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Effects of Organic Wastes on Microbial Load of Woji Creek in Port Harcourt, Niger-Delta, Nigeria

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ABSTRACT

The impacts of organic wastes contamination on microbial population and physicochemical properties of Woji creek in Port Harcourt Rivers State were studied for two years. Surface water samples were collected monthly for a duration of two year at five sampling points using standard methods. The samples were subjected to microbiological analysis based on total heterotrophic bacteria count and those of hydrocarbon utilizing bacteria, hydrocarbon utilizing fungi, total coliform and total fungi. Physicochemical properties evaluated include: temperature, pH, turbidity, total dissolved solid, total suspended solid, dissolved oxygen, BOD, COD, total organic carbon. Results of microbiological analysis showed no significant difference between seasons. THBC values ranged from $1.98x10^5$ to $2.59x10^8$cfu/ml, while TFC values was higher in the wet season ($1.55x10^4 \pm 5.46x10^3$cfu/ml) than in the dry season ($5.63x10^3 \pm 2.55x10^3$cfu/ml). Temperature range was found to be significantly higher in the dry season (27.92 ± 0.21^0C) than in the wet season (25.81 ± 0.21^0C). The findings of this study indicate that organic wastes are the major factors responsible for *deterioration of the Woji creek.*

INTRODUCTION

In recent years aquatic pollution has become an issue of great interest in Nigeria, especially in urban and semi urban cities. Many rivers in Nigeria are used for disposal of solid wastes and wastes water are usually untreated causing water pollution. This practice has greatly altered the ecological balance of rivers in Nigeria. Most communities in Nigeria lack pipe borne water supply and therefore rely on local surface and shallow ground water even when they are contaminated. There are a number of pollutant sources that continuously deteriorate the quality of surface and ground water based on the foundation of the area. These are industrial establishment, agricultural activities, municipal wastes, fuel stations, garages and health centers (Mehari and Mulu, 2013). On the other hand, surface water bodies has become the dumping site for industrial effluent and domestic wastes. As a result, the naturally existing dynamic equilibrium among the environmental segments get affected leading to polluted rivers. According to World Health Organization's (WHO) decision, water for the consumers should be free from pathogenic organisms and toxic substances.

Pollution of the water ways by organic discharge in Nigeria is a serious threat posed to the Nigerian inland waters. Inland seas, coastal lagoons and estuaries, generally show high productivity because they receive a high proportion of water and runoff from the land via the river. This promotes mixing of the coastal waters, and brings in nutrients such as organic detritus (Nwigwe, 2007).

The objectives of this study therefore were to investigate the effects of organic wastes on the microbiological characteristics and physicochemical parameters of the water body in Woji creek.

MATERIALS AND METHODS

Study Area

The study was carried out in Woji creek. This is one of the several adjoining creeks of the Bonny River Estuary. It lies between longitude 7^03'N and 7^01'3''N and latitude 4'48'E and 4'52'E of Port Harcourt. The creek has its head at Rumuodara and flows unidirectionally downstream through Rumuodara swamp and traverses Port Harcourt-Aba express road. The water remains fresh and flows downstream in one direction until it reaches Mini Okoro bridge at Rumuogba. It has a confluence with the refinery creek at Okujagu to form the main tributary which drains into the Bonny River. Along the shores of the creek are located the Port Harcourt industries, markets, the main abattoir house and Port Harcourt zoological garden.

Sampling Procedures

Samples were collected at 5 sampling points of the Woji creek carefully selected using coordinates. The samples were subjected to microbiological and physicochemical analysis. Samples were collected once a month in two season's i.e dry and rainy seasons for the duration of two years. The dry season was between November and March, while the rainy season was between June and October. Surface samples were collected approximately 20cm below the surface. The samples were put into sterilized plastic containers preserved in ice chest box before taking to the laboratory for further analysis.

Samples for biochemical oxygen demand (BODs) and dissolved oxygen (DO) were collected in BOD glass bottles;

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care was taken to avoid bubbles being trapped before fixing the stopper and later taken to the laboratory for further analysis. Samples for heavy metals analysis were collected in 20ml polyethylene bottles and preserved immediately by acidifying to pH 2.0 with nitric acid (HNO3) until analysis is done. The samples were kept in insulated ice boxes to maintain low temperature which was transported to the laboratory within 4 hours of collection.

Microbiological analysis

Sterilization of media was carried out by moist heat sterilization method using autoclave at 1210C, 15psi and for 15 minutes. Heat stable materials were sterilized using hot air oven at 1600 C for 1 hour as described by Cruickshank *et al.,* (1982). Heat labile materials were aseptically rinsed with alcohol and distilled water. The water samples were aseptically subjected to tenfold serial dilution to dilute the population of microorganisms sufficiently in sterile blanks of 9ml peptone water for every enumeration. The method of Dubey and Maheshwari (2004) was adopted for the inoculation of media. Potatoes Dextrose agar (PDA) was used for the isolation and enumeration of total fungi. Total coliform was done using the Most Probable Number (MPN) method. The method of Cruickshank *et al.,* (1982) was adopted for the preparation of the standard inoculum of bacteria, fungi, gram staining, motility test, methyl red-voges proskauer test and hydrogen sulfide production. Characterization and identification of bacteria isolates were identified to their generic level following the schemes of Holt *et al.,* (1994).

Physicochemical analysis

The pH of the water was determined in situ by immersing the indicator electrode of the pH meter, allowing for few minutes to let the reading settle before taking the final reading. Temperature was determined in situ by dipping the thermometer of 110^0C calibration range into the water and the reading was taken after 5 minutes interval. Conductivity was determined using conductivity meter. Total suspended solids (TSS) and total dissolved solids (TDS) was determined using gravimetric method. Turbidity was determined photometrically using a turbidimeter. Alkalinity was determined using titrimetric method. Dissolved oxygen (DO) and Biochemical oxygen demand (BOD) were determined using modified Wrinkler method as described by Bartram and Balance (1996). Rapid oxidation method was used to determine chemical oxygen demand (COD) and organic carbon. Chloride was determined by Morhr's method.

RESULTS

Total Heterotrophic Bacteria Count (THBC)

THBC values ranged from $1.98x10^5$ to $2.59x10^8$cfu/ml with a mean of $2.18x10^7 \pm 4.83x10^6$cfu/ml. The highest mean value ($3.09x10^7 \pm 1.38x10^7$cfu/ml) was recorded in sampling point 2 while the lowest mean value ($1.37x10^7 \pm 7.91x10^7$cfu/ml) was recorded in sampling point 5. Mean value was higher in the wet season ($1.83x10^7 \pm 1.21x10^7$cfu/ml) than in the dry season ($1.53x10^7 \pm 1.00x10^7$cfu/ml). There was no significant seasonal variation in THBC (sig t=0.853) at p<0.05.

Hydrocarbon Utilizing Bacteria (HUB)

HUB value ranged from $2.30x10^2$cfu/ml to $1.43x10^6$cfu/ml with a mean of 1.00x105 ± 2.10x104cfu/ml. The highest mean value (1.39x105 ± 6.25x104cfu/ml) was recorded in sampling point 2 while the lowest mean value (5.68x104 ± 2.42x104cfu/ml) was recorded in sampling point 5. The mean value was higher in the wet season than in the dry season. There was no significant seasonal variation (sig t = 0.214) at p<0.05.

Total Fungi Count (TFC)

TFC values ranged from 0.00 to $1.01x10^5$cfu/ml with a mean of $1.13x10^4 \pm 1.56x10^3$cfu/ml. The highest mean value ($1.48x10^4 \pm 5.22x10^3$cfu/ml) was recorded in sampling point 2 while the lowest mean value ($8.01x10^3 \pm 3.26x10^3$cfu/ml) was recorded in sampling point 4. The Mean value was higher in the wet season ($1.55x10^4 \pm 5.46x10^3$cfu/ml) than in the dry season ($5.63x10^3 \pm 2.55x10^3$cfu/ml). There was no significant seasonal variation (sig t=0.160) at p<0.05.

Hydrocarbon Utilizing Fungi (HUF)

HUF values ranged from 0.0 to $2.80x10^4$cfu/ml with a mean of $2.56x10^3 \pm 4.30x10^2$cfu/ml. HUF had the highest mean value ($3.60x10^3 \pm 1.32x10^3$cfu/ml) was recorded in sampling point 1 while the lowest mean value ($1.72x10^3 \pm 8.32x10^3$cfu/ml) was recorded in sampling point 2. The Mean value was higher in the dry season ($3.26x10^3 \pm 1.46x10^3$cfu/ml) than in the Wet season ($1.43x10^3 \pm 5.06x10^2$cfu/ml). There was no significant seasonal variation (sig t=0. 073) at p<0.05.

Total Coliform Count (TCC)

TCC values ranged from 1.70x102 MPN/100ml to $2.40x10^3$ MPN/100ml with an overall mean of $1.09x10^3$±60.53. The mean value was higher in the wet season ($1.18\pm8.9x10^1$MPN/100ml) than in the dry season ($9.70x10^2\pm1.20x10^2$MPN/100ml) with the mean value ($1.62x10^3$MPN/100ml) and the lowest mean value ($6.22x10^2$MPN/100ml). There was no significant seasonal variation (sig t=0. 207) at p<0.05.

Generally, the results of the microbiological analysis were above the limits of USEPA maximum contamination levels (MCLS) of <100cfu/ml in drinking water (USEPA, 2003). The fungal isolates include *Aspergillus species*, *Fusarium species*, *Penicillum species*, *Rhizopus species*, *Mucor species* and *Candida species*. The bacteria isolates and percentage (%) occurance include *E.coli* (100%), *Salmonella species* (57.50%), *Shigella species* (67.50%), *Vibrio species* (93.33%), *Streptoccocus species* (75.83%), *Staphylococcus species* (100%), *Pseudomonas species* (65%), *Enterobacter species* (93.33%), *Citrobacter species* (69.17%), *Serratia species* (55.83%) and *Bacillus species* (80%).

Levels of the physico-chemical parameters

Surface water temperature

The surface water temperature values ranged from 24^0C to 30^0C with a mean of 26.80±0.12 during the study period. The highest mean value 27.15 ± 0.36^0C was recorded in sampling point 5 while the lowest 26.04 ± 0.17^0C was recorded in sampling point 1. The mean value was higher in the dry season (27.92±0.11) than in the wet season (25.81±0.21) however there was a significant variation in water temperature (sig t=0.00) at P<0.05.

pH

The pH values ranged between 4.74 and 7.28 with a mean of 6.06±0.05 was recorded during the experiment. The highest mean value (6.16±0.11) was recorded in sampling point 4 and the lowest 6.01±0.09 was recorded in sampling point 5. The mean value was higher in the dry season (6.36±0.12) than in the wet season (6.21±0.34) however there was no significant variation in the pH (sig t=0.228) at P<0.05.

Total Organic Carbon (TOC)

Total organic carbon value ranged from 0.02 to 0.304 mg/l with a mean value of 0.048±0.017 mg/l. There was a

slight variation of TOC across the sampling points with the highest mean value of 0.033±0.013mg/l at sampling point 1 and lowest mean value of 0.030±0.013mg/l at sampling point 4. The mean value was higher in the wet season than dry season. However there was no significant seasonal variation in TOC (sig t=0.231) at P<0.05.

Dissolved Oxygen (DO)

DO values in the study area ranged between 0.0 and 5.6mg/l with a mean value of 2.25±0.15mg/l. There were slight variations across the sampling points. The highest mean value (2.64±0.36mg/l) was recorded in sampling point 1 while the lowest mean value (1.68±0.26mg/l) was recorded in sampling point 5. Mean value was higher in the wet season (2.76±0.62mg/l) than in the dry season (1.92±0.25). There was no significant seasonal variation in DO at P<0.05.

Turbidity

Turbidity values ranged from 0.4 to 2.48mg/l with a mean value of 0.1±0.04mg/l during the study period. The highest mean value (0.6±0.57) was recorded in sampling point 2 and 4 while the lowest mean value (0.58±0.54) was recorded in sampling point 1. There was a slight fluctuation across the sampling points. The mean value was higher in the dry season than wet season. There was no significant seasonal variation in turbidity (sig t=0.49) at P<0.05.

Biochemical oxygen demand (BOD_5)

BOD_5 values ranged between 6.40 and 180mg/l with a mean value of 51.71±4.34mg/l. Sampling point 5 recorded the highest mean value (60.10±10.36mg/l) while the lowest mean value (40.23±8.09mg/l) was recorded in sampling point 2. Values fluctuated across the sampling points. Mean value was higher in the dry season than in the wet season. There were no significant variation at P<0.05.

Chemical oxygen demand (COD)

COD values ranged between 16.0 and 530mg/l with a mean of 127.33±7.91mg/l. The highest mean value was recorded in sampling point 4 while the lowest mean value was recorded in sampling point 2. There was variation of values across the sampling points. Mean value (159.42±13.76mg/l) was higher in the dry season than wet season (104.48±21.22). there was no significant seasonal variation at P<0.05.

Total Dissolved Solids (TDS)

TDS values ranged between 180 and 25950mg/l with an overall mean value of 9536.78±567.81mg/l. The highest mean value (10335±1245.55mg/l) was recorded in sampling point 4 and the least mean value (9047.67±1141.16mg/l) was recorded in sampling point 1. Mean value was higher in the dry season than the wet season. However there was no seasonal variation in TDS at P<0.05.

Total Suspended Solids (TSS)

TSS values ranged from 40 to 5200mg/l with a mean value of 2166.58±287.27mg/l. However there was variation of values across the sampling points. At sampling point 4, TSS was highest (1753.75±209.65mg/l) and lowest (1432.71±179.46mg/l) at sampling point 2. Mean value was higher in the wet season than dry season. There was significant seasonal variation in TSS at P<0.05.

Total Hardness

Total Hardness values ranged between 8.01 and 8001mg/l with a mean value of 683.99±148.90mg/l. The highest mean value was recorded at sampling point 4 while the lowest mean value was recorded at sampling point 1. There was a wide fluctuation of values across the sampling points. Mean value was higher in the wet season than the dry season. There was no seasonal variation at p<0.05.

DISCUSSIONS

Results of microbiological analysis showed that the river is highly polluted (Table1). The mean values for total heterotrophic bacteria count were higher in the wet season than the dry season (Table 2). Surface runoffs and sewage overflow from the municipal wastes, dumping of unprocessed slaughter wastes; animal blood, etc into water bodies is likely to increase the presence of pathogens, especially *Salmonella sp*. During the sampling period of the wet season, there was an occurrence of river over flow in Nigeria that led to erosion, destruction of crops and loss of lives; these may have contributed to increase in the microbial load during the wet season. The heavy rainfall may have contributed to the contamination of Woji creek as it washed down wastes into the creek resulting in high microbial load recorded, this is in agreement with the work of Ihejirika (2011). Dezuane (1990) reported that water with microbial counts under 100cfu/ml should be considered 'potable' and values between 100 and

Table 1. The range, mean standard error of microbial load in Woji creek.

Parameter	Minimum	Maximum	Mean ± Standard Error(SE)
THBC(cfu/ml)	1.98×10^5	2.59×10^8	$2.18 \times 10^7 \pm 4.8 \times 10^6$
HUB(cfu/ml)	2.30×10^2	1.43×10^6	$1.00 \times 106 \pm 2.10 \times 10^4$
TFC(cfu/ml)	0	1.01×10^5	$1.13 \times 104 \pm 1.56 \times 10^3$
HUF(cfu/ml)	0	2.80×10^4	$2.56 \times 103 \pm 4.30 \times 10^2$
TCC(MPN/100ml)	1.7×10^2	2.40×10^3	$1.09 \times 103 \pm 6.05 \times 10^1$

Key: THBC: Total Heterotrophic Bacteria Count, HUB: Hydrocarbon Utilizing Bacteria, TFC: Total Fungi Count, TCC: Total Coli-form Count.

Table 2. Seasonal Variation (Students t-test p<0.05) of Microorganisms.

Parameter	Season	Mean ± Standard Error(SE)	t	Sig t
THBC	Wet	$1.83X10^7 \pm 1.21x10^7$	-0.191	0.853
	Dry	$1.53x10^7 \pm 1.00x10^7$		
HUB	Wet	$8.13x10^4 \pm 2.99x10^4$	1.337	0..214
	Dry	$4.54x10^4 \pm 9.72x10^3$		
TFC	Wet	$1.55x10^4 \pm 5.46x10^3$	1.530	0.160
	Dry	$5.63x10^3 \pm 2.55x10^3$		
HUF	Wet	$1.43x10^3 \pm 5.05x10^2$	-1.084	0.307
	Dry	$3.26x10^3 \pm 1.46x10^3$		
TCC	Wet	$1.18x10^3 \pm 8.9x10^1$	1.361	0.207
	Dry	$9.70x10^2 \pm 1.20x10^2$		

Key: THBC: Total Heterotrophic Bacteria Count, HUB: Hydrocarbon Utilizing Bacteria, TFC: Total Fungi Count, TCC: Total Coli-form Count.

Table 3. Spatial Variation of Microbiology in water of Woji creek.

Sampling Point					
Parameter	**1**	**2**	**3**	**4**	**5**
THBC	$3.07x10^7 \pm 1.36x10^7$	$3.09x10^7 \pm 1.38x10^7$	$1.73x10^7 \pm 9.02x10^6$	$1.59x10^7 \pm 8.57x10^6$	$1.37x10^7 \pm 7.91x10^6$
HUB	$1.24x10^5 \pm 4.93x10^4$	$1.39x10^5 \pm 6.25x10^4$	$1.08x10^5 \pm 3.90x10^4$	$7.44x10^4 \pm 5.27x10^4$	$5.68x10^4 \pm 2.42x10^4$
TFC	$1.01x10^4 \pm 2.64x10^3$	$1.48x10^4 \pm 5.22x10^3$	$9.62x10^3 \pm 2.76x10^3$	$8.01x10^3 \pm 3.26x10^3$	$1.37x10^4 \pm 3.07x10^3$
HUF	$3.60x10^3 \pm 1.32x10^3$	$1.72x10^3 \pm 8.32x10^2$	$2.42x10^3 \pm 8.08x10^2$	$2.45x10^3 \pm 8.02x10^2$	$2.60x10^3 \pm 9.88x10^2$
TCC	$1.42x10^3 \pm 1.48x10^2$	$1.21x10^3 \pm 1.29x10^2$	$8.88x10^2 \pm 1.40x10^2$	$1.07x10^3 \pm 1.49x10^2$	$8.78x10^2 \pm 7.32x10^1$

Key: THBC: Total Heterotrophic Bacteria Count, HUB: Hydrocarbon Utilizing Bacteria,
TFC: Total Fungi Count, TCC: Total Coli-form Count.

Table 4. Spatial variation of physico-chemical parameters in Woji creek (mean ± standard error).

			Sampling points		
Parameter	**1**	**2**	**3**	**4**	**5**
TEMP ^0C	26.04±0.17	26.79±0.18	26.88±0.23	27.13±0.34	27.15±0.36
pH	6.06±0.11	6.05±0.12	6.02±0.12	6.16±0.11	6.01±0.09
TURB (mg/l)	0.58±0.54	0.62±0.57	0.61±0.56	0.62±0.58	0.61±0.57
Total Hardness (mg/l)	617.79±299.56	776.02±394.18	637.47±291.25	785.97±392.27	652.68±297.30
DO (mg/l)	2.64±0.36	2.58±0.31	2.36±0.33	2.00±0.33	1.68±0.26
BOD_5 (mg/l)	40.40±6.91	40.23±8.09	55.32±11.09	56.57±10.42	60.10±10.38
COD (mg/l)	118.40±18.32	108.91±12.62	125.06±17.01	145.29±23.25	139.01±15.90
TDS (mg/l)	9047.67±1141.16	9843.67±1453.64	9176.71±1158.37	10335.00±1245.55	9280.83±1406.39
TSS (mg/l)	1647.50±261.02	1432.71±179.46	1536.38±200.62	1753.75±209.65	1698.00±191.09
TOC (mg/l)	0.033±0.013	0.031±0.013	0.031±0.013	0.030±0.013	0.031±0.013

Table 5. The range, mean standard errors of Physico-chemical parameters of Woji Creek.

Parameter	Minimum	Maximum	Mean±standard Error
Temperature ^0C	24	30	26.80 ± 0.12
pH	4.74	7.28	6.058 ± 0.048
Turbidity (mg/l)	0.040	2.48	0.606 ± 0.040
Total Hardness (mg/l)	8.010	8008.00	639.99 ± 148.90
DO (mg/l)	0.00	5.60	2.252 ± 0.145
BODs (mg/l)	6.40	180.00	51.705 ± 4.341
COD (mg/l)	16.00	530.00	127.329 ±7.906
TDS (mg/l)	180.00	25950.00	9536.775 ± 567.811
TSS (mg/l)	40.00	20650.00	2166.583 ± 287.268
TOC (mg/l)	0.002	0.304	0.048 ± 0.017

Table 6. Seasonal variation (students t-test; p<0.05) of physicochemical parameters.

Parameter	Season	Mean±SE	R	Sig r	T	Sig t
TEMP ^{0}C	Wet	25.81±0.21	-0.047	0.898	-8.891	0.000
	Dry	27.92±0.11				
pH	Wet	6.21±0.34	0.563	0.090	-0.530	0.609
	Dry	6.36±0.12				
TURB(mg/l)	Wet	0.55±0.03	-0.276	0.440	-0.713	0.494
	Dry	0.68±0.16				
T/HARD(mg/l)	Wet	1224.80±731.71	-0.182	0.613	1.092	0.303
	Dry	356.62±204.94				
DO(mg/l)	Wet	2.76±0.62	0.714	0.631	1.339	0.214
	Dry	1.92±0.25				
BOD_5(mg/l)	Wet	44.07±12.98	0.161	0.656	-1.299	0.226
	Dry	63.54±9.88				
COD(mg/l)	Wet	104.48±21.22	-0.069	0.850	-2.107	0.064
	Dry	159.42±13.76				
TDS(mg/l)	Wet	7540.20±2302.65	-0.467	0.174	-1.193	0.170
	Dry	12398.80±1462.59				
TSS(mg/l)	Wet	2485.08±1376.57	-0.599	0.068	0.256	0.804
	Dry	2082.80±298.93				
TOC(mg/l)	Wet	0.06±0.031	-0.343	0.332	0.256	0.231
	Dry	0.014±0.003				

500 cfu/ml 'questionable'. Therefore the Woji creek water samples have questionable water quality.

Bacteria of interest isolated from Woji creek at different sampling points include *Escherichia coli*, *Salmonella species*, *Shigella species*, *Vibrio species*, *Streptoccocus species*, *Staphylococcus species*, *Pseudomonas species*, *Enterobacter species*, *Kiebsiella species*, *Proteus species*, *Citrobacter species*, *Serratia species* and *Bacillus species.* These organisms have been found to be pathogenic, causing diseases such as typhoid, cholera and dysentery.

The coliform values were higher in the wet season than in the dry season (Table 2). The values obtained in this study were above the WHO standards for consumable water limit of 0MPN/100ml. The presence of *E.coli* which is of public health concern, is a clear evidence that the water is unfit for human consumption. Bacteria, indicators of faecal pollution especially *E.coli*, were isolated from all the water samples (Table 3) analyzed which is in line with the work of Nwaopara (1997).

The hydrocarbon utilizing bacteria values were higher in the wet season than in the dry season. This increase may have been due to the increased soil erosion and surface runoff into the river. Hydrocarbon utilizing bacteria play a major role in hydrocarbon degradation in the aquatic ecosystem. The hydrocarbon utilizers isolated were dominated by gram negative bacteria as also recorded by West *et al.,* (1984). The genera isolated include *Proteus sp, Pseudomonas sp, Bacillus sp, E.coli, Serratia and Vibrio sp.*

Total fungi counts (TFC) were higher in the wet season than in the dry season. The reasons adduced for total heterotrophic bacteria count being higher in the wet season are also responsible for TFC. Some of the isolates recorded during the study period include *Mucor sp, Aspergillus sp, Penicillum sp, Rhizopus sp*, and *Candida sp*. Fungal are becoming of increasing concern due to the increasing numbers of immune compromised patients and those with other risk factors.

Hydrocarbon utilizing fungal counts were higher in the dry season than in the wet season. The high counts in the dry season could be as a result of human activities in and around the river this is likely to affect the microbial load. This is in agreement with the work of Nkwelang *et al.,* (2008).

Physicochemical Parameters

The temperature values ranged between 24 to 30^{0}C during the study period (Table 5) and these were within the ranges reported by (Chindah *et al.,* 1999). The temperature fluctuation in this study can be attributed to the changes in weather condition i.e geology and climate change.

The mean pH was noted to have slight variation between sampling points and seasons (Table 4 and 6), variation in pH could be as a result of climate change or meteorological event. This is in agreement with the works of Odokuma and Okpokwasili (1993).

The wet season values of total hardness were generally higher than the dry season values. The level of total hardness recorded was between 8.0 and 8008 (Table 6). It exceeded the permissible limit of 100 to 250mg/l. Water with hardness above 200mg/l may cause scale depletion in treatment works, excessive soap consumption and subsequent scum formation (WHO, 2004). This will also increase the use of water for domestic purposes.

The high mean value of dissolved oxygen (DO) recorded in the wet season agrees with the findings of Egborge (1971), who reported that dissolved oxygen is generally higher during the wet season in the tropics. The higher BOD level in dry season could be the effect of higher temperature and putrefaction of substances deposited in the creek from the surrounding (Davies *et al.,* 2008).

The chemical oxygen demand (COD) was higher in the dry season than in the rainy season. The reasons could still be attributed to increase in organic and inorganic waste load noted during the study. The mean values for total dissolved solids (TDS) were higher in the dry season than in the rainy season. The lower values of this parameter suggest that the run-off water only contributed to its dilution in the rainy season. This is in contrast with the results of Odokuma and Okpokwasili (1990).

Total suspended solid (TSS) refers to the filterable particles in water which may be of organic or inorganic source. Total suspended solids values obtained during the rainy season were higher than the values for dry season.

This may be as a result of run-off of rain water from the slaughter house and the environment. The recorded range of TOC concentration was below the 1 to 30mh/l for natural water. Higher levels in water indicate pollution resulting from anthropogenic inputs. Turbidity values were higher during the dry season than the rainy season this have to do more with nutrient load of the effluent and the kind of activities that go on at the abattoirs to the river bodies.

CONCLUSION

Water quality assessment of Woji Creek was conducted based on selective water quality parameters which are relevant in indicating the suitability of water for drinking and agricultural purposes. The high turbidity as observed in the study is often associated with disease causing microorganism such as bacteria and other parasites. The high values of microbial counts and physicochemical parameters indicate organic contamination implying that the Woji Creek water is unsafe for domestic purposes without some forms of physical and chemical treatments.

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