Journal of
Environment
(JE)

ASSESSMENT OF THE HEAVY METALS AND PHYSICOCHEMICAL PROPERTIES OF SOILS, IN DUMPSITES AND ADJACENT FARMLANDS IN KAFANCHAN TOWN, KADUNA, NIGERIA

CARI Journals

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022
www.carijournals.org

ASSESSMENT OF THE HEAVY METALS AND PHYSICOCHEMICAL PROPERTIES OF SOILS, IN DUMPSITES AND ADJACENT FARMLANDS IN KAFANCHAN TOWN, KADUNA, NIGERIA

By

*Dogo, Rita Blessing,**Tanko , AA,ᴴ , and*** G.A Ajibade

*Department of Biological Sciences Kaduna state University

**Federal University, Lokoja.

***Department of Biological Sciences, Nigerian Defence Academy Kaduna

ABSTRACT

Purpose: This study focuses on establishing the presence and concentration of heavy metals as well as investigating the physicochemical properties of dumpsite soils and adjacent farms in the vicinity of Aduwan, Katsit, Bayan-loco, Ungwa Bala and Faringida in Kafanchan town, Kaduna Nigeria, using Atomic Absorption Spectrophotometry.

Methodology: Surface soil was randomly sampled at the depth of (0-15 cm) from the dumpsites and adjacent farms and analyzed for physicochemical parameters and contamination by lead (Pb), chromium (Cr), Nickel (Ni) and cadmium (Cd).The sample soils were generally sandy-loamy with pH ranging from 7.30 to 7.28. The cation exchange capacity (CEC) ranged between 5.61cmol/kg and 7.80cmol kg^{-1}. The mean concentrations of heavy metals in Aduwan dumpsite are: Ni(240.15±20.55 mg/L), Cr(45.65±1.15 mg/L), Pb(100.10±2.30 mg/L); Bayan-loco dumpsite: Ni(168.1±15.75 mg/L), Cr(41.05±6.45 mg/L), Pb(81.20±18.90 mg/L); Ugwan-bala dumpsite: Ni(175.65±3.45 mg/L), Cr(34.45±5.95 mg/L), Pb(98.95±2.30 mg/L); Farin-gida dumpsite: Ni(166.45±31.15 mg/L), Cr(58.25±28.85 mg/L), Pb(85.15±67.43 mg/L); Katsit dumpsite: Ni(125.25±6.85 mg/L), Cr(32.45±5.15 mg/L), Pb(76.80±1.42 mg/L).Cadmium was not detected at all in all sampled plots.

Findings: Analytical results showed that Lead (Pb) was the predominant ion in soils of the sampled areas.

Unique contribution to theory, practice and policy: The study observes that dumpsites were serving as major reservoirs of heavy metals. WHO identify the discussed heavy metals to be highly toxic therefore a better waste management system need to be instituted to minimize their accumulation soils.

Key words: *heavy-metals, physicochemical properties, surface soil, dumpsite, cation exchange capacity, Kafanchan*

INTRODUCTION

Metals are an intrinsic part of daily living. The food consumed and a wide range of all manufactured products contain some degree of metals. Some metals, especially in the right amounts, have the potential to significantly contribute to our health, wellbeing and general quality of life. Others, however, are highly toxic and if not properly managed can have adverse impact on health and environment. Heavy metals are a class of metals that are of particular interest in this regard. Different metallic properties have been used to define what a heavy metal is, but in most cases, density is the defining factor. Heavy metals are thus commonly defined as those having a specific density of more than 5 g/cm^3 (Järup**,** 2003).

Regarding human health and wellbeing, the most notable of threats from heavy metals are linked with exposure to lead, cadmium, mercury and arsenic. It has been reported that there is no known level of lead exposure that is considered safe, and lead poisoning in childhood is linked to cognitive impairment, violent crime in adulthood, and loss of economic productivity (Landrigan *et al.*, 2017). One property of heavy metals that makes them particularly hazardous pollutants is their resistance to biodegradation in addition to their ability to accumulate in living organisms, causing serious diseases and disorders (G. Liu *et al.*, 2014). Pollution by heavy metals occurs largely from industrial, domestic and agricultural wastes as well as from combustion of fossil fuel by automobiles and industries (Kallagbor *et al.*, 2017).

During the last decades of the twentieth century, there was an awareness of the importance of the soil as an environmental component and recognition of the need to maintain or improve its capacity to allow it to perform its various functions (Anegbe et *al.*, 2016). Soil which is the topmost layer of the earth serves as a reservoir for numerous materials that could contaminate the environment and heavy metals constitute a major risk group because of their ability to accumulate in the tissues and organs of animals. (Ajai *et al.*, 2017).

In recent times, there had been a proliferation in the number of dumpsites and the amount of waste produced by many urban centers had been on the increase as a result of population growth and rapid industrialization (Olayiwola et al, .2017). In Nigeria, the use of dumpsites and surrounding soils as farmlands is a common practice as the soils are considered to be fertile because of the decayed and composted dumps (Ajai *et al.*, 2017).

National and international heavy metal monitoring regimes are not consistent. This reality emerges with particular force among developing countries where incidents of heavy metal exposure often go unnoticed or unreported, and public health laws are not properly captured to

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022
www.carijournals.org

be enforceable (Mamtani, Stern, Dawood, & Cheema, 2011). Faced with this massive shortfall of data that reflects a vast range of heavy metal occurrences, health threats, and environmental impacts, this study aimed at investigating the presence and amounts of heavy metals in dumpsite soils, their associated physicochemical properties and documenting the results. These results are hoped will serve as a basis for discouraging the use of such soils for agricultural purposes and to make clear the need for a better waste management system.

MATERIALS AND METHODS

Description of Study Area

Kafanchan is situated in Kaduna south, north-western Nigeria. It extends from Latitude: 9° 30’00" N to 9° 45’15’ N and Longitude: 8° 15' 00" E to 8° 25' 30" E. It sits at an average elevation of 739m with a population of 79522 as of 2006 census. The mean annual temperature is 27^{O}C. The annual relative humidity is ranged between 70 – 98%. The average yearly precipitation is 2484mm. Two distinct seasons are obtainable in Kafanchan; dry and rainy seasons. Between November and April is dry season while the rainy season spans from June through September.

Collection of samples

Five (5) different dumpsites were selected. In each dumpsite, four locations were randomly mapped out for soil collection. Samples of the soil were obtained from three locations using a soil auger and a meter rule, at a depth between 0-15 cm and polled together into a composite sample for the area in clean plastic buckets. In total, ten soil samples were gathered from the waste dumpsites for the two sampling periods at three month interval. Similarly, four replicate soil samples were taken from three (3) adjacent farmlands to make in all; six samples of the soil were obtained from adjacent farmlands two periods. All samples were safely stored in sterile polythene bags and taken for analysis at the National Soil and Water laboratory of the Federal Ministry of Agriculture and Rural Development, Kaduna state, Nigeria.

Soil Samples Preparation

Soil samples were collected and ground into powder by means of mortar and pestle after they have been air dried. A 2mm sieve was used to obtain a subsample less than 2 mm in diameter (Smart 2012) the less than 2mm fractions were used for soil pH, particle size distribution, organic carbon, exchangeable bases, and exchangeable acidity (Tanko 2012), Sodium Absorption Ratio (SAR) and Exchangeable Sodium percentage (ESP) analysis. A gram of the sampled soil was measured into a digestion flask. Undiluted acid made up of (Nitric Acid: 350ml, 80ml of HCl and 20ml of H_2SO_4) was mixed with the weighed sample and an electric stove was used to digest it. After this was achieved, it was left to cool and 30ml of distilled water poured in and the entire mixture was filtered with a Whatman filtering paper into a clean flat bottom flask for use in the measurement of heavy metals in the Atomic Absorption Spectrophotometry (AAS) machine.

Determination of:

pH: 20g of dried soil sample mixed with 20cm^3 of distilled water and a pre calibrated hand held Hanna pH meter (model H12211) was used to determine the pH according the method described in Kumar *et al*., (2008).The pH was also taken in 0.01$Cacl_2$.

Electrical conductivity: Electrical conductivity was measured using a conductivity meter as proposed by Kumar *et al*., (2008), and Kalra and Maynard (1991). 25g of shade dried soil sample wetted with distilled water was later mixed with 50cm^3 of distilled water. The electrode of the conductivity meter was inserted into 40cm^3 of the final mixture to record the electrical conductivity of the soil.

Particle size distribution: Fifty grams (50g) of 2mm sieved soil was prepared using 100 cm^3 of 50% Calgon solution and 100ml of distilled water. The hydrometer reading at 4secs and 2hrs was taken. A blank solution was prepared and the blank hydrometer values were taken at respective time interval. The temperatures of both solutions were taken. The final hydrometer readings C (g/dm^3) were obtained by subtracting the blank reading from initial reading (g/dm3).This formula was used to convert the temperature from ^{0}F to ^{0}C: $^0F = {^0C} \times 1.8 + 32$(Gee and Or, 2002).

Textural classes- this was determined using USDA formulae for soil textural class's distribution: USDA (1975).

Cation exchange capacity (CEC): The CEC of the soil was determined by the $BaCl_2$ Compulsive Exchange method described by Ross and Ketterings (1996) where the pH and ionic strength of the soil were the major determining factors. In the procedure, about 2g of the soil was transferred to a funnel containing low grade filter paper and slowly leached with 20cm^3 of 0.1 M $BaCl_2.2H_2O$ allowing each to be completely absorbed by the soil before additions are made. The pH and conductivity of the samples were determined and the CEC were calculated.

Soil organic carbon: according to the WB-T method described by Nelson and Sommers (1982), 0.5g of soil sample was weight and 5ml of $K_2Cr_2O_7$ and 10ml of H_2SO_4 were added. After cooling, 100ml of distilled water was added to complete the base.

It was titrated using 0.5N $(HN_4)_2FeSO_4$ acid and a phenolpthalene indicator until a pink endpoint was achieved. The blank flasks are titrated in the same way. It was assumed that only 77% of the organic matter is oxidized and a factor of 100 /177 or 1.33 is used in the calculation:

Exchangeable Bases: These were obtained using 1M of NH_4OAC (pH 7) solution. The concentrations of K and Na in the extract were determined using Flame analyzer (Model FP640) while Mg was obtained by versenate titration. 3g of the sample was weigh into conical flask with

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022
www.carijournals.org

funnel and filter paper inside.50ml of 1NKCL was added and then filtered to get the filtrate (Anderson and Ingram, 1993).

Exchangeable Acidity: This was Determined by shaking soil in 0.01MKCl and filtrate to be titrated with 0.1MNaOH (Agbenin, 1995). 5g of the sample was weigh into the beaker.(Al^{3+} and H^{+}) was measured after the soil samples were extracted with 1M KCL and titrating against 0.01M standard solution of NaOH.

Sodium Absorption Ratio SAR: This is taken to be equivalent to the Exchangeable {Na^{+} / √1/2 (Ca^{2+} + $Mg^{2+)}$} (Oster and Posito, 1980).

Exchangeable Sodium Percentage ESP: This is taken to be equivalent to the Exchangeable {Na /Ca+ Mg + K + Na} x100. (Oster and Posito, 1980).

Data Analysis

Validation of the atomic absorption technique was conducted on the digested soil samples. To do this, the pre-digested samples were spiked with multi-element standard solution (5 mg/dm3 of Cd, Ni, Pb and 0.5 mg/dm3 Cr) as reported by Awofolu (2005).

The heavy metals content were expressed as mg/L of the dry weight sample. The collected data were processed and the mean values and standard errors evaluated for analysis. Descriptive group statistics was used to quantitatively describe or summarize the data and equality of means was used to determine whether there is significant difference in the physicochemical properties and heavy metals in the soil using SPSS version 23.

RESULTS

Physicochemical Parameters of the Dumpsite Soil and adjacent farmlands

Mean percentage of particle size and textural classes of the soil in the dumpsites and adjacent farmlands is presented in Table 1. Soil from Aduwan dumpsite were sandy Loamy –type with percentage sand 65.6±0.64%while the adjacent farm was sandy clay with percentage sand 59.1±1.14%. The percentage clay and silt in the adjacent farm were higher than the dumpsite.

The soil from BayanLoko dumpsite was sandy clay with percentage sand at 64.1±5.14% while the adjacent farmland was sandy loamy with percentage sand at 61.6±4.47%. The percentage sand and silt were generally higher in the dumpsites than in the adjacent farm while percentage clay was generally less in the dumpsite than in the adjacent farm.

The soil from U/Bala dumpsite and adjacent farm was sandy loamy with percentage sand 75.1±3.14% and 57.6±0.64% respectively. The percentage clay was less in the dumpsite compared to the adjacent farm while percentage silt was equal in both dumpsite and adjacent farm. The soil from Farigida and Katsit dumpsites were sandy loamy with percentage sand of 70.6±5.64% in each .The percentage silt and clay were less in the dumpsites.

Table 2: shows the chemical characteristics of soils from the dumpsites and adjacent farmland. The pH in water ranged from 7.15 to 7.3 in all the dumpsites and 6.83 to 7.00 in adjacent farmland. The highest pH occurred in Farigida dumpsite while the lowest pH occurred in Aduwan dumpsites. The mean pH in $CaCl_2$ ranged from 6.65 to 7.08 in the dumpsites and 6.5 to 6.18 in the adjacent farm.

The organic carbon composition of the soil varied from 0.91% to 2.51% with the lowest value occurring in BayanLoko adjacent farm and the highest value occurring in Aduwan dumpsite soil. Ungwan Bala and Farigida dumpsite soil also had organic carbon of 1.93% and 1.99% respectively. The nitrogen values ranged between 0.15% to 0.45% with lowest value occurring in BayanLoko adjacent farm and the highest value occurring in Farigida dumpsite soil.

The available phosphorus had 12.16mg/kg at Katsit dumpsite as the lowest quantity while the highest amount of phosphorus 52.27mg/kg was in the soil from Farigida dumpsite. Soils from the dumpsites were generally having more available phosphorus compared to their adjacent farm lands except Ungwa Bala where the soil in adjacent farm was richer in phosphorus than the dumpsite.

Mean concentration of exchangeable cations in dumpsites and adjacent farm lands is presented in Table 3. The calcium content of the soil ranged from 4.28 to 6.69cmol/kg in Mh all the dumpsites. The highest amount of calcium was in soil of Ungwa Bala dumpsite (6.69cmol/kg) followed by Aduwan (6.35±1.90_) dumpsites soil and the least in the soil of Ungwa Bala adjacent farm land. Comparing dumpsites with adjacent farm land showed that calcium in Aduwan and Ungwa Bala dumpsites were higher than their adjacent farms. However, reverse was the case in BayanLoko where the adjacent farm had more calcium than the dumpsite. A similar trend was observed in Mg content with more of mg in dumpsites than farmlands except in Ungwa Bala where Mg was higher in the farm land (0.30cmol/kg) than the dumpsites soil (0.22cmol/kg).

Similar, observation was made for the amount of potassium in soil. There was high amount in all dumpsites and less in adjacent farms except for BayanLoko which was less (0.07cmol/kg) than the adjacent farm (0.08cmol/kg), while in Farigida and Katsit dumpsites, it was equal. The sodium content of the soil was generally high in all the dumpsites. Zn, Mn and Cu were generally high in all the dumpsites than their respective adjacent farms.

Table 4: Is the mean concentration of derived chemical properties of the soil. Sodium Absorption Ratio was found to be equal in both the dumpsites and adjacent farms in all the sites, except in Ungwa Bala. The mean SAR ranged from 0.10-0.12ds/m.

The EC of the soil was higher in dumpsites than adjacent farms. EC was having its lowest concentration of 0.05ds/m in the soil from Ungwa Bala adjacent farmland while the highest concentration of 0.22ds/m was in Farigida soil. A similar trend was found in EA of the soil. The minimum concentration of EA (0.42cmol/kg) was in the soil from Aduwan adjacent farmland while the maximum concentration (0.63cmol/kg) was obtained in BayanLoko dumpsite.

ESP was also found to be higher in all dumpsites than their adjacent farms except in BayanLoko and Ungwa Bala. The ESP ranged from 2.08ds/m at Aduwan adjacent farmland to the maximum concentration of 3.11ds/m at Farigida dumpsite.

The CEC was generally higher in all the dumpsites except in BayanLoko. The minimum concentration of CEC was at Ungwa Bala adjacent farmland (5.38cmol/kg) and the maximum (7.80cmol/kg) was at Ungwa Bala dumpsites.

Concentration of Heavy Metals in the Dumpsite Soil and adjacent farm lands

The results of the validity of the precision and accuracy of the atomic absorption spectrophotometer using spiking experiments gave the mean percentage recoveries of these heavy metals: Cd, Cr, Ni and Pb in the digested soil samples in (Table 5). Mean percentage of Nickel in the dumpsite soil in Aduwan was greater (240.15 ± 20.25mg/l) than the adjacent farm (238.70 ± 4.10mg/l). Nickel in BayanLoko and Ungwa Bala were less in the adjacent farms. Chromium had its highest concentration 0f (58.25 ± 28.55 mg/l) at Farigida dumpsite and the lowest concentration of (32.45 ± 5.15mg/l) at Katsit dumpsite. Generally, chromium concentrations were higher in the farm lands compared to their respective adjacent dumpsites.

Lead concentration ranged from (38.60 ± 15.00mg/l) to (100.10 ± 2.30mg/l) with the highest concentrations recorded in Aduwan dumpsite soil and the lowest concentrations in BayanLoko adjacent farm. The dumpsites generally had higher concentration of lead than their adjacent farms. Cadmium was not detected in any of the dumpsites.

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022

www.carijournals.org

Table 1: Mean Concentration of Particle Size Distribution and Textural Classes

Dumpsites	% Clay	%Silt	% Sand	Textural classes USDA,NRCS(1992)
Aduwan	12.84±0.64	12.06±9.50	65.6±0.64	Sandy Loam
Adjacent farm	21.34±4.14	21.34±3.00	59.1±1.14	Sandy Clay Loam
BayanLoco	14.34±9.16	21.56±4.00	64.1±5.14	Sandy Clay Loam
Adjacent farm	19.84±5.36	19.56±1.00	61.6±4.47	Sandy Clay Loam
Ungwa/Bala	6.35±1.15	18.55±1.99	75.1±3.14	Sandy Loam
Adjacent farm	23.84±2.64	18.56±2.83	57.6±0.64	Sandy loam
Farigida	7.84±2.64	21.56±3.00	70.6±5.64	Sandy Loam
Katsit	6.84±1.64	16.06±2.50	70.6±5.64	Sandy loam

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022

www.carijournals.org

Table 2: Chemical Characteristics of Soils from Dumpsites and Adjacent Farms

Dumpsites	Soil pH (Mean±SE) H_2O	$CaCl_2$(lm)	Mean±SE % OC(%)	%TN(%)	AV.P(mg/kg)
Aduwan	7.15±0.15	6.65±0.25	2.51±0.84	0.27±2.21	17.02±4.87
Adjacent farm	7.00±0.25	6.5±0.15	1.28±0.10	0.16±1.58	14.59±13.37
BayanLoco	7.18±2.20	6.38±2.24	2.36±1.50	0.30±0.15	44.36±35.86
Adjacent Farm	6.98±0.28	6.08±0.58	0.91±0.42	0.15±2.06	32.21±29.78
U/Bala	7.28±0.13	6.38±0.28	1.93±0.46	0.18±1.27	17.02±4.87
Adjacent farm	6.83±0.18	6.18±2.24	1.76±0.17	0.18±2.25	26.74±8.51
Farigida	7.3±0.15	6.58±0.33	1.99±0.14	0.45±0.71	52.27±30.39
Katsit	7.4±0.10	7.08±0.71	2.00±0.27	0.18±1.27	12.16±4.87

Key: OC= Organic Carbon; TN= Total Nitrogen; Av.P= Available Phosphorus; SE= Standard Error

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022

Table 3: Mean Concentration of Exchangeable Cations of Dumpsites soil and Adjacent Farms in Kafanchan Town

								Mean±SE
Dumpsites	Ca(cmol/kg)	Mg(cmol/kg)	K(cmol/kg)	Na (cmol/kg)	Zn (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Fe
Aduwan	6.35±1.90	0.30±0.70	0.09±0.71	0.19±2.06	54.25±9.53	71.67±13.87	11.43±3.39	86.03±9.16
Adjacent farm	5.42±0.73	0.29±0.70	0.07±0.00	0.16±1.27	5.78±10.25	33.59±7.81	4.77±0.48	40.73±11.43
BayanLoco	5.25±2.84	0.33±2.00	0.07±1.58	0.19±2.38	40.46±7.88	41.28±8.90	5.06±2.58	20.83±8.81
Adjacent farm	5.38±1.42	0.31±2.00	0.08±0.71	0.17±2.55	22.44±12.74	38.41±0.32	5.25±0.79	47.92±16.01
U/Bala	6.69±0.36	0.22±1.90	0.08±0.71	0.22±1.27	59.69±13.36	56.8±8.41	11.87±5.43	57.02±33.85
Adjacent farm	4.28±0.96	0.30±1.58	0.07±0.71	0.14±1.43	34.14±2.64	35.97±1.72	5.44±0.75	36.68±6.02
Farigida	4.52±1.50	0.29±2.55	0.08±1.00	0.18±1.75	47.28±9.82	37.70±13.61	4.09±1.04	33.83±19.36
Katsit	6.05±0.60	0.28±1.00	0.08±0.00	0.18±1.27	51.68±8.73	43.44±11.12	6.89±0.09	15.55±1.12

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022
www.carijournals.org

Table 4: Mean concentration of derived chemical characteristics of dumpsite soils and adjacent farm lands in Kafanchan town.

Dumpsites	SAR(ds/m)	EC(ds/m)	ESP(ds/m)	EA(Cmol)	CEC(cmol)
Aduwan	0.10±2.30	0.18±1.58	2.79±0.62	0.58±2.70	7.50±2.21
Adjacent farm	0.10±3.00	0.07±1.00	2.08±0.42	0.42±0.25	6.37±0.93
BayanLoco	0.11±2.25	0.12±2.38	2.78±0.26	0.63±1.27	6.46±2.17
Adjacent farm	0.11±3.00	0.07±2.00	2.91±1.06	0.59±0.00	6.52±1.42
U/Bala	0.12± ± 2.00	0.16±2.55	2.89±0.65	0.58±2.70	7.80±0.35
Adjacent farm	0.10±1.27	0.05±0.00	2.91±1.28	0.59±0.00	5.38±0.93
Farigida	0.11±2.55	0.22±2.30	3.11±0.16	0.54±1.43	5.61±1.55
Katsit	0.10±2.00	0.21±2.30	2.47±0.33	0.54±1.43	7.14±0.61

Key: SAR= Sodium Absorption Ratio; EC= Electrical Conductivity; ESP= Exchangeable Sodium Percentage; EA= Exchangeable Acidity; CEC= Cation Exchange Capacity

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 2, Issue No. 1, pp 39- 55, 2022

www.carijournals.org

Table 5: Mean percentage recovery of heavy metals in dumpsite and adjacent farm of Kafanchan town

Location	Ni(mg/L)	Cr (mg/L)	Pb (mg/L)	Cd (mg/L)
Aduwan dumpsite	240±20.55	45.65±1.15	100.10±2.30	00 ± 00
Adjacent farm	238.70±4,10	51.70±3.40	61.75±13.20	00 ± 00
Bayaloco dumpsite	168.14±15.75	41.05±6.45	81.20±18.90	00 ± 00
Adjacent farm	169.05±21.25	44.60±13.60	38.60±15.00	00 ± 00
U/Bala dumpsite	175.65±3.45	34.45±5.95	98.95±2.30	00 ± 00
Adjacent farm	212.60±5.60	40.45±4.95	67.65±10.95	00 ± 00
Farigida dumpsite	166.45±31.15	58.25±28.85	85.15±67.43	00 ± 00
Katsit dumpsite	125.25±6.85	32.45±5.15	76.80±1.42	00 ± 00
WHO	3.5mg/kg	100mg/kg	85mg/kg	0.8mg/kg

DISCUSSION

Physicochemical Parameters:

Particle Size Distribution

The textures of soil were predominantly sandy loamy. The sand fraction was generally higher compared to the other fractions. Clay fraction was shown to be lower in the dumpsites than in adjacent farms. Silt particle was variable depending on the location factor. High percentage of sand on the topsoil in all locations would encourage seepage (Uba *et al.*, 2008) especially of heavy metals thereby contaminating a larger proportion of the soil as it moves downwards. Although, sandy loamy texture was recommended (Loughry, 1974) as being suitable for waste dumpsites, since they are highly permeable, excessive drainage of sandy soil can encourage leaching of major cations and anions to deeper layers. This will increase the possibility of ground water pollution.

Soil pH

Soil pH affects mobility of heavy metals. It has been reported that lower pH would favour availability, mobility, and redistribution of the metals Pb and Cd in the various fractions due to increased solubility of the ions in acidic environment (Oviasogie and Ndiokwere, 2008). In the present study pH (in H_2O) shows a moderately acidic soil from the adjacent farmlands which may be an indication of increased micronutrients solubility and mobility as well as heavy metal concentration in the soil (Odu *et al.*, 1985). However, all the samples of soil from the dumpsite were slightly alkaline (pH 7.4 to 7.15). This might be due to the absorption of metals in the soil (Lee and Saunders, 2003).

Soil Organic Carbon

Organic carbon increases the cation exchange capacity (CEC) of the soil. The moderately high amount of organic carbon in the dumpsite soils indicates decomposition of compostable wastes (Munoz *et al.*, 1994). Ayolagha and Onwugbuta (2001) observed that high SOC (>2.0%) in soils is ideal for heavy metal chelation formation.

The Total Nitrogen Content

The nitrate contents in this research is less compared to that which was reported by Uba *et al.*, (2008) which ranged from 4.17 to 11.33 % for soil of dumpsites in Zaria Metropolis, Nigeria. Similarly, the results reported by Osazee *et al.*, (2013) had the range 3.476 to 4.522 % which was also higher than the concentration reported in this study. Higher levels of nitrite and nitrate nitrogen in adjacent farms soil are indicative of humus rich nitrogenous materials.

Available Phosphorous

Higher levels of phosphorus were present in the dumpsite as compared to the adjacent farm lands; this may be due to high amounts of organic matter and decomposed plants Ideriah *et al.,* (2006). All the dumpsites recorded values of available phosphorus (>10mg/kg) that is considered adequate for crop production (FAO, 1976)**.**

Cation exchange capacity of the soil

By definition, cation exchange capacity is the exchangeable cation in 1kg of dry soil. Its presence is determined by pH, and how much clay and organic carbon is contained in the soil. The higher CEC values of the dumpsites soil as compared to that of the adjacent farms indicate that a large amount of exchangeable bases at the dumpsites could have been in a form of water-soluble bases and not in an exchangeable form.

Heavy metal concentrations:

Pb concentrations in the dumpsite soils and adjacent farm

On contact with soil, Lead attaches to particles of soil in the upper layers (ATSDR, 2007). Pb concentrations recorded in this study was above the permissible limits of heavy metals in soil by WHO (1996). A greater health and environmental hazard could be inferred from this this result.

Mean Cr concentrations in the dumpsite soils and adjacent farms

Chromium concentration in the dumpsite soils was shown to be below WHO permissible limits in soil (100mg/kg). Soil Cr may arise from automobiles, electronic waste, polythene and plastic materials (Jung and Casher, 2006) .The concentration range of Cr that this study records agrees with the range of values reported by Adelekan and Alawode (2011) being (13.15 – 75.55 mg/kg) but were lower than those recorded by Awokunmi *et al*. (2010) being (212.00 – 2020.00 mg/kg).. From the statistical analysis, the concentration of Cr was lower in the dumpsites than in the adjacent farm lands. This could be as a result of the excessive transfer of dumpsite soil by farmers to adjacent farms for agricultural reasons.

Mean Ni concentrations in the dumpsite soils and adjacent farm lands.

The higher Ni concentration in dumpsite soils above the 3.5mg/kg limit set by WHO(996), implies that the soil was contaminated with Ni. A source of Ni is majorly through prehistoric and natural means such as effluents resulting from fossil fuel usage, industrialization and mismanagement of compounds that contain Ni (Kasprzak *et al*., 2003). The concentration range as recorded in this research work were above the concentration range recorded by Adelekan and Alawode (2011) being 4.35 – 49.80 mg/kg, and the range (1.50 – 54.80 mg/kg) reported by Ukpong *et al* (2013), Opaluwa *et al* (2012) (0.21– 0.31 mg/kg) and range (7.10 – 14.90 mg/kg) reported by Akpofure (2012).

CONCLUSION

This study showed that dumpsites had higher concentrations of heavy metals (Ni,Cr, and Pb) than the corresponding adjacent farmlands. Even though the results varied by sampling site and metal type; the overall order of metal content in this study was: Ni > Pb > Cr > Cd. The metallic ions in dumpsites were also shown to be more mobile as the physicochemical properties (pH, cation exchange capacity, organic carbon, and higher %sand) were seen to favour the mobility of metallic ions within the soil structure. Thus, it is hereby suggested that there is a high probability of food chain contamination via underground water and plants absorption.

Phytoremediation of these heavy metals is necessary for clean-up of the environment from these toxic metals. It is further recommended that speciation of other toxic metals be carried out at various depth in these dumpsites and other major ones in Kafanchan town, so as to obtain a thorough and broad database for elucidating the environmental impact of heavy metals in the dumpsites of Kafanchan town.

REFERENCES

Adelekan, B.A. and A.O. Alawode, (2011). Contributions of municipal refuse dumps to heavy metals concentrations in soil profile and groundwater in Ibadan Nigeria. J. Applied Biosci., 40: 2727-2737.

Agbenin, J.O. (1995). Laboratory manual for soil and plant analysis. Department of soil Science, *Ahmadu Bello University, Zaria*. pp. 15 – 52.

Ajai AI, Inobeme, Jacob, JO, Bankole , MT and Olamoju , KM(2017).

Akpofure, R. (2012). Uptake of heavy metals by Okro (*Hibiscus esculentus*) grown on abandoned dump sites in Effurun, Nigeria. *Journal of Emerging Trends in Engineering and Applied Sciences*, **3**(4): 640-644.

Anderson, J.M. and Ingram, J.S.I. 1993. Tropical Soil Biology and Fertility: A handbook of the methods (2nd edition) C.A.B. International,Wallingford, United Kingdom, 221 pp.

Anegbe, B., Okuo, J. M. and Okieimen, F. E. (2016). The impact of inorganic and organic pollutants in soil from the vicinity of mechanic workshops in Benin City. International Journal of Chemical Studies. 4(3):106-112

Awofolu, O.R. (2005). A survey of trace metals in vegetation, soil and lower animals along some selected major roads in metropolitan city of Lagos. *Environmental Monitoring and Assesment*,105:413-447

Awokunmi, A., Asaolu, S. and Ipinmoroti, K. (2010). Effect of leaching on heavy metals concentration in some dumpsites. *African Journal of Environmental Science and Technology*, **4**(8): 495-499.

Chemistry, 2(2), 78-83.

contents in soil and plants at dumpsites: a case study of Awotan and Ajakanga dumpsite Ibadan,Oyo State, Nigeria. Journal of Environment and Earth Science, 7(4), 11-24.

Determination of the physicochemical and heavy metals content of soil around selected

FAO/WHO (2001). Food additives and contaminants. Joint FAO/WHO food standards program, ALINORM 01/12A: 1-289.

Gee, G. W. and J. W. Bouder,1986. Particle size analysis. In: Klute, A. (Ed.), Methods of soil analysis. Part 1. Physical and mineralogical methods. 2nded. Agronomy monography no: 9, ASA and SSSA, Madison, WI, pp. 825-844

Gupta, A.K. and Sinha, S. (2006). Chemical fractionation and heavy metal accumulation in the plant of *Sesamum indicum* (L.) Var. T55 grown on soil amended with tannery sludge: selection of single extractants. *Chemosphere,* 64: 161-173.

H. A. Olayiwola, L. Abudulawal, G. K.Adewuyi and M. O. Azeez (2017). Heavy metal

Ideriah, T.J.K., Omuaro, V.O.T and Adiukwu, P.A. (2005). Heavy metals contamination of soils around municipal solid wastes dimp in Port Harcourt, Nigeria. *Global Journal of Environmental Sciences, 4(1):1-4.*

Järup L. Hazards of heavy metal contamination. Br Med Bull. (2003);68(1):167–182

Jung, H.G. and Casler, M.D. (2006). Maize stems tissues: impact of development on cell wall degradability. *Crop Science*, **46**(4), 1801.

Kalagbor, I.A., Okarahia, F.P., John, O.A. and Okiri, M.A. (2017) Evaluation of Heavy Metals in Some Food Items from Three Markets on the Eleme-Ogoni Highway, Rivers State, Nigeria. Journal of Chemical Society of Nigeria, 42, 12-17. [Citation Time(s):

Kalra, Y.P., Maynard, D.G. (1991). Methods for forest soil and plant analysis. Information report NOR-X-319. Forestry Canada, North-West Region, Northern Forestry Center. Pp. 116.

Kumar, G.P., Yadav, S.K., Thawale, P.R., Singh, S.K. and Juwarkar, A.A. (2008). Growth of Jatropa curcas on heavy metal contaminated soil amended with industrial wastes and Azotobacter- A greenhouse study. *Bioresource Technology 99(6): 2078-2082.*

Lee, M.K. and Saunders, J.A. (2003). Effect of pH on metal precipitation and sorption: Field bioremediation and geochemical modeling approaches. *Vadose Zone Journal*, **2**(2): 177-185.

Loughry, F.G., 1974. The use of soil science sanitary landfill selection and management. Geoderma, 10: 131-139.

Munoz M, Pena L, Ballrooms JO (1994). Use of an Industrial by- product as a liming source. J. Agric. Univ. Puerto Roil 78 (3-4) 73-86.

Nelson, D.W. and Sommers, L.E. (1982) Total Carbon, Organic Carbon, and Organic Matter, 539-579 in A.L. Page et. al. Methods Of Soil analysis part 2, 2nd ed., Agronomy No. 9, American Society Of Agronomy, Madison, WI.

Odu CTI, Euros' OF, Nwaboshi IC, Ogunwale JA (1985). Environmental study (Soil and Vegetation) of NigeriaAgip Oil Company Operation Area. A report submitted to Nigeria Agip Oil Company Limited, Lagos, Nigeria. pp. 102-107.

Osazee, O.J., Obayagbona, O.N., Daniel. E.O. (2013). Microbiology and physicochemical analyses of top soils obtained from four municipal waste dumpsite in Benin City, Nigeria. *International Journal of Microbiology and mycology*, **1**(1): 23-30.

Oviasogie , PO, Ndiokwere CL (2008). Fractionation of lead and cadmium in refuse dump soil treated with cassava milling effluent. J. Agric. Environ. 9:10.

Uba, S., Uzairu, A., Harrison, G. F. S., Balarabe, M. L. and Okunola, O. J. (2008). Assessment Of Heavy Metals Bioavailability in Dumpsites in Zaria. *African Journal of Biotechnology*, 7:122-130.

WHO, 1996. Trace Elements in Human Nutrition and Health. World Health Organization, Geneva, Switzerland