

COMPARATIVE STUDY OF HEAVY METALS AND ANIONS CONTENTS OF WATER FROM DIFFERENT WATER BODIES IN UNWANA, AFIKPO NORTH L. G. A, EBONYI STATE.

A.N. Oko¹, Okoro, O. E.¹, C.O. Oji¹, C.O. Apie¹ and O.I. Okoro¹

¹*Department of Science Laboratory Technology,*

Akanu Ibiam Federal Polytechnic Unwana, Ebonyi State, Nigeria

Corresponding Author: okoahamefula1@gmail.com +2348030941379

Abstract

The aim of the study was to determine the heavy metals and anions contents of water from different water bodies in Unwana, Afikpo North Local Government Area of Ebonyi State. A total of 20 water samples comprising of 10 and 10 from River and Streams were collected from Unwana over a period of 5 months. Samples were analysed for heavy metals and anions using standard scientific procedures. Atomic Absorption Spectrometry. Results revealed varying ranges in Aluminum ($0.02 \pm 0.01 - 0.12 \pm 0.02 \text{ mgL}^{-1}$), Arsenic ($0.02 \pm 0.00 - 0.10 \pm 0.02 \text{ mgL}^{-1}$), Cadmium ($0.02 \pm 0.00 - 0.34 \pm 0.00 \text{ mgL}^{-1}$), Chromium ($0.02 \pm 0.01 - 0.08 \pm 0.01 \text{ mgL}^{-1}$), Copper ($0.45 \pm 0.00 - 0.62 \pm 0.00 \text{ mgL}^{-1}$), Lead ($0.12 \pm 0.00 - 0.19 \pm 0.02 \text{ mgL}^{-1}$), Mercury ($0.10 \pm 0.02 - 0.35 \pm 0.00 \text{ mgL}^{-1}$), Zinc ($0.08 \pm 0.00 - 1.02 \pm 0.00 \text{ mgL}^{-1}$), Chlorides ($45.00 \pm 0.02 - 192.00 \pm 0.08 \text{ mgL}^{-1}$), Nitrates ($15.00 \pm 0.08 - 28.00 \pm 0.01 \text{ mgL}^{-1}$), Sulphate ($64.00 \pm 0.00 - 248.00 \pm 0.08 \text{ mgL}^{-1}$) and Phosphates ($0.12 \pm 0.01 - 18.00 \pm 0.04 \text{ mgL}^{-1}$). The results revealed that the heavy metals and anions contents in the water samples were beyond WHO recommended limits indicating potential problem for human and animal health. It is important to monitor the quality of water and strict quality control measures should be strengthened to ensure the effective treatment of drinking water. Educational programmes should be organised by researchers and government agencies to enlighten the villagers on the proper use of water and potential dangers associated with human consumption of contaminated water.

Keywords: Atomic Absorption Spectrophotometry, Heavy Metals, Anions, Water bodies.

Introduction

Water is an important natural resource for sustainability of life on earth. Without food humans can stay for a week, but cannot stay a few days without water because it is needed to replenish the fluids lost during physiological activities, such as perspiration, respiration and urination (Shalom *et al.*, 2011). The hydrosphere is estimated to contain about 1.36 km^2 , only

about 0.3% of the water exist as fresh waters in rivers, streams and aquifers for human use, the remaining 99.7 % is locked up in seas and oceans. In developing countries such as Nigeria, lack of portable water is a challenge. Portable water also known as drinking water, is water which is fit for consumption by humans and other animals (Tchobanoglous *et al.*, 2003)

The usual sources of water for drinking such as streams, rivers, wells and boreholes are mostly untreated and associated with health risk (Agbaire and Obi, 2009). The unavailability of infrastructure for effective treatment and distribution of water accounts for high morbidity and mortality rate associated with water borne diseases in developing countries (Shalom *et al.*, 2011).

Water is said to be potable and safe if it meets certain physical, chemical and microbiological standards. Scientific methods have been used to determine these parameters in water sources; boreholes, streams, rivers ponds and packaged water (Okorundu *et al.*, 2015).

Heavy metals are elements with the density of 5.0 gcm^3 and above (Aken *et.al.*, 2010). The heavy metals are not degraded rather bioaccumulate and in excessive or high level become toxic to man and the ecosystem (Hussein *et al.*, 2011). Heavy metals contamination is dangerous because they accumulate inside the living organism and their primary seat of accumulation is in the liver and kidney (Demirezen and Urue, 2006; Thirulogachandar *et al.*, 2014).

However, heavy metals may enter into water bodies through burning of fossil fuels, application of inorganic fertilizers, biosolids, agrochemicals, animal manures, industrial effluents that contain heavy metals (Thirulogachandar *et al.*, 2014).

Other anthropogenic activities that could introduce heavy metals into water bodies include volcanic eruptions, and weathering of rocks (Nicholson *et al.*, 2003; Ong and Kamnuzzanman,

2009; Zaira *et al.*, 2011). Some heavy metals have no biological functions in the body system rather they bioaccumulate in the body especially the livers and kidney and are toxic. Such heavy metals include: mercury (Hg), lead (Pb), cadmium (Cd) and arsenic (As) (Mohammed *et al.*, 2010; Demirezien and Urue, 2006). However, some heavy metals are essential to plants and animals for normal growth and development because they are constituents of many enzymes and are important in some metabolic activities going on in body. These metals include zinc (Zn), copper (Cu), iron (Fe) and chromium (Cr). They are needed in minute quantities, in excessively high amounts; they become toxic to the organisms (Bromley *et al.*, 2002; Mbong *et al.*, 2013; Okoye *et al.*, 2015).

Mercury (Hg) is a cumulative metal without any biological function (Lee, 2009). The permissible limit is 0.00 mgL^{-1} in drinking water by WHO (Sabine and Wendy, 2009).

Lead (Pb) is naturally present as galena and lead produced is used to make lead acid batteries, lead pipes and solders. The permissible limit is 0.05 mgL^{-1} in drinking water by WHO. (Sharma, 2011).

Arsenic (As) occurs in water due to mineral dissolution of industrial wastes or application of insecticides (Sharma, 2011). Permissible limit of arsenic in drinking water is 0.01 mgL^{-1} (Lee, 2009).

Cadmium (Cd) is naturally present in soil and rocks. The permissible limit of cadmium in water is 0.05 mgL^{-1} (Sabine and Wendy, 2009; Lee, 2009).

Copper (Cu) is an essential element for living organisms plants and animals. At proper concentration, is beneficial to health (Lee, 2009; Okoye *et al.*, 2011). The permissible limit of copper in drinking water is $1.0 - 1.5 \text{ mgL}^{-1}$ by WHO (Sharma, 2011).

Zinc (Zn) is an essential element that is required in small amount by both animals and plants (Lee, 2009). The permissible limit of zinc in drinking water is 5.0 mgL^{-1} by WHO (Sharma, 2011).

Chromium (Cr) is important for both animal and human health. Chromium (Cr) aids insulin production and regulates glucose level in the body (Sabine and Wendy, 2009). The recommended limit of chromium in drinking water is 0.05 mgL^{-1} by WHO (Sharma, 2011).

Iron (Fe) is present in gravel, sand and rocks. The permissible limit of iron in drinking water is 0.3 mgL^{-1} by WHO (Sharma, 2011).

Chloride (Cl^-) presence of chloride in natural water can be attributed mainly to dissolution of salt deposits in the form of ions (Cl^-). High level of chloride indicate pollution by sewage, industrial wastes, intrusion of sea water or other saline water. Chloride is not considered as being harmful to human health. High chloride content has a deleterious effect on metallic pipes and structures, as well as agricultural plants. Excessive chloride concentrations increase rates of corrosion of metals in the distribution system, depending on the alkalinity of water. This can lead to increased concentrations of metals in the supply (WHO, 2004).

Sulphate (SO_4^{2-}) is a polymeric anion with the formula SO_4^{2-} and it is a salt or an ester of sulphuric acid. It occurs as microscopic particles (aerosol) resulting from fossil fuel biomass combustion. It increases the acidity of the atmosphere contributing to acid rain (Sharma, 2011). The permissible limit in drinking water is 250 mgL^{-1} .

Nitrates (NO_3^-) occurs in natural water and waste water. Its presence indicates complete oxidation of organic matter in water (Sharma, 2011). The permissible limit by WHO is 50 mgL^{-1} .

Phosphates (PO_4^{2-}) occurs in natural waters as orthophosphates, condensed phosphates and naturally found phosphates. It can come from a variety of sources such as geological

formations, agricultural fertilizers, domestic spent water (human wastes, synthetic detergent, biological protoplasm) and various industrial spent waters (Jackson, 1993).

Materials and Methods

Study Site and Description of Study Area.

The study area of this research was Unwana. Unwana is located, situated upon a hill and is the hometown of Late Ezeogo Dr. Akanu Ibiam, the first governor of Eastern region, Nigeria.

Unwana city is located in Ebonyi State South Eastern Nigeria. It is located at latitude 5.7833' and 5°N, longitude 7.933 and 7°56E. It has a population of 120,000 and a land mass of about 190 square kilometers (NPC census, 2006). To this study, water samples were collected from two water source which include Unwana river and streams.

The area was chosen because most households are flooded and unhygienic, and defecation on open fields and farmlands is a common practice observed in this area. Apart from rainwater and boreholes in a few households, sources of water for drinking and domestic use come from Unwana river and streams that are regularly contaminated with human and animal faeces. The water is used for transportation, agriculture, human consumption, various industrial activities and domestic purposes. Some of such water sources constantly receive effluents from farmlands and domestic power plants.

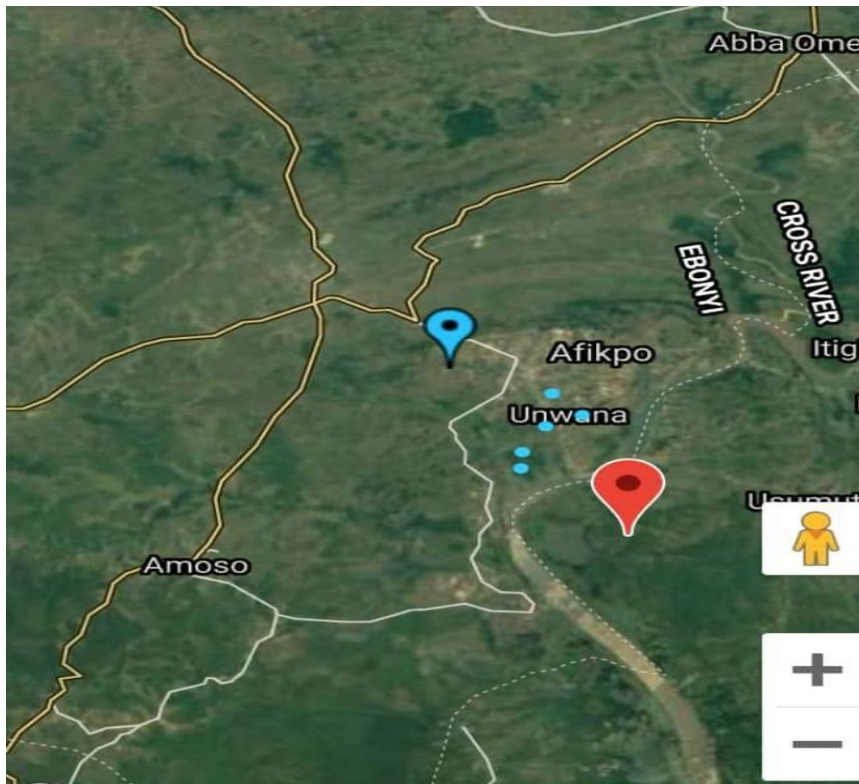


Fig 1. Map showing Unwana the sampling location in Afikpo North Local Government Area (Okoh, Eyo, and Ezenwaji, 2007)

Sample Collection

The sampling procedure used is the simple Grab Sampling methods (Mahfenz *et al.*, 1995). Mechanical methods were used in collecting the water samples in clean amber bottle containers. Five samples each of river and stream water were collected from designated areas were analyzed. The number of samples from Unwana river were 10 and the number of samples streams were 10. The studies were carried out between November, 2021 - January 2022, and May - July 2022. Water samples from river and streams within the study areas were collected with plastic bottles that were washed with detergent and distilled water, rinsed with 1:1 nitric acid and sulphuric acid and rinsed with distilled water. Water samples, 1.5 L from each

sampling point were collected into bottles with identification label fixed on them and were transported to Water Research Laboratory Abakaliki for analysis.

Sampling Guide

For easy identification, the water sample were labelled as R1 - R10 and S1 - S10 for samples from river and streams.

Table 1: Water Samples from Unwana River / Streams

| S/N | Water source | Nov. 2021 - Jan. 2022 | May 2022 - July 2022 |
|-------|--------------|-----------------------|----------------------|
| | | No. of samples | No. of samples |
| 1. | River | 5 | 5 |
| 2 | Stream | 5 | 5 |
| Total | | 10 | 10 |

Metal Analysis

Determination of Heavy Metals in the Water Samples

Eight (8) heavy metals including: aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg) and zinc (Zn) were determined in each sample using atomic absorption spectrometer (AAS) model according to standard analytical procedures (Mendham *et al.*, 2000).

Analysis of Anions

The levels of anions in the water were determined using Perkin Elmer UV-Vis spectrophotometer at different wavelengths. Anions determined included chlorides, nitrates, sulphates and phosphates. Chlorides was determined by Mohr's method using argentimetric titration (Ademoroti, 1996).

Chloride Determination

The analytical method for the determination of chloride is based on the formation of mercury (II) chloride from a reaction between chloride and mercury (II) thiocyanate. The liberated thiocyanate ion reacts with the ferric nitrate to produce coloured ferric thiocyanate whose concentration is measured spectrophotometrically at wavelength of 463nm. The concentration of ferric thiocyanate is proportional to chloride concentration. The determination was done according to method of Shalom *et al.*, 2011.

Determination of Nitrates

Nitrates was determined using the UV-Visible spectrophotometric method as described by Shalom *et al.*, 2011.

Determination of Phosphate

The analytical method for the determination of phosphate is based on the formation of 12-molybdophosphoric acid from phosphate ion and molybdate in acid solution and subsequent reduction to a blue heteropoly compound (phosphomolybdenum blue). The determination was done according to method of Shalom *et al.*, 2011.

Determination of Sulphate

The analytical method for the determination of sulphate is based on the reaction of sulphate ion with barium chloride to form a suspension of barium sulphate which is stabilised by gelatine and thymol. Hydrochloric acid is present to prevent the precipitation of barium carbonate, phosphate and sulphite. The turbidity is measured spectrophotometrically at 495nm. The determination was done according to the method of Shalom *et al.*, 2011.

Statistical Analysis

The raw data on the physicochemical analysis obtained were presented as mean \pm standard

deviation in tables. Data were interpreted using simple descriptive statistics such as minimum, maximum, and one way analysis of variance (ANOVA) with the aid of IBM Statistical Package for Social Sciences (SPSS) version 22 and Microsoft Excel 2013 software.

Results

Table 2: Heavy Metal Contents of Water Samples Collected from Different Sampling Points along Unwana River Compared with WHO Recommended Limit.

| SN | Metals (mgL ⁻¹) | Sampling Points along Unwana River | | | | | WHO Standard Recommended Limits (mgL ⁻¹) |
|----|-----------------------------|------------------------------------|-------------|-------------|-------------|-------------|--|
| | | Point A | Point B | Point C | Point D | Point E | |
| 1 | Aluminium (Al) | 0.12 ± 0.02 | 0.02 ± 0.01 | 0.03 ± 0.02 | 0.03 ± 0.00 | BDL | 0.20 |
| 2 | Arsenic (As) | BDL | 0.02 ± 0.02 | 0.02 ± 0.00 | 0.03 ± 0.00 | 0.03 ± 0.02 | 0.01 |
| 3 | Cadmium (Cd) | 0.32 ± 0.00 | 0.34 ± 0.00 | 0.20 ± 0.01 | 0.10 ± 0.02 | 0.02 ± 0.00 | 0.003 |
| 4 | Chromium (Cr) | 0+.08 ± 0.01 | 0.05 ± 0.00 | 0.06 ± 0.02 | 0.03 ± 0.00 | 0.02 ± 0.01 | 0.05 |
| 5 | Copper (Cu) | BDL | 0.60 ± 0.00 | 0.45 ± 0.00 | 0.60 ± 0.00 | 0.48 ± 0.02 | 1.00 – 2.00 |
| 6 | Lead (Pb) | 0.16 ± 0.02 | 0.12 ± 0.00 | 0.15 ± 0.01 | 0.18 ± 0.02 | 0.14 ± 0.00 | 0.01 |
| 7 | Mercury (Hg) | 0.10 ± 0.02 | BDL | BDL | 0.20 ± 0.02 | 0.35 ± 0.00 | - |
| 8 | Zinc (Zn) | 0.66 ± 0.00 | 0.70 ± 0.00 | 0.82 ± 0.00 | 1.02 ± 0.00 | 1.00 ± 0.01 | 5.0 |

Table 3: Heavy Metal Contents of Water Samples Collected from Streams in Different Locations in Unwana Compared with WHO Recommended Limit.

| SN | Metals (mgL ⁻¹) | Location of Water Sources | | | | | WHO Standard Recommended Limits (mgL ⁻¹) |
|----|-----------------------------|---------------------------|---------------|----------------|-------------|-------------|--|
| | | Ochighaighai | Ihiere Unwara | Ogbagu Ndemiyi | Oke Ohia | Ogbagu Uja | |
| 1 | Aluminium (Al) | 0.04 ± 0.00 | 0.02 ± 0.03 | 0.03 ± 0.02 | 0.03 ± 0.00 | 0.02 ± 0.02 | BDL |
| 2 | Arsenic (As) | 0.02 ± 0.01 | 0.02 ± 0.00 | BDL | 0.03 ± 0.00 | BDL | 0.20 |
| 3 | Cadmium (Cd) | BDL | 0.30 ± 0.01 | 0.20 ± 0.01 | 0.10 ± 0.02 | BDL | 0.01 |
| 4 | Chromium (Cr) | 0.08 ± 0.00 | 0.08 ± 0.02 | 0.06 ± 0.02 | 0.03 ± 0.00 | 0.02 ± 0.02 | 0.003 |
| 5 | Copper (Cu) | 0.50 ± 0.01 | 0.62 ± 0.00 | 0.45 ± 0.00 | 0.20 ± 0.01 | 0.48 ± 0.02 | 0.05 |

| | | | | | | | |
|---|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 6 | Lead (Pb) | 0.16 ± 0.02 | BDL | 0.16 ± 0.01 | 0.19 ± 0.02 | 0.14 ± 0.00 | 1.00 – 2.00 |
| 7 | Mercury (Hg) | 0.20 ± 0.00 | 0.20 ± 0.01 | 0.15 ± 0.00 | 0.20 ± 0.02 | BDL | 0.01 |
| 8 | Zinc (Zn) | BDL | 0.80 ± 0.00 | 0.82 ± 0.00 | 1.02 ± 0.00 | 1.00 ± 0.00 | 5.0 |

Table 4: Anion Contents of Water Samples Collected from Different Sampling Points along Unwana River compared with WHO Recommended Limit.

| Sampling Points along Unwana River | | | | | | | |
|------------------------------------|---|--------------|--------------|--------------|--------------|---------------|--|
| S/N | Anions (mg/L) | Point A | Point B | Point C | Point D | Point E | WHO Standard Recommended Limits (mgL ⁻¹) |
| 1 | Chlorides (Cl ⁻) | 45.00 ± 0.02 | 48.00 ± 0.00 | 64.00 ± 0.02 | 60.00 ± 0.03 | 192.00 ± 0.08 | 200-250 |
| 2 | Nitrates (NO ₃ ⁻) | 28.00 ± 0.01 | 16.00 ± 0.02 | 21.22 ± 0.06 | 25.20 ± 0.08 | 20.00 ± 0.00 | 10.0 |
| 3 | Sulphates (SO ₄ ²⁻) | 184.0 ± 0.02 | 84.00 ± 0.04 | 76.00 ± 0.08 | 222.0 ± 0.02 | 248.0 ± 0.00 | 250 |
| 4 | Phosphates (PO ₄ ²⁻) | 0.16 ± 0.00 | 0.12 ± 0.01 | 1.46 ± 0.02 | 14.20 ± 0.08 | 18.00 ± 0.04 | 0.30 |

Table 5: Anion Contents of Water Samples Collected from Streams in Different Locations in Unwana Compared with WHO Recommended Limits.

| Anions (mgL ⁻¹) | Ochighaighai | Ihiere Unwara | Ogbagu Ndemiya | Oke Ohia | Ogbagu Uja | WHO Standard Recommended Limits (mgL ⁻¹) |
|---|--------------|---------------|----------------|--------------|---------------|--|
| 1 Chlorides (Cl ⁻) | 64.00 ± 0.00 | 82.00 ± 0.06 | 54.00 ± 0.02 | 62.00 ± 0.20 | 118.00 ± 0.20 | 200-250 |
| 2 Nitrates (NO ₃ ⁻) | 15.00 ± 0.08 | 26.20 ± 0.10 | 22.86 ± 0.10 | 15.20 ± 0.04 | 25.04 ± 0.02 | 10.0 |
| 3 Sulphates (SO ₄ ²⁻) | 218.8 ± 0.82 | 64.00 ± 0.00 | 86.60 ± 0.20 | 218.0 ± 0.02 | 210.0 ± 0.10 | 250 |
| 4 Phosphates (PO ₄ ²⁻) | 0.40 ± 0.08 | 5.22 ± 0.01 | 1.20 ± 0.03 | 7.20 ± 0.00 | 9.02 ± 0.08 | 0.30 |

Discussion

Aluminum was highest (0.12 ± 0.02 mgL⁻¹) in river water samples from Unwana while stream water samples from Unwana recorded the lowest (0.02 ± 0.02 mgL⁻¹). The standard recommended limit of aluminum in water is 0.20 mgL⁻¹ as given by WHO. There was

significant difference ($p < 0.05$) in the aluminum concentration of water sample. John 2018, reported a mean aluminum content of $0.04 \pm 0.00 \text{ mgL}^{-1}$ in water samples from Abakaliki Local Government Area. High aluminum content in water can lead to vitamin D-resistance, osteomalacia, central nervous system alterations and erythropoietin-resistant microcytic anemia. In very high doses, aluminum is associated with altered function of the blood - brain barrier (Shalom *et al.*, 2011).

The levels of **arsenic** measured from Unwana River and streams ranged from 0.03 ± 0.00 to $0.02 \pm 0.02 \text{ mgL}^{-1}$. The highest level of $0.03 \pm 0.00 \text{ mgL}^{-1}$ was obtained from Unwana river at points D and E while the least value was detected in the other points in the river and streams. However, on the point to point average on the river and of the different streams, point D recorded the lowest while Oke Ohia stream recorded the highest. The levels detected in this study are however above the WHO permissible level of 0.01 mgL^{-1} . The level reported here were meanwhile comparable to that of Rankin *et al* (2005). Rankin *et al.*, (2005) reported $0.02 \pm 0.01 \text{ mgL}^{-1}$ in river using AAS. The occurrence of arsenic in water could be as a result of farming activities in nearby environment which releases heavy metals into body of water. Arsenic occurs in water due to pesticides and insecticides application (Shalom *et al*, 2011). Drinking water that contains arsenic at high concentrations for a prolonged period may result to health problems such as constriction of the throat, difficulty in swallowing, vomiting (Shalom *et al*, 2011)..

The highest concentration level of **Cadmium** $0.34 \pm 0.00 \text{ mgL}^{-1}$ was obtain from point B of Unwana river while the least was obtained from point E of $0.02 \pm 0.00 \text{ mgL}^{-1}$. The standard recommended limit of Cadmium in water is 0.003 mgL as given by WHO. In water source from streams, the results revealed that almost all the concentrations of Cadmium are beyond

WHO standard. This shows that water sample from these locations have high amount of Cadmium. Michael *et al* (2015) reported a mean concentration of $0.001 \pm 0.00 \text{ mgL}^{-1}$ in Kogi. Cadmium finds their way in drinking water through erosion and weathering of rocks and soils. Cadmium exposure in high level causes effects on metabolism in body tissues, liver, pancreas, kidneys and bones (Ayandele *et al.*, 2015).

The level of **Chromium** measured from Unwana river and streams ranged from 0.02 ± 0.00 - $0.08 \pm 0.01 \text{ mgL}^{-1}$. The highest amount of $0.08 \pm 0.01 \text{ mgL}^{-1}$ was obtained from Unwana river and streams. The least was in the stream from Ogbagu Uja ($0.02 \pm 0.02 \text{ mgL}^{-1}$). The standard recommended level of chromium in water is 0.05 mgL^{-1} . Saeed and Mahmoud (2014) reported a mean and standard deviation value chromium of 0.01 ± 0.00 - $0.04 \pm 0.01 \text{ mgL}^{-1}$ in borehole water sample from Kano town in Kano state. Drinking hard water and eating food cooked with stainless steel utensils increase the chromium content of food (Shalom *et al.*, 2011). Chromium has effect on some enzymes, peroxidase, catalase (Shalom *et al.*, 2011).

The levels of **copper** measured from stream and Unwana river ranged from (0.45 ± 0.00 - $0.62 \pm 0.00 \text{ mgL}^{-1}$). The highest amount of $0.62 \pm 0.00 \text{ mgL}^{-1}$ was obtained from stream in Ihiera Unwana while the least amount was found in Ogbagu Ndemiyi of $0.45 \pm 0.00 \text{ mgL}^{-1}$. The standard recommended level of copper by WHO is 1.00 - 2.00 mgL^{-1} . Upon all the amounts of copper in the water sample, they are below WHO standard. Reuben *et al* (2018), obtained a mean copper concentration of $0.01 \pm 0.002 \text{ mgL}^{-1}$ which is lower than our results. Excess intake of copper causes widespread of gastrointestinal irritation and capillary damage.

Lead was highest ($0.19 \pm 0.02 \text{ mgL}^{-1}$) in stream water samples from Unwana while water from Unwana river point B lowest ($0.12 \pm 0.00 \text{ mgL}^{-1}$). From the results obtained from the study, it was found that the results obtained were beyond WHO standard. The standard recommended

limit of Lead in water is 0.01 mgL^{-1} . Lead is the most heavy metal contaminant. Lead is poisonous for mammals. It finds its way to water body through mining activities (Shalom *et al*, 2011)..

Mercury was highest ($0.35 \pm 0.00 \text{ mgL}^{-1}$) in river water sample from Unwana at point F compared with other points in Unwana river and streams and lowest ($0.20 \pm 0.00 \text{ mgL}^{-1}$) in stream water of Ochighaighai. From the results recorded, in this study, all the concentrations of mercury in the water sample are above WHO permissible limit of drinking water. The standard recommended limit of mercury in drinking water is nil as given by WHO. A mercury concentration of $0.010 \pm 0.01 \text{ mgL}^{-1}$ was reported in drinking water sources in Ivo Local Government of Ebonyi State by Nzubechukwu *et al.*, (2015). Mercury causes tremors, lungs and brain damages (Shalom *et al*, 2011).

Zinc was the highest ($1.02 \pm 0.00 \text{ mgL}^{-1}$) in the river water samples in Unwana at point D while stream water sample from Ihiera Unwana recorded the lowest ($0.08 \pm 0.00 \text{ mgL}^{-1}$). All the water samples were lower than the WHO recommended limit of zinc in drinking water is 5.0 mgL^{-1} .

Reuben *et al.*, (2018) obtained a mean zinc concentration of $0.03 \pm 0.017 \text{ mgL}^{-1}$ which is lower than the result in this study.

Zinc help in the regulation of vitamin A concentration in the blood. High concentrations of zinc may cause a better, undesirable taste and form crazy films especially when boiled (Shalom *et al*, 2011).

Chlorides was highest ($192.00 \pm 0.08 \text{ mgL}^{-1}$) in water sample from Unwana river at point E while stream water samples from Unwana from Ihiera Unwana recorded ($54.00 \pm 0.02 \text{ mgL}^{-1}$). The concentration of chlorides in all the water samples from all the study locations were below

WHO standard. The standard recommended limit of chloride in water is 200 – 250 mgL⁻¹ as given by WHO. Chloride play a key role in maintaining cell homeostasis and transmitting actions potential in neurons (Jentsch *et al.*, 2002).

Chloride excess amount can constitute a health hazard (Tay, 2007), Nwali *et al.*, (2016) reported that observed chlorides values in both are 10.62 mgL⁻¹ (Ope - ekwe) and 14.35 mgL⁻¹ (Ikwoihie) which falls below the result of the present study. Excess chloride concentration of increase rate of corrosion of metals (Tay, 2007).

Nitrates was highest (28.00 ± 0.08 mgL⁻¹) in water sample from Unwana river at point A while stream water sample from Unwana from Ochighaighai recorded lowest (15.00 ± 0.08 mgL⁻¹). The concentrations of all the nitrates from all the study locations were higher than WHO standard. The standard recommended limit of Nitrate is 10.00 mgL⁻¹ as given by WHO. The high concentrations of nitrate in the water samples may be as a result of farming activities at the bank of the water bodies, farmer consistently using fertilizers for farming activities which can be washed into the water bodies. Michael *et al.*, (2015) reported a low nitrates concentration of 0.58 ± 0.6 mgL⁻¹ in Kogi State. High nitrate content can lead to cyanosis disease or blue baby syndrome.

Sulphates was highest (248.00 ± 0.00 mgL⁻¹) in water samples from Unwana river at point E while stream water samples from Unwana, from Ihiera Unwana recorded lowest (64.00 ± 0.00 mgL⁻¹). The concentrations of all the sulphates from all the study locations were lower than WHO standard. The standard recommended limit of sulphates is 250 mgL⁻¹ as given by WHO (Yasiri *et al.*, 2015). Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals (Shinivasa and Venkateswaralu, 2000). (Adefemi and Awokunmi, 2010) revealed the concentration of sulphate found in Itaogbolu River in Ondo State to be 300

mgL⁻¹. Excess sulphate in water impose danger to health such as kidney disorder (APHA, 2012).

Phosphate was highest (18.00 ± 0.04 mgL⁻¹) in water samples from Unwana river at point E while water sample from Unwana river point B recorded lowest (0.12 ± 0.01 mgL⁻¹). However, the water sample from the stream Okeohia recorded the highest (9.02 ± 0.08 mgL⁻¹). The water samples from Unwana river from point C - E are above WHO standard. On other hand, water samples from all the steams are beyond WHO standard limit of drinking water. The standard recommended limit of phosphate in water is 0.30mgL⁻¹ as given by WHO. A lower amount of 1.60 ± 1.41 mgL⁻¹ phosphates was obtained by Michael *et al.*, (2015). High concentration of phosphate could be as result of chemical fertilizer used in farming activities. High level of phosphate in drinking water could cause diuresis and haemorrhaging of the spleen (Reimann *et al.*, 2003).

Conclusion

The comparative study of heavy metals and anions contents of water from different water bodies in Unwana, Afikpo North Local Government Area, Ebonyi State was successfully carried out during the 2021/2022 dry and wet seasons. This study revealed that the contents of the parameters in water samples were beyond WHO standard recommended limit for consumption, may pose risk to human and animal health.

Recommendation

Effective treatment of drinking water should be carried out and educative programmes and public enlightenment by government should be organized in order to expose the village dwellers on the dangers of consuming contaminated water.

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