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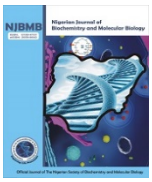

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Research Article

Physico-chemical and Bacteriological Analysis of Water used for Drinking and other Domestic Purposes in Amaozara Ozizza, Afikpo North, Ebonyi State, Nigeria

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ABSTRACT

Physicochemical properties, selected metal contents, microbial load and antibiotic susceptibility pattern of three main drinking water sources in Amaozara Ozizza, Afikpo North L.G.A, Ebonyi State, Nigeria were investigated. Three drinking water samples were collected from three water sources: Ogo borehole, Ogbuku and Ugwuiyi. Physicochemical parameters analyzed were: pH, temperature, dissolved oxygen (DO), chemical oxygen demand (COD), total dissolved solute (TDS), electrical conductivity (EC), phosphate (PO_4^{3-}), sulphates (SO_4), nitrates (NO_3-N) and nitrites (NH_4-N); Metals (Ca, Cl, Mg, K, Zn, Ni, Mn, Pb, Fe, Cu, Cr and Cd) and pathogenic microbiological presence were also analyzed using standard procedures. The results showed that the majority of the parameters determined did not exceed the permissible limit of set standards. However, some parameters that deviated from set standards such as COD, turbidity, PO_4^{3-} and NH_4 can be improved by adequate water treatment. *Escherichia coli, Shigella, Klebsiella, Salmonella, Vibrio cholera,* and *Proteus spp* were amongst the identified isolates from the water samples. 80% of isolates were sensitive to maxipime, augumentin and mefoxin while 20% isolated were resistant to cloxacillin and rocephin. The presence of these microorganisms depicts fecal contamination which portends health risk among the community that utilize the water for drinking and other domestic purposes.

Keywords: *Amaozara Ozizza, Ugwuiyi, Susceptibility, Metals, Isolates*

INTRODUCTION

About 783 million of total world population has no access to safe water, and majority of these population reside in rural areas (Salehi, 2022). This trend is predicted to rise because of increasing population and pressure on already limited water sources. Inadequate good drinkable water has warranted the use of other water sources like groundwater, and surface water by rural dwellers. However, studies abound negating the use of water sources because of hazardous health implications that this unhygienic practice portend (Ocheri, 2014). Generally, water is claimed to be polluted once it doesn't befit the internationally approved standards (Lin et al., 2022). The extent of pollution of any water depends on the quality and quantity of effluent discharged into the water also as other run-off (Sharma & Bhattacharya, 2017). Analysis of water includes evaluation

of its physical, chemical and bacteriological characteristics for elucidation of its quality (Sharma & Bhattacharya, 2017).

Pollution occurs when a change in the physical, chemical or biological environmental condition adversely affects quality of human life, animals and plants (Pona et al., 2021). Agricultural practices, industrialization and discharge of sewage into water bodies are among the factors accountable for pollution (Pona et al., 2021). Ayandiran and others (Ayandiran et al., 2018) reported that the majority of the water samples utilized by rural dwellers in Nigeria contained Pb and Cd above the WHO limits for portable water.

In evaluating the quality of drinkable water, microbiological assessment is of utmost importance especially in developing countries. Escherichia coli, Aerobacter aerogenes, Klebsiella sp., Pseudomonas sp., Proteus sp., Staphylococcus sp., Shigella and Acaligenes sp. are isolated from groundwater (Efuntoye & Apanpa, 2010). These pathogenic bacteria can cause various diseases like typhoid, dysentery, cholera and other intestinal diseases especially in patients whose system is compromised (Ayandiran et al., 2018). It's estimated that about 1.8 million people, mostly children, die each year because of water related diseases (UNICEF, 2013a; Wolf, 2013).

The principal occupations of Amaozara Ozizza settlers are farming, fishing and trading. The people also engage in wrestling, especially during festive periods. Amaozara topography is hilly with undulating plains. There are three different bodies of water in Amaozara Ozizza which serve for the purpose of drinking and other domestic uses. The various bodies of water are Ogo borehole, Ogbuku and Ugwuiyi which are both streams were used for this research. These water sources are surrounded by farmlands and residential houses. Therefore, there's a huge chance of being exposed to sewage and other waste materials including agricultural wastes. The increased anthropogenic activities within these areas will normally influence water quality. It is, therefore, of importance to look at the water quality parameters of Amaozara Ozizza to determine whether the water quality remains suitable for various purposes. So far, no study has been undertaken to assess the water quality of Amaozara Ozizza. Therefore, this study envisaged to quantitatively determine some physico-chemical parameters, microbial status and metals content of the Amaozara drinkable water sources and to match the values with the drinkable water standards recommended by World Health Organization (WHO) and Nigerian Standard for Drinkable Water Quality (NSDWQ).

MATERIALS AND METHODS

Study area

Amaozara Ozizza was the study area. Amaozara is one of the six sub-groups of communities that make up Ozizza town. Ozizza is found in Afikpo North Government Area of Ebonyi State, Nigeria and is found on the axis of fifty, 54N and 7^0 56^0E. There are two main seasons here which are rainy (April–October) and dry seasons (November – March). The samples were collected in September.

Sample collection

Exactly two litres of water samples were aseptically collected from each of the three main sources of drinkable water in Amaozara Ozizza (Ogbuku, and Ugwuiyi) and both been stream waters Ogo borehole in pre-cleaned containers in September 2019 and transported to the laboratory within 24 hours for analysis. On site measurements were conducted using standard methods.

Sample analysis

The Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO) were determined in line with APHA method ((APHA), 2005.). Electrical Conductivity (EC), Total Dissolved Solids (TDS), temperature and pH were measured using the Hanna multi-parameter bench-top meter (Hanna, HI 98108) by following the manufacturer's instructions. Inorganic salts (nitrate, phosphate, sulphate and carbonate) in samples were determined using spectrophotometric and titrimetric methods supported by Vogeel (2002.) and Ibitoye (2005) methods.

For metal analysis, water samples were preserved with trioxonitrate (vi) acid (HNO_3) to avoid precipitation of the metals. Thereafter, Atomic Absorption Spectrophotometer was employed to quantify the metals.

The microbial assessment of the water was done by culturing the water, using culture media. The microorganisms were identified, using biochemistry methods in line with Cheesbrough (Cheesbrough, 2000). Thereafter, antibiotics susceptibility test of the identified isolates was investigated.

The quality of drinking water and the water pollution status were evaluated according to the standards suggested by WHO (WHO., 2012) and NISDWQ (NISDWQ, 2007) in order to calculate the number of samples that did not comply with the guideline values.

Statistical analysis

Data were analyzed by calculating mean ±standard deviation of three replicate values. ANOVA was utilized to check differences among the samples and significance difference calculated at $P<0.05$.

RESULTS AND DISCUSSION

Results

Physicochemical properties of main drinking water sources in Amaozara Ozizza, Afikpo, Nigeria

The physicochemical properties of the drinking water in Amaozara Ozizza, Afikpo, Nigeria is presented in Table 1. Colour, Taste and Odour were within the world health organization (WHO) and New Nigerian International Standard for Drinking Water Quality (NISDWQ) standards of 2012 and 2007, respectively. Temperature (°C) of Ogo Bolehole, Ogbuku and Ugwuiyi were higher than the WHO standard while Conductivity (µs/cm and total dissolved solids TDS (mg/l) were far below the WHO standards. pH in Ogo Bolehole of 5 was below the WHO and NISDWQ standard of 6.20-8.50, dissolved oxygen DO (mg/l), Turbidity (FAU) in the three water sources was below WHO standard with the chemical oxygen demand COD mg/l) in Ogo Bolehole were below WHO standards with values in Ogbuku and Ugwuiyi far above the WHO standards.

Table 1. Physicochemical Properties of Main Drinking Water Sources in Amaozara Ozizza, Afikpo, Nigeria

Water parameter	Ogo Bolehole	Ogbuku	Ugwuiyi	WHO (2012)	NSDWQ (2007)
Colour	Colourless	Colourless	Colourless	Colourless	Colourless
Taste	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless
Odour	Odourless	Odourless	Odourless	Odourless	Odourless
Temperature (°C)	30.00±0.01	29.00±0.02	29.00±0.01	27-28	-
Conductivity (µs/cm)	0.03±0.01	0.02±0.00	0.03±0.01	250	100
TDS (mg/L)	0.02±0.00	0.01±0.00	0.02±0.00	500	500
pH	5.00±0.01	6.82±0.02*	6.30±0.01*	6.20-8.50	6.50-8.50
DO (mg/L)	0.71±0.00	0.55±0.00	0.13±0.00	Not specified	Not specified
Turbidity (FAU)	2.21±0.00	1.96±0.01	4.48±0.02	5	Not specified
COD (mg/L)	7.31±0.02	18.28±1.20*,[a]	29.52±1.11*,[a]	10	Not specified

TDS (mg/l)-Total dissolved solids, DO (mg/l)-Dissolved oxygen, COD (mg/l)-Chemical oxygen demand, FAU -Formazin Attenuation Units. *Significantly different vs Ogo Bolehole, [a]Significantly different vs WHO (2012).

Distribution of other chemical parameters of main drinking water sources in Amaozara Ozizza, Afikpo, Nigeria

The distribution of other chemical parameters of main drinking water sources in Amaozara Ozizza, Afikpo, Nigeria is presented in Table 2. The following chemical compounds $CaCO_3$, PO_4 (mg/L), SO_4 (mg/L), NO_3 (mg/L), NH_4 (mg/L) Cl^- (mg/L), Ca (mg/L), Mg (mg/L) and K (mg/L) were assessed in the three water bodies, and all chemical compounds were below the WHO and NISDWQ standards, the only exception was Mg (mg/L) which was higher than WHO and NISDWQ standards.

Table 2. Distribution of Other Chemical Parameters of Main Drinking Water Sources in Amaozara Ozizza, Afikpo, Nigeria

Water parameter	Ogo Bolehole	Ogbuku	Ugwuiyi	WHO (2012)	NSDWQ (2007)
Hardness ($CaCO_3$)	152.00±4.21	130.05±3.49*,[a,b,c,d]	140.25±3.10[a,*,d]	500	150
PO_4 (mg/L)	0.74±0.00	0.65±0.01	0.98±0.01	0.10	-
SO_4 (mg/L)	1.09±0.01	1.16±0.00	1.75±0.01	200	100
NO_3 (mg/L)	1.78±0.01	0.29±0.01	2.06±0.02	50	50
NH_4 (mg/L)	1.70±0.00	0.42±0.01*,[a,b]	2.72±0.01	0.10	-
Cl^- (mg/L)	61.16±2.21	58.50±1.57*,[a,b,c]	42.77±2.11*,[a,c]	200	-
Ca (mg/L)	38.09±2.10	30.09±2.11*,[a,b]	38.08±1.21	75.0	-
Mg (mg/L)	13.38±1.11	8.52±1.20	10.95±1.33	6.5	0.2
K (mg/L)	0.50±0.01	0.48±0.00	0.53±0.01	-	-

*Significantly different vs Ogo Bolehole, [a] Significantly different vs WHO (2012), [b]Significantly different vs Ugwuiyi, [d] Significantly different vs NSDWQ (2007), $CaCO_3$-Calioum trioxocarbonate (iv), PO_4 –Phosphate, SO_4-Sulphate, NO_3-Nitrate, NH_4-Ammonium, Cl^- Chloride, Calcium, Mg-Magnesium, K-Potassium

Metal composition of three main drinking water sources in Amaozara Ozizza, Afikpo, Nigeria

The metal composition of three main drinking water sources in Amaozara Ozizza, Afikpo, Nigeria is presented in Table

All the macro mineral elements had values below the WHO and NISDWQ standards. However, the amount of cadmium Cd (mg/L) 0.007 present in Ogo Bolehole was far above the WHO and NISDWQ standards.

Table 3. Metal Composition of Three Main Drinking Water Sources in Amaozara Ozizza, Afikpo, Nigeria

Water parameter	Ogo Bolehole	Ogbuku	Ugwuiyi	WHO (2012)	NSDWQ (2007)
Zn (mg/L)	0.03±0.00[a,d]	0.002±0.00[a,d]	0.008±0.00[a,d]	3.0	3.0
Ni (mg/L)	0.012±0.00	0.009±0.00	0.018±0.00	0.02	0.02
Mn (mg/L)	0.012±0.00[a,,b]	0.013±0.00[a,b]	0.135±0.01	0.2	-
Pb (mg/L)	0.006±0.00	0.008±0.00	0.007±0.00	0.01	0.01
Fe (mg/L)	0.053±0.00[a,b,d]	0.041±0.00	0.183±0.01[a,d]	0.30	0.30
Cu (mg/L)	0.094±0.00[a,d]	0.004±0.00[a,d]	0.084±0.00[a,d]	1.00	1.00
Cr (mg/L)	0.001±0.00	0.001±0.00	0.001±0.00	0.05	-
Cd (mg/L)	0.007±0.00	0.002±0.00	0.021±0.00	0.003	0.003

[a] Significantly different vs WHO (2012) [d] Significantly different vs NSDWQ (2007). [b]Significantly different vs Ugwuiyi. Zn-Zinc, Ni-Nickel, Mn-Manganese, Pb-Lead, Fe-Iron, Cu-Copper, Cr-Cromium, Cd-Cadmium

Bacteria obtained from water samples in Amaozara Ozizza Afikpo and their reactions in the chemicals used in identifying them

The Bacteria obtained from water samples in Amaozara Ozizza Afikpo and their reactions in the chemicals used in identifying them are presented in Table 4 *Escherichia coli, Vibrio cholera, Proteus spp* were detected inOgbuku while *Escherichia coli, Klebsiella spp ,Salmonella spp, Shigella spp* were detected in Ugwuiyi. The borehole showed a complete absence of the detected bacteria species.

Table 4. Bacteria Obtained from Water Samples in Amaozara Ozizza Afikpo and their Reactions in the Chemicals Used in Identifying them

Water Source	Colour On MacConkey Agar	Eosin methylate blue agar (EMB)	*Salmonella shigela* agar (SSA)	Thiosulfate citrate bile salts sucrose agar (TCBS)	Gram stain	Shape	Isolate
Ogo Bolehole	-	-	-	-	None present	-	No growth
Ogbuku	Pink gray	Deep metallic purple	pink	yellow	-ve	Rod	*Escherichia coli, Vibrio cholera, Proteus spp*
Ugwuiyi	Mucoid	Mucoid	-	-	-ve	Rod	*Escherichia coli, Klebsiella spp, Salmonella spp,Shigella spp*

Antibiotic susceptibility pattern of isolated bacteria

The antibiotic susceptibility pattern of isolated bacteria from the water bodies is shown in Table 5. The detected bacteria showed some level of sensitivity and resistance to specific antibiotics with no growth observed in Ogo Bolehole.

Table 5. Antibiotic Susceptibility Pattern of Isolated Bacteria

Water Source	Cefepime	Ceftriaxone	Amoxicillin clavulanic acid	Cloxacillin	Cefoxitin	Microorganism found
Ogo Bolehole	-	-	-	-	-	No growth
Ogbuku	S	R	S	R	S	*Escherichia coli, Vibrio cholera, Proteus spp*
Ugwuiyi	S	S	S	R	S	*Escherichia coli, Klebsiella spp, Salmonella spp, Shigella spp*

Key: S= Susceptible; R= Resistant

The antibiotic susceptibility result revealed that samples gotten from Ogbuku and Ugwuiyi Amaozara had 20% resistance to the different classes of antibiotics used in the study, whereas Ogo bolehole had no microorganism present.

Discussion

Water is one among the fundamental necessities of life. However, in developing countries people do not have ready access to an adequate and safe water supply especially those that live in rural areas. Diseases associated with contamination of portable water constitute a serious burden on human health. Therefore, interventions to improve the quality of drinking water provide significant benefits to health. In this study, the three drinking water sources in Amaozara Ozizza were investigated and values were compared with known standards.

The mean values of the physical and chemical parameters of samples from various water sources are shown in Table 1. Result of the physical characteristics of all the water samples analyzed showed that they were tasteless, odorless and colorless.

The temperature range of all the water samples were between 29-30^{o}C and this is above the World Health Organisation (WHO) range (27- 28^{o}C) (WHO, 2022). This could portend thermal pollution of the water samples. Water temperature is one among the foremost important physical characteristics of aquatic systems. As water temperature rises, the speed of photosynthesis increases, thereby providing adequate amounts of nutrients.

Conductivity values obtained were below WHO (WHO, 2012) and NISDWQ (NISDWQ, 2007) limits for drinking water (Table 1). Low electrical conductivity is an indication that the water samples have low amount of dissolved solid. The electrical conductivity of water is directly associated with the concentration of dissolved solids within the water which influence the power of that water to conduct an electrical current (EPA (Environmental Protection Agency) 2014). Result of this study corroborates with previous reports by other researchers (Abakpa et al., 2013; Ibiam et al., 2010).

pH values obtained in Ogo Bolehole and Ugwuiyi were 5.0 and 6.3, respectively, and these were below 6.5-8.5 range set by WHO (WHO, 2012) and NISDWQ (NISDWQ, 2007). However, Ogbuku recorded a pH value of 6.82 and hence within the WHO and NISDWQ approved limit. pH measures the acidic or basic nature of a solution (Kumar & Puri, 2012). Ample evidence suggests that at low pH, water can be corrosive and cause damage to equipment, since it can increase metal leaching from pipes and fixtures, such as copper and lead. Therefore, low pH values indirectly affect human health, since heavy metals released into the water from pipes can have adverse effects on people. Damaged metal pipes because of acidic pH values also can result in aesthetic problems, causing water to possess a metallic or sour taste (Pehkonen et al.,, 2002; Triantafyllidou et al., 2021).

Dissolved Oxygen (DO) measures the quantity of gaseous oxygen dissolved in a solution. Microorganisms such as bacteria, viruses and protozoa are domiciled in highly turbid water. Therefore, turbid waters can indirectly constitute a health issue. Also, high levels of turbidity can protect microorganisms from the effects of disinfection, giving rise to a significant chlorine demand and reducing the performance of some disinfection treatments (WHO, 2012). Thus, turbidity could be used to assess the microbiological quality and disinfection of water. In this study, turbidity values of Ogo bolehole, Ogbuku and Ugwuiyi were within WHO permissible limit (2.21, 1.96 and 4.48), respectively. The ideal turbidity should be below 5 NTU. However, the highest value observed in Ugwuiyi sample could be as a result of microbial contamination since it is an open surface and lack of disinfection of the water as well.

Our results also showed that $CaCO_3$ (total hardness) and SO_4 levels in Ogbuku and Ugwuiyi were within WHO ((WHO), 2022) and NISDWQ (NISDWQ, 2007) limits (Table 2). However, in Ogo Bolehole water, $CaCO_3$ was above levels recommended by NISDWQ. The PO_4^{3-} values reported exceeded the tolerable limits. A high concentration of PO_4^{3-} signifies the presence of contamination and is largely responsible for eutrophic conditions (WHO, 2006). Extremely high level of phosphate could lead to digestive problems (Kumar, 2012) .

Nitrate is the most highly oxidized kind of nitrogen and therefore the major sources of nitrates in drinkable water are runoff from fertilizer use, leakage from septic tanks, sewage, and erosion of natural deposits (EPA (Environmental Protection Agency) 2014). Consumption of water that contains excess nitrates could pose a major hazard to the consumers and is particularly a risk factor for developing many cancers (EPA (Environmental Protection Agency) 2014; Njeze, 2014). All the water samples tested had their nitrate level within acceptable limits of NISDWQ and WHO standards (50mg/l) (NISDWQ, 2007& WHO, 2012). However, the Environmental Protection Agency (EPA) of the United States of America set the maximum contaminant level (MCL) of nitrate in drinking water as10mg/l. All tested samples recorded nitrate levels far below this limit. Excess concentration of nitrate and nitrites can cause methemoglobinemia especially in infants (Kumar, 2012).

NH_4-N values recorded were 1.70, 0.2 and 2.72 for Ogo Bolehole, Ogbuku and Ugwuiyi, respectively. These values

are high when compared with the WHO and NISDWQ standards which is 0.10. High concentration of NH_4-N causes poor taste and odour of water and also is toxic to aquatic lives (WHO, 2006). High NH_4-N concentration could be due to domestic and public toilet waste water that is discharged directly into the water bodies. High NH_4-N portends deterioration of water quality. Therefore, adequate treatment techniques are advocated. Ogo Borehole had a low pH value below the WHO range and total hardness, phosphate, and nitrates values above the tolerable limits, also with high temperature as against the recommendation of WHO and NISDWQ. Large amounts of nitrates and phosphates may have entered the water system as a result of high agricultural runoff rates, indicating the occupation of the people of the area could be more of agriculture, since there was no indication of pathogenic microorganism present in the water body. This may have detrimental health effects on humans and other organism around the water body who depend on the borehole as a source of water (Pal, 2017).

The result of this study indicates that the levels of Zn, Ni, Mn, Pb, Fe, Cu and Cr in the test samples were within the recommended WHO (WHO, 2012) and NISDWQ of 2007 (NISDWQ 2007) standards (Table 3). However, water sample from Ugwuiyi recorded high level of Cd (0.021 mg/L) and this is higher than the recommended WHO 2012 report (WHO, 2012) and NISDWQ (NISDWQ, 2007) limits (0.003 mg/L). This signifies possible Cd contamination of this water source. Cd has been shown to impair many enzymes in animals. High level of Cd causes birth defects, osteomalacia in adults or rickets in children and impaired metabolism of Vitamin D while small Cd intake over many years may cause kidney, liver and blood damage and fragile bone (Nordberg and Kjeustrom, 1995).

Sources of heavy metal in drinking water could be either natural or activities of man (Izah et al., 2016; Tracy & Guo, 2020). Generally, in non-industrialized regions, the levels of most of the metals are very low and are mostly derived from the mineralogy and weathering of rocks (Macheyeki et al., 2020). Amaozara is a community surrounded by rocks and hills. Therefore, the source of the metals in these study locations could be from these rocks rather than human pollution.

Pb, Cd and Ni have been reported to produce major outbreaks of chronic disorders in humans (Tchounwou et al., 2012). Pb inhibits aminolevulinic acid dehydratase (ALA-D) and ferrochetase, two key enzymes involved in heme biosynthesis and hence could be a systemic poison. Inhibition of these two enzymes by Pb impairs heme synthesis.

Drinking water picks up Pb pollution from several sources like household paint, vehicle exhausts and industrial wastes. Pb builds up in the human body over many years (bioaccumulation) and can damage the brain, red blood cells, reproductive systems and kidneys (Rice et al., 2014 & Tchounwou et al., 2012).

Ni is essential in small quantities but can have adverse effects to human if taken in high quantity (Genchi, et al 2020). Ni toxicity is leads to inhibition of activities of some enzymes involved in vital physiological activities. Enzymes that require Ni include: cytochrome oxidase, malate dehydrogenase, succinate dehydrogenase and NADH-cytochrome C reductase (Yu, 2001; Lee, 2003). Ni intoxication also causes lung embolism, birth defects, respiratory failure, dizziness and chronic bronchitis (Anke, et al., 1995).

Mn level in Ugwuiyi was the highest (0.135 mg/L). This is within the WHO permissible limit of 0.2 mg/L. However, Mn concentration over 0.1 mg/L could have adverse impacts such as water coloration, metallic taste, odor problem, increased turbidity and corrosion, and staining of laundry and plumbing fixture. High Mn concentration in Ugwuiyi could be the cause of high turbidity level observed in this sample. Increased amounts of Mn may cause apathy, irritability, headache, insomnia, likewise gastrointestinal irritation and respiratory disorder (Dosi et al., 2013; Kim et al., 2017).

In the microbiological assessment of the water samples, the following microorganisms were present: *Escherichia coli, Vibrio cholera, Proteus spp in* Ogbuku *and Klebsiella spp, Salmonella spp, Shigella spp* in Ugwuiyi and none was isolated in Ogo borehole. The presence of these microorganisms in two of the water samples studied presents serious public health risk. It portends the possibility of gastrointestinal diseases, urinary tract infection, and neonatal meningitis to individuals that use these water sources especially children and individuals of low immune system.
E. coli is the traditional indicator of fecal pollution in aquatic ecosystems and determination reveals vital information regarding water quality(Rochelle-Newallet al., 2015). Other fecal coliform bacteria are *Klebsiella spp, Enterobacter spp* and *Citrobacter spp*. However, *E. coli* is the best predictor of fecal contamination (Nowicki , 2021). Samples from Ogbuku and Ugwuiyi showed presence of *E. coli*. Therefore, these water samples are completely unfit for

drinking purposes unless given proper treatment. The antibiotics susceptibility result revealed that organisms isolated from Ogbuku and Ugwuiyi Amaozara had 20 % resistance to the different classes of antibiotics used in the study. This study is in agreement with the work done by Schechner *et al*. (2013), who recorded minimal amount of resistance to antibiotics used in their study. This could be as a result of less usage of antibiotics by people residing in these locations.

CONCLUSION

The conclusion of this study indicate that majority of the parameters studied (Physicochemical properties and Metal composition) did not exceed the permissible limit of set standards. However, some parameters that deviated from set standards such as COD, turbidity, PO_4 and NH_4 were noted these parameters can be improved by adequate water treatment. There was no growth of pathogenic microorganisms in Ogo Borehole water but the presence of pathogenic microorganisms like *Escherichia coli, Vibrio cholera, Proteus spp, Klebsiella spp, Salmonella spp, and Shigella spp* was found in Ogbuku and Ugwu water sources. Since the presence of these pathogenic microorganisms portends fecal pollution. We therefore wish to draw the attention of public health organizations to the result of this investigation. Since lack of good drinking water and proper sewage disposal drive people to sort for alternative and less safe sources. Provision of adequate sewage disposal outlets and good drinking water to inhabitants of Amaozara Ozizza is of utmost importance so as to avert epidemic of water related diseases.

AUTHORS' CONTRIBUTIONS

EUA, and DEU conceived and design the study, VMA, OUO, NNE and OPU carried out the laboratory analysis and literature searches, IB, WAO, and MOI wrote the initial draft of the manuscript, EUA and DEU read and edited the final draft of the manuscript for intellectual content. All authors read and approved the final draft of the manuscript for publication

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CONFLICT OF INTEREST

None

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