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Abubakar Haruna

Department of Science Laboratory Technology, School of Science, Mai Idriss Alooma Polytechnic, P.M.B. 1020, Geidam, Yobe State, Nigeria | E-mail: abubakarboyz@rocketmail.com | Tel: +2348068212227

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Abubakar Haruna
Department of Science Laboratory Technology, School of Science, Mai Idriss Alooma Polytechnic, P.M.B. 1020, Geidam, Yobe State, Nigeria

Abstract: *The study was carried out to assess the physicochemical parameters along some parts of river Kaduna. There were no significant differences in the values of physicochemical parameter observed in all the sampling points, except those of the Total Dissolved Solids at point A, and Chemical Oxygen Demand at Point B. Variation was recorded between months and seasons. The levels of some physicochemical parameters were found to be above and within the National Environmental Standard Regulation and Enforcement Agency (NESREA) and World Health Organization (WHO) standards. Authorities are call to take proactive control measures so as to protects its potentials for domestic water supply and irrigation.*

Key words: *Physicochemical, pollution, Kaduna*

Corresponding author: **E-mail:** abubakarboyz@rocketmail.com | **Tel:** +2348068212227

1. Introduction

Water is the basis of all life and primary need for all vital life processes. With increasing industrialization and population growth, water sources available for various purposes such as drinking, recreation, agriculture and aquaculture have been adulterated with industrial as well as animal and domestic wastes. As a result it has become the most important means of transmission of several infectious diseases and. Polluted sewage contains solids and dissolved organic compounds that impact an offensive odour and serves as excellent medium for biomagnifications of toxic substances to Primary, Secondary, and Tertiary consumers in trophic interactions (Aneja, 2005).

Aquatic environments that pass through cities are usually prone to over- loading with variety of pollutants either through direct or indirect discharges. This situation may be worsened by the indiscriminate disposal of untreated wastes such as heavily laden with sewage. Sewage polluted water bodies carry microorganisms, some of which are pathogenic to human and animals (Lipp *et al.*, 2001).

River Kaduna, like many rivers in Nigeria, serves as a center for recreation, fishing, and irrigational purposes and as a sink for disposal of municipal and industrial wastes. A paucity of information exists on the extent of pollution of the river. This study was therefore designed to appraise the level of pollution using some physicochemical parameters as index of pollution.

2. Materials and Methods

2.1. Sample collection areas

In order to find suitable sites along River Kaduna where the research could be executed, certain

factors were taken into consideration concerning the potential sites that were investigated. The criteria include: the types and path way of contamination, anthropogenic activities . After all the potential site were visited the three most suitable ones designated as point A to C were chosen and sampled bi-monthly for the duration of ten month(i.e. 5 month wet season and 5 month dry season).

Point A: This site is situated at the point of raw water intake into malali water treatment works. Here municipal pollutants entering this point consist of faecal contamination, sewage runoff from Malali, Badarawa, Anguwan Dosa, and legislators quarters.

Point B: This site is situated at Gamji park, were river Kaduna passes through the park. Here pollutants into the river are generated from Kaduna state university, old ABU, police college and nearby settlements.

Point C: is located at Nasarawa bridge the along bypass. This site is a confluence point of industrial and municipal effluents flowing from industries and settlements of kakuri, Nasarawa and Makera.

2.2.2. Water sample collection

Guidelines on sampling of rivers and stream as given by SANS 5667-6(2006) were used at the 3 sampling points of the river water and .250 ml bottle covered with black tape was used to collect the water sample for BOD while a 250ml bottle was used to collect water sample for COD analysis. The uncapped 250ml bottle was submerged to a depth of about 10cm under the water surface pointing towards the direction of flow until the bottle was completely filled to the brim, and the cap replaced before it was taken out of water. The sample was put on ice in a cooler and transported to the laboratory of the department of Biological Sciences, Nigerian Defence Academy Kaduna for analysis.

2.2.3. Determination of Physicochemical Parameters

Field meter were checked and calibrated according to manufacturer's specification. The variables analyzed were pH, temperature, Electrical Conductivity, total dissolved solids and turbidity. Standard method were followed in determining the variables(APHA, 1998). In situ measurement of some of the physicochemical parameters, pH, temperature, total dissolved solids, electrical conductivity and transparency were measured using Hanna multiparametric meter(model 191300), transparency was measured using Secchi disc(diameter 20.2). Dissolved oxygen, Biological Oxygen Demand and Chemical oxygen demand of the water sample in mg/l was measured titrimetrically using standard method, as detail in (Aneja,2005).

2.2.4. Data analysis

Analysis of variance was used to test differences while mean were compared using Duncan's multiple range test(DMRT). $P<0.05$ was selected as significance difference and calculated using SPSS (version 16.0) statistical package.

3. Results and Discussion

The results of the physicochemical parameters analysis in sampling points and seasons of river Kaduna showed different ranges of variation and are shown in Tables 1 to2

Table 1: Analysis of variance of mean physicochemical parameters at various sampling points along river Kaduna during the sampling period

Parameters	Point A	Point B	Point C
Temperature (^{o}C)	19.85 ^{a}	21.60 ^{a}	20.70 ^{a}
pH	6.94 ^{ab}	6.10 ^{ab}	6.99 ^{ab}
Electrical Conductivity(µs/cm)	0.30 ^{c}	0.31 ^{c}	0.30 ^{c}
Total Dissolved Solids(mg/l)	0.17 ^{ab}	0.31 ^{ac}	0.31 ^{ac}
Turbidity (cm)	23.7 ^{d}	21.6 ^{d}	24.2 ^{d}
Dissolved Oxygen (mg/l)	2.60 ^{ad}	3.55 ^{ad}	3.45 ^{ad}
Biological Oxygen Demand (mg/l)	1.85 ^{e}	2.0 ^{e}	2.38 ^{e}
Chemical Oxygen Demand (mg/l)	0.28 ^{ae}	0.58 ^{af}	0.30 ^{ae}

Figures with the same alphabet in the same column are not statistically significantly different ($p < 0.05$) according to DUNCAN MULTIPLE RANGE TEST

Table 2: Seasonal variation of mean physicochemical parameters along river Kaduna during the two sampling seasons

Parameters	wet season	Dry season
Temperature(^{o}C)	18.4 ^{a}	23.7 ^{b}
pH	6.7 ^{a}	8.4 ^{b}
Electrical conductivity(µs/cm)	0.28 ^{a}	0.30 ^{a}
Total dissolved solids(mg/l)	0.48 ^{a}	0.27 ^{b}
Turbidity(m)	10.5 ^{a}	37.2 ^{b}
Dissolved oxygen(mg/l)	1.89 ^{a}	4.71 ^{b}
Biological oxygen	1.40^{a}	2.70 ^{b}

demand(mg/l)		
Chemical oxygen demand (mg/l)	0.28[a]	0.61 [b]

Figures with the same alphabet in the same column are not statistically significantly different($p< 0.05$) according to DUNCAN MULTIPLE RANGE TEST

Mean water temperature ranged between 10.9 and 29.6^{o}C during the study period. All sampling point showed nearly uniform temperature. The was no significant differences($p> 0.05$) between the points sampled. Significance were noted between the months and seasons. The temperature recorded are within the range being ideal for aquatic life. Lower temperature recorded during the dry season months could be as a results of prevailing low atmospheric temperatures in the area of the study during the Harmattan period. Present study agree with those obtain by Balarabe(1981), Olademeji and Wade(1984).

The range of pH was between 6.5 and 7.7. pH was found the same in all the sampling points throughout the study. The minimum was in June and the maximum was attained in March and April. The dry season showed significantly higher ($p> 0.05$) pH than the wet season. The range recorded, indicates that the water is within neutral range suggesting a low buffering capacity for the river and it is within the range for inland waters,(6.5-8.5) as reported by Boyd and Liehtkopper (1979). Antoine and Alsaadi (1982) also report this range being ideal for aquatic life.

The mean value of Electrical Conductivity fluctuated between 0.3 and 0.43 µs/cm. all the sampling points showed similar fluctuation in EC. Peak conductivity was noted in December, whereas the minimum value occurred in June. Dry showed slightly higher conductivity than the wet season, but statistically indifferent ($p< 0.05$). Low EC may be due to granite which form the basement rock of the river, is known to have a low ionic content (Winger, 1981).

Total dissolved solids in broad sense reflects pollutant burden on the aquatic system. The value of TDS fluctuated between 0.9 and 0.52mg/l. point B and C showed higher($p<0.05$) TDS than point A. The maximum TDS occurred in September and minimum in August. The rainy season showed significantly higher ($p<0.05$) TDS than dry season. The TDS increased during the wet season, this may be attributed to the rising water level in the river because of increase in flow from point and non point discharges during the rainy season and increase in colloidal suspension from effluent discharge into the river may have increase TDS and in turn raised turbidity and reduce transparency of the water. Low turbidity observed during the dry season may be attributed to the low water level in the river due to low flow of drainage water from the drains into the river (Ali, 2002).

The clarity of natural body of water is an important determinant of its condition and productivity. The turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organism. The mean turbidity ranged between 2.8 and 2.9.4cm. Generally all the sampling points showed similar fluctuation in turbidity (Table 1). The dry season gave significantly ($p<0.05$) higher transparency than the rainy season. The higher could be due to presence of flood water, surface runoffs and settling effects of suspended materials that followed the cessation of rainfall. Most of the settlers along the course of river Kaduna might inadvertently discard refuse along the drain that

discharges particle into the river (Kemderim, 1990; 2005) reported similar finding. Low transparency during the rainy season when there is high turbulence and high turbidity, has corresponding low primary productivity.

Dissolved oxygen is one of the most important factor in stream health. Its deficiency directly affects ecosystem of river. The dissolve oxygen in water depend on a number of physical, chemical and microbiological process. Oxygen is the single most important gas for most aquatic organism; free oxygen is needed for respiration. Mean DO value was found to be ranging from 0.38 to 9.97mg/l. The maximum dissolved oxygen concentration occurred in March and April and the minimum in August. The dry season showed a significantly($p<0.05$) higher oxygen concentration than wet season at all the points. The high dissolved oxygen value for the dry season months coincides with period of lowest turbidity, little flow of runoffs. In the cool harmattan season, wind which increases wind action, and decrease in surface runoffs might have contributed to the increase in oxygen concentration during the dry season, while torrential rain that washes large quantity of organic matter, increase in turbidity and water depth thus contributing in depletion of dissolved oxygen during the wet season. Oniye *et al* (2002), made a similar observation in Zaria and Kemderim(2005) in Kangimi reservoir.

4. Conclusion and Recommendation

When looking at the data discussed, it is evident that some results of physicochemical parameters comply with the guidelines while other are above recommended values. It is recommended that the appropriate authorities are made aware of this problem, so as to take proactive measures on environmental legislation in Kaduna metropolis and its environs.

Further the above observations, as time goes , human population will grow as well as quantity of effluent released and without proactive control measures the river could face very serious deleterious consequences which might affect its potentials for domestic water supply or increase the cost of treatment at the water works and finally destroying potential for aquatic organism in the system.

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