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Comparative Study of physico chemical parameters of Water Samples from Brackish and Fresh Water of New Calabar River, Port Harcourt, River State, Nigeria

Woke, G.N and Umesi N

Animal & Environmental Biology University of Port Harcourt, Federal College of Education Omoku, Rivers State.

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ABSTRACT

Physico-chemical parameters of brackish and freshwater of the New Calabar River were studied between October to December, 2016, using standard methods. The comparative results showed the mean temperature (27.77±0.170 and 28.00±0.180C), pH (7.12±0.01 and 6.23±0.03), total dissolved solids (2657.00±24.0mg/L and 9.90±0.14mg/L), salinity (6269.95±67.25mg/L and 7.19±0.04mg/L), dissolved oxygen (6.34±0.06mg/L and 6.09±0.01mg/L), biochemical oxygen demand (17.53±0.11mg/L and 51.06±0.20mg/L) for brackish and freshwater respectively. Analysis of variance (ANOVA) showed a significant difference ($p < 0.05$) in pH, TDS, TSS, DO, BOD and COD whereas temperature showed no significant difference ($p > 0.05$) when both water bodies are compared. The physico-chemical parameters from both water bodies were favourable for fish production although some were to a large extent above the WHO limits. The study revealed the need for continuous pollution monitoring and management programme of surface water in Rivers State and Nigeria as a whole.

Introduction

Water quality is the suitability of water for growth of aquatic organisms like fish (Boyd, 2006). Water quality is defined by the physical, chemical and biological characteristics of waters which include temperature, turbidity, dissolved oxygen content, biological oxygen demand, ammonia, nitrate contents, faecal coliform content etc. (Nnaji *et al*, 2011).

Human, livestock and aquatic organisms may be affected by poor water quality causing death, sickness or impaired growth. Thus, understanding water quality parameters are essential due to the daily demand for water by the entire ecosystem (ololade and Ajayi, 2009).

Previous studies have shown that water quality affects species composition, assemblages and distribution of plankton (Woke & Babatude, 2009), benthos (Woke & Wokoma, 2006) and fish (Woke & Wokoma, 2007). No reliable data exist in published form on the ecology of fresh in brackish water of new Calabar river. Onwugbuta-Enyi *et al*, (2008) raised concerns as to the dependency on post impact studies data when baseline data for comparison are lacking. It is therefore necessary that the quality of drinking water should be checked at regular time interval because due to the use of contaminated drinking water, human population suffers from a variety of water borne diseases (Manjare, *et al*, 2010). Thus, the present study was aimed at providing preliminary information on the physico-chemical parameter of fresh and brackish water of New Calabar river in the lower Niger Delta basin of Rivers State, Nigeria.

Materials and Methods

Study Area

The study area is the New Calabar which lies on the eastern arm of the Niger Delta (RPI, 2006).

It is a tributary of River Niger and River Benue that form a Delta plain in the Niger Delta area. The entire river course transverse through five local government areas of Rivers State viz: Ikwerre, Obio/Akpor, Emohua, Degema, Asari-Toru between $006^{0}53'$ 53.086"E ($7^{0}60'$E) and latitude $04^{0}53'$ 19.020"N ($5^{0}45'$N) in the coastal area of the Niger Delta, Nigeria. It is one of the series of the Niger Delta Rivers which drain into the Atlantic Ocean and is connected to other rivers via creeks in the coastal area of the Niger Delta (Ezekiel, 2001). At the source (Choba) the water is fresh and acidic but brackish at the mouth (Iwofe). Choba is the upstream part of the river where the water is fresh and tidal while Ogbakiri and Iwofe are down streams (Edu and Efiuvwevwere, 2012).

However, the river is a major source of fish, shrimps and crabs, fringed by riverside swamp forest, houses an abattoir, poultry, a fabrication company and a weekly market (Fig. 1).

Description of Sampling Sites

Two sampling sites were established as brackish and freshwater respectively. The brackish water is a tidal environment located around Ogbogoro and Iwofe communities where human population is high and industries are concentrated. The vegetation fringing the river at the left and right banks consists of mangrove plants such as *Rhizophora*, *Avicennia* and *Nypha fruticans* (Nypa palm), arising from a characteristic muddy substrate that produces a foul odor.

Freshwater has a little tidal influence from the immediate tidal mangrove zone. It is located around Choba community where human and industrial population is low compared to the brackish water. The vegetation fringing the river at the right banks consist of mangrove plants such as *Nypha fruticans* (Nypa palm) etc, while the left bank consists of seas weeds and borders toward the market.

Tele:

E-mail address: g.woke@yahoo.com

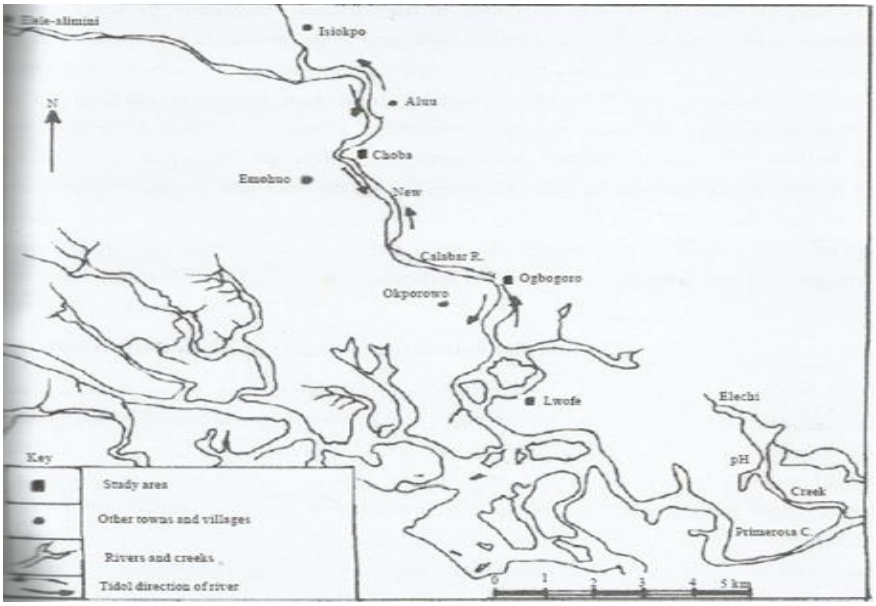

Figure 1. Map of the New Caliber River showing locations of the Brackish and Freshwater (Source: Edun and Efiuvwevwere, 2012).

Collection of Water Samples

Duplicate water samples were collected from brackish and freshwater along the New Calabar River in the morning hours between 9-11am with IL polyethylene bottles. The bottles were rinsed about 2 – 3 times with the river water before collection in-situ measurement recorded before samples were immediately transported to the laboratory and analyzed within 24 hours of collection. The physical and chemical parameters were temperature, pH, total dissolved solids (TDS), total suspended solids (TSS), salinity (‰), dissolved oxygen (DO), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). The methods used were as described by APHA, 1998.

Results/Discussion

Spatial variations of the physico-chemical results of fresh and brackish water are presented in Table 1, 2 & 3 and Fig. 2. Temperature had a range of 27.65^0C – 27.89^0 in brackish water but there was a decline in freshwater (decreased from 28.10^0C – 28^0C). The mean temperature value for brackish water was 27.77 ± 0.17^0C while that of freshwater was 28.00 ± 0.18^0C, the difference in temperature values were not statistically significant ($p > 0.05$).

pH values in the brackish water were high with a mean value of 7.12±0.01, compared to that of freshwater with a mean value of 6.23±0.03.

Total dissolved solids (TDS) were generally lower in freshwater (mean 19.84±0.40mg/L) than in brackish water (mean 2657.00±24.04mg/L). Indeed, it was observed that the brackish water was more turbid than freshwater confirmed by the higher values of total suspended solids (TSS) and total dissolved solids (TDS) obtained from brackish water (mean 506.55±9.26mg/L) and 19.84±0.40mg/L respectively). Salinity in the brackish water was higher (mean 6269.95±67.25mg/L) compared to the freshwater with mean 7.19±0.04mg/L. It was observed that salinity fluctuated.

Furthermore, mean dissolved oxygen (DO) in brackish water was 6.34±0.06mg/L while that of freshwater was 6.09±0.01mg/L. However, the mean bio-chemical oxygen demand (BOD) value was 17.53±0.11mg/L in brackish water compared to 19.99±0.022mg/L in freshwater (Table 3) (Fig. 2**).**

Values for COD were higher in brackish water than in freshwater with mean of 59.18±0.04mg/L in the former and 51.06±0.20mg/L in the latter respectively.

Discussion

In aquatic ecosystem, variations exist between the different environmental compartments with regard to physical, chemical and biological characteristics. However, elogical conditions are mutually reinforcing and to a large extent determine the biotic component and structural patterns. Temperature values were not statistically significant ($p > 0.05$) with mean of 27.77±0.17 in brackish water and 28.00±0.18 in freshwater (Table 1).

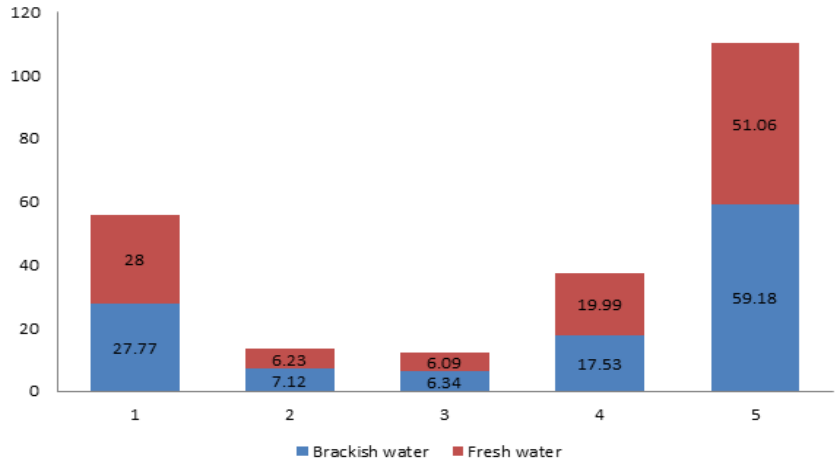

Fig 2. Mean value of physiochemical parameters of the brackish and fresh water.

Table 1. Physico-chemical parameters of brackish water.

S/N	Temp. (^{0}C)	pH	TDS (mg/L)	TSS (mg/L)	Salinity (‰)	DO (mg/L)	BOD (mg/L)	COD (mg/L)
1	27.65	7.13	2640.00	500.00	6317.5	6.40	17.60	57.20
2	27.89	7.11	2674.00	513.10	6222.4	6.31	17.45	59.18
Mean	27.77	7.12	2657.00	506.55	6269.95	6.34	17.53	59.18

Table 2: Physic-chemical parameters of freshwater

S/N	Temp. (^{0}C)	pH	TDS (mg/L)	TSS (mg/L)	Salinity (‰)	DO (mg/L)	BOD (mg/L)	COD (mg/L)
1	28.10	6.25	19.56	10.00	7.22	6.08	20.00	51.20
2	27.89	6.21	20.12	9.80	7.16	6.10	19.97	50.92
Mean	28.0	6.23	19.99	9.90	7.19	6.09	19.99	51.06

Table 3: Mean values ±SD of the physico-chemical parameters of the brackish and freshwater

Parameters	Brackishwater	Freshwater	WHO[d]	Standards
Temp (^{0}C)	27.77±0.17	28.00±0.18	-	23-35[a]
pH	7.12±0.01*	6.23±0.03	6-9.5	6.5-9[a]
TDS (mg/L)	2657.00±24.00*	19.84±0.40	1500	2000[c]
TSS (mg/L)	506.55±9.26*	9.90±0.14	50	30[a]
Salinity (mg/L)	6269.95±67.25*	7.19±0.04	-	
DO (mg/L)	6.34±0.06	6.09±0.01*	-	
BOD (mg/L)	17.53±0.11	19.99±0.02	100>4	50[c]
COD (mg/L)	59.18±0.04*	51.06±0.20	-	

***The mean difference is significant at the 0.05 level.**

Moreover, there were significant differences ($p < 0.05$) in pH TDS, TSS and salinity when values from both water bodies were compared, having a mean value of 7.12±0.01, 2657.00±24.04mg/L, 506.55±0.40mg/L, 9.90±0.14mg/L and 7.19±0.04mg/L respectively for freshwater. Also, there were statistical differences ($p > 0.05$) in DO, BOD and COD when values from both water bodies were compared. The brackish water had a higher mean value relative to DO and COD (mean 6.34±0.06mg/L) and 59.18±0.04mg/L) respectively, compared to freshwater. On the other hand, mean BOD was higher in freshwater (19.99±0.02mg/L) than in brackish water (17.53±0.11mg/L) (Table 1). The amount of solids in suspension also affects the rate of oxygen dissolution (Olorode *et al*, 2015). Total dissolved solids (TDS) value obtained followed same increasing trend with total suspended solids (TSS) in the brackish water compared to freshwater.

The significantly high TDS and TSS of the brackish water ($p < 0.05$) are implicative of high level of pollution of brackish water when compared to fresh water, relative to WHO standards which recommends 1500mg/L and 500mg/L for TDS and TSS respectively, while FEPA recommends a maximum of 2000mg/L for surface waters.

Dissolved oxygen (DO) is an inevitable water quality parameter and is the recommended minimal value for domestic use and to maintain good fish population is 5µg/L of higher nutrient contents from industrial effluent, abattoir waste, waste from Choba market, agricultural activities due to microbial action and higher consumption of DO, compared to the brackish water.

The biochemical oxygen demand (BOD) values in freshwater were high compared to the brackish water implying that oxygen levels were more deficient due to microbial load which employ oxygen to breakdown organic matter thereby depleting oxygen level in the former than in the latter. The mean BOD from both water bodies were within limits of WHO (2006) and FEPA (1991).

Comparison of the results to WHO and other standards desirable limit in drinking water shows that although pH was tantamount in both water bodies, other parameters such as TDS, TSS, salinity, COD, etc. were higher in the brackish water than in the freshwater.

Finally, the need to carry out comprehensive environmental impact assessment studies before the commencement of any major developmental project is stressed. In the light of this, careful measures should be adopted with regards to environmental pollution inputs because of their potential and direct impacts on the ecosystem which indirectly impact on humans.

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