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Physicochemical Properties of Surface Water from Ogbia Axis of Kolo Creek, Bayelsa State, Nigeria

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Abstract Surface water samples were collected from three stations along the Ogbia axis of Kolo Creek and were evaluated for physical and chemical properties. The observed mean values from the analysis of the water samples were; electrical conductivity 38.05±5.01 µS/cm, turbidity 11.87±0.99 NTU, total dissolved solids 17.08±0.78 mg/L, total suspended solids 7.19±1.76 mg/L, pH 5.67±0.24, salinity 26.57±1.03 mg/L, chloride 16.67±0.57 mg/L, nitrate 9.89±2.29 mg/L, sulphate 69.71±57.53 mg/L, phosphate 4.16±5.19 mg/L, dissolved oxygen 5.88±0.17mg/L, chemical oxygen demand 24.03±21.94 mg/L and biochemical oxygen demand 9.11±5.13mg/L. All the examined physiochemical parameters across the stations except pH, turbidity, dissolved oxygen and biochemical oxygen demand were within the permissible limit by WHO. The result indicated that the quality of the creek water has been compromised and as such not suitable for human consumption.

Keywords Physico-chemical parameters, pollution, surface water, freshwater, creek.

Introduction

The Kolo Creek in Bayelsa State, Nigeria is a non-tidal fresh water body that empties into the River Nun. This creek is connected by several small lakes which are either artificial ornatural, including ponds, borrow pits and tributaries that run into it. This region is known for its large fresh water swamps and tropical rain forest. It is encompassed by so many oil fields, which are connected to the Kolo Creek flow station along the creek. There was also a power generating plant known as Kolo Creek gas turbine, although not functional at the moment in between the flow station. Hence, it evidential that these industrial operations discharge their effluents into the creek. This creek serves as the major source of drinking water to it's the indigenes, irrigations for plants, watering of animals and other forms of aquatic lives for the rural dwellers.

Water play a central role in the lives of all organisms. However, the quality water and its conservation is particularly precarious for human survival. Over 71% of earth's surface is covered by water. Thus, water is unevenly distributed among aquatic environments. Mostly is the sea water. The ocean contain over 97% of water that make up the biosphere and the polar ice caps and glaciers contain an additional 2% and 1% is fresh water in rivers, stream and creeks, which actively exchanged ground water from waste generated such as agriculture, domestic, industrial and natural sources. All these forms are very important in life cycle [1-3].

The adulteration of surface water could also be attributed to the nature of its surrounding water bodies [4]. The measure of quality water does not solely lie on its intake by human alone, but rather, suitable for other important anthropogenic and recreational activities [2]. The basic purpose for monitoring the quality of water is imperative, both as a medium to check its current state and as an instrument for managing good policy implementation. Hence, a comprehensive evaluation or investigation of water imply the examination of all the required constituents such as biological, chemical and physical properties of the said surface water in comparison to set standards, which could be natural or man-made for a specific purpose [5].

Even with a deep insight to the fact that water pollution or contamination is a global pandemic, yet the nature of water pollution varies, depending on the developmental stage of the place under investigation. Likewise, countries or regions with fast growing population without good waste management are prone to generate much more waste product that will constitute nuisance within its environment than those countries with smaller population growth rate, that are practicing good waste management skills [6].

Thus, anthropogenic activities is constantly doing two things, polluting or degrading the earth's surface. These coupled with the concurrent yearly rise of flood water across all low land, river banks and creeks of the Niger Delta region of Nigeria, there is the possibility of the area being prone to drift of stream organisms out to sea if not properly checked. As a result, these changes pose untold danger to streams, creeks and rivers and aquatic organisms that dwell in them. Added to these also is the continuous oil exploitation and maintenance activities being carried out at Imiringi sub-station and its environs which may likely pile up wastes that would in turn affect these areas.

Therefore, the need to evaluate and constantly monitor the Kolo Creek for effective for optimum utility, better living and working condition of all and sundry.

Materials and Methods

Sample collection: Surface water samples were collected from Kolo Creek from three stations namely; Imiringi (station 1) Emeyal (station 2) and Otuabagi(station 3) from a depth of 10-15cm under water using glass bottles. The bottles were instantly corked and kept in a cooler filled with ice. The samples were immediately moved to the laboratory for analysis.

Analysis of samples: Standard analytical procedures were used to determine the selected physical and chemical properties of water. The examined physicochemical parameters were; pH, salinity, chloride, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), nitrate, sulphate, phosphate, electrical conductivity, turbidity, total dissolved solids (TDS) and total suspended solids (TSS). The pH of the samples were measured using portable meter [7]. Turbidity and total suspended solids was analyzed using the method of Dirican [8]. A turbidity meter (HACH model 2100An) was used to measure the turbidity. Electrical conductivity was analyzed with conductivity meter. Nitrate was measured using the method of Cheesbrough [9]. Phosphate and sulphate were analyzed using APHA (1985) method [10].

Dissolved oxygen (DO), biochemical oxygen demand and chemical oxygen demand were analyzed using the modified Winkler-azide method [10] whereas, chloride was analyzed using DPD colorimeter.

Results and Discussion

The results of the water physical parametersof surface water from Kolo Creek along the Ogbia axis are given in Table 1.

Table 1: Physical parameters of surface water samples from Different stations inKolo Creek

Physical Parameters	**Stations**				
	Imiringi	**Emeyal 1**	**Otuabagi**	**Mean±SD**	**WHO standard**
Electrical conductivity (µS/cm)	35.76	45.00	33.40	38.05±5.01	5000
Turbidity (NTU)	12.3	12.81	10.50	11.87±0.99	5
TDS (mg/L)	18	17.13	16.10	17.08±0.78	2,000
TSS (mg/L)	4.72	8.16	8.70	7.19±1.76	30

Electrical Conductivity

The electrical conductivity of the water varied from 33.40 – 45.00 µS/cm and a mean value of 38.05±5.01µS/cm. The observed value from all the stations in the creek were lower than the 2500 - 5000 µS/cm stipulated guideline by WHO. Water capability to conduct electrical current is known as electrical conductivity. It serve as a tool that is used to assess water purity. This behaviour solely depends on the presence of ions, their total concentration, temperature measurement, valence, mobility and relative concentration. Low experimental values of electrical conductivity observed in the creek indicates low content of inorganic ions in the water [11]. According to Suthar et al. [12], electrical conductivity is increased in water as a result of disposal of sewage which contains salts and ions at elevated concentrations [12]. Agricultural wastes from farms and runoffs from loosened soils also contribute to increased water conductance [13]. At very high values of electrical conductivity, aquatic species are subject to serious that may lead to physiological imbalance and death [11].

Turbidity

Turbidity values obtained in water from Kolo varied from 10.5 - 12.81 NTU and a mean value of 11.87±0.99 NTU. The values observed for turbidity in the present work are higher than the 5.0 NTU permissible limit by WHO standard. Turbidity measures the obscurity or opacity of a solution. The turbidity of water could be as a result of the presence of colloidal and fine particles dispersed in water. The major impediment cause by turbidity is the prevention light penetration, which causes deleterious effect on aquatic flora and fauna and thereby depreciation of water quality [14].

Increased water turbidity is associated with change in the colour of the water and accompanied with odour and taste [15]. High turbidity of water affects optical characteristics negatively, which consequent on cost implications of water treatment due to the quantity of flocculants required to make the water clear [16]. The greater the value of turbidity, the likelihood of high levels of disease causing microbes in the water. Therefore, increased turbidity can be used to predict the presence of elevated levels of bacteria [17].

Total Dissolved Solids (TDS)

The amount of total dissolved solids observed in the creek ranged from 16.1 - 18.0 mg/L. The mean value for the creek was 17.08±0.78 mg/L. Values of TDS in an aquatic environment underscores the concentration of ions present in a given water medium whose sizes may be lesser than 2 microns. It is a measure of organic matter, inorganic salts and must materials found in water solution, be it ground or surface water [18].

When total dissolved solids (TDS) concentrations in water is high, it may not necessarily poses health risk since TDS is a subordinate requirement for consumable water. However, it presents more of visual role relative to that of a threat to well-being [19]. An elevated TDS value may possibly be an indication of the presence of dissolved ions which has the potential to cause water saltiness, brackish taste and corrosivity. These characteristics, results in the formation of scale and cause a decrease water heater performance [20]. Undue intake of water laden with dissolved solids by the human populace can lead to health issues such assoreness, impairment of the brain and faintness.

Total Suspended Solids (TSS)

The results of total suspended solids in the creek ranged from 4.72 - 8.16mg/L. the observed mean value of TSS was 7.19±1.76 mg/L. The amount of TSS in water is directly proportional to turbidity of the water [21].

Certain human activities increases the amount of particles that can possibly remain on the water surface. Such factors or activities include loosening of soil due to erosion and runoffs into water bodies, excavation, road construction, mining, land slide, land tilling, building of houses, and the season [21], but natural caused increase of suspended particles in water results from re-suspension sediment silt particles due to turbulent flow of aquatic system and algae.

The results of some chemical parameters in surface water from Kolo Creek along the Ogbia axis is given in Table 2.

Table 2: Chemical parameters of surface water samples from different stations in Kolo Creek

Chemical parameters	**Stations**				
	Imiringi	**Emeyal 1**	**Otuabagi**	**Mean±SD**	**WHO standard**
pH	5.34	5.76	5.90	5.67±0.24	6.5-8.5
Salinity (mg/L)	25.70	28.01	26.00	26.57±1.03	600
Chloride (mg/L)	16.00	17.40	16.60	16.67±0.57	250 - 500
Nitrate (mg/L)	9.67	12.80	7.20	9.89±2.29	50
Sulphate (mg/L)	47.00	148.72	13.40	69.71±57.53	400
Phosphate (mg/L)	0.42	0.57	11.50	4.16±5.19	5.0

pH

The pH in water samples from the three stations ranged from of 5.3 - 5.9. The mean value of pH along the creek was 5.67±0.24. The values obtained is lower than the permissible limit of WHO which ranges from 6.5-8.5, thereby making the water unfit for human consumption.

When the pH of any aquatic water body falls to values as low as 5.5 and below, aquatic organisms dwelling there are most likely at risk [22]. It therefore follows that this creek may not be good for water organism since the pH level at some of the points are very low. Principally, the pH is resolved by the quantity of carbon dioxide that may have dissolved in it, which reacts to forms carbonic acid and thereby increasing the acidity of the water [23]. Other factors that may influence the pH of water include the presence of organic acids, which are occasioned by decaying plants and dissolution of minerals containing sulphides [24]. However, high pH value can result from influx of fresh water and dilution from rain water [25]. Fluctuations in pH values in any water system due to discharge of unbalanced or not well treated effluents from industries [22].

Salinity

The value of salinity observed in the creek ranged between 25.7 - 28.01 mg/L. The salinity values observed were low when compound to the permissible limit given by WHO for drinking and Irrigation of farm lands and feeding of livestocks.

Salinity impacts on the density of water and could lead to water stratification. It affects the health and general wellbeing of natural aquatic vegetation and thereby cause death of animals and plants within a given ecological ecosystem. Salinity is a very important ecological factor in the sense that it affects the abundance and distribution of plants and animal species in water environment [26]. The low content of salinity in the creek is because of the time when sampling was done (being the rainy season). Rain water and influx of increased flooding affects the saline content of water, coupled with the fact that this a fresh water environment where the salinity value is expected to be very low naturally. This observation is similar to the findings of other authors in a similar water system [27-28].

Chloride

The result of chloride concentration in Kolo Creek ranged between 15.6 - 17.4 mg/L. The observed mean concentration of chlorides in the creek was 16.67±0.57 mg/L. The different stations values were all lower than the WHO required standard of 250 mg/L. Low chloride value in the creek is because of fresh water system, which is always associated with low chloride values except where industrial activities associated with chlorides discharge are going on.

The examination of chloride ion in water is very important because it affects the overall salinity of any water and provides information on pollution due to sewage discharge, industrial wastes and interference of seawater [29]. Individuals accustomed to elevated chloride content in water may occasionally suffer from purgative effects. Human faeces, urine, industrial wastes, and sewage discharge also contribute to chloride input in fresh water systems [30]. In natural waters, the occurrence of chloride is due to leakage of chloride from rocks and soils which contains chlorides, which come in contact with the water during the course of flow [31-32].

Nitrate

The concentrations of nitrates in the Kolo Creek varied from 7.20 - 12.80 mg/L with a mean value of 9.89±2.29 mg/L. These values were lower than the 50 mg/L guideline value of WHO. Nitrates are always present in water environments, but human factors or activities usually lead to their increased occurrence in water. The major contributing human activity that lead to increased nitrates in water is agricultural practices (fertilizers and livestock farming), which was followed by industrial discharges and effluents from sewage sludge. Compounds of nitrates are very soluble in water and are easily transported from one point to the other in the environment [15]. Nitrates in terrestrial environments, from fertilizers and wastes are easily transported to water surroundings such as streams, rivers, creeks and lakes by runoffs [33-34].

Human and animal excreta and wastewater of aquatic fish farms generally cause an increase in the concentrations of nitrate in the aquatic surroundings. This increase results from high ammonia content present in excreted waste, which through microbial interaction are converted to nitrate and nitrite. Nitrate is next to phosphate as a eutrophic agent at elevated concentration in a waterbodies. High levels of nitrates leads to oxygen depletion in water and with the resultant consequence of mortality of aquatic biomes. The mortality of aquatic plants and animals in the event of low oxygen content affects the nitrogen cycle and thus provides a more toxic environment, due to high presence of nitrite and ammonia in the water [12, 32].

Sulphate

The results observed for sulphate concentrations in the stations along the creek varied from13.4 - 148.72 mg/L. The mean values of sulphate in the creek was 69.71±57.53 mg/L. The observed value was lower than the WHO limit of 400 mg/L in drinking water. The presence of sulphate in water naturally come from leaching of gypsum containing rocks and other forms of minerals originating from sulphur. Wastes discharged from industries and residential quarters as well increases the amount of sulphate in water. When the level of sulphates in water is high and it is used for irrigation, it reduces the amount of availability phosphorus that plants will take up as nutrients [21].

Phosphate

The concentrations of phosphate from the Kolo Creek varied from 0.42 - 11.50 mg/L. The mean value observed from the stations was 4.16±5.19 mg/L. The value of 11.5 mg/L observed in station 3 Otabagiwas higher than the WHO value of 5.0 mg/L. This increase probable arose from influx of phosphate based fertilizers from farmlands carried by runoffs and also from direct discharge of wastes into the creek by the rural dwellers.

Phosphate could either be organic or inorganic form. It is readily present as free ion in water systems and serves as salt in land or soil environs [35]. Phosphate bound fertilizers used in agricultural farms is one of basic sources of phosphate in our surroundings. When used on farms, rain water could easily carried way, this waste into the nearby water bodies through runoffs. The high presences of phosphate in domestic water may cause muscle damage, kidney failure and effect breathing [36]. Hence excessive phosphate concentration in water bodies lead to eutrophication and reduction in the amount of dissolved oxygen in water [37-38].

Table 3: Gross organic pollutant parameters of surface water samples from different stations in Kolo Creek

Gross organic pollutants	**Stations**					
	Imiringi	**Emeyal 1**	**Otabagi**		**Mean±SD**	**WHO standard**
DO (mg/L)	5.83	6.11		5.71	5.88±0.17	10
COD (mg/L)	10.83	54.95	6.30		24.03±21.94	40
BOD (mg/L)	7.21	16.13	4.00		9.11±5.13	4

Dissolved Oxygen (DO)

Dissolved oxygen content of the water from Kolo Creek from the examined stations varied from 5.71 – 6.11 mg/L and the mean value was 5.88±0.17 mg/L. The observed values were lower than the WHO required limit for drinking water. Low dissolved oxygen content in water as observed in the present work typifies a water system where aquatic biomes are burden or stressed for lack of oxygen in the water. Low values of dissolved oxygen are caused by high temperature, amount of sewage and other waste present in the water, growth of aquatic plants covering the surface of the water and flow system of the water [14, 32]. The presence of aquatic plants interferes with photosynthetic and respiratory activities of plants and animals in water, which is consequent on the amount of oxygen produced and consumed by plants and animals dwelling in the water [22, 39].

Dissolved oxygen is a critical water quality parameter assessment index of physical and biological developments taking place in water which favors the solubility of oxygen [40]. Dissolved oxygen is important for survival of fishes and other water inhabiting organisms [41] and is responsible for the sustenance of several chemical reactions necessary for suitable water functions [42].

Chemical Oxygen Demand (COD)

Chemical Oxygen demand content of the water from Kolo Creek varied from 6.30 – 54.95 mg/L. The observed mean value was 24.03±21.94 mg/L. The value obtained at Emeyal 1 being 54.95 mg/L was higher than the

WHO value of 40.0 mg/L. COD defines the amount specified oxidant that can react with other chemical species in water. High COD content in water arises from the use of chemicals and it is also defined by the amount of oxygen required to oxidize both organic and inorganic matters present in a water sample.

When a strong oxidizing agent is present in water, almost all organic matter can be oxidized more especially under a predominant acid medium. It can be used to predict the concentration of organic in a given sample. It is an important water quality parameter in that it can be used to evaluate the level of pollution and toxicity of an aquatic environments. COD also examines the quantity of oxygen consumed in wastewater and alsothe magnitude of organic matter available [43-44].

Biochemical Oxygen Demand (BOD)

The Biochemical Oxygen Demanded content of the water samples from Kolo Creek varied from 7.21 - 16.13 mg/L. The observed mean value was 9.11±5.13 mg/L. All the values observed were higher than the WHO value of 4.0 mg/L except the value observed at Otabagi station. BOD is a function of the amount of oxygen essential for microorganisms to decompose organic matter present in wastewater in aerobic condition. An increase in the level of biochemical oxygen demand is due to organic matter present in water resulting from domestic waste, livestock and industrial waste that contains elevated levels of organic pollutants [45].

Conclusion

The findings of the present study on physicochemical parameters of Kolo Creek along the Ogbia axis established that the water is slightly contaminated. The contamination probably originated from domestic discharges of organic waste and dumping of solid waste into the creek and secondly from artisanal refining of crude around the area, which might have caused increase in turbidity values. Therefore efforts should be geared at curbing the sources of pollution to forestall future ecological problems.

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