A survey of the physico-chemical characteristics of river Jameson, Delta State, Nigeria (part 1)

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Abstract

Water is a most valuable resource to man and living things and being universal solvent can dissolve many substances. A research work to ascertain the Physico-chemical characteristics (PCCs) of River Jameson was carried out. The surface water from five randomly sampled locations was tested for twelve PCCs. The results showed that eleven of the PCCs- apart from the water surface temperature (26.95^{O}C, ±0.8) existed within WHO permissible limits. The pH values from all the studied stations (Efrurokpe = 7.0, the others = 6.5) were all within permissible limits. Ebrifo recorded the highest temperature (27.3) and ironically the highest DO (7.5). The BOD (12.25) was comparatively higher in Pamol. Lead and Mercury were virtually undetected in three of the five stations and were very minimal in the other two: Ebrifo (Pb = 0.01mg l^{-1} & Hg = 0.000 mg l^{-1}) and Pamol (Pb & Hg = 0.0005mg l^{-1}). The other PCCs were more or less the same in all the stations except the BOD in Otefe (8.75mg l^{-1}) and Pamol (12.25mg l^{-1}). There is need to ensure sustainable uses and guide against future contamination of this natural fresh water river in the Niger Delta zone of Nigeria.

Key Words: Jameson River, Surface Water, Physico-Chemical Parameters (PCPs), Shallow Zone.

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Introduction

Water is one of the earth's natural resources and three quarters of the earth's surface is covered by it (Akpofure *et al*, 2007). It is a most valuable resource to man and living things, essential for the sustenance of life on earth as exemplified by its diversified uses (drinking, cooking, washing, irrigation, farming etc). Indeed water is life. Human beings are made up of water, in roughly the same percentage as water is in the surface of the Earth. Our tissues and membranes, brains, and hearts, our sweat and tears - all reflect this important recipe for life. Unequivocally, water is essential for the development and maintenance of the dynamics of every ramification of society. Availability of safe and reliable source of water is an essential prerequisite for sustained development. (Gore 1993 and UNSCD 2000). Incidentally, water in its natural state may not be pure, because it is a universal solvent with the ability to dissolve numerous substances and so carry a lot of impurities either in solution or suspension that can be injurious to human health, if it exceeds tolerable limits. It is therefore important that water for drinking and domestic use must be free from significant concentration of toxic and stray substances (WHO 1999).

As the world is ushered into the modern era of civilization, water and its management will continue to be a major issue, which will definitely have profound impact on our lives and that of our planet Earth than ever before. Continuous urban development and large solid waste pose as major environmental risks because of the difficulties in disposal. Landfills and other solid wastes disposal sites are major targets of pollution because rainfall and groundwater leach these highly contaminated substances into rivers, streams and waterways (Surface waters) which are inadvertently used by people residing in such areas. This scenario can lead to many water related health problems. It is said that water borne diseases kill 50,000 people daily (Herschy, 1999) and yearly, about 4 million children under the age of five die in developing countries due to water related problems (USAID, 1990; Warner, 1998). Throughout the world, about 2.3 billion people suffer from diseases that are linked to water related problems (WHO, 1997) and which continue to kill millions of people yearly, debilitate billions, thereby undermining developmental efforts (Nash, 1993; Olshansky *et al.*, 1997).

Clean water is essential to life itself. Adverse changes to the water quality of one stream can impact all the bodies of water downstream – rivers, lakes, or even the ocean. When water quality degrades, changes to plant, invertebrate, and fish communities may occur and affect the entire food chain. Through water quality monitoring, communities can assess the health of their streams and rivers over time. It is very essential that potable water should be devoid of heavy metals such as Pb, Cr, Cd, Zn and Fe which are known to be toxic to man at certain levels of intake (Wakawa *et al.*, 2008, & WHO, 1999)). The physico-chemical quality of water is very vital for the life of aquatic organisms and it is part of water quality monitoring. These environmental variables include pH, temperature, salinity, dissolved oxygen, biological oxygen demand, turbidity, transparency, etc. These parameters are used to detect any perturbation in the aquatic environment (Davis *et al.*, 2008).

In most urban and rural settings in the Niger Delta area major sources of water for drinking and domestic purposes are: rivers/creeks/streams/ponds, hand-dug wells and harvested rain water (FGN 2000). The provision of potable water has been a major problem in Nigeria, a characteristics feature of developing countries. In Nigeria, the situation is complicated by the presence of crude oil and gas exploration and production activities in the Niger Delta area (Ashbolt 2004). Ironically, studies on the physico-chemical composition of many water bodies in Nigeria are still scarce and limited. This paper presents a study on the physico-chemical characteristics of River Jameson which is one of the prominent freshwater rivers used for drinking and domestic purposes in this region of Delta State, Nigeria.

2.0: Materials and Methods

2.1: Study Area

River Jameson is located in the Niger Delta region of Nigeria. It has its source from Sakponba in Orhionwon LGA of Edo state, but flowed into and through Oghara in Ethiope West Local Government Area of Delta State. It is about 60km long. Most of its length (the lower stream, mid-stream and upper stream) flowed through Oghara villages, hamlets and emerging towns. It served as boundaries between Oghara and Ugbakele, as well as Mosogar Clan at the North West end. At its Lower-stream, the river formed a confluence with Ethiope River after Mosogar to form the Larger Ethiope River or Benin River in Sapele. From Sapele the Larger Ethiope River emptied itself into the Atlantic Ocean. See figure 1.

Jameson River is presently like an unchartered water way. The people living along its coastline use it for domestic and drinking purposes. It is tidal. The lush water vegetation that girds the coastline grows without being meddled-in for most of its length. The river flows in loneliness, unhampered by human activities such as fishing, boating, dredging, logging and what have you. The water fauna (which are highly unexploited) also thrive unmolested. Added to these is the fact that it is a fresh water river flowing in its clear sparking dark blue hue.

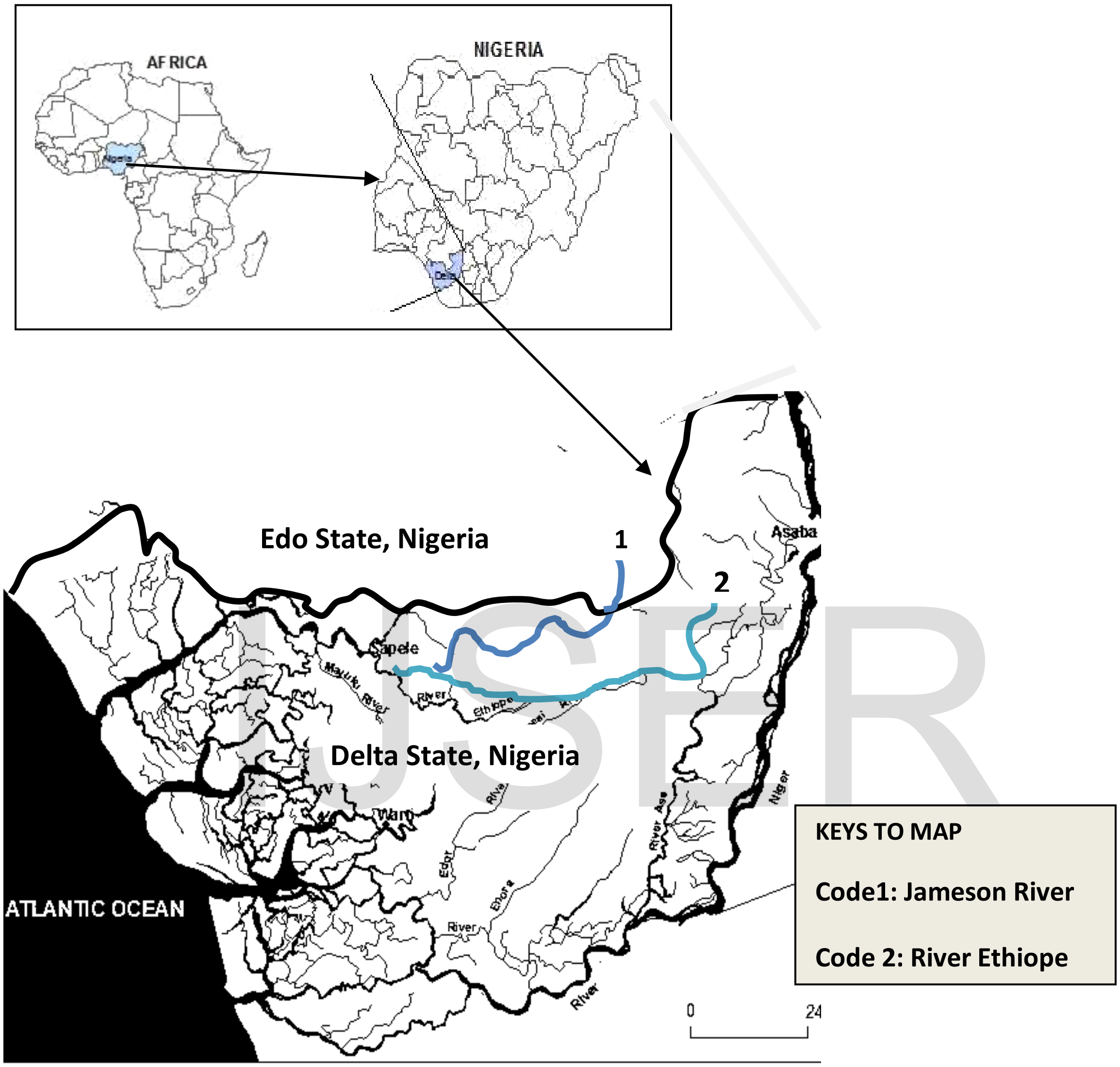

Figure 1: Map of Delta State, Nigeria; showing Jameson River.

2.2: Sample collection

Surface water samples for this study were collected during dry season (between October 2011 and February 2012) according to the *Standard Methods* (APHA, 1992). Five sample stations were randomly selected. Station 1(STA 1) was sited at Ugbakele, STA 2: Ebrifo, STA 3: Otefe,

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STA 4: Efrurokpe and STA 5: Pamol. Ugbakele represents the upper-stream, Ebrifo and Otefe the mid-stream while Efrurokpe and Pamol represent the lower stream. In all, five visitations were made to each station. At each time of surface water collection, two separate set of samples were collected, one for the determination of ions and time independent physico-chemical parameters (PCPs) and the other for the determination of time dependent PCPs. The fast changing parameters of the water (pH, temperature, dissolved oxygen (DO), total dissolved solids (TDS), turbidity and electrical conductivity) were measured in-situ. At each sampling location, the surface water sample was collected both from the edge and the middle of the river and stored in clean plastic bottles that have been prewashed with 10% nitric acid and thoroughly rinsed with deionized or distilled water.

3.3: Water Quality Analysis

The PCPs earmarked for analysis in this research work are pH, temperature, electrical conductivity (EC), total dissolved solid (TDS), Total Suspended Solid (TSS), Dissolved Oxygen (DO), Biological oxygen demand (BOD), Turbidity in **Naphenometric Turbidity Units** (NTU), phosphate (PO_4^{3-}), Sulphate (SO_4^{2-}), iron (Fe), lead (Pb), and mercury (Hg).

The pH was measured with a standard pH meter, the temperature with a mercury thermometer, Turbidity with Hach Spectrophotometer, model DR2010 and Electrical Conductivity (EC) with the Suntex Conductivity meter. Total Suspended Solid (TSS), total dissolved solid (TDS) were determined at the time of sampling in the field using a portable HANNA, HI991301 Model. Phosphate (PO_4^{3-}) and Sulphate (SO_4^{2-}) were determined according to APHA (1992) methods. Dissolved Oxygen (DO) and Biological oxygen demand (BOD) were also determined following the procedure of Hamer (1986). Iron (Fe), lead (Pb), and mercury (Hg) were analyzed in the laboratory. All methods of analyses were consistent with APHA (1992), FMENV (2002) and WHO (1984).

Results

Data about the twelve PCPs from the five stations were recorded. The summaries of their values for both the shallow and deep zones of the river are shown in table 1. Fe^{2+} was not detected in any of the stations. The pH range (1) was highest at Pamol, almost insignificant at the upper and mid stream. The temperature range (1.1) was highest at the upper stream than the other parts of the river. PO_4^{3-} fluctuated in values between the shallow and deep zones all through the upper, mid and lower stream until it became homogenous at the Pamol end (range = 0). Mercury was almost negligible in both zones in all the studied stations except in Pamol (0.001$mg\ l^{-1}$) where it is also almost negligible. The same trend was also found with Pb as it was virtually undetected in all the stations and zones except in Efrurokpe and Pamol (lower stream) at a negligible concentration. The range values of Turbidity, BOD and TDS tend to be higher between the shallow and deep waters of the mid stream.

Overall, the values of the recorded PCPS were higher in the shallow zone than the deep zones of Jameson River. As shown in table 1, the PCPs wherever they were detected are higher in concentration or intensity at the shores than the deep zones. Clear exceptions to this trend were Pb and Hg at the Pamol station. Note that this station is not only close to the confluence area with River Ethiope but serves as the lower stream and has a high level of perturbation through local sand dredging. At this Station, the values of Pb (0.01$mg\ l^{-1}$) and Hg (0.001$mg\ l^{-1}$) which were not detectable in the other stations were the same at both the shallow and deep zones.

Table 1. The twelve PCPs recorded from five study stations in River Jameson, Delta State, Nigeria, showing their values both from the shallow and deep water as well as their ranges.

S/N	Parameters	Collection Zone	Sampling Stations				
			STA 1 Ugbakele	STA 2 Ebrifo	STA 3 Otefe	STA 4 Efrurokpe	STA 5 Pamol
1	pH	SW	6.5	6.5	6.5	7.0	6.0
		DW	7.0	7.0	6.5	7.0	7.0
		Range (±)	0.5	0.5	0	0	1
2	Temperature OC	SW	27.4	27	26.5	26.5	27
		DW	26.5	27.6	27	26.5	27.5
		Range (±)	1.1	0.6	0.5	0	0.5
3	EC mS/cm	SW	120	123	120	120	120
		DW	120	124	121	124	123
		Range (±)	0	1	1	4	3
4	Turbidity NTU	SW	4	4	4	4	5
		DW	4	4	5	4	5
		Range (±)	0	0	1	0	0
5	TDS mg l^{-1}	SW	7	7	6	7	7
		DW	7	7	8	7	7.5
		Range (±)	0	0	2	0	0.5
6	BOD mg l^{-1}	SW	8.0	8.0	8.0	8.0	12.0
		DW	8.0	8.5	9.5	8.0	12.5
		Range (±)	0	0.5	1.5	0	0.5
7	DO mg l^{-1}	SW	7.0	7.5	7.0	7.0	7.0
		DW	7.5	7.5	7.4	7.5	7.0
		Range (±)	0.5	0	0.4	0.5	0
8	SO_4^{2-} mg l^{-1}	SW	24.5	25.0	24.5	25.0	25.0
		DW	25.0	25.5	25.0	25.5	25.0
		Range (±)	0.5	0.5	0.5	0.5	0
9	PO_4^{3-} mg l^{-1}	SW	0.68	.067	0.65	0.67	0.65
		DW	0.68	0.67	0.7	0.68	0.68
		Range (±)	0	0	0.5	0.1	0.3
10	Fe^{2+} mg l^{-1}	SW	ND	ND	ND	ND	ND
		DW	ND	ND	ND	ND	ND
		Range (±)	-	-	-	-	-
11	Pb^{2+} mg l^{-1}	SW	0.00	0.00	0.00	0.00	0.01
		DW	0.00	0.00	0.00	0.01	0.01
		Range (±)	0.00	0.00	0.00	0.01	0.00
12	Hg mg l^{-1}	SW	0.000	0.000	0.000	0.000	0,001
		DW	0.000	0.000	0.000	0.001	0.001
		Range (±)	0.000	0.000	0.000	0.001	0.000

SW = shallow water, DW = deep water, ND = Not Detectable.

The summary of the PCPs for each of the studied stations is shown in table 2. Overall, the EC was found to be highest in Pamol end of the river. The pH values from all the studied stations (Efrurokpe = 7.0, the others = 6.5) are all within permissible limits. Ebrifo recorded the highest temperature (27.3) and ironically the highest DO (7.5). The BOD (12.25) was comparatively higher in Pamol. Lead and Mercury were virtually undetected in three of the five stations and were very minimal in the other two Ebrifo (Pb = 0.01mg l^{-1} & Hg = 0.000 mg l^{-1}) and Pamol (Pb & Hg = 0.0005mg l^{-1} each). The other PCPs were more or less the same in all the stations except the BOD in Otefe (8.75mg l^{-1}) and Pamol (12.25mg l^{-1}) which differ prominently.

Table 2: The summary of the PCPs recorded from five studied stations in River Jameson in Delta State , Nigeria.

S/N	Parameters	Sampling Stations				
		STA 1 Ugbakele	STA 2 Ebrifo	STA 3 Otefe	STA 4 Efrurokpe	STA 5 Pamol
1	pH	6.5	6.5	6.5	7.0	6.5
2	Temperature O^C	26.95	27.3	26.75	26.5	27.25
3	EC mS/cm	120	120.5	122	120	123.5
4	Turbidity NTU	4	4	4.5	4	5
5	TDS mg l^{-1}	7	7	7	7	7.25
6	BOD mg l^{-1}	8	8.25	8.75	8	12.25
7	DO mg l^{-1}	7.25	7.5	7.2	7.25	7
8	SO_4^{2-} mg l^{-1}	24.75	25.25	24.75	25.25	25
9	PO_4^{3-} mg l^{-1}	0.68	0.67	0.675	0.675	0.665
10	Fe^{2+} mg l^{-1}	ND	ND	ND	ND	ND
11	Pb^{2+} mg l^{-1}	0.00	0.00	0.00	0.01	0.01
12	Hg mg l^{-1}	0.000	0.000	0.000	0.0005	0.0005

The Mean of the PCPs put together and compared with the acceptable standard units is shown in table 3. All the PCPs apart from the water surface temperature met with the WHO acceptable standards. Going by the studied PCPs, this indicated the potable status of the water from Jameson River starting from the lower to upper stream. Also shown in table 4.3 are the range values of the recorded PCPs. These were found to be less than one (<1) except for EC (±3.5) and

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BOD (±4.25). This indicated that the PCPs were more or less the same through the length of Jameson River.

Table 3: The Mean and Range of the recorded PCPs from River Jameson, Delta State, Nigeria.

S/N	Physico- chemical Parameters	Recorded Mean/Range	Standard Unit*	Status
1	**pH**	6.6 ±0.5	6.5 – 8.5	QA
2	**Temperature O^C**	26.95 ±0.8	19.5 – 21^OC	NA
3	**EC mS/cm**	121.2 ±3.5	400	QA
4	**Turbidity NTU**	4.3 ±0.5	5.0	QA
5	**TDS mg l^{-1}**	7.05 ±0.25	500	QA
6	**BOD mg l^{-1}**	9.05 ±4.25	Not >10	QA
7	**DO mg l^{-1}**	7.24 ±0.5	>3.00	QA
8	**SO_4^{2--} mg l^{-1}**	25 ±0.5	200	QA
9	**PO_4^{3--} mg l^{-1}**	0.673 ±0,015	200	QA
10	**Fe mg l^{-1}**	ND	0.10	QA
11	**Pb mg l^{-1}**	0.004 ±0.000	0.05	QA
12	**Hg mg l^{-1}**	0.0002 ±0.000	0.001	QA

QA = Quality Accepted, NA = Not Acceptable, ND = Not Detectable, ± = Range between highest and lowest PCPs. (* Source: WHO, 1998)

5.0: Discussion

From the results presented above which is based on the selected PCPs, the surface waters collected from all the studied stations in River Jameson can be regarded having good quality and therefore fit to be regarded as potable water. All the studied PCPs except temperature were well within the permissible level for potable water (WHO, 1999). The issue of temperature is understandable. Jameson River is located in the tropical region where temperatures of rivers and streams seldom fall below 26°C (Ajayi & Adelaye, 1977). The Low EC values (Approx. 121.2; Std Unit = 400) are indicative of low inorganic contents in the water. The relatively low levels of turbidity could be attributed to the absence of decaying organic matter and the dredging activities, which though is a common occurrence in the Niger Delta waters, (Eborge 1994) is however not the case with River Jameson. This is indicative of low impoundment of this river.

The observed DO levels (7 – 7.25 mg/l) are adequate for marine life survival. DO level maintained above 5 mg/l is required for the survival of fish and other aquatic life. The relatively low levels of BOD can be attributed to the absence of decaying organic matter. This is quite unlike many other water bodies in the Niger Delta were due to sewage and industrial effluents BOD becomes high. (RPI, 1985). However, it should be noted that the Pamol section of the river is showing some signs of pertubation due to the local dredging, logging activities and untreated effluent from Pamol rubber factory flowing into the river. Furthermore, it should be noted that the section of the river at the Pamol end is closed to the confluence area with river Ethiope. And as Jameson River is tidal, PCPS at Pamol and even Efrurokpe, were notable different from the other three locations. It is possible for the water from river Ethiope to mix with some of that of Jameson River during the inter-tidal exchange at the confluence zone.

The results also showed that unlike many rivers in this part of Nigeria (Ekweozor and Agbozu, 2001), River Jameson can be classified as a river with unpolluted surface water as far as the selected PCPs are concerned. The cations and anions levels were all within the permissible limits. Lead which is regarded as the most common toxicant in any environment, (Goyer, 1993); is almost absent in Jameson River. This is significant as it speaks volumes about this lone river amidst industrial impact on several water bodies.

Conclusion

Based on the selected PCPs, the results have shown that the surface waters of Jameson River are safe for human uses. This is attested to by the examined parameters which can detect any level of perturbation in an aquatic environment. The water can be considered well enough for many uses especially in the areas of domestic uses, industrial development and navigation, boating, and fishing. This has the implication to guide against the impact of future perturbation on the river.

Especially in the face of increasing population density, urbanization and industrialization which have been known to have profound impact on human life and aquatic environment in terms of quantity and quality.

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