Determination Of Heavy Metals In Soils At Gombe Town, Gombe, North Eastern Nigeria.

*** [1]Ogidi A. Ogidi, [2]Danja B.A., [3]Mausul Umar, [4]Kawuwa Bakari**

*(Department of Chemical Sciences, Federal University of Kashere, Gombe state, Nigeria)

(E-mail; ogidiadam1981@gmail.com)

(*Phone; +2347069680768*)

DOI: 10.29322/IJSRP.10.09.2020.p10575
http://dx.doi.org/10.29322/IJSRP.10.09.2020.p10575

Abstract

The heavy metals content of soils where determined in Gombe state, North-Eastern Nigeria, the heavy metals analyzed in this study are, Cd, Cr, Pb, and Zn using an Atomic Absorption Spectrophotometer (AAS), Perkin Elmer 400ASS (9). A general over view of the study shows that Pb had the highest concentration, and Cr had the least concentration. The trend of heavy metals in the study is as follows; Cr < Cd < Zn < Pb. the result of the heavy metal analysis shows that the concentrations of heavy metals in the soils at the study sites where below the permissible limits of the various metals for soil and thus are of no environmental or health consequences and the soil is relatively safe for cultivation of agricultural crops.

Key words: Heavy metals, Atomic Absorption Spectrophotometer, Soil, Concentration.

1.0 INTORDUCTION

Soils are made up of particles, gaseous and liquid constituents. They act as sink for pollutants through the adsorption process which bind inorganic and organic pollutant with varying strength to the surface of soil colloids, Soil may become contaminated due to the accumulation of metals via emissions from industrial sites, mining operations, and disposal of wastes containing metals, leaded gasoline, and paints, application of fertilizers and animal manures, other agrochemicals and spillage of petrochemicals (1). Heavy metals are natural components of the earth's crust that that are not biodegradable. Heavy metals tend to be transferred into the human body trough the ingestion of food materials, water and air. At low concentration levels, certain heavy metals such as copper, manganese, zinc and iron are essential in maintaining certain body functions. However above the recommended concentrations they pose health risk (2). Examples of heavy metals include, Ar, Cd, Cd, Co, Cu, Au, Ag, Fe, Mn, Hg, Ni, Pb, and Zn (1). Some heavy metals become toxic at levels slightly above the background concentrations normally present in nature. It is necessary to provide information about the health impact of metals and carry out proactive measures to prevent excessive exposure to heavy metals. Heavy metal toxicity is a critical medical condition when it occurs. If not detected or not properly treated, it leads to serious health issues and reduce the quality of human life (3). The presence of toxic heavy metals (at levels that contaminate) in soil pose risk and creates health issues in humans and also affects the ecosystem via the direct intake of food and drinking of contaminated ground water. It also affects the quality of food (affecting the safety and market value of such foods) via reduction in land usability for agricultural production, leading to food insecurity (4). Living organisms require trace amounts of some heavy metals e.g. cobalt, vanadium, strontium and zinc (5). The increase in the uptake of these heavy metals by plants and animals (most of which ends up as food for

man) pose as health risk to humans. Excessive levels of essential metals can have environmental effects on organisms. Non- essential metals of such as Cd, Cr, Hg, and Pb even at low concentrations pose threats to the health of humans. The main threats to human well-being however, are associated with lead, arsenic, cadmium, and mercury (5). Plants have the capacity to accumulate metals (from water, and soil) that are essential for growth and development; examples of these metals are Fe, Mn, Zn, Cu, and Ni (6). Heavy metals are toxic if they cannot be metabolized by the human body and thus accumulate in the soft tissues of the human body. Heavy metals tend to get into the human body via food, water, air, or absorption by skin due to contact with humans during agriculture and manufacturing processes, also in pharmaceuticals, industrial, and residential environments. Exposure from industries is a means of exposure in humans. Ingestion serves is the most common means of exposure in children. The no hand-to-mouth activity of small children often result to toxic levels of heavy metals concentrations when they come in contact with soil contaminated with the metals or by consuming substances which are not eatable foods such as dirt or paint chips, (7). Less common routes of exposure are from a suicide or homicide attempt involving the use of substances containing the toxic metals (8).

This study involves the determination of heavy metals (Cd, Cr, Zn and Pd) concentrations in soil at Gombe town, North-Eastern Nigeria. The significance of this study is to provide information on the heavy metal content of soil in certain parts of Gombe town and also enlighten the public on the ability of food crops to absorb and bio-accumulate heavy metals from soils and also the adverse effects of these metals on human health.

2.0 MATERIALS AND METHODS

2.1 Study Site

Gombe is the capital of Gombe state located in the North- Eastern part of Nigeria with an estimated population of 261,536, and a geographical location of Latitude; 10^0 16' N, and Longitude 11^0 09' E.

2.2 Sample collection, preservation and pretreatment

Soil samples were collected from five different sites at Gombe town (Pantami, Bolari, G. R. A., Herwagana, Tudun Wada). Samples were obtained from soil surface from a depth of 0 – 20cm, at ten different spots for each sample site with the help of stainless steel spoons and made into a composite sample. The soil samples were placed into a nitric acid treated polythene bags to prevent metals from adhering to the containers, transported to the laboratory, air dried for about 3days then oven-dried to constant weight at 105℃, ground to powder in a ceramic pestle and mortar, sieved, and stored for further treatment.
(5, 2).

2.3 Sample digestion

Soil samples were digested with 15mL of concentrated acid mixtures (5mL conc.$HClO_4$, 15mL conc.HNO_3, and 10mL conc. H_2SO_4) was poured into the 100mL beaker containing the soil sample (1g), covered with watch glasses, and heated over a water bath in a fume cupboard until the digestion was complete. The content of the beaker was then diluted to 100mL with de-ionized water and transferred to dispersing bottles for heavy metal analysis (2, 9).

2.4 Apparatus/ reagents

All apparatus used such as glass wares, sample bottles, burette, and pipettes were washed cleaned and rinsed with HNO_3, and rinsed further using distilled water to avoid errors arising from contamination. All reagents used were of analytical grade (10, 11).

2.5 Method of Analysis

The Atomic Absorption Spectrophotometric (AAS) method is employed in this study, because it is readily accessible, has a wide range of application, also for its specificity, and having a low detection limit (11). The heavy metals content of soil samples where determined using an Atomic Absorption Spectrophotometer (AAS), Perkin Elmer 400ASS (9).

2.5 Statistical Analysis

The minimum, maximum, average values, and standard deviations of the concentrations of heavy metals in soil samples were determined using Microsoft excel (windows 2007).

3.0 RESULTS /DISCUSSION

Cadmium

The average concentration of Cd in soils at Gombe 0.88 mg/Kg was greater than the values for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.,* (2017) and by Ibrahim *et al*., (2014) also greater than the maximum concentration in soils at Mwazan Region in Tanzania reported by Kisamo, (2003), but less than the recommended limit for soil set by USEPA. Pantami had the highest concentration of Cd this could be due to the use of agrochemicals, presence of waste dumps in the area (13). The lowest concentration was at Bolari, this could be as a result of low agricultural activities, absence of industries and dumpsite at Bolari. Cd nonessential to the health of humans and animal, at higher concentrations in organisms above the recommended limits it is toxic (14). Cadmium accumulates in human body creating adverse effects on the soft tissues and organs (kidney, lungs, placenta, liver, and brain) as well as the bones (1, 15). Cadmium accumulation in humans also leads to certain health issue affecting systems of the body such as reproduction, growth and development, renal functions, blood and immune systems (15).

Chromium

Cr concentration in the soil samples was an average value of, 0.54 mg/Kg was within the range of Cr concentration in irrigated soils at Gombe state, Nigeria reported by Babangida *et al.,* (2017), but less than the concentration of Cr in soils at Makurdi reported by Ogidi, (2015), the maximum value at Mwazan Region in Tanzania reported in Kisamo, (2003), the content of soils at Keritis, Chania, Greece reported in Papafilippaki1, *et al.* (2007) and also less than the recommended limit for soil (3000 mg/kg) set by USEPA. The highest concentration of Cr was observed from soils at Pantami, this could be due to the use of agrochemicals, and dumping of domestic and agricultural waste (13). The least concentration was at G.R.A and Herwagana both having the same concentration; this could be due to the absence of serious agricultural activities, absence of industries and dumpsites. The Cr content in the soils could have originated from domestic, industrial and agricultural waste disposal, application of organic manures, inorganic fertilizers with the use of pesticides, insecticides and herbicides on the soil. Excessive concentration in soils has adverse implication on the health of humans and animals due to it bioaccumulation in plants (1, 15).

Lead

The concentration of Pb in soils has a mean value of 6.54 mg/Kg this is greater than the concentration in irrigated soils at Gombe state, Nigeria reported by Babangida *et al*., (2017), the value for soils reported in Papafilippaki1, *et al.* (2007), but less than the mean

concentration of Pb in soil at Makurdi, North Central Nigeria reported by Ogidi, (2015), and the recommended limit for soils set by USEPA. The highest concentration of Pb was observed in Tundun Wada; this could be due to vehicle emission, use of leaded gasoline and disposal of waste paint cans e.t.c. (9). The lowest concentration was observed at Herwagana. Excess Pb content of soils above regulatory limits create serious health hazards to humans and animals as a result of its ability to bio-accumulate in soft tissues (brain, liver, lungs, kidneys) and other tissue like bones, hair and teeth, creating organ and tissue failures (17).

Zinc

The Zn concentration of soils in this study has an average value of 2.74 mg/Kg which is less than the value range in irrigated soils at Gombe state, Nigeria reported by Babangida *et al*., (2017), less than the mean concentration of Zn in soil at Makurdi, North Central Nigeria reported by Ogidi, (2015), and the mean value for soils at Mwazan Region in Tanzania reported by Kisamo, 2003 also below the regulatory limit of Zn in soils (50mg/Kg) set by WHO (2007). The highest concentration was observed at Herwagana this could be due to the presence of Zn smelting, and fabrication industries around the area. The lowest concentration of zn was observed at Pantami. The Zn content of the soil has no serious toxicity hazard to humans, animals or plants, but often zinc contaminated soils are also contaminated with non essential elements such as Cd and Pb (20).

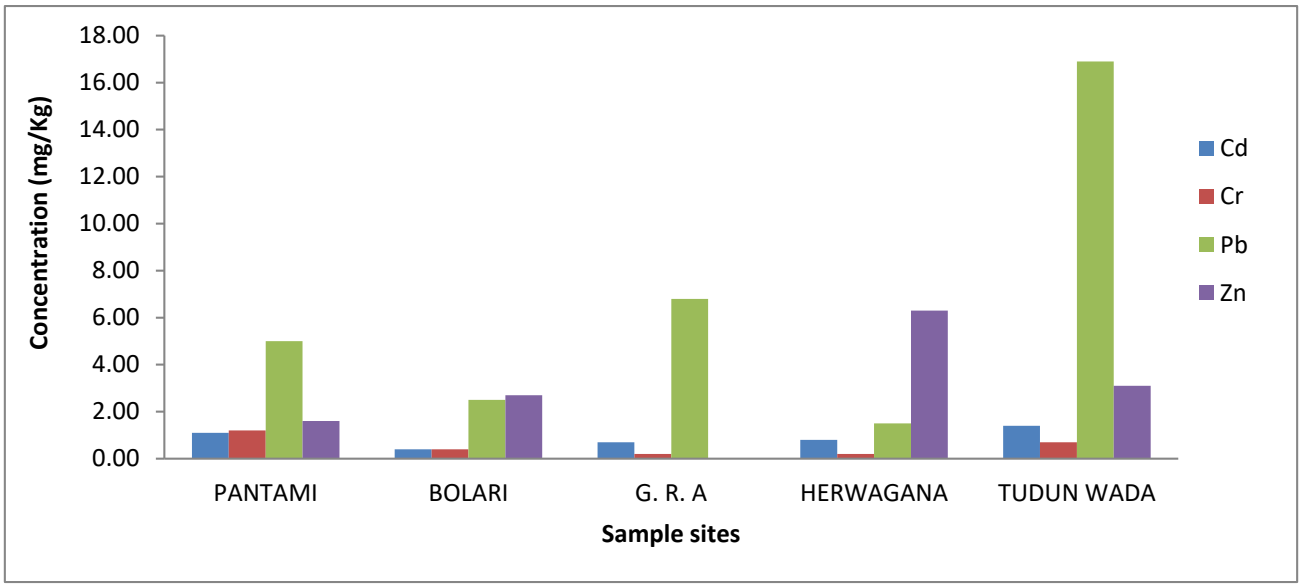

Figure 1: Heavy Metals Content of Soils at Gombe.

Table 1: Statistics of heavy metal content of soils at Gombe.

Parameter	Cd	Cr	Pb	Zn
Max	1.10	1.20	16.90	6.30

Min	0.40	0.20	1.50	1.60
Average	0.88	0.54	6.54	2.74
Std Dev	0.38	0.42	6.15	2.32

(a) Max = maximum, (b) Min = minimum, (c) Std Dev = standard deviation

4.0 Conclusion

Heavy metals were found to be present in all soil samples at the various sites sampled, Pb was present in all sample and had the highest concentration at Pantami, G.R. A and Tundu Wada this could be as a result of vehicular emission, use of gasoline containing lead and lead paints, e.t.c., Cr had the least concentrations in soil at study sites except at Patami where Cd had the least concentration in soil samples. At G.R.A. Zn was not detected in the soil. A general over view of the study shows that Pb had the highest concentration, and Cr had the least concentration. The trend of heavy metals in the study is as follows; Cr < Cd < Zn < Pb. The heavy metals were all below the recommended limits required for soils.

4.1 Recommendation.

Heavy metals contents of soils need to be monitored at all times to ensure safety of agricultural products for consumption, and also prevent heavy metals poisoning due to soil ingestion. Soil serves as a sink for many pollutants and some are transferred into ground waters. Plants have ability of absorbing and adsorbing heavy metals from the soil, thus if crops are planted on heavy metals contaminated soils the plants absorb the metals, and when eating by humans and animals this heavy metals bio accumulates in tissues and organs in the body. There is a need to determine and analysis the heavy metal content of soils before cultivation of crops. The government needs to enforce regulations on indiscriminate dumping of industrial, domestic and agricultural waste.

References

[1] Ogidi, A.Ogidi. (2015). Comparative Assessment of Heavy Metals in Fluted Pumpkin (*Telfaria occidentalis*), Water Hyacinth (*Eichhornia crassipes*), Water and Soil from River Benue. (M.Sc Thesis) Department of Chemistry, University of Agriculture, Makurdi, Benue state, Nigeria. 1-115pp.

[2] Ndimele, P.E. and Jimoh, A.A. (2011). Water Hyacinth {*Eichornia crassipes (Mart.) Solms.*} in Phytoremediation of Heavy Metal Polluted Water of Ologe Lagoon, Lagos, Nigeria. *Res. J. Environ. Sci.*, 5:424-433pp.

[3] Ferner, D.J. (2001), Heavy metals. *eMed.j*. 2(5): 1pp

[4] Wuana, R.A. and Felix, E.O. (2011). Heavy metals in contaminated soils; a review of sources, chemistry, risks and best available strategy for remediation. *International Scholarly Research Network. ISRN ,Ecology* 2011, 20pp.

[5] Kisamo, D.S. (2003). Environmental Harzards Associated With Heavy Metals In Lake Victoria Basin (East Africa), *Tazania. Afr Newslett on Occup Health and Sefty*.13: 64- 69

[6] Langille, W. M. and MacLean, K.S. (1976). Some essential nutrients in forest plants as related to species, plant parts, season and location. *Plant Soi*l. 45:17-25pp.

[7] Dupler, D. (2001). Heavy Metal Poisoning. Gale Encyclopedia of Alternative Medicine. Farmington Hills, Gale Group. pp: 23-26.

[8] Lupton, Y., Beckman, S.L. (1995). Role of mercury (Hg) in resistant infections and effective treatment of *Chlamimydia trachomatis* and *Herpes* viral infections (and potential treatment of cancer) by removing localized Hg deposit with Chinese parsley and delivering effective antibiotics using various drug uptake enhancement methods. Acupunct. Electrother.Res. 1996; 1(2); 133-60pp.

[9] Ogidi A. Ogidi, Danja B.A., Sanusi K.A., Hammashi H. Lodma, Nathaniel Sunday Samuel, Abdurrahman Abubakar, And Nasiru Aminu Rano (2018). Heavy Metal Content Of Agricultural Soils At Pindiga, Akko Local Government Area Of Gombe State, Nigeria. *Int. J. Adv. Res. 6(11), 223-233.*

[10] APHA, (1985). Standard Method for the Examination of Water and Waste Water. 16th Edtn., American Public Health Association, Washington, DC., USA. ISBN: 0-87553-131-8, pp: 1268.

[11] Ademoroti, C.M.A. (1996).Standard Methods of Water and Effluent Analysis, Foludex press. 13-19,20-22, 27-28, 114- 118pp.

[12] Babangida, H., Hassan, A.F., Hassan, M.A.K and Ibrahim, U. (2017). Determination of Heavy Metals Concentration in Irrigated Soils in Gombe State, Nigeria. Asian Journal of Science and Technology. 8(12): 7047-7054.

[13] Ogidi A. Ogidi, Danja B.A., Hammashi H.Lodma, Nathaniel Sunday Samuel, Sanusi K.A. (2019). Heavy Metal Content of Agricultural Soils at Kashere, Akko Local Government Area of Gombe State, Nigeria. *International Journal of Scientific and Research Publications, Volume 9(3): 745-748*.

[14] Ogidi A. Ogidi, Danja B.A., Sanusi K.A., Nathaniel Sunday Samuel, Abdurrahman Abubakar, Hammashi H. Lodma. (2019). Heavy Metal Content of Agricultural Soils at Tumu, Akko Local Government Area of Gombe State, Nigeria. *International Journal of Scientific and Research Publications, Volume 9(2):745-748*.

[15] Simone, M, Fernando, G. C and Maria, L. P. (2012). Heavy Metals and Human Health, Environmental Health - Emerging Issues and Practice, ISBN: 978-953-307-854-0, *InTech*, pp 21

[16] Papafilippaki, A. Velegraki, D., Vlachaki, C. and Stavroulakis, G. (2007). Total and Bioavailable Forms of Cu, Zn, Pd and Cr In Agricultural soils, A Study From The Hydrological Basin of Ketritis, Chania , Greece. *Nest Journal*, 3; 201- 206pp.

[17] Baker, E.L, Feldman, R.G, White, R.A, Harley, J.P, Niles, C.A., Dinse, G.E., and Berkey, C.S. (1984). Occupational lead neurotoxicity: A behavioral and electrophysiological evaluation. Study design and year one result. *Br. J. Ind. Med.*, 41: 352–361pp.

[18] W.H.O. (2007). Joint FAO/WHO Expert standard program codex alimentation commission. Geneva, Switzerland.

[19] Hasnine, M .T., Huda, E.M., Khatun, R., Saadat, A.H.M. *et al*. (2017). Heavy Metal Contamination in Agricultural Soil at DEPZA,Bangladesh. *Environment and Ecology Research*. 5(7): 510 – 516.