Effect Of Municipal Solid Waste on Soil and Ground Water Quality in Akure South, Ondo State

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Abstract- Improper waste disposal practices have raised concerns about potential environmental hazards. It is fueled by rapid urbanization and population growth. This study focuses on assessing the changes in the physiochemical properties of the soil in proximity to a municipal dumpsite and evaluating the extent of groundwater contamination. A total of ten soil samples were collected, three at varying distances around three different dumpsites, and groundwater samples were taken from three wells at different landfills. The soil parameters determined include pH, organic carbon content, organic matter content, nitrogen, potassium, phosphorus, sodium, calcium, magnesium, copper, iron, chromium and zinc. The water parameters determined include pH, calcium, copper, iron, nitrate, hardness, sulphate, total dissolved solids, dissolved oxygen, turbidity, chloride and zinc. The study found that the soils at the dumpsite were slightly acidic, with a pH range of 5.20 to 6.16. The heavy metals (Cu, Cr, Fe, Zn) were in the same range as the control site. The organic carbon and organic matter content were mostly in the same range as the control site, with ranges 0.28 % to 2.99 % and 0.48 % to 5.12 % respectively. The macro-nutrient concentrations were also in the same range as the control site. The water samples tested had a slightly acidic pH range of 5.94 to 6.68, with minimal heavy metal presence. Calcium levels were found ranging from 55.06 mg/l to 152.88 mg/l. Nitrate was found ranging from 12.45 mg/l to 2600.00 mg/l exceeding the NSDWQ and WHO standard. Other parameters like total dissolved solids, hardness, chloride, turbidity, and sulphate were below the NSDWQ and WHO limits. Statistical analyses indicated significant differences at 95% level. Treatment of water before use and use of alternative water sources as well as landfill redesigning are suggested.

Indexed Terms- Dumpsites, Groundwater, Wastes, Pollution, Hazard, Soil

I. INTRODUCTION

In the face of rapid urbanization and population growth, the Management of Municipal Solid waste (MSW) has emerged as a critical environmental challenge in many cities around the world. Municipal solid waste dumping is a frequent practice in underdeveloped countries, including Nigeria. Waste from various sources, including residential, office, and commercial buildings, often ends up in dumpsites. The various means of disposing of solid waste include burying, burning, open dumps, controlled tipping, feeding livestock, breakdown of biodegradable solid waste, deep geological injection, recycling, and sanitary landfills [25]. Burning of wastes and poorly disposal of ashes often occur, destroying organic components and causing metal oxidation. The ashes are enriched with metal, causing environmental pollution. An overabundance of waste has a detrimental impact on aesthetic value, ruins sceneries, and agitates the ecosystem in urban areas [32]. Additionally, it increases the breeding grounds for infections and disease vectors, raising the rates of morbidity and mortality as well as the cost of healthcare for locals [21].

Leachates and landfill gases are produced by waste decomposition, which occurs largely anaerobically. Due to the high organic fraction of solid waste discharged, dumpsites are also good gardening grounds [11]. Leachate is a contaminated liquid that flows through the bottom of solid waste disposal facilities like landfills [19]. Leachate's chemical composition concentration is mostly influenced by the sort of waste that is dumped there, as well as by the amount of irrigation, water infiltration, technology, and waste degradation that has taken place. Leachate from degraded solid waste carries harmful compounds and heavy metals such as Fe, Cu, Cd, Ni, Pb, and Zn [13].

Improper management of municipal solid waste (MSW) leads to pollution in air, soil, and water. Indiscriminate waste disposal contaminates water, causing stagnant water for insect breeding and flooding. Uncontrolled burning of wastes contributes to urban air pollution, while landfill decomposition generates greenhouse gases. Untreated leachate pollutes soil and water bodies. Improper MSW management also poses health and safety issues, as it can spread diseases and expose individuals to contaminants [9].

Groundwater is a vital natural resource and essential element of the environment used in human activities. It is the purest form of water and is least polluted. However, water quality is influenced by physical and chemical constituents due to weathering of parent rocks and anthropogenic activities. Groundwater consist of rainwater that percolates into the earth and comes into contact with soil minerals that may dissolve in the water. Contamination of groundwater can occur through the percolation of toxic substances through the soil. The rapid increase in industrialization and urbanization has led to the disposal of untreated effluents without proper treatment [16]. Groundwater is a crucial source of water for drinking, industry, and agriculture in the driest continent. It flows beneath the land surface, moving along flow paths from recharge areas to streams, lakes, and wetlands. Groundwater acts as a natural filter, protecting it from surface pollutants. It is found underground in aquifers, filling soil pores and cracks [28].

Leachate migration from waste sites and landfills can pose a significant risk to groundwater resources, which are unfit for their intended use. Groundwater can be contaminated if located near farming land, gas stations, septic tanks, waste-disposal sites, pesticides, fertilizers, and landfills. These contaminants can introduce bacteria into the water, contaminating it. Therefore, it is crucial to have well water tested for contaminants to ensure the safety of drinking water. Proper management of Leachate migration is essential to prevent water pollution. [1]. Groundwater protection is a critical environmental concern. Although open dumps are the oldest method of solid waste disposal, many have been closed. Because of human population expansion, industrial and technological revolutions, and complicated systems governing soil waste fate, waste management has grown increasingly complex [34].

Akure, the capital city of Ondo State, Nigeria, has experienced urban expansion and demographic changes over recent years [25]. As urbanization progresses, so does the generation of MSW, often exceeding the capacity of the existing waste management infrastructure. This situation has led to the accumulation of MSW in open dumpsites and uncontrolled landfills, raising concerns about its potential influence on soil quality and groundwater resources. Therefore, the objectives of this study are determine the impact of open dumpsite on soil and ground water quality in Akure South.

II. MATERIALS AND METHODS

2.1 Location of Study Area

The study area is the Federal University of Technology, Akure (FUTA) in Akure South Local Government, Ondo State. Akure is a medium-sized metropolitan center and the capital of Ondo State, one of Nigeria's thirty-six states. It is roughly located between Latitude 70 10'5.35"N and Latitude 70 18'56.77"N and Longitude 50 7'23.21"E and 50 22'35.48"E. The area is moderately undulating, with surface elevations ranging between 353 and 410 meters above mean sea level. It is located within the sub-equatorial climate belt of tropical rain forest vegetation, characterized by wet and dry seasons [5]. Dry season from November to March and a wet season from April to October. Akure has an average yearly rainfall of 1405 mm to 2400 mm with an average temperature of 27°C. The relative humidity ranges between 85 and 100% during the rainy season and less than 60% during the dry season period. with the rainy season accounting for 90% of the total, and the month of April marks the start of rainfall [6].

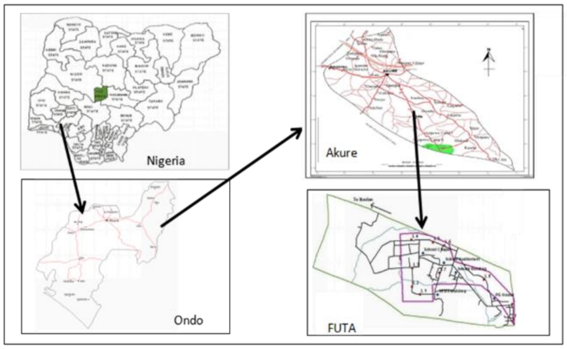

Fig 2.1. Map of Study area

2.2 Soil Samples Collection and Preparations
Soil samples are randomly taken from three different waste dumpsite, three samples form each site and one sample as a control from a neutral location void of municipal solid waste, all at a depth of 0 to15 cm using a soil auger according [22]. These depths are where the majority of plant nutrients are found [11]. A soil auger was used to extract soil samples from the ground. The samples were labeled as followed: location 1, location 2, location 3 and control point accordingly.

Soil samples were air dried at room temperature, with the drying time varying based on moisture content and weather conditions. The soil samples were then sieved through a 2 mm sieve. The physiochemical properties tested for includes pH, potassium, sodium, calcium, magnesium, organic carbon, organic matter, nitrogen, phosphorus, iron, chromium, zinc, and copper. The samples was taken to the Crop, Soil and Pest Laboratory in The Federal University of Technology Akure for tests.

2.3 Ground water sampling and collection
A total of Six water samples were obtained from the closest wells located within the distance of 20m radially away from the centre of each of the dumpsite sites at the three different dumpsites, two from each well [17]. The water samples taken were collected in 600 ml sterilized polyethylene bottles from each wells, then stored in a refrigerator at the laboratory, they were kept in a refrigerator between 0 and 14 degrees Celsius before being tested [7]. The analyses covered physical and chemical parameters of water samples. The parameters tested for included: pH, dissolved oxygen (DO), total dissolved solids (TDS), total hardness, total iron, nitrate, nitrite, turbidity, chloride, calcium and heavy metals such as copper, zinc and lead. The analysis was carried out in the Central Research Laboratory (CLR) Futa, Akure.

A pH meter of model HI-2211by Hanna instruments with pH range of -2 to 16 pH was used to determine the pH. Atomic absorption spectrophotometer (AAS) of model 210VGP by Buck and AAS wizard (software) was used to determine the heavy metals concentration. The determination of dissolved oxygen (DO), total dissolved solids (TDS), total hardness, total iron, nitrate, nitrite, turbidity, chloride and calcium concentration was carried out in the laboratories using standard methods for the examination of water. The analysis result was compared to World Health Organization (WHO) and Nigeria Standard for Drinking Water Quality (NSDWQ).

2.4 Statistical Analysis
Descriptive and analysis of variance statistics were used to compute physicochemical parameters concentration levels at different distances from dumpsites. Laboratory analysis was presented using charts, and one-way Analysis of Variance (ANOVA) was used to determine significant soil quality variations at depths of 0-15cm and the groundwater quality was analyzed using the one sample T test between the samples and the international standard values. The significance reported at ($P < 0.05$). The statistics were performed within batches using SPSS software version 25.

III. RESULT

This section presents the result of the data analysis. This is carried out in line with the research questions raised and hypotheses formulated to guide the study.

3.1 Soil Analysis

Table 3.1: Soil Test Results of Soil Samples at Various Locations within the Dumpsites.

Location	pH	OC (%)	OM (%)	N (%)	P (mg/kg)	K (Cmol/kg)	Na (Cmol/kg)

L1S1	6.02 ± 0.03	0.30 ± 0.01	0.51 ± 0.01	0.07 ± 0.01	7.35 ± 0.06	0.18 ± 0.01	0.24 ± 0.01
L1S2	5.20 ± 0.01	0.29 ± 0.01	0.49 ± 0.01	0.06 ± 0.01	9.44 ± 0.06	0.21 ± 0.01	0.43 ± 0.01
L1S3	5.73 ± 0.04	0.58 ± 0.01	1.01 ± 0.02	0.09 ± 0.01	10.15 ± 0.06	0.20 ± 0.01	0.28 ± 0.01
L2S1	5.89 ± 0.01	0.85 ± 0.01	1.47 ± 0.03	0.12 ± 0.0	15.86 ± 0.0	0.30 ± 0.01	0.36 ± 0.0
L2S2	5.70 ± 0.01	0.97 ± 0.01	1.67 ± 0.03	0.12 ± 0.0	37.04 ± 2.18	0.29 ± 0.0	0.36 ± 0.01
L2S3	5.22 ± 0.01	1.16 ± 0.01	2.00 ± 0.02	0.21 ± 0.01	12.79 ± 0.06	0.34 ± 0.01	0.45 ± 0.01
L3S1	5.72 ± 0.02	2.77 ± 0.01	4.78 ± 0.02	0.45 ± 0.01	30.44 ± 0.06	0.68 ± 0.01	0.80 ± 0.01
L3S2	5.78 ± 0.01	2.98 ± 0.01	5.12 ± 0.0	0.49 ± 0.01	32.47 ± 0.06	0.72 ± 0.0	0.87 ± 0.01
L3S3	5.96 ± 0.00	2.75 ± 0.00	4.76 ± 0.04	0.47 ± 0.01	46.80 ± 0.06	0.67 ± 0.01	0.86 ± 0.01
L4 (Control)	6.14 ± 0.03	1.14 ± 0.01	1.97 ± 0.02	0.19 ± 0.01	17.93 ± 0.05	0.23 ± 0.0	0.31 ± 0.01

Table 3.2: Soil Test Results of Soil Samples at Various Locations within the Dumpsites.

Location	Cu (PPM)	Fe (PPM)	Zn (PPM)	Cr (PPM)	Ca (Cmol/kg)	Mg (Cmol/kg)
L1S1	0.811 ± 0.001	1.322 ± 0.003	0.925 ± 0.001	0.070 ± 0.003	4.00 ± 0.0	1.90 ± 0.0
L1S2	0.585 ± 0.001	1.427 ± 0.001	0.911 ± 0.001	0.087 ± 0.004	4.35 ± 0.01	2.30 ± 0.01
L1S3	0.485 ± 0.002	0.861 ± 0.002	0.785 ± 0.001	0.075 ± 0.001	6.95 ± 0.01	3.45 ± 0.01
L2S1	0.655 ± 0.001	0.785 ± 0.001	0.847 ± 0.001	0.093 ± 0.001	6.70 ± 0.01	3.20 ± 0.01
L2S2	0.497 ± 0.001	1.035 ± 0.001	0.785 ± 0.001	0.085 ± 0.001	2.30 ± 0.01	1.20 ± 0.0
L2S3	0.564 ± 0.001	0.795 ± 0.001	1.045 ± 0.001	0.104 ± 0.003	12.60 ± 0.01	6.20 ± 0.01
L3S1	0.636 ± 0.001	0.957 ± 0.001	1.425 ± 0.001	0.089 ± 0.4	13.00 ± 0.0	6.50 ± 0.0
L3S2	0.494 ± 0.0	1.454 ± 0.0	0.046 ± 0.0	0.081 ± 0.4	14.70 ± 0.01	7.30 ± 0.01

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L3S3	0.732 ± 0.000	0.896 ± 0.001	1.217 ± 0.000	0.101 ± 0.001	14.40 ± 0.01	7.10 ± 0.01
L4 (Control)	0.524 ± 0.001	0.787 ± 0.002	0.699 ± 0.001	0.092 ± 0.001	6.80 ± 0.0	3.40 ± 0.0

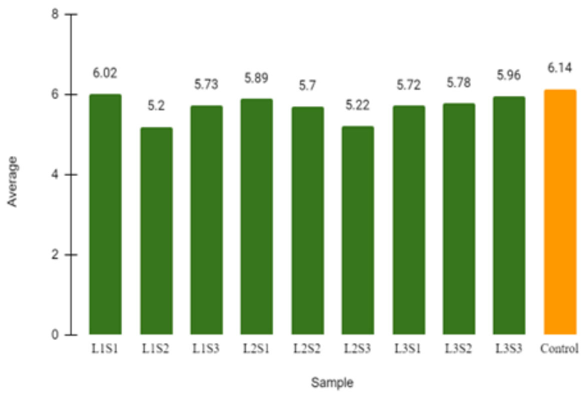

Figure 3.1: A chart showing the average pH

pH

The soil samples in locations L1, L2, L3, and Control site had a mean pH of 5.80, indicating slightly acidic surface soil at depth 15 cm.

The highest pH value was 6.16 at L4, while the lowest was 5.20 at L1 as shown in fig 3.1. The study found significant differences in mean values between the control site and other locations, However L1, L2, and L3 showed no significant difference. The pH value of the soil samples analyzed were similar in range to a study reported by [31]with pH range 5.23 to 5.83 but contrary to similar studies done by [14] and [18] with ranges from 7.6 to 7.95 and 6.95 to 7.4 respectively. However they all still fall within the safe range for soil.

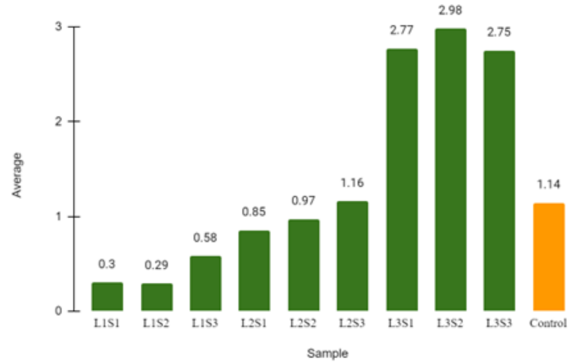

Fig 3.2: A chart showing the average organic carbon

Organic Carbon

The soil samples showed a range of organic carbon content from 0.28 % to 2.99 %, with a mean of 1.34 %. The highest OCC content was recorded at L3, while the lowest pH value was 0.28 % at L1 as shown in fig 3.2. The statistical analysis showed significant differences among locations, with L3 having the highest organic carbon content. The range of OCC in this study is similar to a study done by Akinbile (2012) but different to study carried out by [17] where the OCC recorded at the dumpsite was lower than that of the control.

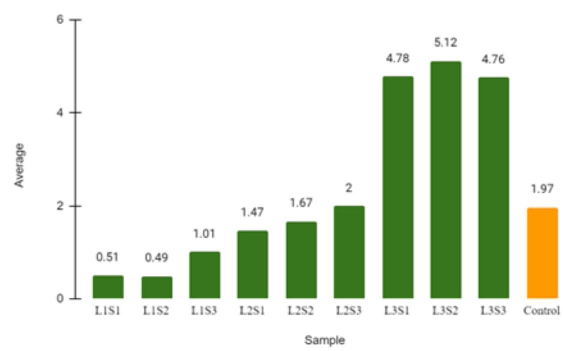

Fig 3.3: A chart showing the average organic matter

Organic Matter

The soil samples showed a range of organic matter content from 0.48 % to 5.12 %, with a mean of 2.30 %. The highest OMC content was at L3, with the lowest pH value at L2 as shown in fig 3.3. The statistical analysis showed significant differences among locations, with L3 having the highest OMC. The increase in OMC at L3 may be due to soil microbial activities decomposing organic waste, affecting moisture content and permeability [11]. Similar studies done in Ibadan Oyo state by [8], Akure, Ondo state by [6] and Akwa Ibom state by [20] recorded ranges 1.39 % to 5.89 %, 2.44 to 4.27 % and 0.41 % to 3.73 % respectively.

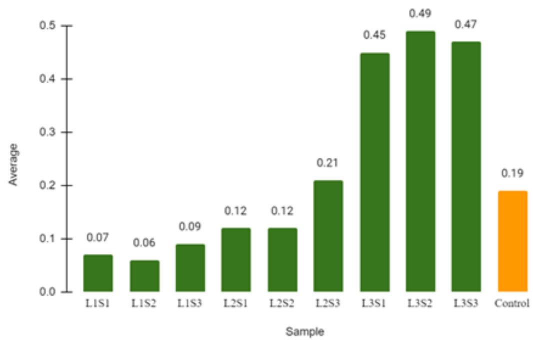

Fig 3.4: A chart showing the average nitrogen

Nitrogen

The range of nitrogen content in the various soil samples ranged from 0.05 % to 0.5 % and the mean value of 0.22 %. The maximum value of nitrogen content, 0.5 %, was observed at L3, while the minimum value of 0.05 % was recorded at L1 as shown in fig 3.4. The statistical analysis carried out shows significant difference ($p < 0.05$) in mean value among all the locations with L3 the highest, then L4, L2 and L1. The range of OCC in this study is in line with studies done in Ibadan, Oyo state by [8], Benin, Edo state by [31] with ranges 0.58 % to 1.66 % and 0.14 % to 0.16 % respectively.

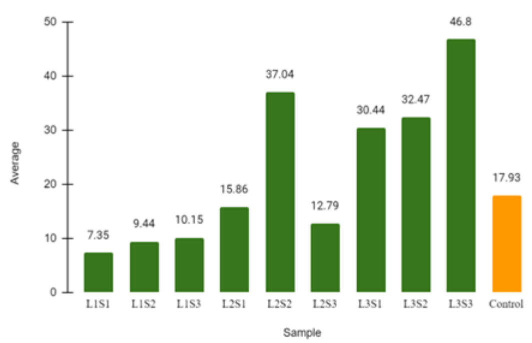

Fig 3.5: A chart showing the average phosphorus

Phosphorus

The soil samples showed varying concentrations of phosphorus, with a mean value of 21.28 mg/kg. The highest concentration was found at L3, possibly due to domestic waste and organic matter in the dumpsite. The lowest concentration was at L1, while the highest was at L3 as shown in fig 3.5. The statistical analysis showed significant differences in all mean values, with L3 having the highest concentration and L1 having the lowest however No significant difference was found between L2 and L4. The range of phosphorus in this study is not in tandem to similar studies done in Akure, Ondo state by [6] and Owerri, Imo state by [10] with phosphorus ranged from 11.36 to 33.52 mg/kg, and also ranged from 13.80 mg/kg respectively.

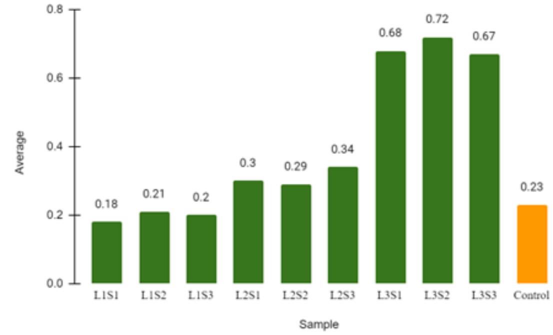

Fig 3.6: A chart showing the average potassium

Potassium

The study found a range of potassium concentrations in dumpsite soil, ranging from 0.17 Cmol/kg to 0.72 Cmol/kg, equivalent to 66.47mg/kg to 281.52 mg/kg. The lowest concentration was recorded at L1, while the highest was at L3. The mean value was 0.35 Cmol/kg, with L3 having the highest concentration as shown in fig 3.6. Potassium sources in dumpsite soil include decomposing organic matter, food waste, discarded items, packaging materials, and containers. The range of potassium in this study is in tandem to a study by [29] who found that the potassium content in most of the samples around the dumpsite were higher than the control site and in contrary to Gupta (2019)Who found potassium values lesser than this study.

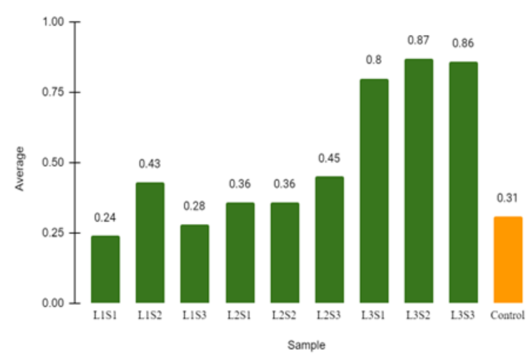

Fig 3.7: A chart showing the average sodium

Sodium

The range of sodium concentratio varied from 0.24 Cmol/kg to 0.87 Cmol/kg with a mean value of 0.46 Cmol/kg. The lowest value recorded at L1 is 0.24 Cmol/kg and the highest value recorded at L3 is 0.87 Cmol/kg. The mean value recorded at the control location is 0.524 Cmol/kg as shown in fig 3.7. The statistical analysis carried out shows significant difference ($p < 0.05$) in mean value with L3 being the highest then L2, L1 and then L4. However there is no significant difference in mean value between L1 and L4.A study carried out by Ahmed et al. (2014) recorded a higher range of sodium concentration from 1052.5 to 1779.6 mg/Kg which is not in line with this research.

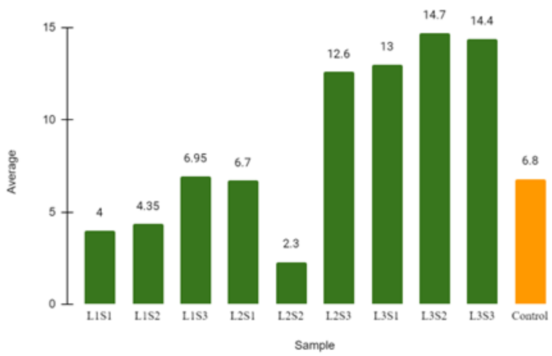

Fig 3.8: A chart showing the average calcium

Calcium

The calcium concentration ranged from 2.30 to 14.70 Cmol/kg, with a mean of 8.28 Cmol/kg. The lowest value was recorded at L2, while the highest was at L1. The control location had a mean of 6.80 Cmol/kg as shown in fig 3.8. Statistical analysis showed significant differences in mean values between L3 and other locations, but no significant difference was found between L1, L4, and L3. Studies done by [35] and [11] recorded contrasting range with maximum value of 7.21 Cmol/kg and 16.9 mg/kg respectively.

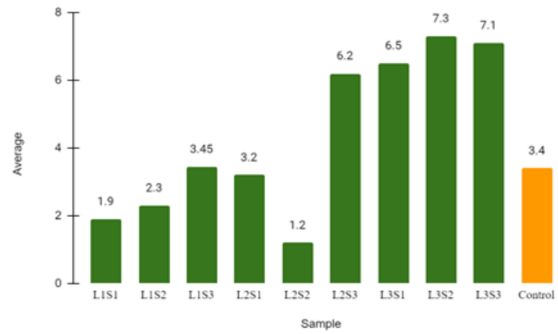

Fig 3.9: A chart showing the average magnesium

Magnesium

The magnesium concentration in a dumpsite ranged from 1.20 to 7.30 Cmol/kg, with a mean of 4.10 Cmol/kg. The lowest value was recorded at L2, while the highest was at L1. The control location had a mean value of 0.524 Cmol/kg as shown in fig 3.9. Magnesium sources in the dumpsite include fruit, vegetables, and fertilizers. Statistical analysis showed significant differences in mean values between locations. [35] recorded the maximum value as 1.3 Cmol/kg in a study which does not align with ranges of this study. Another research by Ahmed et al. (2014) recorded ranges from 72 to 579.5 mg/Kg which is not in tandem to this study.

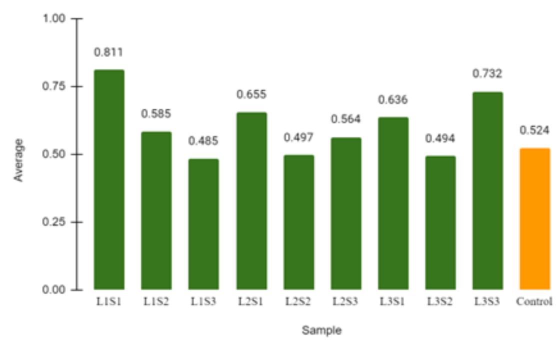

Fig 3.10: A chart showing the average copper

Copper

The concentration of copper in soils at the landfill ranged from 0.485 ppm to 0.811 ppm, with a mean value of 0.583 ppm. The lowest concentration was recorded at L1, while the highest was at L1 as shown in fig 3.10. Possible sources of copper include copper wires, vehicle parts, copper pipes, and alloys containing Cu. No significant difference was found in mean values across all locations. A study done in Bulawayo, Zimbabwe by [15] and Gazipur, Bangladesh by [36] reported a contrasting range of copper concentration from 49.7 mg/kg to 84.5 mg/kg. and 0.20 mg/kg to 0.51 mg/kg.

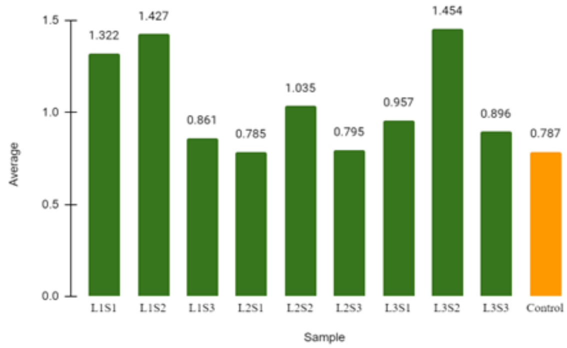

Fig 3.11: A chart showing the average iron

Iron

The iron concentration ranged from 0.785 ppm to 1.454 ppm, with a mean value of 0.991 ppm. The lowest value was recorded at L2, while the highest was at L3 as shown in fig 3.11. The control location had a mean value of 0.787 ppm. Statistical analysis showed no significant difference between the control site and L2, L2 and L3, and L3 and L4. Similar study done in Port-Harcourt, Nigeria by [20] recorded high levels of iron concentration than this study but contrary to a study done by [24] who found no trace of iron concentration.

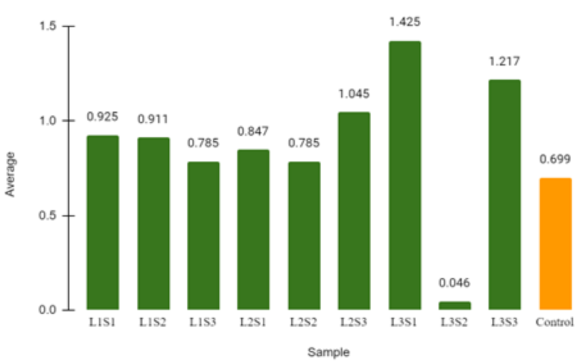

Fig 3.12: A chart showing the average zinc

Zinc

The zinc concentration in the dumpsite soils ranged from 0.045 ppm to 1.425 ppm, with a mean value of 0.088 ppm. The lowest and highest values were recorded at L3, respectively as shown in fig 3.12. No significant difference was found in mean values between control and other locations. The zinc concentration value range of the soil samples analyzed were not in line to a study by [20], with a range of value from 0.47 mg/kg to 5.43 mg/kg and by Ahmed et al. (2014) with a range of value from 29.88 mg/kg to 236.7 mg/Kg as they recorded higher levels. Zinc sources in the soils may include electronic waste, tires, rubbers, batteries, and paint cans.

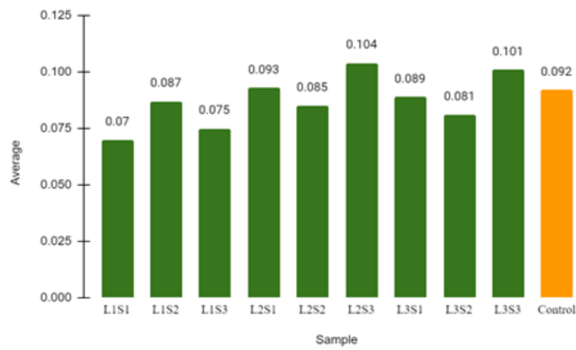

Fig 3.13: A chart showing the average chromium

Chromium

The chromium concentration ranged from 0.068 ppm to 0.106 ppm, with a mean value of 0.88 ppm. The lowest value was recorded at L1, while the highest was at L2 as shown in fig 3.13. The statistical analysis showed significant differences ($p < 0.05$) in mean values between L1 and other locations, with L1 having the least and L2 having the highest. However, no significant difference was found between L2, L3, L4. The mean value range of this study are in contrary to studies done in Eket Local Government Area of Akwa Ibom State, Nigeria by [20] with a range of value from 0.11 mg/kg to 1.68 mg/kg, another study done in Hyderabad, India reported by Ahmed et al. (2014) with a range from 10.31 mg/kg to 25.64 mg/Kg.

3.2 Water Analysis

Table 3. Soil Test Results of Soil Samples at Various Locations within the Dumpsites.

Sample	Ca (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TDS (mg/l)	Cl (mg/l)	DO (mg/l)	Hardness (mg/l)
Site 1	70.53	16.38	0.20	69.35	11.48	5.9	87.7
Site 2	151.40	2044.5	0.20	228.5	54.7	5.57	220.2

Site 3	55.21	2550.00	0.20	51.5	20.55	5.96	71.75
WHO	75	50	4.0	600	200 - 300	ND	100
NSDWQ	75	50	5.0	500	250	ND	150

Table 4. Soil Test Results of Soil Samples at Various Locations within the Dumpsites.

Sample	Sulphate (mg/l)	Cu (mg/l)	Zn (mg/l)	Pb (mg/l)	pH	Fe (mg/l)
Site 1	ND	ND	0.05	0.12	5.96	0.12
Site 2	70.723	ND	ND	ND	6.68	0.11
Site 3	0.57	ND	ND	ND	6.47	0.18
WHO	250	1	3	0.01	6.5 - 8.5	0.3
NSDWQ	100	1	3	0.01	6.5 - 8.5	0.3

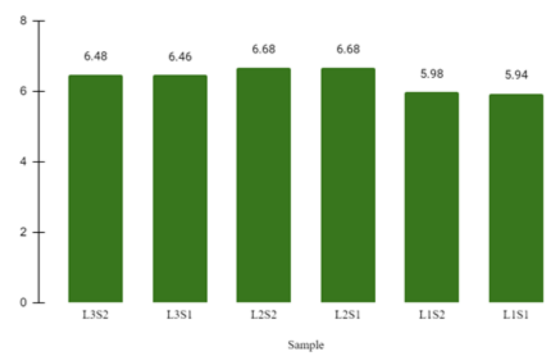

Fig 3.14: A chart showing the average pH

pH

The study reveals a range of pH values in water samples from 5.94 to 6.68, with the lowest recorded at L1 and the highest at L2 as shown in fig 3.14. This range is in tandem to result from studies done by [6] and [2]. The pH is slightly below the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality standards, indicating the presence of metals like zinc and lead. These metals may be attributed to the disposal of damaged battery cells and improperly disposed aerosol and disinfectant cans in landfills. The toxic, acidic nature of the water is due to exposure to air and water. Effective disinfection with chlorine requires a pH less than 8, but lower-pH water (approximately pH 7 or less) is more likely to be corrosive.

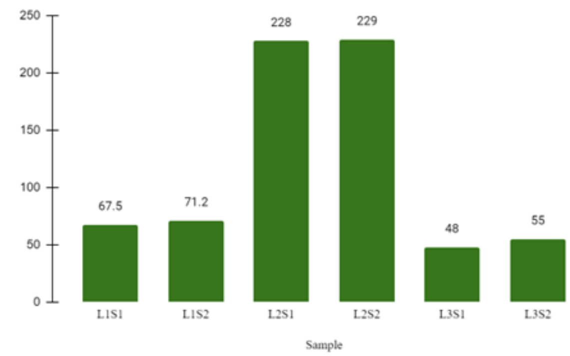

Fig 3.15: A chart showing the average total dissolved solids

Total dissolved solids

Table 4.16 shows the range of total dissolved solids in water samples from 48.00 mg/l to 229.00 mg/l in the study areas as shown in fig 3.15. The study's TDS range differ from previous studies by [6] and [2] as they found higher levels of concentration. The lowest value was 48.00 mg/l at L3, while the highest was 229.00 mg/l at L2. Statistical analysis comparing the study's results to WHO and NSDWQ standards reveals that the water's total dissolved solids content is significantly below permissible limits ($p > 0.05$).

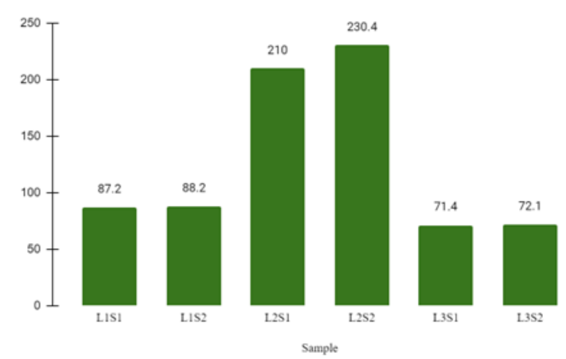

Fig 3.16: A chart showing the average hardness

Hardness

Hardness ranged from 71.40 mg/l to 230.40 mg/l, with the lowest values at L3 and L2. Iron ranged from 0.06 to 0.18, with the lowest values at L1 and L2 as shown in fig 3.16. This range is in tandem to results reported from a study by Okunade et al. (2019). The range of hardness in this study compared to the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality (NSDWQ) showed that the hardness of water for L1 and L3 is significantly below the permissible limits, while the hardness of water for L2 is significantly above the limits.

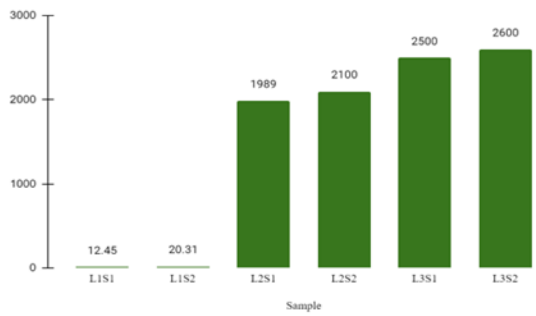

Fig 3.17: A chart showing the average nitrate

Nitrate

Nitrate ranged from 12.45 mg/l to 2600.00 mg/l, with the lowest values at L1 and L3. Chloride ranged from 11.04 mg/l to 58.18 mg/l, with the lowest values at L1 and L2 as shown in fig 3.17. This range is in contrary to studies by [23], [26] who found less values for nitrate concentration and [27] who found the nitrate value concentration to be 0 mg/l. The result of the study in comparison to the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality standards show that the nitrate concentration is significantly above the standard range of 50 mg/l.

Chloride

The range of chloride in the various water samples of the study areas ranged from 11.04 mg/l to 58.18 mg/l with a mean value of 28.91 mg/l. The lowest value recorded 11.04 mg/l at L1 and the highest value 58.18 mg/l recorded at L2 as shown in fig 3.18. The result of the study in comparison to the sample parameters in the World Health Organization (WHO) standard and the Nigerian Standard for Drinking Water Quality using a statistical analysis shows that the concentration of chlorine in the study is significantly below the permissible limit ($p < 0.05$). The range of this study is tandem with a studies done by [33] and [17].

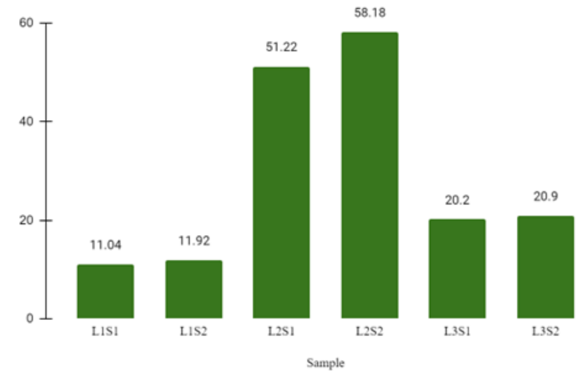

Fig 3.18: A chart showing the average chloride

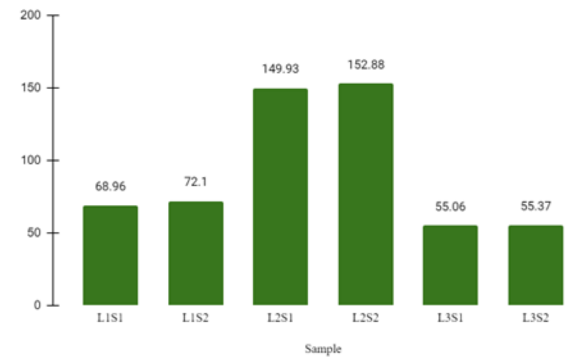

Fig 3.19: A chart showing the average calcium

Calcium

Calcium ranged from 55.06 mg/l to 152.88 mg/l, with the lowest values at L3 and L2 as shown in fig 3.19. This is in tandem with a studies done by [33] and [26] and [27]. The calcium content of water samples in this study in comparison to the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality (NSDWQ) standards show calcium in the study is significantly below the permissible limit ($p < 0.05$) at L1 and L3 however, the concentration of calcium at L2 is significantly above the permissible limit ($p > 0.05$).

Zinc

Zinc was only detected in one location and ranged from 0.05 mg/l. The result of the study in comparison to the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality standards show that the zinc slightly below the standard range. This is in tandem to a study done by [3] and [26].

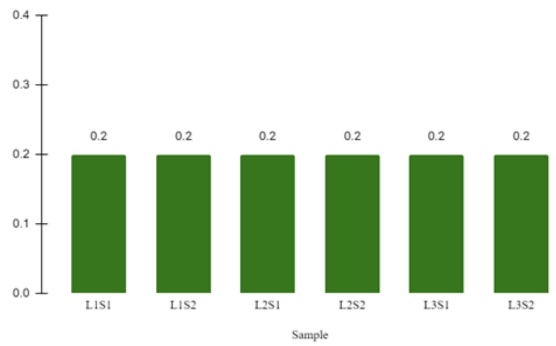

Fig 3.20: A chart showing the average turbidity

Turbidity

Turbidity ranged from 0.20 NTU. The turbidity of the water sample in comparison to the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality standards show that it is below the standard value of 5 NTU.

Copper

There was no trace of copper in any of the samples.

Lead

The study found that lead concentration in water samples in the study areas is above the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality limits although only L1 sample had lead concentration. This contradicts previous studies by [30] and [26], which showed levels of lead in water below the standard limits.

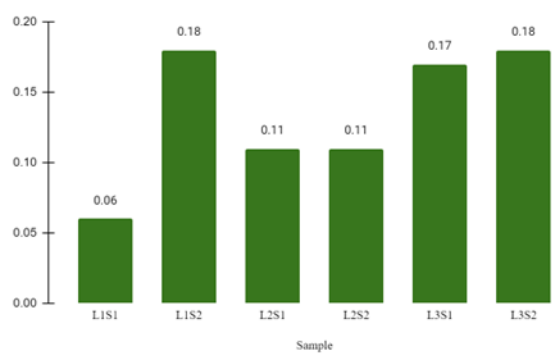

Fig 3.21: A chart showing the average iron

Iron

The range of iron in the various water samples of the study areas ranged from 0.06 to 0.18 with a mean value of 0.14. The lowest value recorded 0.06 at L1 and the highest value 0.18 recorded at L2 as shown in fig 3.21. The result of the study and comparison of the sample parameters in the World Health Organization (WHO) standard and the Nigerian Standard for Drinking Water Quality (NSDQW) shows that the concentration of iron in water in this study is below the permissible limits. This is in tandem to studies conducted by [12] and [17].

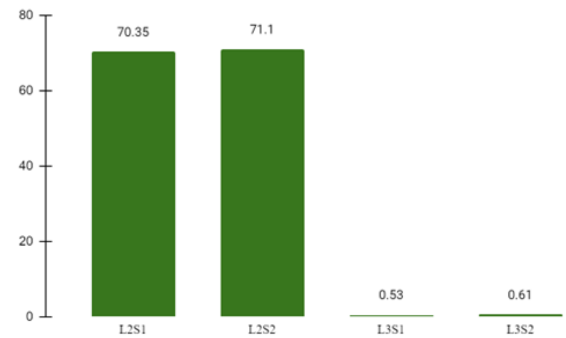

Fig 3.22: A chart showing the average sulphate

Sulphate

The study analyzed water samples in the study areas, ranging from 0.53 mg/l to71.10 mg/l, with the lowest value recorded at L1 and the highest at L2 as shown in fig 3.22. Statistical analysis showed that the concentration of sulphate in the study is significantly below the permissible limit ($p < 0.05$), consistent with previous studies by [6] and [23], which also found sulphate level below permissible limits.

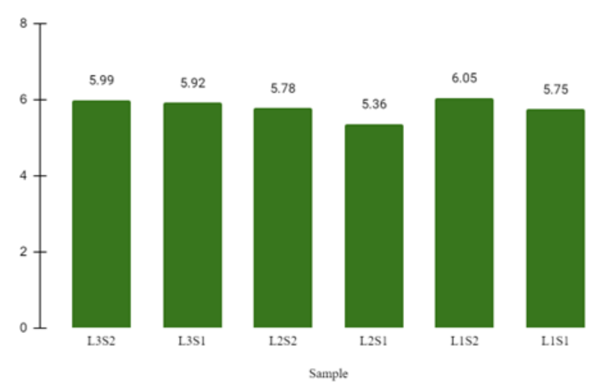

Fig 3.23: A chart showing the average dissolved oxygen

Dissolved Oxygen

The dissolved oxygen in water samples in the study areas, ranged from 5.36 mg/l to 6.05 mg/l. The lowest value was 5.36 mg/l at L2, while the highest was 6.05 mg/l as shown in fig 3.23. The study aligns with previous research by [23] and [17].

DISSCUSSION

This study indicated that soils at the dumpsite ranged between 5.20 to 6.16 in pH indicating the soils are slightly acidic. Result shows that the heavy metals (Cu, Cr, Fe, Zn) in the dumpsites location although were in range with the control site usually had the highest value at the dumpsite in Location 3. The organic carbon and organic matter content of the dumpsites mostly were in range with the control site with the soil in location 3 with twice the value at the control site. The macro-nutrients (N, P, K, Na, Ca, Mg) concentration of the dumpsites mostly were in range with the control site however, the soils in location 3 were twice the value at the control site. The pH of the water samples ranged between 5.94 to 6.68 indicating the are slightly acidic. There were little to no trace of the heavy metals (Cu, Fe, Zn) in the water tested. However, the traces of lead found in well 1 is above the permissible limit. The amount of calcium is mostly below the permissible limit with well 2 containing a high amount. Other parameters tested including total dissolved solids, hardness, chloride, turbidity and sulphate were below the permissible limit stated by NSDWQ and WHO.

CONCLUSION

This study shows valuable knowledge to the understanding of the environmental consequences of municipal solid waste. The findings underline the interconnectedness of soil and groundwater quality, emphasizing the importance of a comprehensive approach to environmental management. Some suggestion to remedy this situation include implementation of enhanced waste management practices to reduce the environmental impact of municipal solid waste. This may include waste segregation, recycling initiatives, and proper disposal techniques, Implement water quality treatment measures, such as the installation of permeable barriers, to prevent contaminants from leaching into groundwater, Strengthen and enforce regulatory measures related to waste disposal, ensuring that businesses and individuals comply with environmental standards to minimize the introduction of pollutants into the soil and groundwater, finally, alternative sources of water should be considered.

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