

Investigation of Prevalence of *Escherichia coli* in Public Drinking Water sources randomly Collected in and around Doibu Residential Area of Port Harcourt, Niger Delta

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Abstract: *Escherichia coli* contamination of drinking water source has continued to emerge, as an important public health concern across the globe. This had been associated with water born epidemic outbreak, especially in rural communities where access to potable water remains a massive challenge. However, identifying the source of *Escherichia coli* pollution in public water source had been hugely attributed to faecal contamination either from man or animals which constitute a serious environmental and public health threat to man. This study was designed and thus, aimed to determine the bacteriological quality of borehole water sources with specific reference to *E. coli* contamination in the studied locations (in Mile 2 and 3 area of Diobu, Port Harcourt). However, A convenience random sampling research design was explored to collect 50 water samples aseptically, and it was analyzed, using standard microbiological cultural technique (All samples were cultured on MacConkey and Nutrient agar plates respectively). The positive samples were examined for faecal coli form. Identification of *Escherichia coli* was done based on microscopic, cultural and biochemical characteristics. Of the 50 samples collected and processed for coli form presence, 22 samples (44%) showed growth of *Escherichia coli* when cultured on nutrient agar, 15 samples (30%) showed growth of *Escherichia coli* when cultured on MacConkey agar while 13 (26%) showed no growth on both media. This result strongly suggest that 74% of the boreholes studied did not meet up with the World Health Organization Standards guideline for drinking water source, thus will certainly pose a public health risk to the inhabitant of the area if left untreated. Nonetheless, it is firmly recommendation that borehole water from these affected areas should be treated, boiled and filtered before use for drinking and washing of fresh fruits to avert the possibilities of an outbreak of the water borne epidemic in the area.

Keywords: Public Health, Water, Borehole, *Escherichia coli*, Prevalence, Diobu, Port Harcourt

1. INTRODUCTION

Increasingly, public water drinking sources in urban settlements could potentially harbor dangerous strain of *Escherichia coli* from numerous sources, such as from animal and human carriers. It is strongly believed that after drinking contaminated water, within few hours or days, the organisms will settle in the gut [1]. *Escherichia coli* as the predominant facultative organism in the human intestinal tract hence, consist of a small proportion of the intestinal bacteria load burden.

Nevertheless, the presence or detection of *Escherichia coli* in public water is an indicator of potential faecal contamination of myriad of sources [2]. *Escherichia coli* has a fimbriae that is specie specific and each fimbriae adhesion help to attach them to specific receptor site on the enterocytes of the proximal small intestine [3]. There are five classes of *Escherichia coli* that produce disease, based on their pathogenesis. They are *Enterotoxigenic Escherichia coli*, *Enteropathogenic Escherichia coli*, *Enteropathogenic Escherichia coli*, *Enterohemorrhagic Escherichia coli* [4].

Interestingly, the pathogens enter a water supply chain sporadically and do not survive for long periods of time; however, presence of *Escherichia coli* in water supplies also suggests that other intestinal pathogens could also be present, since they are all present in faeces found in the small

intestine. Hence, it is of essence that while examining water for bacteriological safety, it is essentially important that critical attention should be focused on pathogens that are linked to animal faecal waste droppings in the environment [5]. These pathogens which are a group of Gram negative, non-sporing rods grow aerobically and are lactose fermenters at 35 - 37°C within 24 – 48 hours. They are collectively called Coli form Organisms [2, 6]. Nonetheless, regular sanitation exercise remains critical and key for maintaining standards in public water supplies, as it would require constant surveillance and proactive evaluation; that is, “keeping a careful watch at all times from the public health point of view, over safety and acceptability of drinking water supplies” standard [7]. According to WHO (2005) [7], sanitation inspection as part of surveillances, places so much emphasis on the systematic inspection of water installations/systems with the sole aim of identifying potential sources of risks of contamination, and any other source(s) of pollution and thus, recommend appropriate measures as soon as possible to avert grievous outbreak of water borne epidemic, that would affect large amount of people in less than no time, especially in remote communities with visible lack of basic water infrastructure in place. Nevertheless, there is increasingly paucity of data of research outcome, that is specifically targeted to the investigation of prevalence and contamination of *E. coli* pathogen in drinking water source in Diobu metropolis part of Port Harcourt, which harbors large amount of people of an average middle class citizens but serially dominated by lowest social class citizens and also less educated subjects, even as majority of the inhabitants are traders. It is firmly believed that data generated from the study would stimulate the interest of government and relevant government agencies towards pushing for more coordinated, effective and more practical actions based approach geared towards the provision of potable water to the inhabitants, and also increase the need of enhancing health education with respect to personal hygiene, environmental sanitation and prompt action towards the eradication of open defecation health challenges and possibly provision of public water system toilet in strategic locations of public places to reduce the littering of the environment with fresh human and animal faecal matter, which remains a major sources of water and in general environmental pollution through water run-off and seepage through water broken pipes underground.

2. STUDY LOCATION / DESCRIPTION

This research involved 50 boreholes as source of drinking water located at Mile 2 & 3 area of Diobu, Port Harcourt residential area. It is a densely populated area in Port Harcourt, noted for its largely unclean surroundings and a high sense of unhygienic practices such as poor waste disposal system and poor drainage systems. It is at the cardinal part of the city of Port Harcourt with numerous industrial and trading activities; notable among them are Mile 3 Market, Mile 3 Bus Park, Mile 3 Building Materials Market and Rivers State University, etc.

3. SAMPLE COLLECTION

The samples were aseptically collected into 50ml screw capped sterile tubes. Each water samples were collected by sterilizing the nozzle of the borehole tap using 70% (v/v) ethanol. The water was allowed to flow for two minutes before obtaining the sample into the tubes. The water samples were transported to the laboratory immediately for bacteriological analysis in an ice packed container to prevent external heat in the environment from altering the pathogen loads through inactivation process.

4. EXPERIMENTAL (LABORATORY ANALYSIS)

Three sets of three tubes each were arranged in rows in a test tube rack. MacConkey broth was aseptically prepared according to the manufacturers' instructions. 10ml MacConkey broth was aseptically added to three test tubes containing 10ml, 1ml and 0.1ml of the water sample respectively. The well sterilized Durham tubes were aseptically introduced into the medium. The mouth of the tubes were flamed and covered with sterilized cotton wool to avoid contamination. The tubes were examined after 24 hours' incubation at 37°C for colour change and gas production. Nevertheless, the tubes showing colour change from purple to yellow indicated fermentation while gas trapped in the Durham tube indicated gas production. These positive broths were re-incubated in fresh MacConkey broth in water bath at 44°C for 24 hours. Colour change after incubation indicated that the water was contaminated with *Escherichia coli*. The MPN was then estimated from the MPN table. The wire loop

Investigation of the Prevalence of *Escherichia coli* in public Drinking Water sources randomly Collected in and around Doibu Residential Area of Port Harcourt, Niger Delta

was first passed across the flame which was allowed to cool off. The wire loop was used to pick the sample and apply the inoculum to a small area of the plate on both Nutrient and MacConkey agar plates. Another sterile wire loop was used to aseptically spread the primary inoculum all over the plates. After which the plates were incubated at 37⁰c for 24 hours and observed for growth of organisms. The organisms isolated were characterized and identified by their biochemical reactions on citrate agar, methyl red/vorges proskaner, indole test and Gram staining reaction respectively according to Cheesbrough, (2000) [2]

5. RESULTS

Of the 50 water samples collected randomly for this study, 13 samples showed no growth on both MacConkey and Nutrient agar, 15 showed growth on both MacConkey and Nutrient agar while 7 showed growth only on MacConkey agar plate. Therefore, 74% of the sampled water showed growth of *Escherichia coli* whereas 26% showed no presence of *Escherichia coli*. The water sampled were grouped into 5; A, B, C, D & E

The results of the heterotrophic count (Table 6) of various sampled borehole drinking water source reveled that water sample from the B GROUP had the highest heterotrophic count of 7.5 x10² seconded by D GROUP 5.3x10⁴ and the least was E GROUP which recorded 1.5 x10⁴ respectively

Table1. Table showing the result of broth cultures of *E. coli* from Group A.

Quality of water sample	10ml	1ml	0. 1ml
Amount of broth inoculated into the 3 tubes	10ml	10ml	10ml
Number of samples of each quantity tested	10	10	10
Number of positive Reaction and gas production	2	2	1

MPN value = 0. 28

Table2. Group B shows the result of Broth cultures of *Escherichia coli* isolated from the water samples.

Quality of water sample	10ml	1ml	0. 1ml
Amount of broth inoculated into the tubes	10ml	10ml	10ml
Number of samples of each quantity tested	10	10	8
Number given positive Reaction and Production	3	1	1

MPN value = 0. 75

Table3. Shows the result of Broth cultures of *Escherichia coli* for Group C.

Quality of water sample	10ml	1ml	0. 1ml
Amount of broth inoculated into the 3 tubes	10ml	10ml	10ml
Number of samples of each quantity tested	10	10	10
Number given positive Reaction and gas Production	1	3	2

MPN value = 0. 24

Table4. Shows the result of Broth cultures of *Escherichia coli* for Group D.

Quality of water sample	10ml	1ml	0. 1ml
Amount of broth inoculated into the tubes	10	10	10
Number of samples of each quantity tested	2	3	3

MPN value = 0. 53

Table5. Shows the result of Broth cultures of *Escherichia coli* isolated from the water samples of Group E.

Quality of water sample	10ml	1ml	0. 1ml
Amount of broth inoculated into the 3 tubes	10ml	10ml	10ml
Number of samples tested	10	10	10
Number of positive reaction and gas production	1	1	2

MPN value = 0. 15

Table6. Heterotrophic Count of Sampled Water

Group	Heterotrophic Count
A	2. 8x10 ⁴
B	7. 5x10 ⁴

Investigation of the Prevalence of *Escherichia coli* in public Drinking Water sources randomly Collected in and around Doibu Residential Area of Port Harcourt, Niger Delta

C	2.4×10^4
D	5.3×10^4
E	1.5×10^4

6. DISCUSSION

Interestingly, the ultimate goal of public health perspective is to save lives and protect the health of the general public, especially the most vulnerable in the remote communities with little or no access to functional health facilities and robust health education. Water is very essential compound for effective coordination and maximum functioning capacity of all organs and cells of the body, hence it is described as the fluid of life, it is a critical survival substance for all living things. This emphasizes the importance of understanding the role provision of potable water, could play in protection of public health outcome in a given society. Nonetheless, this research had demonstrated the presence of faecal contamination in 74% of sampled drinking water in the Diobu area of Port Harcourt. These strongly suggest that, there may probably promote high risk of water borne disease transmission in the studied area, if urgent and sustainable steps are not taken in good time to prevent it. Never the less, an indication of the poor bacteriological public water quality within the area to a large extent; is a critical public health risk in the entire Port Harcourt metropolis given the spontaneous rapid spread of water borne epidemic outbreak in resource limited countries, due to lack of needed infrastructure peculiarities in swift monitoring, evaluation and furthermore, lack of trained and well-coordinated expertise on ground. Nevertheless, this result supports the assertion of Chees brough (2000) [2] that opined that the greatest risk to human health is from faecal contamination of the environment, which water is a strong integral part of the environment that should be sustained and protected at all time from deleterious microbial sources of pollution.

However, most published report showed that *Salmonella* species were potentially implicated in water borne diseases as recorded by Hughes and Kaplan(2005) [8], but this is not in agreement with the present work, as the *Salmonella* organism was not detected in this study. However, one critical important observation of the studied organism in this present study, that should be watched very closely is it's low infectious dose characteristics of some *Escherichia coli* strains, these makes it more important and critical public health challenge outcome to handle in community epidemic outbreak. Nevertheless, *Escherichia coli*, which is a common pathogen already implicated in urinary tract infections, sepsis bacteria, wound, diarrhea disease, etc, as much as possible, care should be taken seriously, considering its public health implications, due to the population density of the studied area. Also, there may be probably frequent cases of unreported diarrhea cases, which may be higher than the 40% reported by Scheutzel (1996) [9] for the United State population, due to variations in public health indices and the extent of strategic public health planning and execution systems, even as method of monitoring and swift response may differ hugely. Other obvious reasons that may promote variation in the two different studies may be linked to behavioral pattern, level of personal hygiene and environmental sanitation and methods of diagnostic assay deployed and their associated sensitivities and specificities to the targeted organism.

Nevertheless, considering the evident based fact, through continuous physical visitations/ observations' by the researchers, which strongly suggest that water supply in the studied area do not undergo frequent public health risk evaluation, treatment and quality certification, it is therefore imperative that more sensitization should be carried out by public health stake holders to raised strong and sustainable advocacy on the need for both government and individual households to strengthen their water quality systems, through regular treatment and public health laboratory water sample monitoring to avoid faecal contamination and other toxic chemical impurities in their drinking water sources, that are also used for other important domestic use like washing of fresh ready to eat fruits and vegetables. None the less, it is interesting and worthy of note to state as opined by, Featherstone and Rogers, (1999) [10], who reported that drinking water accounted for 3% of *Escherichia coli* outbreaks and 15% of all outbreak related cases in the United States of America between May to December, each year. Also, Robert *et al.*, (2000)[11] reported that *Escherichia coli* present in drinking water offered to livestock may contribute to the prevalence of cattle diarrhea infections, and beef meat contamination. The heterotrophic count assessment from the most probably number as shown in table. 6 indicate that there was an estimated range of organism per ml of the originally diluted water sample which ranged between 1.5×10^4 - 7.5×10^4 1ml.

It is probably believed that this high range of bacterial contamination may have arisen due to the poor environmental conditions of buildings and residential quarters within the studied area with congested buildings, having breakage sewage tanks and boreholes built/situated next to each other with no visible or laid out consideration of health and safety of the inhabitants. This may probably cause underground contamination due to seepage of sewage from the water system tanks into the next close water body (borehole wells). Ironically, this has been a recurrent structural abnormality in the area under study, and there had been a consistent overlook and sharp compromise on the part of the public health regulatory bodies, to sanction such buildings/residence in order to sanitize and protect the public water supply structure in the area.

Nevertheless, the situation is made worse because of the inherent lack of public hygiene and environmental sanitation of the populace, as well as the lack of adequate will-power by the government and public servants to implement and enforce policies that will engender public health sanity, for the good and health of the common man. Similarly, the observable lack of sanitary inspection and surveillance activities around the studied environment could also be attributed to be a factor responsible for the high load of *Escherichia coli* content of the studied water in the area and as such, should be revisited through regular monitoring and swift inspection response of environmental sanitation outcome

7. CONCLUSION AND RECOMMENDATION

The study revealed that the results of the heterotrophic count (Table 6) of various sampled borehole drinking water source revealed that water sample from the B GROUP had the highest heterotrophic count of 7.5×10^2 seconded by D GROUP 5.3×10^4 and the least was E GROUP which recorded 1.5×10^4 respectively. Furthermore, all the sources of boreholes drinking water sampled, none was able to meet up with WHO guideline standard for provision of drinking water, hence in view of the above findings, there may probably be increasing cases of gastro-enteritis in the sampled research area, even as many of them may remain undiagnosed, thus there could be so many cases unreported in the end, due to lack of interest towards visiting the already existing weak health centers for prompt diagnosis and subsequent treatment, though which could be associated with seemingly ignorance and lack of fund on the part of the inhabitants

Furthermore, this study has revealed the need for effective strategic policy on public health inspection, surveillance and enforcement of public health laws. Also this research has shown that, urgent attention should be paid to improving awareness on personal hygiene at homes and public places, as well as the incorporation of a public health engineers in building, planning and approvals to ensure that the public health of those around the proposed site is put into consideration before the commencement of the project. This is important as it will help to prevent and avert any unforeseen health dangers that may arise in future, due to poor planning and subsequent implementation of public health indices.

Furthermore, government and its public health authorities should ensure strict adherence to quality standards for all water to be used for drinking and industrial or domestic purposes, in order to maintain standard and ensure sustained public health outcome for its entire citizen.

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