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Physicochemical and Bacteriological Assessment of EZU River

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ABSTRACT: *The work is aimed at obtaining useful physicochemical and bacteriological properties of surface water sample from Ezu River in Amansea village of Anambra state, Nigeria which will directly inform the choice of an optimum treatment approach. Similarly, the general water quality standard of the sample was established via the information obtained from the analytical and parametric evaluation of the sample surface water properties. The analytical properties of the water sample considered are; the aesthetic (non-health related) parameters (like, colour, turbidity and temperature), physical parameters (like, total dissolved solids, total suspended solids, total solid, pH, alkalinity, hardness, and conductivity) and chemical parameters (like, chloride, sulphate, nitrate, cadmium, copper, magnesium, zinc and phosphate concentrations). The result showed that in most cases, the obtained parametric values fell within the WHO permissible limit for potable water. Similarly, the bacteriological assessment results attest to the presence of various microorganisms in the water sample, with Pseudomonas aeruginosahaving the highest frequency of occurrence (about 68.8%). Hence, the study highlights the potential health risk associated with the use of Ezu River, especially to the rural communities with great dependence on the River for their daily water needs.*

Key words: *Bacteriological assessment, Ezu-River, turbidity, Physicochemical and Bacteriological study,*

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I. INTRODUCTION

Every living organism on earth requires clean and quality water for their existence; hence water is considered an important resource for life(Umedum et al.,2013). However, among all the available water sources, surface waters remain the most accessible and widely used for several purposes (Okoye and Nyiakagha,2009). According to Hendrawati, et al., (2016),surface water is any water that collects on the surface of the earth and they include; oceans, seas, lakes, rivers, or wetlands. Generally, rivers and oceans are the predominant fresh water sources and they contribute about 97% of the earth's total water resources, while the remaining 3% is considered to be underground water(Haliru et al.,2014). Due to the high demand for fresh water sources occasioned by the ever increasing global population, many countries of the world (especially developing countries) are experiencing growing freshwater stress and scarcity.According to the projection by Comprehensive Assessment of Water Management in agriculture (2007), the population of people living in water – stressed and water – scarce countries will grow to about 4.0 billion (44% of the world Population) by the year 2050.

The issue of water scarcity is further heightened by the incessant and rapid contamination of the already stressed fresh water sources(Aniagor and Menkiti,2018). Considering the fact that surface waters are open to the environment, the incidence of their contamination by human and animal activities is usually very high. Similarly, their quality may also change significantly with the weather (storms or heavy rain). Human activities like indiscriminate discharge of untreated waste from process industries and municipal waste into water bodies, poor drainage system, population increase and rapid urbanization; as well as river bank erosion are some of the prominent factors that compromise the surface water quality (Hossain, 2009). Recent study has shown that water sample from most riversare capable of endangering human health and could also poison the surrounding ecosystem; due to their high level of pollution and depletion(IPS, 1999).

Meanwhile, the quality requirements of water sourcessuitable for human usage (either for drinking, irrigation, recreation and industrial processes) are factored in the physicochemicaland bacteriological properties of such water (Maitera, et al., 2010). Umedum et al.,(2013) conducted the physicochemical analysis of five rivers in Warri, Delta state of Nigeria. The parameters determined include colour, odour, total dissolved solids, total suspended solids, dissolved oxygen, pH, alkalinity, hardness, temperature, conductivity, turbidity, chloride, sulphate, nitrate, iron, copper, manganese, arsenic. The research findings showed that most of the parameters analyzed fell within WHO permissible limit for potable water in the samples. Salim, et al., (2014) analyzed the physicochemical properties of surface and ground water from Karrary locality, Omdurman, Sudan. The properties evaluated are temperature, pH, total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), calcium, magnesium, chloride, iron, nitrate, nitrite and fluoride. Meanwhile, the findings showed that all the physicochemical properties fell within permissible standard for WHO, except the total hardness. Adejuwon and Adelakun, (2012) examined the physiochemical and bacteriological properties of selected surface water in Ewekoro Local Government Area of Ogun State, Nigeria. The findings showed that the values obtained for total alkalinity, total hardness, calcium, nitrate and calcium carbonate were above maximum permissible limit for World Health Organization (WHO). Similarly, *Escherichia coli* were found to be present in all the rivers; while, *salmonella* growth was not detected in any of the water samples.

Amansea is a moderately populated area which is about 30 km from Awka capital territory, Anambra state of Nigeria. It has a population range of 40,000 and 60,000 people(Mbah, et al., 2016). The town is located between Latitude: 6° 12' 45.68" N and Longitude: 7° 04' 19.16" E. It is bounded by towns and a river (Ezu River). The terrain of Amansea community is majorly upland with the aquifer layer buried deep inside the ground. This situation make the sinking of borehole very unpopular, as heavy machineries (which requires huge funding) will be required. Such trend compelsthe locals inhabiting the farm settlement in the area and the nomads to rely heavily on the available surface water (Ezu River) for their daily water need; as well as for their animal consumption(Egereonu, 2003). It is therefore plausible to ascertain the quality standard of Ezu River as a proactive measure towards mitigating the spread of water borne diseases. According to WHO report, an estimated 80% of all diseases and illnesses stems from inadequate sanitation and polluted water(Yongabi et al.,2012).Therefore, the research was conducted to evaluate the physicochemical and bacteriological quality of Ezu River. This research work is imperative as it hopes to sustain far reaching positive effect, not only to the locals who consume the water but also the general public who may get infected via the consumption of meat from infested livestocks; considering the fact that majority of the beefs consumed in Anambra state originated from the area.

II. MATERIALS AND METHODS

2.1. Collection of water samples

The water samples were obtained from five different locations along the Ezu River. Strategic sampling was carried out before collection so as to obtain true representation of the area under study. The aesthetic (non-health related) parameters like, colour, turbidity and temperature (using thermometer) were performed on-site at the sample collection point along the Ezu River. Afterwards, the collected water sample was then transferred into one liter plastic container which have been previously washed, rinsed with deionised water, and labeled properly for easy identification. Furthermore, the bacteriological analysis of the sample was conducted within 24 h of collection.

2.2. Preservation and storage of samples

Due to the uncontrollable changes occurring in a given water sample, collected sample was transported to the Civil Engineering Laboratory of Nnamdi Azikiwe University, Awka, were relevant physicochemical analyses were conducted as promptly as possible. Meanwhile, the sub-samples meant for metal ion analysis (which could not commence immediately) were stored at 4°C or relevant preservative were added depending on the parameter to be determined and duration of preservation.

2.3. Analytical methods

I. Determination of pH and Temperature

The sample pH was determined using digital pH meter while it's temperature was simultaneously obtained from the meter printer of the digital pH meter.

II. Determination of Conductivity

The procedure for determining conductivity has been described by Gains (1993) and Greenberg et al.,(1992). A conductometer was used to obtain the conductivity of the water samples.

III. Determination of Alkalinity

This was obtained by titrimetry as described by Larson and Henley, (1973).The samples were titrated with standard solutions of acid. All reagents used were of analytical grade.

IV. Determination of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)
The total suspended solids in the water samples were obtained by the method described by Ikomi and Enuh, (2000).The TDS was by gravimetry as described by Franson, (1978).

V. Determination of Dissolved Oxygen (DO)
Dissolved oxygen was analyzed using a Jenway dissolved oxygen meter (Model 970).

VI. Determination of Ions (anions and cations)
The chloride, phosphate and sulphate (Cl^- , PO_4^{2-}, SO_4^{2-}) content were determined as described by Franson, (1978). Similarly, nitrate (NO_3^{2-}), zinc, copper, magnesium, lead and cadmium concentrations were determined using the method described by APHA, (1976).

VII Bacteriological quality assessment
The bacteriological quality assessment of the water sample was carried out using five tube most probable number technique as describe by APHA, (1980). Meanwhile, the microorganisms (*Escherichia coli, Klebsiella spp, Entrobacter Spp, Salmonella spp, Serratia spp, Pseudomonas aeruginosa, and S. aureus*) were identified and characterized based on their colonial morphology and gram stain reaction. Similarly, some key biochemical tests (such as catalase, coagulase, motility, indole, and oxidase tests were conducted on the microorganism isolates according to recommendations by Ahoyo, et al., (2011).The test for total viable count (TVC), total coliform counts (TCC) and total faecal coliform count (FCC) of the sample was conducted via the procedure documented by Ihuma et al., (2016).

III. RESULTS AND DISCUSSION

The aesthetic parameters together with the World Health Organization (WHO) permissible limits were presented in Table 1. According to WHO guideline (2011), a particular water sample is considered safe if the concentration of undesired substances do not exceed the WHO safe limit. Meanwhile, the physical/visual observation of the water sample showed a characteristics light-yellowish colour. The presence of suspended and dissolved particles could be the probable cause of the observed colour. Similarly, the water sample was relatively turbid at 240.3 NTU; a value which is above WHO safe limit. Since turbidity refers to the clarity of a given water sample, the large amount of total suspended solids (TSS) observed in the study (510 mg/L) could have contributed to the murky nature of the water and the measured high turbidity level. However, it is worthy of note that the increased TSS value could have existed due to the presence of phytoplankton, particulate (like clay and silts from shoreline erosion), re-suspended bottom sediments, increased flow rate, floods and movement of fish in the water body.Also, it is obvious from Table 1 that the on-site temperature of the water sample was in tandem with the WHO safe limit.

Table 1: Aesthetic (non-health related) parameters

	Test	Value obtained	WHO Safe Limit
1.	Colour	500 (Light yellow)	6
2.	Turbidity (NTU	240.3	5
3.	Temperature (^0C)	30^0	30^0

Table 2 presents the analytical values obtained for selected physical parameters. The pH 7.9 obtained in this study falls within the WHO safe limit. Okieimen et al.,(2012)reported that a highly acidic or alkaline water body cannot support fish life. Also, in the presence of high level acidity or alkalinity, the toxicity of certain inorganic pollutants (ammonia, hydrogen sulphide and cyanide) is greatly influenced (Eboatu and Okonkwo, 1999). Therefore, the pH 7.9 obtained in this study is considered acceptable.

Also from Table 2, it is seen that the electrical conductivity of the sample was 38µS/cm, while the total dissolved solid was 130 mg/L. Incidentally; both values fall within the range of WHO safe limit. Electrical conductivity value is an important parameter in determining the nature of the water body (whether fresh or marine) and it is related to the total dissolved solid (TDS) in a sample.According to Okieimen, et al., (2012), a water sample could be regarded as freshwater (if its electrical conductivity value is below 1000µS/cm), marine water (if its electrical conductivity value is above 40,000µS/cm) and as brackish water (if its electrical conductivity value is between 1000 and 40,000µS/cm).The electrical conductivity value of Ezu river is 38 µS/cm (which is below 1000 µS/cm); hence one would conveniently submit that Ezu River is a fresh water source. It should be noted that although the obtained electrical conductivity and TDS values did not exceed WHO safe limit, they were still relatively high. Hence, it will be plausible to further reduce their respective concentrations; as high conductivity and elevated dissolved solids could limit the applicability of the water for industrial, agricultural and domestic purposes.

Total solids (TS) and total suspended solids (TSS) value of 640 mg/L and 510 mg/L, respectively was obtained in the study as shown in Table 2. These valueswere relatively higher than the stipulated WHO safe limit; thus could portend negative environmental impact on aquatic life and humans. The concern on environmental impact of TS and TSS is fueled by the fact that some of the suspended solids may contain very toxic and carcinogenic metals (like mercury, arsenic, cadmium, chromium, cobalt, lead and zinc) which could endanger aquatic and human health if ingested. Also, the decomposition of some of the suspended solids may give rise to unpleasant odour; thus serving as breeding ground for disease-causing microorganisms(Umedum, et al., 2013).

The alkalinity value obtained from the study (22 mg/L) was below the WHO safe limit; thus it is acceptable. The buffering capacity of any water system depends on its alkalinity value and any compromise to the buffering capacity of a given water system could result in significant pH changes(Umedum, et al., 2013). Such significant pH change could spell disaster for aquatic life; as well as impactthe distribution of biotic factors within the aquatic system.

A total hardness of 0.84 mg/L was obtained in the study (Table 2) and this value is well below the WHO safe limit. Hardness is most commonly associated with the ability of water to precipitate soap and it is commonly reported as the sum of carbonate and non-carbonate hardness. Although calcium ion (Ca^{2+}) and magnesium ion (Mg^{2+}) are the prevalent hardness-causing cation in fresh water, other cations (like iron (Fe^{2+}), strontium (Sr^{2+}) et. c) may also constitute hardness in water (American Public Health Association (APHA), et al., 1976).

Table 2: Some physical parameters

	Test	Value obtained	WHO Limit
1.	pH	7.9	6.5-9.2
2.	Conductivity (µs/cm)	38	8-1000
3.	Total dissolved solid (mg/L)	130	1200
4.	Total suspended solid (mg/L)	510	<30
5.	Total solid (mg/L)	640	500
6.	Alkalinity (mg/L)	22	50
7.	Total hardness (mg/L)	0.84	500

The total chloride was 33.4 mg/L and such value falls below the WHO safe standard as shown in Table 3. This result is acceptable considering the fact that recent study by Okieimen et al.,(2012) noted the carcinogenic potentials of chlorine as it forms compounds such as tetrachloromethane (TCM) which produces hormonal analogue on exposure to humans. Also, high chloride concentration in a given watersample can render such water unpalatable and non-portable. Similarly, the obtained value for sulphate concentration was much lower than the WHO limit (Table 3). The observed sulphate concentration level is acceptable because high sulphate content in water impacts unfavorable taste; as well as exerts a laxative effect when the concentration is over 1000mg/L(Okieimen, et al., 2012). The nitrate content for the water sample was negligible compared to WHO limit. This result is acceptable as high concentration of nitrate ion in water is not desirable (especially for infants) because it can cause methaemoglobinaemia. There are no stipulated WHO safe limits for zinc, ammonia and phosphate; hence the effective comparison of their values could not be executed. The concentrations of copper (Cu), lead (Pb) and cadmium (Cd) were negligible and barely detected as shown in Table 3.

Table 3: Some chemical parameters

	Parameter	Value obtained	WHO standard
1.	Nitrate (mg/L)	7.041	50.0
2.	Sulphate (mg/L)	4.432	500
3.	Ammonia (mg/L)	4.2	-
4.	Chloride (mg/L)	33.4	250
5.	Phosphate (mg/L)	3.868	-
6.	Magnesium (mg/L)	5.213	6.5
7.	Zinc (mg/L)	8.923	-
8.	Copper (mg/L)	0.357	2.0
9.	Lead (mg/L)	0.152	-
10	Cadmium (mg/L)	0.198	-

IV. BACTERIOLOGICAL ASSESSMENT

Table 4 presented the water sample microbial characterization and activity result obtained using 16 different microbial activities testing in order to investigate the possible existence of such activities in the suspected micro-organism. From the result obtained, the presence of bacterial contaminants was pronounced. It was however observed that glucose, maltose, lactose, sucrose, monnitol and catalose test was predominantly positive (+) in almost all the suspected micro-organisms with only very few exception. Similarly, oxidase, indole and gram stain test were predominantly negative (-) for all the suspected micro-organism with the exception of few. Table 4 also provided clear indications on the probable morphology of these micro-organisms. It could be clearly seen that only ***Staphylococcus** aureus* possessed a divergent morphology (cocci) but the rest organism had rod like morphology. Furthermore, *Pseudomonas aeruginosa*had the highest frequency (about 68.8%) of bacteria isolated from the water followed by *Staphylococcusaurueus* (62.5 %). The other microorganisms detected in the water showed about 50 % occurrence. These high values were contrary to the WHO guideline for safe water (WHO, 2006). However, the high level presence of these microorganisms, especially *E. coli* bacteria indicates high contamination of faecal waste, whichmay have been washed into Ezu River. According to WHO (1985)guideline for untreated and non chlorinated supplies, the detection of faecal coliform alone can generally serve as an adequate guide for determining whether pathogenic organisms are present in the water. This finding was in tandem with earlier report by Ihuma, et al., (2016) and May, et al., (2013) on the bacteriological make-up of selected Nigeria.

Similarly, the total viable count (TVC) of 6.4×10^7 cfu/mL obtained for the study exceeded the World Health Organization (WHO) standard (of not be more than 100 cfu/mL) in potable water (WHO, 2006). Similarly, the high total coliform count (3.5×10^5 cfu/mL) and faecal (1.8×10^4 cfu/mL) contamination values obtained in the study does not conform to the WHO and EPA (Environmental Protection Agency) standard (zero total coliform and total faecal per 100 mL of drinking water or water to be used in irrigation of any food crops to be consumed raw) (Cheesbrough, 2000). The high faecal and coliform contamination on Ezu River poses serious health concerns to the surrounding communities whose depends on the River for their daily water needs. According to Chessbrough, (2000), the occurrence of high coliform counts in any water sample is an indication of high faecal contamination.

Table 4: Isolation and characterization of microorganisms in water sample

RESULTS																	
Morphology	Gram stain	Urease	Methyl Red	Indole	V – P	Chrate	Catalase	Oxidase	Coagolase	Spore	Motility	Glucose	Maltose	Lactose	Sucrose	Monnitol	Suspected Organism
Rods	-	-	+	+	-	-	+	-	-	ND	+	+	-	+	+	+	*E.Coli*
Rods	-	-	-	-	+	+	+	-	-	ND	-	+	+	+	+	+	*Enterobaceter*
Cocci	+	+	+	-	-	-	+	-	+	-	-	+	+	+	+	+	*Aureus*
Rods	+	-	ND	-	ND	-	-	-	ND	+	-	+	+	+	+	+	*Bacillus Spp*
Rods	-	+	-	-	+	+	+	-	-	ND	-	+	-	-	-	-	*Klebsil Spp*
Rods	-	-	+	+	-	+	+	+	-	-	+	+	+	+	+	+	*Pseudomonas Spp*
Rods	-	-	-	-	+	+	-	-	ND	ND	+	+	+	+	+	+	*Serratia Spp*
Rods	-	-	-	-	+	-	+	-	ND	ND	+	+	+	-	-	+	*Salmonella Spp*
For *Salmonella* on triple Iron Sugar Agar																	
Slope	Butt			H_2S			Gas					Suspected					
Red	Yellow			+			+					*Salmonella Spp*					

Key:
+ = Positive
Yellow – Acid Reaction
- = Negative
ND = Not Done
H_2S= Hydrogen Sulphide (Blackening)
Rod = Alkaline Reaction

V. CONCLUSION

The concentration level of the various physical and chemical parameters analyzed in the present study fell within the WHO permissible limit with few exceptions. The exceptions were observed in the case of turbidity, total solid (TS), total suspended solid (TSS) and total dissolved solid (TDS) where the values obtained were higher than the WHO safe limit. Similarly, due to the carcinogenic nature of the chloride ion; special care must be taken in handling them in any given water sample. Hence, despite the fact that their concentration in the sample studied fell below the WHO limit, they were still considered to be high.Heavy metal presence in the sample was very negligible.The bacteriological assessment analysis of Ezu River indicates high microbial occurrence; thus suggesting that the water requires further purification and treatments.

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