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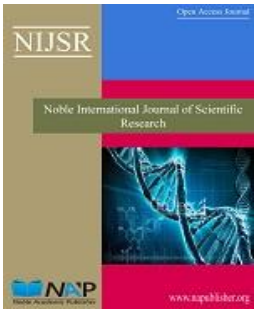

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ASSESSMENT OF BACTERIOLOGICAL CHARACTERISTICS OF SURFACE WATER OF TAYLOR CREEK IN BAYELSA STATE, NIGERIA

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ABSTRACT: Microorganisms which are ubiquitous and found in all environmental components have been identified as the main cause of infectious diseases. Water is an essential resource required for human existence. The study assessed the bacteriological characteristics of surface water of Taylor Creek in Bayelsa State, Nigeria. Water samples were collected in triplicates from 5 different locations along the creek. The samples were analyzed using standard microbiological techniques. Results showed that the density of the bacteria at Obunagha, Okolobiri, Tunama, Koroama and Polaku were 4.831 ±0.2588 log cfu/ml, 5.313±0391 log cfu/ml, 4.529 ± 0.099 log cfu/ml, 5.818±0.084 log cfu/ml and 5.14±0.640 log cfu/ml, respectively for total heterotrophic bacteria count; and 4.480±0.204 log cfu/ml, 4.629±0.024 log cfu/ml, 4.291±0.088 log cfu/ml, 4.458±0.152 log cfu/ml and 4.402±0.781 log cfu/ml, respectively for *Enterobacteriaceae* family counts. There was a significant difference ($P<0.05$) among the various locations for total heterotrophic bacteria counts, and *Enterobacteriaceae* family counts showed no statistical deviation ($p>0.05$) across the locations. The bacteria isolates include *Escherichia coli*, *Aeromonas*, *Klebsiella*, *Pseudomonas*, *Enterobacter*, *Streptococcus* and *Staphylococcus* species. The occurrence of some of these pathogens suggests that the water is unfit for domestic purposes especially drinking. Some individuals living in the communities along the creek depend on the surface water to meet their domestic needs, including cooking, washing, bathing and sometimes drinking. Therefore, there is a need to treat the water before use to make it free from pathogens.

Keywords: Aquatic ecosystem, Creeks, Microbial contaminants, Potable water, Public health

1. INTRODUCTION

Water quality is the measure of water status in relation to its potability (for animals and humans), utilization for domestic purposes and health of the aquatic ecosystem. Water quality also expresses the suitability of water to sustain various uses or processes. Water quality is basically used as reference to establish standards for compliance. Unlike other environmental conditions such as air and soil, water quality is mostly affected by a wide range of anthropogenic activities and to a lesser extent natural influence [1]. Some of the important natural factors that influence water quality include geological formations, hydrological processes, and climatic factors, while the human activities that may influence water quality include poor waste management [2-7] and water flooding.

Water quality parameters are often used to assess the status of the aquatic ecosystem including groundwater resources. As such a significant alteration to water quality is an indication of an abrupt change to the natural aquatic ecosystem. The effects of anthropogenic activities on water quality are of varying degrees depending on other factors such as the physical, chemical and biological condition of the substances that cause the alteration in the water quality. The changes in water quality often restrict its utilization.

Several parameters are used to assess water quality, and they are often grouped as physicochemical and biological characteristics. The most commonly assessed physicochemical characteristics include colour, pH, turbidity, total suspended and dissolved solids, total hardness, alkalinity, salinity,

conductivity, nitrate, nitrite, sulphate, calcium, sodium, magnesium, potassium, carbonates, dissolved oxygen, chemical and biological oxygen demands, and heavy metals such as iron, manganese, zinc, chromium, copper (essential) and cadmium, arsenic, lead and mercury (non-essential) [8]. The biological characteristics of water are often assessed based on microbial density and diversity. The microbial density is often assessed for total heterotrophic bacteria and fungi counts, bacteria belonging to the *Enterobacteriaceae* family (which are mainly grouped as total and faecal coliforms), Salmonella-Shigella, *Vibrio* and *Staphylococci* counts. These physical, chemical and microbial parameters provide information about the nutrient availability to their aptness to biological diversity especially aquatic life forms, pollution index, and appropriateness of potability.

The presence of microbial contaminants in water above certain stipulated values could lead to ill health in consumers and users of such water depending on what it is used for. Microorganisms by their nature have beneficial and detrimental roles to biodiversity including humans. But some have been grouped as microbes of public health importance. Their presence in consumable substances (such as drinking water and food) is a major source of concern. A typical example of such microbes includes *Clostridium perfringens, most species of Proteus, Aeromonas, Citrobacter*, *Streptococcus, Klebsiella, Enterococcus* and *Escherichia*. Most species belonging to these genera have been reported in drinking water sources of humans in Nigeria [8] which include groundwater, surface water and rainwater [9, 10]. Some microorganisms are also useful to humans and have several industrial applications. Typical examples are *Lactobacillus bulgaricus* and *Streptococcus thermophiles* which are used as a starter culture for the production of certain yoghurts, and *Saccharomyces cerevisiae* that is used in bakery.

Many microbes that are found in water are obligate aerobes (microorganisms that grow in the presence of oxygen and cannot respire or ferment anaerobically e.g. *Bacillus subtilis*, *Pseudomonas aeruginosa*); microaerophilic or aerotolerant anaerobes (this group of organisms grow better in the presence of a low amount of oxygen e.g (*Streptococcus pneumoniae*); facultative anaerobes (microbes that respire in the presence of oxygen but could switch to the anaerobic mode of respiration e.g. *E. coli* and *S. aureus).* Though, information about obligate anaerobes (microorganisms that respire anaerobically only e.g *Propionibacterium, Bifidobacterium, Bacteroides* species and *Clostidium botulinum*) in potable water sources in Nigeria is scarce in literature.

In Bayelsa state, Nigeria, surface water is used for domestic purposes especially by inhabitants of the coastal areas. In addition, municipal wastes including sewage are often dumped into the water bodies. Due to the possible effect of microbial contamination, several water bodies have been studied in the area including Nun River at the Agudama-Epketiama to Amassoma area [4, 11], Epie creek [3], but information about the microbial characteristics of Taylor creek is scanty in literature. Hence, this study aimed at assessing the bacteriological characteristics of surface water of Taylor creek in Yenagoa Local Governmental Area of Bayelsa State, Nigeria.

2. MATERIALS AND METHODS

2.1. Study Area

The study was carried out at Taylor creek which has its source from Orashi River, and flows through Gbarain clan in Yenagoa Local Government Area of Bayelsa State, Nigeria and empties into Nun River. The study area stretched from Polaku to Okolobiri along the creek. Most creeks and flood channels in Bayelsa state are interconnected within the freshwater swamp forest. The Taylor creek is linked with Nun river and it usually forms a mass of water body during the high flood (wet season in the area). Some of the activities frequently carried out in Taylor creek include fishing and artisanal dredging [12, 13]. Also, wastes from workshops and municipal solid wastes which are deposited close to the surface water often end up in the surface water through runoff after precipitation.

2.2. Collection of the Water Samples

Water samples were collected in triplicates from 5 different stations at Taylor creek, station 1, Tunama community, 05° 99' 40"N and 006° 18' 26"E; station 2, Obunagha, 05° 20' 26"N and 006° 18' 40"E; station 3, Polaku 05° 17' 15" N and 006° 17' 10" E; station 4, Koroama 05° 29' 57" N and 006° 18' 8" E and station 5, Okolobiri 05° 1' 29" N and 006° 18' 25"E. The samples were collected in sterile universal containers by submerging the container into a depth of about 20cm with the mouth facing the current. The sample containers were covered, labelled appropriately and transported to the laboratory for analysis.

2.3. Microbial Density Determination

Nutrient Agar and MacConkey agar were used to enumerate the density of total heterotrophic bacteria and bacteria of the *Enterobacteriaceae* family respectively. The enumeration of the bacteria density was carried out using the pour plate method previously described by Pepper and Gerba [14] and Benson [15]. 1.0ml of the serially diluted water samples was aseptically plated in prepared Nutrient Agar and MacConkey agar and it was incubated at 37ºC for 24- 48 hours. At the end of the incubation, the resultant colonies were counted and expressed as colony-forming units per millilitre of the water samples. The bacterial cells were isolated for characterization.

2.4. Identification of the Bacteria Isolates

The bacteria isolates were characterized following the biochemical test previously described by Cheesbrough [16] and Benson [15]. The resultant features of the bacteria isolates were compared with those of known taxa as provided by Cheesbrough [16] and Bergey's Manual of Determinative Bacteriology by Holt, et al. [17]. The bacteria isolates were also streaked in Kligler iron agar, Thiosulphate Citrate Bile Salts Agar (TCBS agar) and the subsequent features were matched with the scheme of Cheesbrough [16].

2.5 Statistical Analysis

SPSS version 20 was used for the statistical analysis. Data were expressed as mean ± standard deviation (n=3); one-way analysis of variance was carried out at apha = 0.05. Tukey Honestly Significant Difference statistics was used to discern the source of variations across the locations.

3. RESULT AND DISCUSSION

Table 1 presents the Microbial Density in surface water of Taylor creek, Bayelsa state, Nigeria. The total heterotrophic bacteria counts was 4.831±0.2588 Log cfu/ml, 5.313±0.391 Log cfu/ml, 4.529±0.099 Log cfu/ml, 5.818±0.084 Log cfu/ml and 5.141±0.640 Log cfu/ml at Obunagha, Okolobiri, Tunama, Koroama and Polaku, respectively. There was significant difference ($p<0.05$) in the total heterotrophic bacteria density across the various locations. However, Tukey Honestly Significant Difference statistics showed no significant variation between Obunagha, Okolobiri, Tunama and Polaku, and between Okolobiri, Tunama, Koroama and Polaku. The *Enterobacteriaceae* counts were 4.480±0.204 Log cfu/ml, 4.629±0.024 Log cfu/ml, 4.291±0.088 Log cfu/ml, 4.458±0.152 Log cfu/ml and 4.402±0.781 Log cfu/ml at Obunagha, Okolobiri, Tunama, Koroama and Polaku, respectively. Statistically, there were no significant variations ($p>0.05$) across the various locations. The deviations observed for the total heterotrophic bacteria density may be due to the discrepancies in human activities in the surface water during the sampling period [18]. The absence of statistical deviation and actual presence of bacteria of *Enterobacteriaceae* family in the water may be connected to the fact that wastes streams including sewage often end up in the surface water resources either through direct deposition or through runoff after precipitation.

The bacteria density is higher than the World Health Organization/Food and Agricultural Organization allowable limit of 1.0 x 10^2 cfu/ml in drinking water [8, 11, 19-21] and Standard Organization of Nigeria maximum permissible limit of 10cfu/ml for total coliform in drinking water [8, 11, 22]. The values reported in this study are slightly lower than the values previously reported in surface water in Bayelsa state, Nigeria. Agedah, et al. [4] reported a value range of 6.39 – 6.43 Log cfu/ml in surface water within Wilberforce Island, Nigeria. Seiyaboh, et al. [11] reported value range of 1.78 - 9.30 x 10^6 cfu/ml and 23.00 – 28.00 MPN/100ml for total heterotrophic bacteria and total coliform counts, respectively in Nun River at Amassoma axis, Bayelsa state. Seiyaboh and Izah [18] reported value range of 0.74 – 8.43 x 10^6 cfu/ml and 8.10 – 206.67 MPN/100ml for total heterotrophic bacteria and total coliform, respectively in surface water receiving abattoir wastes in a tidal creek of Ikoli in Bayelsa state. Ben-Eledo, et al. [3] reported a value range of 5.38-6.74 log cfu/ml and 2.01-2.83 log MPN/100ml for total heterotrophic bacteria and total coliform, respectively in Epie creek, Bayelsa state.

Figure 1 shows the bacteria diversity found in surface water of Taylor creek in Bayelsa State, Nigeria. The bacteria isolates include *Escherichia coli* (27%), *Klebsiella* (4.25%), *Aeromonas* (3.50%), *Enterobacter* (13.25%), *Pseudomonas* (14.25%), *Staphylococcus* (35.50%) and *Streptococcus* (2.25%). Some of these bacterial are of medical importance and are known to cause diseases in humans. For instance, *Streptococcus pneumonia, E.coli, Klebsiella and Pseudomonas* species could cause bronchopneumonia; sore throat is caused by *Streptococcus pyogenes*, and otitis is caused by *Streptococcus*

pyogenes, *Streptococcus pneumonia*, *Staphylococcus aureus* and *Pseudomonas* species; *Staphylococcus aureus* causes stye, blepharitis, pustules, carbuncles, abscesses, impetigo; *Streptococcus pyogenes* and *Staphylococcus aureus* could lead to osteomyelitis; *Staphylococcus aureus*, *Pseudomonas* and *Klebsiella* species cause urinary tract infection associated with catheterization and *Streptococcus pyogenes* could lead to erysipelas and cellulitis [16]. Some species of *Aeromonas* could cause extra intestinal infections such as septicemia, urinary tract and ear infections.

The bacteria diversity observed in this study had some similarity with previous reports in surface water in Bayelsa state, Nigeria. For instance, Seiyaboh and Izah [18] reported *Pseudomonas*, *Enterobacter*, *Micrococcus*, *Proteus*, *Salmonella*, *Klebsiella*, *Bacillus*, *Citrobacter*, *Shigella* species, *Staphylococcus aureus* and *E. coli* as bacteria found in surface water receiving abattoir effluents. Seiyaboh, et al. [11] reported *Staphylococcus aureus*, *E. coli*, *Pseudomonas*, *Enterobacter*, *Corynebacterium*, *Bacillus*, *Micrococcus*, *Proteus*, *Salmonella*, *Shigella* species as tentative isolates found in Nun river at Amassoma axis. Ben-Eledo, et al. [3] reported *Pseudomonas*, *Enterobacter*, *Bacillus*, *Citrobacter*, *Erminia*, *Klebsiella*, *Shigella*, *Salmonella*, *Proteus*, *Serratia*, *Micrococcus*, *Corynebacterium* species, *Staphylococcus aureus* and *E. coli* in surface water of Epie creek (from Akenfa to Biogbolo axis), Bayelsa state. Studies have attributed this bacteria diversity in surface water mainly to human activities in the area [3, 11, 18]. The bacteria isolates identified in this study have some similarity with the isolates reported by Izah and Ineyougha [8] in a review study of microbes found in potable water sources in Nigeria. The occurrence of these isolates is an indication that the water is not suitable for human consumption.

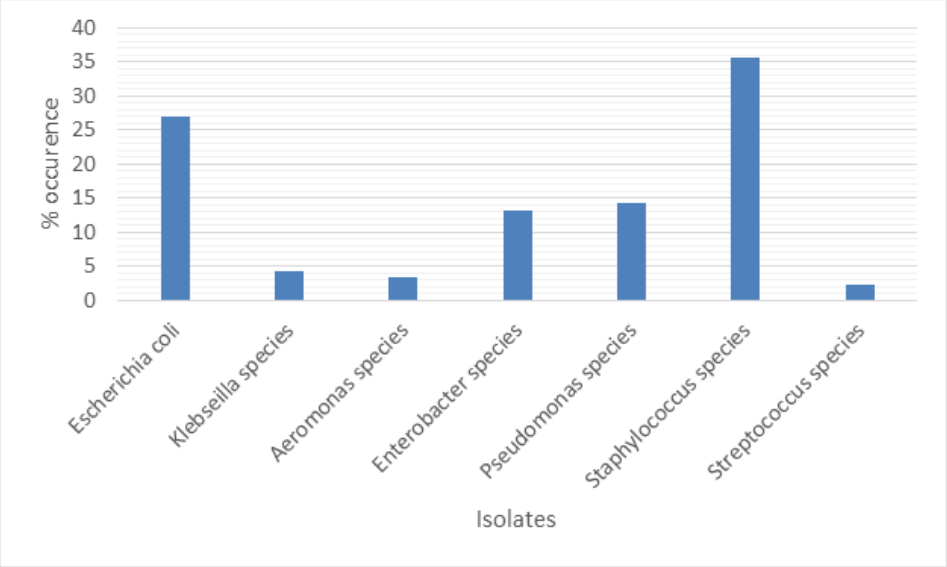
Table 1. Microbial density in surface water of Taylor creek, Bayelsa state, Nigeria

Locations	Total Heterotrophic bacteria count, Log cfu/ml	Enterobacteriaceae count, Log cfu/ml
Obunagha	4.831±0.2588a	4.480±0.204a
Okolobiri	5.313±0.391ab	4.629±0.024a
Tunama	4.529±0.099a	4.291±0.088a
Koroama	5.818±0.084b	4.458±0.152a
Polaku	5.141±0.640ab	4.402±0.781a

Source: Authors

Data are expressed as mean ± standard deviation (n=3); Different letters along the column indicate significant difference according to Tukey Honestly Significant Difference statistics.

Figure 1. Percentage occurrence of bacteria isolates found in surface water of Taylor creek in Bayelsa State, Nigeria



Source: Authors

4. CONCLUSION

Water is an essential resource needed for human existence. In developing nations like Nigeria, groundwater (borehole), some surface water types and rainwater serve as potable water sources. In the coastal region of Bayelsa state, surface water is used for several domestic purposes such as washing,

cooking, bathing etc. by indigenous people of the area. This study evaluated the bacteriological quality of surface water of Taylor creek in Bayelsa State, Nigeria. The result showed that the population of bacteria in the water is far higher than the World Health Organization/Food and Agricultural Organization and Standard Organization of Nigeria limits. Some of the bacteria isolates are of health concern. As such, there is a need for surface water users to properly treat the water with appropriate technology before utilization.

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