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Physicochemical parameters of water samples from taylor creek between Edagberi–Better land axis, rivers state, Niger delta, Nigeria

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Abstract

The concept of pollution is phenomenon that is widely distributed all over the world and has required the involvement of both public and individual efforts to bring about a lasting solution to its continuous growth. Water samples were collected from Taylor Creek between Edagberi and Betterland axis of the Creek. The water samples were analyzed for physicochemical parameters at different stations bimonthly using standard procedures. The result of the variables showed that conductivity and temperature were highest in station 2, salinity was highest in station 1, while total suspended solids (TSS) and total dissolved solids (TDS) were highest in station 4 and turbidity was highest in station 3. Bimonthly observation showed that conductivity was highest in December, TDS and TSS were in June, salinity in February and temperature in August. Te examined values of pH were highest in station 4 and June, those of Chloride (Cl-) were highest in station 2 and February, nitrate (NO_3^-) was highest in station 3 and February, sulphate (SO_3^{2-}) was highest in station 2 and February and phosphate (PO_4^{3-}) was highest in station 4 and April. The values of dissolved oxygen (DO) was highest in station 2 and December, biochemical oxygen demand (BOD) was highest in station 1 and October and chemical oxygen demand was highest in station 3 and February.All the parameters examined were within the WHO requirement for domestic water use except BOD, turbidity that were above the requirements. However, COD and (PO_4^{3-}) that were either lower or higher than the standard requirement. The result showed a water body that has been affected by human interferences and may not be fit for consumption.

Keywords: physicochemical parameters, pollution, environment, taylor creek, water

Introduction

Pollution problems is an issue that has been given serious attention over the years. Efforts aimed at reducing the contamination or pollution of the environment has yielded little or no success. This due to the fact that the continues quest for development and activities to meet both individual and national needs is on the increase. Humans while searching for better ways of life has introduced different chemicals or substances into the environment. Thus interfering with the natural content of such environment. This interference has caused a change to the physical, chemical and biological nature of the environment (Etimand Onianwa, 2013). Every environment has its natural implication and application, therefore, when polluted will render them unfit to be applied for itsoriginal purposes and their application also is hindered. This is because in most cases, they become harmful to the users, which is a result of quality change and variations in the original concentrations of the constituent (Uzoekwe and Oghosanine, 2011) [29]. Pollution induces stress to plants and animals inhabiting that environmentwhich, then call for necessary actions to assess and the environment as to proffer methods to put itunder control (Omoregie *et al*., 1997) [21].

Urban drift and industrialization is associated with population growth, with attendant rise in waste production and thus giving rise to water pollution (Ekaete *et al*., 2015) [9]. The need to take care of the ever increasing population has necessitated increased agricultural activities which have also contributed to water pollution or contamination (William *et al*., 2010) [30]. One importance of water is the transportation of waste products which contains both organic and inorganic based substances. These substances got to the water or river channels through runoffs from farms and industries and precipitation from air through rain and some other natural channels.

There is the need to prevent water resources from destruction and deterioration which are occasion by agronomic, extraction, manufacturing and all practicesthat lead to their contamination or pollution and influence destructively on ground and surface aquatic environment (Iyama *et al*., 2014; Brraich and Jangu, 2015) [12, 14, 4]. These negative influences on the aquatic system (biotic or abiotic) is a consequence of waste discharge from effluence through natural or anthropogenic sources. Discharged wastes (which in most cases are not treated) from whichever sources comprises of diversesubstance which have the ability to alter the environmental chemistry or biochemistry (Adewuyi and Olowu, 2012) [2].

This study was undertaken to assess the physicochemical parameters of water from Taylor Creek.

Materials and Methods

Sample collection

Before sampling, the bottles were washed and dried. At the sampling point, the containers were initially rinsed with the water to be sampled and then sampling was done. Water samples were collected at intervals of two months for a period of one year.The samples were collected with glass bottles at a depth of 10 cm below the water surface and well corked. The samples were immediately transferred into ice chest containers maintained at iced conditions and immediately transferred to the laboratory and kept preserved at a temperature of 4°C.

The measurements of pH, conductivity and TDS were done on the spot of sampling using HANNA pH meter (Model: HI 98129, Hanna Instruments, California, USA). Turbidity wasanalyzed insitu with a portable meter (HARCH, Model 2100An) and salinity determined with an alphanumericdigital meter. The APHA (1995) method was used to determine TSS.Temperature was measured on site with a mercurythermometer. DO was measured on site with DO meter, while BOD was measured with DO equipment after keeping the sample in the dark for five days.The contents of the anions; chloride, phosphate, nitrate and sulphate and COD were determined using standard methods for analysis of water and wastewater (APHA, 1995) using HACH spectrophotometer instrument model No.3900 DR USA

Results and Discussion

The values of the physical parameters in the water samples in the stations and months is given in Tables 1 and 2. The variation of the electrical conductivity of the water in the stations ranged from 36.62 ± 5.81 – 41.03 ± 4.86 µS/cm, while those of the sampled months varied from 27.16 ± 4.93 – 66.29± 11.15 µS/cm. Conductivity or electrical conductivity measures the capacity of a medium to transfer electrical current. This capacity is enhanced by the amount of ionic species present. These species are the carriers of electrical current in the medium (Rahmanian *et al*., 2015) [25]. The conductance of any water or aquatic medium is enhanced by the presence of dissolved solids like Ca, Cl, and Mg. The requirement of electrical conductivity in water for consumption is put within the range of 500-1000μS/cm. Although Conductivity may not have been identified to have any direct health implications on humans yet it did give information on the mineral content of the water, and thus give vital information on the treatment techniques required for the water. Further to this, lies the fact that high conductivity in water add taste to water, enhances corrosion of metallic surfaces and reduces aquatic plant species (Edori and Nna, 2018) [8].

The values obtained for TDS in the present work in the different stations examined varied from 21.47 ± 4.83 - 24.84 ± 3.67 mg/L. In the sampled months, the values varied between 15.34 ± 2.12 - 38.55 ± 5.12 mg/L. The observed values of TDS in the various stations is lower than the WHO value of 1000 mg/L for domestic water. This parameter reveals the amount of both inorganic and organic that is soluble in the water. The observed values of TDS in this work is very low when compared with those of Onojake *et al*., (2017) [22] in Bonny River, River State, Nigeria. The slightly higher values of TDS in the wet months might have resulted from surface runoffs from adjoining lands which may have carried more dissolved materials (Iyama and Edori, 2014) [12, 14]. The low conductivity values may not have effect on the taste of the water, but high TDS content in water cause deteriorating effect on plumbing equipment and appliances, especially those that require heat.

The values of salinity observed in the different stations in Taylor Creek varied from 12.02 ± 3.07 - 14.58 ± 3.44 mg/L, while within the months of examination, the values fall within the range of 8.50 ± 2.13 - 30.12 ± 4.11 mg/L. The observed range of salinity falls within the range expected in a fresh water system. The observation trend within the examined months showed higher values in the dry months as against the wet or rainy months which is attributable to seasonal effects and the volume of water within the period, which may have caused dilution effect. This observation is similar to the findings of Onojake *et al*., (2017) [22]. However, the observed values of salinity in this creek is very low when compared with the those of Onojake *et al*., (2017) [22] in Bonny River. Salinity of any aquatic environment is not just the presence of NaCl, but a function of combined effect of the salts of chlorides, carbonates, sulphates, bicarbonates and nitrates of Na, K, Ca, and Mg.

The range of values of Total Suspended Solids (TSS) observed in the present work in the stations varied from 13.97±3.66 – 15.71±3.97 mg/L, while in the sampled months the range fall within 11.36 ± 1.33 - 18.00 ± 2.93. This value is low when compared with the 500mg/l requirement stipulated by WHO for drinking water. The slightly higher values observed during the wet months is an indication of increased input sources from over flown streams within the area. The values obtained in this river is lower than those observed in a river in Nairobi, Kenya by Dulo, (2008) [6] and NPA and Ekpan River (Nduka *et al*., 2008) [20], but within the range observed in Ubeji, Agbaro, Udu, Markava, Aladja and Otikutu Rivers in Delta State, Nigeria (Nduka *et al*., 2008) [20].

TSS are generally solid materials suspended on the water surface, they comprise of inorganic and organic substances like as clay and loam, silt, plant parts and some biological organisms (spirogyra) and thus cause distress to aquatic plants and animals (Kurnaz *et al*., 2016) [16]. When TSS concentrations in water is high, it prevents the penetration of light by absorbing it. This situation therefore, lead to alteration in the water quality conditions. The deterioration of the quality of water by TSS come from increased water temperature, which is a consequence of the absorbed light, which finally culminate in decreased oxygen presence in the water body (Lawson, 2011).

Turbidity values from this work in the different stations ranged from 8.99 ± 3.11-10.77 ± 2.61 NTU and in the months varied between 5.21 ± 1.15 - 12.51 ± 3.55 NTU. The range of turbidity observed in this work is higher than the 5 NTU recommended by WHO and those of Onojake *et al.*, (2017) [22] in Bonny River, Rivers State, Nigeria, but lower than those of Nduka *et al*., (2008) [20] in Warri River, but lo. The turbidity values observed in the study showed higher values in the wet months than the dry months. This variation or higher values in the wet season is in agreement with other studies (Iyama and Edori, 2014) [12, 14]. This is due to the effect of runoffs which wash surface soil into the water during rainy period. Turbidity measures the visibility or opacity of water. This is due to the presence of different particles in water. It also gives information on the presence of bacteria and other microbes in water. Turbidity influences the amount of light that is allowed to pass through the water, thus affecting the vision of aquatic animals and therefore consequent on their feeding habits. Turbidity can result from soil runoff, waste discharge and re-suspension of bottom sediment. Turbidity has been long known to hinder disinfection by shielding microbes, some of them perhaps pathogens (Nduka *et al*., 2008) [20].

The values obtained for temperature in the Taylor Creek ranged from 27.68 ± 1.11 - 28.13 ± 1.66 ºC in the stations. In the months of examination, the values fall within the range of 27.74 ± 0.31 - 28.17 ± 0.09 ºC. These values conform to acceptable requirements stipulated by WHO. This value is in agreement with the observation of other authors within the same environment (Edori and Nna, 2018) [8], but higher than the values of other authors elsewhere (Sujata *et al*., 2011; Kurnaz *et al*., 2013) [26].

Water temperature impacts organisms' biologicalfactors either directly or indirectly. When there is a change in the temperature of water, there results alteration in the physical and chemical properties of the water, which has a resultant effect organisms' physiological adaptation (Mushtaq *et al*., 2016; Edori and Nna, 2018) [19, 8]. Furthermore, temperature is used to assess ecological fitness of biotic and abiotic factors or components of water, which has direct effect on the normal functions and behavior of the ecosystem (Palamuleni and Akoth, 2015), and the availability of dissolved gases eg oxygen, whose concentration can pose mortal and growth consequences on water inhabiting animals and plants (Patil *et al*., 2012) [24].

Table 1: Physical Parameters of Water Samples from Taylor Creek at the Different Stations

Physical Parameters	Stations			
	1	2	3	4
Conductivity (µS/cm)	40.00 ± 7.82	41.03 ± 4.86	38.36 ± 5.92	36.62 ± 5.81
TDS (mg/L)	24.84 ± 3.67	22.61 ± 4.11	21.47 ± 4.83	33.18 ± 5.02
Salinity (mg/L)	14.58 ± 3.44	14.42 ± 2.51	12.02 ± 3.07	12.55 ± 2.66
TSS (mg/L)	14.88 ± 3.61	14.87 ± 2.53	13.97 ± 3.66	15.71 ± 3.97
Turbidity (NTU)	10.21 ± 1.34	9.69 ± 2.11	10.77 ± 2.61	8.99 ± 3.11
Temperature ºC	28.02 ± 1.26	28.13 ± 1.66	27.68 ± 1.11	27.88 ± 0.26

Table 2: Mean Monthly Variation of Physical Parameters of Water Samples from Taylor Creek

Physical Parameters	Months					
	December	February	April	June	August	October
Conductivity (µS/cm)	66.29 ± 11.15	55.82 ± 10.42	27.16 ± 4.93	29.62 ± 4.26	28.13 ± 3.22	29.04 ± 4.15
TDS (mg/L)	18.59 ± 3.00	15.34 ± 2.12	16.33 ± 2.11	38.42 ± 3.84	38.55 ± 5.12	32.91 ± 4.33
Salinity (mg/L)	10.13 ± 1.17	30.12 ± 4.11	13.61 ± 2.28	9.51 ± 1.53	8.50 ± 2.13	9.08 ± 1.66
TSS (mg/L)	13.52 ± 2.11	11.36 ± 1.33	13.45 ± 3.36	18.00 ± 2.93	17. 79 ± 3.41	15.09 ± 2.91
Turbidity (NTU)	5.21 ± 1.15	7.83 ± 1.89	10.53 ± 2.22	12.51 ± 3.55	12.09 ± 2.59	11.82 ±2.06
Temperature ºC	28.09 ± 1.43	28.07 ± 0.12	28.08 ± 1.00	27.64 ± 1.01	28.17 ± 0.09	27.74 ± 0.31

The result of the chemical parameters in the Taylor Creek is shown in Tables 3and 4. The pH values observed in the present work ranged from 6.92 ± 0.14 - 7.23 ± 0.33 in the stations, while in the months, the variation fell between 6.60 ± 1.53 -7.51 ± 1.26. The values observed for pH in the river fall within the recommended range for domestic water use by WHO. Station and monthly values did not show any significant variation during the study. Change in pH (either to higher or lower values) is a function of the amount of organic pollutants and domestic waste discharged into the river (Dulo, 2008) [6]. The values observed for pH in this work disagrees with the observation of Murhekar, (2011) [18] in Surface Water samples in and around Akot City, India whose values were within acidic range and were lower than the WHO limit and also disagrees with the findings of Dimowo, (2013) [5] in River Ogun, whose values were above the WHO limit for drinking water. Increased pH values which falls within the alkaline range is an indication of the presence of carbonates and bicarbonates in the water. For effective and normal life of aquatic animal, water pH value is expected to fall within the range of 6.5 and 8.5 (Kara and Gömlekçioğlu, 2004) [15].

The value of chloride ion (Cl^-) in the water samples from the stations varied between 7.52 ± 2.67 - 8.41 ± 2.15 mg/L in the station, while in the months of examination, the variation fell within the value range of 5.83 ± 1.24 - 17.06 ± 3.97 mg/L. There were significant variations in the months of analysis. The values of chloride within the period of examination were lower than the WHO limit of 250 – 500 mg/L. The observed variation in the concentration of chloride in the different stations and months in this study could be owing to diverse environment of different locations. The stations or months with higher chloride concentration may be ascribed to the existence of additional eutrophic condition when related to other stations and months. Factors such as closeness to thick and compact drifted gardens with frequent anthropoid activities disrupts the ecology through agricultural activities which include, runoff burdened by fertilizers, pesticides and herbicides and plant and animal based compost manure. Any surface water that excessively exposed to runoffs and sewage discharge has the potential to be contaminated with chloride (Mushtaq *et al*., 2016) [19].

The concentrations of nitrate in the different stations varied from 2.75 ± 0.91 - 3.20 ± 0.85 mg/L, while its values in the examined months varied from 0.64 ± 0.02 – 4.65 ± 1.03 mg/L. These values are lower than the expected value for drinking water as stipulated by WHO.

The ultimate product of nitrogenous organic matters is nitrate. Very high levels of nitratein superficial waters is adesignation of water pollution. The different sources of nitrate in any aquatic environment aredischarged wastewaters, organic nitrogen and the fertilizers used in farming or cultivation activities (Topal and Arslan Topal, 2012). Other sources of nitrates in water are leaching of nitrates as a result of water permeating through the soil profile and passing to the river, sewage discharge and wastes containing nitrates. It is documented that when the level of nitrates is high, up to4 mg/L and above in water environments, death of aquatic animalscan be experienced (Acu, 2000). Surface water contains nitrate due to leaching of nitrate with the percolating water.

The observed concentrations of Sulphates (SO_4^{2-}) in the water samples from Taylor Creek varied between the values of 0.89 ± 0.00 – 1.29 ± 0.11 mg/L in the stations, but the variations within the months of analysis fell between 0.67 ± 0.00 - 1.81 ± 0.01 mg/L. There were significant variations between stations and months. The values recorded in this work is lower than the WHO value of 50 mg/L for drinking water. One of the major sources of natural sulphate in water is the resultant percolation arising from gypsum and some other minerals which contains Sulphur compounds. The concentrations of sulphate in water is increased to warning and deleterious levels due to industrial discharges and sewage discharge from homes (Murhekar, 2011) [18].

The values of phosphates observed in the different stations of Taylor Creek varied between 5.83 ± 1.02 - 8.89 ± 1.44 mg/L, while the change in values within the examined months varied from 3.26 ± 0.54 - 21.53 ±4.62 mg/L. These values were either lower or higher than the 5.0 mg/L value recommended for drinking water by WHO. However, these values were lower than the values observed by Murhekar, (2011) [18] in Akot City River, India and those of Mushtaq *et al*., 2016 [19] in Shallow water samples of Dal Lake Srinagar, Kashmir, India. Phosphate enrichment is associated with fertilizer applications on farms, which are subsequently transported to rivers and other aquatic environments through runoffs. Other sources of phosphate include deterioration of plant and animal materials, excrements from beasts and wastes from industrial outlets, especially fertilizer production companies. One of the notable consequence of high level of phosphate is algal bloom, which will be followed by eutrophication of lakes, lagoons and shallow stationary ponds (Edori and Kpee, 2016) [7]. The major form of phosphates present in any river surroundings is the Orthophosphates (PO_4^{3-}) (Edori and Nna, 2018) [8].

Table 3: Chemical and Nutrient Parameters of Water Samples from Taylor Creek at the Different Stations

Chemical Parameters	Stations			
	1	2	3	4
Ph	7.12 ± 0.03	6.92 ± 0.14	6.98 ± 0.35	7.23 ± 0.33
Cl^- (mg/L)	8.23 ± 2.01	8.41 ± 2.15	7.52 ± 2.67	7.89 ± 1.18
NO_3^- (mg/L)	2.75 ± 0.91	3.16 ± 1.00	3.20 ± 0.85	3.15 ± 0.89
SO_3^{2-} (mg/L)	1.07 ± 0.02	1.29 ± 0.11	1.07 ± 0.02	0.89 ± 0.00
PO_4^{3-} (mg/L)	5.83 ± 1.02	8.06 ± 2.00	8.11 ± 1.97	8.89 ± 1.44

Table 4: Mean Monthly Variation of Chemical and Nutrient Parameters of Water Samples from Taylor Creek

Chemical Parameters	Months					
	December	February	April	June	August	October
pH	6.60 ± 0.53	7.09 ± 1.11	6.36 ± 0.93	7.51 ± 1.26	7.48 ± 0.55	7.36 ± 0.72
Cl^- (mg/L)	6.59 ± 1.64	17.06 ± 3.97	6.50 ± 2.13	5.93 ± 1.33	5.83 ± 1.24	6.70 ± 1.58
NO_3^- (mg/L)	0.64 ± 0.02	4.65 ± 1.03	4.02 ± 1.13	2.72 ± 0.00	3.33 ± 0.98	3.07 ± 1.04
SO_3^{2-} (mg/L)	1.27 ± 0.12	1.81 ± 0.01	1.56 ± 0.00	0.92 ± 0.00	0.80 ± 0.01	0.67 ± 0.00
PO_4^3- (mg/L)	7.08 ± 2.10	7.58 ± 1.99	21.53 ±4.62	6.16 ± 2.03	5.34 ± 1.33	3.26 ± 0.54

The concentrations of gross organic matter of the water samples is given in Tables 5and 6. The dissolved oxygen (DO) values or concentrations in the water samples from the various stations varied from 5.53 ± 1.33 – 6.13 ± 1.64 mg/L, while in the months in view, the values ranged from 5.67 ± 1.69 - 6.05 ± 1.13 mg/L. The level of Do observed in this work is lower than the value of WHO standard for domestic water supply. DO in water originate from air or formed by photosynthetic algae and plants. The major factor that causes reduced DO in water is pollution (Mushtaq *et al*., 2016) [19]. Combined consequences of human activities, which include waste disposal system is reduction in oxygen supply to the aquatic environment, but high level of DO infer proper photosynthetic activities due to presence of large number of macophytes. Factors that affects DO include temperature, disorderor irregular flow at the surface, the area exposed to atmosphere, pressure and the available oxygen in the surrounding. Oil spillage reduces amount of DO in surface water samples. DO is a determinant factor in any water environment, due to the fact that it plays important role in the presence of other chemicals in the water and their chemical or physical state in the environment. At very low concentrations of DO within 5 mg/L or below, higher aquatic animals are not likely to survive (Dimowo, 2013; Uedeme-Naa and George, 2019) [5, 28]

The biochemical oxygen demand (BOD) values of the water samples observed in the stations varied from 8.39 ± 1.66 - 11.78 ± 2.60 mg/L, while in the months the variation fell within the range of 3.76 ± 0.93 - 13.43 ± 2.68 mg/L. The BOD Levels observed in this work is higher than the WHO value of 4.0 mg/L. The obtained values were higher than those of Iyama *et al*., (2019) [13] in Sagbama Creeks, Bayelsa State, Nigeria and those of Edori and Nna, (2018) [8] in effluent discharge point into the New Calabar River, Rivers State, Nigeria. BODis the amountof O_2 consumed by microbessuch as aerobic bacteria during the oxidation of organic material. It is influenced or increased by the presence of organic matter in the environment, especially dead and decaying organic materials. Other factors that negatively influence BOD are runoffs which is laden with nutrients from pasturestimulants, grasses, lawnoffcuts, and paper from domestic areas. When O_2 is excessively consumed during decay or deterioration processes of plants and animals, it leaves negative consequences on aquatic biota that requires oxygen for metabolic activities. This situation leaves behind a condition where lower organisms such as bacteria which require low concentration of O_2 or to multiply.

The Chemical oxygen demand (COD) content of the water samples as observed varied from 9.31 ± 2.13 - 14.95 ± 3.04mg/L in the examined stations and also varied from between 5.70 ± 1.01 - 14.17 ± 3.10 mg/L in the months of investigation. The observed values for COD in the present work is either higher or lower than the WHO requirement for drinking water. COD suggest thequantity of the oxygen correspondingto the percentage of organic components present in water sampleprone to oxidation within a given condition (Bertram and Balance, 1996) [3]. The Level of COD in surface water (rivers, lakes, lagoons, creeks etc) are susceptible flooding which transferseveral organic impurities that are vulnerable to oxidation.

Table 5: Gross Organic Matter of Water Samples from Taylor Creek at the Different Stations

Gross Organic Parameters	Stations			
	1	2	3	4
DO (mg/L)	5.96 ± 1.90	6.13 ± 1.64	5.53 ± 1.33	5.87 ± 1.68
BOD (mg/L)	11.78 ± 2.60	8.39 ± 2.55	10.13 ± 2.13	8.39 ± 1.66
COD (mg/l)	9.31 ± 2.13	10.86 ± 3.54	14.95 ± 3.04	12.02 ± 2.88

Table 6: Mean Monthly Variation of Gross Organic Parameters of Water Samples from Taylor Creek

Gross Organic Parameters	Months					
	December	February	April	June	August	October
DO (mg/L)	6.05 ± 1.13	5.67 ± 1.69	5.85 ± 1.36	5.91 ± 1.12	5.83 ± 1.10	6.03 ± 1.59
BOD (mg/L)	3.76 ± 0.93	8.95± 1.65	7.29 ± 2.10	12.51 ± 2.94	12.82 ± 3.12	13.43 ± 2.68
COD (mg/l)	5.70 ± 1.01	17.02 ± 3.15	9.11 ± 1.33	14.17 ± 3.10	12.83 ± 1.57	12.26 ± 2.53

Conclusion

Majority of the examined parameters were within the standard requirement for drinking water as regulated by WHO. Despite this fact, it cannot be conclusively said thatwater is fit for consumption, because of the presence of some of the parameters above the required standard values. The water needs some level of treatment before it can be used for drinking purposes and aquacultural uses.The low level of DO and high level of BOD observed in the work is an indication of either human interference by direct discharge of waste into the water or the volume of effluents discharged into the river or through runoffs from adjoining farmlands. Therefore, adequate regulations and legislation should be employed to prevent ecological breakdown.

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