ISSN: 2454-1907
DOI: https://doi.org/10.29121/ijetmr.v4.i10.2017.102

IJETMR
International Journal of Engineering Technologies and Management Research
A Knowledge Repository

# HEAVY METALS AND SOME PHYSICOCHEMICAL PARAMETERS IN SOIL OF MAJOR DOMESTIC DUMPSITES IN AKURE TOWNSHIP, ONDO STATE, SOUTH-WESTERN NIGERIA

**Ojo OlabimpeIyabo[1], Jegede Rufus Oluwafemi[2], Ajayi Morenike Grace[3], Osibanjo Oladele[4]**

[1, 2, 3]Department of Chemistry, College of Education, Ikere-Ekiti, Ekiti State, Nigeria
[4]Department of Chemistry, University of Ibadan, Oyo State, Nigeria

**Abstract:**

***Heavy metals and soil physicochemical parameters were identified as environmental pollutants in some major domestic dumpsites in Akure city of Ondo state. The pH of the domestic dumpsites ranged from 7.07 to 7.69 with a mean value of 7.33. the organic carbon for the domestic dumpsites ranged from 0.46% to 1.18%, while the organic matter was between 0.80% and 2.05%. the concentration of Zn, Fe, Cu, Pb, Cd, Ni and Cr in µg/g in the domestic dumpsites A and B ranged between 360.00-441, 169.60-547.20, 37.20-102.00, 18.80-80.00, 2.36-2.95, 11.00-19.20 and 18.00- 42.20 all in µg/g respectively. Also, the contamination pollution index of Zn, Fe, Cu, Pb, Cd, Ni and Cr all in the domestic dumpsites A and B ranged between 2.57-3.15, not detected, 1.03-2.83, 0.32-0.94, 2.95-3.68, 0.31-0.55 and 0.18-0.46 respectively. Pearson correlation indicated that Zn, Fe, Ni and Pb were highly significant (p<0.01).***

**Keywords:** *Heavy Metal; Physicochemical Parameters; Domestic Dumpsites.*

**Cite This Article:** Ojo OlabimpeIyabo, Jegede Rufus Oluwafemi, Ajayi Morenike Grace and Osibanjo Oladele. "HEAVY METALS AND SOME PHYSICOCHEMICAL PARAMETERS IN SOIL OF MAJOR DOMESTIC DUMPSITES IN AKURE TOWNSHIP, ONDO STATE, SOUTH-WESTERN NIGERIA." *International Journal of Engineering Technologies and Management Research*, 4(10), 26-32. DOI: https://doi.org/10.29121/ijetmr.v4.i10.2017.102.

## 1. Introduction

Soil is an extremely important component of terrestrial ecosystem. It is essential to humanly because, it is the top layer of the earth in which plants grow. This makes it to play a vital role in food chain. People in the recent years have engaged in the habit of planting crops on abandoned domestic dumpsites of soil taken from the existing ones because of their fertility (Oluyemi and Eyitayo, 2013). Akure city in the south western part of Nigeria ancient urban city has experienced increase in population and marketing activities in the last few decades since it has become the capital of Ondo State. In order to meet up with man's daily domestic needs, a lot of markets were established by the government at different locations in the city as the state capital from which a lot of domestic wastes are generated from marketing activities. These (extension) marketing activities in the city have led to re-developing of some domestics dumpsites covering

ISSN: 2454-1907
DOI: 10.5281/zenodo.1042404

an expense of land for farming purpose. Therefore, the level of heavy metals and some physicochemical parameters in the dumpsites soil at different locations are assayed.

Heavy metals are chemical elements grouped under the generic name of microelements that exhibit metal properties with relative high atomic weight, density and with a specific gravity of 5.0 or greater (Ademoroti, 1996). The presence of very high contents of heavy metals in the soil causes "heavy metal soil pollution". This indicates that the content of these elements in the soil are higher than the maximum concentration that has a beneficial or harmless effect on vegetation in some areas.

The negative effect of heavy metals depend on the concentration as well as on series of physical and chemical soil specific characteristics, such as texture, organic matter content, pH, redox potentials, and hydraulic conductivity etc. (Lacatusu, 2001).

Concern has been expressed with regard to the accumulation of toxic heavy metal such as Cadmium (Cd), Zinc (Zn), Copper (Cu) and lead (Pb) and their potential effect on human health. Agriculture and natural ecosystems (Adefemi and Awokunmi, 2009). The accumulation of the toxic heavy metal in a particular domestic dumpsite is as a result of indiscriminate dumping of domestic waste, such as decayed food item, rotten eggs, animal slain and bones, useless tin, cans in which heavy metals are found to be mostly trapped i.e in organic decayed matters as been discovered by research.

Hence, the health risk due to heavy metal contaminations cannot be overemphasized and is widely reported (Baker et al, 2000). Therefore, the aim of this study was to determine the levels of heavy metals and some physicochemical parameters in the soil of major domestic dumpsites in Akure Township, the capital of Ondo State of South western Nigeria.

## 2. Materials and Methods

### 2.1. Sampling and Sampling Collection

Soil samples within the depth of 0-15cm, 15-30cm were taken with aid of an auger from the 3 different major dumpsites (Table 1) according to Alter method(Alter, 1989). The collected soil sample was carefully transferred into a black polythene bags, properly labelled and transported to the laboratory.

### 2.2. Sample Preservation

Samples were air-dried for about two weeks and sieved to 2mm by mesh to prevent chemical microbial changes and remove large mineral inclusions and organic debris. The sieved samples were stored in labelled polythene bags and used for subsequent analysis.

### 2.3. Metal Determination

The air-dried sample was pulverized by pounding it in a mortar. About 1g was weighed for each sample into 250ml conical flask. 25ml of the acid mixture was poured on 1g of the sample and

ISSN: 2454-1907
DOI: 10.5281/zenodo.1042404

was heated on the hot plate for about 30minutes. After heating, it was allowed to cool for about 25 minutes. The solid was filtered using Whatman filter paper. The volume of the digest was diluted to 100ml with distilled water in a standard flask and was analysed for heavy metals using the atomic absorption spectrophotometer (AAS).

### 2.4. Organic Carbon

The Walkey-Black (A. Walkey and I A. Black 1984) method was used in the determination of organic in the soil. 2g of sieved soil was weighed out accurately into conical flask depending on the organic carbon content of the soil which could be estimated from the colour and finesse of such soil samples. 10ml of 1N $K_2Cr_2O_7$ standard solution was added to the soil followed by 20ml of concentrated $H_2SO_4$ to prevent the interference of chloride ions. The system was allowed to stand for 30minutes with occasional swirling. After 30 minutes the content of the conical flask was diluted with 10ml of distilled water.

The excess $K_2Cr_2O_7$ was determined by titrating with standard 1.0 N ferrous sulphate solution using ferroin as indicator. The blank titration was carried out in the same manner without the soil.

***Calculations***

The percentage organic carbon (air-dried basis) was calculated as follows:

$$\%\text{organic carbon} = \frac{(M_e K_2Cr_2O_7 - M_e FeSO_4) \times 0.003 \times 100 \times F}{\text{Weight of soil (g)}}$$

$M_e$ = Normality of solution x Volume (ml) of solution used
F = correlation factor =1.33
%organic matter in soil = organic carbon x 1.729
2.6 soil pH. The pH of the soil sample was determined with a pH meter, model: Kent EK 7020 according to the method of Mclean (E.O. Mclean 1996)

## 3. Result and Discussion

Table 1 shows the sample site, the location of the dumpsites, type and the period that the sites had been in existence.

Table 1: Domestic dumpsites locations within Akure metropolis

| Sample site | Location of dumpsites | Type | Year of existence |
|---|---|---|---|
| A | Besides police station, okuta elerinla Estate off Ilesha road Akure. | Domestic | 15 years |
| B | Isinkan market, Ondo Road, Akure. | Domestic | 20 years |

The variable of percentage organic matter with depth in site A and B were revealed in Table 2. In site A, the percentage organic matter which depends on organic carbon is highest at depth 0-15cm with a value of 1.85% and depth 30-45cm with 0.80% value. This is attributable to the fact that the top soil usually contains more plant productivity than lower layers of the soil. These

**ISSN: 2454-1907**
**DOI: 10.5281/zenodo.1042404**

values compare well with similar work done in sites at Lagos and other part of the world. (Ikuyajesin 2002, Batjes, 1996).

Table 2: also shows the variation of pH with depth of soil. The pH is least and with a value of 7.22 at 0-15cm depth and highest with the value 7.28 at 15-30cm is consistent with a similar works done at some soil sites in Akure (Ogundare 1998, Oguntimehin, 2002). In domestic site B, metal concentration ranges between 2.45µg/g in Cd at a depth of 30-45cm to 433.80µg/g in Zn at depth 15-30cm. high values for Zn, Fe, Ni and Cu observed in a similar study by Ogunmodede et al (2013) who investigated the heavy metal and microbial loads of some dumpsites soil in Ado-Ekiti.

Table 2: Percentage organic matter/organic carbon and pH value of site A and B

| | **Depth (cm)** | **Organic matter percentage** | **Organic carbon percentage** | **pH** |
|---|---|---|---|---|
| Site A | 0-15 | 1.85% | 1.06% | 7.22 |
| | 15-30 | 1.48% | 0.85% | 7.28 |
| | 30-45 | 0.80% | 0.46% | 7.26 |
| Site B | 0-15 | 2.05% | 1.18% | 7.07 |
| | 15-30 | 1.72% | 0.99% | 7.44 |
| | 30-45 | 1.10% | 0.63% | 7.69 |

Table 3 shows the variation of metal concentrations with depth in site A and B. In site A, the concentration ranges from 2.55µg/g in Cd at 0-15cm depth to 547.20µg/g in Fe at a depth of 0-15cm. it was observed that the concentration of some metals like Fe, Zn, Cu and Pb were higher than that of Cd, Ni and Cr. The very high level of Iron (Fe) was also observed in a related study by Abata et al (2013) evaluated the level of heavy metals like Cd, Cr, Fe, Mn, Pb and Zn in the sediment of Ala that run to Akure monopoly .

In site B, the percentage organic matter ranges from 1.10% at depth 30-45cm to 2.05% at depth 0-15cm. the value may be attributed to the fact topsoil usually contains more plant residue and vegetable. Also the variation of pH with the depth of soil,In site B shows that the pH is least with a value of 7.07% at a depth of 0.15cm which is similar to work done in a particular domestic dumpsite in Akure, 7.69 was recorded for the highest value of pH at a depth of 30-45cm.

Table 3: variation of metal concentration (µg/g) in soil with depth (Domestic site A and B)

| **Depth(cm)** | **Zn** | **Fe** | **Cu** | **Pb** | **Cd** | **Ni** | **Cr** |
|---|---|---|---|---|---|---|---|
| 0-15 | 441.00 | 547.20 | 78.00 | 80.00 | 2.55 | 17.00 | 22.10 |
| 15-30 | 363.60 | 513.60 | 37.20 | 58.40 | 2.95 | 15.20 | 40.06 |
| 30-45 | 360.00 | 502.40 | 38.40 | 47.60 | 2.70 | 11.00 | 30.02 |
| 0-15 | 385.20 | 169.60 | 96.00 | 24.20 | 2,38 | 19.20 | 18.00 |
| 15-30 | 433.80 | 220.80 | 87.60 | 53.00 | 2.36 | 16.32 | 42.20 |
| 30-45 | 415.80 | 216.00 | 102.00 | 18.80 | 2.45 | 12.20 | 32.06 |

ISSN: 2454-1907
DOI: 10.5281/zenodo.1042404

Table 4 reveals the maximum allowable limit (M.A.L) for heavy metals concentration (mg/kg) use in Nigeria as set by the department of petroleum resources (DPR) in 1991.

Table 4: Values of maximum allowable limits (M. A. L.) for heavy metals in soil (mg/kg) used in Nigeria

| Metals | Target value (mg/kg) | Intervention value (mg/kg) |
|---|---|---|
| Barium | 200 | 5000 |
| Cadmium | 0.8 | 17 |
| Chromium | 100 | 380 |
| Copper | 36 | 190 |
| Mercury | 0.3 | 10 |
| Lead | 85 | 530 |
| Nickel | 35 | 210 |
| Zinc | 140 | 720 |
| Cobalt | 20 | 240 |

Source: DPR Guidelines DPR (1991)

Table 5 reveals the contamination/pollution index for site A and B while Table 6 shows the significant of intervals of contamination/pollution index as reported by Department of Petroleum Resources (DPR, 1991). In domestic site A, at a depth of 0-15cm, the pollution index values 0.22, 0.48 and 0.94 for Cr, Ni and Pb respectively exist at the level of contamination. While the pollution index values 2.16, 3.15 and 3.18 in Cd, Zn and Cu exist at the level of pollution. At 15-30cm, Cr, Ni and Pb with values 0.40, 0.43 and 0.69 respectively exist at the level of contamination while Cd, Zn and Cu with values of 3.68, 2.60 and 1.03 respectively exist at the level of pollution. Cr, Ni and Pb at depth 30-45cm with values of 0.30, 0.31 and 0.56 respectively exist at the level of contamination while that of Cu, Zn and Cd with values of 1.06, 2.57 and 3.37 respectively confirmed the presence of the element at pollution level. The contamination/pollution index for domestic dumpsite B results shows that at the depth of 0-15cm, Cr, Pb and Ni with values of 0.18, 0.28 and 0.55 respectively exist at contamination level. While at the same depth Cd, Zn and Cu with values 2.97, 2.75 and 2.67 respectively exist at pollution levels. At 15-30cm depth Cr, Ni and Pb with values 0.46, 0.46 and 0.62 respectively exist at contamination level while that of Cu, Cd and Zn with values 2.43, 2.95 and 3.09 respectively exist as pollution level. Occurrence of Pb, Cr and Ni with values of 0.32, 0.32 and 0.35 respectively at depth 30-45cm confirmed the presence at contamination level while the occurrence of Cd, Zn and Cu at 30-45cm with values of 3.06, 2.97 and 2.83 respectively confirmed the presence

Table 5: contamination/pollution values for metals in sites A & B

| | Depth(cm) | Zn | Fe | Cu | Pb | Cd | Ni | Cr |
|---|---|---|---|---|---|---|---|---|
| Site A | 0-15 | 3.15 | 0.00 | 2.16 | 0.94 | 3.18 | 0.48 | 0.22 |
| | 15-30 | 2.60 | 0.00 | 1.03 | 0.69 | 3.68 | 0.43 | 0.40 |
| | 30-45 | 2.57 | 0.00 | 1.06 | 0.56 | 3.37 | 0.31 | 0.30 |
| Site B | 0-15 | 2.75 | 0.00 | 2.67 | 0.28 | 2.97 | 0.55 | 0.18 |
| | 15-30 | 3.09 | 0.00 | 2.43 | 0.62 | 2.95 | 0.46 | 0.46 |
| | 30-45 | 2.97 | 0.00 | 2.83 | 0.32 | 3.06 | 0.35 | 0.32 |

ISSN: 2454-1907
DOI: 10.5281/zenodo.1042404

Table 6: Significance of intervals of contamination/pollution index (C/P)

| C/P | Significance | Symbol |
|---|---|---|
| **<0.1** | Very slight contamination | v.s.c |
| **0.10-0.25** | Slight contamination | s.c |
| **0.26-0.75** | Moderate contamination | m.c |
| **0.51-0.75** | Severe contamination | s.c |
| **0.76-1.00** | Very severe contamination | v.s.c |
| **1.10-2.00** | Slight pollution | s.p |
| **2.10-4.00** | Moderate pollution | m.p |
| **4.10-8.00** | Severe pollution | s.p |
| **8.10-16.00** | Very severe pollution | v.s.p |
| **>16.00** | Excessive pollution | e.p |

## 4. Conclusion

All the soil sites are heavily polluted with metals and the highest multiple pollution values was found with site B which has the value 29.26 while the domestic site A is the least polluted with a multiple polluted value of 26.13. The fact that the highest observed value is from site B is exciting and might be due to everyday domestic activity that goes on around the site.Themarketers and all occupant of individual building living around the market normally dispose their domestic waste everyday e.g. food items and some rotten things on the dumpsites.
All the metals have concentrations within the Nigerian target value as published by the Department of Petroleum Resources (DPR) in Nigeria (1991) except for Cadmium which is above the targeted value of 0.8mg/kg as given in table 4.But with none of the values reaching the intervention value.

## 5. Recommendation

Since all the soils have metal concentrations above the target values, except chromium, It is therefore recommended that soil remediation techniques (Chaudri, A.M.2001) should be carried out on all the dumpsites sampled in this research work.
Government should discourage the indiscriminating sitting of markets and food canteen centers in places where wastes could not be centrally collected and reprocessed in an environmentally sound manner.

## References

[1] Abata, E.O., Aiyesanmi, A. F., Adebayo, A.O., & Ajayi, O.O. (2013). Assessment of Heavy Metal Contamination and Sediment Quality in the Urban River: a case study of Ala River in sourthern-nigeria. Journal of Applied Chemistry, 4(3), 56-63.
[2] Adefemi, O.S., & Awokunmi, E.E. (2009). The impact of Municipal solid waste disposal in ado ekiti metropolis, ekiti state, Nigeria. Afri. J. of environ. Sci and Tech., 3(8), 186-191
[3] Ademoroti, C.M.A. (1996). Standard methods of chemical analysis (pp. 45). March print and consultancy Benin, Nigeria.

[4] Aller, N. (1989). Handbook of suggested practices for design and installation of groundwater, monitoring wells, EPA/600/4-89/034. Published by NWWA, Dubling.
[5] Babur, C. (1992). A survey of metal levels in street Dusts in inner London neighbourhood. Enviro. Inter., 18, 263-270. http://dx.doi.org/10.1016/0160-4120(92)90109-H
[6] Baker, B.Y. (1992). Procedure Recommended for overburdens and hydrological studies of surface mines. John wiley pub. Paris france.
[7] Batjes, N.H. (1996). Total carbon and nitrogen in the soils of the world. European J. soil sci., 47, 151-163. http://dx.doi.org/10.1111/j.1365-2389.1996.tb01386.x
[8] Blaylock, M. J., Salt, D.E, Dushenkov, S., Zakharova, O., & Gussman, C. (1998). Field Demonstration of phytoremediation of lead contaminated soils, in phytoremediation proceedings of the 4th international conference on the biogeochemistry of trace elements.
[9] Boulding, J. R. (1994). Description and sampling of contaminated soils. Lewis Publisher N.Y. Second edition A10.
[10] Chaudri, A.M. (2001). Organic Pollutants: Fate in soil and Remediation IACR –Rothamsted. Conference paper delivered at the FAD.IB Conference, Enugu (Personal communication).
[11] Chlopecka, A., Bacon, J. R., Wilson, M. J., & Kay, J. (1996). Forms of cadmium, Lead and Zinc in contaminated soils from south west Poland. Jour of Environ Qual, 25, 69-79. http://dx.doi.org/10.2134/jeq1996.00472425000100009x
[12] DPR. (1991). DPR Environmental Guidelines and standard for the petroleum industry in Nigeria
[13] Gregory, D. J., Ronald, E.S., &Mary, B. C. (1996). Metals in Drinking water, North Carolina cooperative extension service publication No AG- 473-1
[14] Halavay, J., Antal, P., & Karpatiy, K. (1993). Distribution of toxic metals in soil dusts collected at different workshops. Sci. of the total environ, 136, 93-99. http://dx.doi.org/10.1016/0048-9697(93)90299-L
[15] Holmgren, G. S.S., Meyer, M. W, Chancy, P.L., & Daniels, R. B. (1993). Cadmium, Lead, Zinc, Copper and Nickel in Agricultural soil of the united states of America J. environ. Qual., 22, 335-348. http://dx.doi.org/10.2134/jeq1993.00472425002200015x
[16] Hung, J. W., Blaylock, M.J., Kapulnik, Y., & Ensley, B.D. (1995). Phytoremediation of Uranium contaminated soils: Role of Organic Acids in Trigging Uranium Hyperaccumulation in plants. Environ. Set. Tech., 32, 2004-2008. http://dx.doi.org/10.1021/es971027u
[17] Hung, J. W., Chen, J.J., Berti W. R., & Cunningham, S. D. (1997). Phytoremediation of Lead contaminated soils: Role of synthetic chelates in Lead phytoextraction. Environ. Sci. Tech., 31, 800-805. http://dx.doi.org/10.1021/es9604828
[18] Ogumodede, O.T., Ajayi, O.O., Amoo, I.A., & Adewole, E. (2013). Characterization of dumpsite soil: case study of Ado-Ekiti and Ijero-Ekiti, Nigeria. Journal of environmental science, Toxicology and food technology. 3(6), 43-50

*Corresponding author.
*E-mail address:* bimfaitho@ yahoo.com