FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 8 No. 3, June, (Special Issue) 2024, pp 208 - 213
DOI: https://doi.org/10.33003/fjs-2024-0803-2470

EVALUATION OF SPECIFIC HEAVY METALS IN DRINKING WATER CONSUMED IN YAR'AKWA QUARTERS, NA'IBAWA, TARAUNI LGA, KANO STATE, NIGERIA

***[1]Sulaiman Nasir Mujahid, Muhammad Umar Bala, Adam Mubarak Isyaku, Musa Abba, Suleiman Sani, Hussaini Aliyu, Aliyu Muhammad, Yahuza Jamilu, Sani Shafiu, Musa Yusuf Umar**

[1]Department of Pure and Industrial Chemistry, Bayero University, P.M.B.3011, BUK, Kano-Nigeria
[2]Department of Biochemistry and Molecular Biology, Usmanu Danfodiyo University Sokoto.
[3]Department of Chemistry, Faculty of Physical Science, Federal University Dtsin-Ma, Katsina State

*Corresponding authors' email: nasirmujahids@gmail.com

ABSTRACT

The study focused on analyzing selected heavy metals in drinking water used in Yar'akwa Quarters. Water samples were collected from boreholes, taps, and wells across different locations and times. Using Atomic Absorption Spectrophotometry (PerkinElmer PinAAcle 900h AAS), the samples were tested for Ni, Pb, Co, Zn, and Cu. Results showed that Lead (Pb) was not detected in any samples. Cobalt concentrations ranged from 0.032 to 0.050 mg/L, with a maximum of 0.050 mg/L, while copper ranged from 0.040 to 0.057 mg/L, peaking at 0.057 mg/L. Nickel levels ranged from 0.026 to 0.052 mg/L, with a maximum of 0.052 mg/L, and zinc ranged from 0.020 to 0.027 mg/L, reaching up to 0.027 mg/L, all observed in the Na'ibawa borehole water sample. These values conform to World Health Organization (WHO 2020) standards, suggesting that the water in this area is suitable for drinking, domestic, and other purposes. However, ensuring ongoing monitoring of boreholes and tap water sources is recommended.

Keywords: AAS, Concentration, Drinking water, Heavy metals, WHO

INTRODUCTION

Access to safe drinking water is a fundamental human right, akin to clean air. However, in many African and Asian countries, including relatively developed ones like India, safe drinking water remains scarce. Out of the 6 billion people worldwide, over one billion lack access to safe drinking water, and approximately 2.5 billion lack adequate sanitation services (TWAS, 2002). Furthermore, waterborne diseases claim the lives of more than 6 million children annually, amounting to about 20,000 children per day (TWAS, 2002). Water, essential for life on Earth, is naturally odorless, colorless, and tasteless. Yet, due to human and animal activities, it often becomes contaminated with solid and human waste, industrial effluents, and dissolved gases (Ehlers and Krafft, 2001).

Furthermore, water contains trace amounts of heavy metals, also known as "trace elements." These metals are highly toxic and can cause harmful effects even at very low concentrations (as low as parts per million). Heavy metals are metallic elements with high atomic weights and densities much greater than that of water (Anonymous, 2008). They encompass a range of elements from the periodic table, including iron, magnesium, manganese, cadmium, lithium, zinc, copper, chromium, nickel, cobalt, vanadium, arsenic, molybdenum, selenium, lead, and others (Hakam et al., 2009). Some of these minerals are essential as micronutrients for proper human metabolism in small quantities. The concentrations of trace elements in water can fluctuate due to physiological, environmental, and other factors (Sa'id, 2008).

Heavy metals have attracted considerable attention in environmental research in recent decades, largely because of advancements in highly sensitive analytical techniques that enable accurate detection and measurement of trace metal content (Skeat, 1969).

Plants such as vegetables, carrots, and cucumbers, as well as fruits like mangoes, oranges, and bananas, along with water, serve as pathways for heavy metals to enter the human body when consumed. These metals have a tendency to accumulate in the food chain and in both soft tissues (e.g., kidneys) and hard tissues (e.g., bones). Metals can exist in positively charged forms and can bind with negatively charged organic molecules to form complexes. While the body requires essential trace metals, there are also twelve toxic heavy metals such as Pb, Hg, As, Cd, and others. These metals can inhibit enzymatic metabolism in the body, and an overload of heavy metals can impair the body's natural healing functions. Toxic heavy metals enter the body through inhalation, ingestion, and skin absorption (Jarup, 2003). Contamination by heavy metals has received significant attention due to their presence in soils and their toxicity to soil microorganisms. Common first-row transition metals like Fe, Co, Cu, and Zn have been observed to inhibit microbial activities (Lawal and Audu, 2004).

MATERIALS AND METHODS

High-purity reagents and distilled water were utilized exclusively in the study. Water samples underwent analysis using an Atomic Absorption Spectrophotometer (PerkinElmer Pin AAcle 900h AAS). All apparatus and glassware were meticulously cleaned with detergent, rinsed with distilled water, and subsequently dried.

Study Area

Yar'akwa Quarters, Na'ibawa Zaria Road is a place on Mai Unguwa Mansir street Tarauni LGA, in Kano metropolis usually referred to as Kano state located in the northern region of Nigeria. It was the most populous state among country 36 states, it is capital is Kano. The state's slogan is "Centre of commerce" with area of 20,131 km^2 with population of 9,401,288 (2006 Census).

Sampling

Samples of borehole, tap, and well water were collected from different locations within Yar'akwa Quarters, Na'ibawa, Tarauni LGA, Kano State. One liter of each sample was gathered in well-cleaned polyethylene plastic containers, including one liter from the most popular borehole in Yar'akwa Quarters.

Preparation of 0.25M HNO_3

Using a micropipette, 11 mL of concentrated analytical-grade nitric acid was added to 1 liter of distilled water in a volumetric flask. All chemicals used in preparing the reagent were of analytical grade, and distilled water was also employed.

Sample Treatment and Analysis

The procedure began with boiling and settling the samples, followed by decantation. Exactly one liter of each sample was measured and transferred to a clean pot for evaporation on a sand bath until the volume reduced to about 30 ml. The concentrated samples were then transferred to a Pyrex beaker and evaporated until completely dry (Jimoh and Sholadeye, 2011; Jimoh and Aminu, 2011).

The resulting residue was extracted with 30 cm³ of 0.25 mol/dm³ HNO_3, filtered into 30 ml sample bottles, and diluted to 50 cm³ with 0.25 mol/dm³ HNO_3. Adding nitric acid served to stabilize the samples, maintain the oxidation state of the elements, lower the pH to less than 2, and prevent precipitation (ASJ, 2012).

These solutions were then analyzed for Co, Cu, Ni, Pb, and Zn using an Atomic Absorption Spectrophotometer (PerkinElmer Pin AAcle 900h AAS).

Identification of Samples

Table 1: Identification of Samples Site

S/N	Samples	Sample I.D	Location
1	Na’ibawa well water	NWW	Umar Liman street
2	Na’ibawa borehole water	NBW	Unguwar gano street
3	Na’ibawa tap water	NTW	Musa Jidda street

[U1]

RESULTS AND DISCUSSIONS

Results

The samples were analyzed for the presence and concentration of the five metals using atomic absorption spectrophotometry (AAS). The results are presented in Table 1 below.

Table 1: Results from the analysis of water samples and comparison with WHO standards (mg/L)

S/N	Heavy metals (mg/L)	Well water	Borehole water	Tap water	WHO Permissible value (mg/L)
1.	Cobalt	0.036	0.050	0.032	10.0
2	Copper	0.046	0.057	0.040	5.0
3.	Nickel	0.034	0.052	0.026	2.0
4.	Lead	ND	ND	ND	0.015
5.	Zinc	0.025	0.027	0.020	5.0

Discussions

Figure 1 displays the cobalt concentrations detected across all samples. The Na’ibawa borehole water (NBW) showed the highest concentration at 0.05 mg/L, while the Na’ibawa tap water (NTW) exhibited the lowest at 0.032 mg/L. According to WHO (2020), the permissible cobalt concentration is 10 mg/L, indicating that all detected concentrations in the samples are within acceptable limits.

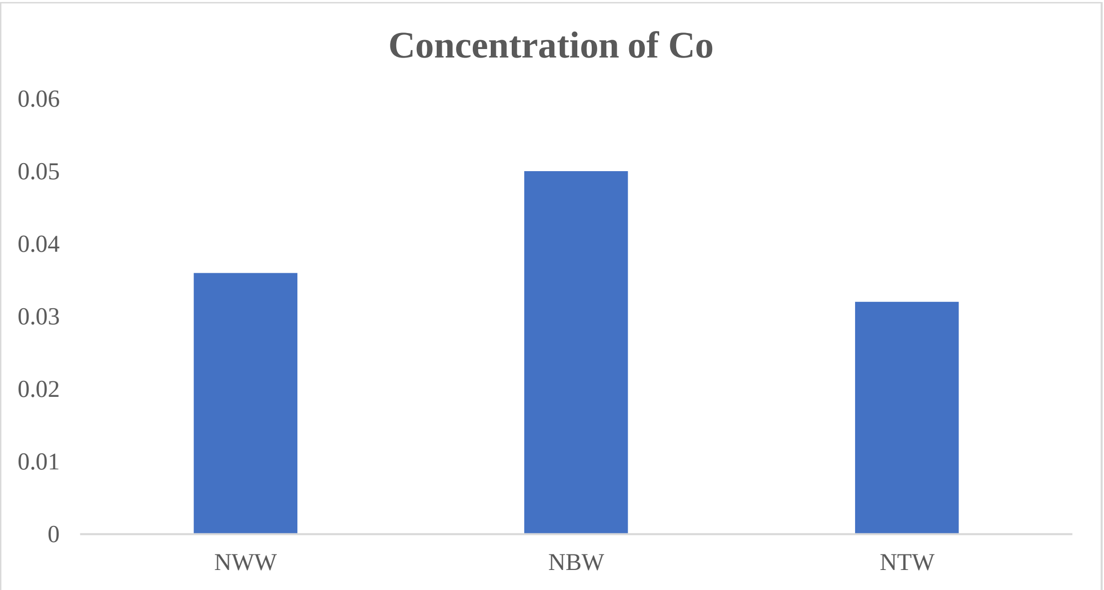

Figure 1: Cobalt Concentration in Water Samples

Figure 2 displays the levels of copper detected across all samples. The Na'ibawa borehole water (NBW) exhibited the highest concentration at 0.057 mg/L, whereas the lowest concentration of 0.040 mg/L was observed in Na'ibawa tap water (NTW). According to WHO guidelines from 2020, the acceptable limit for copper is 5.0 mg/L. Consequently, it is affirmed that the water samples are suitable for consumption.

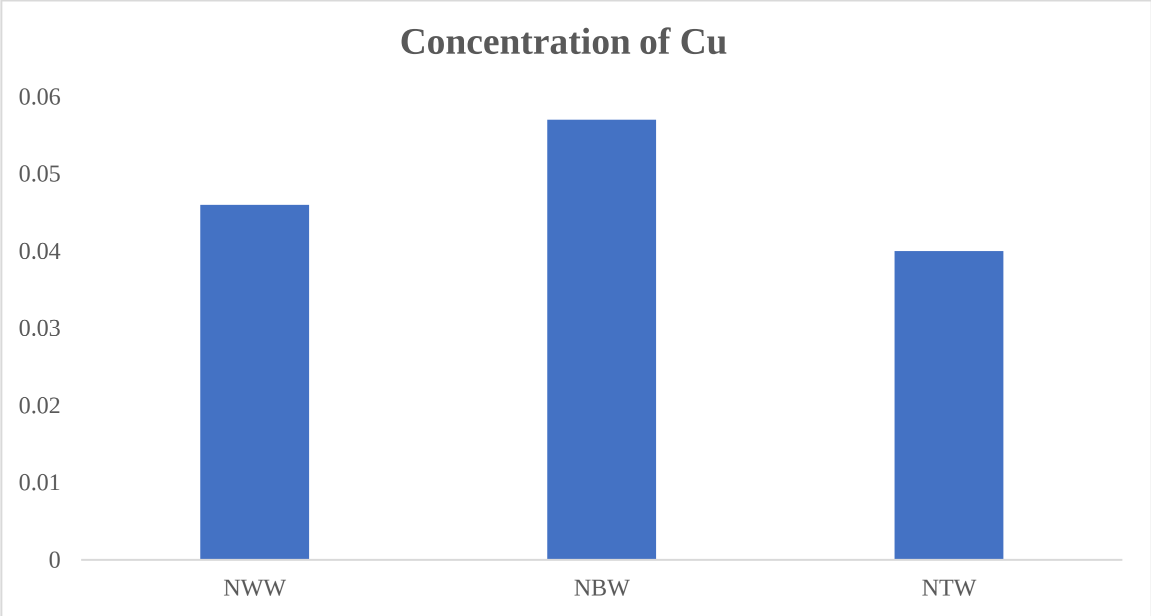

Figure 2: Copper Concentration in Water Samples

Figure 3 shows the concentration of Ni detected in all samples. The highest concentration, 0.052 mg/L, was found in the Na'ibawa borehole water (NBW) sample, while the lowest concentration, 0.026 mg/L, was found in the Na'ibawa tap water (NTW) sample. According to WHO (2020), the permissible concentration of nickel is 2.0 mg/L. Thus, the concentrations in the samples are considered safe for consumption.

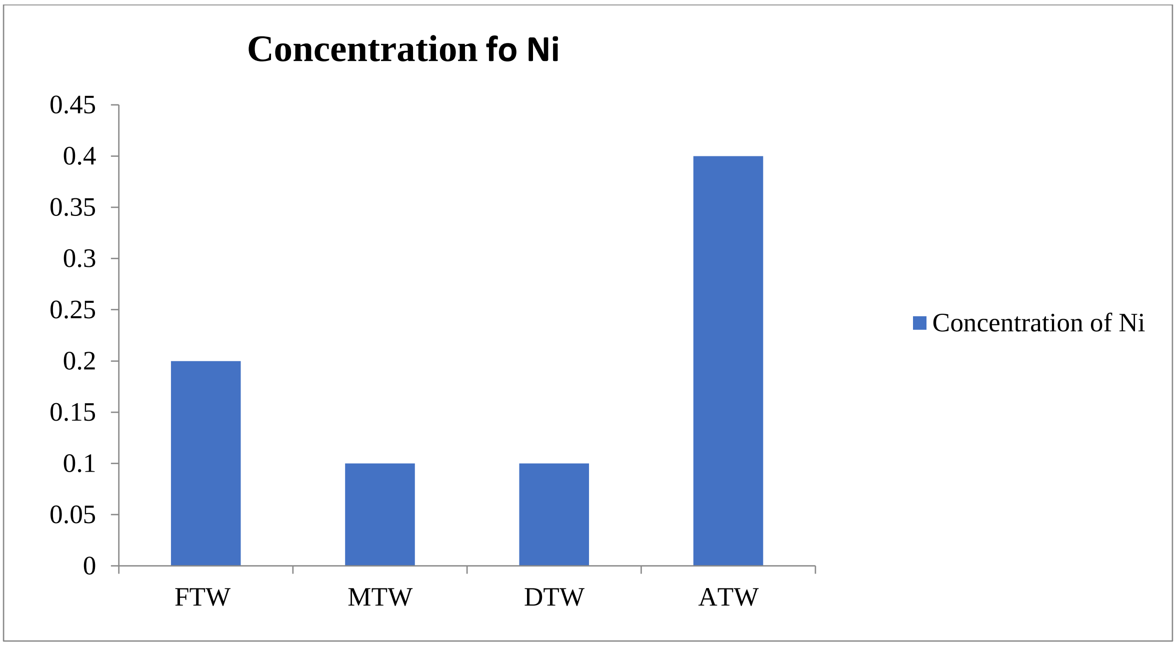

Figure 3: Nickel Concentration in Water Samples

Figure 4 shows the concentration of Zn detected in all samples. The highest concentration, 0.027 mg/L, was found in the Na'ibawa borehole water (NBW) sample, while the lowest concentration, 0.020 mg/L, was found in the Na'ibawa tap water (NTW) sample. According to WHO (2020), the acceptable concentration of zinc is 5.0 mg/L. Therefore, the zinc concentrations in all four samples are within the permissible range.

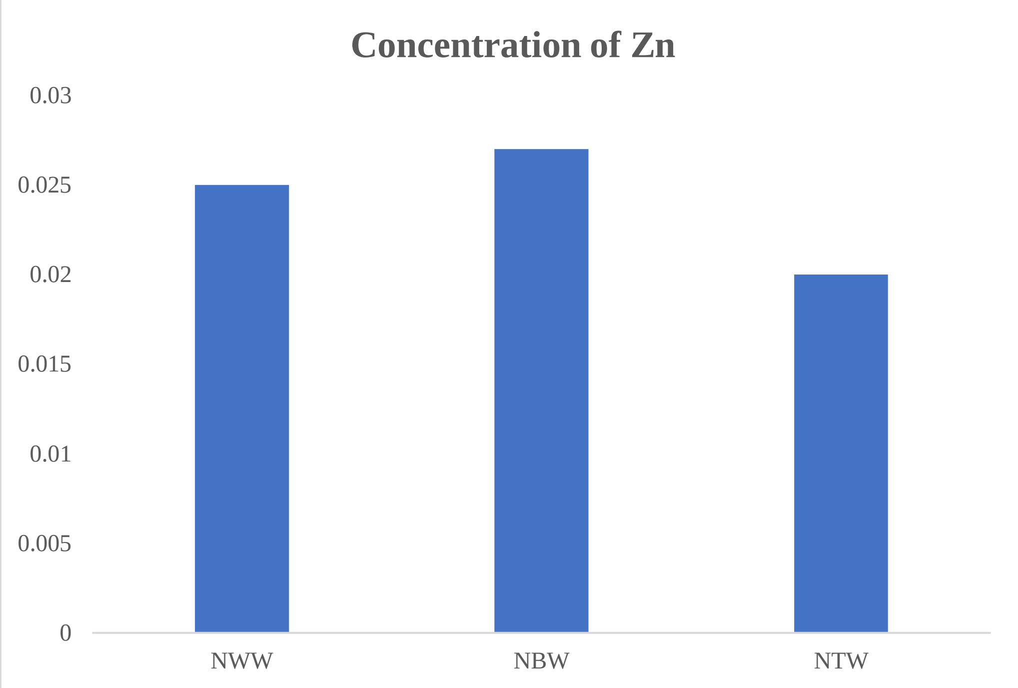

Figure 4: Zinc Concentration in Water Samples

CONCLUSION

The analysis of selected heavy metals in borehole, well, and tap water samples from various locations in Yar'akwa Quarters was conducted using an Atomic Absorption Spectrophotometer (PerkinElmer Pin AAcle 900h AAS). The results were compared with the standard limits set by the World Health Organization (WHO, 2020). It was found that some metals, such as Co and Cu, have higher concentration values in borehole water samples. Lead (Pb) was not detected in any of the samples analyzed. Lead is a non-essential heavy metal. The mean values of lead recorded in the various samples collected from Yar'akwa Quarters were below the detection limit and thus not detected. High concentrations of lead (Pb) can result in health problems. Lead inhibits hemoglobin synthesis, has carcinogenic properties that can damage the liver, and can cause hair loss. Constant exposure to lead (Pb) may delay mental and physical development in infants and children, while in adults; it can cause kidney problems and high blood pressure (Imam et al., 2018). It can be concluded that water in this residential area (Yar'akwa Quarters, Na'ibawa) may be used for domestic purposes such as drinking, washing, and industrial uses.

RECOMMENDATIONS

It was recommended that;

i. The government needs to emphasize efforts to develop efficient, economical, and technologically sound methods to produce clean drinking water for quality assurance.
ii. Heavy metals assessment can further be done using microwave plasma atomic emission spectroscopy (MP-AES) and ICP-OES due to their high sensitivity.
iii. In further investigation, other drinking water such as plastic bottled water and sachet water maybe examine for other testes and analysis.

REFERENCES

Adelekan B.A and Abegunde K.D (2ion011).Heavy metals contamination of soil and Ground water at automobile mechanic villages in ibadan Nigeria

Ademoroti, C. M. (1996). Standard Method for water and Effective Analysis. 1st edition, March Prints and consultancy, Ugbowo Estate, Benin, Pp. 27 – 43

Analytical tool for geochemical studies, anonymous, (2008), Atomic Spectroscopy, (AAS) 35(2), 65-78.

ATSDR (2000). Agency for Toxic substances and Disease Registry, Toxicological profile for heavy metals Atletic Georgia U.S. Department of Health and Human services public health.

Awofolu O.R., Mbolekwa Z., Mtshemia V., and Fatoki O.S. (2005). Levels of trace metals in water and sediments from Tyune River and its effects on an irrigated farmland. Water SA 31(1): 87-94.

Ayoade J. O. (2003). Climate change: A synopsis of its nature, cause, effect and management, Vantage publishers.

Bamishaiye E.I, Ogbonna O, Jimoh W.L, and Awagu E. F. (2011). Determination of some trace elements in water samples within Kano metropolis. Chemistry Department, Bayero University, Kano, Nigeria

Bent, S., and Bohm, K., (1995). Copper induced liver cirrhosis in a 13-month-old boy. *J.Gesundheitswesen*. V., 57 (10): 667-9.

Bodhaditya D, Umlong I M, Saikia L B, Borah K, Kalita H, Srivastava R B,(2008). A study on the physicochemical characteristics of ground and surface water of North and south district of Tripura, proceedingof 53th

Bruins M R, Kapil S and Oehme F W, (2000). *Ecotox Environ Safe*, 45, 198-207. Coey, J. M .D, (1999)

Dupler D. (2001), Heavy metals poisoning. *Jonal Gale of Alternative Medicine. Farmington Hills, MI: Gale Group*

Edori, O. S. and Edori, E. S. (2012). Effect of automechanic works on lead and iron in two Mechanic Villages in Port Harcourt, Rivers State, Nigeria. *Journal of Applied Science and Environmental Management,* 16(4): 317-321.

Edori, O. S. and Kpee, F. (2016). Physicochemical and heavy metal assessment of water samples from boreholes near some abattoirs in Port Harcourt, Rivers State, Nigeria. *American Chemical Science Journal,* 14(3): 1-8.

Edori, O. S., Nwoke, I. B. and Iyama, W. A. (2016). Heavy metas and physicochemical parameters of selected borehole water from Umuechem, Etche Local Government Area, Rivers State, Nigeria. *International Journal of Chemistry and Chemical Engineering,* 6(1): 45-57.

Ehlers, E., T. Krafft, (2001). "Integrated Management of Water Resources"". Understanding the Earth System: compartments, processes, and interactions. Springer.Forstner U, Wittman G.T.W (1981): *Metal pollution in aquatic environment,* 2nd edition Springer Verleg New York.

Elinge, C. M., Itodo, A. U. Peni, I. J., Birnin-Yauri, U. A. and Mbongo, A. N. (2011). Assessment of heavy metals concentrations in bore-hole waters in Aliero Community of Kebbi State. *Advances in Applied Research,* 2(4): 279-282.

Halilu M. Hakam, Modibbo U. and Haziel, H. (2009). Determination of heavy metal concentration in sachet water sold in Gombe metropolis. BOMJ, 8(1): 15-19. Imam, M. M., Kankara, I. L. and Abba, Y. (2018). Determination of some heavy metals in borehole and well water from selected industrial areas of Kaduna metropolis. *Discovery Science,* 4: 93-99

IPCS (2002). "International Programme on Chemical Safety in Manganese and its Compounds. Genera, *World health organization.A*

Jamode A V, Sapkal V S, Jamode V S,.(2004). Uptake of Fluoride ions using leaf powder of Ficusreliglius, *Journal of Indian Water Work Association, 53--61.*

Jarup.L.(2003). *Hazard of heavy metal contamination British medical Bulletin.* 68, 167-182.

Jennings, G., D.; Sneed, R., E.; Clair, M., B., St., (1996). Metals in drinking water. Published by: *North Carolina Cooperative Extension service Publication no.:AG-473-1.* Electronic version 3/1996.

Jimoh, W,L,O and Aminu, D.O(2011). Study of trace elements Quality in Drinking water supply in Ifelodun local government Area, Ikirum ,Osun state , Nigeria .Biol.and Eviron.Sci. *Journal.For the Tropic* 8:99 – 103.

Jimoh, W.L.O. and Sholadoye, Q.O. (2011). Trace elements as indicators of quality of drinking water in Offa metropolis, Kwara State, Nigeria. *Bayero Journal of Pure and Applied Sciences 4(2): 103 – 108.*

Lacatusu, R. (2000). Appraising levels of soil contamination and pollution with heavy metals. *European Soil Bureau Research Report, 4: 393-402.* Lagos State Waste Management Authority (LAWMA) (2000). Management of landfill waste; The journey so far.

Lawal F.A, (1979). *Ahmadu Bello University Zaria, M.Sc,* Thesis, pp 15-18 & 54.

Lawd. A.O. and Audu A.A. (2004), *Journal of Environmental Sc., 8(1), 40-55*

Lenntech(2010). Heavy metals.www.lenntech.com.Accessed on 2nd july 2012.pp.1-3.

Lide (1992), CRC; *Handbook of Chemistry and Physics, 73rd edition 1992.*Boka Raton FL: CRC Press

Madsen, H., Poultsen, L., and Grandjean, P., 1990: Risk of high copper content in drinking 25): 1806 water. Ugeskr. Laeger. Jun.18, 152 (-90041-5782.

Marcovecchio, J. E., Botte, S. E. and Freije, R. H. (2007). Heavy metals, major metals, trace metals. In: Nollet, L. M. editor. Handbook of Water Analysis. 2nd ed. London: *CRC Press, 273-311.*

MCA and AGSO (1999). Iron Factsheet, Minerals Council Of Australian Geological Survey Organisation, www.australiaminesatlas.gov.au *accessed on 10/08/2017.*

McMurry, J. and Fay, R. C. (2004). Hydrogen, oxygen and water. In: McMurry fay Chemistry. K. P. Hamann, (Ed.) 4thEdn. *New Jersey: Pearson Education, 575-599.*

Momodu, M. A. and Anyakora, C. A. (2010). Heavy metal contamination of groundwater.

Musa H., Yakasai I.A., and Musa H.H. (2004). *ChemClass Journal, (14-18);* AWA, Newsletter of American Water work, 1991, 12-16

Obadai E.A., Boamponsem L.K., Adokoh C.K.,Essumang D.K., Villawoe B.O.,Aheto D.W and Debrah J,S.(2011).Concentration of heavy metals in two Ghanaian Lagoons.

Prasad B. V., P. R Chandra, (1997). Ground water quality in an industrial zone,Poll. *Res. 16(2):105--107.*

Rajaganapathy V.,Xavier F.,Sreekumar D.and Mandal P.K (2011).Heavy metals contamination in Soil, Water and Fodder and their presernce in Livestock and Products: *A Review Journal of Environmental Science and Technology; 4:234-249.*

Rathore J , Jain S, sharma S , Choudhary V., Sharma A.(2009). Ground water Quality Assessment at Pali, Rajasthan (India). JESE,51(4):269--272.Rica and Panama). Marine Pollution Bulletin 24, 554–561.

Roberts J.R. (1999). Metal toxicity in children. Training manual on pediatric environmental health. Putting it into practice. Emeryville, CA: Childrens Environmental Health Network.

Sa'id, M. D. (2008). Chemical Analysis of some water samples across Kano state. PhD thesis,Department of chemistry, Bayero, University, Kano

Serban A. S. (2000). Surface Water Pollution with Heavy Metals in the Lower Catchment of Jiu River Basin, according to the Water Framework Directive. Aerapa Conference; pp. 357-364.

Sindhu P.S (2005). Environmental chemistry, new age international ltd publisher, *New Delhi pp199, 224 and 226*

Sinha D K, Srivastava A K(1995). Physico-chemical characteristics of river Sai at Raeareli, *Indian journal of environmental Health, 37(3):205--210.*

Skeat, W., O.(1969). *Manual of British water engineering practice.* Vol. b: water quality and treatment, The institution of water engineers, London, England.

Standard Organization of Nigeria (2007). Nigerian Industrial Standard: Nigerian standard for drinking Water Quality, NIS 554: 2007

Suciu I., Cosma C., Todica M., Bolboaca S. D. and Jantschi L. (2008). Analysis of Soil Heavy Metal Pollution and Pattern in Central Transylvania. *International Journal of Molecular Sciences; 9(4):434-453.*

TWAS (2002). Safe drinking water-the need, the problem, solutions and an action plan, *Third world academy of sciences*, Trieste, Italy.

Tyler Miller G. J.(1991). *Environmental Science«AddressBlock»*: Sustainining the earth: Wordsworth, B element, California, p. 232 .

U. S. environmental Protection Agency (EPA). (2013). Washington, DC (EPA/600/R-09/052F). “Exposure Factors Handbook: 2011 Edition”. Retrieved 4th January, U.S. Geological Survey (2009), mineral commodity summaries 2009: *U.S. Geological Survey*, p195.

USDA and NRSC (2000). Heavy Metal Soil Contamination. Soil Quantity-Urban Technical Note. 3:1-7.

USEPA (1994). Drinking Water Criteria Document for Manganese. US Environmental Pollution Agency Washington, DC, Office Of Water.

Vaibhav R. (2010), Sorting signed permutations in O(nlogn) time, *Jornal of computational Biology, pp: 489-501*

Wuana R.A. and Okieimen F.E. (2020). “Heavy Metals in Contaminated Soils”, A Review of Sources, Chemistry, Risks and Best Available Strategies for Remediation, *ISRN Ecology article, (20).*

Yahaya A.,Adegbe A.A and Emurotu J.E (2012). Assessment of heavy metals content in the surface water of Oke-Afa canal Isolo Lagos ,Nigeria. *Achieves of Applied science Research,4(6),pp.2322-2326.*