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Determination of Physicochemical and Some Heavy Metal of Soil around Dana Steel Industry Limited Katsina, Katsina State, Nigeria

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Abstract
The aim of this study was to investigate the physicochemical parameters and level of some Heavy metal concentrations in dumpsites soil around Dana steel limited dumpsite located in latitude $12^{\circ}\ 57^{1}\ 43^{11}$N to $12^{\circ}\ 58^{1}\ 7^{11}$N, Longitude $7^{\circ}\ 37^{1}11^{11}$E to $7^{\circ}\ 37^{1}\ 16^{11}$E and altitude 522.5m to 616.6m in Katsina state of Nigeria were investigated in this research. Soil samples were collected from the dumpsite and control site at depths ranges 0- <10cm, 10- <20cm, 20-<30cm and 30-<40cm. The result of physicochemical parameters within the samples A, B, C,D and the control shows that there is a significant difference between contaminated and control soil. This is a clear indication of low moisture and organic matter content observed in the entire sampling site. For the heavy metals contents, Atomic Absorption spectroscopy (AAS) was used to obtain the composition and concentration of the six studied heavy metals (Zn, Cu, Cr, Co, Ni, and Pb). The Result obtained in this research showed that Pb had the highest concentration with the ranged average of 16.464-11.741mg/kg and Fe which has the lowest concentration with 0.219-0.379mg/kg. Statistical significant difference was observed between the mean of toxic metal concentration in the dumpsite and control area which suggested the effect of anthropogenic inputs, Therefore, the results indicated that the area under investigation was polluted with Cr, Fe and Cu withrespect to heavy metals content in contaminated soil and low Fe content with respect to the control soil. Somemetals content investigated were above the US EPAstandard of heavy metals in soils that requires cleanup
Keywords: *Keywords: Soil; heavy metals; Dana steel; environment; physicochemical.*

INTRODUCTION

Increase industrialization, population growth, and complete disregard for environmental health have led to global environmental pollution (Avwin *et al.,* 2014).Pollution is one of the most serious problems facing humanity and other form of life on earth now is environmental pollution (Inbome *et al*., 2014). The release of pollutants into the environment may occur accidentally or due to anthropogenic activities which ultimately results in soil, water, and air pollution, leading to many health hazards. Pollution of the natural environment by the heavy metals is a universal problem because these metals are indestructible and most of them have toxic effects on living organisms when permissible concentration levels are exceeded (Audu *et al*., 2016).).major environmental concern in the iron and steel industry in Nigeria is associated with the management of the industrial wastes generated in their different processes since it is becoming increasingly difficult for safe disposal of these volumes (Avwin *et al.,* 2014).human activity create wastes and it is the way this wastes are collected, handled, stored and disposed off that constitute risk to the public health and environment. the dumping of large amount of waste materials in sites without adequate soil protection measures results in soil surface and ground water pollution as well as degradation of abiotic and biotic components of the ecological systems (Inbome *et al*., 2014; Rahib *et al*., 2015 and Audu *et al*., 2016).the process of industrialization and continuous exploitation of earth resources for sustainable growth has depleted the non-renewable resources of the earth there by adversely affecting the environment. An integrated steel plant unit exhausts several harmful dusts, Fumes and substances that are quite injurious to human health, vegetation, crops, animals etc. such discharges contaminate and damage inland waters, environment, soil, food, human settlements and even plants and animals. Therefore, these wastes cannot be left uncared for and that is why threshold limits for such harmful substances have been fixed and industries are required to adhere to these norms.

Heavy metals through anthropogenic activities have been reported by various researchers (Rahib *et al*., 2015; Audu *et al*, 2016; Bello *et al*., 2015; and Zauro *et al*., 2017). The concentration of heavy metals in this dumpsite may be enhanced by bioaccumulation due to the presence of painted metals scraps and large volume of slags that were ubiquitous in the site. The main objective was to: Determine the physicochemical parameters of the contaminated and control soil and to Determine the concentration of Chromium (Cr), Zinc (Zn), Lead (Pb), Iron (Fe), Nickel (Ni) and Copper (Cu) of the contaminated and control soil.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Katsina, Northwestern region of Nigeria in April, 2015. Katsina town is bordered to the north-east by Kaita, Jibia and Batsari to the North-west, Batagarawa to south and Mani local Government Areas to the east (Kankia *et al*., 2014). It is located at 12.59° N and 7.36° E at an elevation of 464 meters above sea level. The mean annual maximum and minimum temperatures are 33.2°C and 18.7°C respectively and the average relative humidity is 60% with mean annual rainfall of 600 mm (Tomlinson *et al*., 2016).

Sample Collection

Soil sampling

Stratified random sampling method was used as follows; each sampling area (the four cardinal points) representative samples were collected randomly at a depth 0- <10cm,10- <20cm,20- <30cm and 30-<40cm.from different dumping site in the company, mixed and homogenized. The representative samples were obtained using cone and quartered method. The samples were transported to the laboratory for analysis in clean polythene bags (Audu *et al*., 2012). The sampling areas were labeled as A = North, B= West, C = South and D = East.

Sample Pre-Treatment

Soil was air dried for one week (7days). Foreign and non soil materials were removed and the soil was crushed using pestle and mortar, sieved via 1.5 mm mesh sieve.

Soil Digestion

One gram of each soil sieved soil was put in a digestion tube. 5 cm3 of conc. H_2SO_4, 1 cm3 of 60% $HClO_4$ and 0.5 cm3 HNO_3 were added to the sample. The digestion tube were placed in a block digester, heated to 105^oC until a clear fumes was obtained. The digest was then splashed with distilled water and allowed to cool. After cooling it was filtered into a 50cm^3 volumetric flask and diluted to the mark with distilled water (Zauro *et al.,* 2017).

Soil Analysis

The filtrate was used for metals analysis using flame Atomic Absorption Spectrophotometer (AAS) Ahmad *et al*., (2014) and physico-chemical parameters (pH, Organic matter, moisture and cation exchange capacity, Electric conductivity, exchangeable acids and mineral elements (nitrogen, potassium and phosphorus) etc were determined in Soil Lab. of Faculty of Agriculture, Bayero University, Kano.

Statistical Analysis

In this research, physicochemical parameters and heavy metals concentrations in the samples were computed using Analysis of Variance (ANOVA) with SPSS version 10.0 statistical packages. Also, test of significance difference of their means were determine by the Duncan's Multiple Range Test DMRT (α=0.05) method (Ahmad, 2014*)*. The statistical variations was considered significant at $p<0.05$. Comparison using t-test would also be carried out to detect any significant differences in metal concentrations between polluted and Control Site (Audu *et al*., 2016).

RESULTS

The results of thePhysical parameters of soil obtained from the contaminated and control soils were presented in Table 1 while chemical propertiesof then soil samples were presented in Table 2, expressed as Mean ± Standard deviation of mean of triplicate analysis.In order to understand the level of difference between the parameters in contaminated and control area to ascertain the cause of the variation, the values obtained of A, B, C and in the target and control area were analyzed using Microsoft excel 2007 T-test (Pair two samples for means) at $P<0.05$ significance (one-tail.

Result of the heavy metals analysis was displayed in figure 1 which showed that there is a significant difference in the means of Zn, Cu, Cr, Co, Ni, and Pb.

The mean valuesfromthe four different sampling sites including the control soil showed that Pb had the highest concentration with the ranged average of 16.464-11.741mg/kg and Fe which has the lowest concentration with 0.219-0.379mg/kg. Using Duncan multiple statistical analysis of variance (ANOVA) there issignificant difference between heavy metals in contaminated and control soils.The E.C value ranged from 1.648-1.071% mean and found to be very significant among all the samples treated samples).Therefore, this suggested that all the significant toxic metals concentrations can be attributed to the industrial activity.

Table 1: Physical Properties of the Soil samples used.

Sample location	Sand (%)	Silt (%)	Clay (%)	Texture class	Colour	%Carbon	Moisture content (%)	pH(H_2O)
A	78.77^b	15.82^b	5.41^a	S-L	BLK	2.05^c	3.80^c	7.18±0.03^b
B	76.97^b	13.77^b	9.26^c	S-L	BLK	2.01^c	2.00^b	7.10±0.20^b
C	80.42^b	11.11^b	8.47^b	S-L	BLK	2.14^c	1.50^a	7.11 ±0.30^b
D	74.26^b	15.77^b	9.97^c	S-L	BLK	1.45^b	2.00^b	7.10±0.09^b
CTRS	65.40^a	19.90^a	14.70^d	S-L	L-B	0.18^a	1.00^a	5.98±5.94^a

*Values are expressed in percentage and Mean ±S.D in pH. Values having different superscript in the same column are significantly ($p<0.05$) different.
Key: A, B, C&D: Contaminated Soil, **CTRS:** Control Soil, **S-L** (Sandy-loamy); **BLK** (Blackish); **L-B** (Light brown).

Table 2: Chemical Properties of the Soil samples used.

Sample Location	N (%)	Organic Matter(%)	P (Cmol/mg/kg)	K (Cmol/kg)	Ca (Cmol/kg)	Mg (Cmol/kg)	Na (Cmol/kg)
A	0.20^b	3.73±0.42^b	31.55±1.35^c	2.35±0.78^b	4.46±0.50^c	2.41±0.52^d	0.94±0.79^b
B	0.22^b	2.75±1.07^b	27.37±5.77^b	3.00±1.31^b	5.14±0.46^b	1.51±0.72^b	0.92±0.07^b
C	0.28^b	5.82±0.28^d	22.62±1.97^a	2.48±0.58^b	1.97±1.19^c	1.88±0.95^d	0.27±0.25^a
D	0.18^b	4.22±0.85^c	23.59±10.20^b	2.10±0.55^b	3.22±1.26^c	1.13±0.12^b	0.19±0.06^a
CTRS	0.035^a	0.29±0.05^a	14.76±0.96^a	0.04±0.01^a	1.12±0.11^a	0.72±0.25^a	0.01±0.01^a

Mean ±S.D. Mean values having different superscript in the same column are significantly ($p<0.05$) different. **A, B, C&D:** Contaminated Soil, **CTRS:** Control Soil.

Table 3:Cation Exchange Capacity of the soil and Exchangeable ions in the Soil Samples.

Soil Sample	CEC (%)	E.A(Cmol/kg)	EC (dS/m)	pH (CaCl2)
A	10.76±2.66^c	0.61±0.24^a	1.65±0.51^a	6.77±0.15^c
B	12.25±3.55^c	0.74±0.45^a	1.52±0.4^a	6.33±0.74^b
C	6.98±2.66^b	0.37±0.06^a	1.07±0.18^a	6.43±0.47^b
D	6.99±3.36^b	0.36±0.14^a	1.58±0.36^a	6.30±0.17^b
CTRS	2.94±0.32^a	0.71±0.06^a	0.08±0.01^b	5.69±0.15^a

*Values are expressed as Mean ±S.D. mean values having different superscript in the same column are significantly different ($p<0.05$).**A, B,C&D:** Contaminated Soils, **CTRS:** Control Soil.

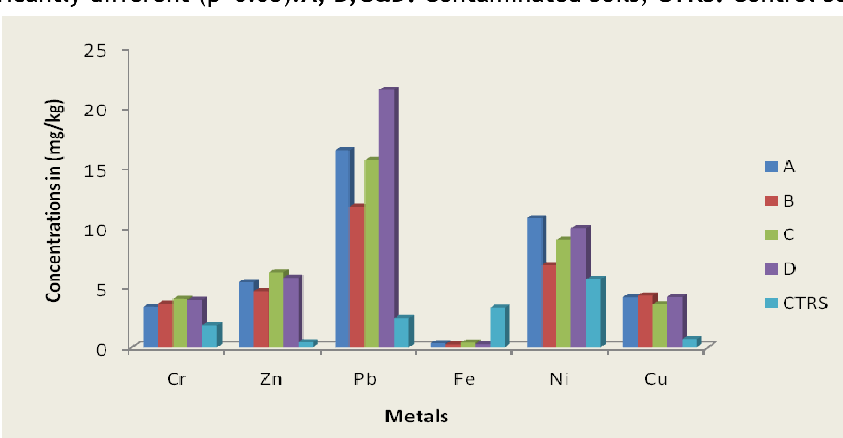

Figure 1. Showing Heavy metals concentration in soil samples.
Key: A, B,C&D: Contaminated Soils, **CTRS:** Control Soil.

DISCUSSION

Observation from this study shows that there were little variationsin physicochemical parameters. The physiochemical properties of the treated soils in this study indicated that contaminated dumpsite soil has poor nutrient content due to the highly industrial waste composed by the soil which differs with the control soil in all the parameters of the findings. The pH value of the soil in water and pH value in acid are varied with the value in sample A, B,C and D which indicated that the soil in the entire samples site and in control soil were mildly basic and slightly acidic soil in nature. pH is one of the most important parameter that serve as an indication for pollution. It is term used universally to describe the intensity of acidic or alkaline nature of the soil similar with what (Inbome *et al*., 2014; Rahib *et al*., 2015 and Audu *et al*., 2016) reported from different study areas. The total number of cations a soil can hold or its total negative charge is the soil's cation exchange capacity. The percentage cation exchange capacity (CEC) represents the total exchangeable cation held within the soil. In the present study, the CEC of these findingswere lower when compared to the work reported by Zauro *et al*., (2017) in the same study area but agreed with the work of Bello *et al*., (2015) respectively. The percentage Organic matter of this in soil of these findings showed that it falls within the range of low fertility class. This low Organic matter could be due to low humus content of the soil (Abdulhamid, 2017) The obtained values were lower than the reported value by Bello *et al*., (2014) and Zauro *et al*., (2017) in the same study area but agreed with the work of Inbome *et al*., 2014.Therefore, Soil organic matter is a principal factor that affects the heavy metal distribution in soil (Van and Maggio 2015). Increase in soil organic matter content lead to elevation of soil adsorption capacity hence enhancing the accumulation of trace metals. Organic matters can therefore be considered as one of the medium through which heavy metals are incorporated into the soil. Soil in all the sampling points generally contained low organic. The percentage moisture content in all the samples is low. This could be attributed to the time of sampling (May) which is dry season. The moisture content value ranges from 1.0% to 3.8%. The obtained results in this study are low when compared with what was reported Mmolawa *et al*., 2011 and Zauro *et* al., 2017). E.C value ranged from 1.65-1.05% mean and found to be very significant among all the samples treated and low value recorded in control (0.70). EC serves as a measure of soluble nutrients ((Nowell *et al*., 2013 and Avwin *et al*., 2014) for both cations and anions and is useful in monitoring the mineralization of organic matter in the soil (Van and Maggio 2015). The result of EC shown on in thesefindings were quite high compared with the work of Nowell *et al*., (2013) and Ahmad, (2014) but very low compared with the work of Hakanson *et al*., (2016). The exchangeable Sodium, Potassium, Calcium and Magnesium (Na, K, Ca and Mg) were low in all the samples. This is due to the low values of CEC in all the samples. The only element that affects Sodium levels in the soil is Potassium. When Sodium percentage is higher than Potassium then there is often trouble on the horizon from soil health and crop productivity point of view (Boadu *et al*., 2017).

The Mean concentration ofheavy metals in all the sampling point investigated between Zinc (Zn), Lead (Pb) and Copper (Cu) and higher variation between Iron (Fe) and copper (Cu). This could be connected with the sources of the wastes (Mmolawa *et al*., 2011) their work reported seasonal differences in elementconcentration throughout the year. This could be associated with natural variation of trace metalin the environment. This has to be monitored continuously for year (Bello et *al*., 2014).These metals were in the order of Pb>Ni>Zn>Cu>Cr>Fe. Therefore, high level of such trace metals or heavy metals recorded in this study agrees with the findings of (Inbome *et al*., 2014; Rahib *et al*., 2015 and Audu *et al*., 2016). The concentration of Pb being highest in the soil samples A, B, C, D and control also disagrees with resultof the report of heavy metals in soil conducted by (Zauro *et al*., 2017). But agrees with the work of Bello *et al*.,(2015) in the same study area therefore, the presence of Pb in this study could be connected with the major road very closed to the dump sites where vehicles are moving and other industrial wastes are deposited to the sites. The value of Fe is recorded lower than the ones obtained from the results of the report of heavy metals in soil, water, plants and sediment in river Challawa (Audu *et al*., 2016). Although Zn is widely used for making paints, dyes, rubber, wood,preservatives and through wares and tears (Kankia and Abdulhamid, 2014). The Mean level of Pb, Cr, Fe and Cu determined were above the safety standards and health criteria established by World Health Organization (WHO) United Environmental Protection Agency (USEPA) except forZn and Ni which is within the range recommended by WHO, USEPA and other regulatory bodies.

The level of Zn in such samples is however within the range recommended by EPA.Fe though high above WHO safety standard, it is still safe because it has benefits to organismsthough in very high concentration leads to conjunctivis, chroiditis and retinitis if it is in contactand remains in the (Rahib *et al*., 2015). Its presence in any compartment of the terrestrial ecosystem indicatescontamination. Concentrations of metals were low in contrast to higher when compared to other polluted. (Kankia and Abdulhamid, 2014) According to the WHO, the maximum allowable limits for metals in soil should not exceed theirunit depending on the metals, for, Zn (10), Cr (1.3), Fe (0.02), Ni (10) and Cu 0.1 and Pb (10) mg/kg, excess of essential metals are highly toxic. The high level of these metals in the soil are as a result of the dumping of industrial, domestic wastes and other reasonable factors in the environment at different points are known to containheavy metals such as As, Cd, Co, Cu, Fe, Hg, Mn, Pb, Ni, and Zn which will eventually end upin this aquatic ecosystem.

CONCLUSION

This research presented data on the Physicochemical and levels of heavy metals contents from dumpsites soil around Dana Steel Company Katsina. The results obtained showedthat the soil of the study area is basic/alkaline and of low fertility. Otherparameters such as CEC, E.A, E.C, pH (H_2O and Cacl2), Na, K, Ca and Mg ions etc. were low in the soil. Likewise, the results of heavy metals showed that all the metals analyzedwere present in samples A, B and C, D and the control. The Pb was found high. The amount of metals obtained in this work showed that the area was polluted with heavy metals. These heavy metals can cause environmental problems in ecosystem of the area due to the release of toxic metals from the contaminated soil to the ground water system and also in the plants grown in the soil. This alarming situation should be regularly monitored for health related problems in the inhabitants of the area. It is therefore strongly recommended that Phyto and bio-remedial measures be considered by appropriate authorities in order to minimize the extent of accumulated pollutant

Recommendations

1. Public enlighten campaign on danger imposed by heavy metal pollution in to the environment for safety alternate disposal especially people residing and farming around the industry
2. Secondly, Phyto and bio-remedial measures to be considered by appropriate authorities in order to minimize the extent of accumulated pollutant.

REFERENCES

Abdulhamid,Y and Bello Z, (2017).Determination of some physicochemical and heavy metal in soil around Barhim village, Batagarawa, Katsina . *Archivers Applied Sciences.***6** (6), 80-87

Ahmad K, Khan ZI, Ashfaq A, Ashraf M, Yasmin S (2014): Assessment of heavy metal and Metalloid Levels in Spinach(Spinacia Oleracea) grown in waste soil of Sarghoda ,Pakistan. *Pakistan Journal of Botany,* **46**(5),1805-1810.

Audu. A. Abdulhamid Y., Liman I. ((2016)). Accumulation and contamination of heavy metals in soils and Vegetation from industrial Area of River Challawa, Kano, Nigeria *Journal of Pure and Applied Chemistry Research,*1:25-34

Avwin, G. O, Olatubosin, D.O, Paul S.A (2014) Assessment of the Environmental radioactivity in selected dumpsites in Port Harcourt, Rivers State Nigeria. *International Journal of Scientific and Technology research.***3**(4),567-578

Bello S., Zakari Y.I, Ibeanu G.E, and Muhammad B.G (2015).Evaluation of heavy metal pollution in soils of Dana Steel limited dumpsite, Katsina State, Nigeria using Pollution load and degree of contamination indices. *American Journal of Engineering Research (AJER)* **4**(12), 161-

Boadu Theophilus Marfo (2017). Heavy Metals Contaminations of soil and water at Agbogbloshie Scrap Market, Accra, Unpublished Thesis. Kwame Nkrumah University of Science and technology. M.Sc Thesis. *Archivers Applied Sciences.***6** (6), 80-87

Chen J, Jiang Y, Xu C, Yu L, Sun D, Xu L, *et al*. *Ecotoxicology and Environmental Safety*.

Das S, Raj R, Mangwani N, Dash HR, Chakraborty J. 2 - Heavy Metals and Hydrocarbons:

Dhanakumar S, Solaraj G, Mohanraj R. *Ecotoxicology and Environmental Safety*.

Di Veroli A, Santoro F, Pallottini M, Selvaggi R, Scardazza F, Cappelletti D, *et al*. *Environment*. **2014**;476–477(0),144-57.

Environmental pollution control in Nigeria. **2013**:27-112

FEPA. Federal Environmental Protection Agency of Nigeria. (2014**)**The reports from World

Ge H-L, Liu S-S, Su B-X, Qin L-T. *Journal of Hazardous Materials*.;268(0):77-83.

Hakanson I., (2016): Ecological risk index for aquatic pollution control, a sedimentological Approach. *Water resources*,14: 975-1001.

Health Organization (WHO), Food and Drugs Administration (FDA), FAO, (CCFAC, 2001) and Hu X-F, Jiang Y, Shu Y, Hu X, Liu L, Luo F. *Journal of Geochemical Exploration*.

Inobeme A, Ajai AI, Iyaka YA, Ndamitso M, Uwem B. (2014). Determination of physicochemical and heavy metal content of soil around paint industries In Kaduna. International Journal of Scientific &Technology Research.**3**(8), 221-225.

Kanagasabapathy KV. **(2014)** *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*. Li S, Wallis LK, Ma H, Diamond SA. *Science of The Total Environment*.;466–475

Mmolawa K. B., Likuku A. S. and Gaboutioeloe G. K. (2011): Assessment of heavy metal pollution in soils along major roadside areas in Botswana. *African Journal of Environmental Science and Technology*, **5** (3),186-196.

Nigussie A, Kissi E, Misganaw M, Ambaw G. (2015).Effect of biochar application on soil properties and nutrient uptake of lettuces (*Lactuca sativa*) grown in chromium polluted soils. *American-Eurasian Journal of Agriculture & Environmental Sciences*.;12(3):369-376.

Nowell LH, Norman JE, Moran PW, Martin JD, Stone WW. *Science of The Total*

Rahib Hussain, Seema A. Khattak,Muhammad Tahir Shah,Liaqat Ali (2015): Multistatistical Approaches for Environmental geochemical Assessment of pollutants in soils of gadoonAmazai Industrial Estate, *Pakistan Journal of soils Sediments* 15:1119-1129

United Environmental Protection Agency (USEPA) on Guidelines and Standards for heavy metals.

Van Oosten MJ, Maggio A. *Environmental and Experimental Botany*. 2015;111(0):135-46.

Vaz-Pinto F, Torrontegi O, Prestes ACL, Álvaro NV, Neto AI, Martins GM. *Marine*

Wallis LK, Diamond SA, Ma H, Hoff DJ, Al-Abed SR, Li S. *Science of The Total*

WHO (World Health Organization), ―International standards for soil and drinking water quality,World Health Organization, Geneva, 1984.

Zauro SA, Dabai MU, Tsafe AI, Umar KJ, Lawal AM. (2013). Extent of some heavy metals contamination in soil of farmlands around Sokoto metropolis. *European Scientific Journal*.;9(3),30-36.

Zauro, S. A., Muhammad K. J. Umar, I. Abubakar, Sani, Y. M., K. Bello and Isah A. A. (*2017)*. Assessment of Physicochemical and Selected Heavy Metal of Soil around Dana Steel Industry Limited Katsina, Katsina State, Nigeria *Asian Journal of Chemical Sciences*

Gondek K, Baran A, Kopeć M. *Chemosphere*. 2014;117(0):33-9.

Environmental Research. 2014;94(0):72-9.