Vol. 04, No. 01, pp. 20 – 24 (2023)
ISSN: 2708-1818

JOURNAL OF LIFE AND BIO-SCIENCES RESEARCH

www.jlbsr.org

Microbial and Physicochemical Evaluation of Water Sourced from the Diobu Neighborhood Water Scheme, Port Harcourt, Nigeria

Chidi N. Amadi-Ikpa[1,], Victoria G. Awari[2]

[1]*Department of Biology, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt, Rivers State, Nigeria (chidinduka@yahoo.com).*
[2]*Department of Microbiology, Faculty of Natural and Applied Sciences, Tansian University Umunya, Anambra State, Nigeria (ofoezievictoria@gmail.com)*

[*]Correspondence: *chidinduka@yahoo.com*

Abstract

The microbial and physicochemical evaluation of sourced water from the Diobu Neighborhood Water Scheme (DNWS) in Port Harcourt, Nigeria was investigated due to some skepticism by households in apprehension of infection and diseases, so the households disinfect their sourced water using chemical agents to control microbes. Sixty water samples were collected from two household groups; household group 1- 4 and 5-8 with each group having 30 samples each. Physiochemical and microbial property of water samples were analyzed using standard laboratory procedure. Heterotrophic bacteria, total coliform, fecal coliform and heterotrophic fungi recorded mean ± standard deviation counts of 219.5 ± 6.0 x 10^3, 29 ± 1.0 x 10^1, 21 ± 3.0 x 10^1 and 105 ± 3.0 x 10^2CFU/ml, for household group size 1- 4 persons respectively. Whereas, household group size 5-8 persons, had mean ± standard deviation counts of 890 ± 1.0 x 10^3, 55 ± 3.0 x 10^1, 24 ± 8.0 x 10^1 and 81 ± 2.0 x 102 cfu/ml, respectively. Temperature of water samples obtained from the household group size 1-4 ranged, from 28°C to 30.5°C whereas, the water samples from homes with household group size 5-8 ranged, from 260C to 300C. The physiochemical results reported hydrogen ion concentrations (pH) of water samples as 5.0 from household group size 1-4 persons while that of the water samples from household group size 5-8 persons recorded between 5.0 and 6.0. Although, drinking water from household size group 5-8 were more laden with microbes of medical importance, there was no significant amount of chlorine, bromine, magnesium and calcium elements observed in the water samples obtained from the homes. Hence, physicochemical examination showed acceptability despite the alleged interference of chemical. Therefore, the alleged use of chemical agents in water had no effect on the microbial quality of the sourced water.

Keywords: *Chemical Agents, Household, Microbial, Physicochemical, Sourced Water.*

Received: December 2nd, 2022/ Accepted: February 6th, 2023/Online: February 10th, 2023.

I. INTRODUCTION

The Diobu Neighbourhood Water Scheme (DNWS) are the bore-hole water supply facilities located in parts of Diobu area of Port Harcourt, Nigeria. The water pumping station from which this water is sourced is characterized by overgrown vegetation, poor drainage system, no toilet facility and poor disposal point (RSGN, 2008). According to (GRSN) 2016, the Diobu Neighbourhood Water Scheme (DNWS) was executed under government's assisted or somewhat franchise programme by government functionaries, especially, legislators as part of their constituency projects. The Rivers State Government legislated and implemented the water supply and sanitation project with support from the African Development Bank and the World Bank, aimed at providing water service in Port Harcourt and Obio/Akpor Local Government Area (RSGN, 2008). Thus, the impact of an increasing human population has been associated with mostly poor sanitation and solid waste management (Osumenya *et al*., 2021). Due to the uncertainty of the water quality sourced from Diobu Neighbourhood Water Scheme, some residents who use it for drinking resort to the application/introduction of chemical agents into their water for the singular purpose of microbial control. Such chemical agents include: chlorine, hypochlorite, soap etc (Banach *et al*., 2021). Chemical disinfection of water with high concentration for the purpose of containing microbes is generally not recommended, particularly iodine agent due to its adverse effect on the thyroid gland (WHO, 2017). Basically, in the application of chemical agent to the water for drinking, it is important to

doi: 10.38094/jlbsr40194

www.ipacademia.org

consider the type of microbes targeted (WHO, 2017). For instance, the use of fluorine in water has been recommended and reported to prevent tooth decay and dental diseases carriers (Featherstone,1999). Despite the benefit of the use of these chemicals in the containment of microbes in water, the probability of any chemical occurring in significant concentration must be assessed on a case-by-case basis (Syafrudin *et al*., 2021). Ordinarily, bacteria in contaminated water survive for weeks without any form of sterilization (Banach *et al*., 2021). However, sterilization particularly, boiling, is a measure employed in warding off bacteria in water (Okoli *et al*., 2001). It is rarely applied by most households or even sometimes neglected, thereby gives room for consumption of contaminated water, which in-turn causes waterborne diseases (Osiemo *et al*., 2019). Thus, the harmful or negative effect of consuming water contaminated with bacteria or other microbes cannot be under emphasized. The significance of this study is that it evaluates the general suspicion over the current state of Water sourced from the Diobu Neighbourhood Water Scheme and the challenges / health risks associated with its veracity to the residents who consume the water by way of drinking. The study was aimed at determining the bacteriological and physicochemical properties of the water sourced from the scheme and used in homes within the schemes' vicinity

II. Materials And Methods

A. Water Sample Collection and Study Design

Water samples were collected from homes with different household sizes in Diobu sub-hub of Port Harcourt, Nigeria. The Diobu sub-hub is majorly a district that has turned to a settlement of mostly low-income families associated with huge commercial and economic activities (Wokekoro and Owei, 2014). The Households depends largely on several water supply schemes embarked upon under government assisted or somewhat franchise, executed through government officials such as legislators (GRSN, 2016). For the purpose of this work, Household sizes of one to eight were adopted. The household population was collapsed into two groups, namely household group 1- 4 persons and household group 5-8 persons in a home. According to Nsing (2016), the household represents a group of persons who make common provision of food, shelter and other essentials for living. The water samples from these household groups were collected in three phases for each of the homes. A total of fifteen water sample for each phase were collected from the household-size group, making each group 45 samples each for the study.

B. Bacteriological Analysis

Bacteriological analysis involved subjecting the water sample to a serial dilution, inoculation into appropriate media and incubation. This is was then followed by isolation for pure cultures of bacterial isolates, their identification and preservation as adopted by Wemedo *et al*. (2016). Bacteriological analysis adhered aseptically to allotted procedure and time. In preparing the media and water samples for analyses. The collected water samples were subjected to ten (10) fold serial dilution (Laboratory Tools and Techniques, 2017). The ten- fold serial dilution of the sample contained in it after preparation, sodium chloride, whose function was to revive any viable cell present in the water. Ten-fold serial dilution was adopted to reduce the number of viable cells by one-tenth (Ben-David & Davidson, 2014). Following the dilutions, an aliquot of the sample was aseptically plated on an already prepared Nutrient media, Eosin Methylene Blue media, MacConkey media and Sabaraud Dextrose media to obtain counts for heterotrophic bacteria, fecal coliform, total coliform and heterotrophic fungal at a standard temperature condition and time (Akani *et al*., 2020).

C. Biochemical Characterization of the Bacterial Isolates

Reagents such as Oxidase, Methyl red, Voges-Proskauer, Citrate, Glucose, Sucrose, Lactose, Indole, Catalase and Coagulase were prepared and used to characterize the isolates biochemically (Sawian *et al*., 2017).

D. Physico-Chemical Analyses of the Aater Samples

The determination of physical characterization of the water soughted for parameters such as: colour, turbidity, suspended or floating matter and total dissolved solid, as carried out by Karki (2018). Chemical characterization of the water samples, involved investigation for: magnesium, calcium, chlorine and iodine elementsreference (Gautam, 2020).

1- Temperature Determination. The temperatures of the water samples were determined using the mercury in glass thermometer. The process involved dipping the thermometer into the water sample for five (5) minutes, followed by observation, for rise in the mercury level and reading of the graduation (Rahman *et al*., 2021).
2- Hydrogen Ion Concentration. The hydrogen ion concentration (pH) of the water samples were determined using a calibrated pH meter. The meter was dipped into the water samples and readings obtained and noted (Brandt *et al*., 2017).
3- Alkalinity Test. The test was done to determine the alkaline status of the water sample. The test as employed by Brandt *et al.* (2017) involved the use of methyl orange indicator reagent, in drops of 4-6 into a 50ml water sample, contained in a conical flask. A change in the color of the medium to yellow indicated an alkaline status (positive) while a pink coloration indicated an acidic status/medium (negative) (Brandt *et al*., 2017).
4- Colour Examination. The colour of the water sample was determined by its appearance under the influence of light ray as carried out by Hongve and Akesson (1996). The sample as contained in a test tube was placed under light ray, and the reflection for green, blue, black, yellow etc. colours were investigated. Colourless samples were declared negative and coloured sampled declared positive (Hongve & Akesson, 1996).
5- Turbid Examination. This examination was done to determine if the water sample can be seen through as employed by Fondriest Environmental Inc. (2014). The

water contained in a test tube was gazed for about 60 seconds. A clear view was declared negative while an unclear view declared positive.

6- Filtration Paper Analysis. The analysis involved passing the water sample through a filter medium (filter paper) as used by Aryal (2022). The filter paper was used to separate any suspended or floating mater in the water. In carrying out this analysis, a filter paper was placed on a funnel enclosed to a beaker, and the sample poured unto it. Observation for presence of suspended solids or residue on the surface of the filter paper were noted positive while an absence of residue on the filter paper indicated negative (Aryal, 2022).

7- Solvent solubility assay. This test was done to determine dissolved solids in the water sample. The concentration of solute in the water was determined as carried out by Woodard *et al*. (2021), where the water samples were allowed to stand for 20 minutes in a conical flask and a positive result for solubility was visibly observed, by settling-down of solute in the bottom of the flask. The absence of a dissolved solute signified a negative result, while presence of it indicated positive.

8- Calcium, magnesium, chlorine and bromine titration assay. Titration assay was employed as used by Amine and Mahammadi (2019) to determine calcium, magnesium, chlorine and bromine contents in the water samples. The assay required carrying out a chemical reaction to neutralize the water samples. With the sample placed on a beaker, the reagents of calcium, magnesium, chlorine and bromine contained in a long-graduated tube (burrete), from which the flow of the various reagents can be controlled with a stop cock. Reagents from the burette were then added drop-wise until a complete neutralization of the water sample is achieved called end-point (Amine and Mahammadi, 2019). In the absence of neutralization or end point or colour change, the element was declared absent. A positive end-point of grey/dull and pink colours were noted for calcium and magnesium respectively, while a negative end point indicated no colour change (Amine and Mahammadi, 2019).

III. RESULTS

A. Microbial Properties of Water Samples Sourced from Different Household Sizes

Table 1 shows the counts of the microbial loads of water samples obtained from household size between 1-4 and 5-8 persons. Counts of coliforms and heterotrophic bacteria/fungi were detected. The counts varied across the household size groups. Heterotrophic bacteria had a mean count of 2.14×10^4 cfu/ml and 1.78×10^4 cfu/ml for water samples from Household size of 1- 4 and 5 - 8 persons respectively. The household size between 1-4 person's water samples had a lower count; significantly different from the water samples from 5 - 8 persons at a probability value less than 0.05. Total coliform had a mean count of 2.9×10^2 cfu/ml and 5.5×10^2 cfu/ml for water samples from homes with 1 - 4 and 5 - 8 persons respectively. The counts showed a significant difference at a probability value less than 0.05 between the water samples from the homes/household sizes group. The fecal coliform mean count of 2.1×10^2 cfu/ml obtained from the water samples from households with 1- 4 persons were significantly not more than 2.4×10^2 cfu/ml counts obtained from the water samples in homes with 5 - 8 persons at a probability level less than 0.05. The mean ± standard deviation counts, of 1.05×10^3cfu/ml was obtained for heterotrophic fungi in water samples derived from homes with 1 - 4 persons. This count was thus lower and significantly different at a probability value less than 0.05 compared with that obtained in homes with 5 – 8 persons, which had a fungal counts of 8.1×10^2 cfu/ml.

Table 1. Mean variation of microbial loads in water samples sourced from household size groups.

S/no*	Household Sizes/ Persons	Total Heterotrophic Bacteria (cfu/ml)	Total Coliform Bacteria (cfu/ml)	Fecal Coliform Bacteria (cfu/ml)	Fungal (cfu/ml)
I	1 – 4	1.78×10^4	2.9×10^2	2.1×10^2	1.05×10^3
Ii	5 – 8	2.19×10^4	5.5×10^2	2.4×10^2	8.1×0^2

*Values are mean of triplicates determinations ± Standard Deviations (SD).

cfu/ml= Coliform Forming Unit per ml, WHO= World Health Organization, P =Probability.

Table 2. Occurrence of bacterial isolates in drinking water samples obtained from different household sizes groups.

S/no	Household Sizes/Persons	Total Heterotrophic Bacteria	Fecal Coliform Bacteria	Total Coliform Bacteria	Total Heterotrophic Fungi
I	1 – 4	10	35	14	34.5
Ii	5 – 8	1	10	4	3.5

B. Physicochemical Properties of Water Samples Obtained from Household Size

Table 3 below shows the physicochemical characteristics of the water samples sourced from the household size unit. The storage temperature of the water samples obtained varied independently of the household size units investigated. The water samples obtained from the household size of 1 - 4 persons had temperature that ranged from 28 to 30.5^0C while the water samples within household size 5-8 had temperature range from 26 to 30^0C.Total dissolve solid, total suspended solid and turbidity analysis were absent in drinking water samples obtained in both homes under this study. The hydrogen ion concentrations (pH) of water samples obtained from household sizes within 1-4 persons was 5.0 while that of the water samples from household size of 5 - 8 persons ranged from 5.0 and 6.0. There were no chlorine, bromine, magnesium and calcium elements in the water samples.

Table 3. Physicochemical features of water samples obtained from household size groups.

Water Samples From*	Temp. ^{0}C	Total Dis. Solids	Total Susp. Solids	Turb.	(pH)	Aka-linity	Cl	Br	Mg	Ca
HS 1-4	29	-	-	-	5.0	-	-	-	-	-
HS 1-4	30	-	-	-	5.0	-	-	-	-	-
HS 1-4	30.5	-	-	-	5.0	-	-	-	-	-
HS 1-4	27	-	-	-	5.0	-	-	-	-	-
HS 1-4	28	-	-	-	5.0	-	-	-	-	-
HS 1-4	28	-	-	-	5.0	-	-	-	-	-
HS 1-4	29	-	-	-	5.0	-	-	-	-	-
HS 1-4	28.5	-	-	-	5.0	-	-	-	-	-
HS 1-4	29	-	-	-	5.0	-	-	-	-	-
HS 1-4	30	-	-	-	5.0	-	-	-	-	-
HS 5-8	27	-	-	-	5.0	-	-	-	-	-
HS 5-8	26	-	-	-	6.0	-	-	-	-	-
HS 5-8	37	-	-	-	5.0	-	-	-	-	-
HS 5-8	27	-	-	-	5.0	-	-	-	-	-
HS 5-8	28	-	-	-	6.0	-	-	-	-	-
HS 5-8	28	-	-	-	5.0	-	-	-	-	-
HS 5-8	29	-	-	-	5.0	-	-	-	-	-
HS 5-8	28.5	-	-	-	5.0	-	-	-	-	-
HS 5-8	29	-	-	-	6.0	-	-	-	-	-
HS 5-8	30	-	-	-	5.0	-	-	-	-	-

* HS= Household Size Group, + = Positive/Presence, - = Negative/Absence, Temp.ºC = Temperation Degree Celcius, Total Dis.Solids= Total Disolve Solids, Total Susp.Solids = Total Suspended Solids,Turb= Turbidity, Hyd.Ion.Conc= Hydrogen Ion Concentration, Cl=Chlorine,Br= Bromine, Mg=Magnessium, Ca= Cassium.

IV. Discussion

The heterotrophic bacteria load in water sourced from the households of Diobu settlement in Port Harcourt showed that: water samples from the household size 5-8 persons, were significantly different and higher than the water samples obtained in home size 1 - 4 persons. These, suggests why Al-horr *et al*. (2016) believed that the number of occupants in a house have impact on indoor environment quality, invariably affecting drinking water. Moreso, the counts obtained from the household size groups, do not satisfy the permissible counts of heterotrophic bacteria in drinking water. Thus, according to the World Health Organization (2017) report, it stipulated that heterotrophic bacterial counts in potable water should not exceed 100 CFU/ml. Based on the load of heterotrophic bacteria in the water sample, the water is declared unsafe specifically for household with population more than four (4) persons. Total coliform and fecal coliform bacteria which showed a significant difference in counts at $P < 0.05$ between the household sizes suggest why high bacteria count indicated unhygienic condition, as reportedly noted in a densely populated city (Amin *et al.*, 2019). However, heterotrophic fungi counts were higher in household sizes between 1-4 persons than that obtained from 5 - 8 persons given room for suspicion. This however may be due to the presence of fungi in a wide range of natural environment (Kaur *et al.*, 2019), notwithstanding the presence of human population in the area. Based on this, the study area has showed to pose some level of fungal impact on the water and therefore personal hygiene could be considered and hence a major factor in the control of further fungal emergence. The pH of 5 for water samples obtained from household size units of 1-4 persons and a hydrogen ion concentration (pH) of 5 and 6 for household sizes of 5 - 8 persons water samples clearly collaborate with WHO (2009) required pH for bacterial growth in drinking water. The average temperature of 28.9ºC for drinking water samples obtained from both household size groups allowed the expected growth of mesophiles only, and disallows the growth of thermophiles and psychrophiles (Mbah & Oselebe, 2004). The absence of chlorine, magnesium, bromine and calcium elements in both (household) water samples have no significant effect according to WHO (2017). WHO (2017) did not establish permissible concentrations of the above elements in water for drinking, however, according to WHO (2017), these elements raised no health concern even in their presence in water. The presence of these elements, may affect the water acceptability however, the absence of suspended solids, total dissolve solids and turbidity, which is reported may encourage the water acceptability and aesthetic quality or value for consumption and other purposes (WHO, 2017).

V. Conclusion

This study showed that most drinking water samples from households' sizes of 5 - 8 persons were laden with high bacterial contaminants than the drinking water samples obtained from1- 4 family sized homes. The microbial water quality assessment revealed also that the water samples had heterotrophic bacteria and coliform bacterial counts higher than the World Health Organization (2017) satisfactory limit for drinking water. However, fungi counts were different between the home groups.

The physico-chemical examination of the drinking water samples from the two distinct home groups showed acceptability despite the alleged interference of some household with the use of chemical agents on their sourced water. Thus, the alleged use of chemical agents for purpose of containment of microbes had no effect on the microbial quality of the water. Hence, household occupants should check-mate their activities / practices towards keeping proper hygiene in order to obtain safe and portable water sources.

REFERENCES

Akani, N.P., Amadi-Ikpa, C.N., Wemedo, S.A. (2020). Population of Microbes Associated with stored drinking water in some diobu homes, Port Harcourt, *International Journal of Research and Innovation in Applied*, 5(8), 2454-619.

Al-horr, Y., Arif, M., Katafygiotou, M. (2016). Impact of indoor environmental quality on occupant well-being and comfort. *International Journal of Sustainable Built Environment*, 5(1), 1-11.

Amin, M.D., Mamun, M.R. Das, K.K. (2019). Microbiological quality analysis of commercial fruit juice in Dhaka city. *Stamford Journal of Microbiology*, 8(1), 15-18.

Amine, A., Mahammadi, H. (2019). *Encyclopeda of analytical science* (Third Edition) Elsevier, www.sciencedirect.com.

Aryal, S. (2022). Water quality analysis by membrane filter (MF) technique. *Basic Microbiology*, *34*(1) 42.

Banach, J.L., Hoffmans, Y., Appelman, W.A.J., Bokhorst, H.V., Vanasselt, E.D. (2021). Application of water disinfection technologies for agricultural waters. *Agricultural Waste Management*, Elsevier, 244-106527.

Ben-David, A., Davidson, C.E. (2014). Estimation method for serial dilution experiments. *Journal of Microbiological Methods*, 107, 214 – 221.

Brandt, M.J., Johnson, K.M., Elphinston, A.J., Ratnayaka, D.D. (2017). *Chemistry, microbiology and biology of water*, (Seventh Edition). Elsevier limited, 235-321.

Featherstone, J.D. (1999). Prevention and reversal of dental caries: role of low level fluoride. *Community Dental Oral Epidemiology*, 27(1), 31-40.

Fondriest Environmental Inc. (2014). Measuring turbidity, total suspended sediment and water clearing. Fundamental of Environmental Measurement,https://www.fondriest.com/environmental-measurements/measuring-water-quality/turbidity-sensors-meters-and method/>.

Gautam, B. (2020). Chemical evaluation of trace elements in bottled water. *Journal of Healthcare Engineering*. Article ID 8884700.

Government of Rivers State Nigeria (GRSN) (2016). Water supply and sanitation project launch. *Rivers State Water Board Newsletter 7*.

Hongve, D., Akesson, G. (1996). Spectrophotometric determination of water colour in Hazen Units, *Water Research*, *30*(11), 2771-2775.

Karki, G. (2018). Physical parameters of water quality/physical characteristics of water. *www.onlinebiologynotes.com*

Kaur, R., Singh, D., Kesavan, A.K. (2019). Molecular characterization and antimicrobial susceptibility of bacteria isolates present in tap water of public toilets. *The Royal Society of Tropical Medicine and Hygiene*,*9* (5), 342-350.

Laboratory Tools and Techniques (2017). Manual of introductory and general microbiology, department of microbiology, rivers state university: Port Harcourt, Rivers State: ISBN: 978-978-53312-3-2.

Mbah, M.C., Oselebe H.O. (2004). *General biology* (Third Edition). Abakiliki. Ebonyi State: Speed and Skill Publication Company.Pp 47

Nsing, H.A. (2016). Assessment of the role of makeshift housing development in urban housing market: Case study of ikom urban. department of urban and regional planning, faculty of environmental science, Cross Rivers State University of Technology, Calarbar: CodeMint Helpdesk.

Osiemo, M.C., Ogendu, G.M., Erimba, C. (2019). Microbial quality of drinking water and prevalence water related disease in Marigat urban center,Kenya. *Environmental Health Insights*.

Okoli, E.C., Chukwu, D.N., Idah, N.N., Afiukwa, J.N., Nmezi, P.N., Obeta, A.E. (2001). *Foundation chemistry* (First Edition) Enugu State, Nigeria. Mekanand Publications. P. 129s

Osumenya, I.T., Naabiradee, P.B., Mbato, C.Y., Vivian, K.K., Amadi-Ikpa, C.N. (2021). Domestic waste management and Covid-19 pandemic in Rivers State. *Journal of Health, Applied Sciences and Management*, *2*(2), 1597-7085.

Rahman, A., Jahanara, I., Jolly, Y. (2021). Assessment of physiochemical properties of water and their seasonal variation in an urban river in Bangladesh. *Water Science and Engineering*, 14(2), 139-148.

Rivers State Government of Nigeria (RSGN) (2008). The greater Port Harcourt city development authority: Economic Appraisal: Port Harcourt in Niger Delta Region of Nigeria.

Sawian, P., Nongkynrih, K.J., Anand, U., Chavan, A.A. (2017). Biochemical tests performed for the identification of the isolates collected from local rice beer. *Journal of Pharmacognosy and Phytochemistry*, 7(1), 395-397.

Syafrudin, M., Kristants, R.A., Yuniarto, A., Al-Mohaimeed, A.M. (2021). Pesticides in drinking water: a review. *International Journal of Environmental Research and Public Health*,18(2),468.

Wemedo, S.A., Amadi-Ikpa, C.N., Essien, J.P. (2016). Population and virulent attributes of bacteria in sachet water sold in a Port Harcourt Subhub (Rumuepirikom). *Journal of Biology and Genetic Research*, 2(3), 2545-5710.

Woodard, J. (2021). What is total dissolved solid in water and why should you measure it? *Fresh Water System BLOG*

Wokekoro, E., Owei, O. (2014). An assessment of residential quality of life in informal settlements in Port Harcourt municipality. *Journal of Humanities and Social Sciences*, 19(3), 11-26.

World Health Organization (2009). Benefits and risks of the use of chlorine containing disinfectants in food production and processing: Report of a Joint FAO/WHO Expert Meeting, Geneva, Switzerland.

World Health Organization WHO. (2017). Guideline for drinking water quality (fourth edition) incorporating the first addendum Geneva, Switzerland: WHO Library Cataloguing In-Publication ISBN 978-92-4-154995-0.