



## Investigation of Faecal Coliform Contamination of Domestic Water Sources in Ebonyi Local Government Area, Ebonyi State, Nigeria

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### Authors' contributions

This work was carried out in collaboration between all authors. Author CVN designed the study and served as the principal investigator. Author OOO participated in study design and served as the principal supervisor. Author AUN participated in the study design and sample processing, and drafted the manuscript for publication. Authors CCE and INA participated in sample collection and analysis. Authors OIE, IM and COU participated in study design and sample collection. Authors AME and POUA participated in data acquisition and analysis. All authors read and approve the manuscript.

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## ABSTRACT

**Aims:** The investigation of faecal coliform contamination of domestic water sources in Ebonyi Local Government Area, Ebonyi State, Nigeria was undertaken.

**Study Design:** This was a descriptive study.

**Place and Duration of Study:** Ebonyi Local Government Area of Ebonyi State, Nigeria from September, 2014 to October, 2014.

**Methodology:** Samples from different water bodies in each of four communities in Ebonyi Local Government area were collected and analyzed using standard bacteriological methods for water analysis.

**Results:** In the four communities, well water samples from Mbeke and Ndiagu communities showed high content of faecal coliform with 50%, and 90% respectively, while faecal coliform from stream water samples was recovered more from Ndiabor and Nkaleke communities with 55.6% and 50% occurrences respectively. The result of the percentage bacteriological analysis showed that the faecal coliform and *Escherichia coli* have 45% and 12% prevalence respectively in stream water samples, 0% prevalence each in borehole water samples and 12.5% prevalence each in pond water samples.

**Conclusion:** The high presence of faecal coliform bacteria in these water bodies used for drinking, swimming and other domestic purposes is of public health significance considering the possibility of serving as vehicles for disease transmission. Effort should be geared towards educating the inhabitants of the study area on the need for proper disposal of refuse, treatment of sewage and the need to purify their water to make it fit for drinking and other purposes.

*Keywords: Water; faecal contamination; coliform; water-borne diseases.*

## 1. INTRODUCTION

The potential health hazards posed by contaminated water from numerous sources have received an overwhelming concern due to the associated burden of waterborne illnesses [1]. The most predominant waterborne disease, diarrhoea, has an estimated annual incidence of 4.6 billion episodes and causes 2.2 million deaths every year [2]. Children are the main victims of diarrhoea and other faecal-oral disease, and also the most likely source of infection [3] Water pollution has been identified as one of the causes of disease outbreak [4]. Pollution results from an alteration in the physical, biological and chemical regimes in the water environment which dangerously affect human life quality, as well as the life of other animals and plants [5,6].

Globally, water bodies including freshwaters have become one of the major means for the disposal of wastes especially the wastes that comes from industrial and agricultural practices closest to the water sources. The biological, physical and chemical nature of the recipient water bodies are greatly influenced by these habits [7]. The physical quality of the water is initially degraded by the wastes. Subsequently, the water bodies are biologically degraded. This is important as it regards variety, number, as well as organization of the microorganisms [8]. Waste

materials are often assimilated by the water bodies which receive these wastes without reasonable degradation of few water quality regimes, which then give rise to its capacity of assimilation seen as extent of assimilation [9]. Consequently, the freshwater quality is degrading daily as a result of many unwholesome activities by man and other means of freshwater contamination. The addition of waste water, industrial and municipal wastes into the water bodies greatly affect the biological quality thereby rendering them unfit for use [10,11]. Water contamination by effluents has raised a question of considerable public and scientific concerns because of its evidence of extreme danger to human wellbeing as well as biological ecosystems [12].

The recent years have witnessed enormous concern over the microbial quality of drinking water [13-16]. The greatest risk to public health from microbes in water is associated with consumption of drinking-water that is contaminated with human and animal excreta [17]. Human faeces can contain a variety of intestinal pathogens which cause diseases ranging from mild gastro-enteritis to the serious dysentery, cholera and typhoid [18]. Total and faecal coliforms have been enumerated from various water sources [19]. The presence of faecal coliforms indicates the contamination of water with faecal material than may contain

pathogenic organisms. These indicator bacteria were found to be more common in unprotected water sources than protected water sources [20].

The production of water that is good for consumption is the major objective of municipal water system [21]. For this to be possible, a good knowledge of the water quality is necessary to determine the method of purification to be used, should the water source be contaminated. Therefore, this work was an attempt to examine different domestic water sources from Ebonyi Local Government Area of Ebonyi State, Nigeria. It was a solution-based research. The work is tailored towards assessing the rate of domestic water contamination as well as suggesting various ways to mitigate the ugly phenomenon.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study area is Ebonyi Local Government Area, one of the 13 L.G. As in Ebonyi State, Nigeria. Ebonyi Local Government Area is an agrarian council area. It is located between longitude 7°59'E and 8°20'E and latitude 6°22'N and 6°43'N. The area falls within the climatic region of South Eastern Nigeria where the rainy season spans from April to October and dry season from October to April [22]. The average annual rainfall of the study area is about 1500 mm with actual surface temperature (seasonal temperature) of between 24-36°C during dry season and about 18°C during the rainy season [22]. In the local government area, four randomly selected communities namely; Ndiabor, Mbeke, Ndiagu and Nkaleke were used for the study.

### 2.2 Sample Size and Source

Samples were collected from 320 sampling points. Well, stream, borehole and pond water bodies were used for the study. Samples were collected separately in clean sterilized plastic bottles in the month of September, 2014. Samples were collected from Ndiabor, Mbeke, Ndiagu and Nkaleke communities of Ebonyi Local Government Area of Ebonyi State, Nigeria.

### 2.3 Sample Collection

Collection of the water samples was done using a 50 ml pre-sterilized Schott Duran bottle [23]. While sampling in the streams, the collection bottle was lowered in water at a depth of about 15 cm to 30 cm. The bottle was held at

the base and placed against the direction of the water flow. Immediately the water was collected, the bottle was covered tight to avoid contamination from air and hand. As soon as each sample was collected, it was carefully labeled, after which they were transferred to the Department of Applied Microbiology Laboratory, Ebonyi State University, Abakaliki for analysis.

### 2.4 Bacteriological Analysis of Water Samples

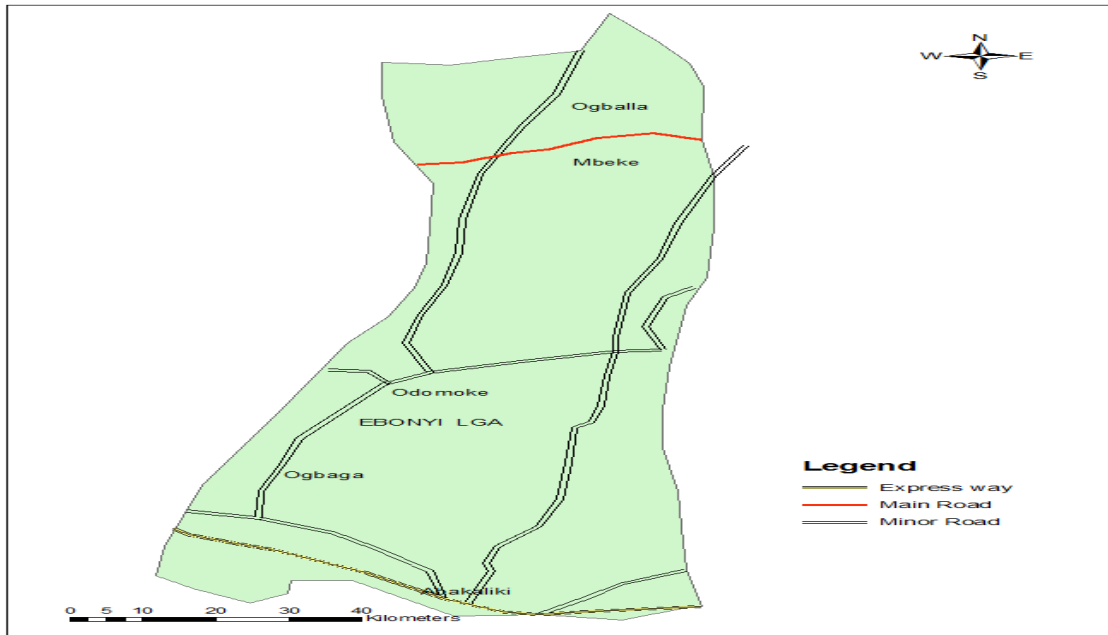
Bacteriological analysis of water samples was done by Most Probable Number (MPN) method [24]. The test was performed sequentially in three stages: presumptive, confirmed and completed tests. Lactose broth tubes were inoculated with different water volumes in the presumptive test. Tubes that were positive for gas production were inoculated into brilliant green lactose bile broth in the confirmed test at 44.5°C and positive tubes were used to calculate the MPN of coliforms in the water samples following the statistical table. The completed test, involving the inoculation of EMB agar plate, nutrient agar slant and brilliant green lactose bile broth and preparation of a gram stain slide from NA slant, were used to establish that coliform bacteria were present in the sample. The complete process including the confirmed and completed tests took at least 4 days of incubation and transfer at 44.5°C.

### 2.5 Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 19.0.

## 3. RESULTS

The bacteriological quality of 40 water samples in Ndiabor community was accessed based on coliform MPN, presence of faecal coliform and *Escherichia coli*. *E. coli* was seen a number of 8 times, out of which well water recorded the most with 6(75%), followed by stream and pond water with 1(12.5%) each, whereas borehole recorded no *E. coli*. Also, 9 faecal coliform were found, of which the highest was in stream water with 5(55.6%), followed by well water 3(33.4%) and borehole recorded no faecal coliform (Table 1). A total of 8 faecal coliforms were recovered from Mbeke community out of which, 4(50%) were from well water, 3(37.5) from stream water while borehole showed the presence of no faecal coliform (Table 2).



**Fig. 1. Map of Ebonyi Local Government Areas showing different communities**  
 (Source: Department of Geology, Ebonyi State University, Abakaliki)

Out of the 15 faecal coliform recovered from Ndiagu community, 9(60.0%) were from well water, while 5(33.3%) were from stream; borehole showed no faecal coliform presence. Also at Ndiagu, a total of 6 *E. coli* isolates was seen; the well water showed the most *E. coli* presence with 3(50.0%) followed by pond water with 2(33.3%) while borehole showed no *E. coli* presence (Table 3).

At Nkaleke, a total of 8 faecal coliform was seen; 4(50.0%) were isolated from stream water, followed by well and pond both with the prevalence of 2(25.0%), borehole showed no faecal coliform. The analysis indicated the presence of 6 *E. coli* isolates, with stream water recording most by 3(50.0%), followed by pond water with 2(33.3%), borehole showed no *E. coli* presence (Table 4).

**Table 1. Faecal coliform contamination of domestic water from Ndiabor community**

Water type	Number examined	Faecal coliform assessment of ndiabor community		
		Coliform MPN/100 ml	Faecal coliform	<i>Escherichia coli</i>
Well	10	7.1	3	6
Stream	10	0.4	5	1
Bore hole	10	0.2	0	0
Pond	10	3.4	1	1

**Table 2. Faecal coliform contamination of domestic water from Mbeke community**

Water type	Number examined	Faecal coliform assessment of Mbeke community		
		Coliform MPN/100 ml	Faecal coliform	<i>Escherichia coli</i>
Well	10	3.4	4	3
Stream	10	0.6	3	0
Bore hole	10	0.1	0	0
Pond	10	5.5	1	0

**Table 3. Faecal coliform contamination of domestic water from Ndiagu community**

Water type	Number examined	Faecal coliform assessment of Ndiagu community		
		Coliform MPN/100 ml	Faecal coliform	<i>Escherichia coli</i>
Well	10	6.0	9	3
Stream	10	0.6	5	1
Bore hole	10	0.3	0	0
Pond	10	5.0	1	2

**Table 4. Faecal coliform contamination of domestic water from Nkaleke community**

Water type	Number examined	Faecal coliform assessment of Nkaleke community		
		Coliform MPN/100 ml	Faecal coliform	<i>Escherichia coli</i>
Well	10	7.0	2	1
Stream	10	0.4	4	3
Bore hole	10	0.8	0	0
Pond	10	2.1	2	2

**Table 5. Percentage of coliform contamination of domestic water sources in Ebonyi local Government area**

Water type	Number examined	Faecal coliform	<i>Escherichia coli</i>
Well	40	18(45%)	13(32.5%)
Stream	40	17(42.5%)	5(12.5%)
Bore hole	40	0(0%)	0(0%)
Pond	40	5(12.5%)	5(5.5%)
<b>Total</b>	<b>160</b>	<b>40(25.0%)</b>	<b>23(14.37)</b>

Table 5 above shows the result of the percentage bacteriological examination of water samples according to water sources. Well water recorded the highest percentage (45%) of faecal coliform while borehole recorded the least (0%) percentage. Well water recorded the highest percentage (32.5%) presence of *E coli* while borehole water samples recorded the least percentage (0%) of *E coli* presence.

#### 4. DISCUSSION

The total coliform count for all the samples except borehole water samples were accordingly higher than the EPA permissible limit. EPA sets a standard of zero faecal coliform per 100 ml of drinking water [25]. Therefore, high coliform count recorded in this study indicated that the water sources were faecally contaminated. Except borehole samples with approximately 0% faecal coliform presence, other samples were highly positive for faecal coliform. According to EPA standard, if faecal coliform is detected in a sample of water, such sample must be further analyzed for *E. coli* with a view to assessing the status of contamination with human and animal

wastes and possible pathogenic bacteria or organisms such as *Giardia* spp. and *Cryptosporidium* spp. [25].

Highest presence of faecal coliform (45%) in the well water samples analyzed may be attributed to shallowness of the wells, location of the wells near septic tanks and soak away pits and non-covering of the wells. The finding is in agreement with the study results of Roohul-Amin et al. [23], Okonko et al. [26], Ngele et al. [27], Ajala et al. [28] and Shittu et al. [29]. The second highest rate of faecal coliform (42.5%) in the sampled streams is attributed to the release of animal and human faecal wastes into the water and other anthropogenic activities of man in and around the water body. Also, after rainfall, faecal materials might have been washed into the stream prior to this study as the study was carried out in rainy season. Pond water samples' low coliform (12.5%) level may be because of regulations instituted by some communities within the local government area against pollution of the pond water systems. The result of zero percent faecal coliform in the borehole samples could be linked to the respective borehole depths and location of

such boreholes away from septic tanks or soak away pits. Similar findings were reported by Iyasele and Idiata [30], where out of 30 borehole water samples assessed bacteriologically from Edo south and Edo north areas of Edo state, Nigeria, none of the samples was positive for total coliform. According to the World Health Organization, the permissible limit for faecal coliform and *Escherichia coli* is 0 mpn/100 ml of water. In this study, the highest presence (32.5%) of *E. coli* as recorded in well water samples also show high contamination by faecal wastes of humans and other animals. Poor hygiene has led to hike in the contamination of the drinking water sources.

## 5. CONCLUSION

The results showed high coliform presence indicative of recent faecal contamination of the water bodies at the time of this study. The result of this study shows that the domestic water sources of Ebonyi Local Government Area are not fit for drinking and other household activities as most of the of the examined samples are in disagreement with international standard for portable water. The high prevalence of pathogens in water used for drinking, swimming and other domestic purposes is of public health significance considering the possibility of serving as vehicles for disease transmission. Water from the domestic sources need to be subjected to treatment processes before use in order to destroy or remove pathogenic organisms. Above all, there is need to undertake further studies on the subject matter for up to twelve months to determine the monthly variations and to be able to identify pathogen free period.

Therefore efforts should be geared towards educating the inhabitants of the study area on the need for proper disposal of refuse, treatment of sewage and the need to purify their water to make it fit for drinking and other purposes.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Edema MO, Omenu AM, Fapetu OM. Microbiology and physico-chemical analysis of different and sources of drinking water in Adeokuta, Ogun State, Nigeria. Niger Journal of Microbe. 2001; 15(1):57-61.
2. WHO. Water for health. WHO Guidelines for Drinking-water Quality, WHO Geneva, Switzerland; 2010.
3. WHO/UNICEF. Global Water Supply and Sanitation Assessment 2000 Report, Switzerland; 2000.
4. Adegboyega AM, Olalude CB, Odunola OA. Physicochemical and bacteriological analysis of water samples used for domestic purposes in Idi Ayunre, Oyo State, Southwestern Nigeria. IOSR Journal of Applied Chemistry (IOSR-JAC). 2015; 8(10 Ver. I):46-50.
5. Thompson FL, Lida T, Swings J. Biodiversity of vibrios. Microbiol Mol Biol Rev. 2004;68(3):403-431.
6. Okoye PAC, Enemuoh RE, Ogunjofo JC. Traces of heavy metals in marine crabs. Journal of Chemical Society of Nigeria. 2002;27(1):76-77.
7. Sandoyin C. Entrophication trends in the water quality of the Rhode River. Journal Maritime Biological Association. 1991; 54(1):825-855.
8. Gray AV. Case study on water quality modeling of Diachi Lake, Yunnan province, Southwest China. Water Science Technology. 1989;40(1):35-43.
9. Fair P. A Hypothesis concerning Silicia and freshwater planktonic diatons limnology. Oceanogra. 1971;16(1):10-18.
10. Dwivedi BK, Pandey GC. Physico-chemical factors and algal diversity of two ponds in Faizabad. India Poll. Resources. 2002;21(3):361-370.
11. Nwidembia CV, Odikamnoru OO, Nnachi AU, Egwuatu CC, Nwinyimagu AJ, Aghanya IN, Achi, EC. Examination of the physicochemical characteristics of domestic water sources in Ebonyi Local Government Area of Ebonyi State, Nigeria. International Journal of Scientific and Technology Research. 2016;5(6): 306-311.
12. Katsuro A, Yashiko K, Yoshinnori S, Takashi T, Hayao S. Heavy-metal distribution in river waters and sediment in a Finefly Village; Shikou Japan: Application of multivariate analysis. Analytical Science. 2004;20(1):79-84.
13. Fewtrell L, Kay D, Wyer M, Godfree A, Neill GO. Microbiological quality of bottled water. Water Science and Technology. 1997;34(1):47-53.
14. Rosenberg FA. The microbiology of bottled water. Clinical Microbiology Newsletter. 2003;25:41-44.

15. Khaniki GRJ, Zarei A, Kamkar A, Fazlzadehdavil M, Ghaderpoori M, Zarei A. Bacteriological evaluation of bottled water from domestic brands in Tehran markets in Iran. *World Applied Science Journal*. 2010; 8(3):274-278.
16. Alli JA, Okonko IO, Alabi OA, Odu NN, Kolade AF, Nwanze JC, Onoh C, Mgbakor C. Parasitological evaluation of some vended sachet water in Southwestern Nigeria. *New York Science Journal*. 2011; 4(10):84-92.
17. WHO. *Guidelines for Drinking-water Quality*, Fourth edition. WHO, Geneva, Switzerland; 2011.
18. Tsega N, Sahile S, Kibret M, Abera B. Bacteriological and physico-chemical quality of drinking water sources in a rural community of Ethiopia. *African Health Sciences*. 2013;13(4):1156-1161.
19. Opisa S, Odiero MR, Jura WZO, Karanja DMS, Mwinzi PN. Faecal contamination of public water sources in informal settlements of Kisumu City, western Kenya. *Water Science and Technology*. 2012;66(12):2674-2681.
20. Zamxaka M, Pironcheva G, Muyima NYO. Microbiological and physico-chemical assessment of the quality of domestic water sources in selected rural communities of the Eastern Cape Province, South Africa. *Water SA*. 2004; 30:333-340.
21. Lamikanra A. *Essential microbiology for students and practitioners of pharmacy, medicine and microbiology*, 2<sup>nd</sup> edition. Amkra Books Lagos; 1999.
22. Ezeh H, Ugwu S. Geo-electric investigation of sulphide mineralization at Egu-Echaraunuhu, Abakaliki, S.E. Nigeria. *Journal of Applied Natural Sciences*. 2007;1(1):59-63.
23. Roohul-Amin, Ali SS, Anwar Z, Khattak JZK. Microbial analysis of drinking water and water distribution system in New Urban Peshawar. *Current Research Journal of Biological Sciences*. 2004;4(6): 731-737.
24. UNICEF. *Official summary, the state of the world children*. United Nations; 2002.
25. EPA. *US environment protect agency safe drinking water amendment*. Environmental Protection Agency. 2003;5:96-100.
26. Okonko IO, Adejoye OD, Ogunnusi TA, Fajobi EA, Shittu OB. Microbial and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos State, Nigeria. *Africa Journal of Biotechnology*. 2008; 7(5):617-621.
27. Ngele SO, Itumoh EJ, Onwa NC, Alobu F. Quality assessment of selected groundwater samples in Amike-Aba, Abakaliki, Ebonyi State, Nigeria. *Canadian Journal of Pure and Applied Science*. 2014;8(1):2801-2805.
28. Ajala L, Ibrahim TA, Adetuyi FO. Preliminary investigations on the physicochemical and microbiological analysis of water from streams used for drinking in Owo Local Government Area of Ondo state. *The Internet Journal of Nutrition and Wellness*. 2013;8(2):1-4.
29. Shittu OB, Olaitan JO, Amusa JS. Physico-chemical and bacteriological analysis of water used for drinking and swimming purposes in Abeokuta, Nigeria. *African Journal of Biomedical Research*. 2008; 11:285-290.
30. Iyasele JU, Idiata DJ. Determining the borehole water quality in Edo south and Edo north areas of Edo state. *Research Journal in Engineering and Applied Sciences*. 2012;1(4):209-213.

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