International Journal of Ecotoxicology and Ecobiology
2017; 2(3): 102-108
http://www.sciencepublishinggroup.com/j/ijee
doi: 10.11648/j.ijee.20170203.12

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

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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, Klesbsiella, Shigella, Salmonella, Proteus, Serratia, Micrococcu*s, *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 disperses 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], Efi lake [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, Edepie 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^o 50'N to 5^o 05'N and 5^o 23N and longitudes 6^{o}15E to 6^o 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, canoeing/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.*

Figure 2. *Pictorial view of the sampling locations along the Epie creek, Yenagoa metropolis, Nigeria.*

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 Feacal 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^{-8}, 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 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. Kligler 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.

Table 1. *Microbial density of Epie creek from Akenfa to Biogbolo in Yenagoa Metropolis.*

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[ab]	2.58±0.09[b]	2.09±0.10[b]	2.54±0.37[a]
Agudama-Epie	6.74±0.30[b]	2.77±0.17[b]	2.10±0.11[b]	2.44±0.42[a]
Tombia Junction	6.72±0.60[b]	2.830.22[b]	2.22±0.12[b]	2.40±0.37[a]
Opolo	6.58±0.45[ab]	2.57±0.19[b]	2.05±0.11[b]	1.83±0.07[a]
Biogbolo	5.38±0.26[a]	2.01±0.11[a]	1.55±0.12[a]	1.83±0.05[a]

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

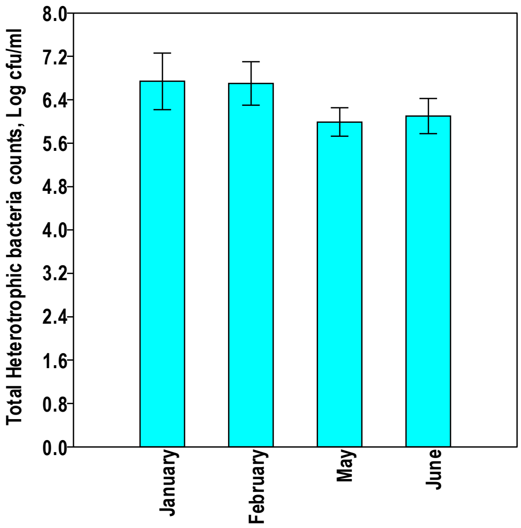

Figure 3. *Total heterotrophic bacteria count Monthly distribution of Epie creek from Akenfa to Biogbolo in Yenagoa metropolis.*

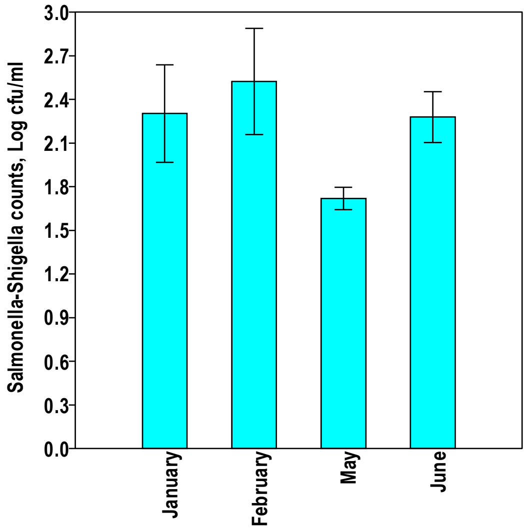

Figure 4. *Salmonella-Shigella count Monthly distribution of Epie creek from Akenfa to Biogbolo in Yenagoa metropolis.*

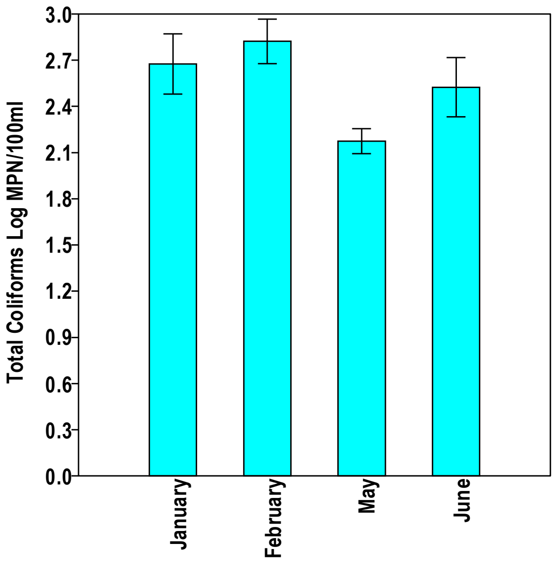

Figure 5. *Total coliform Monthly distribution of Epie creek from Akenfa to Biogbolo in Yenagoa metropolis.*

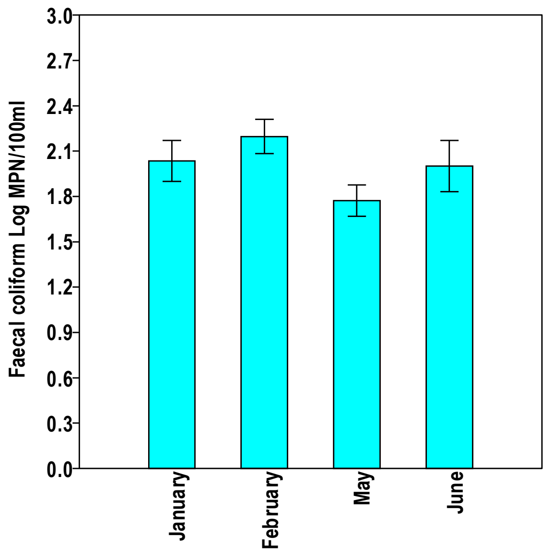

Figure 6. *Fecal coliform Monthly distribution of Epie creek from Akenfa to Biogbolo in Yenagoa metropolis.*

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 to 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.

Figure 7. *Typical sewage pipes connected directly to the creek.*

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 × 10^6, 76.72 - 260.23 and 53.67-157.02 MPN/100ml for total heterotrophic bacteria, total and feacal coliforms respectively [36], 6.389 – 6.434Log 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 water ways. The bacteria isolates from the water samples from Epie creek from Akenfa to Biogbolo, Yenegoa 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.

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	+	+	+	+	+
Serratia sp	+	+	-	-	-
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	+	+	+	+
Serratia sp	+	-	-	+
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.

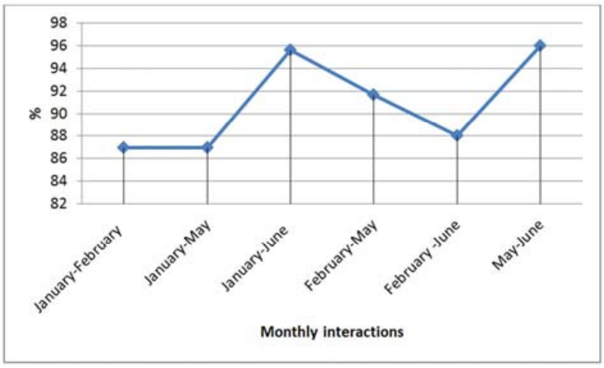

Figure 8. *Monthly interaction of the bacterial isolates.*

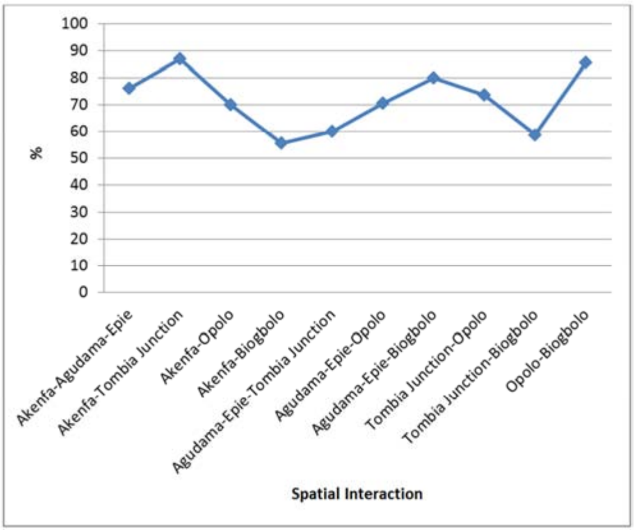

Figure 9. *Spatial interaction of the bacterial isolates.*

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.

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