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Physicochemical and microbial characterization of somberiro river in ahoada east local government area, Rivers State, Nigeria

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Abstract

A total of six water samples collected at three different stations from Somberiro River were analyzed for the physico – chemical and bacteriological parameters. The physico – chemical parameters recorded highest concentration in site A except in conductivity while Phosphate, Potassium and Nitrate were found higher in site C and site B recorded highest in Chloride. Almost all the parameters were within WHO/FEPA limits except color which was 20, 195, 35, and 16co-pt in sites A, B, D and F respectively. Turbidity 72F.T.U was above the EPA/WHO stipulated range in site A. Bacteriological analysis of the water samples using standard methods of isolation of bacteria on the different media gave a total of seven genera of bacteria comprising of *Staphylocccus aureus*, *Eschericia coli*, *Bacillus species*, *Micrococcus luteus*, *Micrococcus roseus*, *Streptococcus faecalis* and *Salmonella species*. Nutrient agar gave highest heterotrophic counts ranging from 5.7×10^6 - 2.22×10^7 with 19 bacterial isolates. The coliform forming unit per ml (CFU/ml) of bacterial isolates on MCA ranging from 2.9×10^5 - 1.44×10^6 produced a total of 18 isolates and the SSA ranged from 3.35×10^4 – 1.56×10^5giving a total of 12 bacterial isolates. These heterotrophic colonial counts of bacterial isolates in these media were all above EPA permissible limits. Three genera of bacteria, *Escherichia coli*, *Streptococcus faecalis* and *Salmonella species* isolated from this river are all of medical importance. They are coliform bacteria whose presence in water shows faecal contamination. Therefore their presence is an indication that this river is polluted and not good for usage.

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Introduction

Water is one of the most common substances known. However, water is required in all forms of life; the roles of water in transportation, power generation, food production and most especially for consumption (drinking) are absolutely basic. These activities simply cannot take place without water. Water is the lifeblood of the biosphere (David *et al*, 2000). Despite its abundance, it has been estimated that nearly1.5 million people lack safe drinking water and that at least 5 million death per year can be attributed to water borne disease (West, 2009). Water pollution is a large set of adverse effects upon water bodies (i.e lakes, rivers, oceans, ground water) caused by human activities (David *et al*, 2000). Water pollution is a major problem in the global context. It has been suggested that it is a leading worldwide cause of deaths and diseases,and it accounts for the death of more than 14,000 people daily(West, 2009). It has also been shown that most diseases of water are of the gastro – intestinal tract (GIT) which include typhoid fever, paratyphoid, dysentery, infectious hepatitis and cholera and a few worms and that many water borne typhoid epidemic are caused by the entrance of intestinal discharge from persons having typhoid or from carriers into surface source of water supply (Cheesebrough, 2000). Dysentery by *Salmonella, Cryptosporidium* and *hepatitis* are among the maladies that results from drinking and using sewage contaminated water (Hamson, 1990). West (2009) reported that water pollution is an even more greater problem in the third world countries, where millions of people obtain water from drinking from unprotected streams and ponds that are contaminated with human wastes, this type of contamination has been estimated to cause more than three million deaths annually from diarrhea in the third world countries, most of them are children. Most of these countries also happen to be the world's developing nations, where water supply and sanitary facilities are still insufficient. The majority of the population relies on untreated point-of-use surface water and groundwater sources that are highly prone to fecal contamination, especially in congested urban and periurban areas. Waterborne disease outbreaks such as cholera have been reported in such settlements (Huntin,*et al*,2003, Legros *et at*, 2000).

In addition, pollution by metals and other inorganic compounds have also done some immeasurable havoc to human health, for example, poisoning by Lead (Pb), a heavy metal is known to cause the disease called plumbism. Lead wastes washed into water bodies accumulate in aquatic biomass, they are concentrated and passed up the food chain to human consumers, and lead is known to damage the brain, the central nervous system (CNS), kidneys, liver, and the reproductive system (Okpokwasili & Ogbulie, 1993). However, the discharge of industrial and domestic wastes into the environment has remained a global problem and the poor waste management, particularly in the developing countries has continued to constitute source of pollution to water bodies thus resulting in the incidences of diseases of various types (Nwigwe, 2000). In recent times, medical statistics have recorded a progressive increase in the incidence of diseases of public health concern whose origin may be traceable to polluted water (Blum *et al*, 1987 & WHO, 1996). The consequences of these water pollution problems have made the provision of portable water and prudent environment a sino- quo- non in the realization of a healthy populace (Seedley & Vandamark, 1981). However, the economic importance of Somberiro River cannot be over emphasized. Presently, no study on the bacteriological analysis on the River has been done except that of Abowei *et al* (2008) who researched on the planton and finfish and the physico – chemical properties of the river. An understanding of their microbiological quality and safety are therefore imperative. Therefore this study aims at examining the bacteriological and physico-chemical parameters of the water samples from Somberiro River in order to determine the suitability of the water for consumption by the community.

Materials and methods

Study Site

The Sombreiro River is located between latitude 6° 30¹ and 7° 0¹ E, and longitude 4°12¹ N and 60 17 N. The river is a distributary of the River Niger, which rises from the northern parts of Ogba/Egbema/Ndoni Local Government Area of Rivers State. It is one of the series of the Niger Delta Rivers that drain into the Atlantic Ocean. It flows southwards from its source to the Atlantic Ocean and is connected to other rivers via creeks in the coastal areas of the Niger Delta (Abowei *et al*, 2008). The river is relatively narrow and deep, and as it flows southwards, it widens. The river is lotic throughout the year, with its peak in the dry season. The river is within the tropical rainforest, though the mouth is within the brackish mangrove zone.

Water samples were collected from three stations comprising the Ehuda, Ihuaba and Idoke, all crisscrossing the Somberiro River in Ekpeye kingdom, Ahoada East Local Government Area of River State. Samples were collected at two points designated as upstream and downstream. Upstream activities include fishing, boating and areas occasionally undisturbed while the downstream activities were bathing, ashing, drinking, sewage disposal and sanitary sites. The studied area served much economic purposes for the local dwellers. The Somberiro River cuts across several villages of Akoh and Upata clans of Ekpeye kingdom of Rivers State with its terminal at Ogbele, where it empties into the Bonny River. The Sombeiro River is a major river in Ahoada East Local Government Area where human activities go on. Special features of each of the studied stations are:

Station 1, there is meat slaughter spot at the bank of river where cows are killed and supplied to the market. Stations 2 and 3 have special features such as agricultural activities, sanitary site.

Sample collection

Samples for the microbiological analysis were aseptically collected at the various contact points. Altogether six (6) samples were collected. Samples A, C and E were carefully collected downstream by dipping bijou bottle 10 -30cm below the water and covered immediately.

Samples B, D and F were collected upstream using a canoe. All the samples were then transported to the Microbiology Department laboratory, Federal University of Technology, Owerri, and where they were analyzed within 24 hours of collection.

Samples sites and samples collected

EHUDA (1) A→ Downstream where activities include bathing, washing etc

B→ Upstream, where there is fishing and boating activities

IHUABA (2) C→ Downstream activities are bathing, washing, waste disposal

D→ Upstream activities include fishing and boating.

IDOKA (3) E→ Downstream activities are bathing, drinking etc

F→ Upstream activities are fishing, boating.

Microbiological analysis of samples

Processing of samples:

Serial dilution of the water samples were carried out using sterile distilled water as in Chesesbrough (2000). All the different dilutions were properly labelled and used for total plate count.

Determination of total bacteria counts:

Total bacteria counts were determined by counting visible and distinct colonies on the media. This was done by dividing the bottom side of the culture plate into four quadrant, counting was done quadrant by quadrant and the total counts expressed as colony forming units per millilitre(cfu/ml)

Isolation of pure cultures

The water samples were examined bacteriologically using culture techniques as in Cheesebrough(2000) and Obiajuru and Ozumba (2009). Each water sample was examined by culture technique using streak plate and spread plate technique. A sterile wire loop was used to collect a loop full of each undiluted water sample and inoculated on the surface of nutrient agar, MacConkey agar and Salmonella Shigella agar (SSA) agar. The inoculated plates were subsequently sub-cultured on fresh nutrient agar, MacConkey agar and Salmonella Shigella (SSA) agar plates to obtain pure cultures which were used to further study their morphological and biochemical characteristics. The pure culture isolates were sub-cultured in nutrient agar slant and incubated at 37°C for 24 hours for bacterial enumeration. They were stored in the refrigerator until required for further use. The samples were processed and analysed to determine heterotrophic bacterial and coliform counts (Total Bacterial counts) using nutrient agar, MacConkey agar and Salmonella Shigella agar (SSA) agar media expressed as colony forming units per millilitre(cfu/ml.).

Identification of bacteria isolates

The bacterial isolates were subjected to various tests such as growth morphology on different agar media and different microbiological identification tests such as gram staining and motility tests and biochemical identification tests such as catalase, coagulase, oxidase, citrate utilization, urease, indole production, hydrogen sulphide production, nitrate and nitrite reduction, methyl red, Voges Proskeur and sugar fermentation tests.

Physico- chemical analysis

The physico-chemical analysis of the water collected from the Sombiroro River included the determination of temperature, turbidity, odour, colour, total solid, total dissolved solid, total suspended solid, pH, conductivity, iron content, acidity, total hardness, and chloride content using the methods of (APHA,1995).

Result

The distribution of bacteria in yhese water samples is shown in Table 1. *E. coli* and *Bacillus spp* were present in all the sampling points. *Staphylocccus spp* was present in all the points except in D, *Micrococcus luteus* and *Salmonella spp* were only found in points A and B. *Micrococcus reseus* was isolated only in sample C while *Streptococcus spp* was present in D and E. Points A and B had five each out of the seven genera of isolated bacteria, four genera of bacteria were available in C and E while three in D and F respectively.

Table 1. Specific point of isolation.

Name of species	A	B	C	D	E	F
Staphylococcus spp	+	+	+	-	+	+
E. coli	+	+	+	+	+	+
Micrococcus luteus	+	+	-	-	-	-
Micrococcus roseus	-	-	+	-	-	-
Streptococcus faecalis	-	-	-	+	+	-
Bacillus spp	+	+	+	+	+	+
Slmonella spp	+	+	-	-	-	-

The result obtained from the analysis of microbial characteristics of Somberiro River shows 7 genera of bacterial isolates as the most probable identity as shown in the Table 2. *Bacillus spp* and *Staphylococcus aereas* grew on all the three culture media presenting highest occurrence 34.7% and (28.6%) respectively. *E. coli* could not grow on SSA medium but had 18.4% prevalence on the other two media respectively. MCA and SSA failed to support the growth of *Micrococcus leteus*, *Micrococcus roseus* and *Streptococcus faecalis* had their respective occurrences of 6.1% and 4.1% while *Salmonella spp* (4.1%) occurred only on NA.

Table 2. Total viable bacterial count on different media.

Probable Bacteria Isolates	Media used and number of isolates on the			Total number of Bacteria isolates	Percentage occurrence
	NA	MCA	SSA		
Staphylococcus aereus	1	6	7	14	28.6
Eschericia coli	3	6	Nil	9	18.4
Micrococcus luteus	3	Nil	Nil	3	6.1
Micrococcus roseus	2	Nil	Nil	2	4.1
Streptococcus faecalis	2	Nil	Nil	2	4.1
Bacillus species	8	6	3	17	34.7
Salmonella species	Nil	Nil	2	2	4.1

Five genera comprising of 18 bacteria were isolated from station 1 (Ehuda) represented by samples A and B. The isolates include *Salmonella species*, *Escheria coli* which are gram negative rods and *Streptococcus faecalis* a gram positive cocci. Others are *Bacillus species* and *Microoccus leteus*. Also five genera of bacteria with sixteen 16 isolates were recorded in station 2 (Ihuaba) designated as samples C and D. The genera include *Staphylococcus aureus*, *Eschericia coli*, *Bacillus species*, *Micrococcus roseus* and *Streptococcus faecalis*. Total faecal bacteria and other bacteria isolates recorded for station 3 (Idoka) which are E and F were 15 representing four genera which include *Staphylococcus aureus*, *Eschericia coli*, Bacillus species and *Streptococcus faecalis*.

The result of the total bacterial counts is presented in Table 3. Nutrient agar gave highest heterotrophic colonial count of bacterial isolates ranging from 5.7×10^6 - 2.22×10^7 giving 19 bacterial isolates. The coliform forming unit per ml (CFU/ml) of bacterial isolates on MCA ranging from 2.9×10^5 - 1.44×10^6 produced a total of 18 isolates enumerated and the SSA ranges from 3.35×10^4 – $1.56\times10^5$with a total of 12 bacterial isolates.

Site A recorded highest concentration of the physico – chemical parameters except in conductivity, Phosphate, Potassium and Nitrate which were found higher in site C while site B recorded highest Chloride. All the parameters were within the range of WHO/FEPA limits except color 195, 20, 35, and 16co-pt in sites A, B, D and F respectively. Turbidity 72F.T.U was above the stipulated range in site A as shown in Table 3. Conductivity ranged from 67 – 93.5µs/cm, T.D.S. fell within 40.87 – 56.12FTU, Magnesium ranged from 1.75 – 2.2mg/ml, COD was very minimal ranging from 0.02 – 8.00mg/ml while the value for Total Hardness was from 12 -17mg/ in this river.

Table 3. Total colonial counts of bacterial isolates on different media.

Sample code	Nutient agar(NA)	MacConkey agar(MCA)	Salmonella Shigella agar(SSA)
A	1.6×10^7	1.44×10^6	1.56×10^5
B	2.1×10^7	3.0×10^6	8.8×10^4
C	1.74×10^7	5.0×10^5	9.2×10^4
D	2.22×10^7	6.2×10^5	-
E	5.7×10^6	1.4×10^6	4.1×10^4
F	1.2×10^7	2.9×10^5	-
Total	1.46×10^7	9.86×10^6	3.77×10^4
Mean	2.43×10^7	1.64×10^5	9.43×10^4

Discussion

The result showed varying levels of organic and inorganic pollution. The pollution was highest in the sample from sites A, B, C and E which are the downstream, upstream, and downstream for the physico – chemical parameters while the same samples showed higher degree of contamination for the bacteriological parameters.

Table 4. Physico-chemical data of Somberiro River in Ahoada East Local Government Area, Rivers State, Nigeria.

PARAMETERS	A	B	C	D	E	F	WHO/FEPA
Temperature(°C)	25.8	25.4	25.6	25.4	25.7	25.4	23- 30
pH@23°C	6.45	6.30	5.95	6.15	6.35	6.2	6.5 – 8.5
Conductivity(µs/cm)	92.0	88.0	93.5	67.0	80.0	75.0	100
Turbidity(F.T.U.)	72.0	22.0	6	9.0	11.0	15.0	50
Color(co - pt)	195	20	1.0	35	3.0	16	15
Total dissolved solid(mg/l)	56.12	54.56	49.38	40.87	51.35	45.75	250
Iron(mg/l)	0.21	0.17	0.07	0.06	0.12	0.07	1.0
Calcium(mg/l)	3.6	2.4	2.0	2.4	2.8	2.4	200
Magnesium(mg/l)	2.20	1.9	1.90	1.94	1.75	1.46	200
Phosphate	2.40	2.15	2.75	1.89	2.2	1.30	5
Potassium(mg/l)	2.50	1.95	2.12	1.40	2.0	0.07	5
Nitrate(mg/l)	0.88	2.30	0.43	0.38	1.0	0.22	40
Chloride(mg/l)	1.0	3.0	1.0	0.5	1.5	1.0	600
Total Hardness(mg/l)	14.0	14.0	17.0	14.0	16.0	12.0	<100
Total Alkaline(mg/l)	32.3	25.90	29.0	24.4	26.95	21.55	50
Chemical oxygen Demand(mg/l)	10	8.0	4.0	5.0	6.0	0.02	100

The bacteriological analysis recorded isolation of a total of 7 bacterial genera which included: *Eschericia coli*, *Streptococcus faecalis* and *Salmonella species*, which are bacteria of medical importance. Others are *Staphylococcus aureus*, *Micrococcus luteus*, *Micrococcus roseus* and *Bacillus species*. The occurrence of many of these organisms in the various sites of the river can be associated with the activities (like washing, bathing and swimming, waste discharge etc) going on in these sites. The colony forming unit per ml (cfu/ml) of bacteria isolates on nutrient agar (NA) ranges from 5.7×10^6 – 2.22×10^7 with a total bacteria of 19, while that on MacConkey agar (MCA) is 2.9×10^5 – 9.86×10^6 resulting in 18 bacteria isolates. Also those on Salmonella Shigella agar gave 3.77×10^4 – 1.56×10^5 with a total of 12 isolates. The greatest number (19) obtained with nutrient agar confirmed the fact that it is all purpose medium while the other two are selective in nature. The coliform test is a reliable indicator of the possible presence of faecal contamination and is, consequently, correlated with pathogens. These levels far exceeded both the limit of 1.0×10^2 of heterotrophic count drinking water as stipulated by EPA (2002) and this suggests the pollution of the water by organic materials. The sources of these bacteria could be from materials deposited from human and animal wastes while more drained from runoff and seepages from agricultural

activities and industrial wastes. Additional sources include seepage or discharge from septic tanks, sewage treatment facilities and natural soil /plant bacteria EPA (2002). These contaminants are reflected in the highest bacterial load obtained in this study for the river and Somberiro river water samples.

The bacteriological analysis recorded the isolation of organisms of public health importance. These include *Streptococcus faecalis, Bacillus sp*, *Staphylococcus sp*, and *Eschericia coli*. *Staphylococcus sp* which were detected virtually from all the points except in point D and this could be linked to the swimmers and other users of the water sample since it is a normal flora of the skin (Yoshape & Goldenman, 1987) as these three sampling points are heavily engaged with human activities. E. coli may be from human or animal excreta washed into the river (Le Minor, 2003), and is a predominant coliform as it is found in all the six points/samples. It indicated recent fecal contamination of the different sources Cabral (2010). The presence of *Salmonella spp* in the water sample might be due to contamination from domestic sewage, agricultural waste and storm water runoffs (WHO, 2008). According to Le Minor (2003), *Salmonella typhi* is responsible for salmonellosis, especially typhoid and gastroenteritis. This implies that controlled sewage water systems and personal hygiene will reduce the incidence of gastroenteritis and typhoid fever (Popoff & Le Minor, 2005). *Staphylococcus* spp. isolated from samples implied possible contamination from effluent sources and bodies of people swimming and excavating sand at the River points (Kayser, 2005). Faecal *Streptococcus* spp is responsible for gastrointestinal illness (Donovan *et al*, 2005). *Bacillus* spp. was present in all the samples which might be because they survive in a wide range of environmental conditions (Prescott *et al*, 2005).

In addition, the average pH of the samples was below 6.5, which may be attributed to the high waste discharges. The conductivity values of the samples were within the permissive limits, that is within the WHO range which showed that the ion current was within the permissive limits. Furthermore, the total hardness, total dissolved solids and total suspended solids were observed to be within acceptable range according to WHO standard. However, there were a marked deviation in color in samples from upper point A, B, D and F which could be as a result of high level of activities while turbidity mean value fell within the permissive range of WHO and FEPA. The water samples from all the sites showed acceptable levels of nitrates, calcium, chlorides, iron, potassium, magnesium, and Potassium. Nitrate, Phosphate and Potassium were within the permissive range of WHO. The presence of these compounds could be from agricultural activities in some areas around the river, but the concentrations were not high enough to cause eutrophication. The chemical oxygen demand concentration was below the acceptable range of surface water quality standards of 100mg/ml as described by FEPA. The river is expected to support aquatic life. Therefore, the result of this work has clearly shown that Somberiro river is polluted bacteriologically due to the presence of faecal coliforms such as *Eschericia coli*, *Streptococcus faecalis* and *Salmonella* species (Buchanan & Gibbon, 1974).

Conclusion and recommendation

This result of the study has clearly shown that Somboriro River is slightly polluted and not fit for human consumption but can support aquatic lives. There is every reason to say that the unhygienic nature of the water is as a result human activities. It is therefore recommended that:

The users of this natural source of water should be educated on sanitary and hygiene for better understanding of the importance of protecting these waters.

Again the water should be treated before supply to the households or before usage and,

Government should make a policy that will include safe and reliable water campaign and monitoring exercise

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