendered many water resources unwholesome and hazardous to biodiversity including human that consumes such water [8]. Three wastes stream are discharged into the environment include liquid, solid and gaseous emissions. To a large extent, solid wastes constitute higher nuisance due to the fact that it occupy space and takes longer time to degrade, with exception of few such as plastic and nylons which are recalcitrant to degradation by normal metabolic pathway of microorganisms.

Wastes are discharged into the environment especially in unapproved dumpsites including markets, drainage channels, undeveloped land [1], and surface water [9]. This is associated to inadequate and irregular evacuation practices by the government waste disposal authority [1, 2]. Due to inadequate management practice, solid wastes often block part of the major high way.

Worst still, during the raining season, the waste are deposited into nearby surface water (river, stream, creek) via runoff [10]. These often led to pollution of the water body. In Nigeria, some inhabitants of the coastal areas obtain their drinking water from the surface water [9, 10]. Some of the microbial species found in the surface water are of medical importance. Microbes found in surface water include *Staphylococcus* aureus, *Escherichia* coli, *Bacillus, Pseudomonas, Proteus, Citrobacter, Enterobacter, Klebsiella, Streptococcus, Salmonella, Shigella, Vibrio* species [11, 12]. Similarly, in leachates, bacteria species of the genera *Escherichia, Salmonella, Shigella* and *Vibrio*

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have been identified [13]. Other microbes isolated from leachate includes *Pseudomonas, Proteus, Bacillus, Micrococcus, Flavobacterium, Arthrobacter, Klebsiella pneumonia* and *Staphylococcus* species *Enterobacter cloacae* and *Escherichia coli* (bacteria), *Fusarium oxysporum, Trichoderma harzianum, Aspergillus, Penicillum* species (fungi) [14]. Egharevba et al. [8] reported *staphylococcus aureus, Proteus mirabilis, Klebsiella aerogenes, Serratia marcescens* and *Alcaligens* species (bacteria), *Aspergillus, Rhizopus* species and yeast as microbes found in leachate in Benin City, Nigeria. In Ekiti state, *Escherichia, Enterobacter, Klebsiella, Bacillus, Enterococcus, Salmonella, Pseudomonas and Staphylococcus* species have been isolated from leachate in dumpsite [15]. Some of these microbes are linked to borne diseases such as cholera, typhoid fever, diarrhoea etc when they find their way to drinking water sources. In addition, dumpsites also serve as media for transmission of infectious and non-infectious diseases [7, 16].

Owing to the different chemical composition of these wastes discharged into the environment, it could contain some recalcitrant and toxic materials [14] including heavy metals. On aquatic ecosystem, these wastes could influence the water quality (i.e. physico-chemical and microbial characteristics) due to the presence of heavy metals, ions, oil and grease, organic compound [9]. Heavy metals cannot be degraded hence they leach into the environment i.e food chain [1], which could affect aquatic life forms. Heavy metals pose a risk to human health on exposure via water consumption especially the once not needed by the body such as mercury. Organism contamination is largely linked to industrial solid waste such as mercury amalgam, dental fillings, lead in paints, chemical residues in processed foods and personal care products such as cosmetics, shampoo and other hair products, mouth wash, toothpaste, soap [16]. These are also part of the wastes deposited dumpsite.

Leachates are formed when precipitation enter wastes in a dumpsites. The configuration and composition of the leachates depends of the type microbes (saprophytic and pathogenic) found in such condition, in addition to the heavy metals and radioactive elements [8]. Leachate composition is mainly a function of the age of the landfill and the level of waste stabilization [17]. Generally, leachates are generated mainly from wastes. Industrial solid waste and municipal sludge leachates induced DNA damage in human peripheral blood lymphocytes [8]. This could be deleterious to human health. The leach-ability of contaminants from solid waste to water bodies has become a major source of concern; as such the microbial population and heavy metal properties of leachates from solid wastes in River and Bayelsa state are investigated.

2 Materials and Methods

2.1 Sample collection

Seven leachates samples were obtained from dumpsite in Rivers state (Eliozu, Nkwogu and Abuloma) and Bayelsa state (Amassoma, Ogobiri, Swali and Tombia junction) in triplicate. A sterile McCartney bottle was used to collect the sample meant for microbial analysis while 500 ml bottle was used for the sample meant for physicochemical (Total hardness and Chemical oxygen demand) and heavy metals analysis in the Month of July 2014. The sampling station was chosen based on the proximity of dumpsite to surface water. Figure 1 presents a typical dumpsite aligning surface water.

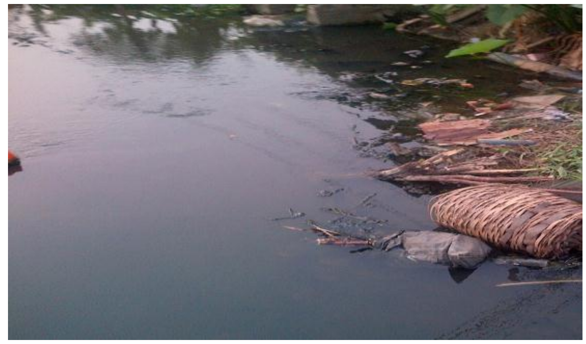

Figure 1: A typical dumpsite aligning the coastal area of the Niger Delta, Nigeria

2.2 Laboratory analysis

2.2.1 Physicochemical and heavy metal analysis

The water physico-chemical parameters including pH, conductivity, total dissolved solid (TDS) were analyzed *in-situ*. The pH was analysed using portable field kits Hanna instruments HI9820. A digital multi-parameter (HANNA Instrument: HI 9813) was used to measure electrical conductivity and total dissolved solids. The *in-situ* analysis was based on the equipment manufacturers' guide. Chemical oxygen demand (COD) was determined by titrimetric/dichromate oxidation method described by APHA [18] and Ademoroti [19]. Total hardness by titration using the scheme of Ademoroti [19]. The heavy metals were analysed using Atomic Absorption Spectrophotometer (AAS) (APHA 301A) [19] (model: 5100 PC, Perkin-Elmer, Boston, USA). Hg were also determined using spectrophotometer [20].

2.2.2 Enumeration of Microbial counts

The microbial populations of total heterotrophic bacteria (THB), total fungi of the leachates were enumerated using serial dilution pour plate method of Pepper and Gerba [21], Benson [22]. About 0.1ml of water sample was serially diluted in sterile distilled water and aliquots of the dilutions were aseptically plated into Nutrient Agar and Potato Dextrose Agar. The agar plates were incubated inverted at 37°C for 24-48 hours for THB and 30°C for 3 – 5 days for fungi to enumerate the aerobic and facultative microbes. The resultant growth/colonies on the plates were counted and expressed as colony forming units (cfu)/ml. The total and faecal coliforms was determined using multiple tube fermentation technique expressed as MPN (Most Probable Number – 3 tube method). Lactose broth was used as fermentative broth i.e MacConkey. The lactose broth in the first 3 tubes were prepared in double strength, while the last 6 tubes were prepared in single strength. About 10 ml of the leachates water sample was transferred into the tubes containing the double strength lactose broth, while 1m and 0.1ml of the sample was also transferred to the single strength lactose broth, 3 each. The tubes were incubated for 24 hours at 35°C to enumerate the faecal coliforms then after the incubation temperature was adjusted to 44°C for another 24 hours to enumerate the total coliforms. Positive results were based on colour change, gas production trapped in the Durham tubes. The MPN table of Pepper and Gerba [21], was used to determine the population of total and faecal coliforms.

2.3 Statistical Analysis

SPSS software version 16 was used to carry out the statistical analysis of the physicochemical and heavy metals parameters and the log transformed microbial population. The data were expressed as Mean ± standard error. A one-way analysis of variance was carried out at P = 0.05, and Tukey HSD Test was used to determine the source of the detected differences. Pearson's correlation matrix was used to identify the relationship among the heavy metals.

3 Results and Discussion

Table 1 presents the microbial population (THB, total fungi, total coliform and fecal coliform) from water samples obtained at the dumpsite in the Niger Delta region of Nigeria. THB, total fungi, total coliform and fecal coliform ranged from 8.23 – 10.79 Log cfu/ml, 6.25 – 8.64 Log cfu/ml, 2.42 – 2.66 Log MPN/100 ml, and 1.97 – 2.34 Log MPN/100 ml respectively, being significance difference (P<0.05) in among the sampling communities for all the microbial populations. The total bacteria count of this study is slightly higher than previous study. Sulaimon et al. [14] reported the microbial population of leachate from Orita-aperin and Awotan dump sites, Ibadan in the range of 1.9×10^8 to 3.77×10^9cfu/ml. Egharevba et al. [8] reported leachate from Benin City in the order 10^6 and 10^5 for THB and total fungi respectively. Aderemi et al. [22] reported total viable count of *Enterobacteriaceae* as 1.26×10^5cfu/ml in Lagos, Lagos state, Nigeria. Odeyemi et al. [15] reported total bacteria and coliform counts of 70.6×10^7 cfu/ml to 7.3×10^8 cfu/ml and 39.9×10^7 cfu/ml to 1.9×10^8 cfu/ml respectively from leachate in dumpsite in Ekiti-State Government Destitute Centre. The high microbial load suggest that the water is heavily contaminated. The presence of fecal coliform also suggest that sewage are been deposited in the dumpsite. During runoff, this leachate may enter surface water and it could lead to contamination. Hence, the people that obtain their drinking water from such water body could contact water borne diseases including typhoid fever, diarrhea etc. Again, the results of this study also suggest that microbes such as fecal streptococcus, *Chlostridum perifringes, E. coli, Enterobacter* species could be presence in the leachates. Generally the total coliform is high than 10 cfu/ml maximum permissible limit for drinking water, specified by standard organization of Nigeria (SON).

The physicochemical characteristics of the leachates from the dumpsite entering the surface water is presented in Table 2. The pH, electrical conductivity, total dissolved solid, total hardness and chemical oxygen demand ranged from 4.63 – 7.43, 1005.33 – 2049.73 µS/cm, 2018.03 – 7009.03 mg/l, 384.82 – 801.31 mg/l, 57.34 – 308.80 mg/l respectively being significantly different (P<0.05) among the sampling community for all the parameters. The physicochemical results of this study is close to the findings of several authors. Nubi et al. [6] reported leachate from Aba Epo in Oyo state Nigeria as 4.7 (pH), 1870 mg/l (COD), 228 mg/l (hardness), and 2900 mg/l (TDS). Egharevba et al. [8] reported pH (5.44 – 7.37), conductivity (168.8 – 1558.0 µS/cm), TDS (9.39 – 9.22 mg/l), COD (33 – 69mg/l) from leachates in Benin City, Nigeria. Aiyesanmi and Imoisi [23] studied leachates in Benin City, Nigeria and reported pH (6.76 – 7.49), electrical conductivity (13718 - 64344 µS/cm), total hardness (104.86 – 163.39 mg/l), TDS (6830 – 32192 mg/l). High COD is an indication of pollution level. Parameters such as conductivity and hardness exceeded maximum allowable limit of 1000 µS/cm and 150 mg/l respectively recommended by Standard Organization of Nigeria. Similarly, apart from one sampling location the pH of the water was also lower that the limit of 6.5 – 8.5 recommended for potable water consumed in Nigeria. Hence, the water is moderately acidic in nature.

Table 1: Microbiological population of leachates

Sample Code	Locations	Total Heterotrophic Bacteria, Log cfu/ml	Total Fungi, Log cfu/ml	Total Coliform Log MPN/100mL	Faecal Coliform (Log MPN/100mL)
LHI	Amassoma	9.01±0.01b	7.13±0.01b	2.60±0.07bc	2.31±0.07bc
LH2	Ogobiri	8.99±0.32b	7.87±0.02cd	2.60±0.07a	2.22±0.05bc
LH3	Tombia	10.79±0.01d	8.64±0.02e	2.41±0.03c	2.34±0.02b
LH4	Swali	10.02±0.01c	7.97±0.01d	2.66±0.00a	2.22±0.05bc
LH5	Eliozu	8.97±0.01b	6.25±0.03a	2.41±0.03ab	1.97±.000a
LH6	Abuloma	9.08±0.01b	7.73±0.07c	2.44±0.03a	2.11±0.07ab
LH7	Nkwogu	8.23±0.03a	7.95±0.01d	2.42±0.05c	2.34±0.02b

Along the column different letters indicate significant differences at *P*< 0.05 according to the Tukey HSD Statistics; each value is expressed as mean ± standard error (n = 3)

Table 2: Physicochemical parameters of water sample from the leachates

Sample Code	Locations	pH	Electrical conductivity, µS/cm	Total Dissolved Solid, mg/l	Total Hardness, mg/l	COD, mg/l
LHI	Amassoma	4.63±0.07a	1439.70±3.33a	5913.23±3.00d	801.31±1.00e	114.44±0.00b
LH2	Ogobiri	6.47±0.07d	1803.73±1.67d	2018.03±0.67a	572.97±1.33d	57.34±0.43a
LH3	Tombia	6.13±0.09cd	1677.03±3.05c	6717.83±2.91e	909.80±0.58f	172.93±0.88d
LH4	Swali	6.43±0.33d	1992.33±4.41f	3314.43±3.71b	394.82±1.79b	179.0±0.17e
LH5	Eliozu	5.40±0.17b	1005.33±3.33a	4060.63±3.33c	474.38±0.33c	194.07±0.67f
LH6	Abuloma	5.90±0.00bc	1946.03±4.16e	6871.53±0.88f	388.74±0.33a	308.80±0.577g
LH7	Nkwogu	7.43±0.17e	2049.73±2.91g	7009.03±0.33g	978.03±0.58g	137.93±1.20c

Along the column different letters indicate significant differences at *P*< 0.05 according to the Tukey HSD Statistics; each value is expressed as mean ± standard error (n = 3)

Heavy metals characteristics of the water from the leachate are presented in Table 3. Cd ranged from 0.00 – 0.17 mg/l, being not significant difference ($P>0.05$) among the sampling locations. Basically, in most of the location, cadmium was not detected. The findings of this study are not in consonance with previous report. Cd concentration of 0.029 mg/l was found in leachates in Aba Epo Oyo state [6] and 0.02 – 0.04 mg/l were reported in leachates in Benin City Nigeria [23]. The high cadmium reported in this study could be attributed to the type of waste discharged in the location, noting that it was only detected in two out of the seven sampling locations. The mean concentration from this study is slightly higher than the permissible limit for drinking water by the regulatory agencies (Table 4).

The concentration of Cr from this study ranged from 0.00 – 0.46mg/l. There were significance difference ($P<0.05$) in the Cr level among the sampling points. The concentration of Cr from this study is slightly higher than the findings of other author. Cr concentration found in leachate is in the range of 0.04 – 0.06mg/l from Benin City, Nigeria [23], 0.014 mg/l Aba Epo in Oyo state Nigeria [6], Like Cd, the mean concentration of Cr from this study is higher than the permissible limit for potable water by the regulatory agencies (Table 4). This suggests that the water is contaminated.

The level of Cu found in the leachates ranged from 0.00 – 0.70mg/l, being significantly different ($P<0.05$) among the sampling points. Cu was not detected in one of the sampling point (Swali). The findings of this study are lower than previous report. Sulaimon et al. [14] reported the level of Cu in leachate from Orita-aperin and Awotan dump sites, Ibadan in the range of 0.475 - 1.51 mg/l. Egharevba et al. [8] reported concentration of Cu from leachates in Benin City, Nigeria in the range of 2.50 – 6.70mg/l. The findings of this study is higher than some previous reports. Aiyesanmi and Imoisi [23] reported Cu in leachates in the range of 0.49 – 0.61 mg/l in Benin City, Nigeria. Nubi et al. [6] reported leachate from Aba Epo in Oyo state Nigeria as 0.018 mg/l. Odeyemi et al. [15] reported Cu in the range of 0.001–0.02mg/l from leachate obtained from dumpsite in Ekiti state, Nigeria. Sabejeje *et al*. [16] reported Cu in the range 0.01 - 0.02mg/l from leachate obtained from dumpsite in Ondo state, Nigeria. The mean concentration of Cu from this study is lower than the permissible guideline for potable water by the regulatory agencies such as WHO, SON (Table 4). Also, the concentration was lower that the standards for the discharge of effluents into water and land as stated by the national Environment (NE-SDEs).

The Mn level in this study ranged from 0.20 – 0.60mg/l, being significance difference ($P<0.05$) among the sampling locations. Mn significantly correlates with nitrate ($r=0.468$, $P < 0.05$). The concentration of Mn in this study is lower than previous report. An author have reported Mn in the range of 0.6 – 1.2mg/l in Benin City, Nigeria [8]. A result higher than the findings of this study have been reported in literature. Mn concentration ranging from 0.27 – 0.38 mg/l were observed from leachates in Benin City, Nigeria [23]. The mean concentration of Mn obtained from this study is higher than the permissible limit specific by SON, but lower than the standards for the discharge of effluents into water and land as stated by the NE-SDEs (Table 4).

The concentration of Hg ranged from 0.00 – 0.27 mg/l, being significance difference ($P<0.05$) among the sampling locations. The concentration reported in this study is not in consonance with previous report. Several authors have reported Hg from leachates in the range of 0.03 – 0.06 mg/l [23], 0.00 – 0.25 mg/l [8]. However, Odeyemi et al. [15] have reported that Hg concentration is basically below equipment detection limit (BDL). In this study, Hg was not detected in 2 of the sampling locations (Amassoma and Ogobiri). The mean concentration of Hg from this study is higher than the permissible guideline for potable water by the regulatory agencies such as WHO and SON (Table 4).

The concentration of Fe ranged from 0.20 – 8.41mg/l, being significantly different ($P<0.05$) among the sampling points. Fe show negative relationships ($r=-0.494$, $P < 0.05$) with Pb. The Fe concentration from this study is higher than previous reports. Authors have reported Fe level in leachates in the range of 1.40 – 3.2 mg/l [8], 1.96 – 3.19 mg/l [23]. The current findings is comparable to the result of another author. Sabejeje *et al*. [16] reported Fe in the range 7.00 - 8.00mg/ from leachates obtained from dumpsite in Ondo state, Nigeria. The mean concentration of Fe in this study is greater than the permissible limit specific by SON, but lower than the NE-SDEs standards (Table 4).

The level of Pb in this study ranged from 0.27 – 2.77 mg/l, being significantly different ($P<0.05$) among the sampling communities. The concentration of Pb in this study is slightly higher than the findings of other authors. Sulaimon et al. [14] reported the Pb of leachate from Orita-aperin and Awotan dump sites in the range of 0.568 - 0.86mg/l. Aiyesanmi and Imoisi [23] reported Pb in leachates from dumpsite in Benin City in the range of 0.05 – 0.12 mg/l. Odeyemi et al. [15] reported Pb in the range of 0.001-0.002mg/l from leachate obtained from dumpsite in Ekiti state, Nigeria. Sabejeje *et al*. [16] reported Pb in the range 0.80 - 0.90 mg/l from leachates obtained from dumpsite in Ondo state, Nigeria. Egharevba et al. [8] also reported Pb in the range 1.00 – 2.0 mg/l from leachate in Benin City, Nigeria. Nubi et al. [6] reported leachate from Aba Epo in Oyo state Nigeria as 0.073 mg/l. The mean concentration of Pb is higher than the permissible limit for drinking water as well as regulatory limit for effluent discharge (Table 4).

Zn level in the leachates under study ranged from 0.00 – 4.10 mg/l. There were no significance difference ($P>0.05$) among the various sampling locations. The Zn concentration in this study is higher than the result of other authors. Nubi et al. [6] reported Zn level of 0.48 mg/l in leachate from Aba Epo, Oyo state Nigeria. Aiyesanmi and Imoisi [23] reported Zn in the range of 0.37 – 0.65 mg/l from leachates obtained from Benin City, Nigeria. Odeyemi et al. [15] reported Zn in the range of 0.001–0.02mg/l from leachate obtained from dumpsite in Ekiti state, Nigeria. The mean concentration of Zn is lesser than the permissible limit for potable water and regulatory limit for effluent discharge (Table 4).

Generally, the concentration of the different heavy metals found from each dumpsite is a function of the level of such metal found in the solid wastes. Heavy metals enters into the environment through wastes from electroplating, metal finishing, textile, storage batteries, lead smelting, mining, plating, ceramic and glass industries

[24], pharmaceutical industries including recalcitrant substances such as antibiotics, anti-epileptics, tranquilizers etc [25]. Specifically, chromium enters in the environment through activities tanning, electroplating, pigment production [26]. Pb could have probably enter the environment due to waste from tyre wear, lubricating oil, grease [27], batteries production and ceramics [28]. Cu in the leachate could be due to corrosion by the copper materials in the environment. Apart from Fe, the heavy metal content of the solid wastes that formed the leachate is below the threshold value of 3mg/l specified by WHO as stated by Sulaimon et al. [14]. The analyzed heavy metals are in the order Cd<Hg<Cr<Cu<Mn< Zn< Pb <Fe. This indicates that iron is the most dominant heavy metals found in the leachates in the Niger Delta region. This could be attributed to the presence of rusted materials found in the dumpsites. Additionally, iron is one of the dominant heavy metal found in the Niger Delta environment.

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Table 3: Heavy metals characteristics of the Leachates

Sample Code	Locations	Cd, mg/l	Cr, mg/l	Cu, mg/l	Mn, mg/l	Fe, mg/l	Hg, mg/l	Pb, mg/l	Zn, mg/l
LHI	Amassoma	BDL	0.23±0.08a	0.70±0.06b	0.35±0.04ab	8.41±0.86d	0.00±0.00a	0.83±0.07a	0.47±0.01a
LH2	Ogobiri	BDL	0.05±0.00a	0.06±0.01a	0.37±0.08ab	2.01±0.23b	BDL	0.5333a	BDL
LH3	Tombia	BDL	0.46±005b	0.58±0.02ab	0.60±0.07ab	1.30±0.17ab	0.03±0.00ab	1.70±0.25ab	4.10±0.95a
LH4	Swali	0.17±0.02a	0.03±0.00a	BDL	0.70±0.05b	1.00±0.05ab	0.01±0.00ab	2.77±0.67b	1.27±0.14a
LH5	Eliozu	BDL	BDL	0.20±0.05ab	0.30±0.00ab	5.87±0.19c	0.21±0.01ab	0.27±0.17a	BDL
LH6	Abuloma	0.10±0.06a	0.38±0.01a	0.16±0.01ab	0.37±0.12ab	2.53±0.12b	0.29±0.03c	0.46±0.03a	0.30±0.01a
LH7	Nkwogu	BDL	0.05±0.01a	0.37±0.17ab	0.20±0.06a	0.20±0.05a	0.27±0.02ab	1.70±0.15ab	1.14±0.23a

Along the column different letters indicate significant differences at *P*< 0.05 according to the Tukey HSD Statistics; each value is expressed as mean ± standard error (n = 3); BDL = below detection limit

Table 4: Mean value of the heavy metals from leachate and potable water and effluent permissible guideline

	Cd, mg/l	Cr, mg/l	Cu, mg/l	Mn, mg/l	Fe, mg/l	Hg, mg/l	Pb, mg/l	Zn, mg/l
Mean	0.04	0.17	0.30	0.41	3.05	0.12	1.18	1.04
WHO [29]	0.003	0.05	2.00	-	-	0.006	0.01	-
SON [30]	0.03	0.05	1.00	0.20	0.3	0.001	0.01	3
NE (SDE)	-	-	1.00	1.00	10.0	0.01	0.1	5

The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations (NE-SDE)

The contamination of surface water by runoff of leachate could have adverse effects on the aquatic biodiversity including bio-accumulate in the body and organs of biological diversity, reduction in the rate of respiration by fishes due to precipitation of mucous secretion and reduction in oxygen level on long time exposure. It could also lead to changes in the physicochemistry of the water leading to increased cost of treatment.

4 Conclusions

Leachates from solid waste dumpsites are linked to contamination of both surface and groundwater as a result of infiltration and runoffs. The Niger Delta is a flood plain associated with shallow water table. Most of the heavy metals exceeding the allowable limit for potable water as specific by Standard Organization of Nigeria and World Health Organization. Similarly, the microbial population is also high. Based on the findings of this study, there is the need to effectively review waste disposal system Nigeria. To forestall leaching of pollutants into water bodies, location of dumpsites should be at an appreciable distance to our water bodies. In addition, municipal dumpsites should be replaced with proper engineered landfills.

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