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Microbial Pollution of Water Resources in an Oil Producing Community (IBAA)

Ebere Joy Uchechi[1, *], Amajuoyi Chinomso Allwell[2]

[1]Department of Microbiology, University of Port Harcourt, Rivers State, Nigeria
[2]Department of Applied and Environmental Biology, Rivers State University of Science and Technology, Nkpolu, Port Harcourt, Rivers State

Email address
jgirl14sure2001@yahoo.com (E. J. Uchechi), allwellcave@yahoo.com (A. C. Allwell)

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Abstract
This work was undertaken to investigate microbial pollution of water resources in IBAA, one of the oil-producing Communities in Rivers State, Nigeria. A total of seven water samples were collected from different points in the following order: sample of underground water were collected from three different boreholes, a well water sample and surface water were collected from three points in a river, 200m apart and all located close to a spill site which occurred in June, 2007. Test results showed that the total bacterial counts and total coliforms counts were above limit for all the borehole samples tested while *Escherichia coli* and *Salmonella typhi* counts were within limit as specified by Department of Petroleum resources and World Health Organization for effluent water samples and drinking water samples respectively. Other microorganisms isolated from the water samples include *Staphylococcus aureus, Enterobacter species,* and *Bacillus subtilis*. Generally, the level of contamination of borehole water samples differ from that of both the well and river water samples. The river water and the well water samples were of poor microbial quality. To ensure supply of safe drinking water to the public, routine chemical analysis and microbial analysis is imperative to detect on time, incidental and eventual deterioration of water quality especially the Community High School water (CHSW) area which is prone to industrial pollution from the river.

1. Introduction

Water is indispensably and intricately connected to life as if without water there is no life. Seventy percent of the human body is water; seventy percent of the planet earth is water. This is the reason for which water must be given the necessary attention at all times. Good drinking water is not a luxury; it is one of the most essential amenities of life itself. The supply of safe drinking water to all has therefore engaged the attention of many individuals, groups, governmental organizations and the private sector. Safe drinking water is the priority of all people. The quality of water of a people can be a measure of their civilization.

In many developing countries, availability of water has become a critical and urgent problem and it is a matter of great concern to families and communities depending on non-public water supply system (Abu and Egenonu, 2008; Okonko *et al*., 2008). Increase in human population has exerted an enormous pressure on the provision of safe drinking water especially in developing countries (Umeh *et al*., 2005). Unsafe water is a global public health threat, placing persons at risk for a host of diarrheal and other diseases as

well as chemical intoxication (Hughes and Koplan, 2005).

Microorganisms play a major role in water quality and among the microorganisms that are concerned with water borne diseases are *Salmonella* sp., *Shigella* sp., *Escherichia coli* and *Vibrio cholerae* (Birmingham *et al*., 1997). These bacterial pathogens cause such illnesses like typhoid fever, diarrhea, dysentery, gastroenteritis, and cholera. Other agents of water borne diseases are protozoa which cause diarrhea example *Entamoeba histolytica*, *Giardia lamblia*, *Balantidium coli* (Jawetz *et al*., 1991) and *Cryptococcus pervum* (Kelly *et al*., 1997). There are also enteroviruses of various clinical ailments such as *Polivirus*, *Rotavirus*, *Hepatitis* A virus (Hejkal *et al*., 1982) and Hepatitis E virus (Benjelloun *et al*., 1997). The most dangerous form of water pollution occurs when feces enter the water supply. Many diseases are perpetuated by the faecal-oral route of transmission in which the pathogens are shed only in human feces (Tortora *et al*., 1998). The presence of faecal *coliforms* namely *E. coli* is used as an indicator for the presence of any of these water borne pathogens (Chukwura, 2001; Okpokwasili and Akujobi, 1996; Okafor, 1985). To maintain good health, water should be of good quality and quantity meeting local and WHO recommended standards of taste, odor and appearance (Cheesbrough, 2000).

It has been reported that crude oil pollution tends to change physical and chemical properties of the soil thus indirectly affecting the growth of plants (Frankenberger and Johanson, 1982).

About 90% of the Nigerian economy largely depends on revenue derived from crude oil. Although this particular natural resource has influence on the economy of nations, its exploration and exploitation bring a lot of hardship and negative effects as a result of oil pipeline rupture, oil well blowout, storage tank failures, effluent from petrochemical and refineries to mention a few.

Water bodies are constantly used as receptacles for untreated waste water or poorly treated effluents accrued from industrial activities. This may render the water bodies unsuitable for both primary and/or secondary usage. One of the most critical crises in developing countries is the lack of adequate potable water. The usual source of drinking water is from streams, rivers, wells and boreholes which are usually not treated. In the Niger Delta region of Nigeria, the problem is getting potable water because of environmental pollution and degradation (Efe, 2002). Several studies in Nigeria had identified anthropogenic activities as easy source of water pollution (Ayoade, 1988 and 1994, Ayoade and Oyebande, 1983; Obasi and Balogun, 2001; Ovrawah and Hymore, 2001; Abu and Egenonu, 2008).

Though water is important to life, it is one of the most poorly managed resources in the world (Fakayode, 2005). The geology of the Western Niger Delta region is of the sedimentary type with a lithology of top layer of silty clay, and sand, followed by a thick sand layer (Okoye *et al*., 1987). The aim of this research therefore is to have a clear picture of how surface and groundwater resources in an oil producing community are impacted by microbial population and to make some recommendations as applicable.

2. Materials and Methods

2.1. Sample Collection

Seven water samples comprising three from boreholes: Elenwo's compound (ELW), Ohaka's compound (OHW), Comprehensive High School compound (CHSW); three (R_AW, R_BW, R_CW) from points in a river 200m apart all located close to a spill site which occurred in June, 2007 in IBAA Community in Emoha Local Government Area and one from a well (W_EW) were collected and analyzed.

Samples collected include Elewo borehole (310^{o}NW; 4^o 38'28"N and 6^{o}42'23"E), Ohaka borehole (332^{o}NW; 4^o 57'33"N and 6^{o}45'49"E), Comprehensive High School borehole (116^{o}SE; 4^o 55'44"N and 6^{o}48'28"E), Point A river water (353^{o}N; 4^o 55'44"N and 6^{o}48'28"E), Point B and C river water (111^{o}N; 4^o 55'44"N and 6^{o}48'28"E), and Well water (55^{o}NE; 4^o 49'44"N and 7^{o}1'33"E). The water samples aseptically collected using labeled sterile sample bottles were transported to the laboratory for microbial examination. Water samples were analyzed for total bacterial counts, total coliforms counts, total hydrocarbon utilizing bacteria, *Escherichia coli*, *and Salmonella and Shigela species*.

2.2. Microbiological Analysis

2.2.1. Enumeration of Total Hydrocarbon Utilizing Bacteria

Total viable hydrocarbon utilizing bacteria was enumerated using the vapour phase method. Mineral salts medium was used to selectively isolate hydrocarbon utilizing bacteria using the vapour phase transfer method.

2.2.2. Enumeration of Total Bacteria Count

The total bacteria counts were enumerated on nutrient agar plates by spread plate method using 0.1 ml of dilutions 10^{-1} to 10^{-4} of the bacterial suspensions. All inoculated plates were incubated for 24-48 hours at room temperature. The bacterial colonies on the plates were counted and randomly picked and purified by sub-culturing unto fresh agar plates using the streak plate technique.

2.2.3. Enumeration of *Escherichia coli*

About 100ml of the water samples was filtered through membrane filter with the aid of vacuum pump. The filter membrane was placed in the m-HPC agar plate. This was incubated using an incubator pre-set to 45.5 ± 5^{o}C for 24hours.

2.2.4. Enumeration of Total Coliforms Count

About 1ml water sample was pipetted into 9ml normal saline to form ten-fold dilution. Serial dilutions of 10^{-1} to 10^{-3} were carried out using 1:9 dilution ratio for each sample.

A 0.1ml aliquot of the pre-enrichment broth of 10^{-1} and 10^{-3} dilutions was aseptically selected with a sterile pipette and

spread plated in duplicates with flame sterilized glass spreader on well dried MacConkey agar plates. The plates were incubated at 35°C for 24hours.

2.2.5. Enumeration of *Salmonella* – *Shigela* Counts

About 1ml water sample was pipetted into 9ml buffered peptone water to form ten-fold dilution. Serial dilutions of 10^{-1} to 10^{-3} were carried out using 1:9 dilution ratio for each sample.

A 0.1ml aliquot of the pre-enrichment broth of 10^{-1} and 10^{-3} dilutions was aseptically selected with a sterile pipette and spread plated in duplicates with flame sterilized glass spreader on well dried *SS* agar plates. The plates were incubated at 35°C for 24hours.

2.2.6. Identification and Characterization of Isolates

Identification of the isolates was based on their culture morphology microscopic examination, carbohydrate fermentation, colonial morphology, Gram staining, Catalase, oxidase, motility, starch hydrolysis, IMViC and citrate utilization tests. References were made to Bergey's Manual of determinative Bacteriology (1974) 8th Edition for the identification of bacteria.

3. Results and Discussion

Seven water samples comprising three from boreholes: Elenwo's compound (ELW), Ohaka's compound (OHW), Comprehensive High School compound (CHSW); three from points in a river: (R_AW, R_BW, R_CW) and one from a well (W_EW) were analyzed.

The total bacteria counts (Table 1) of the water samples ranged from 3.7×10^2 cfu/ml to 3.3×10^5 cfu/ml with no sample having bacteria count within the limit of 100cfu/ml allowed for potable water (NSDWQ, 2007). Generally, the microbial loads of the samples analyzed were high above standard limits specified by WHO for total coliforms (Table 2) except ELW, OHW and CHSW that showed average values of 0cfu/100ml and 0cfu/ml for *Salmonella species* and *E. coli* counts respectively (Tables 3 and 4). There was no observed growth for total hydrocarbon utilizing bacteria (Table 5).

Table 1. *Total Heterotrophic Bacteria (cfu/ml)*

Sample Identity	Average
ELW	3.7×10^2
OHW	7.4×10^2
CHSW	2.7×10^3
R_AW	3.3×10^5
R_BW	2.5×10^5
R_CW	2.3×10^5
W_EW	2.5×10^4

Legend:
ELW – Elenwo Water; OHW – Ohaka Water; CHSW – Comprehensive High School Water; R_AW – River A Water; R_BW – River B Water; R_CW – River C Water; W_EW - Well Water.

Table 2. *Total Coliforms Counts (cfu/100ml)*

Sample Identity	Average
ELW	0.8×10^1
OHW	1.2×10^1
CHSW	1.6×10^1
R_AW	6.8×10^2
R_BW	3.4×10^2
R_CW	2.5×10^2
W_EW	1.2×10^2

Table 3. *Salmonella (cfu/100ml)*

Sample Identity	Average
ELW	0
OHW	0
CHSW	0
R_AW	1.3×10^1
R_BW	0.3×10^1
R_CW	0.4×10^1
W_EW	0.2×10^1

Table 4. *Escherichia coli (cfu/100ml)*

Sample Identity	Average
ELW	0
OHW	0
CHSW	0
R_AW	0.3×10^1
R_BW	0.2×10^1
R_CW	0.2×10^1
W_EW	0.2×10^1

Table 5. *Hydrocarbon Utilizing Bacteria (cfu/ml)*

Sample Identity	Average
ELW	0
OHW	0
CHSW	0
R_AW	0
R_BW	0
R_CW	0
W_EW	0

The average total bacteria counts of the borehole samples ranged from 2.7×10^2 to 7.4×10^2cfu/ml with 66.67% of the borehole samples count within the limit of 400cfu/ml allowed for potable water (WHO, 1985). Both the river water and well water samples contained high values of total bacterial counts ranging from 2.5×10^2 to 3.3×10^5cfu/ml. Erah *et al*., (2002) in a study conducted on the quality of ground water in Benin City, Nigeria found unacceptable levels of aerobic bacteria and fungi present in borehole water of Teboga District of Benin City. In another similar work, Eniola *et al*., (2007) obtained a range for bacteria of 5.0×10^2 to 7.0×10^2 cfu/ml for stored borehole water samples. In the present study, general quality of water samples was very poor with very high counts of bacteria. The total coliforms ranged from 0.8×10^1 to 6.8×10^2cfu/100ml. Similar results have been described by other researchers (Obi *et al.*, 2004; Potgier *et al.,* 2007) on studies done in different rural communities. Several

sources of contamination could be suggested and could include contamination from pit latrines. In fact construction of boreholes in rural areas does not always respect the location regulations (Dzwairo *et al.,* 2006) to make sure that these boreholes are not situated close to pit latrines. For all the boreholes, contaminations maybe due to lack of sewer pipe for discharge of sanitary waste into the treatment plant which will result in underground disposal of sewage into the aquifer. For river contamination, may be through run-off during rains carrying indiscriminate excreta disposed by humans and animals thereby impacting the aquatic environment. Nyati (2004) showed that the quality of borehole water supplies in Zimbabwe showed a seasonal fluctuation, with higher coliform counts in the wet season, while municipal and mining compound water were of satisfactory microbial and chemical quality. All the samples contained *Escherichia coli* except the borehole samples that were devoid of *E. coli* (Table 4). It is note-worthy that only 42.9% of the water samples have zero *E. coli* counts whereas 100% of the water samples analyzed contained total coliforms.

The presence of *E. coli* in any borehole sample is unacceptable from the public health point of view. This organism can be pathogenic. Therefore, there is need for caution when using this borehole water for any purpose. Eniola *et al.,* (2007) obtained some members of coliforms in stored borehole water samples.

Results of the *Salmonella species* showed that borehole samples analyzed did not contain *Salmonella species*. However, *Salmonella* counts ranging from 0.2×10^1 to 1.3×10^1cfu/ml were obtained in both the river water samples as well as the well water samples. The presence of *Salmonella species* could be attributed to several activities that go on around and within the sample sites. These activities include bathing, washing, and are considered risk factors.

Different types of organisms were identified from their morphological and biochemical characteristics. These include *Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Enterobacter species, and Salmonella typhi.* Similar bacteria profiles have been isolated from borehole samples (Ibe and Okplenye, 2005).

4. Conclusion

Some microbiological parameters are above standard limits for the borehole water samples. The total bacterial counts and total coliforms counts are above limit for all the borehole samples tested while *Salmonella species* and *E. coli* counts of the borehole samples are within limit. Hence, there should be proper treatment of all borehole samples to ensure safety of the water samples especially from contamination by total bacteria and total coliforms as the contamination can be attributed to the old nature of the distribution network of pipes.

Generally, there is a variation in the level of contamination between the borehole water samples and the river water samples in both their physicochemical and microbiological characteristics. The river water and the well water samples are of poor microbial quality.

To ensure supply of safe drinking water to the public, routine chemical analysis and microbial analysis is imperative to detect on time, incidental and eventual deterioration of water quality especially the CHSW area which is prone to industrial pollution from the river.

Recommendation

According to the results obtained in this study, it can be concluded that the borehole water samples used, are of poor quality and it is recommended that possible mitigation measures, treatment and follow up should be imbed and sources of contaminations traced. Disinfection of water in storage tanks before distribution through the taps should be implemented. There is also need to carry out a comprehensive social study to determine the number of people suffering from illnesses or diseases related to the microbial quality problems identified in these study areas. This will provide information on the actual health problems on ground as well as contribute to the use of untreated groundwater, and will also lead to the recommendation of realistic remediation methods for each specific health problems. This will be valuable in the design and implementation of intervention strategies as applicable. This study is important because of dependence by the masses on borehole, river water and well water as the only source of water. This will also enable the provision of data available to indicate that groundwater does not meet the national guidelines of water for human consumption as observed in the study area unless treated before use.

References

[1] Abu, G.O. and C. Egenonu (2008). The current pollution status of new Calabar River in the Niger Delta region of Southern Nigeria: A survey of antibiogram profile of its bacterial isolates. *African Journal of Environmental Science and Technology,* 2:134-141.

[2] Ayoade, J.O. and B.C. Oyebande (1983). Water resources in Efe, seasonal variations of physicochemical characteristics in water resources quality in Western Niger Delta Region, Nigeria. *J. Appl. Sci. Environ.,* 9:191-195.

[3] Ayoade, J.O. (1994). *Human Impact on the Environment*. In Filani (eds) Ibadan Region, Ibadan. Rex Charles Pub.

[4] Benjelloun, S., B. Bahbouhi, N. Bouchrat, L. C hericaoni, N. Nad, J. Mahyour and A. Bensumane (1997). Seroepidemiological study of an acute Hepatitis E outbreak in Morocco. *Res. Virol*., 148: 279-283.

[5] Birmingham, M.E., L.A. Lea, N. Ndayiminje, S. Nkurikiye, B.S. Harsh, J.G. Well and M.S. Ijeming (1997). Epidemic cholera in Burundi: patterns of transmission in the Great Rift Valley Lake region. *Lancet.,* 349: 981-985.

[6] Cheesbrough, M. (2000). *District Laboratory Practice in Tropical Countries*. Part 2, Cambridge University Press, pp. 143-154.

[7] Chukwura, E.I., (2001). *Aquatic Microbiology*. Otoba Press Limited, Onitsha, Nigeria.

[8] Dzwairo, B. Z. Hoko, D. Love, and E. Guzha (2006). Assessment of the impacts of pit latrines on groundwater quality in rural areas: a case study from Marondera district, Zimbabwe. *Phys. Chem. Earth. J.* 31:779–788.

[9] Efe, S. T. (2002). Urban Warming in Nigerian cities: The case of Warri metropolis. *African Journal of Environmental Studies,* 2: pp 6.

[10] Eniola, K. I. T., D.Y. Obafemi, S.F. Awe, I.I. Yusuf, and O.A. Falaiye (2007). Effects of containers and storage conditions on bacteriological quality of borehole water. *Nigerian Journal of Microbiology*, 21:1578 – 1585.

[11] Erah, P. O., C.N. Akujieze, and G.E. Oteze (2002). The quality of groundwater in Benin City: A baseline study on inorganic chemicals and microbial contaminants of health importance in boreholes and open wells. *Tropical Journal of Pharmaceutical Research*, 1:75-82.

[12] Fakayode, S.O. (2005). Impact assessment of industrial effluent on water quality of the receiving Alaro River in Ibadan, Nigeria. *Ajeam-Ragee* 10: 1-13.

[13] Frankenberger, Jr. W.T. and J.R. Johanson (1982). Influence of crude oil and refined petroleum on soil dehydrogenese activity. *J. Environ. Qual.* 11: 612 – 617.

[14] Hejkal, T.W., B. Keswick, R.L. Labella, C.P. Gerba, V. Sanchez, G. Dreesman, B. Hafkin and J.L. Melnick (1982). Viruses in a community water supply associated with an outbreak of gastroenteritis and infectious Hepatitis. *J. Am. Waterwork. Assoc*., 74: 317-321.

[15] Hughes, J.M. and J.P. Koplan. (2005). Saving lives through global safe water. *Journal of Emerging Infectious Diseases,* 11:1636-1637.

[16] Ibe, S.N. and J.I. Okplenye (2005). Bacteriological analysis of borehole water in Uli, Nigeria. *Afr. J. Appl. Zool. Environ. Biol.,* 7: 116–119.

[17] Jawetz, E., J.L. Melnick and E.A. Adelbery (1991). *Medical Microbiology*. 19th Edn., Appleton and Lange, Norwalk, Connecticut.

[18] Kelly, P.B., K.S. Ndubani, P. Nchito, N.A. Luo, R.A. Feldman and M .J. Farthing (1997). Cryptosporidiosis in adults in Lusaka, Zambia and its relationship to oocyst contamination of drinking water. *J. Infect. Dis*., 176: 1120-1125.

[19] National Standard for Drinking Water Quality (NSDWQ) (2007). *National Standard for Drinking Water Quality*, pp 1-22.

[20] Nyati, H. (2004). Evaluation of the microbial quality of water supplies to municipal, mining and squatter communities in the Bindura urban area of Zimbabwe. *Water Sci. Technol*., 50: 99–103.

[21] Obasi R.A. and O. Balogun (2001). Water quality and environmental impact assessment of water resources in Nigeria. *African Journal of Environment Studies,* 2:228-231.

[22] Obi C.L., P.O. Bessong, M.N.B. Momba, N. Potgieter, A. Samie, E.O. Igumbor (2004). Profiles of antibiotic susceptibilities of bacterial isolates and physicochemical quality of water supply in rural Venda communities, South Africa. *Water SA,* 30: 515-519.

[23] Okafor, N. (1985). *Aquatic and Waste Water Microbiology*. Fourth Dimension Publishing Ltd, Enugu, pp87.

[24] Okonko, I.O., O.D. Adejoye, T.A. Ogunnusi, E.A. Fajobi and O.B. Shittu (2008). Microbiological and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos Nigeria. *African Journal of Biotechnology*, 7:617-621.

[25] Okoye, N.V., Schoutan Jr, and A.J. O'Sullivan (1987). Monitoring and Evaluation of Oil Related Pollution in NNPC Operations. In Proceeding of the 1987 Seminar on the Petroleum Industry and Nigeria Environment held at Imo Concorde Hotel, Owerri.

[26] Okpokwasili, G.C. and T.C. Akojubi (1996). Bacteriological indicators of tropical water quality. *Environ. Toxicol*. *Water Qual*., 11: 77-82.

[27] Ovrawah, L. and F.K. Hymore (2001). Quality of water from hand-dug wells in Warri Environs of Niger Delta Region. *African Journal of Environmental Studies*, 2:169-173.

[28] Potgieter N, L.S. Mudau, F.R.S. Maluleke (2007). Microbiological quality of groundwater sources used by rural communities in Limpopo Province, South Africa. *Water Sci. Technol*., 54: 371–377.

[29] Tortora, J., S. Funke and L. Case (1998). *Microbiology*. *An Introduction*. 16th Edn., The Benjamin Cummings Publication, pp: 906-1001.

[30] Umeh, C. N., O.I. Okorie, and G. A. Emesiani (2005). Towards the provision of safe drinking water: The bacteriological quality and safety of sachet water in Awka, Anambra State. In the Book of Abstract of the 29th Annual Conference & General Meeting on Microbes as Agents of Sustainable Development, organized by Nigerian Society for Microbiology (NSM), University of Agriculture, Abeokuta, pp. 22.

[31] World Health Organization (1985). *W.H.O International Standards for Drinking Water*. pp 10-15.