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Research Paper

Assessment of the Domestic Water Quality in a Higher Institution in the Niger Delta of Nigeria

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Abstract— This current study assessed the domestic water quality in a higher institution in the Western Niger Delta of Nigeria. The study objectives focused on evaluating the microbiological and physicochemical parameters associated with the used domestic water in the institution, compare the results with the National (NESREA) and International (WHO) Standards for domestic water acceptability, demonstrate sources of contamination and suggest technological solutions. The regulatory standards of the National Environmental Standards and Regulations Enforcement Agency (NESREA) of Nigeria and the World Health Organization (WHO) were used as control standards in this study. Twenty-two (22) domestic water samples were collected from six different sampling stations of the institution. These sampling stations were labeled as Male Hostel 1, Male Hostel 2, Female Hostel, Staff Quarters, Cafeteria and Law Faculty Borehole respectively. Standard microbiological and physicochemical methods were employed for water quality assessment. Average results of microbiological parameters such as Total Heterotrophic Bacteria (3.6 x 10^5 CFU/ml), Total Coliform (6.6 x 10^4 CFU/ml), Fecal Coliform (4.4 x 10^4 CFU/ml), Fecal Streptococci (2.7 x 10^4 CFU/ml), *Vibrio* (7.8 x 10^4 CFU/ml), *Pseudomonas aeruginosa* (3.9 x 10^4 CFU/ml) and Total Fungi (1.8 x 10^4 CFU/ml) from all the sampling stations, were above the National (NESREA) and International (WHO) regulatory limits of Total Heterotrophic Bacteria (1.0 x 10^2 CFU/ml), Total Coliform (0 CFU/ml), Fecal Coliform (0 CFU/ml), Fecal Streptococci (0 CFU/ml), *Vibrio* (0 CFU/ml), *Pseudomonas aeruginosa* (0 CFU/ml), Total Fungi (0 CFU/ml) in all the water samples analyzed. Protozoa (8.5 x 10^2 cysts/ml) and Helminthes (1.5 x 10^2 cyst/ml) were found in only two (2) samples in the study. Results of some of the physicochemical parameters such as Dissolved Oxygen (39.25 mg/l), Calcium (61.175 mg/l), Oil and Grease (287.83 mg/l), Potassium (24.63 mg/l) and Turbidity (6.03 NTU) from all the sampling stations were above the National (NESREA) and International (WHO) regulatory limits of Dissolved Oxygen (4 – 10 mg/l), Calcium (50.00 mg/l), Oil and Grease (100.00 mg/l), Potassium (0.50 mg/l) and Turbidity (5.00 NTU) for drinking water. *Escherichia coli* is the predominant organism isolated from all the sampling stations assessed in this current study. The study showed that the domestic water used in the higher institution in the creeks of the Western Niger Delta of Nigeria, did not meet the NESREA and WHO regulatory standards for domestic water acceptability. Lack of water treatment plant, poor hygiene of water users, poor sanitation and lack of proper maintenance of the water facilities are causes of contaminations in the used domestic water of the institution. The study therefore, recommends construction of Water Treatment Plant across boreholes, regular inspection and maintenance of water facilities as well as proper handling of the water before usage.

Keywords— Microbiological. Physicochemical. Domestic Water. Regulatory Limits. Western Niger Delta.

1. Introduction

The availability of potable domestic water in an academic environment is necessary to prevent health hazards. The need for potable water cannot be overemphasized. Water plays crucial role in diverse ways which includes but not limited to; its physiological potential to accelerate food digestion by activating enzymes to act on ingested foods and create increase level of assimilation by the body cells. Intake of safe potable water increases bodily fluids and thus, reduces dehydration. Clean domestic water is essential in assessing the quality of foods being prepared, use of safe domestic water for bathing, brushing of teeth and drinking prevent the emergence and contraction of waterborne diseases such as dermatological conditions, cholera, typhoid and so on among domestic water users. Water serves as a medium for microbial growth including both commensals and pathogenic strains. Industrially, water is used as a raw material in food-producing industries and pharmaceutical companies, as universal solvent for dissolving substances in chemical industries, as a coolant for turning turbines for electricity generation in the hydroelectric power stations such as the Kainji Dam in Nigeria. In microbiology laboratory, the steam generated after heating water is of great importance to initiate moist heat sterilization of media and laboratory glass-wares in order to remove contaminants. In industries making products intended for human consumption such as pharmaceuticals or cosmetics, the quality of water is important with various levels of purification being required to remove toxins and bacteria. Paper and pulp production, chemicals, mining, metal processing and petroleum refining industries, all use substantial amounts of water in their operations.

Quality is the most important and the primary indicator for drinking water safety due to its major public health implications [1,2]. The quality of water used in food preparation in an institution can be critical with respect to food quality, the reliability of food preparation processes and the minimization or eradication of potential waterborne pathogens that would have make their way into the food products thereby, improving the safety and good health of the consumers. Domestic water as the name implies, can be defined as potable water used for various functions such as cleaning, drinking, bathing, cooking, irrigating the garden, building, bathing domesticated pets and laundry services at home or in an institution. Domestic water can be sourced from different channels like rainwater, borehole, spring water, stream and others depending on its specific need.

Most potable water contains chemical substances which are required in minute quantity by the body cells for metabolism to occur. For instance, sodium, potassium and chloride are common chemical substances found in minute quantities in most water and these elements are vital in the metabolic activities of the human body. These are called electrolytes. While the presence of other trace elements at high concentrations in water causes health risk challenges to the body. For instance, the presence of fluoride in water when consumed causes dental problem and other issues. Fluid balance is vital to all humans. A domestic water can be regarded as being Potable due to absence or presence of minimal level of disease-causing microbes otherwise known as pathogens and hazardous chemical substances which are detrimental to health.

Besides its aesthetic appearance, water intended for human consumption should not contain chemical contaminants and any microorganisms and parasites in such a level that could be harmful to human health [3]. Use of unsafe domestic water basically for drinking, cooking and bathing purposes by staffs and students in a higher institution present them with communicable diseases of waterborne origins.

The main source of the domestic water used throughout the higher institution in the creeks of the Western Niger Delta of Nigeria, is groundwater. There are many boreholes across the institution but there is no single Water Treatment Plant in the institution that will aid treatment of potential waterborne pathogens and unsafe concentrations of physicochemical contaminants present in the used water. There is highly poor maintenance of storage tanks thereby leading to rusting of these storage tanks mounted overhead across designated points in the institution. Often time, some small organisms such as ants, pebbles, sands and dirt were seen in the water sample during bathing and other uses. A safe domestic water should be odourless, tasteless, transparent and colourless but the available domestic water in this institution, has some unpleasant taste, highly turbid by macroscopic observation, causes dermatological problems and waterborne diseases after use. Most student usually complain of the water quality to be unacceptable and suffered lots of waterborne infections. Microbiological analysis will help to evaluate the presence or absence of common water-borne pathogens such as the coliform bacteria, fecal coliforms, fecal streptococci, *Pseudomonas aeruginosa*, fungi (molds and yeasts), *Vibrio*, Helminthes, etc. Also, the domestic water quality can be assessed by analysing the physicochemical properties which include; temperature, pH, turbidity, Total Hardness, Calcium, Sodium, salinity, oil and grease, etc. These microbiological and physicochemical parameters supposed to be analysed from time to time as long as the domestic water is continuously supplied and used in the institution. This simply implies that the borehole domestic water used in this institution has zero or poor treatment and a dilapidated maintenance and this has posed lots of health hazards thereby causing different waterborne infections, foodborne toxico-infection, foodborne intoxications as well as foodborne infection to both students and staffs of the institution. This challenge of non-availability of potable domestic water ignited the need to analyse these domestic water parameters in this institution and the primary data obtained from the laboratory analysis were compared with the regulatory limits as stipulated by the National (NESREA) and International (WHO) organizations.

2. Related Work

Below are some of the related works on domestic water quality:

[4] Sanwal Ram, Mamta Patel, Vimla Chowdhary (2018) reported assessment of ground water quality of Rajasthan with special reference to Balotra (Barmer) region.

[5] Josiah J. Sunday et al. (2014) reported on Physicochemical and microbiological properties of water samples used for domestic purposes in Okada town, Edo state, Nigeria. They isolated Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella species and physicochemical properties such as pH, temperature and turbidity in all the water samples analysed in their studies and confirmed the water unfit for human consumption, though can be used for other purposes.

[6] J. Ghosh and M. Das (2021) reported results of seasonal change on Physical and Chemical Properties of Borehole Water of Schools of Barasat, North 24 Parganas, West Bengal. They studied pH, temperature and turbidity of ground water samples in two different seasons.

[7] Melad K. A. (2002) Reported on the Evaluation of ground water pollution with waste water microorganisms in Gaza Strip, Palestine. He reported mean results of Total

Heterotrophic Bacteria (THB) and Nitrate (NO_3) which were similar to that reported in this current study.

[8] Shash M.S., M.M. Kamel, R.S. Al-Wasify and F.A. Samhan (2010) reported on rapid detection and enumeration of coliforms and *Escherichia coli* in River Nile using membrane filtration technique. In their studies, they reported average population of Coliform bacteria which are similar to that recorded in this current study.

[9] Aydin A. (2007) reported The Microbiological and Physicochemical Quality of Groundwater in West Thrace, Turkey. The pH range reported in his study is within the pH range recorded in this current study.

The average concentration of sodium (13.92 – 15.99mg/l) recorded in the current study is between that reported by Agrawal et al. (2011) who reported 29.70mg/l and Othman et al. (2012) who reported 75.00 – 294.00mg/l of sodium concentrations from domestic water quality assessment in their studies [10, 11].

3. Experimental Method

3.1 Sample Collection

Twenty-two (22) water samples were collected across different sampling stations in the higher institution in the creeks of the Western Niger Delta. These sampling stations were labelled as Male Hostel 1, Male Hostel 2, Female Hostel, Cafeteria, Staff Quarters and Law Faculty Borehole respectively. Two (2) water samples were collected each from the sampling stations. MacConkey bottles were used for the collection of samples used for microbiological quality assessment whereas samples for physicochemical analysis were collected using 1000ml capacity reagent bottles (i.e. 1L glass bottles). Water samples used for both analyses were collected first thing in the morning in order to obtain fresh samples and quality results of the assessment. The water samples collected in MacConkey bottles were strictly monitored against pre-contamination which serves as a quality control measure. Temperature parameter for all samples analysed in this study was assessed at the point of collection.

3.2 Sterilization and Calibration

All the laboratory glass-wares, sample containers and media used in this study were sterilized via autoclaving method prior to sample collection and analysis. The laboratory workbench was sterilized with 70 percent acid alcohol. For the microbiological analysis, all the procedures were carried out in the Sterilization Chamber. The essence of these series sterilizations is to prevent pre and post contaminations of the samples thus, leading to the true representative primary results recorded in this study. The reagent bottles for the physicochemical analysis were cleaned and all the machineries such as the Spectrophotometer, DO probe, pH probe, TDS meter, Vacuum pump and so on, were calibrated where appropriate prior to sample analysis.

3.3 Microbiological parameters

Culture media used for estimation of microbiological parameters recorded in this current study include; Saboraud Dextrose Agar (SDA), Potato Dextrose Agar (PDA), Nutrient Agar (NA), MacConkey Agar (MA), Eosin Methylene Blue Agar (EMB), Tripple Sugar Iron Agar (TSI-Agar), Blood Agar (BA) and Salmonella-Shigella Agar (SSA). The media were aseptically prepared following the Manufacturers' specifications. Sterility testing of all media used was conducted to ensure that culture plates are free from contaminations from external sources. Most Probable Number (MPN) method was employed for the estimation of Total Heterotrophic Bacteria (THB). Membrane Filtration (MF) method was employed for Total Coliform (TC), Fecal Coliform (FC), Fecal Streptococci, Protozoa and Vibrio bacteria. *Pseudomonas aeruginosa* was determined by direct streaking method on Blood Agar. Helminthes were determined by physical examination using simple hand lens and microscopic examination for the presence or absence of adult Helminthes or cysts or larvae. After media preparation, the plates were charged with the water samples via serial dilutions or direct streaking where appropriate and then incubated for 24 to 48 hours. Culture plates were examined for morphological characterization. Representative microbial colonies were sub-cultured on selective media in order to obtain pure isolates e.g EMB used for *Escherichia coli* and other Enterobacteriaceae. As part of providing therapeutic control, this study also carried out Antibiotics Test on the bacterial isolates using Disc Diffusion Method.

3.4 Physicochemical parameters

Temperature was measured using a mercury in glass thermometer (APHA 2005). pH was measured using a pH probe. Biochemical Oxygen Demand (BOD) was measured using azide modification (APHA 2005) [12]. Chemical Oxygen Demand (COD) was measured using open reflux and wet oxidation with Potassium Permanganate (APHA 2005). Dissolved Oxygen (DO) was measured using DO probe (Model: 9500). Nitrate, potassium and sodium were measured by measuring the absorbance at 220 nm wavelength, 766.6 nm wavelength and 589 nm wavelength respectively using spectrophotometer. Calcium was measured by EDTA titrimetric method. Chloride was measured using Argentometric titrimetric method. Oil and Grease was measured using Partition Gravimetric method and Electrical Conductivity (EC) was measured using EC probe (Model: EC 215).

4. Results and Discussion

The microbiological and physicochemical results of the laboratory assessment of samples from all sampling stations in this study are significantly higher than the Nigerian (NESREA) and International (WHO) regulatory limits for potable domestic water. These regulatory standards for physicochemical and microbiological parameters for potable domestic water are shown in table 4 and 5 below. These standards were used as controls in this study to compare the laboratory results of the domestic water assessment and deduce whether or not the available domestic water in the higher institution in the creeks of the Western Niger Delta, meet with the local and international standards.

4.1 Results of Microbiological parameters

Table (1) below showed morphological and biochemical characteristics of bacteria isolated from all samples analysed in this study. Gram reaction, Voges Proskauer (VP), Methyl Red (MR), Indole test and Sucrose test were biochemical tests carried out along with examination of Colonial Morphologies such as colony elevation, colony pigmentation and colony edge of the organisms isolated which aid proper identification of the microbial Genera. *Escherichia, Klebsiella, Yersinia, Salmonella, Pseudomonas, Vibrio and Streptococcus* were the bacterial Genera identified from all the sampling stations with *Escherichia coli*, the most predominant organism recorded in this study. Table (1) also showed that, Gram-Negative bacteria are higher than the population of Gram-Positive bacteria.

Table (2) showed morphological and biochemical characteristics of fungal isolates from all the water samples analysed. The colonial parameters carried out on fungal isolates includes colony pigmentation, colony edge and colony elevation. Catalase test, sucrose test and motility test were carried out for biochemical characterization. Tentative fungal Genera isolated across sampling stations in this study are *Aspergillus. Mucor, Penicillium* and *Yeast* respectively.

Table (3) below, showed morphological characteristics of Helminthes and Protozoa from all samples tested in this study. Shape of cell, Cellular pigmentation and presence of cyst/oocyst using microscope, were carried out. Total population of protozoa and Helminthes encountered in this study were scanty and hence, reported as insignificant.

And table (5) showed the average population of microbiological parameters recorded from all the samples and the regulatory limits. In this table, average results of THB, TC, FC, FS, PS, *Vibrio* and TF from all sample locations were far higher than the allowable regulatory standards. Protozoa and Helminthes were below the regulatory standards in all the sample locations except in Female hostel samples which recorded average population of Protozoa above the allowable regulatory standards of WHO and NESREA.

Some selected microbiological parameters (THB, TF and *Vibrio*) from all the sampling stations are shown in figure (1) below. Figure 1 is a graphical representation of THB, TF and *Vibrio* from all sampling stations in this study.

The Total Heterotrophic Bacteria (THB) analysed in this study, ranged from 357.00 – 751.50 CFU/ml. Water samples collected from the female hostel shows the highest population with 751.50 CFU/ml while the lowest number of colonies was recorded from samples collected from the law faculty borehole with 357.00 CFU/ml. Law Faculty Borehole is the only borehole point analysed in this study and it clearly shows that water samples extracted at the borehole point itself has minimal microbial load compared to the microbial populations in water samples collected from various points such as from tap in restrooms, cafeteria, hostels and so on. Human factors indeed are major factorial determinant of the contamination source of the domestic water used in this institution. The average total population of THB from all the water samples was 3581.50 CFU/ml. The Total Heterotrophic Bacterial population found in all the tested samples between the range of 357.00 – 751.50 CFU/ml, was about six times greater than the national and international regulatory limits (100 CFU/ml) for THB in safe domestic water. The mean results of THB (357.00 – 751.50 CFU/ml) reported in this current study were very similar to that obtained by Melad (2002) in a study that investigated ground water pollution with waste water microorganisms in Gaza Strip, Palestine who found THB in all tested wells with the highest number of THB colonies as 750 CFU/ml. Following the guideline of the Nigerian as well as guideline of WHO which stated the maximum allowable number of THB to be 100 CFU/l for safe drinking water, it implies that the domestic water used in this institution, has greater population of microbiological parameters which are indicators of water pollution.

The highest population of Total Coliform (TC) bacteria (163.50 CFU/ml) was recorded from the female hostel samples while the lowest number of colonies (78.50 CFU/ml) was recorded from samples estimated from male hostel 1. Presence of coliform bacteria in the samples analysed in this study, serves as indicator organisms for water quality used in the institution. The results (78.50 – 163.50 CFU/ml) were higher than the regulatory limit of WHO and NESREA of 0.00 CFU/ml for safe drinking water. The results of Total Coliform bacteria (78.50 – 163.50 CFU/ml) recorded in this project study are within that reported by Shash M.S., M.M. Kamel, R.S. Al-Wasify and F.A. Samhan (2010) who reported 104 CFU/ml respectively. Coliform bacteria in domestic water result from use of untreated domestic water, use of poorly treated water, unhygienic practices of water handlers as well as lack of proper inspection and maintenance of both water storage and the distribution systems which introduced these waterborne pathogens into the domestic water thus, making the domestic water polluted and unsafe for human consumption.

The highest number of colonies of Fecal Coliform (FC) bacteria (98.50 CFU/ml) was recorded from water samples collected from male hostel 2 while the lowest number of colonies (18.00 CFU/ml) was recorded from samples collected from the law faculty borehole. All the results (18.00 – 98.50 CFU/ml) were higher than the NESREA and WHO regulatory limits. In this current study, mean results recorded from all the samples tested did not meet the NESREA and WHO standards. Fecal Coliform bacteria found in drinking water are principally from human fecal origins. Fecal Coliform (FC) bacteria are mainly found in water samples obtained from environment with poor hygienic practices such as improper sanitization of the environment, use of water from water bodies polluted by fecal matters as well as setting up borehole very close to septic tanks where human fecal wastes are being discharged. The rapid increase showing a positive trend in the fecal contamination of the domestic water used in this higher institution accounts for the ideal source of FC bacteria in the used domestic water. For instance, in this current study, mean result of FC bacteria from law faculty borehole was 18.00 CFU/ml and that from the staff quarter was 59.00 CFU/ml. The are septic tanks in staff quarter whereas, there is no septic tank at the law faculty borehole being sampled. The reverse is in the case with the rest sampling stations such as female hostel (90.00 CFU/ml), male hostel 1 (98.50 CFU/ml), male hostel 2 (87.50 CFU/ml) and finally, cafeteria with mean population of FC as 89.00 CFU/ml respectively. This trend implies that water source that is far distance from a septic tank has minimal population of fecal coliform bacteria compare to water source that is very close to a septic tank.

The Fecal Streptococci bacteria (FS) were found in all the samples tested. The highest number of FS bacteria (71.00 CFU/ml) was recorded from water samples collected from cafeteria while the lowest number of colonies (31.00 CFU/ml) was recorded from samples collected from both male hostel 1 and staff quarter in the institution. All the results of FS recorded in this current study (31.00 – 71.00 CFU/ml) did not meet the NESREA and WHO regulatory limits for domestic water acceptability.

The highest count of *Pseudomonas aeruginosa* (PS) (155.50 CFU/ml) was recorded from water samples collected from male hostel 2 while the lowest number of colonies (35.00 CFU/ml) was recorded from samples collected from staff quarters. The total population of *Pseudomonas aeruginosa* recorded from all the sampling stations was 387.00 CFU/ml. PS recorded from all the water samples in this current study (35.00 – 155.50 CFU/ml) were higher than the Nigerian standard as well as the guideline of WHO which do not allow the presence of any PS in drinking water (0 CFU/ml). This is far higher than that conducted by Liguori in 2010 who reported that only one sample out of the total samples collected from tap drinking water from dispensers in Italy contains *Pseudomonas aeruginosa.* Ingestion of *Pseudomonas aeruginosa* through drinking water causes septicaemia (invasion of the bloodstream of the patient), Urinary Tract Infections (UTIs), Respiratory Tract Infections (RTIs), meningitis and other gastroenteritis.

The highest count of *Vibrio* colonies was 293.00 estimated from cafeteria while the lowest number of colonies (54.00 CFU/ml) was recorded from samples analysed from male hostel 2. The total population of *Vibrio* bacteria recorded in the current study was 784.00 CFU/ml. The mean population of *Vibrio spp.* (54.00 – 293.00 CFU/ml) estimated from all samples collected from all the sampling stations were higher than the Nigerian and the WHO standards for drinking water. *Vibrio spp.* especially *Vibrio cholerae* is the causative agent of cholera. Consumption of water contaminated by *Vibrio cholerae* account for cholera outbreaks among humans in different parts of the world including Nigeria.

The Molds, *Aspergillus spp., Mucor spp., Penicillium spp.* and yeasts were isolated from all samples recorded in the current study. Male hostel 1 had the highest total population of fungi (267.50 CFU/ml) while the lowest population of total fungi (98.00 CFU/ml) was recorded in samples from the law faculty borehole. The total population of fungi recorded from all the sampling stations in the current study was 1167.00 CFU/ml. The results of the total fungal population (98.00 – 267.50 CFU/ml) were higher than the NESREA and WHO limits of 1.25 X 10^2 CFU/ml for drinking water. The highest population of *Mucor sp.* was recorded in samples from cafeteria and this account for the spoilage of most foods as experienced by most students who purchase their gastronomic delights from these cafeterias on daily basis in the institution. Ingestion of mycotoxins which are collective toxins released by different species of fungi causes fungal disease generally referred to as mycotoxicosis resulting from intake of domestic water containing pathogenic fungi.

Protozoa were found in only 4 samples out of the total 22 water samples collected across all the sampling stations in this study. The highest number of protozoan cysts (6.00cyst/ml) was recorded from female hostel while the lowest number of protozoan cysts (0.00 cyst/ml) was recorded from male hostel 2, staff quarter and the law faculty borehole. The total population of protozoa found in all samples analysed in this project study was 8.50cysts/ml. The mean population of protozoa estimated from all the samples between the range of 0.00 – 8.50cysts/ml were a bit higher than the permissible number of protozoa of 3.00 cysts/ml for drinking water. This indicates that the domestic water used in the higher institution in the creeks of the Western Niger Delta is not obviously contaminated by protozoa.

Helminthes were found in only one sample out of the total 22 water samples tested in this project study. The highest number of Helminthes was 1.50 cyst/ml recorded from samples collected from staff quarter while the lowest number of Helminthes found in the samples analysed was 0.00 cyst/ml recorded from male hostel 2, male hostel 1, female hostel, cafeteria and the law faculty borehole. The total population of Helminthes found in all samples analysed in this project study was 1.50cyst/ml. The mean population of Helminthes estimated from all the samples between the range of 0.00 – 1.50 cyst/ml were within the permissible number of Helminthes of 3.00 cysts/ml for drinking water.

Results of Antibiotics Sensitivity test showed susceptibility and resistance properties of E. coli to various antibiotics on Gram-Negative Antibiotics Disc. *E. coli*, a Gram-negative bacterium shows high susceptibility to Oxafloxacillin and Gentamycin on Foreign Gram-negative multiple sensitivity disc which indicates that these antibiotics can be used for the effective management of *E. coli* waterborne diseases. Meanwhile, this Enterobacteriaceae shows high resistance to Augmentin, Chloramphenicol, Erythromycin, Streptomycin and Pefloxacillin on Gram negative multiple sensitivity disc.

4.2 Results of Physicochemical parameters

Table (4) below showed the average physicochemical parameters recorded from all the water samples and the regulatory limits. Average results of pH, temperature, alkalinity, sodium, calcium, potassium, oil and grease, turbidity, Dissolve Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Dissolved Solids, Chloride, nitrate and electrical conductivity are recorded in Table (4). Results of Na^+, E/C, BOD and Cl^- recorded across sampling stations were lower than the regulatory standards. Temperature, DO, pH, Alkalinity and TDS were within the normal range of WHO guidelines for domestic water acceptability. K^+, turbidity, Ca^+ and OG results across sample locations were higher than the WHO guidelines. Average result of NO_3 from all sample locations were within the normal range except in samples from female hostel which recorded higher concentrations of nitrate in the samples analysed. And figure (2) below showed graphical representation of Cl^-, EC, K^+, Na^+ and Turbidity recorded from all the sampling stations.

The pH values indicated that the highest mean level of pH of 8.81 was estimated from the samples collected from the female hostel while the lowest mean level of pH of 6.12 was estimated from water samples collected from the law faculty borehole. The average pH value in all the water samples was 6.94. The study showed that the pH values of most samples analysed in this study, were within the WHO permissible regulatory limit. However, water in the female hostel recorded a pH value of 8.81 which was slightly above the regulatory limit. This pH value may be due to dissolution of metals in the tank which was metallic and may have created slightly alkaline conditions. Use of acidic water through various means like drinking, brushing of teeth, bathing, cooking, etc. causes an indirect ingestion of dissolved metals such as lead, zinc, iron, etc. The accumulation of lead in the body through the use of acidic domestic water is a major cause of health-related events like stroke, cancer, kidney disease, memory loss and high blood pressure. Aydin (2007), recorded pH values in groundwater from Edirne and Cana kale of between 5.50 - 8.50 which is within the pH range (6.12 - 8.81) reported in this current study.

The highest mean value of temperature recorded (30.50^{o}C) was collected from cafeteria of the institution while the lowest mean temperature value (29.7^{o}C) was collected from male hostel. 2.

The average temperature recorded from all the sampling stations assessed was 29.97^{o}C. The mean temperature values estimated from samples analysed in this project study were within the regulatory limit of NESREA and WHO. The temperature of water changes with seasonal variation. In dry season, temperature of water rises whereas during the wet or raining season, water temperature decreases. For instance, in this current study, the temperature parameter of the water samples was assessed in two distinct seasons between November to January, 2018 and between April to July, 2019 to study the effect of seasonal variation on the domestic water samples after which the mean value was taken and recorded.
The highest mean level of turbidity (8.20 NTU) of the water samples was obtained from the female hostel while the lowest mean concentration (3.93 NTU) was recorded from male hostel 1 of the institution. Majority of the sampling stations assessed in this study recorded average turbidity level higher than the permissible allowable limit of 5.00 NTU for domestic water. These sampling stations with turbidity concentrations higher than the national and international regulatory limits includes male hostel 2 (8.03 NTU), female hostel (8.20 NTU), staff quarter (5.83 NTU) and the cafeteria (6.20 NTU) as shown in figure 2 and table 4. Turbidity assessment helps to ascertain whether or not given sample of water is clear or cloudy otherwise known as turbid. The turbidity status of the domestic water in this institution is due to the presence of intrinsic suspended solids and the higher populations of microbial load as recorded in this study. Domestic water should be clean, clear, transparent, colourless and odourless, hence the available domestic water in the institution needs urgent attention.

The highest mean value of EC (103.00 µs/cm) was recorded from water samples collected from cafeteria section of the institution while the lowest mean value (33.00 µs/cm) was recorded from female hostel in the institution. Total average value of EC in all the water samples was 67.00µs/cm. Results of EC obtained from all sample analysed in this study, are far lower than the national and international regulatory limits of 500.00µs/cm for drinking water. The low levels of EC (33.00 – 103 µs/cm) estimated from all the water samples analysed indicates unacceptable concentration of electrolyte in the used domestic water.

The highest mean concentration of TDS (500.00 mg/l) was recorded from water samples collected from both male hostel 2 and cafeteria while the lowest mean concentration of TDS (200.00 mg/l) was recorded from samples collected from both male hostel 1 and the law faculty borehole in this institution. And the average concentration of TDS from all sampling stations being analysed in this project study was 366.67 mg/l. The TDS recorded in the current study were within the national and international regulatory limits of 500.00 mg/l for domestic water. High levels of TDS in the groundwater are as a result of salt water intrusion into the aquifer. Hence, the moderate levels of TDS obtained from all the water samples in the higher institution in the creeks of the Western Niger Delta indicates the absence of salt water intrusion despite its location to salt water surface system.

The study showed that the highest mean concentration of Cl^- was 6.00 mg/l obtained from samples collected from male hostel 1, while the lowest mean concentration was 2.00 mg/l from samples collected from the law faculty borehole. Average concentration of Cl^- from all sampling stations was 3.67 mg/l. All the results of Cl^- recorded in the current study were within the national (NESREA) and the international (WHO) regulatory limits of 200 mg/l for potable water. These low chloride contents of the groundwater showed that the groundwater source was free from salt water intrusion. Using the guideline of the national and international standard of chloride for domestic water, the concentration of chloride of the domestic water used in this institution is within the acceptable limit for domestic uses.

The highest mean concentration of alkalinity (28.00 mg/l) was recorded from samples collected from the law faculty borehole while the lowest mean concentration (4.50 mg/l) was recorded from samples collected from staff quarter of the institution. The average concentration of alkalinity estimated from all the water samples analysed in this study was 9.00 mg/l. The mean results obtained from samples collected from male hostel 1, male hostel 2, female hostel, cafeteria and the staff quarter with values between the ranges of 4.50 – 6.00 mg/l were within the national and the international regulatory standard of 6.00 – 9.00 mg/l for domestic water. While result of mean values of 28.00 mg/l obtained from samples collected from the law faculty borehole, exceeded the national and international regulatory standard of alkalinity for drinking water. Alkalinity acts as a pH buffer that neutralizes the acidity thus, making the water more alkaline rather than acidic. Alkalinity is a measure of bicarbonate, carbonates and hydroxides in water which neutralizes the acidity of the water and thus making drinking water safer for consumption. The main sources of alkalinity in water are the soil and bedrock through which it passes. This implies that the high concentration of alkalinity recorded from the law faculty borehole samples occurs as a result of direct pumping of the domestic water from the ground and the alkalinity levels reduces as a result of the decrease in the bicarbonate and hydroxide compounds along the water distribution system, storage and point of use in the institution thus, making the water at the law faculty borehole more alkaline more than other locations such as the staff quarter with alkalinity level of 4.50 mg/l which indicates acidic level of the used water.

The highest mean concentration of Dissolved Oxygen (DO) was 10.08 mg/l obtained from samples collected from male hostel 2 while the lowest mean concentration was 5.76 mg/l obtained from cafeteria. The average concentration of DO recorded from all the sampling stations was 39.25 mg/l. The mean results of DO (5.76 – 10.08 mg/l) in this study were within the NESREA and WHO regulatory standards of >4.00 mg/l of DO for domestic water. A decrease level of DO below 4.00 mg/l subject aquatic life to stress. Thus, high level of DO in water promote growth of aquatic organisms in that water. Microbiologically, high levels of DO in water favour the growth and survival of aerobic microorganisms and inhibit the growth of anaerobic organisms in the water samples. Generally, a higher level of DO indicates better water quality. Every human required about 19.5% of oxygen from the air for respiration to occur. Some portion of this oxygen is absorbed by the body cells in the form of Dissolved Oxygen obtained from drinking water.

Total average concentration of BOD from all the sampling stations analysed in this study was 0.81 mg/l. The highest mean concentration of BOD (1.65 mg/l) was detected from female hostel, while the lowest mean concentration (0.28mg/l) was detected from samples collected from law faculty borehole. These results were similar to that obtained by Melad in 2002 in a study aimed to evaluate the ground water pollution in Beth Lahia, Gaza Strip, Palestine who found the mean concentrations of BOD as 3.3 mg/l, 3.6 mg/l and 5.5 mg/l in water samples collected from some wells. Nonetheless, both concentrations of BOD reported by Melad (2002) between the range of 3.3 – 5.5 mg/l and the concentrations of BOD estimated from water samples used in this institution (0.28 – 1.65 mg/l) in this current study were below the Nigerian and international regulatory standard of 3.00 mg/l for safe domestic water.

Concentration of NO_3 in this current study shows different levels in the tested water samples. Highest mean concentration of nitrate (120.00 mg/l) was estimated from samples collected from the law faculty borehole while the lowest mean concentration was 27.00 mg/l estimated from both male hostel 2 and the female hostel. The average concentration of nitrate in all the water samples analysed in this project study was 43.61mg/l. These results were similar to that obtained by Melad (2002) in a study that aimed to evaluate the ground water pollution in Beth Lahia, Gaza Strip, Palestine who found mean concentration of NO_3 of the samples collected from some wells as 57.3 mg/l, 60.3 mg/l, 65.2 mg/l and 72.4 mg/l. The mean concentration of NO_3 between 27.00 – 120.00 mg/l from all the sampling stations in the study, were generally within the NESREA and WHO regulatory standard (50.00 mg/l) for drinking water except for samples estimated from the law faculty borehole which had mean concentration of NO_3 as 120.00 mg/l above the regulatory standard.

The current study shows that the highest mean concentration of Ca^+ was 76.90 mg/l estimated from law faculty borehole samples while the lowest mean concentration was 48.15 mg/l estimated from male hostel 1 samples. The average concentration of Ca^+ from all sampling stations was 61.175 mg/l. Most of the results of Ca^+ recorded in the current study are above the allowable standard (50.00 mg/l) specified by the Nigerian standard as well as the guideline of WHO for domestic water. Samples collected from the female hostel, staff quarter, cafeteria and the law faculty borehole, had concentration of Ca^+ above the regulatory standard while water samples estimated from both male hostel 1 and male hostel 2 had concentration of Ca^+ within the regulatory standard of the Nigerian and WHO respectively. Calcium (Ca) and magnesium (Mg) are the two major elements of hard water which causes high levels of impurities in water. An impure domestic water containing higher concentrations of calcium as demonstrated in the current study consumes much washing soaps and detergents to wash small quantity of clothes because these compounds of impurities (magnesium and calcium compounds) reduce the penetrating potentials of detergents and soaps to make their way into the dirt particles such as oily plates, clothes etc. Also, bathing with water containing high concentration of calcium reduces the melanin (a typical skin hormone) level thus, reduces the skin pigmentation of the affected individuals. Hence, the domestic water used in this higher institution need urgent attention for effective treatment before usage.

The highest mean concentration of Na^+ (15.99 mg/l) was estimated from male hostel 1 samples while the lowest mean concentration (13.92 mg/l) was estimated from cafeteria. The average concentration of Na^+ in all the tested water samples was 14.58 mg/l. All the results of mean concentrations of Na^+ between the ranges of 13.92 – 15.99 mg/l obtained from all sampling stations assessed were greatly less than the Nigerian and the WHO regulatory standard (200.00 mg/l) for domestic

water. These results (13.92 – 15.99 mg/l) were nearly similar to that obtained by Agrawal et al. in 2011 in a study of groundwater quality assessment of samples collected from Begusarai District, Bihar. They found that the average concentration of sodium in the tested water samples was 29.7 mg/l. But the results of Na^+ concentrations in the current study (13.92 – 15.99 mg/l) were far less than that obtained by Othman al el., 2012 who found Na^+ concentrations between 75.00 – 294.00 mg/l in all samples tested. Higher concentration of sodium in drinking water increases the salt content of the water thus, making the water tasty. But the minimal concentrations of sodium obtained in this current study, accounts for the moderate taste of the used domestic water in the institution. Sodium as an important parameter in the Electrolyte, Urea and Creatinine (E/U/Cr) which is a medical investigation to assess the functionality of human kidneys, is crucial in the control of salt influx into the body system thereby, preventing onset of hypertensive conditions.
The highest mean concentration of K^+ was 49.98 mg/l from female hostel samples while the lowest mean concentration was 18.46 mg/l estimated from samples collected from male hostel 2 of the institution. All the results of K^+ from all the samples tested and recorded in the current study exceeded the permissible limit of the Nigerian and the WHO standard (0.50 mg/l) for domestic water. The greater variation between the results of potassium concentrations in the current study and that of the national and international regulatory standards (Nigerian and WHO standards) indicates higher contamination of the domestic water used in this institution by potassium.

The highest mean concentration of Oil and Grease (OG) (431.00 mg/l) was recorded from law faculty borehole samples while the lowest mean concentration (60.00 mg/l) was recorded from male hostel 1 samples. All the results of mean concentrations of OG across all the sampling stations were higher above the permissible limit of the Nigerian and the WHO standards (100.00 mg/l) for drinking water except for samples analyzed from male hostel 1 in this institution with the mean concentration of OG of 60.00 mg/l which was within the regulatory standards. Water samples collected from the law faculty borehole, female hostel and the staff quarter contains higher concentrations of OG more than samples collected from male hostel 1, male hostel 2 as well as the cafeteria sampling stations of the institution.

Figures and Tables

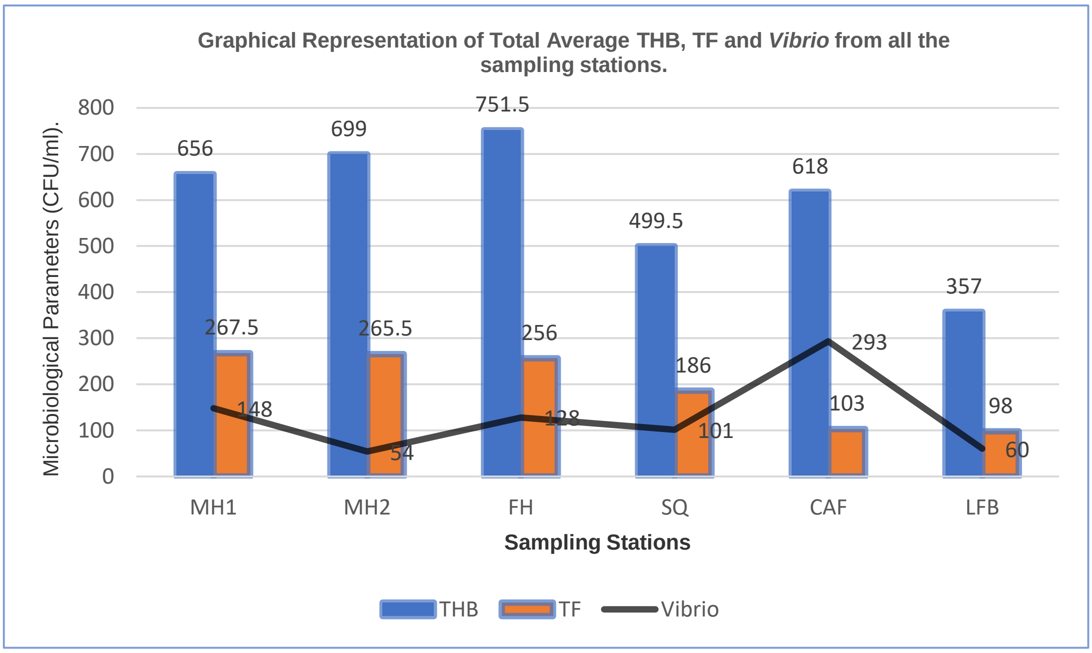

Figure 1. Graphical representation of Total Average THB, TF and *Vibrio* from all the sampling stations.
Key: THB = Total Heterotrophic Bacteria, TF = Total Fungi, MH1 = Male Hostel 1, MH2 = Male Hostel 2, FH = Female Hostel, SQ = Staff Quarters, CAF = Cafeteria, LFB = Law Faculty Borehole.

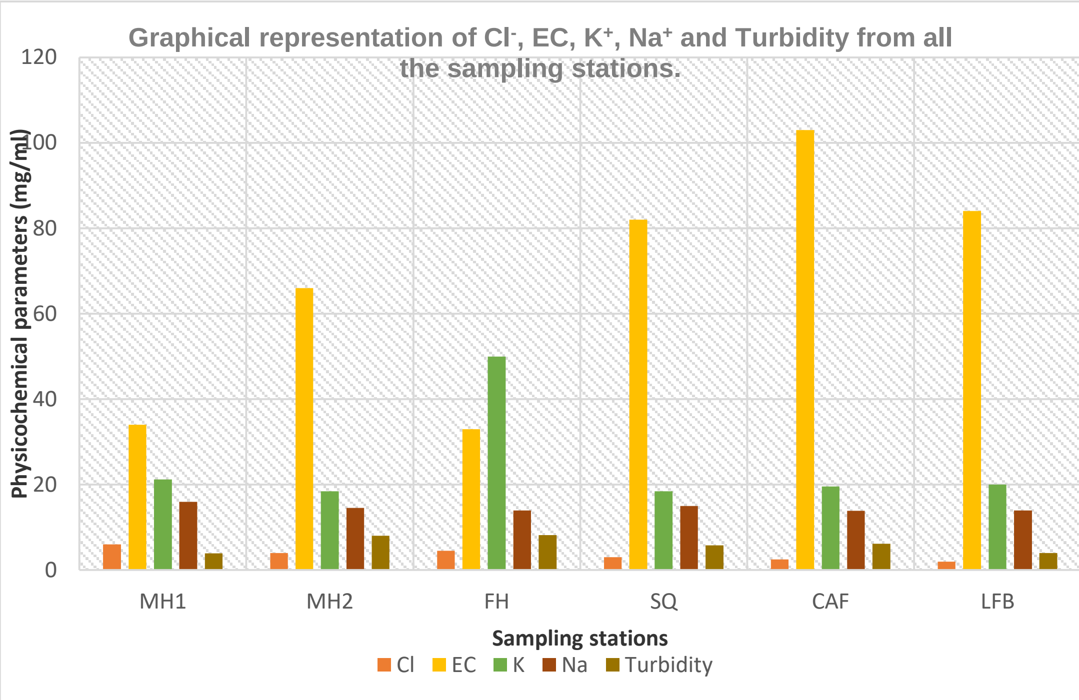

Figure 2. Graphical representation of Cl^-, EC, K^+, Na^+ and Turbidity from all the sampling stations.

Key: Cl^- = Chloride, EC = Electrical Conductivity, Na^+ = Sodium, K^+ = Potassium, MH1 = Male Hostel 1, MH2 = Male Hostel 2, FH = Female Hostel, SQ = Staff Quarters, CAF = Cafeteria, LFB = Law Faculty Borehole.

Table 1. Morphological and Biochemical characteristics of bacterial isolates from all the water samples.

Isolate	**Colony Elevation**	**Colony** Pigmentation	**Colony Edge**	**Gram reaction**	**MR**	**VP**	**Indole**	**Sucrose**	**Tentative Genera**
MH 1	Slightly raised	Green metallic sheen	Entire	_	+	_	+	+	*Escherichia*
	Unbonate	Pink	Undulate	_	_	+	_	+	*Klebsiella*
	Raised	Pale yellow	Entire	_	+	_	_	_	*Yersinia*
	Convex	Pale colorless	Entire	_	+	_	_	_	*Salmonella*
	Unbonate	Diffusible green	Wavy	_	_	_	_	_	*Pseudomonas*
	Convex	Pale colorless	Entire	_	+	-	+	_	*Vibrio*
	Flat	Grayish white	Lobate	+	+	_	+	+	*Streptococcus*
MH 2	Slightly raised	Green metallic sheen	Entire	_	+	_	+	+	*Escherichia*
	Unbonate	Pink	Undulate	_	_	+	_	+	*Klebsiella*
	Raised	Pale yellow	Entire	_	+	_	_	_	*Yersinia*
	Convex	Pale colorless	Entire	_	+	_	_	_	*Salmonella*
	Unbonate	Diffusible green	Wavy	_	_	_	_	_	*Pseudomonas*
	Convex	Pale colorless	Entire	_	+	-	+	_	*Vibrio*
	Flat	Grayish white	Lobate	+	+	_	+	+	*Streptococcus*
FMH	Slightly raised	Green metallic sheen	Entire	_	+	_	+	+	*Escherichia*
	Unbonate	Pink	Undulate	_	_	+	_	+	*Klebsiella*
	Raised	Pale yellow	Entire	_	+	_	_	_	*Yersinia*
	Convex	Pale colorless	Entire	_	+	_	_	_	*Salmonella*

	Unbonate	Diffusible green	Wavy	_	_	_	_	_	*Pseudomonas*
	Convex	Pale colorless	Entire	_	+	-	+	_	*Vibrio*
	Flat	Grayish white	Lobate	+	+	_	+	+	*Streptococcus*
SQ	Slightly raised	Green metallic sheen	Entire	_	+	_	+	+	*Escherichia*
	Unbonate	Pink	Undulate	_	_	+	_	+	*Klebsiella*
	Raised	Pale yellow	Entire	_	+	_	_	_	*Yersinia*
	Convex	Pale colorless	Entire	_	+	_	_	_	*Salmonella*
	Unbonate	Diffusible green	Wavy	_	_	_	_	_	*Pseudomonas*
	Convex	Pale colorless	Entire	_	+	-	+	_	*Vibrio*
	Flat	Grayish white	Lobate	+	+	_	+	+	*Streptococcus*
CAF	Slightly raised	Green metallic sheen	Entire	_	+	_	+	+	*Escherichia*
	Unbonate	Pink	Undulate	_	_	+	_	+	*Klebsiella*
	Raised	Pale yellow	Entire	_	+	_	_	_	*Yersinia*
	Convex	Pale colorless	Entire	_	+	_	_	_	*Salmonella*
	Unbonate	Diffusible green	Wavy	_	_	_	_	_	*Pseudomonas*
	Convex	Pale colorless	Entire	_	+	-	+	_	*Vibrio*
	Flat	Grayish white	Lobate	+	+	_	+	+	*Streptococcus*
LFB	Slightly raised	Green metallic sheen	Entire	_	+	_	+	+	*Escherichia*
	Unbonate	Pink	Undulate	_	_	+	_	+	*Klebsiella*
	Raised	Pale yellow	Entire	_	+	_	_	_	*Yersinia*
	Convex	Pale colorless	Entire	_	+	_	_	_	*Salmonella*
	Unbonate	Diffusible green	Wavy	_	_	_	_	_	*Pseudomonas*
	Convex	Pale colorless	Entire	_	+	-	+	_	*Vibrio*
	Flat	Grayish white	Lobate	+	+	_	+	+	*Streptococcus*

KEY: MH 1 = Male Hostel 1, MH 2 = Male Hostel 2, FMH = Female hostel, SQ = Staff quarter, CAF = Cafeteria, LFB = Law Faculty Borehole, MR = Methyl Red and VP = Voges Proskauer.

Table 2. Morphological and Biochemical characteristics of fungal isolates from all the water samples.

Isolate	**Colony Elevation**	**Colony Pigmentation**	**Colony Edge**	**Sucrose Test**	**Catalase Test**	**Motility Test**	**Tentative Genera**
MH 1	Unbonate	Black	Entire	+	+	+	*Aspergillus*
	Raised	White	Flat	+	+	+	*Mucor*
	Unbonate	Pale green	Serrated	+	_	+	*Penicillium*
	Convex	Creamy white	Flat	+	+	_	*Yeast*
MH 2	Unbonate	Black	Entire	+	+	+	*Aspergillus*
	Raised	White	Flat	+	+	+	*Mucor*
	Unbonate	Pale green	Serrated	+	_	+	*Penicillium*
	Convex	Creamy white	Flat	+	+	_	*Yeast*
FMH	Unbonate	Black	Entire	+	+	+	*Aspergillus*
	Raised	White	Flat	+	+	+	*Mucor*
	Unbonate	Pale green	Serrated	+	_	+	*Penicillium*
	Convex	Creamy white	Flat	+	+	_	*Yeast*
SQ	Unbonate	Black	Entire	+	+	+	*Aspergillus*
	Raised	White	Flat	+	+	+	*Mucor*
	Unbonate	Pale green	Serrated	+	_	+	*Penicillium*
	Convex	Creamy white	Flat	+	+	_	*Yeast*
CAF	Unbonate	Black	Entire	+	+	+	*Aspergillus*
	Raised	White	Flat	+	+	+	*Mucor*

	Unbonate	Pale green	Serrated	+	_	+	*Penicillium*
	Convex	Creamy white	Flat	+	+	_	*Yeast*
LFB	Unbonate	Black	Entire	+	+	+	*Aspergillus*
	Raised	White	Flat	+	+	+	*Mucor*
	Unbonate	Pale green	Serrated	+	_	+	*Penicillium*
	Convex	Creamy white	Flat	+	+	_	*Yeast*
KEY: MH 1 = Male Hostel 1, MH 2 = Male Hostel 2, FMH = Female hostel, SQ = Staff quarter, CAF = Cafeteria and LFB = Law Faculty Borehole.							

Table 3. Morphological characteristics of Helminthes and Protozoa Encountered in all the water samples.

Sample	Shape of cell	Cellular pigmentation	Presence of Cyst/oocyst	Tentative Genera
MH 1 sample	Oval	Purple	+	*Giardia*
MH 2 sample	_	_	_	_
FMH sample	Oval	Purple	+	*Giardia*
SQ sample	_	_	_	_
CAF sample	_	_	_	_
LFB sample	_	_	_	_
KEY: MH 1 = Male Hostel 1, MH 2 = Male Hostel 2, FMH = Female hostel, SQ = Staff quarter, CAF = Cafeteria and LFB = Law Faculty Borehole.				

Table 4. Average Physicochemical parameters recorded from all the water samples and the regulatory limits.

S/N	**Parameter**	**Average Results from all the Sampling Stations**						**Total Average**	**Regulatory Limits**	
		MH1	**MH2**	**FH**	**SQ**	**CAF**	**LFB**		**NESREA**	**WHO**
01	pH	6.33	6.59	8.81	6.95	6.82	6.12	41.62	6.50--8.50	6.50--8.50
02	Temp. (°C)	29.80	29.75	30.05	29.80	30.50	29.90	179.80	30.00	30.00
03	Alkalinity (mg/l)	5.50	5.00	5.00	4.50	6.00	28.00	54.00	6.00 – 9.00	6.00 – 9.00
04	Cl^- (mg/l)	6.00	4.00	4.50	3.00	2.50	2.00	22.00	200.00	200.00
05	DO (mg/l)	6.11	10.08	8.42	7.84	5.76	6.23	44.44	>4	>4
06	BOD (mg/l)	0.84	0.68	1.65	0.94	0.40	0.28	4.79	3.00	3.00
07	TDS (mg/l)	200.00	500.00	400.00	400.00	500.00	200.00	2200.00	500.00	500.00
08	EC (µs/cm)	34.00	66.00	33.00	82.00	103.00	84	402.00	500.00	500.00
09	NO_3 (mg/l)	30.25	27.00	27.00	28.99	28.35	120	261.59	50.00	50.00
10	OG (mg/l)	60.00	166.00	377.00	375.50	317.50	431.00	1727.00	100.00	100.00
11	Ca (mg/l)	48.15	49.95	67.95	51.60	72.50	76.90	367.05	50.00	50.00
12	Na (mg/l)	15.99	14.59	13.99	15.01	13.92	13.95	87.45	200.00	200.00
13	K (mg/l)	21.24	18.46	49.98	18.48	19.54	20.05	147.75	0.50	0.50
14	Turbidity (NTU)	3.93	8.03	8.20	5.83	6.20	4.00	36.19	5.00	5.00
Key: MH1 = Male Hostel 1, MH2 = Male Hostel 2, FH = Female Hostel, SQ = Staff Quarters, CAF = Cafeteria, LFB = Law Faculty Borehole, DO = Dissolved Oxygen, OG = Oil and Grease, TDS = Total Dissolved Solids, EC = Electrical Conductivity, BOD = Biochemical Oxygen Demand, NO_3 = Nitrate, K^+ = Potassium, Ca^+ = Calcium, NTU = Nephelometric Turbidity Unit and pH = Potential of Hydrogen ion.										

Table 5. Average population of microbiological parameters recorded from all the water samples and the regulatory limits.

S/N	**Parameter**	**Average Results from all the Sampling Stations**						**Total Population**	**Regulatory Limits**	
		MH1	**MH2**	**FH**	**SQ**	**CAF**	**LFB**		**NESREA**	**WHO**
01	THB (CFU/ml)	656.00	699.50	751.50	499.50	618.00	357.00	3581.50	$1.0 X 10^2$	$1.0 X 10^2$
02	TC(CFU/ml)	78.50	82.50	163.50	85.00	160.00	92.00	661.50	0	0
03	FC(CFU/ml)	87.50	98.50	90.00	59.00	89.00	18.00	442.00	0	0
04	FS(CFU/ml)	31.00	43.50	63.00	31.00	71.00	32.00	271.50	0	0
05	PS(CFU/ml)	43.50	155.50	8.00	35.00	48.00	57.00	347.00	0	0
06	*Vibrio* (CFU/ml)	148.00	54.00	128.00	101.00	293.00	60.00	784.00	50	50
07	TF(CFU/ml)	267.50	265.50	256.00	186.00	103.00	98.00	1176	$1.0 – 2.2X 10^2$	$1.0 – 2.2 X 10^2$
08	Protozoa (CFU/ml)	2.50	0.00	6.00	0.00	0.00	0.00	8.50	3	3
09	Helminthes (CFU/ml)	0.00	0.00	0.00	1.50	0.00	0.00	1.50	3	3
Key: MH1 = Male Hostel 1, MH2 = Male Hostel 2, FH = Female Hostel, SQ = Staff Quarters, CAF = Cafeteria, LFB = Law Faculty Borehole, THB = Total Heterotrophic Bacteria, TC = Total Coliform, FC = Fecal Coliform, FS = Fecal Streptococci, PS = Pseudomonas aeruginosa, TF = Total Fungi, NESREA = National Environmental Standards Regulatory and Enforcement Agency and WHO = World Health Organization.										

6. Conclusion and Future Scope

The domestic water quality in a higher institution in the Wester Niger Delta of Nigeria, were assessed in this project study. Results of microbiological parameters showed above regulatory limits of Total Heterotrophic Bacteria, Total Coliform, Fecal Coliform, Fecal Streptococci, *Vibrio*, *Pseudomonas aeruginosa*, Yeasts and Molds in all the water samples observed. Protozoa and Helminthes were found in only 2 samples in the study. Nitrate, Oil and Grease, Electrical Conductivity, Biochemical Oxygen Demand, Potassium, Turbidity and Calcium were above regulatory limits for drinking water. The study showed that the domestic water used in the higher institution in the creeks of the

Western Niger Delta, was contaminated as a result of lack of water treatment plants to address the presence of contaminants in the used water, poor hygienic practices, poor inspection and maintenance and other environmental factors. The study showed that the domestic water used in this higher institution did not meet the National (NESREA) and International (WHO) regulatory standards for domestic water acceptability. The study aimed to expand the sampling stations such as the institution's administrative building, faculty buildings, health center, the laboratories section, the laundry complex, etc. which have not been analyzed in this current stud in order to assess the holistic quality status of the used domestic water within the institution. Construction of effective water treatment plant across boreholes in this institution is also needed which will address the problem of unsafe domestic water availability in the institution.

Conflict of Interest
We do not have any conflict of interest to disclose.

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Authors' Contributions
The first author carried out proposal development, researched literature reviews, collection of water samples, samples analysis, documentation of this research paper and publication process.
The second author played the role of effective supervision and guidance on the procedures for samples collection and analysis as well as review the whole project report prior to publication.

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