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Bacteriological and Physicochemical Qualities of Ebutte River in Ebutte Community, Uhunmwonde Local Government Area, Edo State, Nigeria

EKHAISE, FRED OSARO; OMOIGBERALE, MAY OYARIBHOR

Department of Microbiology, Faculty of Life Sciences, UniVersity of Benin, Benin City, Edo State, Nigeria

ABSTRACT: The bacteriological and physicochemical qualities of Ebutte River in Ebutte Community were carried out to ascertain the variation in the quality of the river between August, 2010 and January, 2011.The bacteriological and physicochemical assessments were studied using the basic microbiological techniques. The bacterial counts were shown to be highest in the inhabited point (3) while downstream (points 4 and 5) and upstream (points 1 and 2) recorded lower counts due to little or no human activities. The bacterial counts were higher than the acceptable limit of the WHO standards at all sampling points. The total viable counts ranged from 3.40 x 10^5 to 3.71 x 10^6cfu/ml for the months of August, 2010 to January, 2011. The bacterial counts were showed to be highest in the rainy season. The total coliform counts ranged from 27MPN/100ml to 350MPN/100ml while the faecal coliform counts ranged from 5MPN/100ml to 26MPN/100ml. The faecal Streptococci counts were recorded to range from <2MPN/100ml to 14MPN/100 and the *Clostridium* counts ranges from <2MPN/100ml to 6MPN/100ml. The bacterial isolates isolated and characterised includes eleven bacterial genera among which are *Escherichia*, *Klebsiella*, *Pseudomonas*, *Bacillus, Enterobacter, Streptococcus, Salmonella*, *Staphylococcus, Proteus, Clostridium* and *Shigella.* The results of most of the physicochemical parameters analysed were shown to be higher at sampling point 3, which is the point that had direct effect of human activities. Similarly the values obtained for dissolved oxygen was shown to be lowest in the inhabited sampling point 3. Analysis of variance showed that there was a high significant difference (P<0.001) between total viable counts obtained in the two seasons while a significant difference (P<0.05) was obtained for total coliform counts and faecal coliform counts. Significant difference (P>0.05) was obtained for faecal Streptococci and *Clostridium perfrigens* counts. Correlation coefficient showed positive relationship between the total viable counts and some of the physicochemical parameters studied. The Ebutte River water quality studied based on the bacteriological and physicochemical parameters revealed that the human, animal and agricultural activities plays significant role in the contamination of the water source. @JASEM

*Keyword***:** Ebutte River, water quality, bacteriological and physicochemical parameters.

Rivers are vital and vulnerable freshwater systems that are critical for the sustenance of all lives. However, the declining quality of the water in these systems threatens their sustainability and is therefore a cause for concern. Rivers are waterways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes (Farah, 2002). The maintenance of healthy aquatic ecosystem is depended on the physicochemical properties and biological diversity. A regular monitoring of water bodies would not only prevent the outbreak of diseases and occurrence of hazards but would check the water from further deterioration. Bacteriological assessment particularly for coliforms, the indicators of contamination by faecal matters is therefore routinely carried out to ascertain the quality and potability of water to ensure prevention of further dissemination of pathogens. One of the most important factors of water pollution is the microbial contamination especially with pathogenic microorganisms. Enteric pathogens are typically responsible for waterborne illness (Bitton, 1994).Contamination of water is a serious environmental problem as it adversely affects the human health and the biodiversity in the aquatic ecosystem.

The provision of good quality household drinking water is often regarded as an important means of improving health (Moyo *et al*., 2004). According to World Health Organisation (WHO, 1992), there were estimated four billion cases of diarrhoea and 2.2million death annually. The consumption of unsafe water has been implicated as one of the major causes of this disease. Most gradual deterioration of water quality is as a result of increase in human population and urbanization (Ho and Hui, 2001). The primary objective of drinking water microbiology is to prevent waterborne diseases and this can be achieved through proper water treatment, control practices and monitoring of their effectiveness.

The use of indicator bacteria such as faecal coliforms and faecal streptococci for assessment of faecal pollution and possible water quality deterioration in freshwater sources is widely used (APHA, 1995). Currently coliforms and *Escherichia coli* are of great importance among bacterial indicators used in water quality definition and health risk (Schlegel, 2002). Pathogens are of a serious concern for managers of water resources because excessive amounts of faecal bacteria in sewage have been known to indicate risk of pathogen-induced illnesses in humans (McFeters *et al*., 1974). Several species of gram-negative bacteria present in municipal wastewater are pathogenic. This pathogenicity is usually associated with certain components of the cell walls in particular the lipopolysaccharide (LPS) or endotoxin layer

***Email:aiyevbosa.ekhaise@gmail.com or fredfldyn1@yahoo.com**
Tel: +2348063856316 or +2348055648761

(Bonde, 1963). Thus, identification of these pathogenic agents in water resources is beneficial for controlling and prevention of infectious diseases.

Globally many people do not have access to safe drinking water and as a consequence, there is significant morbidity and mortality due to disease causing organisms in water (WHO, 1998). Among these diseases, are cholera, schistosomiasis, onchocerciasis, shigellosis, salmonellosis, yersiniosis, campylobacteriosis, parasitic and viral infections (Simango *et al.,* 1992). Historically water has played a significant role in the transmission of human disease. Typhoid fever, cholera, amoebic dysentery and many other gastrointestinal diseases can be transmitted by water. Contamination of water by sewage and human faecal material present the greatest danger to public health. WHO (2000) reported that nearly one-fourth of all hospital beds in the world are occupied by patients with complications arising from infections by waterborne organisms and it also states that nearly 6000 people, mostly children die everyday due to waterborne diseases. In the United States, an estimated 20billion US dollar is lost annually to diseases caused by waterborne pathogens. Though water is abundant, suitable drinking water is limited by geography, demography and affordability (WHO, 2000).

This research was carried out as a simple and scientific approach to monitor Ebutte River, which serves as a major source of water to Ebutte community and its environs. The study was aimed at investigating the bacteriological and physicochemical qualities of the Ebutte River in Ebutte Community as it is influenced by seasonal variations.

MATERIALS AND METHODS

Study area: The Ebutte River is located in Ebutte in Uhumwonde Local Government Area of Edo State (Fig. 2). The climate in the region is tropical with alternating rainy and dry seasons. The Ebutte River lies between latitude $6^{0}25^{1}$ N to $6^{0}45^{1}$ N and longitude $6^{0}25^{1}$ E to $5^{0}45^{1}$ E (Fig.1). The population of the inhabited community is about 100 to 120 including adult males, adult females and children. The river shares its catchments boundary with Okemuen and Iruekpen communities respectively both in Uhunmwonde and Esan West Local Government of Edo State, Nigeria.

The source of the river is from Iruekpen in Esan West Local Government Area of Edo State. The main tributary is Emuen stream (Fig. 2). The Ebutte River watershed is the principal natural water network irrigating the community. The River is used by the community´ for multiple activities including: agriculture, laundry, drinking, commercial purpose, car washing, bathing, watering of crops for raw consumption and in certain areas swimming by youth. Therefore, an overview of the quality of the River is a major public health issue.

Sampling: The river is about 200meters from the community. Five sampling points were chosen with intervals of about 100 metres apart, and samples were collected against the water current. The sampling was done monthly over a period of six months which spanned through the rainy season (August, 2010 to October, 2010) and dry season (November, 2010 to January, 2011). A total of 30 samples were collected during the sampling period with each point sampled six times. The Sampling points were point 1 (P1) the upstream, point 2 (P2) between the upstream and midstream, point 3 (P3) the midstream, point 4 (P4) between the midstream and downstream and point 5 (P5) the downstream. Samples for bacteriological analysis were collected into sterile clean glass bottles by dipping and corking the bottle in the water. Bottles were labelled before sample collection. For physicochemical analysis, 1litre new plastic bottles with hard plastic screw caps were used for sample collection. The sampling containers were washed properly before use and rinsed with the water to be sampled before final sample collection. Unstable parameters such as temperature, pH and conductivity were measured in-situ while dissolved oxygen was collected with dissolved oxygen bottle and the oxygen was fixed using 1.2ml of Winkler solution A and B. Collected samples were transported immediately to the laboratory for the bacteriological and physicochemical examinations.

The bacteriological parameters monitored included total viable counts, total coliform counts, total faecal coliform counts, faecal streptococci counts and Clostridium perfrigens according the methods of Gerhardt et al., (1994); APHA, (1995); Cruickshank et al., (1980); Bonde, (1963). The isolation and identification of bacterial isolates were carried out in accordance with Bergey's Manual of Determinative Bacteriology (Buchanan and Gibbons, 1974; Gerhardt et al., 1994)

The physicochemical parameters studied were pH, water temperature, turbidity, conductivity, total dissolved solids, total suspended solids, colour, acidity, alkalinity, nitrite, iron, copper, zinc, sulphates, total phosphorous, available phosphorous, nitrate, ammonia nitrogen, chromium, lead, chloride, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand were analysed. The

physicochemical analyses were determined according to Standard Methods for Water and Wastewater (APHA, 1998).

Statistical Analysis: SPSS was used to carry out single factor analysis of variance (ANOVA) on the bacteriological counts to test for statistical significance and where significant differences were detected the Duncan's Multiple Range (DMR) test was further used to locate the significantly different means. Also correlation coefficient test was conducted between the total viable counts and physicochemical parameters at 95% and 99% probability level.

RESULTS AND **DISCUSSION**

The results of the total viable counts (TVC) (cfu/ml) of Ebutte River water samples for the various sampling points are presented in Table 1. The microbial load of the river was high and varied from month to month. The values ranged from 3.40 x 10^5cfu/ml in December, 2010 and January, 2011 (points 1 and 5) to 3.71 x 10^6cfu/ml in August, 2010 (point 3). Table 2 showed the total coliform counts (TCC) for the various sampling points The least total coliform counts of 27MPN/100ml was observed in January, 2011 (point 5) while the highest total coliform counts was 350MPN/100ml and it was recorded in August, 2010 (point 3).

Faecal coliform (FC) counts for the various sampling points are showed in Table 3. Faecal coliform counts ranged from 5MPN/100ml in December, 2010 and January, 2011 (points 5 and 1) to 26MPN/100ml in August, 2010 (point 3).

The results of the faecal Streptococci (FS) counts for the different sampling points are showed in Table 4. The faecal Streptococci counts ranged from <2MPN/100ml in January, 2011(point 5) to 14MPN/100ml in August, 2010 (point 3). The results of the *Clostridium perfrigens counts* (MPN/100ml) are showed in Table 5. Eleven bacterial genera were isolated from the water sample of Ebutte River and these included pathogens and opportunistic pathogens. Members of the Enterobacteriaceae predominated, and the genera are *Escherichia*, B*acillus, Pseudomonas, Klebsiella, Proteus, Staphylpcoccus, Streptococcus, Clostridium, Salmonella, Shigella* and *Enterobacter*. Fig.3 showed the frequency of bacterial distribution in the sampling points. The most prevalent bacterial isolates were *Escherichia coli* (19%), *Streptococcus faecalis* (18%) and *Enterobacter* sp. (12%) while the least prevalent were *Shigella* sp. (3%), *Bacillus* sp. (4%) and *Salmonella* sp. (4%).

Table 6 showed the result of Analysis of variance (ANOVA) on bacterial counts. ANOVA on total viable counts (TVC) showed that there was a high significant difference in total viable counts between the rainy and dry seasons respectively (August, 2010 to October, 2010 and November, 2010 to January, 2011) with ($P<0.001$) level of significance.

The results of the physicochemical assessment of the water sample of Ebutte River are presented in Tables 7, showing the descriptive analysis of the physicochemical parameters of Ebutte River. The pH values recorded were observed to be within the WHO standard of 6.5 – 8.5 except for the months of November, 2010, December, 2010 and Jan, 2011, where the pH values ranged from 5.0 – 7.45. The results of total dissolved solid (TDS) and total suspended solid (TSS) were observed to be far lower than the WHO standard. The results of the dissolved oxygen (DO) showed seasonal changes from August, 2010 to January, 2011.The DO values were found to be higher in the dry season and lower in the rainy season. The results of some of the physicochemical parameters were shown to be higher in sampling point 3, which have direct effect of human activities.

The total viable counts for all the water samples were generally high exceeding the WHO limit of $1.0X10^2$cfu/ml which is the standard limit of total bacterial counts for drinking water (EU, 1998). The values ranged from 3.40 x 10^5cfu/ml to 3.71 x 10^6cfu/ml (Table 1). Total bacterial counts are indicative of the presence of high organic matter in the water. The primary sources of these bacteria in water could be attributed to animal and human activities. These sources of bacterial contamination include surface runoff, pasture, and other land areas where animal wastes are deposited. The total bacterial counts in colony forming unit (cfu/ml) ranged from 3.40 x 10^5cfu/ml in November, 2010 and January, 2011 (Points1 and P5) to 3.71 x 10^6 cfu/ml in August, 2010 (Point 3). Sampling point 3 recorded the highest total bacterial counts value, this point is believed to have received high human and animal activities. The total bacterial counts values were higher during the rainy seasons (Table 1) and longitudinal profile shows that bacterial population increased from upstream (P1) to midstream (P3) and decreased from midstream to downstream (P4 and P5) (Table1). In August 2010, total bacterial counts ranged from 1.69 x 10^6 (cfu/ml) to 3.79 x 10^6 cfu/ml with the least count in point 5 (P5) and the highest in point 3 (P3) (Table 1).

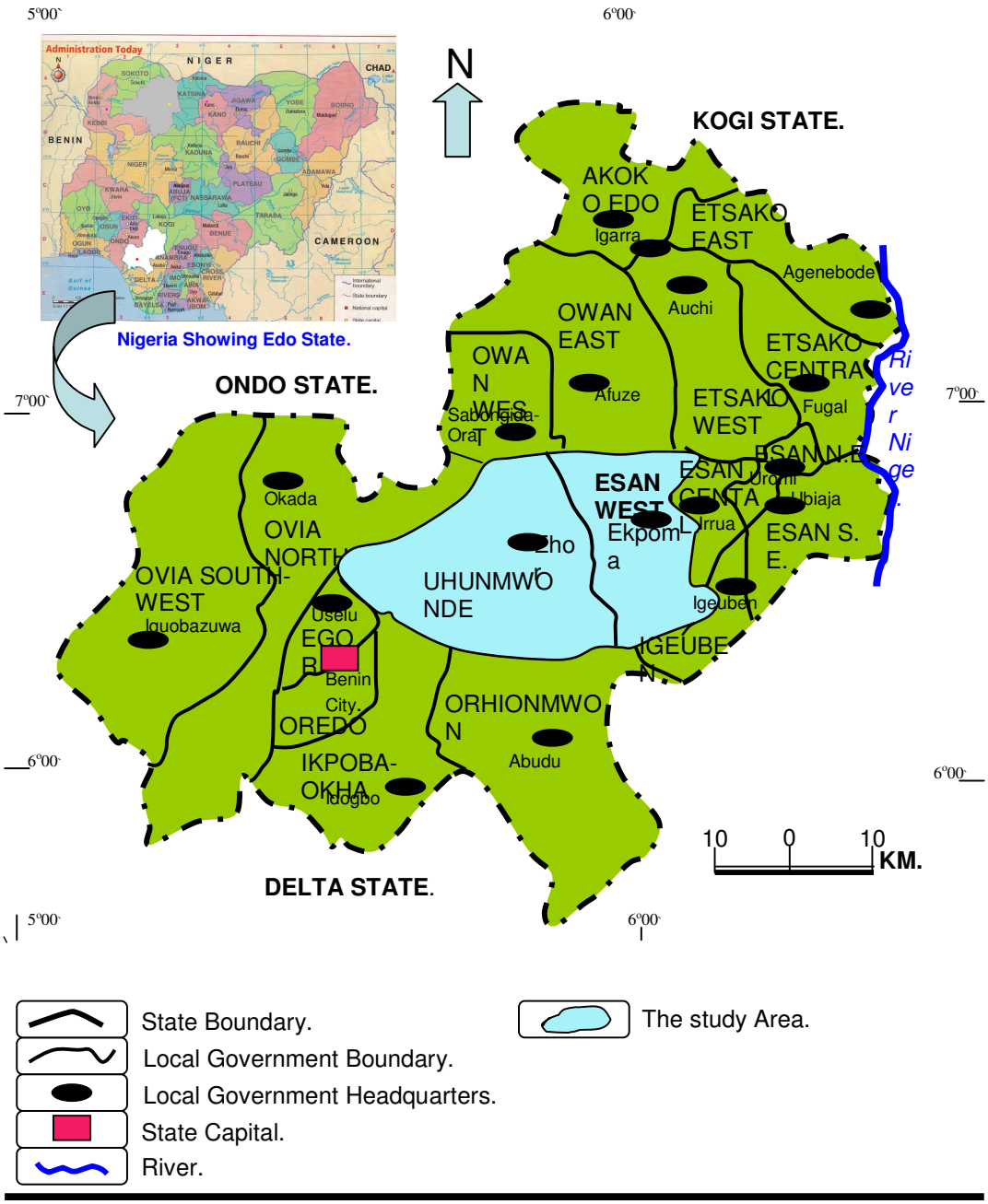

Fig: 1. MAP OF EDO STATE SHOWING THE STUDY AREA

SOURCE: MINISTRY OF LANDS AND SURVEYS, BENIN CITY, 2011.

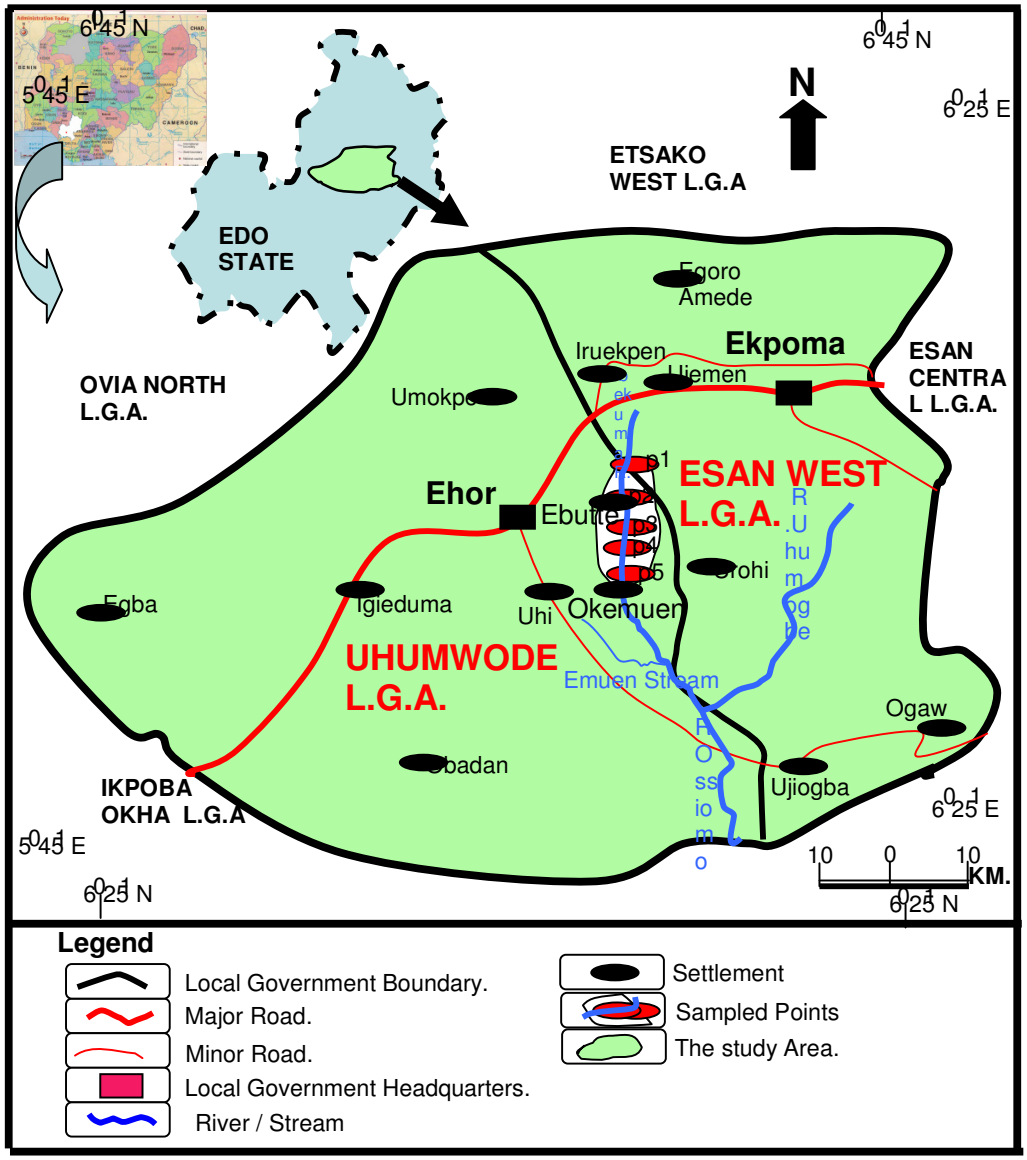

Fig: 2. Map showing ebutte river and sampling points

In September 2010, total bacterial counts ranged from 1.36 x 10^6 cfu/ml in point 1 (P1) to 2.70 x 10^6 cfu/ml in point 3 (Table 1).Total viable counts for the month of October 2010 showed a range of 1.35 x 10^6 in point 1 to 2.37 x 10^6 in point 3 (Table 1). In November, 2010, total bacterial counts ranged from 3.45 x 10^6 cfu/ml in point 1 to 1.69 x 10^6 cfu/ml in point 3 was. The total bacterial counts in December, 2010 ranged from 3.43 x 10^5 cfu/ml in point 1 to 1.35 x 10^6 cfu/ml in point 3 (Table 1) while that of January, 2011 ranged from 3.40 x 10^6 cfu/ml in points 1 and 5 to 6.77 x 10^6 cfu/ml in point 3(Table 1). All sampling points were found to record high total bacterial counts values than the WHO standard acceptable limit and total bacterial counts as reported by Shittu *et al.,* (2008) which was 1.0 x 10^6 cfu/ml. The total bacterial counts were lower in the dry season as compared to rainy season. The counts decreased gradually from August, 2010 to January, 2011. Sampling point 3 (P3) was found to record the highest total bacterial counts in each month sampled. This could be attributed to the high human and animal activities at this point.

The results of the total coliform counts (TCC) for all samples were exceedingly higher than the WHO standard for coliform bacteria in water, which is zero total coliform per 100ml of water (Table 2). The least

total coliform counts was recorded in January, 2011 and it was 27MPN/100ml at sampling point 5, while the highest total coliform counts was 350MPN/100ml (p3) which was recorded in August, 2010. This is contrary to Olayemi, (1994), who recorded higher total coliform counts in the dry season. The total coliform count was highest in point 3 throughout the months of sampling and least in points 1 and 5 respectively. The values increased from upstream to midstream and then a decrease at downstream. The high coliform counts obtained from the samples, is an indication that the water sources have received faecal contamination (Martin *et al.,* 1982). None of the sampling points of the water sources complied with WHO standard for coliform in water and this could be supported by evidence advanced by Shittu *et al*., (2008) who reported high coliform counts of 1600MPN/100ml. According to WHO (1996), every water sample that contains coliform, should be investigated for the presence of faecal coliforms (*E. coli)* (EU, 1998) with a view to ascertaining contamination with human or animal waste and possibly pathogenic bacteria or organisms such as *Gardia* and *Cryptosporidium.*

TABLE 1: Mean values of Total viable counts (cfu/ml) of Ebutte River water sample from August, 2010 to January, 2011

Sampling points	August	September	October	November	December	January	WHO Standard
P1	2.02×10^6	1.36×10^6	1.35×10^6	3.43×10^5	3.40×10^5	3.40×10^5	1.0×10^2
P2	2.03×10^6	2.36×10^6	1.70×10^6	1.02×10^6	1.02×10^6	6.77×10^5	1.0×10^2
P3	3.71×10^6	2.70×10^6	2.37×10^6	1.69×10^6	1.35×10^6	1.01×10^6	1.0×10^2
P4	2.03×10^6	2.03×10^6	1.70×10^6	1.02×10^6	6.77×10^5	6.77×10^5	1.0×10^2
P5	1.69×10^6	1.69×10^6	1.68×10^6	1.01×10^6	3.44×10^5	3.40×10^5	1.0×10^2

Key: P1 – Upstream ; P2 - Between upstream and midstream (less activity); P3 - Midstream (Heavy human and animal activity); P4 - Between midstream and downstream (less activity); P5 – Downstream ; WHO – World Health Organisation

TABLE 2: Total coliform counts (MPN/100ml) of Ebutte River water sample from August, 2010 to January, 2011

Sampling Points	August	September	October	November	December	January	WHO Standard
P1	110	94	79	70	79	27	3coliform/100ml
P2	220	170	170	130	110	110	3coliform/100ml
P3	350	280	220	180	140	140	3coliform/100ml
P4	220	220	180	110	94	110	3coliform/100ml
P5	180	79	110	79	70	33	3coliform/100ml

The results of the faecal coliform (FC) counts for the various sampling points ranged from 5MPN/100ml in December, 2010 and January, 2011 (points 5 and 1) to 26MPN/100ml in August, 2010 (point 3) respectively. The faecal coliform counts were higher in the rainy season and this is contrary to the report by Olayemi,(1994) who recorded higher total coliform and Faecal coliform in the dry season.

Though total coliform and faecal coliform counts were high in all sampling points, faecal Streptococci and *Clostridium perfrigens* counts were low in all sampling points with the exception of sampling point 3. There was a clear seasonal fluctuation in the total viable counts and coliform bacteria densities in the river with all points recording high counts between August, 2010 and January, 2011. Both total and faecal coliforms in this study recorded more counts during rainy season than dry season. Rainy season maxima might be due to discharge of domestic wastes containing faecal matters into the river, open defecation along the sides of river bank and washing of such feaces and other organic waste to the river by floods.

TABLE 3: Faecal coliform counts (MPN/100ml) of Ebutte River water sample from August, 2010 to January, 2011

Sampling points	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	WHO standard
P1	8	11	11	7	7	5	Zero/100ml
P2	17	14	14	11	9	7	Zero/100ml
P3	26	21	26	17	14	9	Zero/100ml
P4	14	9	17	11	9	9	Zero/100ml
P5	11	11	11	7	5	5	Zero/100ml

In the study, eleven bacterial genera were routinely isolated in the water sample which includes pathogens and opportunistic pathogens. Members of the Enterobacteriaceae predominated in the bacterial isolated and this includes, the genera *Escherichia, Bacillus, Pseudomonas, Klebsiella, Proteus, Staphylococcus, Streptococcus, Clostridium, Salmonella, Shigella* and *Enterobacter*. Figure 3 showed the frequency of distribution of the bacterial isolates in the sampling points and it was revealed that the bacterial isolates *Escherichia coli, Streptococcus faecalis* and *Enterobacter* sp. were the most prevalent isolates, while the least prevalent were *Shigella* sp., *Bacillus* sp., *Salmonella* sp. and *Clostridium*. This further confirmed faecal contamination as a major source of water pollution in the rainy season.

TABLE 4: Faecal Streptococci counts (MPN/100ml) of Ebutte River water sample from August, 2010 to January, 2011

Sampling points	August	September	October	November	December	January
P1	4	4	4	2	2	2
P2	4	4	4	4	4	2
P3	14	11	6	5	5	5
P4	4	4	4	2	2	2
P5	4	2	2	2	2	<2

TABLE 5: *Clostridium* perfrigens counts (MPN/100ml) Ebutte River water sample from August, 2010 to January, 2011

Sampling points	August	September	October	November	December	January
P1	<2	<2	<2	<2	<2	<2
P2	4	2	<2	<2	<2	<2
P3	6	4	4	2	2	2
P4	2	2	2	<2	<2	<2
P5	<2	<2	<2	<2	<2	<2

Escherichia coli, the main indicator of faecal pollution constituted about 19% of the identified bacterial isolates in the examined water, an indication that, the river water has received faecal pollution. The genus *Pseudomonas* is an opportunistic pathogen of humans constituted about 11% of the water sampled. In the contrary, *Klebsiella pneumoniae* constituted about 8% of the isolates. This pathogenic bacterium has been previously reported from surface water (Kistemann *et al.,* 2000). *Staphylococcus aureus* represented about 8% of the identified bacteria. *Enterobacter* which constituted about 12% *of the* isolates, an examples of non faecal coliforms found in vegetation and soil which serves as sources through which the pathogens enters the water (Schlegel, 2002). *Salmonella* constituted about 4% of bacterial isolates. *Shigella* sp., constituted about 3% of the identified bacteria, an invasive pathogen which causes Shigellosis or *Shigella* related diarrhoea. *Proteus mirabilis constituted* about 6% which represents an intestinal flora origin widely distributed in soil and water (Schlegel, 2002). The presence of these organisms in water, stream and river samples did not conform to WHO water standard for recreational activities, because they are of public health significance and are associated with gastrointestinal infections, diarrhoea, dysentery, typhoid fever and other form of infections (EU, 1998).

TABLE 6: Significant Difference among The Bacterial Counts In The Months Of Sampling

PARAMETERS	AUG. 2010	SEPT. 2010	OCT. 2010	NOV. 2010	DEC. 2010	JAN. 2011	P-VALUE
	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	$\bar{x} \pm$ SE	
Total viable count	$2.29^{A} \pm 0.36$	$2.028^{A} \pm 0.237$	$1.76^{A} \pm 0.17$	$1.05^{B} \pm 0.22$	$0.75^{B} \pm 0.19$	$0.61^{B} \pm 0.13$	P<0.001
Total coliform	$216^{A} \pm 39.06$	$168.6^{A} \pm 37.85$	$151.8^{B} \pm 25.32$	$113.8^{B} \pm 19.73$	$98.60^{B} \pm 12.38$	$84.0^{B} \pm 22.74$	P<0.05
Faecal coliform	$15.80^{A} \pm 3.09$	$15.20^{A} \pm 2.11$	$13.20^{B} \pm 2.78$	$10.60^{B} \pm 1.83$	$8.80^{C} \pm 1.49$	$7.00^{C} \pm 0.89$	P<0.05
Faecal Streptococci	5.60±2.14	5.40±1.40	3.60±0.75	3.40±0.60	3.60±0.75	3.20±0.80	P>0.05
Clostridium perfrigens	3.20±0.80	2.40±0.40	2.40±0.40	2.00±0.00	2.00±0.00	2.00±0.00	P>0.05

Similar letters indicate no significant difference ; ***Note:****P<0.001 -Highly significant; P<0.05 -Significant; P>0.05 - Not significant*

The pH of the water samples ranged from a minimum of 5.22 in January, 2011 to a maximum of 8.08 in August, 2010. The results of physicochemical parameters showed that the pH ranged from acid

level to fairly alkaline in all the five points studied for the period of sampling, with the exception of the midstream pH which showed high pH value. The dry season minima were due to increased decomposition rate, leading to acidification and lowered pH (Chetana and Somashekar, 1997). The pH values recorded were observed to be within the WHO standard of 6.5–8.5 except for the month of Nov. 2010, Dec, 2010 and Jan, 2011, where the pH values ranged from 5.0 – 7.45. The increase in the pH values could be attributed to the effect of the dry season due to accumulation of particles and dissolved substances.

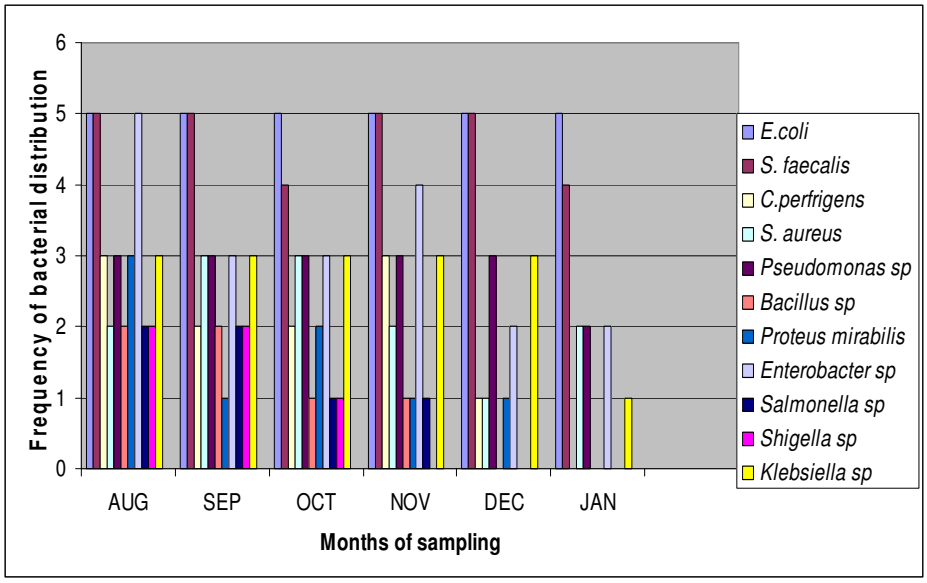

FIG. 3: Frequency of Distribution Of Bacterial Isolates In The Sampling Months (August, 2010 To January, 2011)

The results of total dissolved solid (TDS) and total suspended solid (TSS) were observed to be far lower than the WHO standard of 500mg/l compared to 20–150mg/l. The values ranged from 10.12mg/ml – 20.62mg/ml for TDS and 2.00mg/ml – 9.00mg/ml for TSS. This is contrary to the report of Shittu *et al., (*2008), who reported very high values for total dissolved solid (TSS) and total suspended solid (TSS).

In polluted water temperature exhibit profound effects on dissolved oxygen (DO) and biological oxygen demand (BOD). The fluctuation in river water temperature usually depends on the season, geographical location, sampling time and temperature of effluents entering the river (Ahipathy, 2006). The results of the temperature of the water showed an increase in temperature across the season from August, 2010 to January, 2011.

Conductivity is expressed as a measure of the ability of an aqueous solution to carry an electric current which depends on the presence of ions, their total concentration, mobility and temperature. In this study sampling point 3 showed higher values of electrical conductance in contrast to other points. Increasing levels of conductivity are the products of decomposition and mineralization of organic materials (Abida, 2008). Minimum conductivity was observed in the rainy season compared to the dry season, owing to the effect of dilution in the rainy season.

The sulphate content of natural waters is an important consideration in determining their suitability for public supplies. In this study, it was observed that the sulphate of the water sample were found to be high in the dry season and lower in the rainy season in all the five sampling points. The results were within the WHO limit of 250 – 400mg/l

The results of the dissolved oxygen (DO) showed seasonal changes from August, 2010 to January, 2011.The DO values were found to be higher in the dry season and than in the rainy season. The decrease in the DO content in the rainy season could be attributed to the high microbial load and oxygen utilization in bacterial decomposition of organic matter. Monthly values varied between 5.44 to 9.01mg/l. Dissolved oxygen (DO) content is one of the most important parameter used to determine purity state of the river. Its deficiency directly affects

the ecosystem of a river due to bioaccumulation and biomagnifications (Ahipathi 2006). The oxygen content in water samples depends on a number of physical, chemical and biological processes.

Biological oxygen demand (BOD) is a measure of the amount of oxygen in the water that is required by the aerobic organisms. The biodegradation of organic materials exerts oxygen tension in the water and increases the biochemical oxygen demand (Abida, 2008). Rivers with low BOD have low nutrient levels; therefore, much of the oxygen remains in the water. Unpolluted, natural water has BOD of 6mg/l or less. BOD directly affects the amount of dissolved oxygen in rivers. The greater the BOD, the more rapidly oxygen is depleted in the stream. The consequences of high BOD are the same as those for low dissolved oxygen.

Table 7: descriptive analysis for the physicochemical parameters of ebutte river between august, 2010 and january, 2011

PARAMETERS	AUG. 2010	SEPT. 2010	OCT. 2010	NOV. 2010	DEC. 2010	JAN. 2010
	x̄ ± SE	x̄ ± SE	x̄ ± SE	x̄ ± SE	x̄ ± SE	x̄ ± SE
p^H	7.22±0.127.0 5-8.08	7.20±0.097.0 2-7.45	7.16±0.03 7.01-7.45	5.69±0.24 5-7.45	5.50±0.45 5-6.4	5.26±0.08 5-6.0
Temperature (^{0}C)	26.5±0.462 5.2-26	26.28±0.325.5- 27.2	26.12±0.23 25.6-27	26.96±0.26 26-27.6	26.91±4.3 26-27.7	27.08±0.35 26-28.2
Colour (Pt.Co)	7±0.316 6 - 8	6±0.316 5 - 7	5.8±0.2 5-6	5.6±0.24 5-6	5.2±0.37 4-6	5±0.316 4-6
Conductivity (µs/cm)	34.24±1.720 - 38	36.38±1.730.2- 40.9	36.28±1.78 30-40.2	43.20±4.67 28.8-56.2	44.8±5.82 28.2-60.2	46.96±8.82 28.8-76.2
Total Dissolved Solid (Mg/l)	19.76±0.418.2 - 20.6	19.57±0.44 18.3-20.4	19.31±0.36 18.2-20.2	18.11±0.77 15.2-19.4	17.40±0.87 15.3-19.4	16.61±0.78 14.5-18.4
Total SS (Mg/l)	4.93±1.07 3 - 9	4.84±1.162-9	4.32±0.642-6.12	3.46±0.76 2-6.12	3.03±0.69 1-5	2.4±0.68 1-5
Turbidity(NTU)	2.76±0.771.4 - 5.7	2.71±0.761.52- 5.63	2.05±0.501.22-4	1.19±0.61 0.01-3.2	1.18±0.58 0.01-3.45	1.01±0.61 0.01-3.24
Dissolved oxygen (Mg/l)	6.7±0.57 5.3 - 7.41	6.65±0.585.40- 7.411	6.27±0.575.40- 7.48	6.26±0.45 6.18-8.03	6.21±0.40 6.30-8.54	6.16±0.66 6.40-9.01
Biological Oxygen Demand (Mg/l)	6.53±0.65 5.3 – 8.5	6.42±0.615.28- 8.33	6.40±0.585.26- 8.41	6.35±0.49 5.2-8.28	6.22±0.61 5.01-7.3	6.01±0.75 5.01-6.5
COD (Mg/l)	7.17±0.09 7.04-7.90	7.14±0.047.04- 7.46	7.10±0.037.04- 7.22	6.95±0.11 6.58-7.0	6.93±0.24 6.21-7.01	6.12±0.27 5.28-6.28
Acidity	6.4±2.4 2 - 6	6.42±2.44 2-6	6.45±0.8 2-6	7.22±0.03 6-6.28	7.26±0.27 5.14-6.38	7.30±0.22 6.0-7.1
Alkalinity(Mg/l)	2.8±0.58 2 - 5	2.4±0.58 2-5	2.4±0.51 2-5	2±0 2-3	2.00±0.004 2-3.02	1.82±0.18 2.0-3
Nitrite (Mg/l)	0.01±0.0 0.01– .01	0.01±0.0 0.01-0.01	0.01±0.0 0.01-0.01	0.01±0.0 0.01-0.01	0.01±0.0 0.01-0.01	0.01±0.0 0.01-0.01
Nitrate (Mg/l)	0.16±0.01 0.12-0.2	0.15±0.012 0.12-0.19	0.15±0.02 0.12-0.19	0.042±0.06 0.10-0.052	0.036±0.06 0.022-0.14	0.035±0.05 0.024-0.15
Ammonia Nitrogen (Mg/l)	0.01±0.0 0.01-0.01	0.01±0.0 0.01-0.01	0.01±0.0 0.01-0.01	0.013±0.002 0.02-0.08	0.013±0.002 0.02-0.06	0.012±0.009 0.01-0.05
Total Phosphorous (Mg/l)	0.22±0.01 0.01-0.04	0.20±0.005 0.01-0.04	0.20±0.007 0.01-0.03	0.12±0.01 0.001-0.02	0.11±0.033 0.001-0.11	0.00±0.021 0.001-0.11
Avail. Phosphorous (Mg/l)	0.01±0.003 0.01-0.02	0.01±0.003 0.001-0.02	0.01±0.003 0.001-0.02	0.077±0.01 0.04-0.09	0.059±0.01 0.04-0.099	1.10±1.04 0.01-5.27
Sulphate	2.62±0.02 2.54-2.67	2.64±0.039 2.53-2.74	2.72±0.02 2.64-2.76	6.25±0.95 3-8.22	6.85±0.94 4-9.28	9.93±1.59 5.27-15.2
Chloride(Mg/l)	7.22±0.613 6.3-9.66	7.23±0.73 6.24-9.99	7.43±0.68 6.29-9.99	12.12±13.9 6.2-80.8	12.53±2.74 6.24-21.8	14.35±3.81 0.01-21.4
Iron (Mg/l)	0.01±0.0005 0.01-0.01	0.01±0.0005 0.01-0.01	0.01±0.0002 0.01-0.011	0.07±0.05 0.001-0.27	0.08±0.06 0.001-0.33	0.08±0.002 0.001-0.01
Copper (Mg/l)	0.002±0.0005 0.01-0.03	0.002±0.005 0.001-0.003	0.001±0.001 0.001-0.01	0.001±0 0.001-0.001	0.001±0 0.001-0.001	0.001±0.001 0.001-0.01
Zinc (Mg/l)	0.006±0.001 0.03-0.01	0.006±0.001 0.003-0.01	0.006±0.003 0.003-0.02	0.005±0.0004 0.01-0.01	0.005±0.0002 0.01-0.01	0.005±0 0.01-0.01
Chromium (Mg/l)	0.001±0 0.001-0.001	0.001±0 0.001-0.001	0.001±0 0.001-0.001	0.001±0 0.001-0.001	0.001±0 0.001-0.001	0.001±0 0.001-0.001
Lead (Mg/l)	0.002±0 0.00-0.002	0.002±0 0.002-0.002	0.002±0 0.002-0.002	0.002±0 0.002-0.002	0.002±0 0.002-0.002	0.002±0 0.002-0.002

The BOD value was recorded to be higher in rainy season. All sampling points were found to record BOD values above the WHO permissible limits. The sampling point 3 was observed to record the highest BOD value compared to the other sampling points. This could be attributed to the high human and animal activities compared to other sampling points.

Chemical oxygen demand (COD) is a measure of the oxidation of reduced chemicals in water. The result of the monthly averages of COD content was higher in the rainy season and lower in the dry season. The monthly values ranged from 5.28mg/ml to 7.90mg/l among the sampling points. It is commonly used to indirectly measure the amount of organic compounds in water. The measure of COD determines the quantities of organic matter found in water, it serves as a useful indicator of organic pollution of surface water (Trivedi *et al.*, 2009).

Conclusion: The study of the bacteriological and physicochemical properties of Ebutte River, which serves as the major source of water to the community shares significant importance in improving living standard and quality of life in the region. Therefore the periodic examination of water source for both domestic and commercial activities should be an important component for the protection strategy in this area. Understanding of pathogenic bacterial genera in river is important and useful to arrive at measures that may act as indicators of water quality and pollution. In this study, it was discovered that Ebutte River water which serves as water source is heavily contaminated with biological and physical agents of human and animal origin. The water source fell far below the WHO standard for surface water, which has more than 3 coliform per 100ml. For drinking purposes, according to WHO health reports, the water needs to receive appropriate treatment to make it fit for consumption. However it could be used for other purpose like laundry. Control of human activities to prevent faeces and refuse from entering water body is the major key to avoiding bacterial contamination of the river water. It is of great importance that relevant agency, that is, the government and other stakeholders should provide sanitary facilities especially in the rural areas to control river and water sources from pollution.

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