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Assessment of Toxic and Essential Trace Metals in Unwana Borehole Water in Afikpo North, Ebonyi State

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Authors' contributions

This work was carried out in collaboration among all authors. Author MKN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CEI and AEI managed the analyses of the study. Author CEI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Water samples labeled A, B, C, D and E from five different boreholes in Unwana were analyzed to assess the level of toxicity and essential trace elements present. The results obtained showed slight variation in temperature for all the samples, having sample B, recording the highest values of 28^{o}C. As for pH, sample B recorded a pH of 6.58 which lies within the limits recommended by WHO. For the trace metals, Cd(II), Pb(II), Ni(II), Cr(III) and Zn(II) were present in all the five samples. Cd(II), Pb(II) and Cr(III) concentrations in mg.L^{-1} exceeded the WHO maximum allowed contaminant limit in all the five samples except for Zn (II) that recorded values in all the five samples that were within the maximum allowed contaminant limit proposed by WHO. From the results obtained therefore, it is evident that some toxic trace elements were present beyond acceptable limits making the borehole water unfit for human consumption and hence will require treatments.

Keywords: Trace element; contaminant; variation.

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1. INTRODUCTION

Water (H_20) is the most abundant compound on earth's surface covering 70% of the planet. In nature, water exists in liquid, solid, and gaseous state. It is in dynamic equilibrium between the liquid and gaseous state. At standard temperature, it is a tasteless and odorless liquid [1].

Many substances dissolve in water and this makes water to be commonly referred to as the universal solvent [2]. Water in nature and in use is rarely pure and some of its properties may vary from those of the pure substances. Water is the only common substance found naturally in all three common states of matter and it is essential for all life on earth [3].

In recent times, there has been an increasing related concern associated with quality of drinking water in developing countries [4]. According to recent report, about 780 million people in developing world lack access to clean water due to microbiological and chemical contamination [4].

Contaminant that maybe present in untreated water includes micro-organism like virus, bacteria and inorganic contaminants like heavy metals and trace elements [5]. The inorganic contaminants are constantly of health concern due to their high level of toxicity at low concentrations and tendency to bio accumulate in tissues of living organisms over time [5].

Climate influences the occurrence and distribution of trace elements in underground water whereby more trace elements occur at greater concentrations in wells, boreholes found in humid regions compared to other regions [6]. The Concentration of Arsenic (As), Chromium (Cr), Nickel (Ni) and Copper (Cu) is greater in the drier regions where processes such as chemical evolution, ion complexation, evaporative concentration, to varying degrees, help to mobilize these elements [6]. Toxic metals such as mercury (Hg), Cadmium (Cl), Arsenic (AS), Chromium (Cr), Thallium (Ti) and Lead (Pb) have no beneficial effects in human, as such long term exposure may cause more severe disruptions in the normal functioning of the organ systems where the metals are accumulated [7]. However, as micronutrient some trace metals such as zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) are required by the body in small amount for metabolic activities. These same elements, at high concentration can cause adverse health effect or illness [8].

The quality of borehole water in Nigeria has attracted the interest of many researchers in Nigeria in recent years [9]. Researchers have evaluated quality of borehole water in different part of Nigeria based on the bacteriological and physic-chemical assessment of contaminants. [10] analyzed 20 samples of borehole water in Lagos-Ogun axis of South West Nigeria. They examined the water samples for the presence of contaminants including silver, iron, manganese, lead, nickel, magnesium, cadmium, zinc, sodium, potassium, pH, turbidity, dissolved oxygen, electrical conductivity, alkalinity, total hardness, chloride, nitrate and sulphate. On comparing results they got with WHO standards, they discovered that nineteen out of the twenty of the water samples analyzed fell short of standard for ideal water quality for lifetime use.

[11] Analyzed for micro element on six borehole water samples in Oso Edda, Afikpo North South L.G.A of Ebonyi State and identified cadmium (Cd), lead (Pb), nickel (Ni), arsenic (As) and chromium (Cr) concentration. They arrived to the conclusion that the water posed no health challenge and recommended a further analysis in other to identify the concentration of other likely heavy metals.

Studies on borehole water quality in Nigeria have not reached a general agreement concerning the level of contamination and health risk associated to it. The finding on borehole water quality studies generally reflects on the peculiarity of the environment [9].

This study aims to generate reference data and method for assessment of trace metals in borehole water and monitoring the quality of the water since the majority of the people depends on borehole water for drinking. While the objective is to determine some physico-chemical parameters and concentrations of essential and toxic trace metal in borehole water samples spread around the community.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is Unwana a community in Afipko North Local Government Area Ebonyi State, Nigeria. According to 2006 census, Afikpo North Local Government Area has a population of 156,611 people [12].It occupies a land area of

approximately 190 Km^2 and can be located in a map on latitude 5.86602 degree North and longitude 7.94566 degree East. Vegetation of the study area can be described as a mixture of open grass land and tropical rain forest. The major occupation of people in the area is farming, as the climate favours rice, yam and cassava production. Fig. 1 is GPS map of Unwana in Afikpo North Local Government Area of Ebonyi State.

2.2 Sample Collection

Five sampling station were mapped out and samples were randomly collected in post monsoon season three times in each borehole in Unwana Afikpo North Ebonyi State. The sample container used was washed and rinsed with distilled water to remove contaminants.

2.3 Sample Preparation

Exactly 100 mL of each of the samples for analysis was acidified with 5mL concentrated HNO_3 acid for preservation. Samples were filtered to remove insoluble materials that could clog atomizer, and were stored in a decontaminated plastic bottles under refrigeration at $\pm 4^{o}C$, then transported to laboratory for analysis [14].

2.4 Sample Analysis

The water samples/reagent blank were digested using concentrated HNO_3 acid for the determination of the trace metal ions concentrations using Atomic absorption spectrophotometer model Buck Scientific VCTPRIO. Also prior to metal ion analysis, calibration solutions of the selected metal ions were prepared from analytical grade stock by serial dilution, while pH and temperature were analyzed in the field. Quality assurance was performed according to the method proposed by [15], with all analysis carried out in triplicate and average mean taken.

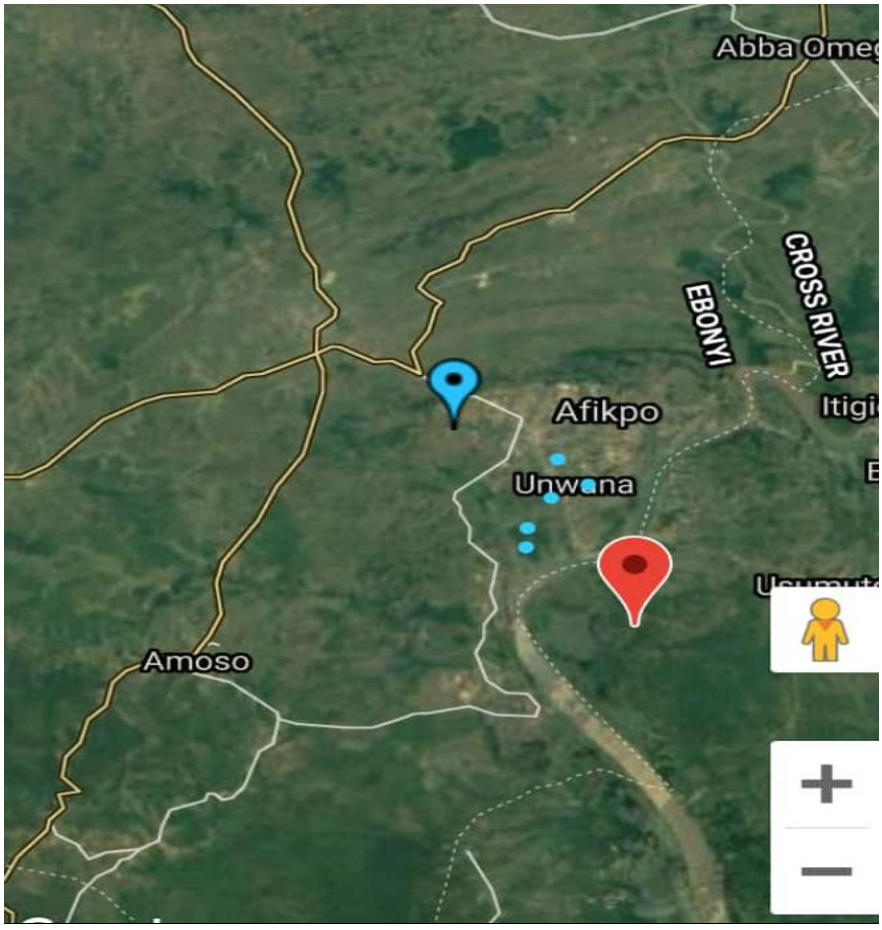

Fig. 1. Map showing Unwana in Afipko north local government area Ebonyi State [13].

3. RESULTS AND DISCUSSION

The results of the average mean triplicate analysis of borehole water sampled from along D12 road, beside Saint Thomas Catholic Church, promoters Street Eziukwu, No.17 Erie Road lodge and Poly Pride Lodge Boreholes in Unwana, labeled A, B, C, D and E. Showing the pH, temperature and concentrations of the trace metals together with their corresponding World Health Organization Standard maximum contaminant limit for drinking water [6], is presented in Table 1.

From Table 1 the results show that they are all within the World Health Organization Standard for drinking water [6].

The elemental concentration of the trace element in the water samples analyzed using the Atomic absorption spectrophotomer (AAS) are tabulated in Table 2. The range of cadmium and lead in the five borehole samples are 0.02-0.06 $mg.L^{-1}$ and 0.2 – 0.7 $mg.L^{-1}$ as presented in Table 2 and Fig. 2 respectively. Concentrations of cadmium and lead in the samples were reported to be above the maximum permissible level in drinking water proposed as 0.005 $mg.L^{-1}$ by the World Health organization WHO [6].

The values for Nickel in samples from along D12 road, beside Saint Thomas Catholic Church and No.17 Erie Road lodge Borehole were within WHO permissible limit for drinking water given as 0.04, 0.01 and 0.04 $mg.L^{-1}$ respectively, this can be compared to similar studies assessment of trace metals in drinking water and ground water sources in Ota Ogun State, done by [16], Samples from along D12 road (A), beside Saint Thomas Catholic Church (B) and No.17 Erie Road lodge Borehole (D) gave similar result. On the other hand samples from promoters Street Eziukwu (C) and Poly Pride Lodge Borehole (E) Samples reported levels that were far above WHO permissible limit. The concentration of chromium in all the five water samples ranged from 0.03 -0.20 $mg.L^{-1}$, samples from beside Saint Thomas Catholic Church borehole (B), promoters Street Borehole Eziukwu (C) and Poly Pride Lodge Borehole (E) were above WHO standards with values 0.11, 0.16 and 0.20 $mg.L^{-1}$, though all the values were within Federal Environmental Protection Agency (FEPA) limit of <1.0 $mg.L^{-1}$. The concentrations of zinc in all the samples were below the maximum contamination limits proposed by WHO and FEPA standard as is indicated in Table 2 and Fig. 2; this can be compared to work done by [17], were range of concentration of Zn between 0.030 $mg.L^{-1}$ to no Zn was detected. This clearly indicates that all the analyzed samples lacked zinc.

Table 1. Temperature and pH of the samples

Samples	Temperature (°c)	pH
A	26.0 ± 2.8	6.65 ± 0.35
B	28.0 ± 1.4	6.58 ± 0.11
C	27 .0 ± 1.4	6.71 ± 0.15
D	25.0 ± 2.1	6.82 ± 0.03
E	26.0 ± 2.1	6.70 ± 0.07
WHO	-	6.5-8.5

Data presented in Mean ± SD (N = 2)

Table 2. Trace metal (Cd(II), Pb(II), Ni(II), Cr(III) and Zn(II) ion concentration in water samples

Samples	Trace Metal Concentration (mg/l)				
	Cd(II)	Pb(II)	Ni(II)	Cr(III)	Zn(II)
A	0.03 ± 0.007	0.3 ± 0.11	0.04 ± 0.020	0.07 ± 0.03	0.13 ± 0.01
B	0.06 ± 0.020	0.7 ± 0.06	0.01 ± 0.003	0.11 ± 0.01	0.09 ± 0.01
C	0.04 ± 0.007	0.2 ± 0.03	0.23 ± 0.014	0.16 ± 0.03	0.14 ± 0.03
D	0.02 ± 0.010	0.3 ± 0.04	0.04 ± 0.014	0.03 ± 0.01	0.15 ± 0.01
E	0.03 ± 0.004	0.5 ± 0.14	0.32 ± 0.030	0.20 ± 0.07	0.11 ± 0.01
Mean	0.04 ± 0.005	0.4 ± 0.03	0.13 ± 0.030	0.11 ± 0.01	0.12 ± 0.01
[6]	0.005	0.05	0.05	0.05	5.00
[18]	0.2-1.80	1.0	<1.0	<1.0	20

Data presented in Mean ± SD (N = 2)

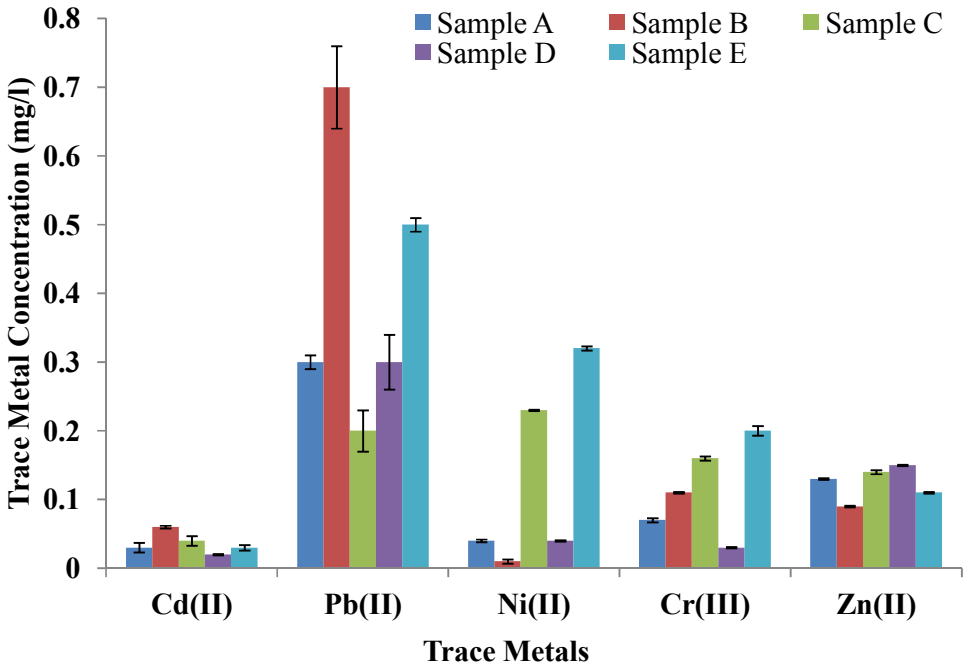

Fig. 2. Bar graph of trace metal ion concentration in water samples compered to WHO and FEPA standards for drinking water

KEY:Sample A: Sampled along D12 road borehole,Sample B: Sampled beside Saint Thomas Catholic Church borehole,Sample C: Sampled in promoters Street Borehole Eziukwu,Sample D: Sampled from street No.17 Erie Road lodge Borehole,Sample E: Sampled from Poly Pride Lodge Borehole.

4. CONCLUSION

Trace metal analysis was conducted using five water samples collected in Unwana Afikpo. The results obtained indicated the presence of some toxic trace elements such as cadmium, lead, Nickel, chromium and zinc. Cadmium, lead and chromium concentrations in some samples were little above WHO and FEPA permissible limit for drinking, nickel in sample A, B and D were below the limit and above the limit in sample C while zinc was below the limit in the entire sample. For pH all the five water samples were within the WHO recommended limit of 6.5-8.5.

In conclusion the five borehole water sampled randomly in Unwana is recommended for treatment as long term consumption may pose health risks to the community.

5. RECOMMENDATION

Having borehole water as the major source of drinking water in Unwana Afikpo North Ebony State, Nigeria it is recommended that the borehole water should be treated before consumption since it is evident that some toxic trace elements are present beyond WHO and FEPA acceptable limits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bruan CL, Sergai NS. "Why is water blue?" Journal Chemistry Education. 5th Edition. 1993;70 (80):612.
2. Anominus. Constant Pressure Heat Capacity of Water versus temperature; 2012.
Available:www. Xydatasource. Com.
Retrieved on 2011-11-22.
3. Anon. Canadian Infrastructural Report Card 1. 2012 Municipal Roads and Water Systems; 2012.
4. WHO/UNICEF. Estimated data from WHO/UNICEF Joint Monitory Programme (JMP) for Water Supply and Sanitation Progress on Sanitation and Drinking Water; 2012.
5. Ikejimba CC, Sakpa S. Comparative Study of some heavy metals concentrations in

water and *Trypanotonus Fuscatus Var radula* Samples of Egboko River Warn Nigeria. International Journal of modern Biological Research. 2014;2(1):7-15.

6. World Health Organization (WHO). Consensus of the meeting: Nutrient Minerals in drinking –water and the potential health consequences of long term consumption of demineralized and altered mineral content in Drinking waters. Rolling revision of WHO guild lines for drinking water. Water quality (draft) (November 11-13, meeting in Rome, Italy at the WHO European Centre for environment and Health; 2004.
7. World Health organization (WHO). WHO Technical notes for emergencies" Water Engineering Development Centre, Loughborough University, Leica's Tarsier U.K; 2011.
8. Valavanidis A, Vlachogianni T. Metal pollution in ecosystem, ecotoxicology studies & arisk assessment in the marine environment. Dept.of Chemistry,University of Athens University Campus Zogafou,15784 Athens Greece; 2010.
9. Abel AO, Damiana AA, Gloria OU. Physico-Chemical Characterization of Drinking Water Boreholes in Afikpo and Unwana Towns of Ebonyi state, Nigeria. Journal of advance studies in Agriculture, Biological and Environmental Science. 2010;6(4):12-29.
10. Adeleke AK, Olumuyiwa O, Mutiu S. Classification and health risk Assesement for borehole water contaminant by metals in selected household in southwest Nigeria. International Journal of pharmacology and & Toxicology. 2016;4(2):88-94.
11. Enoch EA, Eneche PU, Uko NF. Assessment of Micro Elements in Borehole Water Sources in Oso Edda,Afikpo L.G.A Ebonyi State,Nigeria. International Journal of multidisciplinary Research and Modern Education. 2016;2(1):740-747.
12. National Bureau of Statistics (2013). Annual Abstract of Statistics; 2011. Available:http://istmat.info/files/upload/53129/annual_abstract_of_ statistics_2011.pdf.
13. Afikpo North Maplandia (2020). Afikpo North Available:https://www.maplandia.com/Nigeria/abia/afikpo/afikpo
14. Radojevic M, Bashkin, VN. Practical Environmental Analysis", Royal Society of Chemistry, Cambridge. 1999;466.
15. EPA. Environmental protection Agency. Sampling and Analysis of Waters, Waste Waters, Soil and Wastes; 2020.
16. Winifred UA, Nsikak BA, Anuluwa AA, Cyril O, Ehi E, Ifedayo OA. Assesement of Trace Metals in Drinking Water and Ground water Sources in Ota, Nigeria; 2014.
17. Shalom NC, Obinna CN, Adetayo YO, Eze VN. Assessment of water quality in Canaan Land, Ota, Southwest Nigeria. Agriculture and Biological Journal of North America. 2011;4:577-583.
18. FEPA. Federal Environmental protection Agency. Guideline and Standards for Environmental Pollution Control in Nigeria. 1991;350.

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