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Physicochemical and Bacteriological Assessment of Mini-Owhua Stream in Ibaa Community, Emohua LGA, Rivers State

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Abstract
The mini-Owhua stream in the Ibaa village was studied for its physicochemical and bacteriological properties. Station A: Mini-Owhua, Station B: Mini-Aliewechenta, and Station C: mini-Nku streams were sampled using sterile sample bottles and promptly transported to the microbiology and chemistry labs at Rivers State University within one day. A conductivity meter was used to test salinity, a spectrophotometer at 550 nm to detect turbidity, a mercury thermometer to measure temperature, and a Philips model of Pw8412 pH meter to measure pH for the physicochemical qualities. The spread plate technique was used for the bacteriological analysis. With the exception of turbidity, which was slightly higher than acceptable standards at 11–15 NTU, all of the other physicochemical parameters were found to be within the typical allowable range: pH (6.34–7.2), temperature (26.2–27.100C), and salinity (0.16-0.41ppt). In addition, the coliform count varied between 1.0 x 10^2 and 2.6 x 10^2 cfu/ml, while the bacteriological burden was between 1.0 x 10^2 and 3.1 x 10^2 cfu/ml. Staphylococcus aureus, Streptococcus pneumonia, Enterococcus faecalis, Clostridium perfringens, Salmonella enterica, Vibro Cholerae, Pseudomonas aeruginosa, Enterobacter cloacae, Klebsiella pneumonia, and Escherichia coli were among the ten bacterial taxa that were discovered. The least prevalent kind of bacteria was Staphylococcus sp., with E. coli appearing 20% of the time. The World Health Organization has established a bacteriological purity standard of 0 cells per 100 ml, which the mini-owhua stream does not fulfill. If the people of the Ibaa village drink the water straight from the stream, they might be putting themselves at risk. We are requesting that government agencies, private organizations, and wealthy individuals take immediate action to raise public awareness and provide a reliable alternate water source.

Keywords: Mini-owhua, Stream, Bacteriological, Physicochemical, Coliform

Introduction

Water may exist in three different states: gas, liquid, and solid, and it is composed of the chemical elements hydrogen and oxygen. It is a chemical that is both plentiful and significant, according to Singh et al. (2023). Water has the remarkable property of melting a wide variety of other substances, in addition to being a colorless, odorless, and tasteless liquid at room temperature. The majority of the mass of living cells is water, which is also known as the matrix of life (Ramsey, 2023). Water as a resource is becoming more unsuitable for the wide range of demands placed on contemporary society. Water is both a ubiquitous solvent and a vector for infectious diseases that pose serious threats to human health (Janik et al., 2020). Typhoid and paratyphoid fever, dysentery, cholera, polio, and infectious hepatitis are among the watery illnesses that are prevalent in tropical regions (Steffen et al., 2023).According to Singh et al. (2023), the recommendations produced by the World Health Organization (WHO) serve as the foundation for regulation and standard setting on a global scale regarding water quality and human health. Advocating for the adoption of locally suitable norms and regulations, the recommendations for drinking water quality support the preservation of public health. Since publishing the worldwide guidelines for drinking water in 1958, WHO has consistently specified water quality.

As a result of rising populations, there is a greater need for potable water. According to Mustapha et al. (2021), almost half of Nigerians have a severe lack of access to safe drinking water, putting an additional 80 million people at danger. Ponds, streams, rivers (surface water), boreholes, and shallow wells (groundwater) are some of the many sources of water that people rely on for a variety of uses, including household and drinking water. Proper compliance with WHO and SON regulations is necessary for fresh water to be deemed safe for human consumption. The standards of water quality in Nigeria for drinking purposes are approved by SON, the regulating authority. Despite this, groundwater accounts for 24% of the world's fresh water, glaciers and ice caps for 75%, and lakes, rivers, and soils for 1% (Mishra, 2023). The most common sources of fresh water—lakes, streams, rivers, wells, taps, boreholes, etc.—are also necessary for various household, industrial, and agricultural uses.

Several elements determine the water's quality, including the concentration of dissolved oxygen, the levels of bacteria, the salinity, and the turbidity, or the quantity of suspended debris. Water quality may be assessed in certain bodies of water by measuring the concentration of tiny algae as well as the quantity of toxins such as pesticides, herbicides, heavy metals, and others (Shahi et al., 2023). Ecosystems are vulnerable to the negative effects of water pollution. Any naturally occurring body of water with a moving water surface, such as a river, stream, creek, or ditch, is considered a stream under the Clean Water Rule (2015) (EPA, 2015). According to Abu and Wondikom (2018), water is able to flow freely through the bottom of streams because stream soils often consist of several porous layers. Discharge of effluents from different businesses, household trash, land and agricultural drainage, and other sources may alter the water quality of streams in a negative way.

Water quality is indicated by physicochemical parameters, which impact aquatic life and its appropriateness for different purposes (WHO, 2017; APHA, 2017). Temperature, dissolved oxygen (DO), turbidity, nutrition levels (nitrates, phosphates), and biochemical oxygen demand (BOD) are important factors. Adeyemo et al. (2018), Ogbonna and Amangabara (2017), and Ikhajiagbe et al. (2020) all agree that changes in these parameters are typical indicators of pollution and have the potential to disrupt ecological equilibrium.

- The pH level is important for both aquatic life and chemical reactions; a range of 6.5 to 8.5 is generally considered to be ecologically appropriate (APHA, 2017).
- Oxygen in solution (DO): An indicator of organic contamination, low DO levels are necessary for aerobic life (Chapman, 1996, as referenced in Ogbonna &Amangabara, 2017).
- The rate of metabolism and the solubility of gases, such as oxygen, are affected by temperature of the water (Yahaya et al., 2021).According to Okanlawon et al. (2024), turbidity is a measure of how well light can penetrate water and how aquatic environments are affected by suspended particles.
- Nutrients: When levels of nitrates and phosphates are too high, it leads to eutrophication and the proliferation of algae blooms (Smith et al., 1999).

The physicochemical characteristics of water bodies in Nigeria have been studied and found to differ. Ikhajiagbe et al. (2020) found that pH, turbidity, temperature, nutrient levels, conductivity, and biological oxygen demand (BOD) all had an effect on the water quality index values in the Osse River. Similarly, characteristics like as pH (7.6-7.8) and EC (18400-22700µS/cm) were shown to impact overall quality in the Mgbuodohia River evaluations (Ideriah et al., 2020). Temperature and pH were found to be within the World Health Organization's guidelines in the River Argungu assessed by Yahaya et al. (2021), whereas turbidity and biological oxygen demand (BOD) were found to be above normal.
Based on their investigation into the groundwater quality evaluation along Air-port Road in the Obio/Akpor Local Government Area, Nwankwo et al. (2023) found that the water had a low pH and a moderate acidic to alkaline pH as a result of bicarbonate dissociation. When determining the safety of water in relation to pathogens that suggest fecal contamination, bacteriological testing is essential. Potential health hazards are indicated by indicators such as total coliforms and *Escherichia coli* (*E. coli*) (WHO, 2017; APHA, 2017). According to Edberg et al. (2000), coliform bacteria may be a sign of fecal contamination and the potential presence of pathogens.

"*E. coli*" is a specific sign of fecal contamination and the presence of this microbe indicates potential health risks (APHA, 2017).

Diseases caused by waterborne microorganisms, such as cholera and diarrhea, pose a hazard to public health (WHO, 2017).

Odeyemi et al. (2023) found that total coliform counts indicate pollution hazards in Ekiti State streams, which have been analyzed for bacteria such as *Staphyloccocus, Pseudomonas, Escherichia, and Klebsiella.* Similarly, concerns about bacteriology were highlighted by Okanlawon et al., (2024), who discovered heterotrophic plate counts as high as 3.81×10^6 in River Obazagbon, along with isolates such as *Bacillus cereus* and *E. coli*. Based on their findings, the bacteriological analysis was deemed unacceptable by Garcia-Cuerva et al. (2018), who conducted a similar research on water quality evaluation in selected Obio/Akpor communities. All of the water samples showed moderate to heavy bacterial growth, rendering the water unfit for human consumption. In a related study of Obio/Akpor groundwater throughout the rainy and dry seasons, Nwaogazie et al. (2018) investigated the groundwater quality index using sensitivity analysis, the research contrasted the Choba, Ekini, and Ozuoba populations. The findings showed that Choba and Ozuoba have very bad water with high load of microbes.

In another research, forty percent of the samples tested positive for total coliform bacteria, which could be due to faulty borehole construction or contamination of storage tanks, as demonstrated by Ugbaja and Otokunefor (2015) on bacteriological and physicochemical analysis of groundwater in chosen communities in Obio/Akpor. The Millennium Declaration, adopted by the UN in 2000, established a target date of 2015 to cut in half the number of people without access to clean drinking water (WHO/UNICEF, 2015). According to Al-Hazmi et al. (2023), in order for water to be considered safe to drink, it must not only be desiccated, odorless, tasteless, and visually appealing, but it must also be available in sufficient quantities for household use. Additionally, it must not contain any pathogens, such as viruses, bacteria, or protozoan parasites. The lack of access to microbiologically clean drinking water and the prevalence of diarrhea disorders are both caused by insufficient sanitation and the chronic pollution of water sources by human waste (WHO/UNICEF, 2015). The quality of water in bodies of water in Nigeria is affected by several physicochemical and bacteriological characteristics as reviewed in this literature.

According to Yahaya et al. (2021) and Adeyemo et al. (2018), the quality of the water bodies in Nigeria is compromised majorly by human activity, including agricultural runoff and domestic/industrial trash. Additionally, parameter levels, like turbidity, pH, salinity, temperature and nutrient loading, may be impacted by seasonal fluctuations, including the wet/dry seasons (Ogbonna &Amangabara, 2017). Hence, damage to ecosystems, species variety, and human health may result from water that isn't up to par. Waterborne infections are more likely to occur in areas where water supplies are contaminated (WHO, 2017). Targeted actions for water resource management may be facilitated by understanding physicochemical and bacteriological characteristics. On the fringes of the Ibaa Clan, close to the wicked woodland where the bodies of bad men and women are often interred, you'll find the Mini-Owhua stream. A large amount of human waste, including excrement, garbage, fertilizers, pesticides, and rubbish, is dumped into the Mini-Owhua stream, which poses a threat to human health. Ibaa community, Emohua Local Government Area, Rivers State, Nigeria, is home to Mini-Owhua Stream, so researchers set out to learn everything they could about the stream's chemistry and microbiology. They wanted to know things like the stream's pH, temperature, turbidity, and salinity, as well as the numbers of total heterotrophic bacteria, Vibro bacteria, and fecal coliform bacteria.

Materials and Methods

Study Area

There has been and continues to be untreated usage of Mini-Owhua Stream, a fast-flowing, unidirectional stream, for residential uses such as drinking, bathing, and more. The variety of life forms seen in and near streams suggests that these natural water sources may be home to a diverse array of microbes. Just outside of Ibaa Clan is where you'll find it. The water supply for more than 10,000 people is guaranteed by the stream.

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Map of Ibaa Showing the Study Area

Source: Adapted from History of Ibaa book and modified by researcher

Sampling Area

A consistent representation of the sample region was achieved by mapping three sites. Here were the stations: Ogbelegba settlement is home to the Mini-Omuodu Stream, which is covered by Station A.The Ogbelegba people rely on it heavily as a water supply. This station covers the water body in Ngbogizi village, the Aliwechenta Stream, which runs unidirectionally downstream to the next village in the community (Station B). People living in Ngbogizi village rely on it as a primary water supply. A water body located in Mgbere village is drained by station C, the Mgbere Stream. The locals call this section of the watercourse Mini-Nku. Since it is surface water, the stream is probably susceptible to pollution from a variety of sources.

Collection of Sample for Bacteriological Analysis

The liquid methodology for sample collection was based on the shoreline sampling premise outlined by Milne (2013). Between 10 and 11 in the morning, researchers waded out to a depth of just above knees to gather samples from 20 to 30 centimeters below the water's surface. For this experiment, we utilized sterile 250 ml bottles by grasping the bottom of the bottle and lowering it three to five centimeters below the water's surface. We then allowed the bottle to fill up, corked it while it was still submerged, and brought it to the surface (APHA, 2013). Within one day of collection, the samples were sent to the microbiology lab at Rivers State University for examination.

For the physicochemical analysis, we followed the usual protocols for measuring temperature, turbidity, and pH (Njoku et. al., 2015). A mercury thermometer was used for temperature measurement, and a Phillips model of PW 9418 pH meter was used for pH measurement of each water sample. At 555 nm, a spectrophotometer was used to detect turbidity, and at room temperature, the Hach conductivity meter, Model, was used to assess salinity.

The total aerobic heterotrophic bacterial (THB) population was counted by plating 0.1 ml aliquot of each dilution onto duplicate sets of nutrient agar using the spread plate method after the stream water was serially diluted tenfold with physiological saline up to 10-5. This process was followed by the isolation of potential bacterial pathogens. To see if any Staphylococcus species or lactose fermenting enteric bacteria were present, portions of the diluted water samples were also spread out on MSA and MCA plates, respectively. The plates that were infected were kept at 37ºC for 24 hours. Following the manufacturer's instructions, Salmonella/Shigella agar was used to isolate the two bacteria. The water samples were also enriched with selenite F broth before 0.1 ml of the sample was spread out on SSA plates and incubated at 37ºC for 24 hours. Purified bacterial isolates were studied and identified by analyzing their motility, microscopic shape, colonial shape, and metabolic profile according to established protocols.

Results

Table 1. Result showing the physicochemical parameter of the three stations across Mini-Owhua stream

	Physicochemical Characteristics			
Sample sources	pH	Temperature(^{0}C)	Turbidity (NTU)	Salinity (ppt)
AU	7.23	26.9	11	0.41
AD	7.12	26.4	13	0.39
BU	6.41	27.1	15	0.36
BD	6.56	26.8	12	0.34
CU	6,96	26.2	14	0.28
CD	6.34	26.5	13	0.16

Table 2: Result showing the Total Heterotrophic Bacteria (THB) count, Vibro count and Fecal coliform count of the water sample from the three stations across Mini-Owhua stream.

Sample source	THBC (cfu/ml)	Vibro Count (cfu/ml)	FCB (cfu/ml)
AU	2.0 x 10^2	2.3 x 10^2	1.3 x 10^2
AD	1.5 x 10^2	1.2 x 10^2	2.1 x 10^2
BU	1.0 x 10^2	2.0 x 10^2	2.6 x 10^2
BD	1.9 x 10^2	1.3 x 10^2	1.4 x 10^2
CU	1.1 x 10^2	1.7 x 10^2	1.9 x 10^2
CD	1.2 x 10^2	3.1 x 10^2	1.0 x 10^2

Key: AU- Station A, upstream, AD- Station A, downstream, BU- Station B, Upstream, BD- Station B, Downstream, CU- Station C, Upstream, CD- Station C, Downstream

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Table 3: Result showing the distribution of potential pathogens isolated from mini- owhua stream

Potential Pathogens	Percentage Occurrence (%)
Salmonella enterica	8
Vibrio cholerae	8
Pseudomonas aeruginosa	8
Enterobacter cloacae	8
Klebsiella pneumonia	12
Staphylococcus aureus	4
Streptococcus pneumoniae	8
Enterococcus Faecalis	16
Clostridium Perfringes	8
Escherichia coli	20

Discussion

There was a hint of consistency across the physicochemical properties of Mini-Owhua stream water samples taken from different locations. From 6.34 to 7.23, the pH levels varied. Particularly for tropical regions, the pH levels were within the acceptable range of 6.5 to 8.5 as defined by (APHA, 2017). Yahaya et al. (2021) also assessed the physicochemical characteristics of the Argungu River and found PH values within the acceptable range of 6.5-8.5, which is consistent with the results of our study.Temperature values ranging from 26.2-27.10C were also discovered by these research. For a balanced aquatic environment, these temperature readings are well within the desirable range of 20–300°C. Additionally, these temperature readings are consistent with those of Yahaya et al. (2021), who also assessed the temperature range of the Argungu River and found readings that fall within the permissible range of 20-30oC. Also, contrary to the 5 NTU advised by environmental health organizations, this investigation revealed turbidity levels ranging from 11 to 15 NTU. According to the results of this research, the Mini-Owhua stream has a somewhat hazy freshwater environment with a moderate turbidity rating. These turbidity readings are consistent with previous studies mentioned in Yahaya et al. (2021), which similarly found turbidity readings slightly higher than the 5NTU upper limit. Salinity levels between 0.16 to 0.41 parts per thousand were, on the other hand, within acceptable ranges, as is typical of habitats in fresh water. With the exception of turbidity, which slightly above the allowed limits, all of the physicochemical properties that were examined fell within the acceptable ranges established by the appropriate health organizations.

Examination of microorganisms: Counts ranging from 1.0 x 102 to 3.1 x 102 CFU/ml were quite similar across all samples. Nowhere did the bacterial levels vary by more than 1.4 cfu/ml, suggesting that the levels upstream and downstream were same. From the samples taken from the stream, 25 distinct bacterial strains were isolated after culture. Out of the twenty-five (25) distinct bacterial isolates, ten (10) genera were recognized. The gram-positive bacteria Staphylococcus aeureus, Streptococcus pneumonia, Enterococcus faecalis, and Clostridium perfringens made up four of the ten (10) bacterial genera. Among the six types of bacteria, six were gram negative: Escherichia coli, Salmonella enterica, Vibrio cholera, Pseudomonas aeruginosa, Enterobacter cloacae, and Klebsiella pneumonia. The most prevalent of the ten taxa found was Escherichia coli (20%), followed by Staphylococcus sp. (4%). The bacteriological examination of the Mini-Owhua stream showed results that were higher above the acceptable limits of 0 cells per 100 milliliters. Mini-Owhua stream has a high concentration of bacteria genera, which may be caused by human waste and excessive feces. These outcomes are consistent with what other studies have found, Odeyemi et al. (2023) found that there was a danger of contamination in streams in Ekiti State due to the high total coliform counts and the presence of bacteria such as Staphyloccocus, Pseudomonas, Escherichia, and Klebsiella. Similarly, bacteriological pollution was highlighted by Okanlawon et al., (2024), who discovered heterotrophic plate counts as high as 3.81 x 10^6 in River Obazagbon, along with isolates such as Bacillus cereus and E. coli. Mini-Owhua stream does not meet the standards set by the World Health Organization and other international and local environmental health bodies for drinking water. It is not safe to consume untreated water from the Mini-Owhua stream since it is an unpleasant water source.

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Conclusion

Drinking water from the Mini-Owhua stream in the Ibaa village does not fulfill bacteriological quality criteria, according to an evaluation of the water's quality. Bacteriological testing showed levels above both international and local norms of zero (0) cells per 100 ml, even if the Mini-Owhua stream's physical and chemical properties (physicochemical) were within acceptable limits. E. coli had the greatest microbial population, whereas Staphylococcus sp. had the lowest. People in the Ibaa village who get their drinking water from Mini-Owhua stream still face a threat to their health.

Recommendations

Based on the observation of this research, it is absolutely imperative to make the following recommendations;

1. A public health education and awareness campaign is desperately needed to warn the people of the Ibaa village about the risks of consuming untreated water from the Mini-Owhua creek.
2. A different supply of safe drinking water for the Ibaa people should be made available to them, according to the report. In light of this, responsible parties including the public sector, business sector, and people with the necessary skills should recognize the need of ensuring a steady supply of clean water for human use.
3. Mini-Owhua stream's heavy metal quality need more research to determine the concentrations of these contaminants..

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