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Analysis Of Some Heavy Metals In Soil At Ikokwu Automobile Mechanic/Spare Part Village, Port Harcourt, Nigeria

Evbuomwan B.O and Offor I .W
Department of Chemical Engineering, University of Port Harcourt, Port Harcourt, Nigeria

***Abstract*—The analysis of some heavy metals in soil around Ikokwu automobile mechanic/spare parts village have been investigated. The heavy metals that were analyzed included Zn, Pb, Cr, Fe and Cd. The soil samples were digested using nitric acid, hydrogen peroxide and hydrogen sulfate acid. The soil digested samples were analyzed for heavy metals using atomic absorption spectroscopy. Statistical analysis was done with one way ANOVA. The concentration levels of Zn, Fe, Cr, Cd, Pb, at the surface (0-5cm) ranged from 315.5417.5mg/l, 3900-8350mg/l, 20.5-38mg/l, 1.5-3.0mg/l, and 93.5-308mg/l respectively. At (5-15cm) below the surface, concentration ranges from 312.8-385.2mg/l, 2503—8122mg/l, 10.3-30mg/l, 0.2-1.6mg/l and 92.7-283.1mg/l respectively. The pH values of soil samples from sampling site A, B and C ranged from 7.09 – 7.48. Statistical analysis using one way ANOVA revealed significant differences in the levels of zinc in sampling site A (P= <0.0001). The levels of zinc in soils at sampling sites B and C were not significantly different in concentration with P-values (P = 0.8027 and 0.7399 respectively). Similarly, ANOVA revealed no significant difference in the levels of Iron, chromium, cadmium and lead in the soils at the three sampling sites at Ikokwu automobile mechanic/spare part village with P-values of (P = 0.1967) for site A, (P= 0.8027) for site B and (P = 0.7399) for sampling site C. It has shown that mechanical/commercial activities at Ikokwu automobile mechanic/spare part village generates enormous concentrations of heavy metals which affects its immediate environment as well as a distance of 100 and 200m away from the industrial site.**

Keywords—Heavy metals, Analysis, Soil, Concentration, Anova, Automobile

INTRODUCTION

Soil and environmental contamination by heavy metals has become a world-wide problem during recent years since heavy metals unlike some other pollutants that are decomposable by living organisms. Consequently, they are not detoxified but are bioaccumulated in the environment. Heavy metals occupy a special position in soil chemistry because they play very important physiological roles in nature. The contaminant concentration in soil mainly depends on the

adsorption properties of soil matter. Because of increasing anthropogenic activities, heavy metals pollution of soil, water, and atmosphere represents a growing environmental problem affecting food quality and human health. The food chain being contaminated by heavy metals has become a serious issue because of their potential accumulation in biosystems through contaminated water, soil and air[1]. Presently, the most common environmental pollutants in the world are heavy metal[2]. The presence of heavy metals at trace level and essential elements at increased concentration causes toxic effects when they are exposed to human population. The realization of heavy metal accumulation in soils, the origin of these metals and their probable interactions with soil properties are a priority in many environmental monitoring. The build-up of heavy metals in soils used for agricultural purposes is of increasing concern because of food safety issues and potential health risks as well as its after effects on the soil living organisms and their environment. Heavy metals can accumulate in the soils to toxic levels due to long term application of untreated waste waters and fertilizers. Soil that is usually irrigated by waste water and used as a dump site or scrap yard tends to accumulate heavy metals on the soil surfaces and when the soil can no longer retain these heavy metals because of the repeated application of waste water, the heavy metals leach into the soil solution which is supposed to be for plant uptake. In the soil system, pollution by toxic metals is due to both natural processes, such as weathering of minerals and anthropogenic activities, related to industry, agriculture, burning of fossil fuels, vehicular emissions, mining and metallurgical processes and their waste disposal.

Soil contamination by heavy metals is of most important concern throughout the industrialized world. Heavy metal contamination not only results in adverse effects on various parameters relating to plant quality and yield, but it also causes changes in the size, composition and activities of the microbial community. Therefore, heavy metals are considered as one of the major sources of soil pollution. Heavy metal contamination of the soil is caused by various metals especially Cu, Ni, Cd, Zn, Cr, and Pb occurring naturally. The soil properties i.e. organic matter, clay contents and pH have major influences on the extent

of the effects of metals on biological and biochemical properties. Heavy metals indirectly affect soil enzymatic activities by shifting the microbial community which synthesizes enzymes. Heavy metals exhibit toxic effects towards soil ecology by affecting key microbial processes and decrease the number and activity of soil microorganisms. There are wide ranges of aerobic and anaerobic methods that could be used to treat heavy metals. Specifically, some of the methods being used are biosorption [3], activated sludge process , anaerobic digestion [4] and stabilization ponds [5].

The aim of this paper is to analyze some heavy metals present in soil at Ikokwu automobile mechanic/Spare part village in Port Harcourt, Nigeria

MATERIALS AND METHODS

Three sites of Ikokwu automobile mechanic village were selected because of the heavy human activities such as construction, welding, repairs and wrong disposal of oils, chemicals and locomotives.

Study area

Ikokwu automobile mechanic/spare part village is located in Diobu, Port Harcourt. Diobu falls within latitudes 4° 40'50"Nand longitudes 6° 20'10"E. Because it is one of the biggest zones for automobile repairs, selling of motor spare parts, use of different lubricating oils and chemicals is therefore evident. It also has the highest number of aging auto mobiles plying its roads which contribute greatly to the sources of heavy metals in the environment. Ikokwu is the busiest and the key source of contamination in Diobu. Ikokwu is poorly planned with very poor sewerage system and sewerage facilities especially around the slum areas of Diobu and this contributes to heavy metal pollution especially in water.

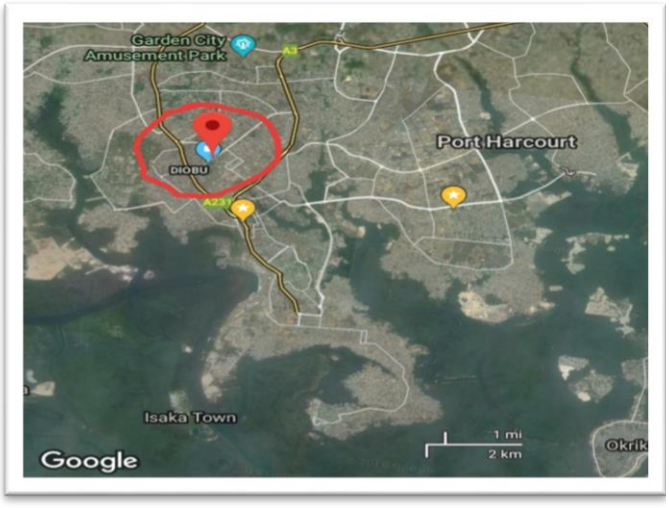

Plate 1: GPS map of Port Harcourt showing the location of Diobu.

Soil sampling

Three sampling sites were chosen based on the anthropogenic sources of heavy metals. At each sampling point, approximately 500g of soil was collected at depths of 0 – 5cm, 5 – 15cm and 15 – 25cm using a hand shovel. The three samples were collected from three different points, thoroughly mixed in a clean plastic container to obtain a representative sample. Samples from sampling site A was collected from a mechanic workshop, samples from sampling site B was collected from a smaller workshop at approximately 100m away from sampling site A while samples from sampling site C approximately 200m from sampling site B was collected along the road at a residential area. Soil samples along the road was collected away from the road and within an area of one square metre. The samples were then dried, crushed and sieved with 2 mm mesh before being stored in polythene bags labeled with masking tapes prior to the analysis. The soil sample was labeled according to the sites and the different depths at which they were taken. Plate 2 shows the different sampling points on a GPS map of Diobu. The soil sampling sites are shown in plates 3 and 4.

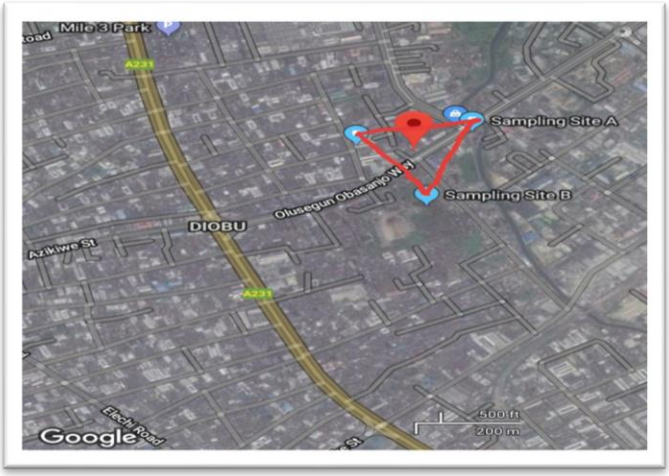

Plate 2: GPS map of Diobu showing the three sampling points in Ikokwu automobile mechanic/spare part village.

Plate 3: Soil sampling site A from Ikokwu automobile mechanic village.

Plate 4: Soil sampling site B from Ikokwu automobile mechanic village.

PREPARATION OF STOCK SOLUTIONS

Lead stock solution (1000 mg/l) was prepared by dissolving 1.59 g of lead (ii) nitrate in 500 ml of distilled water and then made up to 1 litre of solution using distilled water. Zinc stock solution (100 mg/l) was prepared by dissolving 0.289 g of zinc nitrate salt in 300 ml of distilled water and then made up to 1 litre of solution using distilled water. Iron stock solution (1000 mg/l) was prepared by dissolving 0.07 g of standard iron (II) ammonium sulfate hexahydrate salt in distilled water. 2-3ml of concentrated sulfuric acid is added and transferred to a 1000ml volumetric flask, diluting the solution to the mark with distilled water. Chromium stock solution (1000 mg/l) was prepared by dissolving 0.38 g of CrO3 in a solution of 20 ml water and 4 ml of concentrated nitric acid and diluted to 200 ml using distilled water. Cd stock solution (1000 mg/l) was prepared by dissolving 0.275 g of Cd nitrate salt in 500 ml of distilled water and made up to 1 litre of solution using distilled water.

Sample analysis

Buck scientific (210 VGF) flame atomic absorption spectrophotometer machine was used in this analysis. Its parameters were set according to the specifications given in the manufactures manual including lamp current and fuel system of air/acetylene flame. The AAS machine had a picking meter that indicated when the optimum conditions had been realized. Its optimization was automatic. Table 1 below shows elements and their wavelength of analysis in air acetylene flame.

Table 1: Elements and their conditions of analysis.

Elements analyzed	Wavelength (nm)
Zinc	213.8
Iron	510
Chromium	357.9
Cadmium	228.8
Lead	283.3

RESULTS AND DISCUSSION

The results of analysis of heavy metals in soil samples from Ikokwu automobile mechanic/spare part village are reported below

Table 2: Result of analysis of heavy metals at different sampling sites in soil with respect to depths collected.

Parameters	Depths (cm)	Sampling site A (mg/l)	Sampling site B (mg/l)	Sampling site C (mg/l)
Zinc (Zn)	0 – 5	417.5	405.2	315.5
	5 – 15	385.2	373.5	312.8
	15 – 25	352.7	320.6	307.4
Iron (Fe)	0 – 5	8350	7300	3900
	5 – 15	8122	6023	2503
	15 – 25	6325	5135	1642
Chromium (Cr)	0 – 5	38	27.5	20.5
	5 – 15	30	25.1	10.3
	15 – 25	26.5	23.5	10.5
Cadmium (Cd)	0 – 5	3	4.5	1.5
	5 – 15	2.8	3.2	0.53
	15 – 25	0.8	1.6	0.2
Lead (Pb)	0 – 5	283	308	93.5
	5 – 15	264	283.1	92.7
	15 – 25	134.2	156.8	78.3

Table 3: Statistical analysis of heavy metal concentration using ANOVA

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Significance	WHO Permissible
						Lower Bound	Upper Bound		Maximum limits (2001) (mg/l)
Zn	SITE A	3	385.1333	32.40005	18.70618	304.6471	465.6195	.064	
	SITE B	3	366.4667	42.68681	24.64524	260.4268	472.5066		
	SITE C	3	311.9000	4.12432	2.38118	301.6546	322.1454		
	Total	9	354.5000	42.52493	14.17498	321.8124	387.1876		300
Fe	SITE A	3	7599.0000	1109.19025	640.39129	4843.6187	10354.3813	.004	
	SITE B	3	6152.6667	1088.30893	628.33546	3449.1574	8856.1759		
	SITE C	3	2681.6667	1139.55357	657.92156	-149.1413	5512.4747		
	Total	9	5477.7778	2391.29911	797.09970	3639.6626	7315.8930		50,000
Cr	SITE A	3	31.5000	5.89491	3.40343	16.8562	46.1438	.012	
	SITE B	3	25.3667	2.01329	1.16237	20.3654	30.3680		
	SITE C	3	13.7667	5.83210	3.36716	-.7211	28.2544		
	Total	9	23.5444	8.89018	2.96339	16.7108	30.3780		100
Cd	SITE A	3	2.2000	1.21655	.70238	-.8221	5.2221	.116	
	SITE B	3	3.1000	1.45258	.83865	-.5084	6.7084		
	SITE C	3	.7433	.67575	.39014	-.9353	2.4220		
	Total	9	2.0144	1.43958	.47986	.9079	3.1210		3
Pb	SITE A	3	227.0667	80.98403	46.75615	25.8912	428.2422	.049	
	SITE B	3	249.3000	81.06904	46.80523	47.9133	450.6867		
	SITE C	3	88.1667	8.55414	4.93874	66.9170	109.4163		
	Total	9	188.1778	94.97305	31.65768	115.1750	261.1805		100
Ph	SITE A	3	7.3833	.09504	.05487	7.1472	7.6194	.9354	
	SITE B	3	7.2633	.06028	.03480	7.1136	7.4131	.7356	
	SITE C	3	7.1233	.03512	.02028	7.0361	7.2106	<.0001	
	Total	9	7.2567	.12718	.04239	7.1589	7.3544	.010	

Table 4: P^H of soil samples from Ikokwu automobile mechanic village.

Sampling sites	Depth (cm)	pH value	Mean pH value	P-value
A	0 – 5	7.29	7.20	0.9354
	5 – 15	7.20		
	15 – 25	7.12		
B	0 – 5	7.38	7.25	0.7356
	5 – 15	7.27		
	15 – 25	7.09		
C	0 – 5	7.48	7.32	<0.0001
	5 – 15	7.32		
	15 – 25	7.16		

(P>0.05) = Not significantly different (P<0.05) = significantly different

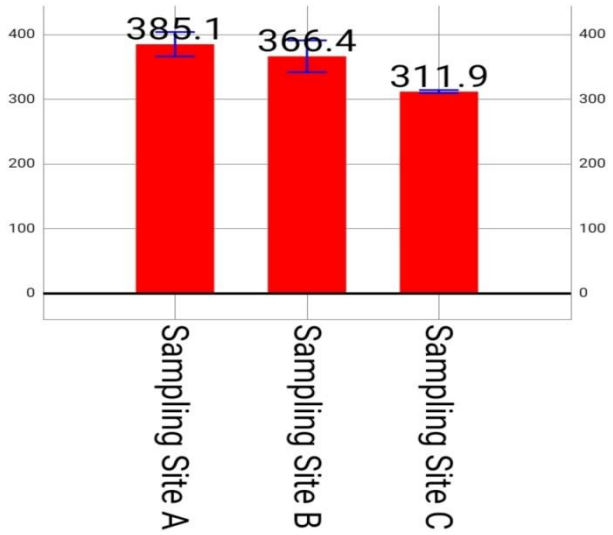

Fig. 1: Levels of Zinc in the soils at Ikokwu automobile mechanic/spare part village.

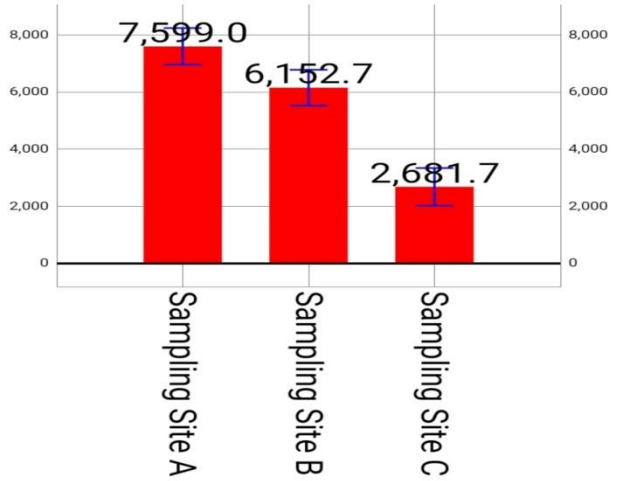

Fig. 2: Levels of Iron in the soils at Ikokwu automobile mechanic/spare part village.

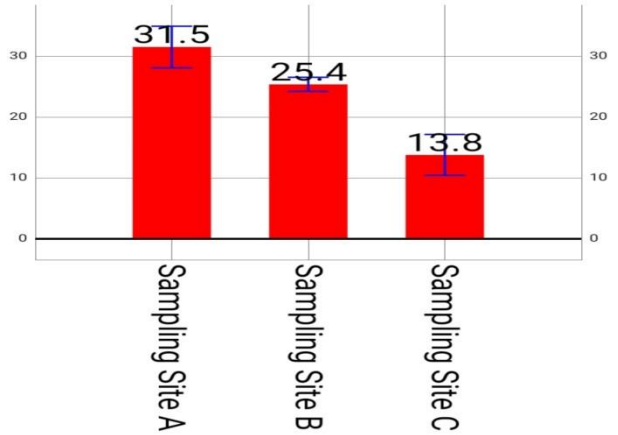

Fig. 3: Levels of chromium in soil at Ikokwu automobile mechanic/spare part village.

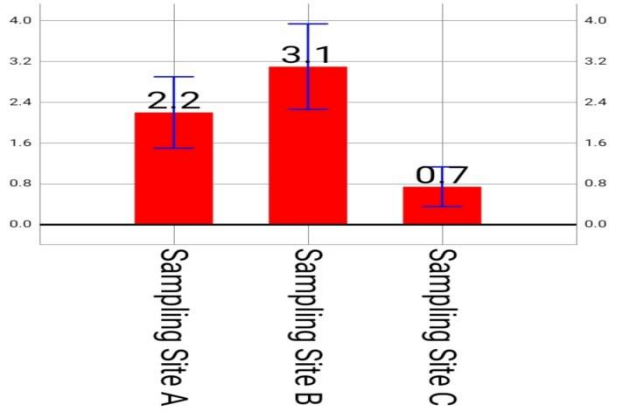

Fig. 4: Levels of cadmium in soil at Ikokwu automobile mechanic/spare part village.

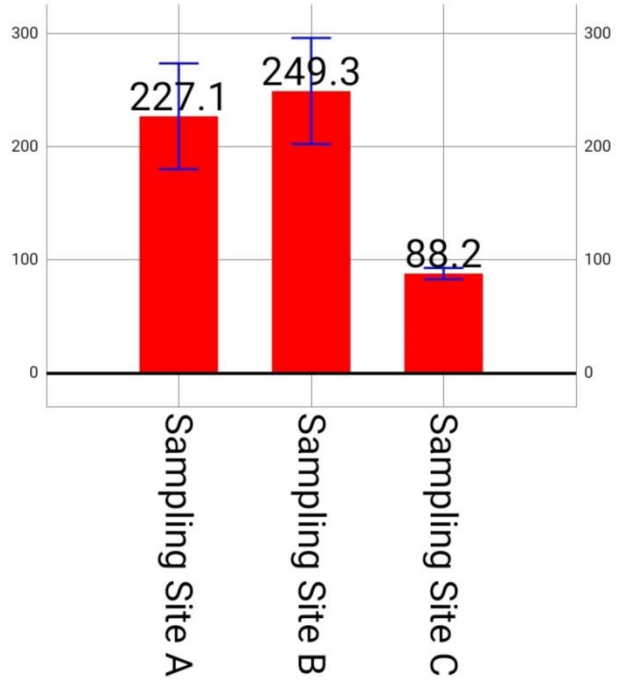

Fig. 5: Levels of lead in soils at Ikokwu automobile mechanic/spare part village.

The concentration levels of zinc at the surface (0 – 5 cm) ranged from 315.5 – 417.5 mg/l. At 5 – 15cm below the surface, concentrations of zinc ranged from 312.8 – 385.2 mg/l and ranged from 307.4 – 352.7 mg/l. Levels of concentration of zinc were higher at the surface because of the major commercial and mechanical activities that are present such as welding of car parts and panel beating. Attrition of motor vehicle tyre rubber triggered by poor road surfaces and poor disposals of lubricating oil in which zinc is found as part of many additives[6]. Zinc was seen to decrease with depth due to the percolation of heavy metals to the groundwater.

The levels of concentration of Iron across the surface (0 – 5cm) ranged from 3900 – 8350 mg/l. At depth 5 – 15cm, the range of Iron was 2503 – 8122 mg/l and 1642 – 6325 mg/l. The surface of the soil experienced greater levels of iron concentration because of higher mechanical activities carried out on the surface at sampling site A. Iron was seen to decrease with depth. The decrease in concentration was due to percolation of heavy metals which deposits them beneath the soil as traces. Chromium levels of concentration across depth 0 – 5cm ranged from 20.5 – 38 mg/l. At depth 5 – 15cm, it ranged from 10.3 – 30 mg/l while at depth 15 – 25cm chromium level of concentration ranged from 10.5 – 26.5 mg/l. The surface of the soil experienced greater levels of chromium at sampling site A compared to the other sampling site depths. This was as a result of mechanical activities that take place in sampling site A. Levels of chromium reduced with depth at sites A and B only. Chromium concentration at depth (15 – 25cm) was higher than depth 5 – 15cm due to surface runoff of soil during heavy downpour.

The range in levels of concentration across the surface (0 – 5cm) was 1.5 – 3.0 mg/l, 0.53 – 2.3 mg/l at a depth of 5 – 15cm and 0.2 – 1.6 mg/l. Cadmium exhibited lower levels of contamination than those of other heavy metals in this study. Human activity contributed to increased levels of concentrations as a result of urban-industrial activity. The concentrations of lead at the surface (0 – 5cm) ranged from 93.5 – 308 mg/l. At depth 5 – 15cm, lead concentrations ranged from 92.7 – 283.1 mg/l while at depth 15 – 25cm it ranged from 78.3 – 156.8 mg/l. Levels of lead at the surface was highest due to the improper disposal of car batteries, poor sewerage system which ends up in water sources after heavy downpour which dissolves lead in water from the surfaces is washed down into groundwater.

Statistical analysis using one way ANOVA revealed significant differences in the levels of zinc in sampling site A (P= <0.0001). The levels of zinc in soils at sampling sites B and C were not significantly different in concentration with P-values (P = 0.8027 and 0.7399 respectively). Similarly, ANOVA revealed no significant difference in the levels of Iron, chromium, cadmium and lead in the soils at the three sampling sites at Ikokwu automobile mechanic/spare part village with P-values of (P = 0.1967) for site A, (P= 0.8027) for site B and (P = 0.7399) for sampling site C.

The pH values of soil samples from sampling site A, B and C ranged from 7.09 – 7.48. Bacterial activity that releases nitrogen from organic matter and certain fertilizers is affected by soil pH, because bacteria operates best in the pH range of 5.5 to 7.0. Plant nutrients leach out of soils with a pH below 5.0 much more rapidly than from soil with values between 5.0 and 7.5. Plant nutrients are generally most available to plants in the pH range 5.5 to 6.5. This shows that the above pH values of different sampling sites are not suitable for planting.

CONCLUSION

This research was carried out on the analysis of some heavy metals in the soil of Ikokwu automobile mechanic/spare part village evaluating Zn, Fe, Cr, Cd and Pb at three different sampling points and at different depth; 0 – 5cm, 5 – 15cm and 15 – 25cm. It has shown that mechanical/commercial activities at Ikokwu automobile mechanic/spare part village generates enormous concentrations of heavy metals which affects its immediate environment as well as a distance of 100 and 200m away from the industrial site. Also, the little presence of heavy metals was as a result of contaminants being dissolved in the water from sampling sites A and B. When percolated water leaches the contaminant from the soil, it flows downward to the water table and into groundwater thereby making water unsafe for drinking once levels exceeded the [7] drinking water standards.

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