Direct Research Journal of Public Health and Environmental Technology
Vol. 8(7), Pp. 109-116, August 2023
ISSN: 2734-2182
DOI: https://doi.org/10.26765/DRJPHET5320715489
Article Number: DRJPHET5320715489
Copyright © 2023
Author(s) retain the copyright of this article
https://journals.directresearchpublisher.org/index.php/drjphet

Original paper

Impact of Leachate Percolation on Groundwater Sources of Maitumbi Community of Bosso L.G. Area, Niger State

Hamzat, A.

Department of Biological sciences, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.
*Author email: fatrash.2011@gmail.com

Received 27 July 2023; Accepted 25 August 2023; Published 30 August 2023

ABSTRACT: Impact of leachate percolation on groundwater sources of Maitumbi community of Niger State were carried out to ascertain the magnitude of dumpsite pollution of groundwater during rainy season. Leachate samples from the dumpsite and groundwater samples (well, borehole, and stream) were collected using different distances away from the dumpsite. All the samples were analyzed for biological parameters according to internationally accepted procedures and standard methods. The presence of faecal coliform in the water samples was upsetting. The higher concentration of total heterotrophic bacteria count (3.58×10^5) in the samples were found alarming. Necessary steps should be taken by the authority to prevent further contamination of water sources from leachate.

Keywords: Groundwater source, Pollutants, Maitumbi Community, Niger,State
Citation: Hamzat, A. (2023). Impact of Leachate Percolation on Groundwater Sources of Maitumbi Community of Bosso L.G. Area, Niger State. Direct Res. J. Public Health and Environ. Technol. Vol. 8(7), Pp. 109-116.
https://doi.org/10.26765/ DRJPHET53207154896 . This article is published under the terms of the Creative Commons Attribution License 4.0.

INTRODUCTION

The disposal of municipal solid waste is a major concern, especially in developing countries where poverty, population growth and high urbanization rates, lack of financial and technical resources can hamper the efficient and sustainable management of waste (Akoteyon *et al*., 2011).

The generation of leachate plume depends upon the quantity and quality of leachate, which varies seasonally depending upon the composition and moisture content of the solid waste, hydro-geological conditions, climate, local population densities, annual precipitation, temperature and humidity. All these factors add to the complexity in landfill leachate characteristics and composition (Christensen et al., 2011).

The contaminant migration greatly depends upon the composition of the leachate or contaminants entering the ground-water system. Similar contaminants may behave differently in the same environment due to the influence of other constituents in a complex leachate matrix (Abu-Rukah and Al-Kofahi , 2011).

Redox environments were found to vary greatly inside contaminant plumes due to variation in contaminant load, groundwater chemistry, geochemistry and microbiology along the flow path (Christensen et al., 2011).

The laboratory experiments revealed that most biological nitrogen removal processes are carried out by the combination of aerobic nitrification, nitrate reduction, anoxic denitrification and anaerobic ammonium oxidation processes or (anammox) (Fux et al., 2012). The NH_4^+ in leachate can undergo sequential bacterial transformation to NO_3^- under oxidizing environment.

The practice of landfill system as a method of waste disposal in many developing countries is usually far from standard recommendations (Mull, 2015). A standardized landfill system involves carefully selected location, and is usually constructed and maintained by means of engineering techniques, ensuring minimized pollution of air, water and soil and risks to man and animals. It involves placing waste in lined pit or a mound (Sanitary landfills) with appropriate means of leachate and landfill

gas control. Land filling of municipal solid waste is a common waste management practice and one of the cheapest methods for organized waste management in many parts of the world (El-Fadel et al., 2002; Longe and Balogun, 2010).

Increasing urbanization results in an increased generation of waste materials and landfills become the most convenient way of disposal. Most of these landfills are mere 'holes in the ground" do not qualify as sanitary means of solid waste disposal. Most of the areas around the Solous dumpsites depend either on dug-up wells or bore-holes which may likely be affected by the generated leachate through waste decomposition from the dumpsites despite the provision of pipe-borne water by government.

SOURCES OF WATER POLLUTION

Inorganic

Nitrogenous pollutants

The landfill leachate having NH4 poses long-term threat of pollution once it escapes into ground or surface waters (Beaven and Knox, 2016). In the UK, average concentrations of about 900 mg NH4(+NH3)–N L-1 have been reported for landfill leachates (Burton and Watson-Craik, 2104) while legislation probably requires concentrations below 0.5 mg NH4–N L-1 for any discharge in the environment (EA, 2013). The laboratory experiments revealed that most biological nitrogen removal processes are carried out by the combination of aerobic nitrification, nitrate reduction, anoxic denitrification and anaerobic ammonium oxidation processes or (anammox) (Fux et al., 2012). The NH_4^+ in leachate can undergo sequential bacterial transformation to NO_3^- under oxidizing environment. Although NO_3^- is less toxic than NH_4^+ it still presents a pollution threat and bacterial denitrification to 'harmless' N2 is required under anaerobic conditions, to eliminate it. When oxygen is depleted, nitrate can be converted to nitrite and finally to nitrogen gas by denitrification. Also, when nitrite is present under anaerobic conditions, ammonium can be oxidized with nitrite as an electron acceptor to dinitrogen gas (anammox) (Mora et al., 2014). The attenuation of N pollution resulting from disposal of organic wastes in landfill sites therefore requires fluctuating redox conditions favouring the transformations: NH_4^+; NO_3^- and $N_2 \rightarrow\rightarrow$. Anaerobic conditions prevent the formation of NO_3^-, so N attenuation by denitrification in landfills is not regarded as a significant process (Burton and Watson-Craik, 2014). Heaton et al. (2015) acquired data for the isotope ratios (13C/12C, 15N/14N and 34S/32S) and dissolved gas (N_2, Ar, O_2 and CH_4) composition of groundwater in and around a landfill site in Cambridge-shire, England. Decomposition of domestic waste, placed in unlined quarries produced NH_4^+ rich leachate dispersing as a plume into the surrounding middle chalk aquifer at approximately 20 m below ground level. Few boreholes around the edge of the landfill extending to the west and north in the direction of plume flow showed evidence of methanogenesis, SO_4^{2-} reduction, and denitrification. The first two processes are indicative of strongly reducing conditions, and are largely confined to the leachate in the landfill area. Denitrification does not require such strong reducing conditions and beyond those strong reducing zones, clear evidence of denitrification comes from data for elevated δ 15N values for NO_3^- (>+10‰) and the presence of non-atmospheric N2. This distribution of redox zones is therefore consistent with an environment in which conditions become progressively less reducing away from the landfill (Christensen et al., 2011; Heaton et al., 2015).

Reduction of sulfate pollutants

Sulfate reduction is a major process for degradation of organic matters and many anaerobic subsurface environments have been found to experience this process. The sulfate reduction is controlled by factors such as availability of utilizable organic matter as electron donors (McMahon and Chapelle, 2015), water potential, sediment pore throat diameter, pH and availability of thermodynamically more favorable electron acceptors (Routh et al., 2019). In anoxic aquifers, lithologic, climatic, hydrological, and biogeochemical processes controlling the sulfate supply may determine sulfate reduction (Ulrich et al., 2013). Ulrich et al. (2013) undertook field and laboratory techniques to identify the factors affecting sulfate reduction in a landfill leachate contaminated shallow, unconsolidated alluvial aquifer. Depth profiles of 35S-sulfate reduction rates in aquifer sediments revealed a Michaelis–Menten-like relationship with an apparent Km and Vmax of approximately 80 and 0.83 µM SO4 -2 day-1 , respectively. The rate of sulfate reduction was in direct correlation with the concentration of the sulfate. Near the confining bottom layer of the aquifer, sulfate was supplied by advection of groundwater beneath the landfill and the reduction rates were significantly higher than rates at intermediate depths (Ulrich et al., 2013).

Heavy metals (HMs)

Although HMs tend to be leached out of fresh landfill, they later became largely associated with MSW-derived dissolved organic matter (DOM) which plays an important role in heavy metal speciation and migration (Li et al., 2009). Christensen et al. (2011) conducted experiments to determine the metal distribution between the aquifer

material and the polluted groundwater samples (Kd) and the difference in distribution coefficients indicated that DOC from landfill leachate polluted groundwater can form complexes with Cd, Ni and Zn. DOM derived from MSW landfill leachate was observed to have a high affinity for metals such as Cu, Pb, Cd, Zn and Ni, enhancing their mobility in leachate-polluted waters (Christensen et al., 2011). However, Ward et al. (2005) deduced that the heavy metal binding capacities largely fluctuated among various leachates due to variable compositions. Earlier, it was demonstrated that HMs mobilization was enhanced by reduced pH of the leachate with oxygen intrusion in landfill (Ma'rtensson et al., 2020) and by the presence of large quantity of fatty acids generated at the initial phase of solid waste degradation (He et al., 2016). In some recent studies, it was revealed that less than 0.02% of HMs in landfills may leach out over 30 years of land filling (Øygard et al., 2017). Qu et al. (2018) monitored mobility of some heavy metals including Cd, Cr, Cu, Ni, Pb and Zn released from a full-scale tested bioreactor landfill (TBL) in the Tianziling MSW Landfill in Hangzhou City, China over the first 20 months of operation. The size of the TBL was approximately 16,000 m 2 with a combined GCL-HDPE bottom liner, and had four layers of 6– 8 m thick MSW layers. At the initial landfill stage, the leachate exhibited high HMs release, high organic matter content (27,000–43,000 g l –1 of TOC) and low pH (5–6). By the fifth month of land filling, the methanogenic stage was established, and HMs release was reduced below the Chinese National Standards. At a landfill age of 0.5 years, 15% of Cr, 25% of Cu, 14% of Ni, 30% of Pb and 36.6% of Zn in solids were associated with amorphous metal oxides and crystalline Fe oxides. At 1.5 years of filling age, these HMs were largely transformed into alumino-silicates forms or released with the landfill leachate. Computer modeling revealed that the humic acid (HA) and fulvic acid (FA) could strongly bind HMs (Qu et al., 2018). Chai et al. (2012) found strong interactions between HA and Hg. They proposed that the overall stability constant of Hg(II)–HA was determined by the abundant O-ligands in HA. Compared to HA, the FA having relatively high content of carboxylic groups had a much higher Hg(II)-complexing capacity. Thus FA played an important role in binding Hg(II) in early landfill stabilization process.

Organic contaminants

Organic contaminants in the form of hydrocarbons usually undergoes degradation by bacterial activity in the vadose zone producing carbonic and organic acids which enhance the mineral dissolution of the aquifer materials (McMahon and Chapelle, 2015). This leads to the production of a leachate plume with high total dissolved solids (TDS) resulting in the increased groundwater conductance observed in and around the zones of active biodegradation (Atekwana et al., 2015). The acidogenic phase in young landfills is associated with rapid anaerobic fermentation, leading to the release of free volatile fatty acids (VFA), whose concentration can be up to 95% of the TOC. High moisture content enhances the acid fermentation in the solid waste (Wang et al., 2013). The methanogenic phase takes over with the maturity of the landfill. Methanogenic microorganisms converts VFA into biogas (CH4, CO2) and in such old landfills, up to 32% of the DOC in leachate consists of high molecular weight recalcitrant compounds (Wang et al., 2013).

vanBreukelen et al. (2014) delineated the leachate plume inside a landfill (Banisveld, The Netherlands) using geophysical tests by mapping the subsurface conductivity to identify the biogeochemical processes occurring. Methane was found to form inside the landfill and not in the plume. Precipitation of carbonate minerals was confirmed by simulation of δ 13C-DIC [dissolved inorganic carbon]. Ziyang et al. (2019) investigated the COD compositions in leachate based on the molecular weight distribution and hydrophobic/hydrophilic partition characteristics. The COD composition varied over the age of the leachate and the ratio of TOC/TC decreased over time, indicating decrease in the percentage of organic matters in leachate and increase in inorganic substances. Giannis et al. (2018) monitored long-term biodegradation of MSW in relation to operational characteristics such as air importation, temperature, and leachate recirculation in an aerobic landfill bioreactor over a period of 510 days of operation in a lab-scale setup. It was evident from the leachate analysis that above 90% of COD and 99% of BOD5 was removed by the aerobic bioreactor. Tuxen et al. (2016) used microcosm experiments to illustrate the importance of fringe degradation processes of organic matters within contaminant plumes and identified increased degradation potential for phenoxy acid herbicide governed by the presence of oxygen and phenoxy acids existing at the narrow leachate plume fringe of a landfill. Anaerobic processes taking place in a leachate contaminated alluvial aquifer was studied near Norman Landfill, Oklahama (USA), along the flow path of aquifer. The center of the leachate plume was characterized by high alkalinity and elevated concentrations of total dissolved organic carbon, reduced iron, methane, and negligible oxygen, nitrate, and sulfate concentrations. Occurrence of anaerobic methane oxidation inside the plume was suggested by values of methane concentrations and stable carbon isotope (δ13C). Methane δ 13C values increased from about –54‰ near the source to >–10‰ down gradient and at the plume margins. Oxidation rates ranged from 18 to 230 μM per year while first-order rate constants ranged from 0.06 to 0.23 per year. Hydro-chemical data suggested a sulfate reducer methanogen consortium mediating this methane oxidation. So natural attenuation of organics through anaerobic methane

oxidation was found to be an important process in the plume (Grossman et al., 2021).

Biological contaminants

Survival of micro-organisms in groundwater, septic tank and leachate plumes has been investigated by few researchers (Grisey et al., 2010; Tuxen et al., 2016). Grisey et al. (2010) monitored total coliforms, Escherichia coli, Enterococci, Pseudomonas aeruginosa, Salmonella and Staphylococcus aureus for 15 months in groundwater and leachate beneath the Etueffont landfill (France). They coupled the microbiological tests to tracer tests to identify the source of contamination. Groundwater was found to have high levels of faecal bacteria (20,000 CFU 100 mL– 1 for total coliforms, 15,199 CFU 100 mL– 1 for E. coli and 3290 CFU 100 mL– 1 for Enterococci). Bacterial density was lower in leachates than in groundwater, except for P. aeruginosa which seemed to adapt favourably in leachate environment. Tracer tests indicated that bacteria originated from the septic tank of the transfer station and part of these bacteria transited through waste. Microcosm experiments were used to measure the fringe degradation of phenoxy acid herbicide across a landfill leachate plume by microbial activity in lab scale experiments.

High spacial resolution sampling at 5 cm interval was found to be necessary for proper identification of narrow reaction zones at the plume fringes because samples from long screens or microcosm experiments under averaged redox conditions would yield erroneous results. The samples were collected by a hollow stem auger drilled down to the desired level of the cores. The collected cores were sealed with aluminium foil and plastic stoppers to maintain the redox conditions and stored at 10 °C to be used within 4 days. These were divided into smaller parts for the microcosm experiments, pore-water extraction, and sediment analyses, determination of MPN, solid organic matter (TOC), and grain size distribution. A multi-level sampler installed beside the cores measured the plume position and oxygen concentration in the groundwater. Microcosm experiments were performed in 50 mL sterilized infusion glass bottles, each containing aquifer material from the sediment samples. In each microcosm, the oxygen concentration was individually controlled to mimic the conditions at their corresponding depths. The number of phenoxy acid degraders was enumerated by a most probable number (MPN) method. The results illustrated the importance of fringe degradation processes in contaminant plumes (Tuxen et al., 20016).

Landfill systems in the developing world

Landfills have been referred to as the ultimate means of survival for the less privileged people in developing countries of the world, especially in Africa. It also serves as alternative source of raw material for recycling, thereby giving substance to the adage that “One man’s meat is another’s poison”. These categories of people, called scavengers perceive waste in another perspective differing from the majority (Figure 1). They recognize waste as wealth and also as being the source of their means of survival. Competition even exists among the scavengers, to the extent that certain “payments” are made to the dump manager to grant access to the dumpsite for scavenging, especially in Lagos dumpsites. Different landfill systems exist globally. With respect to Africa as a continent the open dump approach is the primitive stage of landfill development and remains the predominant waste disposal option in most African countries (Figure 1). A default strategy forunicipal solid waste management, open dump involves indiscriminate disposal of waste and limited measures to control operation, including those related to environmental effects of landfills (Lars and Gavriels, 2018).

An operated or semi-controlled dump is often the first stage in a country’s effort to upgrade landfills (Lars and Gavriels, 2018). Controlled dumps operate with some form of inspection and recording of incoming wastes, practice extensive compaction of waste and control tipping front and application of soil cover. Operated dumps however implement only limited measures to mitigate other environmental impacts. Operated dumps still practice unmanaged contaminant release and do not take into account environmental cautionary measures such as leachate and landfill gas management (Lars and Gavriels, 2018). This is especially relevant where leachate is produced and is unconstrained by permeable underlying rock or fissured geology. This issue may be less critical in semi-arid and arid climate, where dumps do not generate leachate in measurable quantity (Lars and Gavriels, 2018). However, as cities grow and produce waste and their solid waste collection system become more efficient, the environmental impact from open dumps becomes increasingly intolerable. The conversion of open or operated dumps to engineered and sanitary landfills is an essential step to avoid future costs from present mismanagement. The first step and challenge in upgrading open dumps to sanitary landfills involves reducing nuisance such as odour, dust, vermin and birds (Lars and Gavriels, 2018). The term sanitary landfill is generally used to describe a landfill that engages in waste compaction and apply daily soil cover to reduce nuisance (Lars and Gavriels, 2018). Traditional landfills often referred to as “open” or “polluting” dump contains waste under the ground potentially allowing a waste by-product called leachate to enter and contaminate groundwater and other water sources. They also attract rodents, insect and other disease-carrying vermin. Other negative effects of open dump include

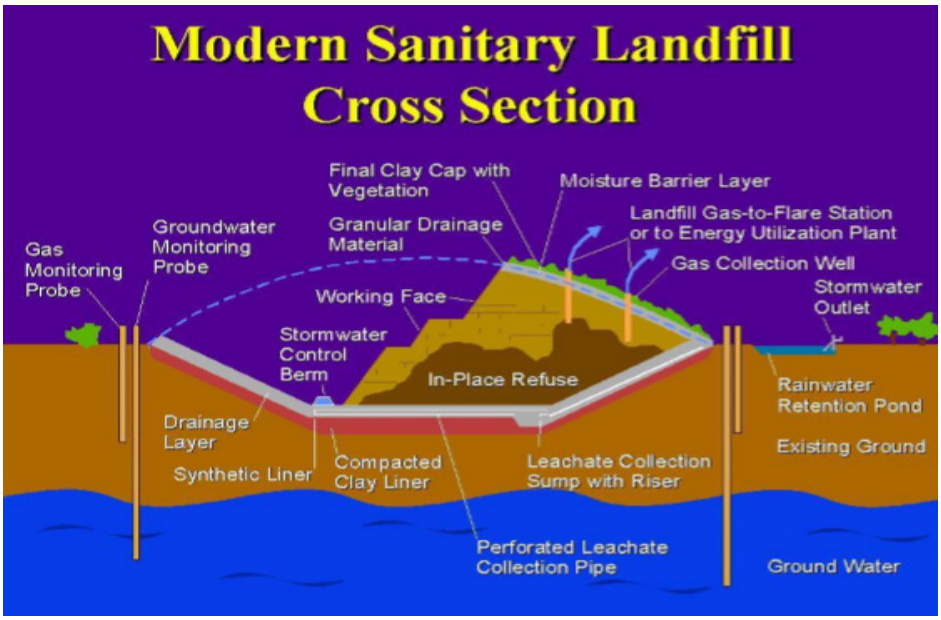


Figure 1: Cross-section of a sanitary landfill (www.carbonfund.org)

emission of air pollution, odour and creation of potential fire hazards. In a sanitary landfill these risks are virtually eliminated.

MATERIALS AND METHODS

Study area

Maitumbi is a village under Bosso Local Government. It is situated a few Kilometers away from Minna the capital city of Niger State in the north central zone of Nigeria. The study area is geographically located on latitude 90 33`N and 90 45`N and longitude 60 34`E and 60 42`E. And is geological situated on basement complex and sedimentary rocks (Uthande, 2001). Some of the major government and private establishment located in the study area include Agricultural Development Projects (ADP), three aim zone and DANA Pharmaceutical company ltd respectively.

Sample site

Niger State Environmental Protection Agency (NISEPA) adopted a dump site situated behind JAMB office MaitumbiMinna. The landfill site is located on the latitude 90 33`N and 90 45`N and longitude 60 34`E and 60 42`E.

Sample collection

Samples of leachate from three sides of Landfill were collected in a sterile sample bottles. Taking proximity of the water sources from the landfill (within 0.30 km radius of the landfill site), water samples from three community water sources were also collected using sterile sample bottles. All the samples were transported to Biology laboratory immediately for microbial analysis.

Analytical methods

Samples were immediately transferred to the laboratory and were stored in refrigerator at 4°C. The sampling wells were selected based on the availability of the wells around the landfill sites and to represent the whole area (BuketYenigul *et al.,* 2005). The analysis was started without any delay using the standard procedure prescribed by the American Public Health Association (APHA, 1994)

Microbial analysis

The total heterotrophic bacterial count (THB) was determined by cultural techniques by plating into nutrient agar (NA), and fungi by plating into Sabouraud dextrose agar. six (6) fold serial dilutions with one ml of the sample, 0.1ml of 10^{-4} dilution was placed on the plates in triplicate and incubation at 37^0C for 24 hours and 27^0C for 48 hours for bacteria and fungi respectively. The colonies were then counted and expressed as colony forming units per ml.

Bacteriological analysis

The bacteriological assessment of the leachate and

Table 1: Microbial count of leachate samples from Maitumbi landfill.

Total heterotrophic bacteria count (THBC)	3.58×10^5
Total coliform count (TCC)	2.46×10^5
Total fungi count (TFC)	9.0×10^5

Table 2: Microbial count of water samples around Maitumbi landfill.

Water Sample	THBC	TCC	TFC
Well	2.69	1.83	11.8
Bore hole	2.38	1.45	10.7
Stream	3.14	1.93	17.1

groundwater was carried out using serial dilution and pour plate method. Streaking method was used to obtained pure bacterial isolates by sub-culturing a previously incubated plate onto a freshly prepared sterile plate.

Fungal assessment

The fungal assessment of the leachate and groundwater was carried out by streaking method. All the cultures will be incubated at 37ºC for bacteria and 25ºC for the fungi culture overnight respectively.

RESULTS

Microbial analysis of leachate and water samples

Table 1 shows the mean total bacterial, coliform and fungi counts in samples from the leachate samples. The analysis therefore reveals total heterotrophic bacteria (THB) counts of 3.58×10^5cfu/ml.Total Coliform (TC) counts of 2.46×10^5cfu/ml. The mean total fungi count was 9.0×10^5cfu/ml. Table 2 shows the mean total bacterial, coliform and fungi counts in samples from the water samples. The analysis therefore reveals total heterotrophic bacteria (THB) counts of 3.58×10^5cfu/ml.Total Coliform (TC) counts of 2.46×10^5cfu/ml. The mean total fungi count was 9.0×10^5cfu/ml.

Cultural characterization and identification of microbial isolates

The microbial isolates were identified on the basis of their cultural cellular morphology, gram's reaction, biochemical characterization and use of fungi atlas. The tentative bacteria and coliform isolates from the various samples were Escherichia coli, Pseudomonas aeruginosa, and Staphylococcus aureus. The organisms were confirmed after a careful comparism of the various test results carried out with the Bergy manual for bacteriological identification. Meanwhile, the fungi isolates include Penicilliumspp, Yeast spp, Aspergillusspp and Fusariumspp they were confirmed using the mycological manual for fungi identification (Tables 3 and 4).

DISCUSSION

Maitumbi solid waste dumpsite is an unlined, uncontrolled planned and open dumpsite. This dumpsite harbored agricultural wastes, medical wastes and all forms of hazardous wastes. Industrial waste which normally contains toxic chemicals and sometimes radio-active substances including electronic wastes, are dumped together with domestic, market and commercial wastes, when mashed together generates fluids known as leachate during the dry and wet season there is a constant run-off from this compost. In this compost, there is presence of bacteria, fungi, and other pathogens including the presence of heavy metals. It is known that the run-off is connected to major water pathways which causes contamination and makes it unfit for consumption. The observed characteristics of leachate contaminated water samples maybe associated with the heavy rainfall that occurs during the rainy season and liquid content present in the waste which might encourage the leaching of the pollutants in the surrounding water.

The present observation indicates that the water samples are indeed polluted when compared with the World Health Organization and Nigerian Drinking Water Quality standards. Additionally, the extent of the pollution of the groundwater increases with decreasing distance from the landfill. Inorganic and heavy metals have been reported to be retained at a lower level than organic chemicals and pesticides (Brenaam, 2000). Johnson et al. (2000) also reported that the concentrations of pollutants in leachate vary with depth of groundwater and the distance from the landfill. Generally, the total bacteria population of the leachate samples is higher than in water samples, this observation is evident in the study conducted out by Hammond and Beliles (2012). The presence of coliform bacteria in the water samples as observed in this study is a source of concern. These bacteria have been associated with a number of health

Table 3: Cultural characterization, cell morphology, gram's reaction and biochemical characterization of bacteria isolates

Sample code	Cultural characterization of bacteria isolate	Cell Morphology and shape	Gram's Reaction	Motility	Indole	Methyl red	VogesProskaeur	Citrate	catalase	Oxidase	coagulase	urase	lactose	sucrose	glucose	Gas production	H2S	Probable organism
L1	Large, mucoid, spherical and flat	Cocci in chain	+	-	-	-	+	-	-	-	-	-	+	+	+	+	-	Streptococcus faecalis
L2	Smooth, circular, complex, mucoid colony	Short rod	-	+	+	+	-	-	+	-	-	-	+	+	+	+	-	Escherichia coli
L3	Greenish, pigmented, smooth and circular	Curved red	-	+	-	+	-	+	+	+	-	-	-	-	-	-	-	Pseudomonas aeruginosa
W1	Smooth, raised, spherical and glistening colony	Cocci in clusters	+	-	-	-	+	-	+	-	+	-	-	-	+	-	-	Staphylococcus aureus
W2	Irregular, milky, flat, large colony	Baccilli rod	+	+	-	-	+	+	+	+	-	-	-	-	-	-	+	Bacillus subtilis
W3	Smooth, circular, convex, mucoid colony	Single short rod	-	+	+	+	-	-	+	-	-	-	+	+	+	+	-	Escherichia coli

Table 4: Cultural characterization and identification of fungi isolates.

Sample Code	Macroscopic or Cultural Characteristics	Microscopic Features	Probable Fungi
L1	Colony was shades of green velvety appearance and wrinkled and grows moderately.	The conidiophore produced head, composed of short branches and bearing. Phialides that are arranged in brush-like pattern.	Penicilliumspp
L2	Colony was shades of brown, velvety colony that grows rapidly with spores	Narrow spherical head that is curved with phialides and septate hyphae	Aspergillusspp
L3	rapid growing colony woolly to cottonlike in appearance and fast spreading	The conidiophore occurred in sickled cell shape and produced conidia that are multicell	Fusariumspp
W1	Colony was white to creamy, soft, smooth and bacteria-like in appearance	Oval and elongated cells with buds attached to the mother cell and in chains	Yeast spp
W2	Colony was shades of green, velvety in appearance, wrinkled and grows moderately	The conidiophore produced head composed of short branches and bearing phialides that are arranged in brush-like pattern	Penicillin spp
W3	Colony was white to creamy, soft, smooth and bacteria-like in appearance	Oval and elongated yeast cell with buds attached to the mother cell and in chain	Yeast spp

problems such as cholera, vomiting and diarrhea (WHO, 2009). The use of leachate contaminated water for domestic purposes may cause several pathological diseases as indicated earlier. Presence of E. coli and total coliform bacteria indicates microbial pollution of the groundwater by anthropogenic activities. All bacterial isolates recovered from the waste dumpsite samples are directly implicated in food-borne infections such as diarrhoea, typhoid and gastroenteritis.

The study further revealed that the concentration of waste materials in the landfill site had systematically polluted the soil and groundwater over time. The effect of such pollution as determined from the study declined away from the polluting source. This implied that the contamination of the surrounding water was more dependent on proximity to dump sites. The less dependency has contaminants in leachate and hard water prior to its disposal into the environment. However, due to extreme variation of leachate composition and operating conditions in different landfills, no guideline or standard operating procedures for leachate treatment and

disposal.

Conclusion

The level of pollution, seepage into surrounding water at the dumpsite was studied by sampling water at the dumpsite containing leachate to reveal the microbial properties and characterization. The study revealed that the composition and disposal of solid waste in Minna metropolis potentially have environmental and public health implications. Therefore, it is pertinent to conclude that the open waste dump at the Maitumbi dumpsite constitute a source of microbial and toxic contamination of the dumpsite. The dumpsite has to a greater extent influenced the pollution or contamination of the water sources within the vicinity.

REFERENCES

Abu-Rukah, Y.and Al-Kofahi, O. (2011).The assessment of the effect of landfill leachate on ground-water quality--a case study. El-Akader landfill site--north Jordan. Journal of Arid Environments, 49: 615-630.

Abu-Rukah, Y.and Al-Kofahi, O. (2011).The assessment of the effect of landfill leachate on ground-water quality--a case study.El-Akader landfill site--north Jordan. Journal of Arid Environments, 49: 615-630.

Akoteyon, I.S., Omotayo, A.O., Soladoye, O., Olaoye, H.O. (2011).Determination of water quality index and suitability of urbanriver for municipal water supply in Lagos-Nigeria. EuropeanJournal of Scientific Research, 54, 263-271.

Beaven, R. P.and Knox, K. 2016. The use of a nitrogen tax as a driver towards more sustainable landfills. Wastes Management: 18-20.

Burton, S. A. Q.and Watson-Craik, I. A. (2014). Ammonia and nitrogen fluxes in landfill sites: applicability to sustainable landfilling. Waste Management and Research, 16: 41-53.

Christensen, T. H., Bjerg, P. L., Banwart, S. A., Jakobsen, R., Heron, G.andAlbrechtsen, H. J. (2011). Characterization of redox conditions in groundwater contaminant plumes. Journal of Contaminant Hydrology, 45: 165-241.

EA, (2013). Hydrogeological Risk Assessment for Landfills and the Derivation of Control and Trigger Levels, Report LFTGN01. Environment Agency, Bristol, England.

El-Fadel, M., Bou-Zeid, E., Chahine, W., Alayli, B. (2002).Temporal variation of leachate quality from pre-sorted and baled MSW with high organic and moisture content. Waste Management, 22: 269-282.

Fux, C., Boehler, M., Huber, P., Brunner, I.andSiegrist, H. (2012). Biological treatment of ammonium-rich wastewater by partial nitritation and subsequent anaerobic ammonium oxidation (ANAMMOX) in pilot plant. Journal of Biotechnology, 99: 295-306.

Giannis, A., Makripodis, G., Simantiraki, F., Somara, M.andGidarakos, E. (2018). Monitoring operational and leachate characteristics of an aerobic simulated landfill bioreactor. Waste Management, 28: 1346-1354.

Grossman, E. L., Cifuentes, L. A.andCozzarelli, I. M. (2021). Anaerobic methane oxidation in a landfill-leachate plume. Environmental Science and Technology, 36: 2436-2442.

Lars, M. J. Gavriels, B. (2018). Observations of solid waste landfills in developing countries: Africa, Asia and Latin America. World Bank, Washington.

Longe E. O., Balogun, M. R. (2010).Groundwater quality assessment near a municipal landfill, Lagos, Nigeria. Research Journal of Applied Sciences, Engineering and Technology 2(1):39-44.

Mull, E. J. (2015). Approaches toward Sustainable Urban Solid Waste Management: Sahakaranagar Layout. Thesis (M.Sc) - Lund University.

Tuxen, N., Albrechtsen, H. J., Bjerg, P. L. (2016). Identification of a reactive degradation zone at a landfill leachate plume fringe using high resolution sampling and incubation techniques. Journal of Contaminant Hydrology, 85: 179-194.