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Assessing the Water Quality of River Obazagbon, Edo State, Nigeria Using Physicochemical and Bacteriological Parameters

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Abstract

Quality water supply is a major challenge to the world populace over the last few centuries due to the alarming concern of diseases outbreak caused by the consumption of contaminated water. This study consists of the bacteriological and physiochemical assessment of water sample gotten from the Obazagbon River, Edo State, Nigeria. Three (3) samples (1 sample from upstream, 1 from midstream and 1 from the downstream) were collected from the river and analyses were carried out using standard procedures. Values consisted of results obtained for the pH (6.57-7.03), temperature (26-280C), electrical conductivity (82-90), total dissolved solids (30.0- 50.37mg/l), dissolved oxygen (2.32-5.24mg/l), biological oxygen demand (0.12- 2.26mg/l), turbidity (0.35-0.76mg/l), phosphate (0.60-1.2mg/l), nitrate (2.20-4.45mg/l), sulphate (2.85-5.84mg/l). The results obtained revealed a heterotrophic plate count ranging from 1.46×10^2 to 3.81×10^6. A total number of 14 bacteria isolates were obtained from the water samples, out of which *Bacillus cereus* had the highest percentage frequency of occurrence of 28.57%, while *Escherichia coli*, *Streptococcus* spp., *Listeria* sp and *Clostridium* sp had the least percentage frequency of 28.56% altogether. All isolates were found present in all samples from the river. This study revealed a microbial load higher than the acceptable limit as recommended by World Health Organization (WHO). Thus, it is advised that water from this river should be treated properly before consumption.

Keywords: Water Assessment; Water Borne Diseases; Physicochemical; Bacteriological Parameters

Introduction

Water is essential to life, a satisfactory, adequate, safe, and accessible supply must then be available to all [1]. Over 70% of the Earth's surface is covered by water; however, not all of it is freshwater. Freshwater makes up just 3.5% of the total, with oceans making up the remaining 96.5%. The freshwater body is characterized by having low concentrations of dissolved salts and other total dissolved solids. Freshwater resources also differ from each other in terms of their movement. Some freshwater bodies are moving continuously, like rivers, whereas some others are stagnant, like ponds [2].

Water exists as surface water, groundwater, and rainwater. Surface water, especially freshwater, is also classified based on its size, viz: creek, pond, lake, stream, river, rivulets, etc.

The quality of river water has been indicated by increased pollution of water bodies with soluble reactive lignin and tannin and by the steady buildup of organic and inorganic suspended matter along the river [3]. Freshwater is mostly used for drinking and other domestic purposes including washing, cooking, bathing, etc., and other economic activities such as fishing, dredging, etc. Water fit for consumption is called drinking water or potable water [4].

Surface water bodies constitute important water resources for human society and deserve to be well managed. Water resources play a vital role in the socio-economic development of any society, in addition to the ecosystem services they provide if their source is surface water bodies. The common sources of surface water include ponds, streams, lakes, and rivers. Surface water is susceptible to contamination given its openness to all manner of influences. For example, anthropogenic activities such as agricultural activities and industrial effluent discharge can significantly alter the quality of a surface water body [5]. The importance of water to man is aptly summarized in the words of Kofi Annan, who said: "Access to safe water is a fundamental human need and, therefore, a basic human right. Contaminated water jeopardizes both the physical and social health of people. It is an affront to human dignity'' [6]. One of the most abundant and readily available sources of freshwater to man is the river.

In the last decades, aquatic contamination has become a global problem that enters aquatic bodies from different natural and anthropogenic sources, which can be either chemical or microbiological. Polluted surface waters can contain a large variety of pathogenic microorganisms including bacteria, viruses, and protozoa [7]. The main origin of these pathogenic microorganisms is the feces of humans and animals, which are brought to the aquatic environments through the release of wastewater effluents, surface runoff, and soil leaching. The microbiological contamination of water, particularly with pathogenic bacteria, is one of the most significant causes of water pollution.

Physicochemical characteristics and biological variety are necessary for the maintenance of a healthy aquatic ecosystem. Regular water body monitoring will not only check for risks and disease outbreaks but also prevent future deterioration of the water. Therefore, it is frequently carried out to determine the quality and portability of water to ensure avoidance of disease dissemination. Water has been described as one of the vehicles for the transmission of microbial diseases, among which are those caused by coliforms [8].

Coliforms, particularly *Escherichia coli*, are used as indicators. For example, the presence of *E. coli* in water serves as an indicator of fecal contamination. Coliforms are a group of closely related Gram-negative, non-spore-forming, rod-shaped aerobes and facultative anaerobes that ferment lactose to produce acid and gas within 48 h at 35 °C. They mostly live in soil, water, and the gut of animals, with few enteric pathogens including *Salmonellae*, *Shigellae*, and enteropathogenic *E. coli* [8].

Materials and Methods

Area of study

Obazagbon is a town located in the Esan west local government of Edo state, Nigeria. The isolation, characterization and other assessment though, was carried out in the biological sciences laboratory of Glorious Vision University, Ogwa, Edo state, Nigeria.

Sample collection

Samples were collected on site, at the obazagbon river using sterile capped plastic bottles. The container was initially rinsed three times with the sample water before sampling. Collection was done by dipping the sample bottle atabout 20cm below the water surface, projecting the mouth of the bottle against the water current. Samples were collected around 9am-10am at two locations of the river namely the upstream, and the downstream, and on two different occasions. The water pH and temperature were monitored using pH meter (Hanna) and mercury glass thermometer respectively before sampling.

Microbiological Analysis

Isolation of bacterial and fungi Isolates

One millitre was weighed and transferred into a test tube containing sterile distilled water for serial dilution. Fifteen ml of the molten agar, left to cool, was poured aseptically into the dishes and gently swirled in both clockwise and anticlockwise directions to allow for even distribution of the colonies at the surface of the agar. The agar was allowed to set. Nutrient and MacConkey agar were incubated in an inverted role at 37°C for 24 hours [9].

Identification and Characterization

Bacterial isolates were characterized based on their colonial morphology, cell morphology, and biochemical characteristics. The identity of bacterial isolates was accomplished following Bergey's Manual of Determinative Bacteriology [9].

Biochemical Identification of Isolates

Catalase, Oxidase, Methyl red, Voges Proskauer, Nitrate

reduction, Citrate utilization, Motility spore staining, Indole, Gelatin, Casein, Starch hydrolysis, growth at different temperatures and pH, and Sugar fermentation were some of the biochemical tests conducted to identify organisms [10].

Physicochemical properties

Physiochemical analyses were conducted on the water sample collected, and these included color, pH, temperature, electrical conductivity, biological oxygen demand, total dissolved solids, turbidity, nitrate, phosphate and sulphate.

Temperature

Temperature refers to the degree of coldness or hotness of a body. For water, it affects its state (liquid, solid, or vapor). The temperatures were measured at the site of collection using a mercury-in-glass thermometer [11].

Hydrogen Potential

The pH of a solution is a measure of hydronium ion (H_3O^+) concentration, which is a measure of acidity. In acidic solutions, the pH is less than 7, while it is greater than 7 in basic solutions. The pH range in water samples is rarely below 4 or above 10. Determining the pH of water is essential as it affects many of the chemical and biological processes that take place in water [12,13]. 100 ml of the water sample was measured in a beaker, and using the pH meter, the pH ranges were determined [11].

Electrical Conductivity

A conductivity meter was used to determine electrical conductivity. The conductivity probe was rinsed and immersed into the sample, and the reading was noted [14].

Dissolved Oxygen

One of the most significant parameters is dissolved oxygen (DO). Its relationship to a water body provides both direct and indirect information, such as bacterial activity, photosynthesis, nutrient availability, stratification, etc [15]. As summer progressed, dissolved oxygen levels declined due to rising temperatures and increased microbial activity. After 5 days of incubation at 293 K, the DO in the sample was determined titrimetrically using Winkler's technique. The amount of oxygen absorbed by the bacteria during this time is determined by the difference between the initial and final DO. Special BOD bottles that isolate the interior environment from ambient oxygen are required for this technique [16].

Biochemical Oxygen Demand

Biological oxygen demand is the amount of dissolved oxygen required by aerobic biological organisms to degrade the organic material present in a water body at certain temperature over a specific time period. It is widely used as an indication of the organic quality of water and thus representing the pollution load. It is most commonly expressed in milligrams of oxygen consumed per liter of sample during 5 days (BOD5) of incubation at 20°C [16].

Phosphate

Tin (II) chloride colorimetric method

Phosphate was determined by the molybdate spectrophotometric method. The standard solution of KH_2PO_4 was prepared to contain 0,2,4,6,8, and 10 mg/l of phosphate. A volume (30ml) of each water sample and the standard solution in 500ml volumetric flask was mixed with 2ml of ammonium molybdate reagent, 6 drops of stannous chloride reagent, and diluted to 100ml distilled water. Absorbance values of the water samples and standard solution were read at 650nm using a spectronic21 spectrophotometer. A standard curve was prepared with the absorbance values and the concentration of phosphate in the sample was extrapolated from the standard curve.

Sulphate

Turbidimetric Method

This method is based on the formation of barium sulfate in the colloidal form by sulfate in the presence of (acidified HCL) barium chloride. Measure 100ml of each solution into 200ml Erlenmeyer flask. Add 5ml conditioning reagent and mix in the stirring apparatus. While stirring the solution, add a spoonful of barium chloride crystals and start timing immediately. Stir exactly for one minute at a constant speed, pour some of the solutions into an absorption cell, and read the absorbance at 425nm in the second minute. Take readings for all the various concentrations and plot the absorbance concentration graph.

Nitrate

Sodium salicylate (Colorimetric) method

Nitrate was determined by the spectrophotometric sodium salicylate method. For most routine analysis It is preferred to the time-consuming distillation method. The standard solution of potassium nitrate was prepared at 0 to 5mg/l and 10ml of each solution was mixed with 1ml of sodium salicylate solution, 2ml of concentrated sulphuric acid, and allowed to stand for 15min. A 15ml volume of distilled water and 15ml of sodium tartrate solution were added to each sample and absorbance of the yellow color developed was read at 420nm. A calibration curve was plotted with the absorbance values of the standard and the concentration (mg/l) of nitrate in the samples was extrapolated from the standard curve [17].

Total dissolved solids

Total solids are made up of dissolve solid and suspended solids (TS = DS + SS). Dry clean dish was placed in an oven at a constant speed of 103-1050C, cool at room temperature in a desiccator. Note the weight. After mixing thoroughly the effluent sample of 100-250ml was pipette in to the dish. Dry the residue for 1 hour in an oven at a constant temperature, transfer quickly into a desiccator, cool at room temperature and weigh. Subtract the weight of the dish from the weight of the residue to obtain the weight of the total solid.

Calculations

Total solids (mg/l) = mg. total solids × 1000/ml samples

Turbidity

The unit of measuring turbidity is turbidity unit (TU). Turbidity larger than 5 TU is easily detected in a glass of water and is objectionable for aesthetic reasons [12,18].

Results and Discussion

Parameters	Upstream	Midstream	Downstream	WHO Limit	FEPA Limit
pH	6.57	6.8	7.03	9-Jun	6.5-9.2
Turbidty	0.35	0.59	0.76	5	NI
EC	82	87	90	300	NI

KEYS: EC= Electrical conductivity, NI= not indicated. All values in mg/l, except pH, and EC (siemens/cm). Drinking water quality as recommended by FEPA and WHO.

Table 1: Physicochemical analysis: pH levels, turbidity, electrical conductivity (EC) obtained from Obazagbon River.

Parameters	Upstream	Midstream	Downstream	WHO Limit	FEPA Limit
BOD	0.12	1.42	2.26	5	NI
DO	2.3	2.39	5.24	14	NI
TDS	30	47.23	50.37	500	2000

KEYS: EC= Electrical conductivity, BOD= biological oxygen demand, TDS=total dissolved solids, NI= not indicated. All values in mg/l. Drinking water quality as recommended by FEPA and WHO.

Table 2: Physicochemical analysis: Dissolved oxygen (DO), biological oxygen demand (BOD), total dissolved solids (TDS obtained from Obazagbon River.

Parameters	Upstream	Midstream	Downstream	WHO Limit	FEPA Limit
Nitrate	2.2	3.5	4.45	5	NI
Sulphate	2.85	3.01	5.84	200	20
Phosphate	0.6	0.93	1.2	1	NI

KEYS: NI= not indicated. All values in mg/l. Drinking water quality as recommended by FEPA and WHO.

Table 3: Physicochemical analysis: sulphate, nitrate, and phosphate obtained from Obazagbon River.

	TOTA Heterotrophic bacterial Count
Sample	THBC (cfu/ml)
Upstream	$1.46x10^2$
Midstream	$2.89 x10^2$
Downstream	$3.81x10^6$

Table 4: Result for Total Heterotrophic Bacterial count.

SOURCE	*E. coli*	*Lactobacillus Sp.*	*Corynebacterium sp.*	*Clostridium sp.*	*Listeria sp.*	*Bacillus sp.*	*Streptococus sp.*
Upstream	-	+	+	-	-	-	+
Midstream	+	-	-	+	-	+	-
Downstream	·	-	+	-	+	+	-

Table 5: Prevalence of bacteria Isolate.

The examination of the physico-chemical and bacteriological parameters of river Obazagbon revealed the quality of the river water. The physico-chemical parameters of the water samples were measured both in-situ and in the laboratory. The parameters measured included air and water temperature, pH, biological oxygen demand (BOD5), dissolved oxygen (DO1), electrical conductivity (EC), total dissolved solids (TDS), sulphate, nitrate, and phosphate. The range values of the measured parameters were compared with World Health Organisation (WHO) and Federal Environmental Protection Agency (FEPA) standards. The findings showed that all the physico- chemical parameters measured were within the tolerable value ranges except phosphate.

Results obtained for the physiochemical analyses of water sample collected from the upstream, Midstream and downstream of Obazagbon river are as shown in table 4.1. Values consisted of results obtained for the pH (6.57-7.03), temperature (26-280C), electrical conductivity (82-90), total dissolved solids (30.0-50.37mg/l), dissolved oxygen (2.32-5.24mg/l), biological oxygen demand (0.12-2.26mg/l), turbidity (0.35-0.76mg/l), phosphate (0.60-1.2mg/l), nitrate (2.20-4.45mg/l), sulphate (2.85- 5.84mg/l). The Total Heterotrophic bacterial Count of water samples collected from Obazagbon River. Samples showed the Total bacterial count of 1.46 x 10^2, 2.89 x10^2 and 3.81 x 10^6 cfu/ml. The pH of the water was found to be between 6.57 to 7.03; showing a moderately acidic to neutral condition in the study area as conforming to WHO (6.5 - 8.5) and FEPA (6.00 - 9.00) limits.

The electrical conductivity was highest at the downstream due to presence of some dissolved ions in it, agreeing with Enerijiofi, et al. [19] and Olatunji, et al. [20]. BOD has the highest value also in the downstream due to the presence of inorganic pollutants in it from disposed domestic wastes [21-23]. The total heterotrophic bacterial count was greater at the downstream (3 lo09008.81x10^6 cfu/ml) indicating high level of human activity at this point. Bacterial load is higher than WHO/FEPA standard which aligns with Kelechi, et al. [22,24]. Higher bacterial counts downstream often result from runoff that includes human and animal waste, industrial effluents, and other pollutants. Increased human activities like agriculture, sewage disposal, or washing in rivers can lead to higher organic and inorganic material, fostering bacterial growth.

Bacillus sp., *Lactobacillus* sp. and *Corynebacterium* sp. were predominantly present in the water samples obtained from the three sampled locations while *Escherichia coli*, *Listeria* sp., and *Streptococcus* sp. had less dominance in the samples from the sampled locations.

Conclusion

The pH values ranged from 6.57 to 7.03, indicating that the river water was moderately acidic to neutral, remaining within the WHO (6.5-8.5) and FEPA (6.0-9.0) permissible limits. Electrical conductivity, which reflects the presence of dissolved ions, was highest downstream at 90 µS/cm, suggesting greater pollution levels in this region, possibly due to dissolved ions from domestic waste. The total dissolved solids (TDS) also varied between 30.0 and 50.37 mg/l, while dissolved oxygen (DO) levels were lowest downstream (2.32 mg/l), which indicates poor oxygenation of the water—likely due to organic matter decomposition. Similarly, biological oxygen demand (BOD) was highest downstream (2.26 mg/l), indicating increased organic pollutant levels from human activities like sewage disposal and agricultural runoff. From a microbiological perspective, the total heterotrophic bacterial count (THBC) was markedly higher downstream (3.81×10^6 cfu/ml), compared to upstream (1.46×10^2 cfu/ml) and midstream (2.89×10^2 cfu/ml), indicating significant microbial pollution at the downstream site. This bacterial count far exceeds the WHO/FEPA standards, which suggests that the water is highly contaminated and unsafe for human use, particularly at the downstream point, where high human activities and waste disposal occur.

The water quality of the Obazagbon River, particularly downstream, is compromised due to anthropogenic activities. Overall, the elevated microbial load and the high BOD and electrical conductivity at the downstream location underscore the negative impact of human activity on water quality. The high bacterial contamination poses a significant public health risk, requiring urgent intervention to manage pollution sources and improve water quality in the Obazagbon River.

Recommendations

Continuous monitoring of the physico-chemical and microbiological parameters of the Obazagbon River should

be established to detect and address pollution trends early. This would involve periodic assessments at the upstream, midstream, and downstream locations to ensure water quality remains within WHO and FEPA standards. Measures should be put in place to control the disposal of domestic waste, agricultural runoff, and industrial effluents into the river. Public awareness campaigns on proper waste disposal and sustainable agricultural practices should be intensified in the community to minimize the influx of contaminants.

The installation of wastewater treatment systems is crucial in preventing untreated sewage and industrial waste from entering the river. Local authorities should invest in or encourage the establishment of affordable and accessible treatment facilities to reduce pollution. Educating the local population about the potential health risks associated with using contaminated water, such as those posed by *Escherichia coli* and other pathogens, should be prioritized. Awareness on the dangers of open defecation and improper waste disposal must be promoted.

References

1. Cotruvo JA (2017) WHO guidelines for drinking water quality: First addendum to the fourth edition. Journal AWWA 109(7): 44-51.

2. Fahad (2020) Freshwater ecosystem: Types, characteristics and animals. Earth Reminder.

3. Ologbosere OA, Aluyi HS, Ogofure AG, Beshiru A, Omeje FI (2016) Physico-chemical and microbiological profile of bacterial and fungal isolates of Ikpoba River in Benin City: Public health implications. African Journal of Environmental Science and Technology 10(3): 67-76.

4. Egberongbe HO, Awoderu VA, Bello OO (2010) Microbial and physicochemical evaluation of some streams along Ilisan-Ago-Iwoye road, Ogun State, Nigeria. Journal of Olabisi Onabanjo University. Microbiology, Applied Zoology and Plant Science pp: 1-10.

5. Loperfido JV (2014) Surface water quality in streams and rivers: Scaling and climate change. In Comprehensive Water Quality and Purification pp 87-105.

6. Aliyu A, Ibrahim YKE, Oyi RA (2016) Bacteriological assessment of river Lavun, Bida, Niger State, Nigeria. Journal of Pharmaceutical Research Development and Practice, 1(1): 34-46.

7. Oladunjoye RY, Fafioye OO (2016) Biochemical and physicochemical characterization of Majidun River water, southwest Nigeria. International Journal of Environmental Chemistry and Ecotoxicology Research 1(1): 1-11.

8. Bhumbla P, Bhumbla D, Gangwar M (2020) Coliforms as indicators of fecal contamination in water. Journal of Water and Health 20(09): 18-26.

9. Okanlawon TS, Adeyemo SM, Agbaje IS (2023) Isolation and identification of microorganisms associated with Jollof rice sold at Bukateria in Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. GSC Biological and Pharmaceutical Sciences 22(01): 178-185.

10. Okafor CF, Okanlawon TS, Olagunju AM, Isatoye EF, Oni TR, et al. (2023) Invertase activities of lactic acid bacteria isolated from traditional fermented milk ("nono"), agadagidi and palm wine obtained from different locations in Ile-Ife, Osun State, Nigeria. GSC Biological and Pharmaceutical Sciences 22(01): 147-156.

11. Agbo BE, Ogar AV, Akpan UL, Mboto CI (2019) Physico-chemical and bacteriological quality of drinking water sources in Calabar Municipality, Nigeria. Journal of Advances in Microbiology, 14(4): 1-22.

12. Davis ML, Cornwell DA (2012). Introduction to environmental engineering 5th (Edn.), New York: McGraw-Hill.

13. Venkateswariu P (2003) Fundamentals of water chemistry. New Delhi: Tata McGraw-Hill.

14. Okorafor DI, Adeoye AO, Adeyanju AO (2012) Electrical conductivity measurement in water: Effects of seasonal changes and environmental factors. Water Research Science 6(3): 30-35.

15. Vikal R (2009) Aquatic ecosystems and dissolved oxygen levels: A comprehensive review. Journal of Environmental Biology 2(8): 16-18.

16. APHA (2015) Standard methods for the examination of water and wastewater 21st (Edn.), Washington, D.C: American Public Health Association.

17. Alli O (2016) Bacteriological studies of water resources: Microbial diversity in Nigerian streams. Journal of Water Science and Technology 3(09): 78-85.

18. Davis ML (2010) Wastewater management and engineering 6th (Edn.), New York: McGraw-Hill.

19. Enerijiofi K, Olatunji E, Irerua P (2018) Effect of human activities on the physicochemical and bacteriological qualities of Ujiogba River, Ujiogba, Edo State, Nigeria. Journal of Applied Life Sciences International 17(1): 1-8.

20. Olatunji EO, Anani OA (2020) Bacteriological and

Physicochemical evaluation of River Ela, Edo State Nigeria: water quality and perceived community health concerns. J Bio Innov 9(5): 736-749.

21. Olatunji EO, Anani OA, Osimen EC, Omojoyegbe RT (2022) Public health concerns and water quality integrity of selected water sources in a Peri-Urban Community of South-South Nigeria: A comparative investigation. Sust. Water Res Managmt 8: 1-10

22. Olatunji EO, Elakhame LA, Osimen EC, Edegbene AO (2023) Assessing the effect of environmental stressors on the community structure of macroinvertebrate and water quality of River Ugbalo, Nigeria Poll 9(4): 1-16.

23. Kolawole OM, Ajayi KT, Olayemi AB, Okoh AI (2011) Assessment of water quality in Asa River (Nigeria) and its indigenous Clarias gariepinus fish. International Journal of Environmental Research and Public Health 8(11): 4332-4352.

24. Kelechi OJ, Nnawuike AJ, Kelechi IS, Emmanuel EJ, Odinaka NP (2021) Assessment of microbial load in water and sediments of Rivers Otamiri and Nworie in Owerri, southeastern Nigeria. International Journal of Pathogen Research 6(3): 27-39.