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Water quality assessment of umuchigbo stream, Abakpa-Nike, Enugu East L.G.A, Enugu

Okwesili L C[1], Ukaba K O[1], Emachi E[1], Nwafor S C[2]
[1] Department of Industrial Chemistry, Enugu State University of Science and Technology, Agbani, Enugu State, Nigeria
[2] Department of Chemistry, State University of Medical and Applied Sciences, Igbo Eno, Enugu State, Nigeria

Abstract
One of the main causes of environmental problems worldwide is water contamination, which has serious negative effects on human health in addition to economic ones. Rural residents view bodies of water as convenient places to dispose of trash. Another well-liked pathway for surface water pollution is erosion runoff. In this paper, a water sample taken from the Umuchigbo region in the Abakpa Nike axis of the Enugu East local government area was tested for the concentration of many water quality indicators. The analysis employed standard ASTM and ALPHA analytical procedures. It was shown that the water's high turbidity (44 NTU) and high concentration of total dissolved solids (TDS) (700.7 mg/L) directly correlate with its high temperature (30.5 0C). The water's pH of 6.37 suggests that it is unfit for human consumption due to its acidity, and its high conductivity of 109 µS/m may be attributed to the presence of dissolved ions. Furthermore, even though the 5 mg/L of chloride is within the W.H.O. standard, it is insufficient to meet the chlorine needs of aquatic animals. This minute concentration might have resulted from the significant amount of water present during the sample collection period because of the extended rains. The absence of nitrate may have resulted from the sample being taken during a season that is known for its heavy precipitation and big water volumes.

Keywords: Water, quality, assessment, physicochemical

Introduction

One cannot overstate the significance of water for life's sustenance (Salihu, *et al*., 2017) [16]. Its uses are endless and important, whether it's for domestic watering, farming, raising livestock, or expanding industrial use (Okwesili *et al*., 2022; Romeo and Gupta, 2017) [9, 15]. Water acts as a medium for the transformation of extremely complex organic compounds that are the building blocks of life processes (Njoyim *et al*., 2016) [8]. The fact that water molecules are made up of dipoles that join together through intermolecular hydrogen bonds in their condensed phase accounts for a large portion of the unique characteristics of liquid water (Gordalla *et al*., 2007; Owa, 2014) [3, 13].

According to Okwesili *et al*., (2022) [9], water pollution has grown to be a significant issue globally, affecting rivers, lakes, seas, and drinking water supplies. Although the size and volume of surface and ground water are restricted, they nevertheless receive a sizable portion of the contaminants produced by human activity (Owa, 2014; Suaad, 2021;) [13, 17]. It is important to stress that there are detrimental effects when this resource is depleted due to contamination or irresponsible use (Owa, 2014; Khatun, 2017; Akaho *et al*., 2022) [13, 6, 1].

Previous research on water indicates that lakes worldwide have an average retention time of 100 years, meaning it takes that long for that volume of water to be replenished. In contrast, rivers have much shorter retention periods. The longer retention periods of lakes highlight the possibility of introducing "environmentally persistent" pollutants, or those that will stay in the ecosystem for a long time. Since rivers have shorter retention periods, pollutants are quickly transported to other areas, like groundwater or the ocean. Groundwater retention times, on the other hand, are measured in hundreds or even thousands of years (Owa, 2014; Suaad, 2021) [13, 17]. Persistent pollutants may remain for extraordinarily extended periods of time because transformation is hindered in the groundwater environment (Okwesili *et al*., 2022, Suaad, 2021) [9, 17]. Pollutants can reach the ocean directly or through surface water and groundwater drainages because a significant fraction of the world's population lives near the coast (Rahmanian *et al*., 2015; Mofor *et al*., 2023) [14, 7].

Some common sources of waste pollution are oil spills, sewage disposal, industrial waste dumps, and domestic or municipal garbage (Owa, 2014; Igor *et al*., 2020; Igwe *et al*., 2017) [13, 4, 5]. These contaminants have the power to alter water's physicochemical characteristics, including its color, taste, acidity, alkalinity, and turbidity. Water's use and function are determined by its mineral concentration (Ezugwu *et al*., 2022; Rahmanian *et al*., 2015) [2, 14].

One soluble substance that is found naturally in the environment is nitrate ($NO^{-}3$). Because it is necessary for plant growth, it is mostly found in inorganic fertilizers (Njoyim *et al*., 2016) [8]. Nitrate concentrations in bodies of water, such as surface and ground waters, are typically low. However, a number of anthropogenic sources, including agricultural runoff and contamination from human or animal waste, can lead to the accumulation of nitrates. As a result, there may be a risk to one's health and the ecosystem may suffer (Salihu *et al*., 2017; Igwe *et al*., 2017) [16, 5].

One of the main inorganic anions in water and wastewater is the chloride (Cl^{-}) ion (Zeyneb, 2021) [18]. Since sodium chloride is a common food item that goes through the digestive system unaltered into sewage, the concentration of chloride in wastewater is higher than in raw water. If this sewage is carried into bodies of water, it raises the chloride content. Furthermore, developing plants as well as metallic pipes and buildings may be harmed by high chloride concentrations. The cleanliness and utility of water are also largely determined by its physicochemical characteristics,

which include temperature, pH, turbidity, conductivity, color, and total dissolved solids (Romeo and Gupta, 2017; Mofor, *et al*., 2023; Igor *et al*., 2020) [15, 7, 4].

Matherials and Method

1. Study Area

Umuchigbo is located in Abakpa Nike axis of Enugu East Local Government Area in Enugu State. This town is a commercial hub with a wide range of commercial operations, including aluminum and furniture manufacturing, chicken farming, electronics maintenance and repair, auto repair, and general buying and selling of household goods. A comparatively tiny body of water called the Umuchigbo stream runs through the Umuchigbo town and the Alulu axis before draining into other areas of the local government. Some use it for irrigation, others for car washing, and others use it for household uses, particularly in the dry season.

2. Sample Collection

The fresh water samples were taken from the Umuchigbo stream in the Enugu East Local Government Area of Enugu State at approximately 11:00 A.M. A sanitized plastic bottle was used to gather samples. Before collecting the sample, the bottle was thoroughly cleaned and detergent-washed.

3. Methods

Several calibrated standard instruments were used in the analysis, in accordance with standard procedures and methods established by the American Public Health Organization (APHA) and the American Society for Testing and Materials (ASTM).

i. Temperature

Glass thermometer (SP Bel-Art, H-B DURAC) was used to measure the water sample's temperature. After rinsing it with distilled water, the thermometer bulb was submerged in the water sample. After three minutes, the reading was taken and noted appropriately.

ii. Colour

The color of the sample was compared to a platinum cobalt reference solution using the ALPHA color measuring standard. By contrasting the sample with platinum-cobalt standards, the color value was determined.

iii. pH

A pH meter (model HI 98130 HANNA, Mauritius, Iramac Sdn. Bhd.) was used to determine the pH of the water sample. The pH meter was calibrated using three standard solutions (pH 4.0, 7.0, and 10.0) prior to usage. A clean stirring stick was used to gently mix the water sample after it had been put into a 50 ml glass beaker. Subsequently, the pH meter's electrode was submerged in the sample, and a stable meter reading was obtained after a few minutes.

iv. Conductivity

The conductivity of the sample was also determined using a conductivity meter (model HI 98130 HANNA, Mauritius, Iramac Sdn. Bhd). The meter was calibrated prior to the analysis using a standard solution with known conductivity. The stability indication vanished after the probe was immersed in the water sample, and the reading was then recorded.

v. Turbidity

A turbiditymeter (model 2100P Turbidimeter HACH, Colombia, USA, Arachem (M) Sdn. Bhd.) was used to test the turbidity of the water sample. After pouring the sample into the sample holder, the meter was used for a short while. Following the attainment of reading stability, the value was noted.

vi. Total Dissolved Solids TDS

A gravimetric analysis using the filtration process was used to determine the total dissolved solids (TDS) concentration in the water sample in accordance with APHA standard procedures. In a measuring cylinder, a 50 mL water sample was put. A conical flask that had been weighed using a scale balance received the filtrate after it was passed through a 250 mm Whatman filter paper. In order to completely evaporate the sample, it was heated in a water bath. TDS was then computed by measuring the conical flask's weight following cooling.

vii. Test for Chlorides

A 2.4 g of powdered AgNO3 were dissolved in distilled water, silver nitrate (0.014M) was created and added to a 1000 mL volumetric flask. A 50 mL burette was filled with the silver nitrate solution. Following that, a measuring cylinder was used to measure 50 mL of the water sample, and a dropper was used to add 1.0 mL of potassium chromate indicator. Using the burette, the mixture was titrated with silver nitrate until it reached a pinkish-yellow end point.

viii. Test for Nitrate

The nitrate was measured using a spectrophotometer.

Result and Discussion

1. Results

The table below displays the findings of the analysis performed on the water sample.

Table 1: Result of Analysis of water sample from Umuchigbo Stream

S/N	Parameter	Concentration	WHO Standard
	pH	6.37	6.5-8.5
	Conductivity (µS/m)	109	100
	Temperature (^{0}C)	30.6	≤25
	Colour (Pt-Co)	410	5
	Turbidity (NTU)	44	5
	Total dissolved solids (mg/L)	700.7	500
	Nitrate NO_3 (mg/L)	BDL	50
	Chlolide Cl^- (mg/L)	5.0	250

BDL: Below detectable limit.

2. Discussion

2.1 pH

According to Igor *et al*. (2020) [4], pH is a measurement of the hydrogen content in water and is influenced by the balance of ions present as well as chemical reactions. The water sample's pH value of 6.37, as shown by the results in Table 1, indicates that the water is acidic and should not be consumed. The pH has a significant role in determining how corrosive water is; the lower the pH, the higher the potential amount of corrosion in water, according to the World Health Organization (2007). The W.H.O. states that drinking water should have a pH between 6.5 and 8.5. This suggests that

consuming the Umuchigbo water sample could have serious negative effects on one's health. This low pH may be directly related to organic matter decomposing in the water body as a result of agricultural wastes and trash disposal. When these materials break down, CO_2 is released, and when that CO_2 mixes with water molecules, carbonic acids are created. Despite being weak acids, carbonic acids when present in significant quantities will lower pH (Romeo and Gupta, 2017; Igwe *et al*., 2017) [15, 5]. Low water pH can also be caused by the presence of some metals like copper, zinc, and aluminum as well as earthly acidifying compounds such sodium carbonates and calcium oxide (Okwesili *et al*., 2022) [9].

2.2 Conductivity
Previous studies have indicated that the electrical conductivity of water is directly influenced by its temperature. Water conductivity is significant because it indicates the concentration of chemicals, minerals, and dissolved substances in the water (Rahmanian *et al*., 2015; Njoyim *et al*., 2016) [14, 8]. higher levels of contaminants lead to higher conductivity. The water sample's conductivity of 109 µS/m suggests that there are many dissolved materials present, which may be related to the aluminum work being done near the stream's edge. Water conductivity may also be impacted by further industrial and agricultural processes.

2.3 Turbidity
In addition, the sample's turbidity of 44 NTU is extremely high, far over the WHO's recommended threshold of 5 NTU for water intake. The presence of suspended materials in the water, such as silt, clay, planktons, industrial wastes, and sewage discharge, may be the cause of this high turbidity. It may also result from the disintegration of silt along the flow path, which releases particulate matter into the water, or from the presence of inorganic particulate matter. The growth of algae, trash discharge, urban runoff, and soil erosion can all cause excessive turbidity in water. A decrease in dissolved oxygen and an increase in water temperature may result from turbid water particles' absorption of solar radiation, according to Lehigh Environmental Initiative (2000–2011). Fish gills may become clogged and damaged as a result of the suspended particles, which can also significantly impact the quality of aquatic life by making it difficult for fish to find food in cloudy water and all other consequences of turbid water, the total of all the individual ingredients that generated the turbidity is what causes further effects (Njoyim *et al*. 2016; Igor *et al*. 2020, Mofor *et al*., 2023) [8, 4, 7].

2.4 Total Dissolved Solids TDS
Water that contains dissolved particles allows less light to flow through it. As a result of the water sample's high TDS of 700 mg/L, less light will reach the water. This implies that photosynthesis would slow down and produce less oxygen, which will cause bottom plants to die (Ezugwu *et al*., 2022; Njoyim *et al*., 2016) [2, 8]. The amount of dissolved oxygen in the water will drop as a result of bacteria decomposing and using up more oxygen, which could stress or even kill aquatic creatures that depend on high oxygen concentrations for survival (Salihu, *et al*., 2017) [16]. Human use of water holding TDS of more than 500 mg/l may irritate the gastrointestinal tract (Ezugwu *et al*., 2022) [2].

2.5 Temperature
The high total dissolved solids and high turbidity found in the water sample directly correlate with the high temperature (30.5 ^{0}C) that was recorded. These contaminants cause the water to absorb and retain solar radiation, raising the water's temperature as a result. At the time of sample collection, it was evident that a low population of aquatic animals resulted from high temperatures. Higher temperatures ≥27 0C decrease the solubility of dissolved oxygen in water, lowering its concentration and therefore its availability to aquatic species, according to a report by Helen Dallas (Water Research Commission) (Njoyim *et al*., 2016; Okwesili *et al*., 2022) [8, 9].

2.6 Colour
Water can be significantly colored by humus, weeds, household and industrial waste, as well as inorganic ions like iron and manganese (Igwe *et al*., 2017) [5]. The World Health Organization states that drinking water should be colorless, with a maximum color unit of 5. However, a study of a water sample from Umuchigbo using the Pt-Co scale yielded a color value of 410. This suggests that the presence of dissolved and suspended particles renders it inappropriate for human ingestion. However, it might be useful for building, cleaning cars, or even feeding animals.

2.7 Chloride
Although chlorides are typically found in water naturally, certain human activities have the potential to raise the concentration of chlorides above permissible levels (Ezugwu *et al*., 2022; Njoyim *et al*., 2016; Zeyneb, 2021) [2, 8, 18]. As the results of the test show, even while the chloride concentration (5 mg/L) is within the WHO standard, it is insufficient to meet the chlorine needs of aquatic creatures. This minute concentration can be the result of the significant amount of water present during the sample collection season because of the protracted rainfall. Since $Cl^-$is naturally leached from these minerals into soil and water by weathering, low Cl^-suggests low concentrations of sodalite, apatite, feldspathoids, and halite in the studied area (Mofor *et al*., 2023; Salihu *et al.*, 2017) [7, 16].

2.8 Nitrates
Small levels of nitrate are present in uncontaminated natural water. Due to the nutrient's absorption by plants and subsequent conversion to cell protein, high concentrations in drinking water are dangerous for young children. Unpleasant eutrophication can result from the promotion of plant growth, particularly algae. Due to the season and time of year the water samples were taken, the spectrophotometric method was unable to detect the nitrate levels. The sample was collected one week following an exceptionally heavy downpour that would have removed the nitrates from the area. The higher water volume in that scenario would lead to a lower nitrate concentration. To establish the nitrate concentration, more research has to be done during the dry season.

Conclusion
In conclusion, it is true that the benefits of water to humanity are immeasurable and that the degree of purity of water determines its suitability for a variety of uses. Water's physical, chemical, and biological qualities are greatly

impacted by a variety of pollutants that originate from human activity. It is safe to say, after looking at a few of these factors, that the water stream that passes through Umuchigbo is not fit for human consumption, while it might be helpful for other uses like irrigation and building construction.

Recommendation

According to the research's findings, some contaminants have lower concentrations because there was more water available during the sample collection period, which is the late rainy season with consistent rainfall. During the dry season, when there is less water and more pollution, more research on this body of water should be encouraged. During the dry season, when water is somewhat limited in the area, more people will also depend on and use the water.

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