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Enumeration of Total Heterotrophic Bacteria and Some Physico-Chemical Characteristics of Surface Water Used for Drinking Sources in Wilberforce Island, Nigeria

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Abstract

Surface water is a source of drinking water in most rural communities in Nigeria. This study evaluated the total heterotrophic bacteria (THB) counts and some physico-chemical characteristics of Rivers surrounding Wilberforce Island, Nigeria.Samples were collected in July 2007 and analyzed using standard procedures. The result of the THB ranged from 6.389 – 6.434Log cfu/ml. The physico-chemical parameters results ranged from 6.525 – 7.105 (pH), 56.075 – 64.950µS/cm (Conductivity), 0.010 – 0.050‰ (Salinity), 103.752 – 117.252 NTU (Turbidity), 27.250 – 27.325 ºC (Temperature), 10.200 – 14.225 mg/l (Dissolved oxygen), 28.180 – 32.550 mg/l (Total dissolved solid), 0.330 – 0.813 mg/l (Nitrate), 0.378 – 0.530 mg/l (Ammonium). Analysis of variance showed that there were significant variation (P<0.05) in the physicochemical properties except for Salinity and temperature between the two rivers. Also no significant different (P>0.05) exist in the THB density of both rivers; upstream (Agudama-Ekpetiama) and downstream (Akaibiri) of River Nun with regard to ammonium and nitrate. Significant positive correlation (P<0.01) exist between dissolved oxygen with ammonium, Conductivity with salinity and total dissolved solid, salinity with total dissolved solid, turbidity with nitrate, and pH with nitrate. The positive correlation (P<0.05) also exist between pH with turbidity. High turbidity and bacteria density in the water samples is an indication of pollution and contamination respectively. Hence, the consumption of these surface water without treatment could cause health related effects.

Keyword: Drinking water sources, microorganisms, physico-chemistry, surface water, Wilberforce Island

1 Introduction

Water is a unique resources needed by biotic organisms including human to thrive. Basically, nearly all life forms require and contain significant amount of water for existence, optimum productivity and growth. On the environment, water resources occur in the form of ground water, rainwater and surface water. Basically, water occurs in three states including solid as ice, liquid as water and gas as water vapour [1]. Generally, nearly 70% of the earth is occupied with water, out of which only 2.7% is fresh water of which 1% is ice free water in Rivers, lakes and atmosphere as biological water [2]. Of the three potable water sources, surface water cover the highest amount of space because it can easily been seen unlike the ground water. The surface water resources include streams, rivers, creeks, lake and sea. Generally, water is known as the most abundant chemical substances that occur naturally on the earth surface [1].

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In Nigeria, surface water abounds and its distribution is higher in coastal region especially in the central Niger Delta region (Bayelsa, Delta and Rivers). Ohimain [3] stated that the Niger Delta ecosystem is dominated by presence of wetland, several creeks and rivers. The coastal region of Nigeria stretch from Lagos in the West to Calabar in the East. The abundance of surface water resources could be attributed to the presences of several tributaries of major river bodies in Nigeria such as River Niger. Also ground water table in the Niger Delta region is also high. The region has been widely been regarded as a wetland because of the presence of peatland/depression with water, providing habitats for biodiversity [4] and also play social, economic and ecological functions thus agent of sustainable development [5].In Bayelsa state for instance, the ground water table ranged from 4 – 60 feet and 5 – 100 feet during the rainy and dry season respectively depending on the location, and relative topography. Ohimain et al. [6] stated that Bayelsa state is a sedimentary basin that is virtually riverine and estuarine and fishing is the major occupation of the inhabitants of the area.

Surface water resources inhabit several obligate macrophytes such as water hyacinth (*Eichhornia crassipes*), water lily (*Nymphaea lotus, N. maculate*), Water lettuce (*Pistia stratiotes*), salvinia (*Salvinia*

nymphellula), and water velvet (*Azolla pinnata var africana*) [7]. The aquatic plants basically constitute nuisance in the water ways, where they has been under-utilized in the Niger Delta despite their potentials. For instance, Tyagi and Agarwal [8] stated that water hyacinth produces several natural products due to the biomolecules and secondary metabolites they exhibits in biological system, hence they have been utilized in several sectors including human therapy, veterinary, agriculture. Similarly, due to the protein content of water hyacinth it has been successfully used in the formulation of livestock feed including fish feed [9 - 11] and goat feed [12, 13].Besides the presence of macrophytes, surface water inhabits large species of fishes, benthic invertebrate, plankton (Zooplanktons and phytoplankton) that are distributed into different taxon.

Surface water act as a dump site in most communities that these rivers passes in Bayelsa State. The wastes streams (solid and liquid) that are often discharged into the water include domestic and municipal wastes. These wastes stream often influence the water quality (i.ephysico-chemical and microbial characteristics). This is because most wastes contain light and heavy metals, ions (cation and anions) oil and grease, organic compound etc. These characteristics often determine the pollution index of the water. Due to flow intensity of the river, dilution effects often occurs rendering the water less toxic as compared to the quantity and concentration of different physico-chemical and microbial characteristics that was deposited in the water. Basically, the wastes deposited into the water could have an effect on the hydrology of the water over time.

Microorganisms have been severally reported to be ubiquitous (i.e. found everywhere). Microbes found in potable water sources renders it unfit for consumption and some are known to cause several human diseases. Most disease conditions that could result from direct consumption of surface water are associated with microbes found in the water including bacteria [14], fungi, and viruses.

Authors have severally reported the microbial species found in potable water sources in the Niger Delta, Nigeria. Akubuenyi et al. [1] studied the microbiological qualities of some surface water used for domestic uses in Calabar Metropolis Cross River State, Nigeria and reported *Staphylococcus* aureus, *Escherichia* coli, *Bacillus, Pseudomonas, Proteus, Enterobacter, Streptococcus, Salmonella, Shigella, Vibrio* species as microbial isolates. Ibiene et al. [15] assessed the bacterial in drinking water sources in Opuraja community of Delta State, Nigeria and reported *Escherichia coli, Salmonella, Shigella, Citrobacter, Proteus, Klebsiella, Vibrio, Bacillus and Enterobacter* species as the microbial isolates. Egbe et al. [16] studied that microbial isolates found in drinking water in Fulani Settlements in Gidan Kwano, Minna, Niger State, Nigeria and reported *Citrobacter diversus, Citrobacter freundii, Klebsiella pnuemoniae, Proteus vulgaris, Salmonella enteric* and *Serratia marcescens.* In River Nun at Amassoma axis, microbial species like *Escherichia* coli and other of the genera *Pseudomonas* and *Salmonella* has been identified from the water [17].These bacteria's are associated with infectious diseases including gastroenteritis, typhoid fever, dysentery, cholera [14], and urinary tract infections etc. The presence of these bacteria's is an indication that such water sources are not potable [1].

Basically, water quality is important in drinking water sources. Water quality deterioration occurs in natural rivers due excessive nutrient inputs, eutrophication, acidification, heavy metal contamination, organic pollution and obnoxious fishing practices [18]. The bacteria density in potable water provides information on the quality and safety of the water; hence, it is essential to perform microbial assessment of water sources regularly to ensure continued safety of water supply within communities [16]. Potability of water is hampered when it contains objectionable materials including odour, colour, metals (light and heavy), microbial population and isolates above the permissible limits. Therefore, this study aimed at evaluating the total heterotrophic bacteria and some physicochemical characteristics of surface water used as drinking water sources in Wilberforce Island, Nigeria.

2 Materials and Methods

2.1 Study area

Sampling was carried out in the rivers bordering the Wilberforce Island, Bayelsa State Nigeria. The Island is surroundedby two rivers; River Igbedi on the West and Nun River on The east. Before River Nun flow into the Island, it has a tributary that form River Igbedi. The Island is situated between latitude 4º50' – 5 º 50' (North) and longitude 6 º05' – 6 º16' (East). According to Seiyaboh et al. [19], Igbedi River, is at the Upper Nun River in the Niger Delta. The Igbedi River cut across Ogobiri (Upstream) and Amassoma (downstream) in the western boundary, while river Nun cut across Agudama-Ekpetima(upstream) and Akaibiri (downstream) communities in the Eastern boundary.

2.2Sample collection

A total of sixteen water sample was collected, four being from each sampling community comprising of the two rivers in the month of July 2007. The water sample were collected aseptically with sterile microbiological bottles and sampling container for microbial and physico-chemical laboratory analysis respectively. The ex-situ water parameters was transported to the laboratory in ice box and preserved at 4ºC prior to analysis.

2.3 Laboratory analysis

2.3.1 Enumeration of total heterotrophic bacteria

The populations of bacteria in the water samples were enumerated using serial dilution pour plate method of Pepper and Gerba [20], Benson [21]. About 0.1ml of water sample was serially diluted in sterile distilled water and aliquots of the dilutions were ascetically plated into Nutrient Agar. The agar plates were incubated inverted at 37°C for 24-48 hours to enumerate the aerobic bacteria. The resultant growth/colonies on the plates were counted and expressed as colony forming units (cfu)/ml of the samples.

2.3.2 Water physicochemical analysis

The water physico-chemical parameters such as temperature, pH, conductivity and dissolved oxygen were

analyzed *in-situ*. The temperature and pH were measured using mercury-in-bulb thermometer and Cole palmer Digisense meter (USA) respectively. The conductivity and dissolved oxygen were measured with lovibond instrument (model: Cm-21), expressed as µS/cm [micro siemen per cm] and yellow string Dissolved Oxygen meter with probe instrument (Horiba, USA) expressed as mg/l. Other, *in-situ* measurement include salinity (expressed as ‰ using digital meter) and turbidity (using a digital spectrophotometric meter), expressed as NTU. These *in-situ* parameters were analyzed based on the equipment manufacturers' guide. Parameters such as nitrate, ammonia, total dissolved solid were measured using spectrophotometric methods (Spectronic instrument model: 21D), expressed as mg/l in conformity with standard procedures as described in APHA [22].

2.4 Statistical analysis

The Total heterotrophic bacteria (THB) count was transformed to log. SPSS software version 16 (SPSS Inc, Chicago) was used to carry out the statistical analysis on the THB and the physicochemical parameters of the samples. A one-way analysis of variance was carried out at P = 0.05, and Duncan's multiple range test (DMR) was used to discern the source of the observed differences. Pearson's correlation matrix was used to identify the relationship between the physicochemical parameters of the water.

3 Results and Discussion

Figure 1 presents the population density of total heterotrophic bacteria (THB) from surface water used as drinking water sources in Wilberforce Island, Nigeria.The density of THB from the water samples from the study area were highest at Amassoma (downstream of River Igbedi) with a mean density of 6.434±0.039Log cfu/ml and least at Agudama- Ekpetima (upstream of River Nun) with a density of 6.387±0.055Log cfu/ml. Also, population density of 6.414±0.078Log cfu/ml and 6.394±0.070Log cfu/ml were observed at Ogobiri (upstream of River Igbedi) and Akaibiri (downstream of River Nun) respectively. However, there were no significant variation (P>0.05) in the THB count of the rivers under study.The similarity in the population density of the various sampling point could be attributed to the fact the people in the region practice this same life style i.e deposition of wastes into the water and other anthropogenic activities such as dredging in the water ways. The result of this study is in agreement from previous studies on surface water in Nigeria. Antai et al. [23] studies THB in Imo River Estuary of the Niger Delta Mangrove Ecosystem and reported the THB during the wet and dry season as 2.23×10^6 cfu/ml and 2.39×10^6cfu/ml respectively. Egbe et al. [16] studied total viable count of microbes in surface drinking water in Fulani Settlements in Gidan Kwano, Minna, Niger State, Nigeria and reported viable microbial density in the range of 0.1 – 2.0 x 10^6cfu/ml. Puyate and Rim-Rukeh [24] reported the THB from some river in the Niger Delta (Orashi River at Ebocha Well 8 Location, Brass River at Brass Terminal jetty, New Calabar River at Wilbros Nig. Ltd., Apoi Creek at Ogboinbiri Flow Station, Dodo Creek at Clough Creek Flow Station, Sangana River at Igbomatoru Community, Nun River at Tebidaba Flow Station, Forcados River at Beniboye Flow Station, Niger River at Independent Power Plant (IPP), and Olagoga Creek at Obama Flow Station to range from 10^5 to 10^6cfu/ml. However, the findings from this study were not in consonance with some author finding in the Niger Delta region of Nigeria on surface water. Akubuenyi et al. [1] studied THB in some surface water in Calabar Metropolis Cross River state, Nigeria and reported the THB as 2.4 – 5.8 x 10^4 cfu/ml from Uwanse, Anatigha, Idim-Ita and Edibe-Edibe streams. Ibiene et al. [15] studied THB in some stream water used for consumption in Opuraja community of Delta State, Nigeria and reported the THB in the range of 0.37 – 1.5 x 10^5 cfu/ml. The variation in the result of this study to previous studies could be attributed to the type of wastes materials that is often discharged and the anthropogenic activities peculiar to the people of the region.

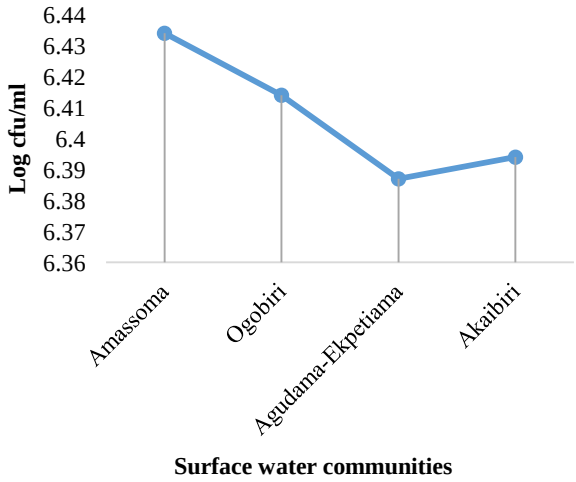

Figure 1: Bacteria density from the surface water used as drinking water sources in Wilberforce Island

Table 1 presents the physicochemical properties of the surface water used as drinking water in Wilberforce Island. While the Pearson's correlation coefficient (r) matrices for the analyzed parameters are presented in Table 2. The highest and least concentration of pH was observed at Amassoma i.e downstream of River Igbedi (7.105±0.261) and Agudama-Ekpetiama i.e upstream of River Nun (6.525±0.310) respectively (Table 1). Basically there were significant variation (P<0.05) between the two rivers. However, no significant variation (P>0.05) between River Igbedi upstream (Ogobiri) and River Nun downstream (Akaibiri). pH significantly correlates with turbidity (r=0.591, P < 0.05), nitrate (r=0.623, P < 0.01) and also show negative relationships with conductivity, salinity and nitrate (P<0.01) and total dissolved solid (P<0.05) (Table 2). The pH value from this study is comparable to the value reported from surface water in the Niger Delta. Izonfuo and Bariwari [25] reported pH of 7.4 – 7.57 (dry season) and 6.9 – 7.33 (wet season) from Epie creek. Aghoghovwia and Ohimain [26] reported the pH of lower Kolo creek, Otuogidi, Bayelsa state in the range of 6.95 – 7.50. Seiyaboh et al. [19] reported mean pH of 7.17 from Igbedi Creek, Upper Nun River. Seiyaboh et al. (2013b) reported pH of 7.4 – 7.5 at Tombia Bridge Construction across Nun

River. Abowei [27] reported pH in the range of 6.8 – 8.5 from Nkoro River. Abowei and George [28] reported the pH of Okpoka creek, which is one of the several adjoining creeks off the Upper Bonny River estuary in the Niger Delta from six sampling locations i.e Oginigba, Slaughter, Woji, Okugagu, Abuloma/Ojimba and Kalio-Ama in the range of 5 .7 – 7.8. Generally, the pH results of this study is far from value of 4.5 – 6.5 from some rivers in the Niger Delta including Orashi River at Ebocha Well 8 Location, Brass River at Brass Terminal jetty, New Calabar River at Wilbros Nigeria limited, Apoi Creek at Ogboinbiri Flow Station, Dodo Creek at Clough Creek Flow Station, Sangana River at Igbomatoru Community, Nun River at Tebidaba Flow Station, Forcados River at Beniboye Flow Station, Niger River at Independent Power Plant (IPP), and Olagoga Creek at Obama Flow Station [24], 4.1 – 5.1 from some streams in Calabar metropolis, Cross Rivers state [1].The pH of the water from this study are is slightly acid and alkaline. Generally, the pH of the water from this study was within the range of 6.5 – 8.5 maximum permitted for potable water as recommended by Standard Organization of Nigeria (SON).

Table 1: Physico-chemical characteristics of the four surface water used for drinking purposes in Wilberforce Island, Nigeria

Parameters	River Igbedi		River Nun	
	Ogobiri (Upstream)	Amassoma (Downstream)	Agudama-Ekpetiama (Upstream)	Akaibiri (Downstream)
pH	6.800±0.294 ^{ab}	7.105±0.261 ^{b}	6.525±0.310 ^{a}	6.725±0.171 ^{ab}
Conductivity, µS/cm	57.975±1.051 ^{b}	56.075±0.591 ^{a}	64.950±0.681 ^{d}	60.050±0.835 ^{c}
Salinity, ‰	0.020±0.008 ^{a}	0.010±0.000 ^{a}	0.050±0.004 ^{a}	0.020±0.008 ^{a}
Turbidity, NTU	114.702±3.451 ^{b}	117.002±2.160 ^{b}	103.752±2.062 ^{a}	107.252±1.708 ^{a}
Temperature, ºC	27.250±0.191 ^{a}	27.325±0.403 ^{a}	27.300±0.245 ^{a}	27.400±0.216 ^{a}
Dissolved oxygen, mg/l	14.225±0.263 ^{d}	10.200±0.283 ^{a}	12.075±0.959 ^{b}	13.275±0.096 ^{c}
Total dissolved solid, mg/l	29.255±0.823 ^{b}	28.180±0.048 ^{a}	32.550±0.666 ^{d}	30.000±0.476 ^{c}
Nitrate, mg/l	0.430±0.022 ^{b}	0.813±0.562 ^{c}	0.350±0.016 ^{a}	0.330±0.014 ^{a}
Ammonium, mg/l	0.530±0.022 ^{c}	0.325±0.352 ^{a}	0.415±0.013 ^{b}	0.378±0.030 ^{b}

The same letters represented as subscript in each row indicate no significant difference (P>0.05) according to the Duncan Multiple Range Test (DMR); Each value is expressed as mean ± standard error (n = 4).

Table 2: Pearson's correlation matrix of the surface water studied

Parameters	pH	Conductivity, µS/cm	Salinity, mg/l	Turbidity, NTU	Temperature, ºC	Dissolved oxygen, mg/l	Total Dissolved Solid, mg/l	Nitrate, mg/l	Ammonium, mg/l
pH	1								
Conductivity, µS/cm	-0.646**	1							
Salinity, ‰	-0.706**	0.837**	1						
Turbidity, NTU	0.591*	-0.837**	-0.727**	1					
Temperature, ºC	0.003	-0.033	0.083	-0.175	1				
Dissolved oxygen, mg/l	-0.305	0.172	0.106	-0.216	-0.053	1			
Total dissolved solid, mg/l	-0.599*	0.977**	0.836**	-0.850**	-0.072	0.184	1		
Nitrate, mg/l	0.623**	-0.699**	-0.547*	0.724**	0.024	-0.765**	-0.690**	1	
Ammonium, mg/l	-0.256	0.127	0.199	0.010	0.031	0.803**	0.145	-0.471	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N= 16, n = 4

The Turbidity value of the water sample from the rivers under study ranged from 103.752±2.062NTU (Agudama-Ekpetima i.e upstream of River Nun) to 117.002±2.160NTU (Amassoma i.e Down stream of River Igbedi) (Table 1). There were significance different (P<0.05) between the turbidity concentration of both rivers; however, no significant variation (P>0.05) between water from Amassoma (downstream) and Ogobiri (upstream) (River Igbedi), and between Akaibiri (downstream) and Agudama-Ekpetima (upstream) (River Nun). Turbidity significantly correlates with nitrate (r=0.591, P < 0.01), and show negative relationships with total dissolved solid (Table 2). The turbidity of the water in this study is not in agreement to previous studies from surface water in Bayelsa state. Izonfuo and Bariweni [25] reported turbidity in the range of 11.67 – 19.67 NTU (dry season) and 16.67 – 28.00 NTU (wet season) from Epie Creek in Yenagoa metropolis. Seiyaboh et al. [19] reported mean turbidity of 62.54 NTU from Igbedi Creek, Upper Nun River. Seiyaboh *et al*. [29] reported turbidity in the range of5 – 64 NTU at Tombia Bridge Construction across Nun River. Aghoghovwia and Ohimain [26] reported the turbidity of lower Kolo creek in the range of 35.0 – 40.5 NTU. Puyate and Rim-Rukeh [24] reported turbidity in the range of 19 – 48NTU from some rivers in the Niger Delta. Akubuenyi et al. [1] reported turbidity in the range of 0.07 – 0.12 NTU from streams in Calabar metropolis. The turbidity of the study areas could be attributed to the fact that the inhabitants have similar life style. Turbidity is a reflection of the visual condition of the water resource and they indicates the presence of pollution [1] because water is basically colourless The high turbidity values may be

associated to the direct discharge of waste materials into the water source in the study area, which is a common a phenomenon in Nigeria [1]. Also, the activities going on during the sampling exercise could have significantly affected the turbidity of the water. Hence, the turbidity of the two Rivers exceeded the permissible limit of 5NTU recommended by SON.

The conductivity ranged from 56.075±0.591µS/cm (Amassoma i.e downstream of River Igbedi) to 64.950±0.681µS/cm (Agudama- Ekpetima i.e upstream of River Nun). There was significant difference ($P<0.05$) between water from both rivers. Conductivity significantly correlate with salinity ($r=0.837$, $P < 0.01$), total dissolved solid ($r=0.977$, $P < 0.01$), and show negative relationships with turbidity, and nitrate (Table 2). The conductivity from this study falls with the range of 18.9 – 156.4 µS/cm from some rivers in the Niger Delta as reported by Puyate and Rim-Rukeh [24]. Aghoghovwia and Ohimain [26] reported the conductivity of lower Kolo creek in the range of 82.30 – 102.0 µS/cm. However, the conductivity were higher than 5.30 – 12.42 µS/cm reported from some streams in Calabar metropolis by Akubuenyi et al. [1]. Abowei and George [28] reported the conductivity of Okpoka creek in the range of 790 – 37800 µS/cm. Seiyaboh et al. [19] reported mean conductivity from Igbedi creek as 76.23 umhos/cm. Seiyaboh et al. [29] reported conductivity in the range of 87 – 95 umhos/cm from Tombia bridge construction area. The conductivity of the water were found to be within the maximum permissible limit of 1000 µS/cm in drinking water sources as recommended by SON.

Temperature of the surface water from the study area is 27ºC across the four sampling point's i.e upstream and downstream of both rivers (Table 1). There were no significant difference ($P>0.05$) in the temperature of water samples from both rivers under study. Typically, temperature is a prevailing water indicator that varies depending on the climatic conditions of the area. The temperature result of this study is close to the temperature value of 27.3 – 29.3 ºC (wet season) but slightly higher than the temperature value 28.7 – 30.5 ºC (dry season) from Epie creek in Yenagoa metropolis, Bayelsa state as reported by Izonfuo and Bariweni [25]. Aghoghovwia and Ohimain [26] reported the temperature of lower Kolo creek in the range of 28.5 – 33.0°C. Abowei and George (2009) reported the temperature of Okpoka creek in the range of 27.0 – 31.0 ºC. Also, Ezekiel *et al.* [30] has reported similar trend in the temperature water from River Sombreiro with value of 27.85 – 28.15 ºC and 28.35 – 29.21 ºC for wet and dry season respectively. Other authors has reported temperature as 26.9 – 28.7 ºC from some rivers in the Niger Delta [24], 26 ºC at Tombia Bridge Construction across Nun River [29], mean of 27.9 ºC from Igbedi creek [19], 25 – 26 ºC from some streams in Calabar metropolis [1]. Abowei [27] reported temperature in the range of 24 – 30ºC from Nkoro River. Typically there no higher variation from the temperature of this study.The temperature of the water is within the ambient air temperature of the region.

The Dissolved oxygen level ranged from 10.200±0.283mg/l (Amassoma i.e downstream of River Igbedi) to 14.225±0.263mg/l (Ogobiri i.e downstream of River Igbedi). Also, at River Nun the concentration of 12.075±0959 mg/l and 13.275±0.096 mg/l were observed at upstream and downstream respectively (Table 1). There were significant difference ($P<0.05$) in the dissolved oxygen level of water from both Rivers under study. Dissolved oxygen significantly correlates with ammonium ($r=0.803$, $P < 0.01$), and show negative relationships with nitrate (Table 2). Basically, the dissolved oxygen from this study is higher than previous study. Seiyaboh *et al.* [29] reported the dissolved oxygen in the range of 4.8mg/l – 7.2mg/l Tombia bridge construction. Seiyaboh *et al.* [19] reported the mean dissolved oxygen from Igbedi creeks 3.7 mg/l. Ezekiel et al. [30] has reported the dissolved oxygen concentration from in Sombreiro to range from 6.84-7.13 mg/l. Aghoghovwia and Ohimain [26] reported the dissolved oxygen of lower Kolo creek in the range of 5.0 – 7.92 mg/l. Akubuenyi et al. [1] has reported dissolved oxygen in the range of 5.81 – 6.66 mg/l from some streams in Calabar metropolis, Nigeria.Other studies that reported similar dissolved oxygen concentration in surface water include; Abowei and George [28] that reported the dissolved oxygen of Okpoka creek in the range of 1.6 – 9.6mg/l. Izonfuo and Bariweni [25] reported the dissolved oxygen from Epie creek in the range of 1.38 – 9.06 mg/l (wet season) and 1.76 – 5.68 mg/l (dry season). Abowei [27] reported dissolved oxygen in the range of 6 – 10mg/l from Nkoro River with highest concentration occurring in the month of September According to Ezekiel et al. [30], at low temperature more oxygen diffuses into the water and the solubility of oxygen in water is measured temperature, salinity, pressure and turbulence of the water caused by wind, current and waves. The high dissolved oxygen observed from this study could be associated to the time of the sampling (i.e afternoon). Ezekiel et al. [30] has stated that dissolved oxygen is usually lowest in the early morning just after sunrise, maximum at late afternoon low again at night. The dissolved oxygen observed from this study suggest that the aquatic organisms is getting the required oxygen need for survival. Ezekiel et al. [30] stated that low dissolved oxygen concentrations is challenge faunal and floral survival in the aquatic ecosystem

The concentration of total dissolved solid ranged from 28.180±0.048mg/l (Amassoma i.e downstream of River Igbedi) to 32.550±0.666mg/l (Agudama-Ekpetima i.e upstream of River Nun) (Table 1). There were significant difference ($P<0.05$) in the total dissolved solid level of both rivers including their respective up and down streams. Total dissolved solid show negative relationships with nitrate (Table 2). Previous study in Bayelsa state has reported the concentration of total dissolved solid from Epie creek in Yenagoa metropolis in the range of 55 - 62 mg/l (dry season) and 33 – 37.33 mg/l (wet season) [25], mean of 36.18 mg/l from Igbedi creek [19]. Extreme low concentration in the range of 0.0011 – 0.0028 mg/l has been reported from some stream in Calabar metropolis by Akubuenyi et al. [1]. However, other result not in agreement of this study has dissolved oxygen concentration of 62.1 – 67.9 mg/l at Tombia Bridge Construction across Nun River [29], 78 – 8450 mg/l from some rivers in the Niger Delta [24], 41.5 – 51.0 mg/l from Lower Kolo creek [26]. The variation from this study could be due to the period of the study. However, during rainy season, the water overflows and dilution effects increases. This could

be the reason why the total dissolved solid has a low concentration during rainy season.

The Nitrate concentration ranged from 0.330±0.014mg/l (Akaibiri i.e downstream of River Nun) to 0.813±0.562mg/l (Amassoma i.e downstream of River Igbedi). There were significant different ($P<0.05$) in the nitrate concentration of both rivers. However, no significant variation ($P>0.05$) occurs between upstream and downstream of Rivers Nun. The result of this study is in agreement with study from Epie creek which as nitrate level in the range of 0.02 – 0.27 mg/l and 0.14 – 0.28 mg/l for dry and wet season respectively as reported by Izonfuo and Bariweni [25]. Aghoghovwia and Ohimain [26] reported the nitrate of lower Kolo creek in the range of 0.1 – 0.24mg/l. However, slightly lower from other studies around the study area. Seiyaboh *et al*. [29] reported the concentration of nitrate from Tombia Bridge Construction across Nun River in the range of 0.32 – 4.15 mg/l. Seiyaboh *et al*. [19] reported mean concentration of nitrate from Igbedi creek as 0.132 mg/l. Puyate and Rim-Rukeh (2008) reported nitrate from some rivers in the Niger Delta in the range of 0.71 – 1.82 mg/l. Also nitrate concentration of 1.48 – 4.33 mg/l has been reported from some streams in Calabar metropolis [1]. Generally the nitrate concentration from this study is lower than the maximum permissible limit of 50 mg/l from drinking water sources as recommended by SON.

Ammonium concentration ranged from 0.325±0.352mg/l (Amassoma i.e downstream of River Igbedi) to 0.530±0.022mg/l (Ogobiri i.e upstream of River Igbedi). Also, concentration of 0.415± 0.013 mg/l and 0.378± 0.030 mg/l were observed at upstream and downstream of River Nun (Table 1). There was significant different ($P<0.05$) between both rivers; however, no significant difference ($P>0.05$) between upstream and downstream of Rivers Nun. The findings of this study is in agreement with ammonium concentration of 0.022 – 0.46 mg/l from some streams in Calabar metropolis as reported by Akubuenyi et al. [1] and 0.003 – 1.0 mg/l (dry season) and 0.15 – 0.21 mg/l (wet season) reported as ammonia from Epie creek by Izonfuo and Bariweni [25].

The concentration of salts (salinity) in the two rivers at Wilberforce Island ranged from 0.010±0.000‰ (Amassoma i.e downstream of River Igbedi) to 0.050±0.004‰ (Agudama – Ekpetiama i.e upstream of River Nun) (Table 1). There were no significant different ($P>0.05$) in the level of salinity from both rivers including their respective upstream and downstream. Salinity significantly correlate with total dissolved solid ($r=0.836$, $P < 0.01$), and show negative relationships with turbidity and nitrate (Table 2). The result of this study indicates a low salt concentration in the water samples. Akubuenyi et al. [1] has reported salinity from some streams in Calabar metropolis in the range of 0.00 – 0.02 ppt. However, a high salt concentration has been reported in the range 0.11 – 6.66 mg/l and 0.25 – 10.11 mg/l for wet and dry season respectively at River Sombreiro [30]. Abowei [27] reported salinity of 5 – 17 ‰ from Nkoro River with highest value being from the month of March and February. Aghoghovwia and Ohimain [26] reported the salinity of lower Kolo creek in the range of 0.009 – 0.04‰. Abowei and George [28] reported the salinity of Okpoka creek in the range of0.17 – 25.7‰. Basically, the low salinity concentration could be associated to fact the water is a fresh water, lacking excess concentration of ions (cation and anions).

4 Conclusion

Surface water abounds in the Niger Delta region of Nigeria. Most inhabits of the region obtain their drinking water from fresh water bodies distributed inthe entire Niger Delta region. This study evaluated the bacteria density and some physico-chemical characteristics of surface water that is used as drinking water in Wilberforce Island. The study found that the bacteria density was in the order of (10^6cfu/ml) and physico-chemical parameters such as turbidity were high which suggests that the water is heavily contaminated/polluted. The consumption of this water could cause adverse health effects. Also, the high dissolved oxygen suggests that the water support the life of aquatic organisms such as fish. The high turbidity level could be reduced to acceptable limit for drinking water via distillation, while the microbial load could be reduced or eliminated through sterilization.

References

1- Akubuenyi, F.C., Uttah E.C. & Enyi-Idoh, K.H. (2013). 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,* 3(2): 31 – 44.

2- Raut, K.S., Shinde, S.E., Pathan, T.S. & Sonawane, D.I. (2011). Monthly variation of physicochemical parameters RavivarPeth Lake at Ambajpgai Dist. Beed Marathwada Region, India. *Global Journal of Environmental Research*, 5 (2): 70 – 74.

3- Ohimain, E. I. (2010). Aerobic bio-precipitation of heavy metal contaminated dredged materials from the Niger Delta. *Research Journal of Environmental Sciences,* 4(1): 93 - 100

4- Ohimain, E. I., Izah, S. C. & Otobotekere, D. (2014). Selective impacts of the 2012 water floods on the vegetation and wildlife of Wilberforce Island, Nigeria. *International Journal of Environmental Monitoring and Analysis*, 2 (2): 73 - 85

5- Ohimain, E. I. (2009). Wetlands protection for environmental sustainability in the Niger Delta of Nigeria. *Nigerian Journal of Plant Protection*, 23: 1-15

6- Ohimain, E. I., Bassey, S. & Bawo, D. D. S. (2009). Uses of seashells for civil construction works in coastal Bayelsa State, Nigeria: a waste management perspective. *Research Journal of Biological Sciences,* 1025 – 1031.

7- Ohimain, E. I. & Akinnibosun, H.A. (2007). Assessment of wetland hydrology, Hydrophytic vegetation and hydric soil as indicators for wetland determination. *Tropical Journal of Environmental Science and Health*, 10 (1): 1 - 11

8- Tyagi, T.R. & Agarwal, M.H. (2014). Aquatic Plants *Pistia stratiotes* L. and *Eichhornia crassipes*(Mart.) Solms: An Sustainable Ecofriendly Bioresources - A Review. *International Journal for Pharmaceutical Research Scholars*, 3(1-2): 540 – 550.

9- Sotolu, A.O. (2010). Digestibility value and nurient utilization of water Hyacinth (*Eichhornia crasipes*) meal as plant protein supplement in the diet of *Clarias gariepinus* (Burchell, 1822) juveniles. *American-Eurasian Journal of Agriculture and Environmental Science,* 9(5): 539 – 544.

10- Sotolu, A.O. (2013). Management and utilization of weed: water hyacinth (*Eichhornia crassipes*) for improved aquatic resources. *Journal of Fisheries and Aquatic Science,* 8(1): 1 – 8.

11- Saha, S. & Ray, A.K. (2011). Evaluation of nutritive value of water hyacinth (*Eichhornia crassipes*) leaf meal in compound diets for Rohu, *Labeorohita* (Hamilton, 1822) Fingerlings after fermentation with two bacterial strains isolated from fish gut. *Turkish Journal of Fisheries and Aquatic Sciences,* 11: 199-207.

12- Sunday, A.D. (2001). The utilization of water hyacinth (*Eichhornia crassipes*) by West African dwarf (wad) growing goats. *African Journal of Biomedical Research,* 4(3):147-149.

13- Hira, A.K., Ali, M.Y., Chakraborty, M., Islam, M.A. & Zaman, M.R. (2002). Use of water – hyacinth leaves (*Eichhornia crassipes*) replacing Dhal grass (*Hymenachne pseudointerrupta*) in the diet of goat. *Pakistan Journal of Biological Science,* 5(2): 218 – 220.

14- Nwidu, L.L., Oveh, B., Okoriye, T. & Vaikosen, N.A. (2008). Assessment of the Water Quality and Prevalence of Water Borne Diseases in Amassoma, Niger Delta, Nigeria. *African Journal of Biotechnology,* 7 (17): 2993-2997.

15- Ibiene, A.A., Agbeyi, E.V. & Okonko, I.O. (2012). Bacteriological Assessment of Drinking Water Sources In Opuraja Community of Delta State, Nigeria. Nature and Science, 10(1):36-41.

16- Egbe, E.O., Mawak, J.D. & Oyewole, O.A. (2013).Microbiological Quality of Water in Fulani Settlements in Gidan Kwano, Minna, Niger State, Nigeria. *Journal of Microbiology Research,* 3(2): 67-70.

17- Ezekwe, I.C., Ezekwe, A.S. & Endoro, P.O. (2013). Biological contaminants in the River Nun and environmental ethics of riverside communities in the Niger Delta: The case of Amassoma, Bayelsa, Nigeria. *Estud Biol.,* 35(84):67-75.

18- Agbugui, M. O. & Deekae, S.N. (2013). Assessment of the Physico-chemical Parameters and Quality of Water of the New Calabar-Bonny River, Porthacourt, Nigeria. *Cancer Biology,* 4(1):1 – 9.

19- Seiyaboh, E.I., Ogamba, E.N. & Utibe, D.I. (2013). 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,* 7(5): 51 – 56.

20- Pepper, I.L. & Gerba, C.P. (2005). Environmental microbiology. A laboratory manual. Second edition. Elsevier academic press.

21- Benson, H.J. (2002) Microbiological Applications: Laboratory Manual in General Microbiology/complete version, 5th edition. McGaraw-Hill, New York

22- American Public Health Association (APHA) (1998). Standard methods for the evaluation of water and waste waters. 20th Ed. Wahington DC. American Public health.

23- Antai, S.P., Unimke, A.A. & Agbor, R.B. (2014). Assessment of the Heterotrophic and Crude Oil Utilizing Microorganisms of Imo River Estuary of the Niger Delta Mangrove Ecosystem. *American International Journal of Biology,* 2(1):29-42

24- Puyate Y.T. & Rim-Rukeh A. (2008). Some physico-chemical and biological characteristics of soil and water samples of part of the Niger Delta area, Nigeria. *Journal of Applied Science and Environmental Management,* 12(2): 135 – 141.

25- Izonfuo, L.W.A. & Bariweni, A.P. (2001). The effect of urban runoff water and human activities on some physico-chemical parameters of the Epie Creek in the Niger Delta. *Journal of Applied Sciences and Environmental Management,* 5(1):47-55.

26- Aghoghovwia, O. A. & Ohimain, E. I. (2014). Physicochemical characteristics of lower Kolo creek, Otuogidi, Bayelsa state. *Nigerian Journal of Agriculture, Food and Environment,* 10(1):23 - 26

27- Abowei, J.F.N. (2010). Salinity, dissolved oxygen, pH and surface water temperature conditions in Nkoro River, Niger Delta, Nigeria. *Advance Journal of Food Science and Technology,* 2(1): 36 – 40.

28- Abowei, J.F.N. and George, A.D.I. (2009). Some Physicochemical Characteristics of Okpoka Creek, Niger Delta, Niger, Nigeria. *Research Journal of Environmental and Earth Sciences,* 1(2): 45-53.

29- Seiyaboh, E.I., Inyang, I.R. and Gijo, A.H. (2013b) Environmental Impact of Tombia Bridge Construction across Nun River in Central Niger Delta, Nigeria. *The International Journal of Engineering and Science,* 2(11): 32 – 41.

30- Ezekiel, E.N., Hart A.I. and Abowei, J.F.N. (2011). The Physical and Chemical Condition of Sombreiro River, Niger Delta, Nigeria. *Research Journal of Environmental and Earth Sciences, 3*(4): 327-340.