Bacteriological Quality Assessment of Water from Epie Creek, Niger Delta Region of Nigeria

Vivian Nkeiru Ben-Eledo¹, Lovet Tarilate Kigigha¹, Sylvester Chibueze Izah¹, *, Benjamin Onyema Eledo²

¹Department of Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Nigeria
²Department of Medical Laboratory Science, Faculty of Health Sciences, Madonna University, Elele, Nigeria

Email address: chivestizah@gmail.com (S. C. Izah)
*Corresponding author

To cite this article:
Vivian Nkeiru Ben-Eledo, Lovet Tarilate Kigigha, Sylvester Chibueze Izah, Benjamin Onyema Eledo. Bacteriological Quality Assessment of Water from Epie Creek, Niger Delta Region of Nigeria. International Journal of Ecotoxicology and Ecobiology. Vol. 2, No. 3, 2017, pp. 102-108. doi: 10.11648/j.ijee.20170203.12

Received: May 15, 2017; Accepted: June 3, 2017; Published: July 21, 2017

Abstract: This study evaluated the bacteriological quality of water samples from Epie creek, Niger Delta. Water samples were collected from five different locations (Akenfa, Agudama-Epie, Tombia, Opolo and Biogbolo) in two seasons viz: dry i.e. January and February and wet season i.e. May and June, 2016). The samples were analyzed following standard protocols. Results from the water quality ranged from 5.38-6.74 log cfu/ml (total heterotrophic bacteria), 1.72-2.54 log cfu/ml (Salmonella-shigella counts), 2.01-2.83 log MPN/100ml (total coliform), 1.55-2.22 log MPN/100ml (faecal coliforms). Analysis of variance showed that there was significance difference (P<0.05) in total and fecal coliform for location, months and interaction for total and fecal coliform, and no significance difference (P>0.05) for total heterotrophic bacteria and Salmonella-Shigella counts. The bacterial isolates were Pseudomonas, Enterobacter, Bacillus, Citrobacter, Erminia, Klebsiella, Shigella, Salmonella, Proteus, Serratia, Micrococcus, Corynebacterium species, Staphylococcus aureus and E. coli. The monthly and spatial distribution similarity interaction ranged from 88.00 – 96.00% and 55.56 – 86.96% respectively, being above critical level of significance = 50% for similarity index. The values showed that anthropogenic activities in the creek are having an impact on the water quality.

Keywords: Water Quality, Bacteria, Epie Creek, Yenagoa Metropolis

1. Introduction

Globally water resources include surface water (i.e. rivers, creeks, streams, rivulets, ponds, creeklets etc which are fresh, brackish or marine water), ground water and rainwater [1]. It is an indispensable resource needed for human existence and by all living organisms [2, 3]. Water also serve as habitat to several biological species including some aquatic mammals, fisheries (both fin and shelled fish), reptiles and birds [4]. Some other organisms such as tadpoles, mosquitoes and parasites that transmit diseases in human and other animals complete their life cycle in water.

Of all the water types, freshwater is the least in abundance but is the most utilized water resource beside transportation activities [5]. Some notable uses of freshwater includes recreational purposes e.g swimming, bathing, washing, cooking, drinking and even some industrial uses. These water resources exist in three forms including solid (in the form of ice), liquid and gas (in the form of vapour) [2, 6].

Water resource frequently gets contaminated by anthropogenic activities and to lesser extent through natural effects. Some notable human activities leading to pollution of water resources especially surface water include wastes disposal (municipal, solid and effluents) from several domestic and industrial area [7 – 10], human activities in the water such as dredging [11, 12], oil and gas activities [13]. Water could be contaminated by effluents from industries including pharmaceutical industries [8, 14 – 16], fertilizer manufacturing [17 – 19], palm oil mill production [20 – 22], cassava processing [23, 24], food processing [25] and market activities.

Most of water pollution activities often increase the
nutrients level of the water bodies which could lead to
eutrophication, acidification and change in hydrology. This
could adversely impact on the productivity of such water
with regard to fish composition and distribution. This could
also lead to changes in general domestic and industrial
utilization of the water. Although, self-purification processes
which occur in a stream enable it to safely disperse some
waste water discharges, however, there is a limit to its
assimilatory capacity.

Water quality parameters are enormous. Water quality is
typically assessed based on three major parameters including
heavy metals, microbial and general physicochemical
characteristics of the water [4, 26, 27]. Some notable
physicochemical parameters often used to assess water
quality and productivity includes temperature, pH, dissolved
oxygen, biochemical oxygen demand, chemical oxygen
demand, electrical conductivity, nutrient determinant (i.e.
calcium, magnesium, sodium, potassium, nitrate, sulphate,
chloride etc). While some heavy metals parameters include
i.e. iron, zinc, chromium, cadmium, copper, nickel,
manganese among others [1, 26].

Bayelsa State has several water bodies including ocean,
fresh and brackish water in different size. The water quality
parameters with regard to physicochemical parameters have
been widely studied. Some of the studies were carried out in
Kolo creek [28 – 31], Igbedi creek [32], some rivers in
Wilberforce Island [2], Ikoli creek [33], Nun River [34], Efiflake [35, 36], Taylor creek [37], Epie creek [38], Sagbama
creek [39]. But information about the microbial quality about
many of the creeks is scanty in literature.

The Yenagoa Metropolis, the state Capital has a creek
aligning the major road from Igbogene (beginning of the
Yenagoa) to Government House. In Yenagoa, surface water is
used for domestic, agricultural and industrial activities. In a
survey study Koinyan et al. [40] reported that 15%, 5%, 5%,
20% of communities in Igbogene, Akenfa, Ediepie and Swali
respectively used surface water.

Due to the importance of this creek to the host
communities, and the increasing and continuous use of this
creek, the water quality has been affected tremendously
posing a serious threat on the people's livelihood and aquatic
life at the downstream. Therefore, this study assessed the
bacteriological quality assessment of Epie creek in Yenagoa
metropolis, Nigeria.

2. Materials and Methods

2.1. Study Area

The Epie creek is an important an important water body
which runs along the Yenagoa metropolis, the Bayelsa state
capital (Figure 1). The creek also has a link with other creeks
such as Taylor creek and lies in latitudes 4° 50'N to 5° 05’N
and 5° 23N and longitudes 6°15E to 6° 3E [38]. The creek
serves as a receiver of poorly managed wastes in spite of the
fact that the creek is used for drinking, bathing, recreational
and transportation activities [38]. Several activities are
carried out in the creek including dumpsite, fishing,
boating (Figure 2). There are two predominant
seasons i.e. wet and dry season occurs in the region. The dry
season usually begins from November and ends in March of
the following year. While the wet season begin from April to
October with brief dry seasons that beginning from end of
July and end in Mid-August. The relative humidity and
temperature of the region range from 50 - 95°C and 29±5°C
respectively throughout the year.

![Figure 1. Map of Yenagoa Local Govt. Area Showing Water Sampling Points Along Epie Creek.](image-url)
2.2. Sample Techniques

The water samples were collected from five direct locations of the creek stretching from Akenfa to Biogbolo between January and February 2016 (dry season) – May and June 2016 (wet season). Based on locations, there are major market activities aligning the water body apart from Biogbolo. The samples meant for microbiological analysis were collected with sterile McCartney bottle. The samples were transported to the laboratory in an ice chest for laboratory analysis.

2.3. Bacteriological Examination of the Water

2.3.1. Determination of Total and Faecal Coliform

The coliform quality test for the water samples was carried out using the guide provided by Benson [41] with light modification from Akubunenyi et al. [6]. Three tube methods were employed. Based on gas production and color change, the result positive tubes were compared with table presented by Pepper and Gerba [42].

2.3.2. Determination of Total Heterotrophic Bacteria and Salmonella-Shigella Counts

Nutrient agar and Salmonella-Shigella count was used to determine the density for total heterotrophic bacteria and Salmonella-Shigella count. The media was prepared according to the manufacturers guide. Pour plate method previously described by Pepper and Gerba [42] and Benson [41] was employed for the analysis. Serial dilution was made up to 10⁻⁷, then after, 1.0ml of diluent was aseptically plated in sterile petri dish and the prepared media was poured. The plates containing the media were allowed to solidify before being incubated at 37°C for 24-48 hours. The resultant colonies after incubation was counted and expressed as colony forming units per the water sample.

2.3.3. Bacteria Identification

The biochemical tests were carried out using the guide of Cheesbrough [43] and Benson [41]. Thereafter, the resultant characteristics were compared with those of known taxa using scheme of Cheesbrough [43] and Bergey’s Manual of Determinative Bacteriology by Holt et al. [44]. Based on gram reaction, the gram positive organisms were streaked in Mannitol Salt Agar plate and incubated inverted at 37°C for 24 hours. The presence of yellowish pigments in Mannitol Salt Agar indicates Staphylococcus aureus. Positive tubes from MacConkey broth were streaked in Levine’s eosin Methylene Blue (EMB) Agar and incubated at 37°C for 24 hours. The water samples were streaked in MacConkey agar and the pure cultures were streaked in Levine’s eosin Methylene Blue (EMB) Agar and incubated at 37°C for 24 hours. The presence of small nucleated colonies with greenish metallic sheen indicates E. coli [41, 42]. The samples were plated in blood agar and the presence of swarming growth on after incubation indicates Proteus species. Kliger Iron Agar (KIA) test following the guide of Cheesbrough [43] was carried out to confirm some of the isolates such as Salmonella, Shigella etc.

2.4. Statistical Analysis

The bacterial density count was transformed to log. SPSS software version 20 was used to carry out the statistical analysis of the bacteria density. Two-way analysis of variance was carried out at P = 0.05, and Duncan’s multiple range test (DMR) was used to determine source of the observed differences were n=4 for spatial distribution and n=5 for monthly distribution. The chart for microbial density was plotted using Paleontological statistics software package by Hammer et al. [45]. The standard error bar was determined at 95% interval level. Sorenson qualitative index by Ogbeibu [46] was used to determine the bacteria diversity similarity between locations and months and Critical level of significance was established at 50% for similarity. The charts for similarity was plotted with Microsoft excel.

3. Result and Discussion

The microbial density of Epie creek from Akenfa to Biogbolo in Yenagoa metropolis, Bayelsa state is presented in Table 1. The total heterotrophic bacteria and Salmonella-Shigella counts ranged from 5.38 – 6.74 Log cfu/ml and 1.83 – 2.54 Log cfu/ml respectively for spatial distribution (Table
1) and 5.99 – 6.73 Log cfu/ml (Figure 3) and 1.72 – 2.52 Log cfu/ml (Figure 4) respectively. There was no significance variation (P>0.05) in spatial and monthly distribution and interaction between spatial and monthly distribution. The total and fecal coliform ranged from 2.01 – 2.83 Log MPN/100ml and 1.55 – 2.22 Log MPN/100ml respectively for spatial distribution (Table 1) and 2.17 – 2.82 Log MPN/100ml (Figure 5) and 1.77 – 2.20Log MPN/100ml (Figure 6) respectively. There was significance variation (P>0.05) in spatial and monthly distribution and interaction between spatial and monthly distribution.

| Location         | Total heterotrophic bacteria counts, Log cfu/ml | Total Coliform, Log MPN/100ml | Fecal Coliform, Log MPN/100ml | Salmonella-Shigella counts, Log cfu/ml |
|------------------|-----------------------------------------------|--------------------------------|-------------------------------|----------------------------------------|
| Akenfa           | 6.49±0.23<sup>a,b</sup>                       | 2.58±0.09<sup>b</sup>         | 2.09±0.10<sup>b</sup>         | 2.54±0.37<sup>b</sup>                 |
| Agudama-Epie     | 6.74±0.30<sup>b</sup>                         | 2.77±0.17<sup>b</sup>         | 2.10±0.11<sup>b</sup>         | 2.44±0.42<sup>b</sup>                 |
| Tombia Junction  | 6.72±0.60<sup>b</sup>                         | 2.830.22<sup>b</sup>          | 2.22±0.12<sup>b</sup>         | 2.40±0.37<sup>b</sup>                 |
| Opolo            | 6.58±0.45<sup>a,b</sup>                       | 2.57±0.19<sup>a</sup>         | 2.05±0.11<sup>a,b</sup>       | 1.83±0.07<sup>b</sup>                 |
| Biogbolo         | 5.38±0.26<sup>a</sup>                         | 2.01±0.11<sup>a</sup>         | 1.55±0.12<sup>a</sup>         | 1.83±0.05<sup>a</sup>                 |

Data are expressed as mean ± standard error (n=4); Different letters along the column indicate significance variation (P<0.05) according to Duncan multiple range test.
Absence of significant variation in the total heterotrophic bacteria and Salmonella-Shigella count suggests the nature of wastes is homogenous across the various location and months. Also, low dilution effect may be responsible for no variation observed. The variation observed in total and fecal coliform could be due to the fact that some section of the water aligning communities discharge sewage water directly into the creek (Figure 7) all year round.

The microbial density observed in this study is similar to the values previously reported in some surface water in Bayelsa state. Some of the values ranged from $0.44 - 1.159 \times 10^6$, $76.72 - 260.23$ and $53.67 - 157.02$ MPN/100ml for total heterotrophic bacteria, total and fecal coliforms respectively [36], $6.389 – 6.434$Log cfu/ml for total heterotrophic bacteria of from some rivers around Wilberforce Island [2].

The occurrence of high microbial density in the surface water could be due to runoff from rainfall and the discharge of wastes into the waterways. The bacteria isolates from the water samples from Epie creek from Akenfa to Biogbolo, Yenagoa metropolis is presented Table 2 (for locations) and Table 3 (for monthly distribution). The bacterial isolates identified include *Staphylococcus aureus, E. coli, Pseudomonas, Enterobacter, Corynebacterium, Bacillus, Micrococcus, Serratia, Proteus, Salmonella, Klesbsiella, Erminia, Shigella* species. These groups of bacteria isolates have been variously reported in surface water in Nigeria. In a review study, Izah and Ineyougha [27] reported *Staphylococcus aureus, E. coli, Pseudomonas, Enterobacter, Yersia, Shigella, Bacillus, Micrococcus, Serratia, Proteus, Salmonella, Klesbsiella, Streptococcus* species. Most of the bacteria isolates occurrence in the water suggested that they are contaminated. Some microbial isolates are of medical importance. The bacteria isolates could aid in transmission of diseases especially the enteric pathogens.

The similarity of the bacteria diversity between the each of the monthly and spatial distribution based on Sorenson qualitative index is presented in Figure 8 and Figure 9 respectively. The monthly and spatial distribution similarity interaction ranged from $88.00 – 96.00\%$ and $55.56 – 86.96\%$ respectively. Basically, the similarity index is above critical level of significance $= 50\%$ for both spatial and monthly distribution. The high bacterial diversity interactions indicate that most of the microbes found in the Epie creek are basically the same. This could be due uniformity in microbial contamination all year round in the creek.

**Table 2. Bacteria isolates across the locations in Epie creek, Yenagoa metropolis, Nigeria.**

| Microbes            | Akenfa | Agudama | Tombia | Opolo | Biogbolo |
|---------------------|--------|---------|--------|-------|----------|
| Pseudomonas sp      | +      | +       | +      | +     | +        |
| Enterobacter sp     | +      | +       | +      | +     | +        |
| Bacillus sp         | +      | -       | +      | -     | -        |
| Staphylococcus aureus| +      | +       | +      | +     | +        |
| Corynebacterium sp  | +      | -       | +      | +     | -        |
| Micrococcus sp      | +      | +       | +      | +     | +        |
| E. coli             | +      | +       | +      | +     | +        |
| Proteus species     | +      | +       | +      | +     | -        |
| Salmonella sp       | +      | +       | +      | +     | +        |
| Shigella sp         | +      | +       | +      | +     | -        |
| Klesbsiella sp      | +      | +       | +      | +     | -        |
| Erminia             | -      | -       | +      | -     | -        |
| Citrobacter sp      | -      | +       | -      | +     | -        |

**Table 3. Bacteria isolates across the months in Epie creek, Yenagoa metropolis, Nigeria.**

| Microbes            | January | February | May | June |
|---------------------|---------|----------|-----|------|
| Pseudomonas sp      | +       | +        | +   | +    |
| Enterobacter sp     | +       | +        | +   | +    |
| Bacillus sp         | +       | -        | +   | +    |
| Staphylococcus aureus| +      | +        | +   | +    |
| Corynebacterium sp  | -       | +        | +   | +    |
| Micrococcus sp      | +       | +        | +   | +    |
| E. coli             | +       | +        | +   | +    |
| Proteus species     | +       | +        | +   | -    |
| Salmonella sp       | +       | +        | +   | +    |
| Shigella sp         | +       | +        | +   | +    |
| Klesbsiella sp      | +       | +        | +   | +    |
| Erminia             | +       | -        | -   | -    |
| Citrobacter sp      | -       | +        | -   | +    |

The similarity of the bacteria diversity between the each of the monthly and spatial distribution based on Sorenson qualitative index is presented in Figure 8 and Figure 9 respectively. The monthly and spatial distribution similarity interaction ranged from $88.00 – 96.00\%$ and $55.56 – 86.96\%$ respectively. Basically, the similarity index is above critical level of significance $= 50\%$ for both spatial and monthly distribution. The high bacterial diversity interactions indicate that most of the microbes found in the Epie creek are basically the same. This could be due uniformity in microbial contamination all year round in the creek.
4. Conclusion

The bacteriological quality of Epie creek in Yenagoa metropolis, Nigeria was analyzed at both spatial and monthly distribution. Results showed that there was no significant variation (P>0.05) total heterotrophic bacteria and Salmonella-Shigella counts across spatial and monthly distribution and interaction between monthly and spatial distribution. But no there is significance difference (P<0.05) for total and fecal coliform. The similarity of the bacterial isolates, they were highly similar across the various months and location of study. The different bacterial diversity and density suggest that the water is highly contaminated and as such not be used for preparation of substances/material that could be ingested into the human system. Therefore, the appropriate agencies in Bayelsa state should enforced relevant environmental laws to minimize the activities of man leading to contamination of the creek. Also the discharge of wastes into the creek should be avoided.

References

[1] Izah SC, Chakrabarty N, Srivastav AL. A Review on Heavy Metal Concentration in Potable Water Sources in Nigeria: Human Health Effects and Mitigating Measures. Exposure and Health, 2016; 8: 285-304.

[2] Agedah EC, Ineyougha ER, Izah SC, Orutugu LA. Enumeration of total heterotrophic bacteria and some physico-chemical characteristics of surface water used for drinking sources in Wilberforce Island, Nigeria. Journal of Environmental Treatment Techniques, 2015; 3 (1): 28 – 34.

[3] Ogamba EN, Ebere N, Ekuma CG. Physicochemistry and Ichthyofauna of Ikoli Creek, Niger Delta, Nigeria. Biotechnol Res 2017; 3 (2): 43-49.

[4] Izah SC, Srivastav AL. Level of arsenic in potable water sources in Nigeria and their potential health impacts: A review. Journal of Environmental Treatment Techniques, 2015; 3 (1): 15 – 24.

[5] Seiyaboh EI, Ayibaefie YW. Assessment of Hydrocarbon Level in Surface Water Aligning Imirigi Oil field Facilities in the Niger Delta. Intern. J. Innov. Biosci. Res. 2017; 5 (2), 1-9.

[6] Akubuenyi FC, Uthai EC, Enyi-Idoh KH. Microbiological and physicochemical assessment of major sources of water for domestic uses in Calabar Metropolis Cross River state, Nigeria. Transnational Journal of Science and Technology, 2013, 3 (2): 31 – 44.

[7] Angaye TCN, Zige DV, Izah SC. Microbial load and heavy metals properties of leachates from solid wastes dumpsites in the Niger Delta, Nigeria. Journal of Environmental Treatment Techniques, 2015; 3 (3): 175 – 180.

[8] Izah SC, Angaye TCN. Heavy metal concentration in fishes from surface water in Nigeria: Potential sources of pollutants and mitigation measures. Sky Journal of Biochemistry Research, 2016; 5 (4): 31-47.

[9] Izah SC, Angaye TCN. Ecology of Human Schistosomiasis intermediate host and Plant Mollusccides used for control: A review. Sky Journal of Biochemistry Research, 2016; 5 (6): 075-082.

[10] Adesuyi AA, Njoku KL, Akinola MO. Assessment of Heavy Metals Pollution in Soils and Vegetation around Selected Industries in Lagos State, Nigeria. Journal of Geoscience and Environment Protection. 2015; 3: 11-19.

[11] Ohimain EI, Jonathan G, Abah SO. Variations in Heavy Metal Concentrations Following the Dredging of an Oil Well Access Canal in the Niger Delta. Advances in Biological Research. 2008; 2 (5-6): 97-103.

[12] Seiyaboh EI, Ogamba EN, Utibe DI. Impact of Dredging on the Water Quality of Igbedi Creek, Upper Nun River, Niger Delta, Nigeria. IOSR Journal of Environmental Science, Toxicology and Food Technology, 2013; 7(5): 51 – 56.

[13] Adewuyi GO, Olouw RA. Assessment of oil and grease, total petroleum hydrocarbons and some heavy metals in surface and groundwater within the vicinity of NNPC oil depot in Apatan, Ibadan metropolis, Nigeria. JIRRAS, 2012; 13 (1): 166-174.

[14] Idris MA, Kolo BG, Garba ST, Waziri I. Pharmaceutical Industrial Effluent: Heavy Metal Contamination of Surface water in Minna, Niger State, Nigeria. Bull EnvPharmacol Life Sci, 2013; 2 (3): 40-44.

[15] James OO, Nwaeezi K, Mesagan E, Agbojo M, Saka KL, Olabanji DJ. Concentration of Heavy Metals in Five Pharmaceutical Effluents in Ogun State, Nigeria. Bull EnvPharmacol Life Sci, 2013; 2 (8): 84-90.

[16] Anyakora C, Nwaeezi K, Awodele O, Nwadike C, Arbabi M, Coker H. Concentrations of heavy metals in some pharmaceutical effluents in Lagos, Nigeria. Journal of Environmental Chemistry and Ecotoxicology, 2011; 3 (2): 25-31.

[17] Agu CC, Menkiti MC, Okolo BI, Nnaji PC. Evaluation of the Level and Impact of Selected Physiochemical Parameters of Fertilizer Effluent on Obinna River, Adani, Enugu State, Nigeria. Journal of Water Resource and Protection, 2014; 6: 722-730.
