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PHYSICO-CHEMICAL CHARACTERISTICS OF WASTE DUMPSITE SOILS AND CONCERNS FOR PUBLIC HEALTH IN MAKURDI NIGERIA

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ABSTRACT

The disposal of household, municipal, and industrial waste indiscriminately on the soils in major cities in Nigeria is a major environmental challenge in the developing world. In this present investigation soil samples were collected from the soils of the selected waste dumpsites in Makurdi metropolitan area and analyzed for the physicochemical parameters using standard methods. The t-test analysis was significant across the physicochemical parameters at 0.05 level of significance in the course of the study. Similarly, results showed significant and positive relationships at 0.01 level of significance indicating that the waste dumped on the sites are the loading source of the elevated concentration of the soil characteristics during the study period. The study revealed that the elevated concentration in the parameters of soil quality of the waste dumpsites may be washed or leached into the groundwater and surface water sources that constitute the major source of domestic water in Makurdi. This situation can cause a health menace and environmental pollution due to the human consumption of theses water sources without adequate treatment thereby compromising the public health and constituting a nuisance to the residents of Makurdi, Nigeria. The study recommends that waste should be recycled and proper dumping facilities should be provided by the regulatory authorities instead of being dumped recklessly on soil to the preserve the quality of the environment and protect public health.

Keywords: Physicochemical, dumpsites, Soil, Makurdi .

1. INTRODUCTION

The public health effects and human living conditions in a deteriorating physical environment he lives is linked to the indiscriminate dumping of waste on the soil (Obianefo *et al.*, 2017). The disposal of solid waste which is usually the practice among humans in their ecosystems is the hygienically doing away with solid wastes from the human habitation. This is to avoid the public health menace of the wastes (Aboho *et al.*, 2011). Dumpsites have been associated with one of the major nuisance of compromising the groundwater quality. Theses wastes that are usually dumped on the sites include municipal, commercial and industrial (Sulaima *et al.*, 2016). Solid waste management is of global concern for both the developed and developing countries (Ahmed, *et al.* 2014). The different waste generated by different activities of humans and the

Vol. 06, No. 01; 2021

ISSN: 2456-8643

manner in which the wastes are disposed off is a threat to the environment and public health (Ahmed *et al* ., 2014). All the same the challenge and main environmental concern linked with the dumping or doing away with wastes generated by industries and urban areas through the anthropogenic activities is one of the soil contamination sources of the soil quality (Ogbonna *et al.*, 2009). Dumping of domestic, commercial and industrial wastes in the globe is a challenge that is on the increase with civilianization of man, with the population growth and there is no method at the moment that is healthy in its totality for the disposal of theses wastes (Osazee, *et al*., 2013). As result of the growth in the human population within the metropolitan areas, the environment is open especially to water or soil as a source of dumping wastes and it has become the major reservoir for liquid and solid wastes generated from the municipal and industrial activities due to the scarcity of disposal sites or facilities and lack of proper planning of a city as it is been observed in Makurdi Benue state, Nigeria. (Borude and Patil, 2011). This situation is very common in Makurdi metropolitan area where waste is indiscriminately dumped on the soil within human residents without minding the effect of these waste on the receiving soil with it consequent effect on the groundwater sources of the area. This attitude of indiscriminate disposal of wastes is also a public nuisance to the environmental and public health with the risk of foul odour, causing eye soar by affecting the anesthetic of the environment and even causing diseases. This is due to the lack of appropriated waste disposal bins in most homes within Makurdi and the lack of designated waste dump sites set up by the sanitation regulatory authorities in the state and the poor attitude of the people towards environmental sanitation. This study therefore is designed to assess the physico-chemical quality of soils of wastes dumpsites in Makurdi.

2. MATERIAL AND METHODS

Study area

The study area was carried out in Makurdi, North Central Nigeria. Five dumpsite located in the major markets in the town were selected for the study. These markets were North-bank, High-level, Markurdi Modern market, Wadata and Wurukum. Makurdi lies between latitude 7^0.44N and longitude 8^0.54N.It is located on the flood plain in lower River Benue valley (Fig 1). The physiographic characteristics span between 73-16m above sea level, sizeable portion of Makurdi is water logged during heavy rain storms. The atmospheric temperature in Makurdi is usually high throughout the year due to constancy of isolation with the maximum of 32^0C and minimum of 26^0C (Irtwange and Sha'Ato, 2009). Harmattan winds are accompanied with cooling effect mostly during the nights of December and January (Nyagba, 1995).

Soil Sample collection

Dumpsite soil samples were collected using a bucket auger at a depth of 0-15cm from five major markets located in Makurdi. These were: North bank, High-level, Wurukum, Morden market and Wadata. A transect section of 10m × 10m was set at each of the dumpsites and the soil was collected within 1m ×1m quadrant throughout the study period at the various dumpsites and taken to the laboratory. In the laboratory the samples were air dried at room temperature of (25^oC), crushed in mortar and passed through a 2-mm mesh size sieve for analysis.

Determination of physico-chemical parameters of the Soil

Vol. 06, No. 01; 2021

ISSN: 2456-8643

The pH and electrical conductivity were determined using a HANNA model 220054 Conductivity meter. The standard titration method was used for the determination of chloride content of the dumpsite soils. About 10g of air dried soil sample from the dumpsite was dissolved with 100ml of distilled water and was stirred thoroughly. A dilution of 1: 10 was prepared and the chloride content of the five locations was determined through the standard titration method. Readings were recorded in mg/l as Chloride Concentration as : V×M×35.457×100/S Where V = is the volume of the titrate (ml), M= morality of the titrate (0.02) and S= the volume of the sample, (Saxena, 1990)

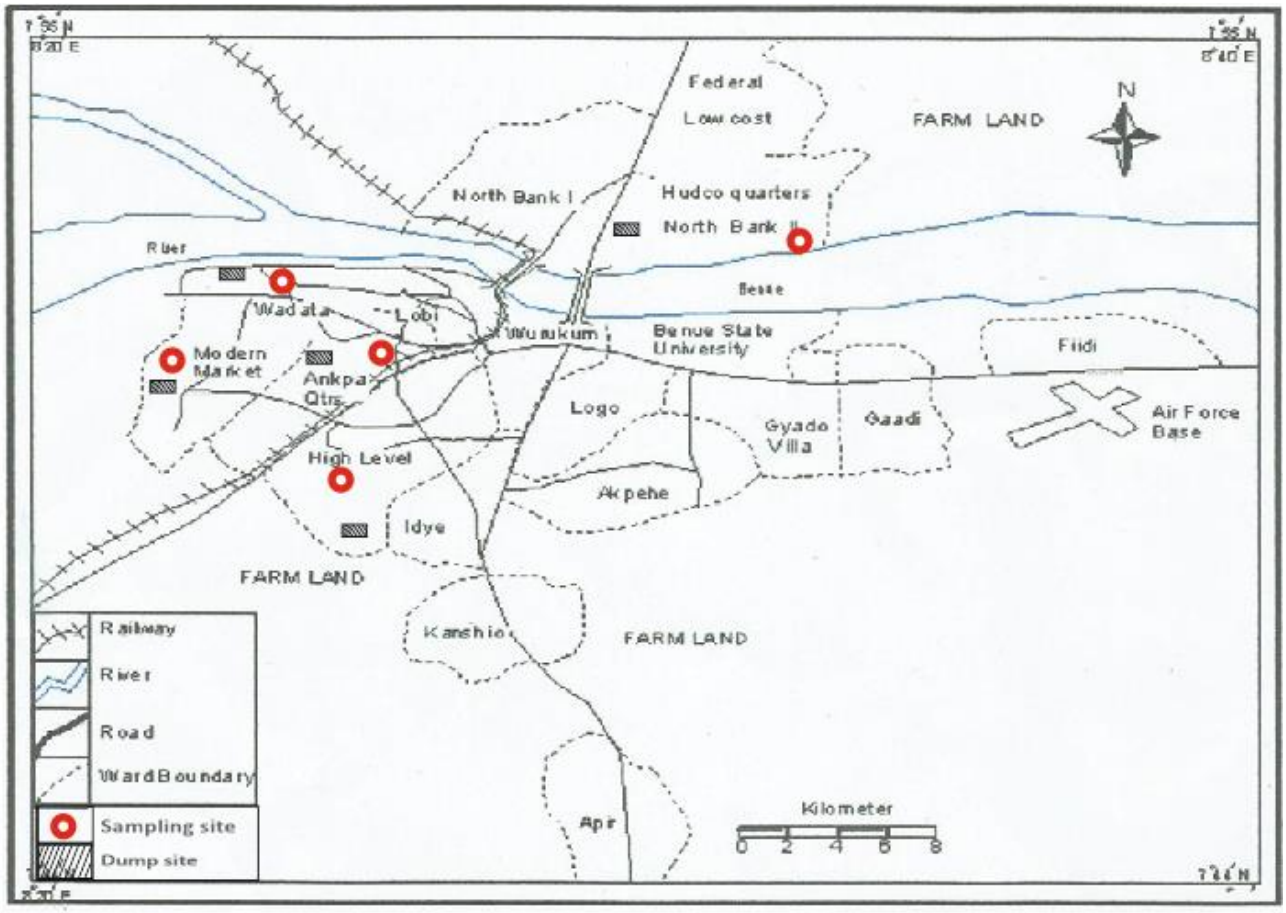

Fig. 1: Map of Makurdi Town Showing the Study Localities (Source: Benue State Ministry for Lands and Survey, 2011)

Vol. 06, No. 01; 2021

ISSN: 2456-8643

Where V = is the volume of the titrate (ml), M= morality of the titrate (0.02) and S= the volume of the sample. .

The reading was then converted to mg/g using the below formula:

$$\text{Concentration of Chloride in mg/g} = \frac{\text{mg/l reading} \times \text{vol. of dilution}}{\text{Weight of sample}}$$

Where: volume of dilution= 100ml, and Weight of sample=10g (Saxena, 1990). The nitrate, sulphate phosphate, copper calcium and magnesium were determined using spectrophometer (DR 2010 model). 10.00g of air dried sub sample from the dumpsite was measured and dissolved in 100ml of distilled water to make 1: 10 preparation for each of the parameters. This mixture was stirred gently to homogenize and equilibrate. The residues were separated through filtration and the concentrations of various parameters in the samples from the five locations were determined after 30minutes using spectrophotometer and the readings were recorded appropriately in mg/l. The results were converted to mg/g using the formula below:

$$\text{Concentration in mg/g} = \frac{\text{reading of spectrophotometer} \times \text{vol. of dilution}}{\text{Weight of sample}}$$

Where: volume of dilution = 100ml and Weight of sample=10g (Saxena, 1990).

3. DATA ANALYSIS

The obtained data was subjected to the measure of central tendency and t test analysis was carried out. Correlation was also determined to test the relationship between the wastes dumpsites and the soil parameters at the different locations in Makurdi. The parameters were also plotted to indicate their trend of concentration at the various dumpsites soils in the study area.

4. RESULTS

Physico-chemical quality of soils at the waste dump sites in Makurdi during the period of the study are shown in table 1. The characteristics of the dumpsite soils were conductivity 118.97±20.31µS/cm, pH 7.56±1.28, TDS, 76.58±41.25mg/g, chloride, 81.35±24.34mg/g, nitrate, 21.44±8.61mg/g, sulphate, 15.59±5.98mg/g, phosphate, 9.19±1.72mg/g, copper, 1.60±0.47mg/g, calcium, 21.47±4.69mg/g and magnesium, 23.34±4.489mg/g during the time of the study.

Table 1: Characteristics of Dumpsite soils in Makurdi

Parameter	Unit	Lowest	Highest	Mean	Std Deviation
Conductivity	µS/cm	89.47	180.31	118.97	20.23
pH		6.40	9.31	7.56	1.28

Vol. 06, No. 01; 2021

ISSN: 2456-8643

TDS	Mg/g	35.14	141.21	76.58	41.25
Chloride	Mg/g	59.44	121.37	81.35	24.34
Nitrate	Mg/g	13.49	33.93	21.44	8.61
Sulphate	Mg/g	9.28	24.64	15.59	5.98
Phosphate	Mg/g	6.75	11.24	9.19	1.72
Copper	Mg/g	1.01	2.11	1.60	0.47
Calcium	Mg/g	11.92	27.33	21.47	4.69
Magnesium	Mg/g	11.78	30.47	23.34	4.89

Table 2 shows the physico-chemical parameters at different dumpsites soil in Makurdi, Benue state Nigeria. A perusal at the result obtained indicate that pH was highest at modern market, (9.31) and lowest across the dumpsite soils at Wurukum market. In terms of electrical conductivity , 180.41µS/cm was highest at the Wurukum market dumpsite soils and that of Wadata market 89.11µS/cm was the lowest across the selected dumpsite soils. Nevertheless, the chloride concentration in the dumpsite soils of modern market of 121.37mg/g was the highest while that of the Wadata market (59.44mg/g) was the lowest in the soils of the dumpsites during the study period. The modern market dumpsite soil had the highest concentration of 33.93mg/g of nitrate ion during the study while that of Wadata market of 13.49g/g was determined to be the lowest among the selected dumpsites soils. The concentration of sulphate 24.64mg/g in the dumpsite soil of modern market was the highest and the lowest sulphate concentration of 9.38mg/g was obtained in the dumpsite soil at High level waste dumpsite. The North bank market dumpsite soil was determined to have the highest phosphate concentration of 10.11mg/g and High level dumpsite soil had the least phosphate concentration of 6.75mg/g among the studied soils. The concentration of copper in the dumpsite soil sample of 2.11mg/g was the highest in the soil of the dumpsite at High level market, while the lowest was in the dumpsite soil at Wurukum (1.01mg/g). Calcium concentration was highest in Wadata with a concentration of 27.33mg/g and the least value was recorded at the Wurukum (15.41mg/g). The concentration of magnesium was 30.47g/g in the soils of the dumpsite at modern market which was the highest, while the lowest magnesium concentration of 18.69mg/g was recorded at Wurukum dumpsite.

Table 2: Physico-chemical parameters at the Different Dumpsite Soils in Makurdi

Parameters	Ankpa	High level	Wadata	Morden	North bank
(Units)	quarters	Market	Market	Market	Market
pH	6.40	8.50	6.74	9.31	6.82

Vol. 06, No. 01; 2021

ISSN: 2456-8643

TDS(mg/g)	141.20	35.40	50.21	67.88	88.47
Conductivity(µS/cm)	180.41	125.11	89.11	131.63	108.31
Chloride (mg/g)	74.31	85.22	59.44	121.37	66.42
Nitrate(mg/g)	14.38	19.21	13.49	33.93	26.17
Sulphate(mg/g)	11.24	9.38	17.12	24.64	15.68
Phosphate(mg/g)	8.34	6.75	11.24	9.49	10.11
Copper (mg/g)	1.01	2.11	1.21	1.95	1.74
Calcium(mg/g)	15.41	18.37	24.12	27.33	22.11
Magnesium(mg/g)	18.69	22.41	19.33	30.47	25.81

Table 3 is the correlation analyses of physico-chemical soil quality between the dumpsites at the studied locations in Makurdi, Nigeria. The result showed a significant relationship at 0.01 levels between Wurukum and high level market, Wadata market, modern market and North bank dumpsites soil throughout the period of the study.

Table 3: Correlation Between the Physico-chemical Parameters at Dumpsite Soils in Makurdi

Correlations

Location	**Correlation type**	**Ankpa quarters**	**High-level market**	**Wadata market**	**Modern market**	Northbank market
Ankpa quarters	Pearson Correlation	1	0.833**	0.933**	0.846**	0.980**
	Sig.(2-tailed)		0.005	0.000	0.004	0.000
	N	9	9	9	9	9
High- level market	Pearson Correlation	0.833**	1	0.959**	0.967**	0.870**
	Sig.(2-tailed)	0.005		0.000	0.000	0.002

Vol. 06, No. 01; 2021

ISSN: 2456-8643

	N	9	9	9	9	9
Wadata market	Pearson Correlation	0.933**	0.959**	1	0.964**	0. 962**
	Sig.(2-tailed)	0.000	0.000		0.000	0.000
	N	9	9	9	9	9
Modern market	Pearson Correlation	0.846**	0.967**	0.964**	1	0.911**
	Sig.(2-tailed)	0.004	0.000	0.000		0 .001
	N	9	9	9	9	9
North bank market	Pearson Correlation	0.980**	0.870**	0.962**	0.911**	1
	Sig.(2-tailed)	0.000	0.002	0.000	0.001	
	N	9	9	9	9	9

**. Correlation is significant at the 0.01 level (2-tailed).

5. DISCUSSION

The physical and chemical quality of the waste dump sites soil in Makurdi, Benue state Nigeria was studied. Obasi *et al.*,(2015) reported lower conductivity values at four dumpsites soil in Abakaliki urban, Southeastern Nigeria that varied from 59.4- 125cm/hr. This finding differs significantly from the result of this study that recorded more higher values of conductivity in the soils of waste dumpsite in Makurdi, Nigeria. The difference in the conductivity values may due the nature and type of wastes dumped at the dumpsites in the different locations and the time of the study. The pH of the waste dumpsites soil of this present investigation differs significantly from the finding of an earlier study of the open waste dumpsite soils in Yenagoa, Nigeria that reported moderately neutral mean pH of the soil of 7.60±0.02, (Amos- Tautua *et al.*, 2014). Similarly the physicochemical parameters of the soils of the waste dumpsite in Benin city, which were conductivity that ranged from 164- 540µS/cm and phosphate concentration of that varied from 8.803- 12.852mg/kg , at four different wastes dumpsite soil that are higher is at variance with the result of this study that reported lower concentration of the two parameters in the soils of the waste dumpsites in Makurdi(Osazee, *et al.*, 2013). However, Osazee *et al.*, (2013) reported lower concentration of pH, phosphate, nitrate calcium, magnesium and copper in their studies as compared to the result of this present study in Makurdi, Nigeria on the waste

Vol. 06, No. 01; 2021

ISSN: 2456-8643

dumpsites soil. The difference in the physicochemical parameters in the soils may be due the nature of the soil and the type of the waste dumped at the soils. Ahmed *et al*., (2014) reported higher concentration of calcium and magnesium in the solid waste dumpsite soils as compared to the findings of this study.

The significant correlation of the parameters amongst the waste dumpsite soils in Makurdi, Nigeria depict that the waste dumped at the different dumpsite sites are the main source of the physiocochemical characteristics of the soil during the period of the study and that the nature of the waste products that are dumped could be similar. It is interesting to note that most of the waste products that are dumped at these sites come from perishable Agricultural produce and exhibit a similarity amongst the markets. These products are found at various stages of decomposition and the products of this process are leached into the soil over time through several processes. They therefore elevate the status of these physicochemical parameters in the soil and may leach into the ground water and surface water sources. This may contaminate the water for consumption at some instances and constitute environmental public health nuisance on the resident of Makurdi that uses these water without adequate treatment as the major source water for consumption and other domestic activities.

As these compounds find their way in the surrounding bodies, they also elevate the status on the beds of these water bodies and incidentally serve as nutrients to aquatic macrophytes that populate these water bodies. This apart from making these water bodies more turbid, it also decreases visibility in these bodies and increases the oxygen demand thus reducing the quality of the water bodies to the detriment of living organisms in these bodies as the presence of organic contaminants in the water also increases.

6. CONCLUSION

The physicochemical characteristics of the soil of the waste dumpsite soils was due to the content of the waste dumped on the sites in Makurdi. These wastes compromise therefore the physicochemical quality of the soil which can be washed into the ground and surface waters thereby polluting them for domestic and other uses. It was concluded that waste should not be dumped indiscriminately without adequate treatment and recommended that that the recycling of the waste and dumping facilities should be provided by the State Government.

The regulatory agencies particularly the State owned sanitation agency should be up and doing as most of these wastes are allowed to stay where they are dumped and the process of decomposition is almost completed before they are removed leaving very foul odors in their trail. Adequate provision should also be made for refuse bins to forestall the effects and menace of environmental public health on the residents of Makurdi.

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