IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 1, January 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

Determination of the Level of Some Heavy Metals and Trace Elements in River Gongola of Adamawa State, Nigeria.

Goje L.J[1]*. Maigari F.U[1]. and Jadeed M[1].

[1]Department of Biochemistry, Faculty of Science, Gombe State University,

P.M.B 127 Gombe, Gombe State, Nigeria.

Abstract.

Heavy metals and trace elements concentrations in River Gongola of Adamawa State, Nigeria were assessed using Atomic Absorption Spectrophotometer (AAS). The study revealed high concentrations of heavy metals and trace elements in the water samples from the different sampling sites with the exception of copper whose concentration was within the permissible limit. The sampling sites from the river with the highest concentrations of the heavy metals are as presented below: Dutin Mata with Mg (2.445±3.21) and Cr (1.09±0.02), Kogin Smuggle with Mn (0.79±0.03), Pb (0.454±0.000) and Cd (1.481±0.03) and Hayin Dorawa with Cu (0.2±0.09); these may be as a result of indiscriminate human activities and run off from refuge dumps around the areas. The concentration of Mg, Cr, Mn, Pb, and Cd in the water samples from all the sampling sites are higher than their respective WHO permissible limits whereas only Cu appeared to be within the WHO permissible limit. This is, probably, because the water source is the second major depository of metals present in the system after sediment. Therefore, it is concluded that there is high concentrations of heavy metals and trace elements in River Gongola and as such consumption of water and other living organisms from these sampling sites whose major source is River Gongola may not be safe until properly treated for the presence of these heavy metals. All the values are presented in (ppm).

Keywords: *Heavy metals, Trace elements, AAS, Permissible limit, WHO, SON, Toxicity.*

1.0 Introduction:

In recent years, the concentration of toxic metals in many ecosystems are reaching unprecedented levels, this is as a result of increased activities of metals and mining industries which led to serious environmental pollution through effluent discharge and improper toxic waste disposal [1].

Heavy metals are those metals having density greater than $5gcm^{-3}$. Most often this term denotes metals that are toxic which include but not limited to Al, As, Cd, Cr, Co, Pb, Hg, Ni, Se, and Zn [2], whereas trace elements are those dietary elements that are needed in very minute quantities for the proper growth, development, and physiology of the organism e.g Cu, Mn, Fe, Co, Zn etc. These groups are interrelated as some of the heavy metals with known functions can still fall within the trace elements. These metals or their compounds may be discharged from industries, farmlands, municipal urban water runoffs, and areas of agricultural activities into surface water and can cause pollution. They vary in types and include large quantities of raw materials, by-products, co-products, and final products of human activities. Many of these wastes are toxic and they find their ways into land water and air. Pollution of streams and rivers flowing through agricultural areas where pesticides, fungicides and herbicides might have been applied and industrial districts where there might have been organic and inorganic waste deposits; all these present varied and difficult problems due to drainage into different water bodies. Effluents discharged into a river, which may affect aquatic life, may do so either directly or indirectly [3]. However, it must be mentioned that some heavy metals are naturally present in some natural water sources. Some of them are essential for health of living organisms but when their concentrations are very high, beyond tolerable limits, they become toxic.

Water which is considered very essential for the survival of man and other organisms due to its multifaceted importance ranging from agricultural, industrial, domestic or household use to recreational and environmental use [4], can become polluted and adversely affected due to addition of large amounts of materials to the water hence making it unfit for the intended use [5].

More also, some heavy metals such as Iron (Fe), Zinc (Zn), Calcium (Ca) and Magnesium (Mg) have been reported to be of bio importance to man [6]. In fact, deficiency of some of these metals can precipitate disease conditions. However, consumption of these metals above the permissible limits can lead to bioaccumulation and hence toxic effects which may include neurotoxic, carcinogenic, mutagenic, and teratogenic effects [6].

People are becoming aware of the complexity of nature and the delicate balance that exist within the global ecosystem. Every action involves in modifying the environment has countless repercussions. Scientists seek to understand the complex interactions so that the present condition of the ambient environment can be assessed and measures taken to prevent or minimize future degradation [7].

1.1 Aim and objectives of the research

1.2 The aim of this research is to determine the levels of some heavy metals and trace elements: Pb, Cu, Cr, Cd, Mn and Mg from five sampling sites in river Gongola of Adamawa State, Nigeria.

1.3 Significance of the research

River Gongola is one of the major sources of water for irrigation, fishing, domestic and industrial purposes in the state. Notably, at present, there is indiscriminate dumping of waste and various agricultural practices taking place in the area. Wastes including both solids and liquids are also admitted through the major drainage networks and emptied into the river. Thus, making the water susceptible to pollution as a result of these indiscriminate activities. Hence, the need to assess the water from this source for heavy metals and trace elements levels so as to be able to advice the public on the best practice to protect themselves from the bioaccumulation of these pollutants and their toxic effects.

2.0 Materials and methods

2.1 Study area

The study area is river Gongola also referred to as Benue River in Jimeta because is the major tributary of river Benue, it is located in Adamawa State of Nigeria. The river passes through Numan Local Government Area of Adamawa State. Adamawa state also known as land of beauty is located on 9’20’N, 12’30’E coordinate on the earth planet. Its capital is Yola. It occupies a total area of 36,917km2 or 14254sq miles. The state is one of the states in the north eastern Nigeria. It emerged from the old Gongola State, with four administrative divisions namely Numan, Mubi, Ganye, and Yola. It is one of the states that constitute the Federal Republic of Nigeria [8].

The Benue River constitutes the major drainage system in river Gongola. It is less than 150m above mean sea level. The mean annual rainfall in Numan is 859.3mm and 917.9mm in Yola [9]. The area is not highly industrialized; the functional industries are the Bajabure industrial complex, Savanna Sugar Company Plc, Yola oil Mill and AFFCOT Nig. Ltd. Others are small-scale industries like the Naggae Company etc. However, some small scale metallurgical works are present [8]. Kiri-Dam located in river Gongola in the state is mainly constructed in order to supply water to the Savannah Sugar Co. in Numan, Numan LGA for irrigation purposes. However, a lot of fishing activities take place there. The economic resources are mainly agricultural crops such as groundnuts, maize and guinea corn which are grown there. Adamawa State is an important breeding center for cattle, sheep and goat [9].

2.2 Methods

2.2.1 Sample collection

The water samples for the elemental analysis were collected from five sampling points using simple random sampling method, taking two samples from the sampling points located in Numan Local Government Area namely: Dutsin Yashi and Dutsin Mata while the other three samples were collected from sampling points located in Jimeta, the state capital namely: Kogin smuggle, Hayin Yan Jimeta and Hayin Dorina. The sampling points were selected using purposive sampling technique based on the need for representative samples. In each of the sampling sites the sampling points were at least 500m away from each other. The samples were collected by lowering pre-cleaned plastic bottles into the bottom of the water body at 30cm deep and allowed to over flow before withdrawing the bottles [10].

2.1.2 Sample Digestion

The water samples collected from the sampling locations were acidified by adding 1ml of 2M HNO_3 to 100ml of the water sample as described by [11]. This is done to keep the required species of cation in solution and stop changes in the water samples. The samples were stored at 4^0C until required for analysis [5].

Twenty (20) ml of each of the water samples was measured into 250ml beaker and 15m1 of concentrated HNO_3 and 5m1 concentrated HCl were added. The solution was heated using Kkjeldahl apparatus until it has evaporated to about 20ml. It was then removed, cooled, filtered and transferred into 100ml sample bottle. The solution was made up to 50ml with deionized water, labeled and analyzed for heavy metals immediately using AAS.

2.1.3 Heavy Metals and Trace elements Determination

The instrument (AAS Buck 205) was switched on and allowed to warm for about 20 minutes. The blank solution (40ml of Aqua rager) was first aspirated into the flame of the machine to set the instrument at its reference point (zero). The light was passed through the flame atomizer into which the same solutions were sprayed. The flame dissolved the sample mist and decomposed the sample solution into atoms of the analyte. The analyte atoms then absorbed the radiation at characteristic wavelength isolated by the monochromator and which decreased the amount of light that reached the detector.

The linear relationship between the measured absorbance and the concentration of analyte atoms in the flame which is proportional to the concentration of atoms in the small solution was obtained. The reading for each sample was taken and the concentration in ppm was obtained from the standard calibration curve.

3.0 Results and Discussion

3.1 Results

Table: 3.1 Concentration of heavy metals and trace elements in the water samples from the five sampling sites of river Gongola in parts per million (ppm).

	Concentration of metals in water sample					
Sampling sites	Mg (ppm)	Cr (ppm)	Mn (ppm)	Cu (ppm)	Pb (ppm)	Cd (ppm)
Dutsin Yashi	2.293±12.01	0.79±0.03	0.226±0.06	0.12±0.04	0.071±0.08	0.362±0.03
Dutsin Mata	2.445±3.21	1.09±0.02	0.090±0.03	0.17±0.09	0.117±0.04	0.006±0.05
Hayin Dorina	1.798±0.93	0.34±0.05	0.097±0.03	0.20±0.04	0.284±0.03	1.020±0.04
Hayin yanJimeta	2.043±1.22	0.53±0.10	0.291±0.07	0.09±0.06	0.298±0.10	0.263±0.06
Kogin Smuggle	1.570±0.330	0.80±0.02	0.79±0.03	0.14±0.03	0.454±0.000	1.481±0.03

All values are presented as Mean(X) ± Standard deviation(SD) of three replicate samples.

Key: DY= Dutsin Yashi, DM = Dutsin Mata, HD = Hayin Dorina, HY = Hayin Yanjimeta and KS = Kogin Smuggle.

Table: 3.2 WHO Permissible limit of heavy metals in drinking water (ppm)

Magnesium (Mg)	Chromium (Cr)	Manganese(Mn)	Copper (Cu)	Lead (Pb)	Cadmium(Cd)
0.3	0.05	0.20	0.2	0.005	0.003

Adopted from WHO (2006). Pp. 491-493.

From table 3.1, the concentrations of the heavy metals and trace elements ((Mg, Cr, Mn, Cu, Pb and Cd) from the five sampling sites in descending order of magnitude are as follows:
For **Magnesium (Mg),** Dutsin Mata (DM) has the highest concentration, then Dutsin Yashi (DY) followed by Hayin Dorina (HD), Hayin YanJimeta (HY), and then lastly Kogin Smuggle (KS). The concentration of Magnesium is greater than the permissible limit of 0.3 ppm (Table 3.2) in all the sampling sites.
In the case of **Chromium (Cr)**, Dutsin Mata (DM) has the highest concentration followed by Kogin Smuggle (KS), Dutsin Yashi (DY), Hayin Yan Jimeta(HY) and then lastly Hayin Dorina (HD). The concentration of Chromium is greater than the permissible limit of 0.05ppm (Table 3.2) in all the sampling sites.
Manganese (Mn) concentration follows this descending pattern: Kogin Smuggle (KS), Hayin Yan Jimeta (HY), Dutsin Yashi (DY). Hayin Dorina (HD), and lastly Dutsin Mata (DM). The concentration of Chromium is higher in all the sampling sites compare to the permissible limit with the exception of Dutsin Mata (DM) and Hayin Dorina (HD) which are lower than the permissible limit of 0.2 ppm (Table 3.2).

The concentration of **Copper (Cu)** in descending order is as follows: Hayin Dorina (HD), Dutsin Mata (DM), Kogin Smuggle (KS), Dutsin Yashi (DY), Hayin YanJimeta (HY). The concentration of copper in all the five sampling sites is within the permissible limit of 0.2 ppm (Table 3.2).

The concentration of **Lead (Pb)** in descending order of magnitude is: Kogin Smuggle (KM), Hayin Yan Jimeta (HY), Hayin Dorina (HD), Dutsin Mata (DM), and lastly Dutsin Yashi (DY). The concentration of lead in all the sampling sites is above the WHO permissible limit of 0.05 ppm (Table 3.2).

Lastly from the results the concentration of **Cadmium (Cd)** followed the order: Kogin Smuggle (KS), Hayin Dorina (HD), Dutsin Yashi (DY), Hayin Yan Jimeta (HY) and Dutsin Mata (DM). The concentration of Cadmium is above the WHO permissible limit of 0.05 ppm (Table 3.2) in all the sampling sites.

3.2 Discussion

The bio-toxic effect of heavy metals refers to as the harmful effects of heavy metals to the body when consumed above the bio recommended limit [6]. The nature of effect could be neurotoxic, carcinogenic, mutagenic, and teratogenic. The poisoning effect of heavy metals are due to their influence on the normal body metabolism when ingested into the stomach acidic pH, these heavy metals are converted into a more stable oxidative states (Zn^{2+}, Pb^{2+}, Cd^{2+}, As^{2+}, Hg^{2+}, Ag^{+}). More also, bio-toxicity can also occur when a heavy metal displaces another metal of metallo-protein, this forms the biochemical principle of toxicity of some herbicides, fungicides, and insecticides [12]. Therefore, the results for the heavy metals and trace elements analyzed in this study area are discussed one at a time as shown below:

Magnesium (Mg)

The result obtained for the concentration of Magnesium in the water samples analysed (Table 3.1) ranged from 1.570±0.330 to 2.445±3.21 ppm with sampling point KS having the lowest value (1.570±0.330) while sampling point DM has the highest value (2.445±3.21). All the results are above [13] and [14] value of (0.3ppm). The water in these locations is not good for human consumption. Magnesium intoxication causes depression of neuromuscular system, causing lethargy, hypotension, respiratory depression, brady-cardia and weak tendon reflexes. In severe conditions, acute rhabdomyolysis results [15]. Hyper-magnesemia induces decrease in serum calcium by inhibiting PTH secretion, which in turn will have deleterious effects on the body [16].

Chromium (Cr)

The result obtained for chromium in the water samples analysed (Table 3.1) ranged from 0.34±0.05 to 1.09±0.02 ppm with sampling points DM (1.09±0.02) and KS (0.80±0.02) having the high values while sample points HD (0.34±0.05) and HY (0.53±0.10) with low concentrations. All the values are above the acceptable values of 0.05ppm of [13] and [14] for water consumption. This is very toxic for the living cell; Liver and kidney damage are seen in chromium toxicity, also Chromium toxicity is associated with gastrointestinal problems, lung cancer and hepatitis [3].

Manganese (Mn)

The result shows that manganese in river Gongola was found to be within the permissible limit of [13] and [14] of 0.20ppm with the exception of KS which is 0.79±0.03 and HY having 0.291±0.07ppm respectively, which could be attributed to the fact that big trucks are being washed there and at the same time the oil spillage which occurs in the process of servicing their boats.

Manganese is mainly biliary excreted and therefore toxicity may cause hepatic dysfunction or cholestasis. Manganese excess can result in Parkinson-like disease and defects of the basal ganglia [16].

Copper (Cu)

The concentration of copper in all the samples analysed ranges from 0.09±0.06 of sample HY to 0.20±0.04 of sample HD and all fall within the recommended standard value of 0.2ppm of [13] and [14]. The concentration of copper in sample HY is relatively low (0.09±0.06).

Over accumulation of Cupper can lead to toxicity, causing renal problems, fits, haemolysis and hypotension. Cupper imbalance is associated with Wilson's disease, ceruloplasmin level in blood is drastically reduced in Wilson's hepatolenticular degeneration. The basic defect is in a gene encoding a copper binding ATPase in cells (ATP7B gene in liver cells). This is required for normal excretion of copper from liver cells; Administration of penicillamine, which helps in chelation and excretion of copper, may help the affected persons [17].

Lead (Pb)

The result obtained for the concentration of lead in the water samples analysed (Table 3.1) ranged from 0.071±0.08 to 0.454±0.000ppm with sampling point DY having the lowest value of (0.071±0.08) while sampling point KS having the highest value of (0.454±0.000). All the results are above the permissible limit of 0.005ppm of [13]and [14]. This could be attributed to the disposal of lead acid battery because these areas are close to where some local battery charging take place [18].

Lead poisoning inhibits several enzymes involved in haem sysnthesis, including PBG synthase and ferrochelatase, which eventually causes anaemia. The urine contains increased amounts of ALA and coproporphyrin. Some of the symptoms of lead poisoning, such as abdominal pain and peripheral neuropathy are similar to those of acute porphyric attack and may cause difficulty in diagnosis. Other features of lead poisoning include lead staining of the teeth and basophilic stippling of red blood cells [8;16].

Cadmium (Cd)

The results (Table 3.1), showed that cadmium in river Gongola was found to be above the permissible limit of 0.003ppm, the values range from 0.006±0.05 at sampling point DM to 1.481±0.03 at point KS. This body of water is not safe for human consumption due to the toxic level of the metal. Clinical features of cadmium toxicity may include nephrotoxicity, hepatotoxicity and bone disease. Cadmium (Cd) is toxic at extremely low level in humans, long term exposure results in renal dysfunction, characterize by tubular proteinuria [6]. Cadmium exposure can be assessed from the level in blood and urine. Renal tubular damaged can be monitored by increased urinary β_2-microglobulin concentration [12].

4.0 Conclusion

From the results of this study it is obvious that all the heavy metals analyzed are present at a concentration above the permissible limits with only the exception of Cupper. Therefore, since the biochemistry of toxicity of these heavy metals involves tissue macro molecule functional alteration, bioaccumulation, mutagenesis and consequently carcinogenesis, the presence of these metals in the water samples studied, poses a great health threat to both direct and indirect consumers of this natural resource. Therefore, deliberate and concerted efforts are required from all stakeholders concerned to device a proper means of treating water meant for public consumption from these sources.

References

[1] H. Musa, I.A. Vakasai, and A.H. Musa, “Determination of Lead Concentration in Wells and Borehole Water in Zaria, Nigeria”. *Chemclass Journal,* 2004, 15(22): 14-18.

[2] O.C. Vaidya, and R.T.T. Rantala, “Determination of Heavy Metals in Mussels (Mytilus edulis) from Eastern Canada”. Int .J. environ. *Anal.Chem*. 1996, 63(3):179-185.

[3] C.M.A Ademoroti, *Environmental Chemistry and Toxicology*. 1996, Pp. 79-121.

[4] USEPA. An Examination of EPA risk Assessment Principles and practices. U.S. Environmental Protection Agency by Members of the Risk Assessment Task Force. Washington, DC.2004.

[5] O.N. Maitera, J.T. Barminas, and S.T. Magilli, “Determination of Heavy Metal Levels In Water And Sediments Of River Gongola in Adamawa state”, *.J. Emerging. Trend Eng. Applied Sc.* 2011, 2(5): 891-896.

[6] J.O. Duruibe, M.O.C. Ogwuegbu, and J.N. Egwurugwu, “Heavy Metal Pollution and Human Biotoxic Effects”. 2007, 2(5): 112-118.

[7] S.C. Bhatai, *Environmental Chemistry*. 2006, Pp. 88-89.

[8] V.O. Ogugbuaja, and R.I. Kinjir, *Study of Portions of River Benue, Lake Geriyo and Kiri-dam in Adamawa State, Nigeria, Research Journal of Science*. 2001, 11(8): 77-83.

[9] J.M. Ishaku, The Hydrogeology of Yola Area and Environs in the Upper Benue River Basin (Adamawa State). North Eastern Nigeria M.Sc project (Unpublished) Submitted to the Department of Geology, University of Nigeria, Nsukka.1995.

[10] C.M.A. Abolude, Standard Method for Water and Effluent Analysis, *Adamawa State Diary,* 2009, Pp. 182.

[11] J. Mendham, R.C. Denney, and M.J. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis.*2002, Pp. 197.

[12] M.O.C. Ogwuegbu, W. Muhanga, "Investigation of Lead Concentration in the Blood of People In The Copperbelt Province Of Zambia". *J. Environmental Sc.* 2005, 5(1):66-75.

[13] SON, Nigeria Standard for Drinking Water Quality. NIS. 2007:554.

[14] W.H.O. Guidelines for Drinking Water Quality. *First Addendum to the Third Edition* 2006, Volume1. Pp. 491-493.

[15] A.M. Babantunde, O.A. Wundi, and A.A. Adeolu, Bioaccumulation of Heavy Metals in fish (Hydrocynus forskahlii, Hyperopisius Bebe Occidentalis Malabaricus And Belone Stonglurus) From Pilicate Lake,North of Nigeria. *Trans. J. Sc. Tech*. 2012, 2(5):119-133.

[16] A. Martin, Clinical Chemistry and Metabolic Medicine. 2006, pp 230-231.

[17] D. Ahmet, Y. Fevzi, A.T. Levent, and O. Nedim, "Heavy Metals in Water Sediment and Tissues of Leucisus Cephalus from a Stream in Southwestern Turkey".Chemosphere. 2006, 63(14):51-58.

[18] A.I. Adekunle, and A.A. Mojisola,"Physico-chemical Analysis of Well Water in Minna and its Environs, Niger State, Nigeria". *Journal of Chemical Society of Nigeria*. 2007, 32(2): 122-127.