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Quality Assessment of River Water in Ogoloma-Okrika

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Authors' contributions

This work was carried out in collaboration between all authors. Author VA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author HOS managed the analyses of the study. Author VA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to determine the physicochemical and bacteriological quality at various points of the Ogoloma-Okrika River. Using composite sampling method, a total of 5 samples were collected at 5 different points (human excrement point (OT), refuse dump point (OW), crude oil effluent discharge point (OO), upstream (OU) and downstream (OD) of the river). The total heterotrophic bacterial count obtained in this study ranged from $7.0x10^4$ $cfuml^{-1}$ to $9.95x10^5$ $cfuml^{-1}$; total coliform 20-210 MPN/100 ml; faecalcoliform 6-53 MPN/100 ml; *Vibrio* $4x10^3$ $cfuml^{-1}$-$1.78x10^5$ $cfuml^{-1}$. A total number of 36 isolates were obtained from the samples. The isolates belong to the genera: *Acetobacter* (7.7%), *Erwinia* (15.3%), *Planococus* (19.2%) *Citrobacter* (23.1%), *Escherichia coli* (19.2%), *Vibrio* (19.2%), *Salmonella* (4%) *Shigella* (15.3%), *Enterobacter* (7.7%), *Kliebsella* (7.7%). Temperature ranged from 27-28°C; pH, 4.97-6.82; electrical conductivity, 6020-6540 µs; alkalinity, 80-120 ppm; total dissolved solids (TDS) 2973-3725 mgL^{-1}; dissolved oxygen (DO) 4.3-7.8 mgL^{-1}; biochemical oxygen demand (BOD)2.5-3.5 mgL^{-1}; chemical oxygen demand (COD) 3.2-4.9 mgL^{-1}. Results indicate high faecal contamination of this important

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river used by a resident for domestic purposes. Concerns for public health safety are raised as most of the parameters monitored were found to be significantly higher than the WHO standards for safe water.

Keywords: Bacteriological quality; Ogoloma-Okrikariver; public health safety.

1. INTRODUCTION

Water is one essential natural resource whose quality has been threatened by development and population explosion [1]. Water cycling ensures the continued availability of this vital resource.About 71% of the earth is water where only about 3% of it is freshwater and the rest is salty [2]. Yet still, only 0.3% of freshwater exist in lakes, rivers and the atmosphere. This presents the challenge of potable water availability in the midst of plenty of water.

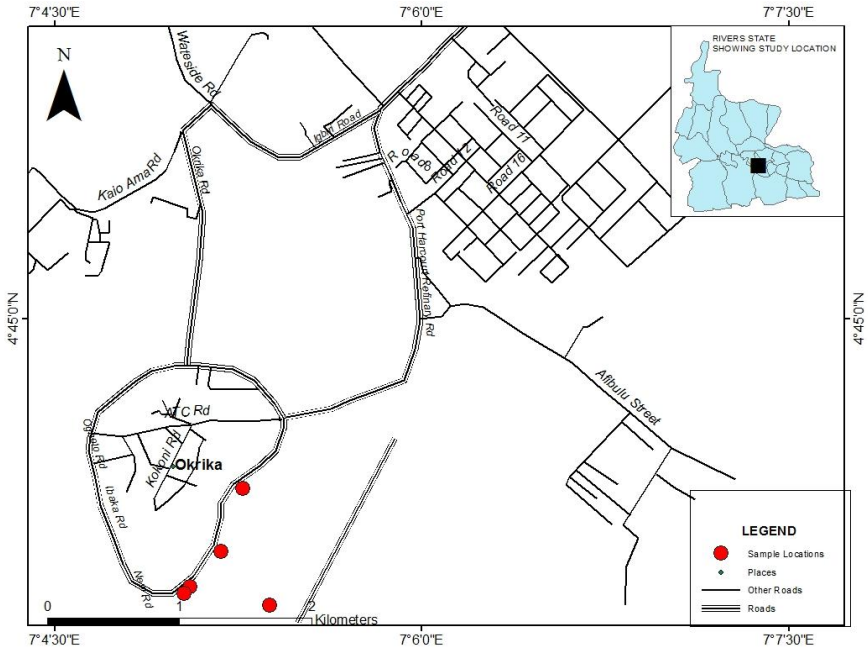
River water could serve for domestic, industrial and agricultural purposes [3]. Depending on the purpose for which water is used, there is the possibility of contamination which may render it unsuitable for consumption [4]. Chemical, physical and microbial contaminations are widely recognized [5,6]. Some common public health significances usually associated with water consumption include gastrointestinal diseases, acute liver disease, renal dysfunction, neurological disorders, cancer, poliomyelitis and a host of other water-borne diseases [5].

River water is subjected to changes from natural and anthropogenic sources as such its quality must be periodically assessed [7]. The aim of this study was to determine the physicochemical and microbiological quality of the Ogoloma-Okrika River.

2. MATERIALS AND METHODS

2.1 Description of Study Site

The study site is Ogoloma-Okrika community of Rivers State of, Nigeria. The river lies within 7°4’30”E, 7°6’0”E and 4º45’0”N. The Port Harcourt refinery discharges its effluent into the river. The river is also under continuous threat of oil pollution from oil and gas facilities due to bunkering and vandalism. Okrika is a densely populated island with shanties and the sanitary condition is poor. River defecation and dumping of refuse are commonplace occurrences. The geolocation is shown in Map 1.



Map 1. Location of sampled river in Ogoloma-Okrikacommunity

2.2 Sample Collection

Using the composite sampling technique, a total number of five samples (5) were obtained from five different points. The sampling points include human excrement point (OT), refuse dump point (OW), crude oil effluent discharge point (OO), upstream (OU) and downstream (OD) of the river. Samples were obtained aseptically using sterile bottles and transported back to the University of Port Harcourt Microbiology Laboratory under standard microbiological conditions.

2.3 Physicochemical Analysis

The following physicochemical parameters (temperature, pH, electrical Conductivity, alkalinity, Total Dissolved Solids, Dissolved Oxygen, Biochemical Oxygen Demand and Chemical Oxygen Demand) were determined using the procedures described by the National Agency for Food and Drug Administration and Control (NAFDAC) [8].

2.4 Bacteriological Analysis

The quality of the water samples were determined bacteriologically by analyzing for total heterotrophic bacteria, *Vibrio*content, *Salmonella* and *Shigella*content, total coliform and faecalcoliform content. Samples were serially diluted to 10^{-3} dilution using physiological saline. Appropriate dilutions were used to inoculate Nutrient Agar, EosineMethylene Blue Agar, Lactose Broth, Triple Sugar Iron Agar, Simmons Citrate Agar, Salmonella-Shigella Agar, Selenite Broth and Thiosulphate Citrate Bile Salts. Discrete and distinct colonies obtained from agar plates were isolated and purified on nutrient agar plates until distinct colonies with homogenous morphologies were obtained, by means of repeated subculturing.

2.5 Total Heterotrophic Bacteria Count (THBC)

Total Heterotrophic Bacteria Count (THBC) was done by spreading 0.1ml of the dilutions (10^{-1}, 10^{-2}, 10^{-3} and 10^{-4}) of each water sample in duplicates, aseptically with a sterile glass rod on freshly prepared dry and labelled nutrient agar plates. The plates were incubated at 37ºC for 24 to 48 hours.

2.6 Coliform Analysis

The coliform (both total and faecal) content of each of the water sample was determined using the multiple tube fermentation method, which was done in three stages: presumptive, confirmatory and completed stage. The only difference between the total and faecalcoliform enumeration was their incubation temperatures (total coliform tubes and plates were incubated at 35°C, while the faecalcoliform and plates were incubated at 44.5°C).

2.7 *Vibrio* Enumeration

This was done using the thiosulphate citrate bile salt agar. Each of the dilutions from each sample was platted each on freshly prepared thiosulphate citrate bile salt plates in duplicates using the spread plating technique and incubated at 35°C for 24 hrs. After incubation, greenish and yellowish colonies, which are tentative for *Vibrio*species were isolated and purified.

2.8 *Salmonella* and *Shigella* Enumeration

This enumeration was done using the S*almonella-Shigella*agar. Each of the dilutions obtained from the enriched samples was plated each on freshly prepared *Salmonella-Shigella*plates using the spread plating technique and incubated at 35°C for 24 hours. After incubation, the tentative colonies of *Salmonella* and *Shigella*were isolated and purified.

2.9 Characterization of Isolates

The isolates were further subjected to series of biochemical tests, and their reactions were used to characterize them. They were characterized using these tests: Gram staining, catalase, oxidase, motility, hydrogen sulphide production (H_2S), indole, Voges-Proskauer (VP), Methyl red (MR), citrate, and urea hydrolysis test.

2.10 Statistical Analysis

Analysis of Variance (ANOVA) was used to establish significant differences within parameters from different sampling points of the river at ($P<0.05$).

3. RESULTS AND DISCUSSION

The results obtained from the physicochemical analyses are shown in Table 1. Temperature ranged from 27-28°C; pH, 4.97-6.82; electrical conductivity, 6020-6540 µs; alkalinity, 80-120 ppm; total dissolved solids (TDS) 2973-3725 mgL^{-1}; dissolved oxygen (DO) 4.3-7.8 mgL^{-1};

biochemical oxygen demand (BOD) 2.5-3.5 mgL^{-1}; chemical oxygen demand (COD) 3.2-4.9 mgL^{-1}. There were no significant differences in physicochemical parameters for water samples from the different points. All physicochemical parameters were within WHO [9] limits with the exception of TDS, conductivity and alkalinity. Alkalinity which is a measure of the acid neutralizing capacity of water body was found to be higher than 8.5 mg/l reported by Olorode, et al. [10]. This might be because there were more mineral molecules in the Ogoloma-Okrika River which is prone to pollution compared to the distant Bonny River in their study. The conductivity of water is an indication of its chemical richness. The high conductivity values can be attributed to chemical pollutants entering the river both organic and inorganic.

Total dissolved solids (TDS) are substances dissolved which affect palatability and colour of water. Where high TDS is recorded the affected system must have been charged with geo-chemicals or chemicals from anthropogenic sources. For the Ogoloma-Okrika River, the reason for the high TDS could be from the refuse dump, effluent discharge and faecal materials. Okrika is a suburb of the oil city of Port Harcourt. The area is densely populated with shanties and the river is used for defecation and oddly for bathing and washing. It has been reported that TDS above 1200mg/l is not suitable for aquatic organisms [11]. Values exceeding 1200 mg/l by several folds were reported in this study. The implication, therefore, is that the ecosystem is under severe threat. The TSS pattern followed that observed in TDS, with higher values. This further suggests that human activities are momentous contributors to observed trend and not just geophysical and geochemical processes.

Dissolved oxygen (DO) is a very important water quality parameter that impacts on aquatic organisms. The DO content of water is influenced by the physical, chemical and biological processes taking place in the system. The DO values for the river were generally low. Although no health-based guideline value is recommended, low values impact on the survival and activities of a living organism in the water.

The observed BOD (Table 1) in the river could be related to biological depletion of organic matter which supported the proliferation of bacteria. The water is moderately polluted as indicated by BOD and COD values. Higher levels of BOD and COD are not desirable because they are linked to low DO which can result to the death of aquatic lives. John and Chimka [12] reported that the levels of DO, BOD and COD in Okrika River ranged from 1.27-3.17 mg/L, 3.36-3.76 and 5.16-5.58 respectively and surmised that insufficient oxygen in the river resulted in suffocation of fishes.

Table 1. Physicochemical properties of the water samples obtained from different points of the Ogoloma-Okrika River

S/N	Sample code	Temperature (°C)	pH	Electrical conductivity (µc)	Alkalinity (ppm)	Total dissolved solids (mgL-1)	Total suspended solids (mgL-1)	Dissolved oxygen (mgL-1)	Biochemical oxygen demand (mgL-1)	Chemical oxygen demand (mgL-1)
1	OW	27	6.82	6440	80	3725	6275	4.7	3.3	4.3
2	OT	28	6.23	6540	100	3590	6410	4.3	3.5	3.8
3	OU	27	4.97	6507	120	2973	5027	7.8	2.7	3.2
4	OD	27	5.84	6249	80	3423	6577	4.1	2.5	4.9
5	OO	27	5.32	6020	100	3240	6760	4.2	3.1	4.2

OT=human excrement point, OW=refuse dump point, OO=crude oileffluent discharge point, OU=upstream, OD=downstream

The results obtained from bacteriological analyses were presented in Table 2 and 3. The total heterotrophic bacterial count obtained in this study ranged from $7.0x10^4$ $cfuml^{-1}$ to $9.95x10^5$ $cfuml^{-1}$; total coliform, 20-210 MPN/100 ml; faecalcoliform 6-53 MPN/100 ml; *Vibrio*, $4x10^3$ $cfuml^{-1}$-$1.78x10^5$ $cfuml^{-1}$ (Table 2). The counts obtained from these samples were generally high and above the regulatory standards stipulated by NAFDAC. This is similar to the results obtained by Hazen and Toranzos [13] that compared the bacteriological diversity of surface water and groundwater systems given and surmised to this high microbial content it cannot serve as a source of water for domestic purposes most especially for drinking.

Salmonella was only present in the sample obtained from the refuse dumping point, while *Shigella*was absent only in the sample obtained from the crude oil effluent discharge point (Table 3). A total number of 26 bacterial isolates were obtained from all the samples and they were identified to belong to either of these genera: *Acetobacter* (7.7%), *Erwinia* (15.3), *Planococcus* (19.2%), *Citrobacter* (23.1%), *Escherichia* (19.2%), *Vibrio* (19.2%), *Salmonella,* (4%), *Shigella* (15.3%), *Enterobacter* (7.7%) and *Klebsiella* (7.7%) (Fig. 1). Most of these isolates are established human pathogens causing a wide variety of diseases. These pathogens have significant percentage occurrence in these samples, therefore; there is a greater risk of diseases such as cholera, pneumonia, salmonellosis, shigellosis and diarrhoea when using water sourced from these locations. On the basis of isolation, and identification, possible diseases that could be acquired while using these water sources include.

Environmental factors contribute to the determination of the survival rate of microorganisms in their respective habitat [14]. The prevailing physicochemical properties observed in this study indicated a favourable environment for the growth of the bacterial species.

Table 2. Bacterial counts obtained from different points of the Ogoloma-Okrika River

S/N	Sample code	Total heterotrophic bacteria ($x10^4$ $cfuml^{-1}$)	Total coliform count (MPN/100 ml)	Faecal coliform count (MPN/100 ml)	Total *Vibrio* count ($x10^3$ $cfuml^{-1}$)	*Salmonella* detection	*Shigella* detection
1	OW	99.5	35	6	178.0	+	+
2	OT	89.0	210	53	6.0	-	+
3	OU	7.0	20	13	15.0	-	+
4	OD	48.3	35	12	4.0	-	+
5	OO	25.0	28	11	-	-	-

OT=human excrement point, OW=refuse dump point, OO=crude oil effluent discharge point, OU=upstream, OD=downstream point, OU=upstream, OD=downstream

Table 3. Bacterial Isolates obtained from Ogoloma-Okrikariver

S/N	Sample code	Isolates
1	OW	*Acetobacter*sp., *Erwinia*sp., *Planococcus*sp., *Citrobacter*sp., *Escherichia coli, Vibrio*sp., *Salmonella* sp., *Shigella* sp.
2	OT	*Vibrio*sp., *Shigella*sp., *Enterobacter*sp., *Escherichia coli, Klebsiella*sp., *Citrobacter*sp., *Planococcus*sp., *Erwinia*sp.
3	OU	*Vibrio*sp., *Shigella*sp., *Enterobacter*sp., *Escherichia coli, Citrobacter*sp., *Planococcus*sp., *Erwinia*sp.
4	OD	*Vibrio*sp., *Shigella*sp., *Enterobacter*sp., *Escherichia coli, Klebsiella*sp., *Planococcus*sp., *Erwinia* sp.
5	OO	*Acetobacter*sp., *Planococcus*sp., *Citrobacter* sp.

OT=human excrement point, OW=refuse dump point, OO=crude oil effluent discharge point, OU=upstream, OD=downstream

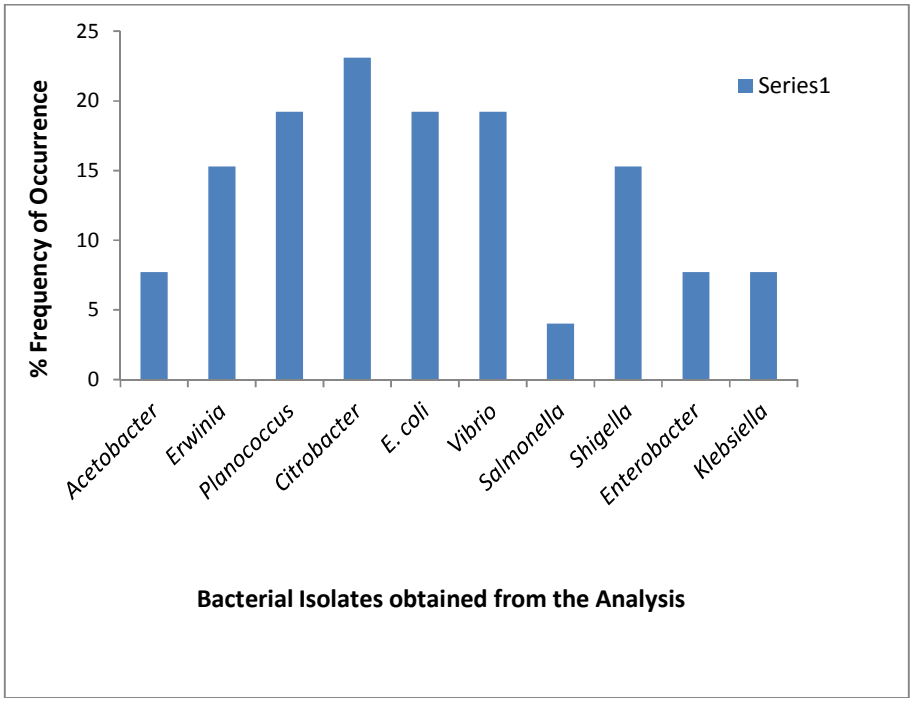


Fig. 1. Overall frequency of occurrence of bacterial isolates obtained from the samples

4. CONCLUSION

This study presents the current status of the water quality of the Ogoloma-Okrika River. From the results obtained from this study, it can be deduced that the condition of the river water in terms of its portability is in a poor state and requires proper measures taken to make it wholesome. Prior to use for domestic purposes, the water should be properly treated.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Stanley HO, Immanuel OM, Nwagboso A. Water quality assessment of the new Calabar River. Journal of Applied Life Sciences International. 2017;15(2):1-5.
2. Gleick PH. The world's water: The biennial report on fresh water resources. Island Press, Washington, D.C; 2008.
3. Molden D. Water for food, water for life: A comprehensive assessment of water management in agriculture. Earthscan, London, UK; 2007.
4. Donerance JJ, Gerba GP, Britton G. Microbial pollutants: Their survival and transport pattern in groundwater. Groundwater Microbiology, Wiley, New York. 2011;12–14.
5. Agency for toxic substance and disease registry (ATSDR). Medical Management Guideline for Water Pollution. 2007;30-31.
6. Sahota PP. Contaminants in drinking water. Research Report Punjab Agricultural University, Tribune Publications; 2005.
7. Stanley HO, Immanuel OM, Nwagboso A. Water quality assessment of the new Calabar River. Journal of Applied Life Sciences International. 2017;15(2):1-5.
8. NAFDAC. NAFDAC Guidelines on Packaged Water Production and Nafdac Consumer Safety Bulletin; 2003. Avaiable:http://www.nafdacnigeria.org/guideline.html
9. WHO. WHO guidelines for drinking-water quality – 4th ed. World Health Organization, Geneva, Switzerland; 2011.
10. Olorode OA, Bamigbola EA, Ogba OM. Comparative studies of some river waters in Port Harcourt based on their physico - chemical and microbiological analysis, Niger Delta region of Nigeria. International

Journal of Basic and Applied Science. 2015;3(3):29-37.
11. Pond GJ, Passmore ME, Borsuk FA, Reynolds L, Rose CJ. Downstream effects of mountain top coal mining: Comparing biological conditions using family-and-genus-level macro in ventebrate bio assessment tools. J. N. Am Benthol. Soc. 2008;27(3):717-737.
12. John NU, Chimka EI. Effect of discharge of partially treated refinery effluent on the Okrika River. J Environ Stud. 2017;3(2):1-6.
13. Abu GO, Egenonu C. The current pollution status of the new Calabar river in the Niger Delta region of Southern Nigeria: A survey of antibiogram profiles of its bacterial isolates. African Journal of Environmental Science and Technology. 2008;2(6):134-141.
14. Edzwald JK. Ed. Water Quality and Treatment, 6th Edition New York: McGraw-Hill, 2011;12.

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