GSJ: Volume 11, Issue 1, January 2023, Online: ISSN 2320-9186
www.globalscientificjournal.com

ASSESSMENT OF HEAVY METAL LEVELS IN SOIL FROM VEHICLE SPARE PARTS MARKET, MILE II, PORT HARCOURT, RIVERS STATE, NIGERIA.

[1*]Nde, N. B. & [2]Edori, O. S.

[1*]DEPARTMENT OF PURE AND INDUSTRIAL CHEMISTRY, FACULTY OF SCIENCE, UNIVERSITY OF PORT HARCOURT, RIVERS STATE, NIGERIA.

[2]DEPARTMENT OF CHEMISTRY, FACULTY OF NATURAL AND APPLIED SCIENCES, IGNATIUS AJURU UNIVERSITY OF EDUCATION, RUMUOLUMENI, PORT HARCOURT, RIVERS STATE, NIGERIA.

Email: ndifrekende@gmail.com

Keywords: contamination, heavy metals, pollution, soil.

ABSTRACT

This study assessed levels of some heavy metals such as Cd, Cr, Zn, Cu, As, Pb, Mn, Co, Fe, and Ni in the soil of vehicle spare parts market in Mile II, Port Harcourt, Rivers State, Nigeria. The levels of heavy metals were determined using Atomic Absorption Spectrophotometer method (AAS). The concentration of the metals in soil samples in mg/kg from "station I" determined were Cu (6.43), Cd (2.32), Cr (2.90), Ni (3.55), Co (0.82), As (<0.001), Fe (114.33), Mn (6.53), Zn (8.38) and Pb (3.33), "station II" were Cu (4.60), Cd (1.48), Cr (5.69), Ni (6.33), Co (1.32), As (0.22), Fe (131.41), Mn (9.61), Zn (13.51) and Pb (5.82) and "station III" determined were Cu (7.32), Cd (2.69), Cr (7.43), Ni (5.62), Co (2.65), As (0.41), Fe (148.71), Mn (13.33), Zn (10.32) and Pb (4.58). The values of all the metals analysed for the soil samples were below values recommended by the World Health Organisation (WHO) except that of Cu and Fe that were higher than the WHO standard limits and there is need for adoption of proper waste management system in the vehicle spare parts market for adequate disposal of waste and a step is necessary in order to remedy the situation.

INTRODUCTION

Soil may be contaminated by heavy metals and metalloids accumulation through emission from the industrial areas, mine tailings, disposal of metal wastes, paints, fertilizer applications, pesticide, wastewater, irrigation, petrochemical spillage and coal combustion residues (Khan *et al.*, 2008). Heavy metals are metallic elements that have relatively high density compared to water (Fergussion, 1990). Heavy metals like chromium (Cr), cadmium (Cd), mercury (Hg), lead (Pb), nickel (Ni) and thallium (Tl) are potentially hazardous in combined or elemental forms. Sources of heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents and atmospheric sources (He *et al.*, 2005). In such areas, mining, foundries and smelters, and other metal-based industrial operations, environmental pollution is very prominent (Bradl, 2002). Although heavy metals are naturally occurring element that are found throughout the earth's crust, most environmental contamination and human exposure result from anthropogenic activities (Shallari et al., 1998 and Goyer, 2001).

Heavy metals contamination of the soil may pose risks and hazards to humans and the ecosystem through direct ingestion or contact with contaminated soil – plant – animal – human), drinking of contaminated ground water, reduction in food quality through phytotoxicity, reduction in land use for agricultural production which leads to food insecurity and land tenure problems (McLaughlin *et al.*, 2000). Significantly, natural phenomena such as weathering and volcanic eruption have also contributed to heavy metal pollution (Nriagu, 1989). Industrial sources such as petroleum combustion, nuclear power stations, metal processing in refineries, coal burning in power plant microelectronic, wood preservation and paper processing plants also contributed to the heavy metal pollution in soil (Arruti *et al*, 2010). Some metals level of toxicity for human follows the sequence Co < Al < Cr < Pb < Ni < Zn < Cu < Cd < Hg (Martin and Grisworld, 2009). The period of exposure, rate of emission and dosage of heavy metals contributed to the harmful effects in human (Valavanidis and Vlachogianni, 2010). Metals such as copper (Cu), chromium (Cr), iron (Fe), magnesium (Mg), nickel (Ni), manganese (Mn), zinc (Zn), molybdenum (Mo), cobalt (Co) and selenium (Se) are known as essential nutrients that are required for various biochemical and physiological function. Variety of deficiency diseases or syndromes are as a result of inadequate supply of these micro-nutrients (WHO/FAO/IAEA, 1996). In various environmental matrices, heavy metals are present in trace concentration (part per billion ppb to less than 10 parts per million ppm) and they are considered as trace elements (Kabata-Pendies, 2001). In various oxidation – reduction reactions, some of the heavy metals are important constituent of several key enzymes which also play important roles since the essential heavy metals exert biochemical and physiological functions in plants and animals (WHO/FAO/IAEA, 1996). For instance, copper (Cu) serves as an essential co-factor for several oxidative stress – related enzymes including catalase, super oxide, dismutase, peroxidase, cytochrome c oxidases, ferroxidases, monoamine oxidase and dopamine β-monooxygenase (ATSDR, 2002, Stern, 2010). In the other hand, according to Chang *et al*, (1996) other metals such as aluminium (Al), antinomy (Sb), arsenic (As), barium (Ba), beryllium (Be), bismuth (Bi), cadmium (Cd), gallium (Ga), germanium (Ge), gold (Au), indium (In), lead (Pb), lithium (Li), mercury (Hg), nickel (Ni), platinum (Pt), silver (Ag), strontium (Sr), tellurium (Te), thallium (Tl), tin (Sn), titanium (Ti), vanadium (V) and uranium (U) have no established biological functions and are considered as non – essential metals.

Cellular organelles and components such as cell membrane, mitochondrial, lysosome, endoplasmic reticulum, nuclei and some enzymes involved in metabolism, detoxification and damage repair have been reported to be affected by heavy metals in biological systems (Wang and Shi, 2001). Metals ion have been found to interact with cell components such as DNA and nuclear proteins, causing DNA damage and conformational changes that may lead to cell cycle modulation, carcinogenesis or apoptosis (Beyersmann and Hartwig, 2008). Toxicity and carcinogenicity are heavy metal – induced which involves many mechanistic aspects, some of which are not clearly elucidated. Each metal is however known to have unique features and physico-chemical properties that confer to its specific toxicological mechanisms of action (Tchounwou et al., 2008).

This study is therefore aimed at assessing the levels of some heavy metals in the soil from vehicle spare parts market in Mile II, Port Harcourt, Rivers State, Nigeria to assess the level of contamination.

Study Area

The study was carried out in vehicle spare parts market in Mile II, Port Harcourt, Rivers State, Nigeria. The sampling locations lies between Latitude 04^o 49' 0'' N and Longitude 006^o 57' 0'' E for Station I (The Young Shall grow former park), Latitude 04^o 49' 30'' N and Longitude 006^o 57' 30'' E for Station II (Anglican Church) and Latitude 04^o 49' 0'' N and Longitude 006^o 56' 0'' E for Station III (Ecobank along Olu-Obasanjo Way)

Collection of Samples

Three sample stations in the vehicle spare parts market were selected namely: (i) The young shall grow former motor park, (ii) The Anglican Church and (iii) Ecobank along Olu-Obasanjo way. Soils samples from these three stations were collected from a depth of 0 – 15 cm with soil auger. The soil samples were put into polythene bags, well labelled and was transported to the laboratory of Jaros Inspection Services Limited, KM 2 Iwofe/College of Education Road, Port Harcourt, Rivers State for further treatment.

Sample Preparation, Digestion and Analysis

The soil samples were air dried to a constant weight and then ground to fine particles in a ceramic mortar. The ground samples were sieved with 2 mm mesh to remove stones. 2 g of the fine samples were digested with ratio of 1: 10 HNO_3: HCl. To the mixture, 25 ml of distilled water was added and then heated for 20 minutes in water bath to obtain a milky colour. The samples were removed from the water bath and allowed to cool. After cooling, the sample were filtered using 11 mm Whattman filter paper and the filtrate were transferred into 50 ml sample bottle and were made up to the mark with distilled water. The digested samples were analysed for heavy metal by Atomic Absorption Spectrophotometry (flame) method using Solaar Thermo Elemental Atomic Absorption Spectrometer model with serial number SE – 710960 made in Germany, with a detection limit of 0.001 mg/kg at the Jaros Inspection Services Limited, KM 2 Iwofa/College of Education Road, Rumuepirikom, Port Harcourt, Rivers State.

RESULTS AND DISCUSSION

The concentrations of heavy metals in the soil in vehicle spare parts market is shown in table 1. The mean concentrations of heavy metals in soil from vehicle spare parts market and international standards is shown in table 2. The concentrations of heavy metals values are as follows for all the sampling stations respectively. The values for Cu are 6.43 mg/kg, 4.60 mg/kg

ISSN 2320-9186

and 7.32 mg/kg, Cd are 2.32 mg/kg, 1.48 mg/kg and 2.70 mg/kg, Cr are 2.90 mg/kg, 5.70 mg/kg and 7.43 mg/kg. The values for Ni are 3.55 mg/kg, 6.33 mg/kg and 5.62 mg/kg, Co are 0.82 mg/kg, 1.32 mg/kg and 2.65 mg/kg, As are < 0.001 mg/kg, 0.22 mg/kg and 0.41 mg/kg, Fe are 114.33 mg/kg, 131.41 mg/kg and 148.71 mg/kg, Mn are 6.53 mg/kg, 9.62 mg/kg and 13.33 mg/kg, Zn are 8.38 mg/kg, 13.51 mg/kg and 10.32 mg/kg and values for Pb are 3.33 mg/kg, 5.82 mg/kg and 4.58 mg/kg respectively.

Table 1: Concentrations of Heavy Metals in Soil in Vehicle Spare parts Markets in Mile II.

Metals (mg/kg)	**Station I**	**Station II**	**Station III**
Copper (Cu)	6.43	4.60	7.32
Cadmium (Cd)	2.32	1.48	2.69
Chromium (Cr)	2.89	5.69	7.43
Nickel (Ni)	2.55	6.33	5.62
Cobalt (Co)	0.82	1.32	2.65
Arsenic (As)	<0.001	0.22	0.41
Iron (Fe)	114.33	131.41	148.71
Manganese (Mn)	6.53	9.62	13.32
Zinc (Zn)	8.38	13.51	10.32
Lead	3.33	5.82	4.58

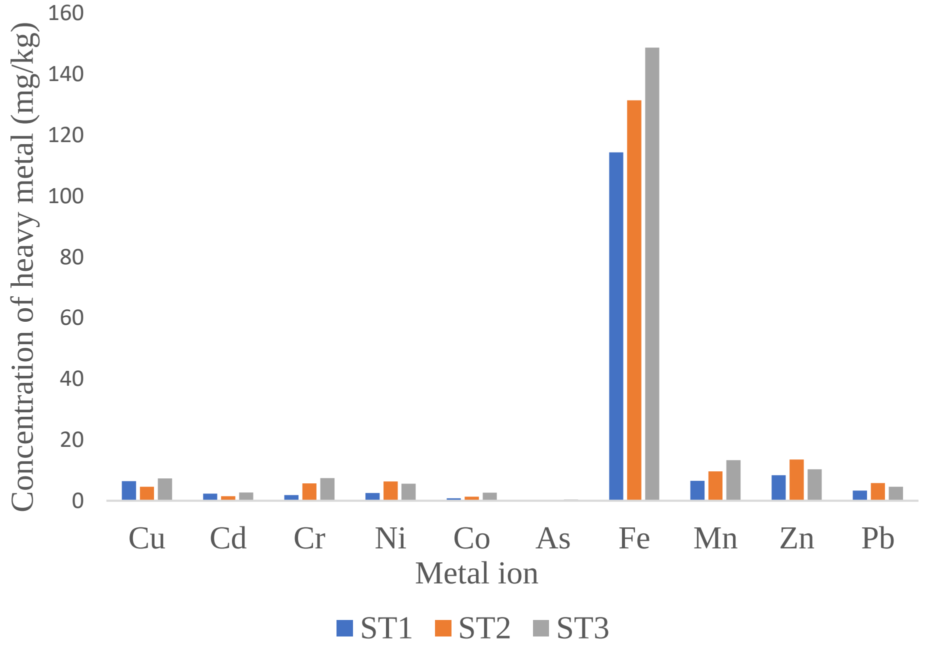

Fig 1: Concentration of heavy metal ions in the soil samples

The heavy metal concentrations analysed in the work were copper (Cu), cadmium (Cd), chromium (Cr), nickel (Ni), cobalt (Co), arsenic (As), iron (Fe), manganese (Mn), zinc (Zn) and lead (Pb). The concentrations analysed for all the heavy metals in the soil samples were below the World Health Organisation (WHO/FAO, 2001) permissible limits except copper (Cu) and iron (Fe) concentrations were high compare to the standard limits by WHO/FAO. The concentrations of Pb, Ni and Cr obtained from the study were high compared to the concentrations of these heavy metals reported by Ukpe and Johnson, (2019) in assessment of levels of heavy metal in Mechanic Village dumpsites in Yenagoa, Bayelsa. The concentrations of cadmium (Cd) ranged from 1.48 mg/kg to 2.69 mg/kg with the least recorded in sampling stations 2 and 3 respectively and the values were low compared to the concentrations of Cd values observed in soil with quarry environment in Akamkpa, Cross River State by Ekpo *et al.*, (2012). The concentrations of chromium (Cr) and manganese (Mn) observed in the study were lower than those observed in index models assessment of heavy metal pollution in soils within abattoirs in Port Harcourt, Rivers State reported by Edori and Kpee (2016).

Table 2: Mean concentrations of heavy metals in soil from vehicle spare parts market with international standards

Metals (mg/kg)	**Mean Samples**	**WHO**
Copper (Cu)	6.11±1.38	2.00
Cadmium (Cd)	2.16±0.62	25.00
Chromium (Cr)	5.33±2.29	100.00
Nickel (Ni)	5.16±1.44	35.00
Cobalt (Co)	1.59±0.94	10.00
Arsenic (As)	0.21±0.20	0.50
Iron (Fe)	131.48±17.19	50.00
Manganese (Mn)	9.82±3.40	100.00
Zinc (Zn)	10.73±2.59	50.0
Lead	4.57±1.24	300.00

The concentrations of Cd, Co, Pb, Fe, Ni, Cu and Zn observed in the study were higher and that of arsenic (As) was low compared to the concentrations of these heavy metals observed by Opaluwa *et al.,* (2012) in heavy metal concentrations in soils, plant leaves and crops grown around dumpsites in Lafia Metropolis, Nasarawa State, Nigeria. The concentrations of Pb and Fe observed were low compared to the Pb and Fe concentrations observed by Edori and Edori, (2012) who studied the effects of auto mechanic works on lead and iron content in two mechanic villages in Port Harcourt, Rivers State, Nigeria. The concentrations of lead (Pb) and iron (Fe) observed in this study were below and higher respectively than the permissible standard limits of World Health Organisation. The increase in the values of lead (Pb) may be as a result of lead containing compounds such as batteries and paints used at the vehicle spare parts market (Adelekan and Abegunde, 2011). Since lead (Pb) has a significant factor in polluting the soil which is due to the fact that its deposit in particular in the soil is greatly influenced by vehicle emission (Martin 2001). Lead also constitute health risk at high concentrations in blood and tissues of animals. Haem synthesis is inhibited by high blood level of Pb which causes irritation, mental retardation, brain damage, produce tumour and also plumbism a general disease problem. In the other hand, the increase in the concentrations of iron (Fe) in the soil may be due to dumping of iron scraps, tin can, solvent, spent lubricant, unused vehicle body parts at the vehicle spare parts market (Ayeni, 2010). Iron (Fe) increase in this soil may be majorly caused by the leftover corroding vehicles since iron is a major component of alloy steel which is the materials used in vehicle body manufacture.

In this study, the concentrations of Cu, Pb and Zn were low compared to the concentrations of Cu, Pb and Zn observed in the heavy metal concentrations in plants and soil along heavy traffic roads in North Central Nigeria reported by Ogundele et al., (2015).

Conclusion

The investigation in the study showed that the soil in vehicle spare parts market in Mile II, Port Harcourt are contaminated with heavy metals, iron (Fe) and copper (Cu) are far exceeding their recommended limit in soil. Although some of these heavy metals were below World Health Organisation (WHO) permissible limit in soil. However, lead (Pb) was found to be above the World Health Organisation (WHO, 1993) standard maxima of 0.01 mg/kg though the soil is still safe i.e. the values of Pb are below the tolerable level of 90 – 300 mg/kg recommended by European Commission (EC, 1986). Also, if borehole water is sunk around the market and the water is not properly treated may eventually leads to health risks of the consumers.

It is therefore recommended that a better waste management system should be adopted for adequate disposal of the wastes generated by the vehicle spare parts market.

REFERENCES

Adelekan, B. A. and Abegunde, K. D. (2011). Heavy metals concentration of soil and groundwater at automobile mechanic villages in Ibadan, Nigeria. *International Journal of Physical Sciences,* **6** (5): 1045-1058.

Agency for Toxic Substances and Disease Registry (2002). Toxicological Profile for Copper. ATSDR, Georgia: Centre for Disease Control, Atlanta.

Arruti, A., Fernandez-Olmo, I. and Iirabien, A. (2010). Evaluation of the contribution of local sources to trace metals levels in urban PM 2.5 and PM 10 in the Cantabria region, Northern Spain. *J. Environ. Monit.*, **12** (7): 1451-1458.

Ayeni, K. E. (2010). Heavy metals pollution in selected industrial locations. *Continental Journal of Renewable Energy*, **1**: 9-14.

Beyersmann, D. and Hartwig, A. (2008). Carcinogenic metal compounds: recent insight into Molecular and cellular mechanisms. *Arch. Toxicol*., **82** (8): 493-512.

Bradl, H. (2002). Heavy Metals in the Environment: Origin, Interaction and Remediation. London: Academic Press, **6**.

Chang, L. W., Magos, L. and Suzuki, T. (1996). Toxicology of Metals. Boca Raton. editors. FL, USA: CRC Press.

Edori, O. S. and Edori, E. S. (2012). Effect of Automechanic Works on Lead and Iron Content in Two Mechanic Villages in Port Harcourt, Rivers State, Nigeria. *J. Appl. Sci. Environ. Manage.*, **16** (4): 317-321.

Edori, O. S. and Kpee, F. (2017). Index Models Assessment of Heavy Metal Pollution in Soils

ISSN 2320-9186

Within Selected Abattoirs in Port Harcourt, Rivers State, Nigeria. *Singapore J. Sci. Res.,* **7** (1): 9-15.

Ekpo, F. E., Nzegblue, E. C. and Asuquo, M. E. (2012). A Comparative Study of the Influence of Heavy Metals on Soil and Crops Growing Within Quarry Environment at Akamkpa, Cross River State, Nigeria. *Global Journal of Agricultural Science*, **11** (1): 1-4.

European Commission (EC, 1986). European Commission Office for Official publications of The European Communities; Luxembourg; Council Directive 66/278/EEC on the protection of environment and in particular of soil, when sewage sludge is used in agriculture.

Fergusson, J. E. (1990). The Heavy Elements: Chemistry, Environmental Impact and Health Effects. Oxford: Pergamon Press.

Goyer, R. A. (2001). Toxic effects of metals. In: Klaassen, CD., editor. Cassarett and Doull's Toxicology: The Basic Science of Poisons. *New York: McGraw-Hill Publisher*, pp. 811-867.

He, Z. L., Yang, X. E. and Stoffella, P. J. (2005). Trace elements in agroecosystems and Impacts on the environment. *J. Trace Elem. Med. Biol.*, **19** (2-3): 125-140.

Kabata-Pendia, A. (2001). Trace Elements in Soils and Plants. Boca Raton, FL: CRC Press.

Khan, S., Cao, Q., Zheng, Y. M., Huang, Y. Z. and Zhu, Y. G. (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China". *Environmental Pollution,* **52** (3): 686-692.

Martin, L. (2001). Urban land use influence on heavy metal fluxes and surface sediment concentrations of small lakes. *Water, Air and Soil Pollution,* **126:** 363-383.

Martin, S and Griswold, W. (2009). Human Health Effects of Heavy Metals, Centre for Hazardous Substance Research, Kansas State University, 15.

McLaughlin, M. J., Zarcinas, B. A., Steven, D. P. and Cook, N. (2000). "Soil testing for heavy metals". *Communication in Soil Science and Plant Analysis*, **31** (11): 1661-1700.

Nriagu, J. O. (1989). A global assessment of natural sources of atmospheric trace metals. Nature, 338: 47-49.

Ogundele, D. T., Adio, A. A. and Oludele, O. E. (2015). Heavy Metal Concentrations in Plants and Soil along heavy traffic roads in North Central Nigeria. *J. Environ. Anal. Toxicol,* **5** (6): 1-5.

Opaluwa, O. D., Aremu, M. O., Ogbo, L. O., Abiola, K. A., Odiba, I. E., Abubakar, M. M. and Nweze, N. O. (2012). Heavy metal concentrations in soils, plant leaves and crops grown around dump sites in Lafia Metropolis, Nasarawa State, Nigeria. *Adv. Appl. Sci. Res.,* **3** (2): 780-784.

Shallari, S., Schwartz, C., Hasko, A. and Morel, J. L. (1998). Heavy metal in soils and plants Of serpentine and industrial sites of Albania. *Sci. Total Environ,* 19209: 133-142.

Stern, B. R. (2010). Essentiality and toxicity in copper health risk assessment: overview, update and regulatory considerations. *Toxicol. Environ. Health. A.,* **73** (2): 114-127.

ISSN 2320-9186

Tchounwou, P. B., Newsome, C., Williams, J. and Glass, K. (2008). Copper-induced Cytotoxicity and transcriptional activation of stress genes in human liver carcinoma cells. *Metal Ions Biol. Med.*, **10:** 285-290.

Ukpe, R. A. and Johnson, E. C. (2019). Assessment of levels of Heavy Metals in Mechanic Village Dumpsite in Yenagoa. *Nig. J. Pharm. Appl. Sci. Res,* **8** (2): 103-106.

Valavanidis, A and Vlachogianni, T. (2010). Metal Pollution in Ecosystems: Ecotoxicology Studies and Risk Assessment in the Marine Environment. *Science advances on Environment, Toxicology & Ecotoxicology issues,* www.chem-tox-ecotox.

Wang, S. and Shi, X. (2001). Molecular mechanisms of metal toxicity and carcinogenesis. *Mol. Cell Biochem.,* **222**: 3-9.

WHO (1993). World Health Organisation, Standard maxima for metals in Agricultural Soils.

WHO/FAO/IAEA (1996). Trace Elements in Human Nutrition and Health. World Health Organisation. Switzerland: Geneva.

WHO/FAO, (2001). Codex Alimentarius Commission. Food Additives and Contaminants. Joint FAO/WHO Food Standards Programme, ALINORM. 10/12A: 1-289.