NAUB JOURNAL OF SCIENCE AND TECHNOLOGY
(NAUBJOST)
e-ISSN:2811-2350
Email: jost@naub.edu.ng http://journal.naub.edu.ng/naubjournal/

HEALTH IMPLICATION OF THE ACCUMULATION OF HEAVY METALS CONCENTRATION IN ARA AND LAMINGA WATER SOURCES OF NASARARAWA LOCAL GOVERNMENT AREA IN NASARAWA STATE, NIGERIA

[1]Rilwan Usman, [2]A. M. Kamal [3]A. Mamman, M.M. [2]Idris, [4]A. Ubaidullah, [2]O.G. Okara and [1]E.I Ugwu
E-mail: rilwan.usman@naub.edu.ng
Phone Number: 08037772627/07055324002
[1]Department of Physics, Nigerian Army University, PMB 1500 Biu, Borno State, Nigeria.
[2]Department of Physics, Nasarawa State University, PMB 1022 Keffi, Nasarawa State, Nigeria.
[3]Department of Chemistry, Nigerian Army University, PMB 1500 Biu, Borno State, Nigeria.
[4]Department of physics, Federal University Dutsin-ma, P.M.B 5001 Dutsin-ma, Katsina

Abstract

Water is an essential component of life, fresh water constitutes about 3% of the total water on the earth, only 0.01% of this fresh water is available, with two thirds of the earth covered by water and the human body consisting of 75% of it, it is obvious that, water is one of the prime elements responsible for life. Present study aimed at assessing the heavy metals concentration in water sources across Ara and Laminga using Micro Plasma Atomic Emission Spectroscopy (MP-AES). The result revealed that, heavy metals for Ara and Laminga in mg/L (Zn (0.35 and 0.2), Cd (0.00 and 0.00), Fe (0.05 and 0.05), Cu (0.02 and 0.01), Pd (0.04 and 0.02), Ni (0.012 and 0.012) and Mn (0.04 and 0.04)) respectively were present in the water. It can be concluded that the mean concentration is insignificant and the area is considered free and the water in those areas is considered as a good water, though, on accumulation, heavy metals may have much impact radiation burden of the populace, hence, gross alpha and beta as well as risk assessment of water in the area is recommended as the concentration may elevate and cause cancer to the populace.

Keywords: - Heavy metals, Bioaccumulation, Toxicity, Bio-indicators, Gastropods, Micro Plasma Atomic Emission Spectroscopy (MP-AES).

Introduction

Water is an essential component of life, fresh water constitutes about 3% of the total water on the earth surface, only 0.01% of this fresh water is available (Hinrichsen & Tacio2002), with two thirds of the earth's surface covered by water and the human body consisting of 75% of it, it is evidently clear that water is one of the prime elements responsible for life on earth. Regrettably, even this small portion of fresh water is under pressure due to anthropogenic sources that results from rapid growth in population and industrial activities (Li *et al*., 2009). Heavy metals are the main pollutants and elements of risk in drinking water (Enaam 2013). Investigation on water contamination by heavy metals has become the prime focus of environmental scientists in recent years Fenglian (Fenglian & Qi, 2011). More attention should be given to toxic heavy elements because of bio accumulation and

bio magnification potential, and their persistence in the environment. Heavy metals concentration in water is a global and serious issue that call for great attention and concern, their presence in water e.g. Lead (Pb), Cadmium (Cd), Zinc (Zn), Iron (Fe), Copper (Cu), Nickel (Ni), Manganese (Mn) etc., could emanate from fertilizers application, Animal manures, atmospheric disposition etc., these are capable of posing health challenges as a result of buildup in different part of the body including blood, kidney, liver, hearth etc. The consumption of water worldwide increases yearly while most of the world's water resources continue to dwindle due to improper environmental management practices (Vanloon & Duffy, 2005). Globally, more than twenty-five thousand people die daily as a result of water related diseases (Jain *et al*., 1995). The increasing dependence on ground water as a source of potable water supply has spurred efforts to protect the quality of this limited resource. Heavy metals are priority toxic pollutants that severely limit the beneficial use of water for domestic or industrial application (Nagendrappa *et al*., 2010). Pollution due to artisanal activities, threatened to increase the heavy metal concentration in water sources of Ara and Laminga villages in Nasarawa Local Government. Whilst different studies in auto repair workshops have been carried out by different authors on soil contamination, little is known on the effect of artisanal activities on water sources, especially in the study area. Therefore, this research work will be of beneficial to the people leaving in the various communities because the study will unveil the existence of heavy metals as well as their respective concentrations in various sources of their portable drinking water using Micro Plasma Atomic Emission Spectrometer (MP-AES) and compare the results with the recommended basic safety standard. Also the research is important in the sense that it is concern with the health of the populace. Other bodies or organizations wishing to carry out researches similar to this research in a broader scope can use this work as reference point for the detailed survey. Hence the research will contribute immensely to literature.

Materials

The instruments/materials that were used for the assessment of heavy metals concentration in portable drinking water across Ara and Laminga in Nasarawa Local Government Area of Nasarawa State are shown in Table 1.

Table 1: Materials, Specifications and Uses

Materials	Quantity	Specifications	Uses
500ml bottles	1	Plastic Type	Used for collection of water samples.
Funnel	1	Plastic Type	Used for easy passage of water samples into the sample bottles.
Cup	1	Plastic Type	Used for easy transfer of water sample through the funnel to bottles.
Hand Glove	5 sets	Polythene	Used to protect the hand from direct contact to the chemicals.
pH Metre	1	Hanna Plastic type, Range 0-14, Resolution 0.1, Accuracy ±0.1, Consort C937.	Used for measuring the acidity and basicity of the water samples.
Concentrated Nitric Acid	500 ml	Liquid Type	Used for rinsing the sample bottles before (HNO_3) sample collection.

Drawer	1	Rubber Type	Used for drawing water from the well.
Masking Adhesive Tapes	1	Paper Type	Used for labeling the water samples as well as sealing the mouth of the bottles.
Global Positioning System	1	URIC Type	Used for taking the coordinates of each sample points.
Sack	1	Leather Type	Used for packaging of collected water samples for easy transportation.
Macro Plasma Atomic Emission Spectrometer.		MP-AES-MY17380004	Used for analyzing the water samples in the laboratory.

Method

On the basis of geologic and tectonic setting, two towns having 3 each were selected for water sampling. The representative water samples (1 L each) were therefore, collected from Borehole (1 sample), well (1 sample) and stream (1 sample). The pH was measured on the spot, using a pH meter (Hanna instrument). From each sampling point, the water samples were collected in cleaned plastic bottles pre-washed with 20% dilute nitric acid (HNO_3) and double distilled water. The water samples were filtered and a few drops of HNO_3 was then added before transporting the sample to the laboratory for analysis.

Study Area

This research work centered on Ara and Laminga of Nasarawa Local Government, in Nasarawa State. The sample points are abbreviated as A1, A2 and A3, for Ara Borehole, Ara Well and Ara Stream respectively, while, L1, L2 and L3 for Laminga Borehole, Laminga Well and Laminga Stream respectively. These points are located at $8^0$36′22.97″N and $7^0$35′02.01″E, $8^0$36′28.63″N and $7^0$34′47.50″E and $8^0$36′19.03″N and $7^0$34′32.01″E for Ara, while $8^0$40′29.99″N and $7^0$49′49.27″E, $8^0$40′59.09″N and $7^0$48′39.93″E and $8^0$40′48.59″N and $7^0$48′32.07″E for Laminga.

Sample Collection

Six (6) water samples were randomly collected from different points in Ara and Laminga. The sampling was carried out in a season. Two (2) drops of nitric acid ($HNO_{3)}$ was added to each water sample before analyzed to maintain the constant pH and minimize loss of sample because of variation in pH, evaporation, precipitation and other relevant physical and chemical properties. Samples were collected from different water sources such as streams, wells and boreholes located in Ara and Laminga. The samples were collected randomly using acidified plastic bottles and mixed. The bottles were filled and then sealed tightly to avoid head space that might cause loss of samples because of oxidation.

Sample Preparation

The samples for analysis were digested by measuring 250ml of the water sample in a conical flask and 5ml of concentrated nitric acid was added to the measured sample and then heated on microwave machine until the total volume was reduced to about one third of the initial volume to break the complex bond and release the sample into solution. The solution was then filtered using a filter paper into another beaker, made up of 50ml with distilled water and mixed thoroughly. The sample was packaged into samples bottles before taking to MP AES machine for analysis.

Sample Analysis

All filtered and acidified water samples were analyzed for all the heavy metals by using Micro Plasma Atomic Emission Spectrometer under standard operating conditions. In view of data quality assurance, each sample is analyzed in triplicate and after every samples two standards (one blank and another of 2.5 mg/L) of respective metal was analyzed on atomic emission. The reproducibility was found to be at 95%confidence level. Therefore, the average value of each water sample was used for further interpretation. Standard solutions of all elements was prepared by dilution of 1000 mg/L certified standard solutions of corresponding metal ions with double distilled water. All the acids and reagents used were of analytical grade. All these analyses were performed in the Micro Plasma Atomic Emission Spectrometer (MP AES), at Bayaro University Kano, Kano State, Nigeria.

Results

The data collected from Ara and Laminga of Nasarawa L.G.A was analyzed using Micro Plasma Atomic Emission Spectrometer (MP-AES). The results of the analysis were obtained and presented in Table 2, which are the Concentration Level of Heavy Metals such as Manganese (Mn), Nickel (Ni), Copper (Cu), Zinc (Zn), Cadmium (Cd) and Lead (Pb).

Table 2: Heavy Metals Concentration (mg/L)

Villages	Sample Points	pH	Zn	Cd	Fe	Cu	Pb	Ni	Mn
LAMINGA	L1	2.7	0.26	0.000	0.07	0.010	0.02	0.002	0.011
	L2	1.7	0.17	0.000	0.01	0.010	0.01	0.022	0.108
	L3	2.0	0.16	0.000	0.07	0.010	0.02	0.011	0.001
MEAN			**0.20**	**0.000**	**0.05**	**0.010**	**0.02**	**0.012**	**0.040**
WHO (2005)			**3.00**	**0.003**	**0.30**	**2.000**	**0.01**	**0.100**	**0.500**
ARA	A1	0.8	0.35	0.000	0.05	0.030	0.03	0.005	0.087
	A2	0.9	0.50	0.000	0.03	0.020	0.06	0.000	0.308
	A3	0.4	0.19	0.000	0.07	0.010	0.03	0.002	0.010
MEAN			**0.35**	**0.000**	**0.05**	**0.020**	**0.04**	**0.002**	**0.135**
EPA (2005)			**5.000**	**0.005**	**0.300**	**1.00**	**0.10**	**0.100**	**0.500**
Mean (Ara & Laminga)			**0.275**	**0.000**	**0.05**	**0.015**	**0.03**	**0.012**	**0.040**
1 = Borehole	2 = Well		2 = Stream		L = Laminga		A = Ara		

Result Analysis

In this study, the results presented in Table 2 were used to plot chart presented in Figs. 2 in order to compare the results with the World Health Organization guide line.

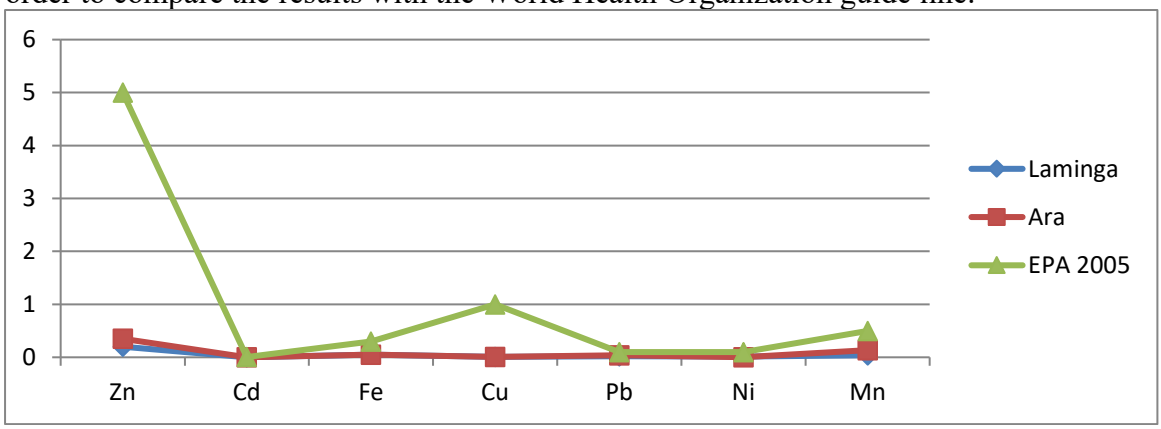

Fig. 2: Comparison of Mean Concentration with World Health Organization guide line

Discussion

The results of the Health Implication of the Accumulation of Heavy Metals Concentration in Ara and Laminga Water Sources of Nasararawa Local Government Area in Nasarawa State, Nigeria using Micro Plasma Atomic Emission Spectrometer have been presented. The mean concentration of various heavy metals found in the water samples are presented in Table 2. Seven heavy metals along with their respective concentrations for Ara and Laminga in mg/L (Zn (0.35 and 0.2), Cd (0.00 and 0.00), Fe (0.05 and 0.05), Cu (0.02 and 0.01), Pd (0.04 and 0.02), Ni (0.012 and 0.012) and Mn (0.04 and 0.04)) respectively were found in the water samples.

Finding of this study have revealed that the mean Concentration of the analyzed heavy metals in the all water samples for all villages arranged in decreasing order is Zn > Fe > Pb; Mn > Cu > Ni > Cd for Ara, while Zn > Fe > Mn > Pb > Ni > Cu > Cd for Laminga.

On Zinc mean concentration level, finding of this study has revealed that the zinc mean concentration level for water samples is 0.275 mg/L. This implies that the mean concentration level of zinc in those areas is not significant compared to WHO (2005) who's mean concentration level for zinc was 3.00 mg/L, and may not cause radiological hazard to the populace unless when accumulated over a long period of time.

On Cadmium mean concentration level, finding of this study has revealed that the cadmium mean concentration level for water samples is 0.00 mg/L. This implies that the mean concentration level of cadmium in those areas is not significant compared to WHO (2005) who's mean concentration level for cadmium was 0.003 mg/L, and may not cause radiological hazard to the populace unless when accumulated over a long period of time.

On Iron mean concentration level, finding of this study has revealed that the iron mean concentration level for water samples is 0.05 mg/L. This implies that the mean concentration level of iron in those areas is not significant compared to WHO (2005) who's mean concentration level for iron was 0.3 mg/L, and may not cause radiological hazard to the populace unless when accumulated over a long period of time.

On Copper mean concentration level, finding of this study has revealed that the copper mean concentration level for water samples is 0.015 mg/L. This implies that the mean concentration level of copper in those areas is not significant compared to WHO (2005) who's mean concentration level for copper was 2.0 mg/L, and may not cause radiological hazard to the populace unless when accumulated over a long period of time.

On Lead mean concentration level, finding of this study has revealed that the lead mean concentration level for water samples is 0.03 mg/L. This implies that the mean concentration level of lead in those areas is significantly high compared to WHO (2005) whose mean concentration level for lead was 0.01 mg/L, and may cause radiological hazard to the populace of the study area.

On Nickel mean concentration level, finding of this study has revealed that the nickel mean concentration level for water samples is 0.012 mg/L. This implies that the mean concentration level of nickel in those areas is not significant compared to WHO (2005) who's mean concentration level for nickel was 0.1 mg/L, and may not cause radiological hazard to the populace unless when accumulated over a long period of time.

On Manganese mean concentration level, finding of this study has revealed that the manganese mean concentration level for water samples is 0.04 mg/L. This implies that the mean concentration level of manganese in those areas is not significant compared to WHO (2005) who's mean concentration level for manganese was 0.5 mg/L, and may not cause radiological hazard to the populace unless when accumulated over a long period of time.

Conclusion

To quantify and evaluate the damages done by the intake of untreated water is not a simple problem. This work shows the preliminary net that is chosen to analyze Ara and Laminga, and it is possible to verify that seven heavy metals along with their respective concentrations for both Ara and Laminga in mg/L (Zn (0.35 and 0.2), Cd (0.00 and 0.00), Fe (0.05 and 0.05), Cu (0.02 and 0.01), Pd (0.04 and 0.02), Ni (0.012 and 0.012) and Mn (0.04 and 0.04)) respectively were present in the water samples. From the findings presented, it can be concluded that the mean concentration level of heavy metals in those areas with the exception of Lead (Pb) in all locations is not significant and may not cause radiological hazard to the populace unless when accumulated over a long period of time. Since concentration levels found shows that the study site can be considered as a free area. It is therefore an indication that the water in the area may be considered as a good water, even though, on accumulation, it may appear to have much impact on the radiation burden of the populace, hence, gross alpha and beta as well as carcinogenic and non-carcinogenic risk assessment of water in the area will compliment this work. It is therefore recommended that proper monitoring exercise should be conducted on the water in the study area from time to time in order to safeguard the population from high concentration of these heavy metals as they elevate with time and cause various forms of cancer to the populace of the study areas.

References

Enaam J.A. (2013). Evaluation of Surface Water Quality Indices for Heavy Metals of Diyala River Iraq. J. Nat. Sci. Res, 3(8), 63-64.

Fenglian F.u., & Qi W. (2011). Removal of Heavy Metal ions from Waste Waters: A review Journal Environmental Management, 92(3), 407-418.

Hinrichsen D. & Tacio H. (2002). The coming fresh water crisis is already here. Finding the source: The linkages between population and water. Woodrow Wilson International Center for Scholars, Washington, DC, ESCP Publication spring. 123.

Jain, C. K., Bhatia, K. K. S. & Vijay, T. (1995). Ground Water Quality Monitoring and Evaluation in and Around Kakinada, Andra Pradesh, Technical Report, CS (AR) 172, National Institute of Hydrogeology, Roorkee, 1994-1995.

Li S., Liu, W., Gu., S., Cheng, X., Xu, Z., & Zhang, Q. (2009). Spatio-temporal dynamics of nutrients in the upper Han River basin, China. J. Hazard. Mater, 162(2), 1340.

Nagendrappa, G., Bhaskar, C. V., & Kumar, K. (2010). Assessment of Heavy Metals in Water Samples of Certain Locations Situated around Tumkur, Karnataka India. E- Journal of Chemistry, 7(2), 349-352.

Vanloon, G. W., & Duffy, S. J. (2005). The Hydrosphere: In Environmental Chemistry: *A Global Perspective, (2nd Edn).* New York: Oxford University Press, 197-211.

WHO (2005). *Trace elements in human nutrition: Manganese. Report of a WHO expert committee*. Geneva, World Health Organization, pp. 34–36 (Technical Report Series No. 532).