International Journal of Energy and Environmental Research

Vol.6, No.1, pp.25-35, May 2018

Published by European Centre for Research Training and Development UK (www.eajournals.org)

IMPACT OF ABATTOIR WASTE ON THE WATER QUALITY OF AMILIMOCHA RIVER ASABA, DELTA STATE

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ABSTRACT: *Water pollution has been a major environmental problem globally. This study investigated the effects of abattoir waste on the water quality of Amilimocha River in Asaba, Delta State, Nigeria. Water samples were collected from three sampling locations upstream L1, point of discharge L2, downstream L3, and a control sample L4. Samples were immediately taken to the laboratory for standard analysis. Salinity varied from (0.01 - 0.06%), conductivity (56.70 - 85.10µs/cm), DO (7.80- 8.55mg/L), BOD (3.00 - 6.21mg/L), COD (8.95 - 15.5mg/L), TDS (20.00 - 53.00mg/L), turbidity (23.00 - 41.50 NTU), NO_3 (0.16 - 0.35mg/L), P_{04}^{2-} (0.02 - 0.6mg/L), temperature (26.00 - 29.10ºC), pH (6.50 - 8.20) and coliform bacteria counts (10.00 - 50.00 cfu/100ml). There was significant heterogeneity in mean variance of the water quality parameters across the sampling locations [F(31.09)>Fcrit(3.94)] at P<0.05. A further structure detection group means revealed that all the parameters contributed to the observed heterogeneity. Mean concentration of DO and BOD (8.22 $\pm$ 0.73 and 5.10 $\pm$ 0.37mg/L) respectively exceeded the World Health Organization 6.80 and 4.0mg/L maximum permissible limits for aquatic life. Abattoir wastes should be properly treated before disposal and freshwater systems should not serve as recipients of untreated abattoir waste.*

KEYWORDS: Abattoir Waste, Water Quality, Human Health, Amilimocha, River, Asaba.

INTRODUCTION

About 75% of the earth's surface is covered by water (Olowosegun *et al,* 2005), even as water is essential for all living organisms and aquaculture production. Human activities such as agriculture, canalization, deforestation and waste disposal have totally ultered the fresh water ecosystem probably more than the terrestrial ecosystem (Cowx, 2002). Water is an essential component of man and over the years man has depended on it for survival (Eja, 2002). It is a vital medium for transport, industry, recreation and many human activities. When there is an imbalance or changes in the physical, biological and chemical condition of any body of water which harmfully disrupts the balance of its ecosystem (Fiset, 2008), water pollution is said to have taken place. According to GESAMP (1986), water pollution is the introduction by man directly or indirectly of substances or energy (heat) into the aquatic environment (including estuarine) resulting in such deleterious effects of harm to living resources, hazards to health, hindrance to marine activities including fishing, impairment of quality sea water and reduction of amenities. Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water (David and Braid, 2007) . In Nigeria, available reports cite gross contamination of most major river bodies across the nation with discharge of industrial effluents, sewage and agricultural waste among others (Joseph *et al,* 2010; World Bank, 1995). The reports further stated that contamination of river bodies from abattoir waste could constitute a significant environmental and health hazard. Abattoir effluent

ISSN 2055-0197(Print), ISSN 2055-0200(Online)

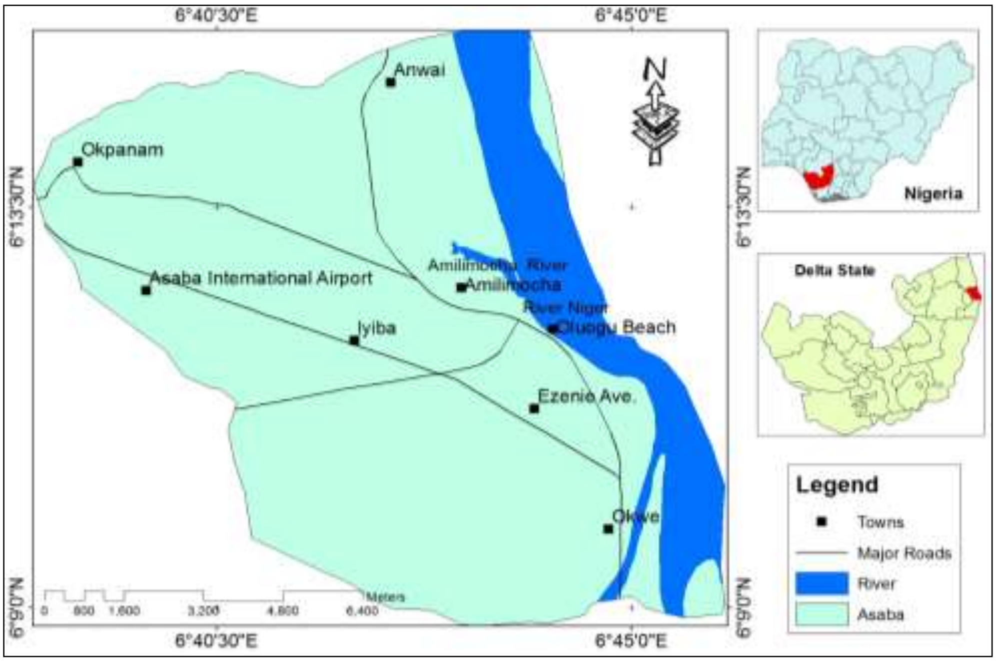
could increase levels of nitrogen, phosphorus and total solids in receiving water body (Omole et al, 2008).The disposal of abattoir effluent into drains and streams is a common practice which poses health and environmental hazards to the people downstream (Deborah et al, 2016).The natural habitat for aquatic animals could have consequential impact on men either directly or indirectly since out of less than 1% of the world's fresh water, about 0.007% of it is readily accessible for direct human use (UNESCO, 2006, Kruntz and Kifferstain, 2005).

The proliferation of abattoirs almost in every market located in Nigeria and the attendant mismanagement of effluent and solid wastes arising from such activity has become a major environmental issue as it causes environmental pollution. A lot of studies have been carried out on river quality but not much emphasis has been led on the quality of abattoir waste contaminated fresh water systems. Amilimocha river in Asaba is a major source of water to the rural dwellers. This therefore has led to the need to carryout comprehensive water quality analysis to help forestall future health problems.

MATERIALS AND METHODS

Study Area

Amilimocha River is situated in Asaba town in Oshimili South Local Government Area of Delta State. The river transverses into River Niger through Otuogwu community to Cable Point, Asaba via Onitsha town in Anambra State, Nigeria. It lies between latitude 6°43'23.974"E 6°12'55.876"N (Fig 1) Delta State Ministry of Lands and Survey (2000). It is situated within the tropical rain forest region with two distinct seasons, the rainy and the dry seasons. Asaba is situated on the valley of River Niger with its tributary streams. There were human settlements along the banks of the River as well as business activities, such as dredging and other commercial and domestic activities in the vicinity of the River. Apart from occupations like civil service, most indigenes were peasant farmers and depended on the river for drinking water source, domestic activity, fishing and recreation.



(Fig. 1) Map of Asaba showing Amilimocha River

ISSN 2055-0197(Print), ISSN 2055-0200(Online)

Sample Collection

Water samples were collected with the aid of sterilized 1 litre sampling bottles from three different locations upstream L1, Discharge point L2, Downstream L3 and a control sample L4. L1 and L3 400m away from the point of discharge. All samples were immediately taken to the laboratory for standard physicochemical and microbiological analysis.

Laboratory Analysis

Physicochemical parameters were analyzed by employing the methods as described by APHA (1998). Microbiological analysis was carried out as described by Prescott (1998)

Statistical Analysis: Descriptive statistics and graphics as provided by the Statistical Analysis (SAS) were used to analyze emerging data. The one-way analysis of variance (ANOVA) was used to test for homogeneity in mean variance of the parameters across the sampling locations at $P<0.05$. Means plots were used to detect structures of means, while the Pearson Correlation (r) was used to establish possible relationships between the physicochemical and microbiological parameters of the river.

RESULT

Physicochemical and Microbiological Analysis.

The results of the variations in physicochemical and Microbiological analysis were as shown in Table 1. Salinity varied from 0.01 - 0.06%. Electrical conductivity varied from 56.70 - 85.10 µs/cm, Dissolved Oxygen (DO) varied from 7.80 - 8.55mg/L, Biological oxygen demand (BOD) varied from 3.00 - 6.21mg/L and Chemical Oxygen demand (COD) varied from 8.95 - 15.50mg/L.

Furthermore, Total Dissolved Solids (TDS) varied from 20.00 - 53.00mg/L and turbidity varied from 23.00 - 41.50 NTU. Nitrate concentration varied from 0.16 - 0.35mg/L while phosphate varied from 0.02 - 0.61mg/L.

Temperature varied from 26.00 – 29.10^{o}C, pH varied from 6.50 – 8.20 and coliform bacteria counts varied from 10.00 - 50.00 cfu/100mg.

Mean DO and BOD levels (8.22 ± 0.73 and 5.10 ± 0.37mg/L respectively) exceeded the Federal Ministry of Environment's 6.8 and 4.0 mg/L maximum permissible limits for aquatic life.

ISSN 2055-0197(Print), ISSN 2055-0200(Online)

Table 1: Descriptive statistics of the Physicochemical and biological parameters of Amilimocha River in Delta State.

Parameters	Minimum	Maximum	Range	Mean	SE	FME(2001)	WHO
Salinity (%)	0.01	0.06	0.05	0.03	0.005	--	--
TDS (mg/L)	20.00	53.00	33.00	39.23	3.15	--	NIL
Turb (NTU)	23.00	41.50	18.50	31.08	1.73	--	NIL
DO (mg/L)	7.80 8.55	0.75	8.22	0.736.8	110%	(13-14mg)	
BOD (mg/L)	3.006.21	3.21	5.10	0.37	4.0	< 5ppm	
COD (mg/L)	8.9515.50	6.55	11.47	0.65	--	<10ppm	
NO_3^- (mg/L)	0.160.35	0.19	0.27	0.02	--	NIL	
PO_4^{2-} (mg/L)	0.020.61	0.59	0.24	0.06	--	50mg/l	
pH	6.508.20	1.70	7.60	0.20	6.0 – 9.0	6.5-8.5.	
Temp (^{0}C)	26.00	29.10	3.10	27.91	0.33	20 –33	--
EC (µs/cm)	56.70	85.10	28.40	66.14	2.75	--	NIL
Coliform (cfu/100mL)	10.00	50.00	40.00	30.67	3.73	--	NIL

SE = standard error of mean, Cond = conductivity, FME = Federal Ministry of Environment.

Spatial Variation in Physicochemical and Microbiological Parameters

Longitudinal spatial variations were observed in the physicochemical and microbiological parameters measured during the study period. Mean maximum temperature of 29.03^{0}C was recorded in sampling location 1 (SL1), while the minimum value of 26.10^{0}C was recorded at SL4. Mean maximum hydrogen ion concentration (pH) of 8.13 was recorded at SL 3 and SL 4, while the minimum value of 6.53 was recorded at SL 1 (Fig 2)

Maximum DO of 8.52mg/L was recorded at SL 3, while the minimum value of 7.81mg/l was recorded at SL 1 (Fig. 3). Mean maximum BOD of 6.21mg/L was recorded at SL 1 while the minimum value of 3.10mg/L was recorded in SL 4. However, mean maximum COD of 14.83mg/L was recorded at SL 1, with a minimum value of 9.02mg/L recorded at SL 4 (Fig 3)

Nitrate had a mean maximum value of 0.33mg/L recorded at SL1, while minimum value of 0.18mg/L was recorded at SL 4 (Fig 4).

Mean Maximum conductivity value of 81.53µs/cm was recorded at SL 1, with the minimum value recorded as 59.23µs/cm at SL 4. Mean maximum TDS level of 52.13mg/L was recorded at SL 1, with the minimum value of 23.34 mg/L recorded at SL 4. Mean maximum salinity of 0.047% was recorded at SL 1 and SL 2, while the minimum value of 0.013% was recorded at SL 4 (Fig.5).

A maximum turbidity of 39.45 NTU was recorded at SL 1, while the minimum value of 24.37 NTU was recorded at SL 2. However, maximum coliform count of 47.67 cfu/100mL was recorded at SL 1, while the minimum count of 14.00cfu/100ml was recorded at SL 4 (Fig.5)

ISSN 2055-0197(Print), ISSN 2055-0200(Online)

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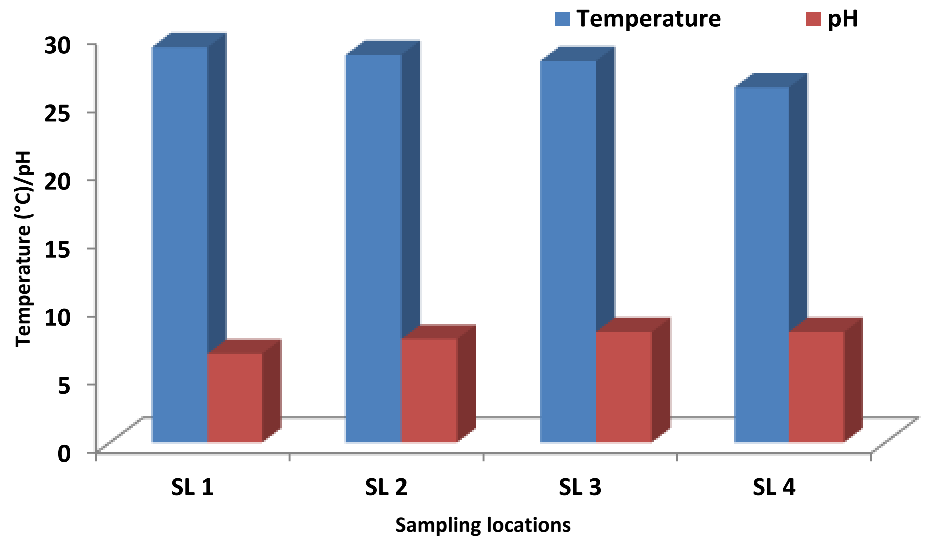

Fig. 2. Variations in temperature and pH of Amilimocha River, Asaba across the sampling locations

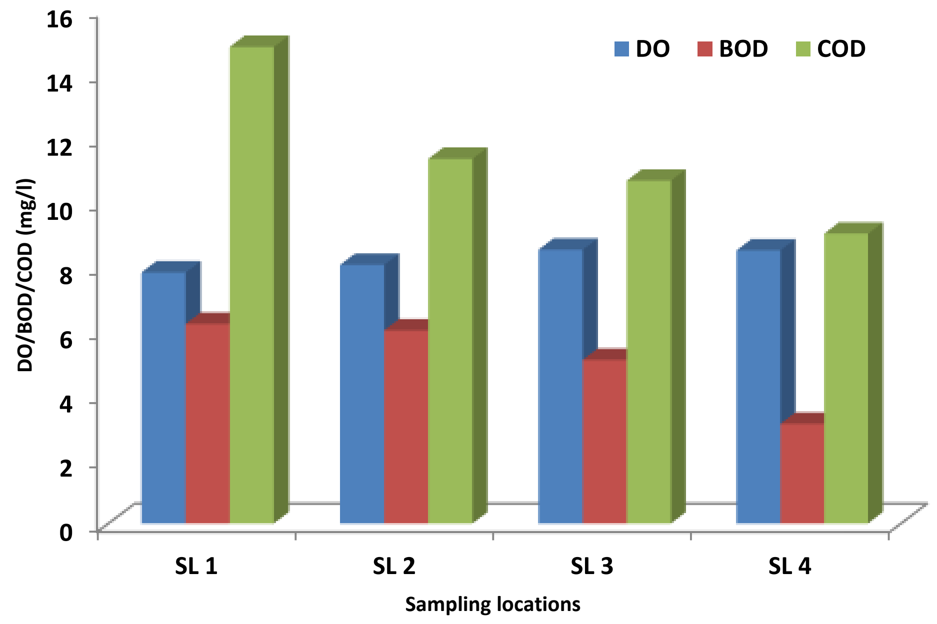

Fig. 3. Variations in dissolved oxygen, biological and chemical oxygen demands of Amilimocha River, Asaba across the sampling locations

ISSN 2055-0197(Print), ISSN 2055-0200(Online)

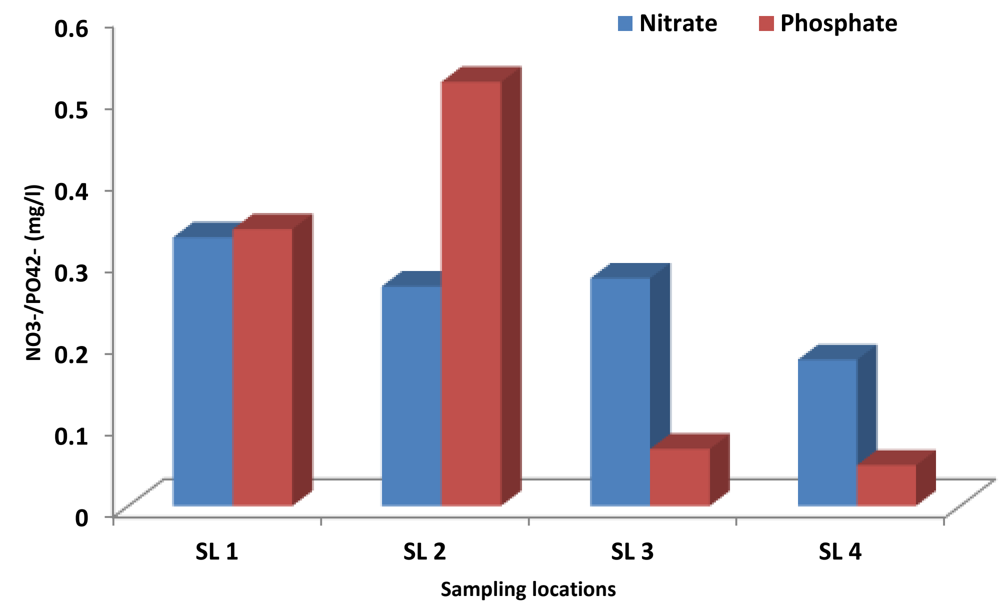

Fig .4. Variations in nitrate and phosphate concentrations of Amilimocha River, Asaba across the sampling locations

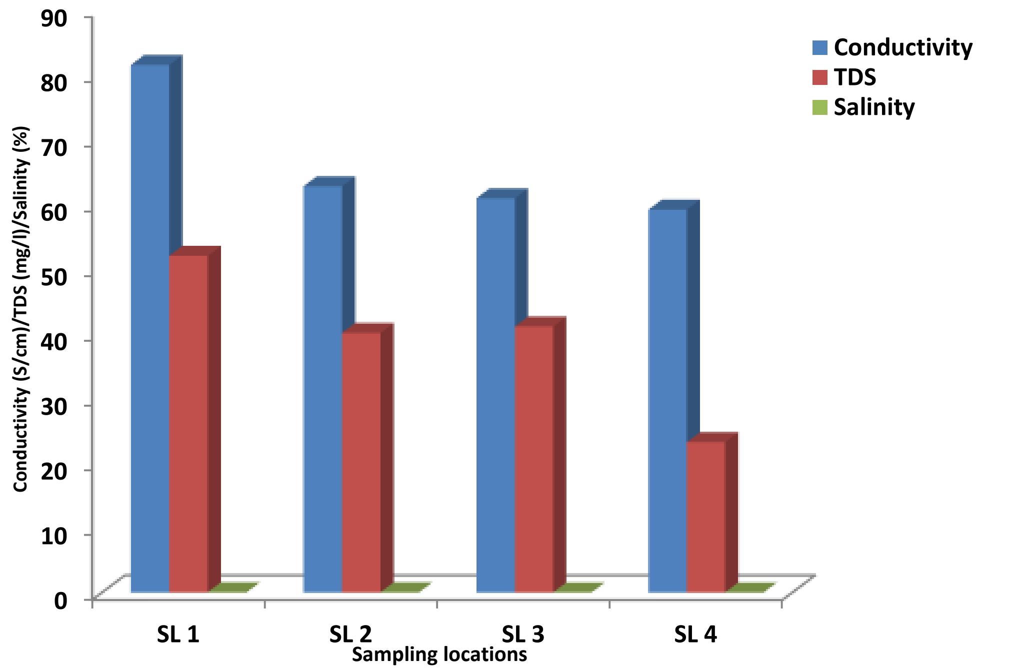

Fig.5. Variations in conductivity, total dissolved solids and salinity of Amilimocha River, Asaba across the sampling locations

ISSN 2055-0197(Print), ISSN 2055-0200(Online)

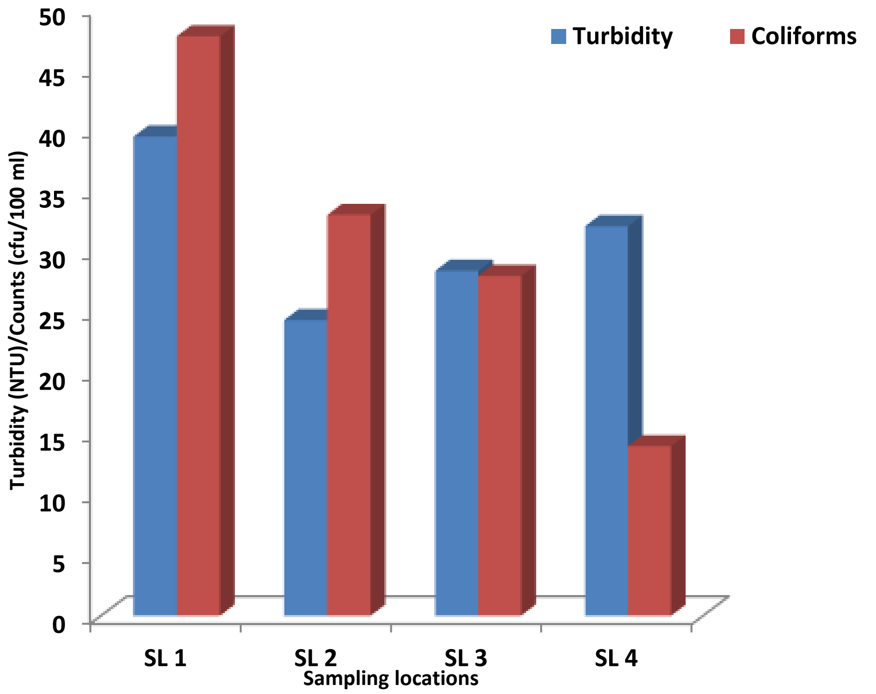

Fig. 6. Variations in turbidity and coliform bacteria counts of Amilimocha River, Asaba across the sampling locations

Interactions of the Physicochemical and Microbiological Parameters

The relationships and interactions between physicochemical and microbiological parameters was as shown in Table 2. Several of the physicochemical and the microbiological parameters showed significant influences on each other At $p< 0.05$, salinity correlated positively with COD (r = 0.705), Nitrate (r = 0.683) and TDS (r = 0.673). DO correlated with nitrate (-0.679). BOD correlated with conductivity (r = 0.617), BOD correlated with pH (r = -0.694), COD correlated with turbidity(r=0.613). Phosphate correlated with Temperature (r=0.663), pH correlated with turbidity (r = -0.641), Electrical conductivity correlated with temperature(r=0.672)

At $P < 0.01$, salinity correlated positively with DO (r = 0.895), BOD (r = 0.801), phosphate (r = 0.825), Temperature (r = - 0.752) and coliform bacteria counts (r = 0.767). DO correlated with COD (r = 0.862), Phosphate (r = 0.781), EC (r = -0.827), pH (0.934),TDS (r = -0.736), Temperature (r = -0.765) and coliforms (r = -0.861). BOD correlated with COD(r=0.801), Nitrate (r=0.861), Phosphate (r=0.746), TDS (0.914), Temp(r=0.988) and coliform (0.893). COD correlated with Nitrate (r = 0.835), conductivity (r = 0.935), pH(r=-O.938) TDS (r = 0.885), Temperature (r = 0.844) and conductivity (r = 0.913). Nitrate correlated with conductivity (r = 0.714), TDS (r = 0.884) Temp (r = 0.844) and coliforms (r = 0.913). Conductivity correlated with TDS (r = 0.752), turbidity (r = 0.788) and coliforms (r = 0.845) TDS correlated with temperature (r = 0.955) and coliforms (r = 0.942) Temp correlated with coliforms (r = 0.923) (Table .2)

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However, at $p < 0.01$, salinity correlated negatively with pH (r = -0.766), DO correlated with COD (r = -0.862), phosphate (r = -0.781) conductivity (r = -0.827), TDS (r = -0.736), Temperature (r = -0.765) and coliforms (r = -0.861) COD correlated with pH (r = -0.938), Nitrate correlated with pH (r = -0.717). Conductivity correlated with pH (r = 0.949) pH correlated with TDS (r = -0.770) Temp (r = -0.720), and coliforms (r = -0.867) .

Table 2: Correlation (r) matrix of the physico-chemical and biological parameters of Amilimocha River.

	Salinity	DO	BOD	COD	NO_3^-	$PO4^{3-}$	EC.	pH	TDS	Temp	Turbidity
DO	0.895**										
BOD	0.801**	-0.785*									
COD	0.705*	-0.862**	0.801**								
$NO3^-$	0.683*	-0.679*	0.861**	0.835**							
$PO4^{3-}$	0.825**	-0.781**	0.746**	0.518	0.413						
EC	0.571	-0.827**	0.617*	0.935**	0.714**	0.364					
pH	-0.766**	0.934**	-0.694*	-0.938**	-0.717**	-0.560	-0.949**				
TDS	0.673*	-0.736**	0.914**	0.885**	0.884**	0.489	0.752**	-0.770**			
Temperature	0.752**	-0.765**	0.988**	0.844**	0.895**	0.663*	0.672*	-0.720**	0.955**		
Turbidity	0.080	-0.396	0.040	0.613*	0.307	-0.179	0.788**	-0.641*	0.306	0.138	
Coliform	0.767**	-0.861**	0.893**	0.913**	0.866**	0.575	0.845**	-0.867**	0.942**	0.923**	-0.396

* = significant at $P < 0.05$, ** = significant at $P < 0.01$, Do = Dissolved oxygen, TDS = Total Dissolved Solid, BOD= Biological oxygen demand, COD= Chemical oxygen demand, EC Electrical Conductivity

DISCUSSION

The concentration of dissolved solids observed at L1 which is the upstream suggests that the water was not too contaminated by the abattoir waste water. The wide variations observed in TDS, turbidity and conductivity at the different sampling locations of the river could be attributed to locational inputs at L2 which is the discharge point and less in L3 which created a wide gradient in concentration of dissolved solids. This is in line with (Umunnakwe et al 2009) in his work in Woji Creek Port Harcourt. A study on the physicochemical parameters of abattoir waste water samples by (Joseph et al, 2010) in Maiduguri also recorded wide variations in total dissolved solids and turbidity but narrow variations in conductivity. A wide variation in coliform counts was also recorded in a study on the interactions of abattoir wastes, industrial effluents and heavy metals in a Nigerian water by (Ezeronye et al, 2004). A research on Abattoir effluents on River Illo Ota Nigeria also recorded wide variations in TDS and electrical conductivity (Omole et al, 2008). In an assessment of seasonal variations in the physicochemical concentrations of a polluted urban River in Nigeria Ayemi et al, (2011) also discovered wide variation in TDS. The narrow variations observed in DO, BOD and COD throughout the sampling locations indicated stability in both dissolved oxygen and its demands by the resident microbial community of the river. The narrow variations in nitrate and phosphates could be attributed to the dilution capacity and flow rate of the river. The narrow variations of salinity, DO, nitrate, phosphates, pH and temperature recorded in the current study is in line with the work of (Umunnakwe et al, 2009) in Woji Creek Port Harcourt. (Ayemi et al, 2011) also recorded narrow variations in pH, DO, BOD and nitrates in their research on seasonal assessment of physicochemical concentration of polluted urban river.

ISSN 2055-0197(Print), ISSN 2055-0200(Online)

The exceedences of DO and BOD over regulatory limits in this work reflects the negative effects of abattoir wastes and other human activities on the quality of the river. This could provide answer to observed sharp decrease in fish abundance of the river. If this phenomenon is left unchecked the Amilimocha River could become increasingly unfit for aquatic lives.

The higher concentration of salinity, BOD, COD, NO_3^-, conductivity, coliform counts, TDS, temperatures, PO_4^{2-} and turbidity at SL2 than at SL3 could be a reflection of proximal inputs of fecal wastes from abattoir activities at SL2 which constitute more organic nutrients, microbial loads, suspended pollutants in the water column. The least concentration of DO and pH at SL1 could be due to the greater use of oxygen in organic decomposition at the sampling locations than SL2.This must have caused increased acidification (lowered pH) in the water column. This goes to confirm the production of acids (humic acid) during microbial decomposition.

Abattoir wastes are discharged directly into the Amilimocha River at SL2 from where they flow to other sampling locations. As the flow continues, dilution and self purification in the presence of sunlight and oxygen takes place thus resulting in reduction in concentration at farther sampling locations. The highest concentrations recorded at SL2 than SL1 for phosphate could be attributed to tidal waves that carried the content to SL2, the closest sampling location to SL1 before dilution took place.

The positive correlation observed between BOD and COD indicates the oxygen demand of both parameters, as both indicators use DO to decompose both organic and inorganic matter in water column. The high value of BOD suggest that oxygen present in water is consumed by aerobic bacteria which leads to fish plankton, mollusks and other aquatic organisms to be difficult to survive.(Animesh and Manish, 2011).The positive correlation between BOD, COD and coliform counts confirms that coliforms depletes oxygen content in water during microbial activities.

The observed correlation between conductivity and TDS indicates that some of the dissolved solids in water column are electrolytes.

The positive correlation recorded between conductivity and turbidity indicates that most pollutants that make the water turbid could also be electrolytes. Salinity which correlated with conductivity positively confirms that in saline waters, salt is an electrolyte. However, negative correlation was observed between pH and temperature . A slight acidity of water recorded at SL1 corresponded with hottest temperatures recorded in the locations. It is known that abattoir effluents are usually warmer than the receiving water bodies. This must have altered the pH regime towards acidity.

The negative correlation observed between DO and BOD, COD and coliform counts indicates the immense relationship existing between dissolved oxygen and microbial loads. Microbes degrade and deplete oxygen contents of water during biodegradation processes. Thus, the higher the microbial loads the lower the oxygen contents of water bodies.

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