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Research Article
Assessment of Physical Quality of Leachates from Dumpsites in Port Harcourt and Environs, Rivers State, Nigeria

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Abstract

Background and Objective: Waste generation and disposal is a common issue all over the world. The problems associated with its disposal on the immediate environment calls for intense concern by man. This is due to contamination and pollution problem associated with wastes. This study was carried out to determine the levels of physical parameters from some selected dumpsites in Port Harcourt metropolis. **Materials and Methods:** Leachates were collected from dumpsites into plastic containers and the Hanna H1 9828 water quality checker was used to monitor the physical parameters of turbidity, total suspended solids (TSS), total dissolved solids (TDS), settleable solids (SS) and electrical conductivity (EC) for a year during dry and rainy seasons. The use of 2-way analysis of variance (ANOVA), t-test, graphs and mean variation were applied to explain trend and variations. **Results:** The results showed that there was no significant difference in temporal dimension (seasonally) but high level spatial variation (stations) in most parameters. TDS, SS, TSS, EC had relatively higher concentrations for both seasons exceeding both FMENV/WHO and standards for waste water discharge at the Rumuolumeni dumpsite. At the Eluozo dumpsite, turbidity, TDS, SS, TSS also exceeded the recommended standards seasonally except EC which was only by the wet season. Similarly, turbidity, SS, TSS, EC all exceeded permissible limits by the dry season while TDS values were below the limits. **Conclusion:** The study revealed that these dumpsites remain major pollutant entrants to the environment. Government can make conscious efforts to recover highly contaminated dumpsites like these by financing active remediation processes, enforceable laws, regulations and public health enlightenment and sensitization. Regular monitoring of the physical nature of dumpsites is advocated because it is what the psychomotor domain observes.

Key words: Physical characteristics, seasonal variation, dumpsite leachate, contaminants, waste management

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Uncontrolled waste disposal practices have remained the only choice of managing waste in our towns and cities probably due to the large volume of waste generated as population explodes without commensurate facilities. Landfilling has been one of the best forms of waste disposal management as it reduces environmental unfriendliness mostly for reducible, recyclable and combustible wastes[1]. Leachates are liquids emanating from water collecting contaminants as it flows through wastes and agricultural applications such as fertilizers and pesticides[2].

One of the major environmental issues in our cities today is improper solid waste handling and disposal[3]. Soils differ in their responses to organic wastes amendments which spur the need to study or the impact of organic wastes on the properties of the soil[4]. Though it has been observed that disposal of organic waste into agricultural land improves its properties, our major cities do not sort generated waste as to identify the unit impact of their inorganic components[5]. Pollutants even in waste dumps are potential threats to the ecosystem[6].

According to Amadi *et al.*[7], Nigerian dumpsites are abandoned burrow pits and acquired areas which were not chosen based on any legal environmental impact assessment studies. Afterwards, these waste dumps become hazards and potential threats to the soil and groundwater as a result of percolation of leachates with time[8].

This research work is an attempt to analyze the physical parameters of the leachates from selected government approved dumpsites within Port Harcourt metropolitan City. Further observation showed that assessment of soil pollution is potentially hard when pollutants emanate from different sources as their results become vastly circulated in different proportions[9]. According to Praveena and Rao[8], leachate percolation changes physico-chemical properties of the soil hence affect the underlying groundwater sources. High concentration of certain water quality parameters were also observed on the leachate characterization and assessment of groundwater pollution near municipal solid waste landfill sites[10]. Leachates from dumpsites differ in composition as a result of the prevalent wastes and its resident time.

The complication arising from the impacts serves a major intellectual property to researchers and the population at large for future references. Hazardous materials dissolved in the leachate has the capacity or potential to contaminate soil and groundwater[11]. High mean percentage variation from the controls for conductivity and other studied parameters has been observed in an earlier study.

Leachate from waste dumpsites is a major environmental concern to the researcher due to its negative impact such as being genotoxic as corroborated by Singh *et al.*[12] on similar area. This study is an attempt to analyze the impact of leaching on the physic-chemical parameters of the run-off water in the active dumpsites in Port Harcourt, Rivers State, Nigeria. The determination of physical properties of leachates from the selected dumpsites and the search for the relationship between the physical parameters and the controls and water quality standards forms the main objective of this study. The USEPA[13], observed that the contamination and hence pollution of water (surface and underground), soil and the atmosphere influences human health and ecological impacts which then add to the breakdown and destruction of important natural resources. Most developing countries do not have adequately lined dumpsites and without environmental impact assessment studies[7]. Improper management of waste from the point of generation to disposal results in the contamination of soil and groundwater[14]. Furthermore, the observed that the presence of water pollutants in all the reported samples showed a scientific relationship between solid waste, leachate and groundwater[14]. According to Dusing *et al.*[15], rivers impacted upon by leachate are usually yellow in appearance and support severe overgrowths of sewage fungus. It is pertinent to note that toxic metals and organics when available in leachates can cause chronic toxin accumulation in local and far populations. Observation has shown that diseases may sprout through water pollution, mostly groundwater contamination which may spiral beyond human reasoning due to its complex flow patterns[16].

Therefore, this study was carried out to investigate the concentration of some physical parameters in selected dumpsite leachates within Port Harcourt and its environs.

MATERIALS AND METHODS

Geography and location of study area: Port Harcourt is the capital city of the oil rich Niger Delta State of Rivers Nigeria. It lies along the Bonny River and Longitudes of 6°59'55" and Latitude of 4°47'21". Port Harcourt has a population of about 1,382,592 as of 2006 which has grown to 1,865,000 inhabitants[17] as at 2016. This is about 34% increase in population within a period of 10 years.

The area covered by Port Harcourt was 15.54 km^2 in 1914 but grew to 360 km^2 by the 1980s due to modernization and urbanization[18]. The study by Ogbonna *et al.*[18] estimated a total of 207.3 t of solid waste generation giving per capita annual waste generation rate of 0.53 t equivalent to a waste

Fig. 1(a-c): Sampling stations at (a) Igbo-Etche, (b) Eluozo and (c) Rumuolumeni dumpsites

Table 1: Study stations and geographical location

Stations	Description	Location
Ae	Igbo-Etche station A	N 04°53'44.8"/E 007°06'58"
B	Igbo-Etche station B	N 04°53'44"/E 007°06'58.6"
Ce	Igbo-Etche station C	N 04°53'44.12"/E 007°06'58.2"
Ao	Elozo station A	N 04°53'06.2"/E 007°00'52.0"
Bo	Elozo station B	N 04°53'07.0"/E 007°00'52.8"
Co	Elozo station C	N 04°53'06.2"/E 007°00'52.0"
Ar	Rumuolumeni station A	N 04°52'56.9"/E 007°00'46.0"
Br	Rumuolumeni station B	N 04°52'56.3"/E 007°00'46.6"
Cr	Rumuolumeni station C	N 04°52'56.6"/E 007°00'46.2"

generator rate of 1.45 kg/capita daily. Similarly, 16.1% of cartons, papers and food remnants had 14.4% whereas 26.6% of total waste generated, respectively. The geographical location of the study sites and sampling locations are shown in Table 1.

Three active dumpsites were chosen for this study within the Port Harcourt Metropolis. These are located primarily in two local governments of Obio-Akpor and Etche. They are the Igbo-Etche, Eluozo and Rumuolumeni dumpsites (Fig. 1) as approved by the regulators, Rivers State Waste Management Agency (RIWAMA). The nature of the longitudinal survey research design was adopted because samples were analyzed at different points or stations in time. Integrated samples were collected using the simple random sampling technique but controlled by and availability of leachates. Sampling was done in December, 2017 and June, 2018 representing the dry and wet season respectively. Leachate water samples were collected from 2 stations labeled A and B whereas, the 3rd station labeled C was taken some distances away from the dumpsite. The control samples were taken from pockets of water retained due to rains (wet season) whereas nearby surface pond water were used as control during the dry season especially in the Igbo-Etche dumpsite. These stations were given corresponding identifications so as to identify them for wet season sampling. This was scientifically noted using a Germin 45 Global Positioning System (GPS).

The physical parameters were measured *in situ* and hence, recorded in field book at the sampling sites using Hanna H1 9828 water quality multimeter checker. Data from the field were tabulated and analyzed using SPSS version 11.0 software package[19]. This included mean, standard deviation, mean variation, t-test, ANOVA and 95% confidence intervals. Similarly, statistical difference between the means of leachates during dry and rainy seasons were done using[19] t-test at $p \leq 0.05$.

RESULTS AND DISCUSSION

Results of analysis from leachates obtained in 3-selected dumpsites in Port Harcourt Metropolis; Igbo-Etche, Eluozo and Rumuolumeni for both the dry and rainy season is presented in Table 2-7. Table 2 is a result of the physical parameters for Igbo-Etche dumpsite during the dry season for turbidity, total dissolved solids, total Settleable solids, electrical conductivity, colour and odour. Station Be recorded the highest values of the physical parameters especially TDS and TSS (376 and 972, respectively). The TSS recorded mean concentration of 124±15.56, turbidity (20±18.03), TDS (300±108.19), SS (551±596.09) and EC (600±216.37). Table 3 is the result of the physical parameters for the leachate samples in Eluozo dumpsites during the dry season. There were relatively higher physical measures in station Ao when

Table 2: Physical parameters for Igbo-Etche dumpsite (dry season)

	Parameters					
Stations	Turbidity (NTU)	SS (mg L^{-1})	TSS (mg L^{-1})	EC (µS cm^{-1})	TDS (mg L^{-1})	Colour/odour
Ae	35	129	135	447	223	No peculiar colour
Objectionable Be	5	937	113	753	376	
Objectionable Ce	180	662	46	303	152	
Mean	20±18.03	551±596.09	124±15.56	600±216.37	300±108.19	
Mean variation (%)	88.89	11.41	62.90	50	49.33	

Table 3: Physical parameters for Eluozo dumpsite (dry season)

	Parameters				
Stations	Turbidity (NTU)	SS (mg L^{-1})	TSS (mg L^{-1})	EC (µS cm^{-1})	TDS (mg L^{-1})
Ao	278	1039	422	18.12	9020
Bo	211	854	316	11.29	5636
Co	53	189	84	236	118
Mean	245±47.38	947±131	369±62.97	14.71±4.83	7328±2393
Mean variation (%)	78.37	80.04	77.24	94.0	98.39

Table 4: Physical parameters for Rumuolumeni dumpsite (dry season)

	Parameters					
Stations	Turbidity (NTU)	SS (mg L^{-1})	TSS (mg L^{-1})	EC (µS cm^{-1})	TDS (mg L^{-1})	Colour
Ar	>1000	1160	520	15610	4880	Dark green
Br	>1000	1379	300	14750	5250	Dark green
Cr	33	658	150	6253	3040	Gray
Mean	>1000	1270±155	410±156	15180±608	5065.62	
Mean variation (%)	-	48.19	63.41	58.81	39.98	

Table 5: Physical Parameters for Igbo-Etche dumpsite (rainy season)

	Parameters				
Stations	Turbidity (NTU)	SS (mg L^{-1})	TSS (mg L^{-1})	EC (µS cm^{-1})	TDS (mg L^{-1})
Ae	9	177.03	4.5	10	5
Be	0	97.3	9	134	608
Ce	1	69.89	25.5	202	101
Mean	4.5±6.36	137.17±56.38	6.75±3.18	72±87.6	307±426
Mean variation (%)	77.78	54.88	25.50	64.36	67.10

Table 6: Physical parameters for the Eluozo dumpsite (rainy season)

	Parameters				
Stations	Turbidity (NTU)	SS (mg L^{-1})	TSS (mg L^{-1})	EC (µS cm^{-1})	TDS (mg L^{-1})
Ao	3	42.14	4.5	908	453
Bo	6	158.41	9	5520	2758
Co	17	24.86	25.5	332	162
Mean	4.5±2.12	100.28±82	6.75±3.18	3214±2307	1605,5±1630
Mean variation (%)	73.53	75.21	73.5	89.67	98.99

Table 7: Physical parameters for the Rumuolumeni dumpsite (rainy season)

	Parameters				
Stations	Turbidity(NTU)	SS (mg L^{-1})	TSS (mg L^{-1})	EC (µS cm^{-1})	TDS (mg L^{-1})
Ar	340	1215	490	15910	5346
Br	200	1155	315	15940	6550
Cr	60	125	110	940	1065
Mean	270±99	1185±42.4	403±124	15925±21	5948±851
Mean variation (%)	77.77	89.45	72.70	94.10	82.09

Table 8: Summary of mean concentration for season/standard limits (Rumuolumeni)

Parameters	Mean (dry)	Mean (wet)	FMENV/FEPA/WHO STDS	STDS for wastewater discharge
Turbidity (NTU)	>1000	270	5.0	
TDS (mg L^{-1})	5065	5948	2000	3500
SS (mg L^{-1})	1270	1185	30	
TSS (mg L^{-1})	410	403	50	40
EC (µS cm^{-1})	15180	15925	125	

compared to station Bo and Co. The mean values for TSS recorded was 369±62.97, turbidity (245±47.38), TDS (7328±2392.85), SS (947±130.82) and EC (14.71±4.83). Table 4 represents the result obtained for the physical parameter recorded at the Rumuolumeni study station with mean concentrations of 410±156, 5065±262, 1270±155 and15180±608 for TSS, TDS, SS and EC, respectively whereas, turbidity was above 1000 except at the control. The result indicated mean concentrations for Turbidity, SS, TSS, EC and TDS as 4.5±6.36, 137.17±56.38, 6.75±3.18, 72±87.68 and 307±426.39, respectively. From the results, the mean concentrations were as follows, turbidity (4.5±2.12), SS (100.28±82.22), TSS (6.75±3.18), EC (3214±2307) and TDS (16055±1630). Similarly, Table 7 gives the result of the mean concentrations of the physical parameters so analyzed for the Rumuolumeni dumpsite by the rainy season. The results indicated that turbidity was 270±99, SS (1185±42.43), TSS (403±124), EC (15925±21) and TDS as 948±851.

Turbidity which is the cloudy condition in water due to suspended silt or organic matter 2 recorded mean concentration of 20 NTU (Igbo-Etche dumpsite), 245 NTU (Eluozo) and >1000 NTU (Rumuolumeni dumpsite) during the dry season. Similarly[20] postulates that turbidity refers to a term describing the optical feature which induces light to be scattered and also absorbed instead of being transmitted in linear form through water. Similarly, during the wet season, Igbo-Etche recorded mean turbidity values of 4.5, 4.5 (Eluozo dumpsite) and 270 at the Rumuolumeni dumpsite. These values were relatively higher during the dry season due to lesser dilution effect and similar to the ones recorded by Nartey *et al.*[20] in Accra, Ghana. The result shows that the control stations had the least turbidity values due to lesser influence of dumpsite waste which was direct opposite of the 180 NTU recorded at the control station of the Igbo-Etche dumpsite due to the turbulence created in the water by domestic animals around the sampling point. These values are shown in Table 2-7 (both seasons). During the dry season, station Ae had higher turbidity value of 35 NTU as well as Ao at Eluozo sampling station which was same at the Ar (Rumuolumeni) station but greater than 1000 NTU. This shows a comparatively high turbidity due to the age, materials and type of soil around this study station. During the dry season, pigs were observed ruffling the leachate in the dumpsite hence, increasing the turbidity especially at the Rumuolumeni dumpsite.

At this study station (Rumuolumeni), turbidity was lower by the rainy season which can be traced to the function of dilution, lesser influence of rodents, pigs and humans on the leachate ponds (Ar and Br). Results also show that the closer the sampling point is from the dumpsite, the higher the turbidity[21].

Total suspended solids (TSS mg L^{-1}) recorded mean leachate concentrations of 124, 369 and 410 (dry) and 6.75, 6.75 and 403 (wet) for the Igbo-Etche, Eluozo and Rumuolumeni study stations. The recorded mean variation (%) from the control showed for dry and rainy seasons as 62.90, 77.24, 63.41 and 54.88, 73.53 and 72.70 for the respective study stations of Igbo-Etche, Eluozo and Rumuolumeni. All the leachate concentrations were above the general industrial waste water discharge standards except for Igbo-Etche and Eluozo during the rainy season (Table 8-10). These leachate concentrations were also above those recorded in earlier research studies except the Igbo-Etche and Eluozo (rainy season) as stated earlier[20]. The mean variation showed that there was serious influence of anthropogenic inputs.

Table 9: Summary of mean concentration for season/standard limits (Eluozo dumpsite leachate)

Parameters	Mean (dry)	Mean (wet)	FMENV/FEPA/WHO STDS	STDS for wastewater discharge
Turbidity (NTU)	245	4.50	5.0	
TDS (mg L^{-1})	7328	16055	2000	3500
SS (mg L^{-1})	947	100.28	30	
TSS (mg L^{-1})	369	6.75	50	40
EC (µS cm^{-1})	14.71	3214	125	

Table 10: Summary of Leachate mean concentrations for season/standard limits (Igbo-Etche)

Parameters	Mean (dry)	Mean (wet)	FMENV/FEPA/WHO STDS	STDS for wastewater Discharge
Turbidity (NTU)	20	4.5	5.0	
TDS (mg L^{-1})	300	307	2000	3500
SS (mg L^{-1})	551	137.17	30	
TSS (mg L^{-1})	124	6.75	50	40
EC (µS cm^{-1})	600	72	125	

The total dissolved solid (TDS) recorded mean concentrations (mg L^{-1}) of 300, 7328 and 5065 at the Igbo-Etche, Eluozo and Rumuolumeni dumpsites during the dry season respectively. This shows that TDS was relatively higher at the Rumuolumeni study station as TDS. This was probably due to the higher percentages of biodegradable organic waste from mostly domestic sources in the Rumuolumeni study station. This was similar to the study of Oketola and Akpotu[22] on the assessment of solid waste and dumpsite leachates and topsoil. This also supported 90% domestic waste composition of dumpsites in Ibadan[22]. Total dissolved solids encompass disintegrated organic and inorganic materials contained in water which in excess makes any water unfit for drinking or even use in industrial and laboratory processes[2]. Amadi[23] reported a range of 11.30-165.80 in dumpsite soils and 14.05-156.55 in groundwater of dumpsites in Aladinma, Owerri in Imo State. These ranges were relatively lower than what was recorded at the Rumuolumeni dumpsite and Igbo-Etche but higher than those of Eluozo both during the dry and rainy seasons. This shows that soil and nature of waste can affect the leachate composition especially the TDS value. The TDS value of 365 mg L^{-1} was recorded during the assessment of surface water quality around dumpsites in Ibadan, Nigeria[24]. In all, these values were far below WHO guidelines and EC admissible levels both of which have a maximum limit[25] of 1500 mg L^{-1}.

Similarly, surface water quality around Orita-Aperin dumpsite between 2004 and 2005 was monitored where TDS had mean values of 400 mg L^{-1} upstream and 910 mg L^{-1} downstream 24 and a yearly mean of 790 mg L^{-1}. The concentration of the total dissolved solid (TDS) also fell below the maximum allowable limit for drinking water[26]. Conversely, the TDS value recorded at the Rumuolumeni study station is well above the minimum (1500 mg L^{-1}) and the maximum (3000 mg L^{-1}) recommended for waste water discharge from urban areas and also general industrial wastewater discharge standards of maximum concentration 3500 mg L^{-1}. Comparatively, the mean TDS concentration was slightly higher in the Igbo-Etche study station (300-307 during the rainy season). Similarly, Eluozo dumpsite had a mean TDS concentration of 7328 during the dry season compared to the 16055 recorded during the rainy season. This is replicated in the Rumuolumeni sampling station as dry season had TDS mean concentration of 5065 while the rainy season recorded 5948. This trend was buttressed by Aboho *et al.*[24], in their study of surface water quality around dumpsites in Ibadan, Nigeria and Amadi[23] on the assessment of the effects of Aladimma dumpsite on soil and ground water. The mean concentrations of TDS were below those recorded by Aboho *et al.*[24] and Al-Yaqout and Hamoda[27], but only higher than those of Igbo-Etche (300 and 307) during both seasons. TDS concentration reflects the degree of mineralization and higher TDS volume can affect the physico-chemical features of the receiving water body. Similarly, high concentrations of TDS were also recorded in landfill sites at Matuail, Dhaka of 734 ppm[28]. The amount of TDS in the leachate exceeded that of WHO standard (2000 mg L^{-1}) for wastewater discharge of inland surface water[29,30]. It is important to realize that TDS is composed mainly of Inorganic salts and dissolved organics [31]. The amount of TDS gives the degree of mineralization hence, higher TDS values changes the physicochemical characteristics of the receiving water body[27].

Settleable solids (SS) which usually indicate the materials heavy enough to sink to the bottom of a wastewater or leachate container, measured an average of 551 (control inclusive) by the dry season at the Igbo-Etche dumpsite. The station Be (Igbo-Etche) had the highest value of 972 mg L^{-1} whereas, the lowest was 129 at the Ae sampling point. When compared to the control of 622 mg L^{-1} showed

that it was in an area of settleable silt and clay materials of heavy particles also. Similarly, in the Eluozo study station, SS was highest at Ao (1039) and least at the control station during the dry season (1039 and 189 mg L^{-1}, respectively). This was also in agreement with the result of the Rumuolumeni dumpsite where the Br had the highest of 1379 mg L^{-1} and the least was found at the control station of Cr (658 mg L^{-1}). The mean SS was 1270 for dry season at the Rumuolumeni site but when compared to the rainy season, the Igbo-Etche dumpsite had a lower concentration which is at variance with the works of Hossain *et al.*[21], on the impact of leachate on surface and ground water quality around dumpsites in Bangladesh. This was also corroborated by DCC and JICA[32], which showed that concentrations of pH, electrical conductivity and total suspended solids in leachate samples are lesser in rainy season sampling. During the rainy season excess concentration at the Eluozo and Rumuolumeni dumpsites recorded maximum concentration of 158.41 and 1215 mg L^{-1}. The excess mean concentration at the Rumuolumeni dumpsite during the rainy season was 1185, arbitrarily highest both in spatial and temporal dimensions which were primarily due to the age of the dumpsite and the nature of the deep leachate pond formed during the rainy season especially. This enables more materials to enter the site hence more SS concentration. Since total solid includes SS, TDS and TSS, it means that they are proportional to each other. As SS increases, the likelihood of TDS increasing is high. It was established by Ogundiran and Afolabi[33] that there is a significant correlation between TS, SS and some metals such as Cu and Cr.

The result showed that the SS mean concentration for all the sites were higher during the dry season. This may also be attributed to the lesser amount of water hence poor dilution effect. The values so recorded exceeded that recommended by environmental quality standards for water, effluent standards and wastewater discharge standards from urban areas[34]. According to Ogundiran and Afolabi[33], there is a significant correlation between Cu, Cr and SS in the leachates from municipal solid waste open dumpsite. The closest TDS value of 5306 mg L^{-1} was reported by Zakaria and Aziz[35] on the characteristics of leachate at Alor Pongsu Landfill site, Perak, Malaysia.

Electrical conductivity is a measure of the ease a given water sample has to allow flow of electrical current[36]. It also shows the potential of the ionizable dissolved mineral salts content in the water (specific conductance). This property which is dependent on the types of and qualities of dissolved substances in water recorded very high concentrations of mean values 12,204 µS cm^{-1} at the Rumuolumeni dumpsite but highest in sampling station Ar (15610) and lowest at the Br (14750) station during the dry season. The average electrical conductivity for the rainy season was 10930 showing that it was relatively higher during the dry season probably due to serial dilution and higher concentration per unit volume of leachate vis a vis the dissolved ions. These mean values were relatively higher than those observed by Agbozu *et al.*[37], ecosystem at Effurun waste dumpsite Southern Nigeria. Conversely, the electrical conductivity values recorded for Igbo-Etche and Eluozo dumpsites were relatively lower than those obtained at the Rumuolumeni dumpsite. Igbo-Etche and Eluozo dumpsites had mean concentrations of 501 and 88.47 (dry season), 115.3 and 2253 (rainy season). The value of 5520 was triggered at sampling point Bo which arbitrarily increased the mean concentration of EC at the Eluozo sampling station. This anomaly may have resulted from either lower measure of ground water intrusion or an indicator of mine waste or waste water. Similarly, electrical conductivity correlates with nutrients but this relative increases in conductivity may be linked to the presence of certain major coins and its interaction with groundwater which decomposes certain materials[38,39]. However, electrical conductivity has remarkable effect on the leachate when compared to those of the control station which is higher at waste dumpsite[40].

Similarly, results have shown that certain significant changes do occur in soils of waste dumps[41]. Electrical conductivity results for the sampled leachates are shown in Table 2-4 (dry season) and 5-7 for the rainy season.

All the dumpsites recorded objectionable odour and colour both during the dry and rainy seasons which was in consonance with earlier works on dumpsites and leachate composition[42], as most leachates generated in municipal landfills contain large quantities of organic and inorganic contaminants such as SS, TDS, nutrients and organics. This gives the leachates their peculiar odour and colour different from those of the control stations.

According to Kettunen and Rintala[42], the leachate composition may be influenced by certain factors such as degree of compaction, waste composition, climate and moisture content in waste. Generally, from research studies, leachates are known to have strong colours and bad odour as shown[43] in Table 2-7. The related trends physical parameters are shown in Fig. 2a-c for the sampled stations of Igbo-Etche, Eliozu and Rumuolumeni, respectively.

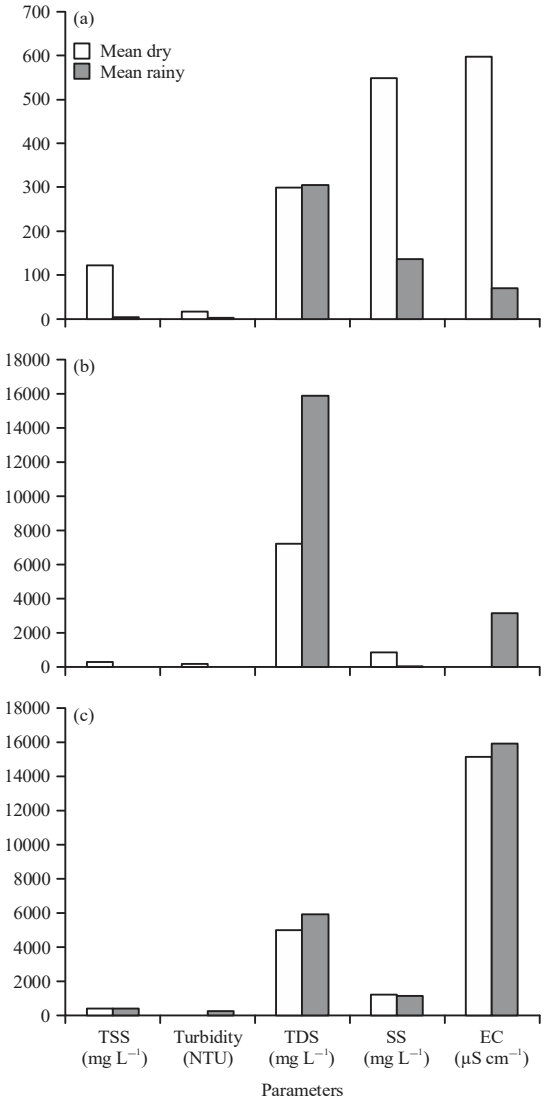

Fig. 2(a-c): Seasonal trend for physical parameters at the (a) Igbo-Etche leachates, (b) Eliozu dumpsite leachates and (c) Rumuolumeni leachates

CONCLUSION

The leachates were observed to be objectionably coloured, poor odour, alkaline and turbid. Physical parameters of the leachates from the samples of selected dumpsites indicate that the dumpsites have stable, objectionably colored, poor odor, alkaline and turbid composition. The TDS, SS, TSS, EC had relatively higher concentrations for both seasons exceeding both FMENV/WHO and standards for waste water discharge at the Rumuolumeni dumpsite. At the Eluozo dumpsite, turbidity, TDS, SS, TSS also exceeded the recommended standards seasonally except EC which was only by the wet season. Similarly, Turbidity, SS, TSS, EC all exceeded permissible limits by the dry season while TDS values were below the limits.

SIGNIFICANT STATEMENTS

This study discovers the possible effects of waste dump on the physical qualities of leachate that come from the dumps. This study will help the researcher to uncover the critical area of leachate characteristics and possible effect it will cause to the immediate environment such as soil and water source (surface and ground water), which might be contaminated by the leachate and subsequent transfer to biota (plants and animal). Thus, a new theory on the migration, transport and translocation of dumpsite leachate and its effect may be arrived at.

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