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Spatial and Seasonal Variation in Physico- chemical Quality of Ikoli Creek, Niger Delta, Nigeria

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Spatial and Seasonal Variation in Physico-chemical Quality of Ikoli Creek, Niger Delta, Nigeria

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ABSTRACT

This study assessed the Spatial and seasonal variation in Physico-chemical quality of Ikoli creek, Niger Delta, Nigeria. Triplicate samples were obtained from 5 locations for a two seasons viz; March and June, 2014. The water samples were analyzed following standard methods. Mean seasonality results for dry and wet were 27.47 and 27.33 °C (temperature), 6.78 and 7.102 (pH), 27.766 and 42.738 µS/cm (conductivity), 45.492 and 29.354 NTU (turbidity), 7.298 and 23.868 mg/l (total dissolved solid), 24.45 and 10.712mg/l (biological oxygen demand), 5.734 and 7.558 (dissolved oxygen), 0.066 and 0.072 mg/l (nitrite), 0.114 and 0.112 mg/l (nitrate), 3.14 and 3.088 mg/l (chloride), 4.354 and 4.336 mg/l (sulphate), 2.234 and 2.634 mg/l (calcium), 1.888 and 2.576 mg/l (potassium), 3.638 and 4.066 mg/l (sodium) and 1.348 and 1.732 mg/l (magnesium) respectively. There was significance difference ($P < 0.05$) in most parameters for spatial distribution as well as seasonality. The study showed that season affect physico-chemical quality of Ikoli creek. Anthropogenic activities in the creek could affect the physico-chemical quality of water. This could be the reason while there was variation based on spatial distribution

Keywords: Bayelsa state, Ikoli Creek, Water quality

INTRODUCTION

Several surface water found in the Niger Delta region of Nigeria including rivers, ponds, lakes, streams, creeks, creeklets (Agedah et al., 2015; Izah and Ineyougha, 2015; Izah and Srivastav, 2015; Izah et al., 2016; Ogamba et al., 2015a). Different categories of wastes stream (solid, effluents, sewage) are deposited in most surface water in coastal communities in the Niger Delta especially Bayelsa state (Ogamba et al., 2015a). Most of this wastes are generated in various section including hospital, market, house hold (Angaye et al., 2015). Some are discarded close to surface water which is washed into the surface water after rainfall via runoff. Other material that could be discharged into the surface water when they are indiscriminately applied in agricultural field or home close to surface water is pesticides (herbicides, insecticides, fungicides, rodenticides etc) (Inyang et al., 2016a-c). Food processing wastes such as oil palm processing (Izah et al., 2016b), cassava processing could contaminate surface water. These activities on the surface water could affect the water quality including microbial density and diversity, heavy metals, oxygen related parameter and general physicochemical properties (Ogamba et al., 2015a,b,c; Izah and Ineyougha, 2015).

Bayelsa state lies in the sedimentary basin and fishing is a major source of livelihood to several families (Ohimain *et al.*, 2009), especially the once aligning the coastal communities. Furthermore, several economic activities are carried out in the water ways including navigation and water transportation of humans and other agricultural produce, timber for construction works etc. The activities in the water could have impact on water quality as well. This is because most wastes discharge into surface water (directly or indirectly) contains high solid materials (including suspended and dissolved solid), organics and oil and grease.

The usefulness of water to biodiversity including plants, animals, microbes, human is enormous. Water is a major part of most biological resources. Water is also a home to several life forms including fisheries, aquatic mammals and reptiles, aquatic plants (macrophytes), plankton (phytoplankton and zooplankton), benthic organisms (Izah and Srivastav, 2015). Several types of water bodies including estuarine, marine and freshwater are found in

large volumes and the organisms that thrive in each type is differs depending on their adaption strategies/mechanisms.

Like groundwater and rainwater, fresh surface water is a source of potable water to several families in Nigeria especially in rural area or communities that groundwater is not readily available (Izah et al., 2015, 2016a; Izah and Ineyougha, 2015; Izah and Izah and Srivastav, 2015). Surface water is also used for domestic activities like cooking, washing bathing etc.

Several studies have been carried out in groundwater resources in Bayelsa state including Yenagoa metropolis (Nkamare et al., 2012; Ohimain et al., 2013; Agbalagba et al., 2011; Amangabara and Ejenma, 2012; Oborie and Nwankwoala, 2014; Nwankwoala et al., 2014 ; Okiongbo and Douglas, 2013), surface water including river nun (Agedah et al., 2015; Ogamba et al., 2015b), Kolo creek (Ogamba et al., 2015c), Igbedi creek (Seiyabog et al., 2013), Taylor creek and Nun River (Daka et al., 2014), Sagbama creek (Seiyaboh et al., 2017), Epie creek (Izonfuo and Benwari, 2001).

However, information about Ikoli creek around abattoir area has been previously reported by Ogamba et al. (2015a). As such, this present study focus on spatial and seasonal variation in Physico-chemical quality of the creek. The physicochemical quality of the creek water was compared with Nigeria drinking water quality standard, 2007.

MATERIALS AND METHODS

2.1 Study Area

The Niger Delta has several creeks, a tributary of major rivers. In Bayelsa state for instance, several creek emanated from Nun river. Ikoli creek is one of the tributaries of Nun River that passes through Yenagoa, the Bayelsa state capital. The economic activities and climatic condition of the area have been previously described by Seiyaboh et al. (2016), Ogamba et al. (2015a), Ogamba et al. (2016).

2.2 Sampling Stations and Collection

Triplicate water samples were collected as subsurface (15-20cm depth) from five locations in March (dry season) and June (wet season) 2014. 1 litre containers was used for sample collection. The samples were labeled accordingly and transported to the laboratory for analysis.

2.3 Physicochemical and heavy metal analysis

The water quality parameters were analyzed in-situ viz: PH, conductivity, temperature, turbidity, total dissolved solid, dissolved oxygen using probes and ex-situ including biological oxygen demand, nitrite, nitrate, chloride, sulphate, calcium, potassium, magnesium, sodium using the method previously described by APHA (1975), Ademoroti (1996).

2.4 Statistical Analysis

SPSS was used to carry out the statistical analysis. Data were expressed as mean. One way analysis of variance was used to show significance difference ($P=0.05$) for spatial distribution. Duncan statistics was used for mean separation; and t-test was used for seasonal variation at $P=0.05$.

3.0 RESULTS AND DISCUSSION

Table 1 and 2 presents spatial and seasonal variation in physicochemical characteristics of water samples from Ikoli creek. Temperature ranged from 27.08 – 27.52°C being not significantly different ($P>0.05$) among the different location apart from location C. Based on seasons, mean temperature for dry and wet seasons were 27.47 and 27.33 °C, being not significantly different ($P>0.05$). Lack of variation in season suggest that water temperature of the area is not significantly affect by season. However, slight variation in spatial distribution could be associated to sampling period (Agedah et al., 2015). The findings of this study had some similarity with the work of Agedah et al. (2015) from some rivers around Wilberforce Island; Ogamba et al. (2015a) from Ikoli creek around abattoirs; Izonfuo and Bariweni (2001) from Epie creek. But higher than the values previously reported by Aghoghovwia and Ohimain (2014) from lower Kolo creek. The variation in temperature could be associated in sampling period. However, the values are within ambient temperature of the area.

The spatial distribution for pH of the water ranged from 6.97 – 7.01, being not significantly different ($P>0.05$) among the various location (Table 1). Furthermore, seasonal variation showed significant variation ($P<0.05$) between both seasons with mean value of 6.78 (dry season) and 7.10 (wet season). The variation in seasons could be due to

dilution factor in wet season of the creek. The pH of the water had some similarity with previous works in surface water including Epie creek (Izonfuo and Bariwari, 2001), Kolo creek (Ogamba et al., 2015c; Aghoghovwia and Ohimain, 2014), Igbedi creek (Seiyaboh et al., 2013), Ikoli creek close to abattoir (Ogamba et al., 2015a), Nun river and Taylor creek (Daka et al., 2014). The pH of the water is within the range of 6.5 – 8.5 for drinking water as specified by Standard Organization of Nigeria (SON, 2007; Agedah et al., 2015).

The conductivity of the water samples ranged from 35.70 – 39.06 $\mu\text{S}/\text{cm}$ (for spatial distribution) and mean value of 27.77 $\mu\text{S}/\text{cm}$ (dry season) and 42.74 $\mu\text{S}/\text{cm}$ (wet season). Basically there was significance difference ($P<0.05$) in location and seasons. Variation in conductivity could be due to difference in anthropogenic activities in the water at various location and seasons. The conductivity level observed in this study is lesser than the values previously reported in some surface water in Bayelsa including lower Kolo creek (Aghoghovwia and Ohimain, 2014; Ogamba et al., 2015c), Igbedi creek (Seiyaboh et al., 2013), Ikoli creek close to abattoir (Ogamba et al., 2015a), Efi lake (Angaye and Mieyepa, 2015), Nun river and Taylor creek (Daka et al., 2014). The conductivity surface water in the Bayelsa state is within the maximum permissible limit of 1000 $\mu\text{S}/\text{cm}$ for potable water sources.

Turbidity of the water samples ranged from 32.20 – 39.06 NTU (for spatial distribution) and mean value of 45.49 NTU (dry season) and 29.35 NTU (wet season) for seasonal variation. Typically, there was significance variation ($P<0.05$) in location and seasons. Differences could be due to effect or runoff after rain fall in wet season, wastes discharged into the water, different anthropogenic activities in the creek and natural characteristics of the creek. Turbidity level is comparable to the values previously reported in surface water in Nigeria including Epie creek (Izonfuo and Bariwari, 2001), Kolo creek (Aghoghovwia and Ohimain, 2014), Nun river (Ogamba et al., 2015b), Ikoli creek close to area abattoir wastes are discharged into (Ogamba et al., 2015a), but higher than values reported in some surface water including Igbedi creek (Seiyaboh et al., 2013). Variation in turbidity level of the creek depends on seasons and prevailing anthropogenic activities in the area. The turbidity has exceeded maximum allowable value of 5 NTU in drinking water as specified by SON (2007).

Total dissolved solid of the water samples ranged from 14.58 – 17.05 mg/l for spatial distribution and mean value of 7.29 mg/l (dry season) and 10.71 mg/l (wet season). There was significance variation ($P<0.05$) in location and seasons. Higher total dissolved solid during the wet season could be due to movement of materials found in the water. Again, overflows and dilution effects increases during wet season this could also be a reason while total dissolved solid is higher dry season (Agedah et al., 2015). The concentration reported in this study is lower than previous reported from surface water in Bayelsa state including Epie creek (Izonfuo and Bariwari, 2001), Igbedi creek (Seiyaboh et al., 2013), Kolo creek (Ogamba et al., 2015c; Aghoghovwia and Ohimain, 2014), Nun River and Taylor creek (Daka et al., 2014), some rivers around Wilberforce Island (Agedah et al., 2015), Ikoli creek close to area abattoir wastes are discharged into (Ogamba et al., 2015a). But comparable to the value reported in Nun River by Ogamba et al. (2015b). The total dissolved solid is lower than 500 mg/l recommended for potable water in Nigeria (SON, 2007). The differences could be due to the period of the study and prevailing anthropogenic activities.

Table 1: Spatial variation in Physico-chemical quality of Ikoli creek

Parameters	Locations				
	A	B	C	D	E
Temp. ($^{\circ}\text{C}$)	27.52 ^b	27.42 ^b	27.08 ^a	27.36 ^b	27.36 ^b
pH	6.99 ^a	7.01 ^a	7.01 ^a	6.99 ^a	6.97 ^a
Conductivity ($\mu\text{S}/\text{cm}$)	35.70 ^a	37.08 ^c	36.90 ^{bc}	36.28 ^{ab}	39.23 ^d
Turbidity (NTU)	38.70 ^c	37.57 ^c	33.97 ^b	32.20 ^a	39.06 ^c
TDS (mg/l)	17.05 ^c	15.12 ^{ab}	14.83 ^a	14.58 ^a	16.23 ^{bc}
DO (mg/l)	8.12 ^e	7.08 ^d	6.40 ^b	5.99 ^a	6.6 ^c
BOD (mg/l)	15.99 ^c	16.83 ^c	14.11 ^{ab}	12.36 ^a	15.91 ^{bc}
Nitrite (mg/l)	0.09 ^b	0.07 ^c	0.05 ^a	0.05 ^a	0.10 ^d
Nitrate (mg/l)	0.11 ^a	0.13 ^a	0.11 ^a	0.11 ^a	0.11 ^a
Chloride (mg/l)	3.42 ^{ab}	3.73 ^b	3.43 ^{ab}	2.73 ^a	2.88 ^a
Sulphate (mg/l)	2.85 ^a	4.26 ^b	4.81 ^{bc}	5.23 ^c	4.25 ^b
Sodium (mg/l)	2.84 ^a	4.40 ^c	4.22 ^c	4.22 ^c	3.58 ^b
Potassium (mg/l)	2.01 ^a	2.34 ^{ab}	2.41 ^b	2.35 ^{ab}	2.05 ^{ab}
Calcium (mg/l)	2.37 ^a	2.37 ^a	2.52 ^a	2.52 ^a	2.39 ^a
Magnesium (mg/l)	1.16 ^a	1.46 ^b	1.88 ^d	1.66 ^c	1.31 ^{ab}

Different letters as superscript across the row indicate significantly different ($P < 0.05$) according to Duncan statistics

Table 2: Seasonal variation physico-chemical characteristics of Ikoli creek, Niger Delta

Parameters	Dry season		Wet season		t-value	p-value	Statistical implications
	Mean	Range	Mean	Range			
Temp. (°C)	27.474	27.30 – 27.80	27.334	26.89 – 27.53	0.928	0.380	NSD
Ph	6.78	6.72 – 6.86	7.102	6.72-7.27	-3.085	0.015	SD
Conductivity (µS/cm)	27.766	25.87-28.57	42.738	27.93 - 49.90	-3.895	0.005	SD
Turbidity (NTU)	45.492	37.73- 50.42	29.354	26.67 - 37.73	4.975	0.001	SD
TDS (mg/l)	7.298	6.83 - 7.40	23.868	23.10- 25.67	-23.754	0.000	SD
BOD (mg/l)	24.45	21.53 - 26.37	10.712	6.80- 25.01	3.747	0.006	SD
DO (mg/l)	5.734	5.31- 6.63	7.558	5.45 - 9.60	-2.36	0.046	SD
Nitrite (mg/l)	0.066	0.01 - 0.09	0.072	0.02 - 0.10	-0.3	0.772	NSD
Nitrate (mg/l)	0.114	0.09- 0.13	0.112	0.09 - 0.14	0.183	0.86	NSD
Chloride (mg/l)	3.14	2.60 - 4.10	3.088	2.60 - 3.56	0.163	0.874	NSD
Sulphate (mg/l)	4.354	2.65 – 5.43	4.336	3.04 - 5.59	0.027	0.979	NSD
Sodium (mg/l)	3.638	2.57 - 4.20	4.066	3.11 - 4.60	-1.027	0.335	NSD
Potassium (mg/l)	1.888	1.68 - 2.22	2.576	2.38 - 2.67	-4.836	0.001	SD
Calcium (mg/l)	2.234	2.11 - 2.53	2.634	2.51 - 2.59	-3.761	0.006	SD
Magnesium (mg/l)	1.348	1.10 - 1.67	1.732	1.38 - 2.08	-2.362	0.046	SD

NSD- Not Significantly different, SD = Significantly different

Biological oxygen demand and dissolve oxygen concentration ranged from 12.36 – 16.83 mg/l and 5.99 – 8.12mg/l respectively for spatial distribution, and mean of 24.45 and 5.73mg/l respectively (dry season) and 10.71 and 7.56mg/l respectively (wet season). Basically there was significance variation ($P < 0.05$) in location and seasons for both parameter. The concentration observed in this study for dissolved oxygen is slightly lower than the concentration reported by Agedah et al. (2015) from surface water around Wilberforce Island. Dissolved oxygen is close to the work of Daka et al. (2014) from Nun River and Taylor creek. The concentration of dissolved oxygen is comparable, while biological oxygen demand has higher than the level previously reported in Kolo creek by Aghoghovwia and Ohimain (2014). But higher than the concentration reported by Seiyaboh et al. (2013) from Igbedi creek; Izonfuo and Benwari (2001) from Epie creek for both dissolved oxygen and biological oxygen demand. The variation could be due differences in the characteristics of the various water bodies and prevailing condition close to the area. Also different in sampling period could also contribute to variation in dissolved oxygen of the water. This is because dissolved oxygen of water is usually in order: morning or night > afternoon (Ezekiel et al., 2011).

The anions concentration of the water including nitrite, nitrate, chloride, sulphate ranged from 0.05 – 0.10mg/l, 0.11 – 0.13mg/l, 2.73 – 3.73mg/l and 2.85 – 5.23mg/l respectively for spatial variation and mean of 0.07, 0.11, 3.14 and 4.35 mg/l for dry season respectively and 0.07, 0.11, 3.09 and 4.34mg/l for wet season respectively. No significance variation ($P > 0.05$) between most of the location for all the parameters. However, there was no significance difference ($P > 0.05$) between different seasons. Lack of variation suggests that anion concentration in the water is not significantly affected by season. The concentration of anion observed in this study is far from the work of Seiyaboh et al. (2013) apart from nitrite. Daka et al. (2014) reported chloride and nitrate concentration not comparable to the findings of this study from Nun River and Taylor creek. Ogamba et al. (2015b) reported higher concentration of sulphate and chloride and lower level of nitrate in water samples from Nun River. Ogamba et al. (2015c) reported higher concentration of sulphate and chloride and comparable level of nitrate in water samples from Kolo creek. Chloride and nitrate concentration have similarity with the values previously reported in abattoir area of the creek as reported by Ogamba et al. (2015a). Izonfuo and Bariweni (2001) reported nitrate and chloride concentration in Epie creek which is comparable to the results of this study. The variation in this study from previous work could be associated to differences in characteristics of the water and its sediment. However, the anions concentration were within the maximum permissible limit of 50mg/l (nitrate), 0.2mg/l (nitrite), 100mg/l (sulphate) and 250mg/l (chloride) as specified by SON (2007).

The cation concentration of the water including sodium, potassium, calcium and magnesium ranged from 2.84 – 4.40mg/l, 2.01 – 2.41 mg/l, 2.37 – 2.52 mg/l and 21.16 – 1.88 mg/l respectively for spatial variation and mean

of 3.64, 1.89, 2.23 and 1.35mg/l for dry season respectively and 0.07, 0.11, 3.09 and 4.34mg/l for wet season respectively. Sodium concentration showed significant difference ($P < 0.05$) for spatial distribution and no significant variation ($P > 0.05$) among both seasons. Calcium and potassium showed no significance difference ($P > 0.05$) for

spatial distribution, but they are significantly different ($P < 0.05$) based on seasons. No significance variation ($P > 0.05$) between most of the location for all the parameters. However, there was no significance difference ($P > 0.05$) between various seasons. Like most anions, cations appear not to have been impacted by seasons. Difference in spatial distribution could be due to difference anthropogenic activities close to sampling locations. The concentration reported in this study for the various cations were higher than the values previously reported in Kolo creek (Ogamba et al. 2015c), Nun river (Ogamba et al., 2015b). Furthermore, Izonfuo and Bariweni (2011) reported higher calcium and magnesium and comparable sodium and potassium in Epie creek. Cation were within permissible limit 200mg/l (sodium), and higher than limit of 0.2mg/l (magnesium) specified by SON (2007). Higher magnesium in water could result to poor acceptability by users.

CONCLUSION

Water is an essential resources need by living things including human. This study was designed to evaluate spatial and seasonal variation in Physico-chemical quality of water from Ikoli creek, Bayelsa state, Nigeria. The study found that there is significant variation ($P < 0.05$) between both seasons with regard to pH, conductivity, turbidity, total dissolved solid, dissolved oxygen, biological oxygen demand, potassium, calcium and magnesium concentration. Differences also exist based on locations. The water parameters were within the value recommended for potable water in Nigeria as specified by SON except turbidity and biological oxygen demand. As such we conclude that the water is unfit for drinking based on parameters assessed. Hence, there need to the treat the water prior to consumption and for other domestic purposes such as washing and cooking.

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