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A STUDY OF ALGAL SPECIES OF KANO RIVER, TAMBURAWA, KANO STATE, NIGERIA

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ABSTRACT
An ecological study of algae at Kano River in Tamburawa village was carried out within the period of March, 2013 to August, 2013 at five different sites. The sampling sites were selected for the purpose of the study based on differences in their anthropological conditions. Physico-chemical and biological parameters were determined using standard methods. Physico-chemical and biological parameters showed that Temperature, pH, Dissolved Oxygen, 5-days Biochemical Oxygen Demand, Nitrate, Phosphate, Electrical Conductivity and Turbidity ranged between 22^0C to 28^0C, 6.10 to 9.20, 2.00mg/L to 9.83mg/L, 0.50mg/L to 4.93mg/L, 0.00mg/L to 14.40mg/L, 0.01 to 6.65mg/L, 38.2 µs/cm to 135.3 µs/cm and 67 FAU-2060.70 FAU respectively. A total of fifty six (56) algal species were identified out of which thirty seven (37) species belong to the Class Bacillariophyceae with Nitzchia spp having the highest cell counts, Seventeen (17) species belong to the Class Chlorophyceae with Spirogyra spp having the highest cell counts, two species belong to the Class Cyanophyceae with Oscillatoria sp having the highest cell count. The result shows significant difference (P<0.05) among the sites and regarding their monthly fluctuation. The correlation coefficients of Algal abundance and physico-chemical parameters were positive with DO, BOD, Nitrate and phosphate. However, it had negative correlation with Temperature, pH and Conductivity. The results of the study showed that Kano River is eutrophicated as a result of the anthropogenic activities taking place in the area. The river is also polluted due to the presence of some pollution indicators identified in the area.
Keywords: Algae, Anthropogenic conditions, Kano River, Physico-chemical parameters.

INTRODUCTION

Water is an essential resource for sustainability of life on earth. It is the most vital requirement after oxygen, as its constant supply is needed to replenish the fluids lost through normal physiological activities such as respiration, perspiration and urination (Shalom *et al*., 2011).Although the hydrosphere is estimated to contain about 1.36 billion km^3 water, only about 0.3% of this water exists as fresh water in rivers, streams, springs and aquifers available for human use, the remaining 99.7% is locked up in seas and oceans (Muhammad *et al*., 2007). A River is a body of freshwater flowing from upland source to large lake into sea and fed by sources such as a spring tributary stream (Ennis and Albright, 1982). The main parts of a river include a channel in which the water flows and on other side of the channel sand flood plain, a river starts at hill side as small channel or rills, the rills combine to make a large channel that eventually come together forming direct stream (Franson, 1975). Water bodies are known to support a wide array of aquatic organisms which include phytoplankton/algae, zooplankton, nektonic and other variety of small species substantially floating on the water (Hester, 1986). The quantity and types of such organisms depend on the water quality, especially on physical and chemical qualities and the characteristics of the environment (Bard *et al*., 1976). Water quality affects the abundance, species composition, stability, productivity, and physiological condition of indigenous populations of aquatic organisms. Therefore, the nature and health of the aquatic communities is an expression of the quality of the water (APHA, 1985). Environmental factors comprising physical and chemical components have been reported in several studies to have a great influence on the well-being of aquatic species, plankton inclusive (Ovie, 1997; Kawo, 2005; Okogwu and Ugwunba, 2006).The aim of the research was to carry out an ecological study of Algae present in Kano River at Tamburawa. This includes investigation of specie composition and abundance in relation to physico-chemical parameters. Viz. Temperature, pH, Conductivity, Turbidity, Dissolved oxygen, Biochemical oxygen demand, Nitrate and Phosphate ions concentrations. The implication of findings was discussed in relation to public health.

MATERIALS AND METHODS

STUDY AREA

Kano River is a stream in Kano State. It is located at an elevation of 402 meters above sea level. Kano River is also known as Kogin Kano. It is located on latitude $11^0$50'45" N and longitude $8^0$30'21" E (Getamap.net, 2012). River Kano emanates from the southern Kano highlands which is also referred to as the foot slope of the Jos plateau. It flows up to central Kano where it makes a confluence at Tamburawa with River Challawa (Aliyu, 2012). For decades; this river basin sustains local communities along its course particularly for agricultural activities.

Similarly, the new Tamburawa water treatment plant is situated near the river and it sources its raw water from the river. Thus, providing source of water for agricultural, industrial and domestic purposes in Kano metropolis.

Sampling Site

Five (5) sampling sites were selected for the purpose of this study based on differences in their anthropological conditions. GPS 12 model (GARMIN, USA) was used in marking the global position of the sites.

Site A: This site is located on latitude $11^0$50′39″N and longitude $008^0$30′33″E.The site is near a farmland, other human activities taking place regularly include sand collection and fishing.

Site B: This site is located on latitude $11^0$50′32″N and longitude $008^0$30′43″E.At the site, individuals source water for irrigation activities.

Site C: This site is located on latitude $11^0$50′33″N and longitude $008^0$30′44″E.This is the point at which the new Tamburawa water treatment plant draws its raw river water for purification purposes.

Site D: This site is located on latitude $11^0$50′23″N and longitude $008^0$31′02″E.At this site activities such as fishing and sand collection are taken place.

Site E: This site is located on latitude $11^0$50′05″N and longitude $008^0$31′10″E.Activities such as sand collection,washing and bathing are taken place regularly.

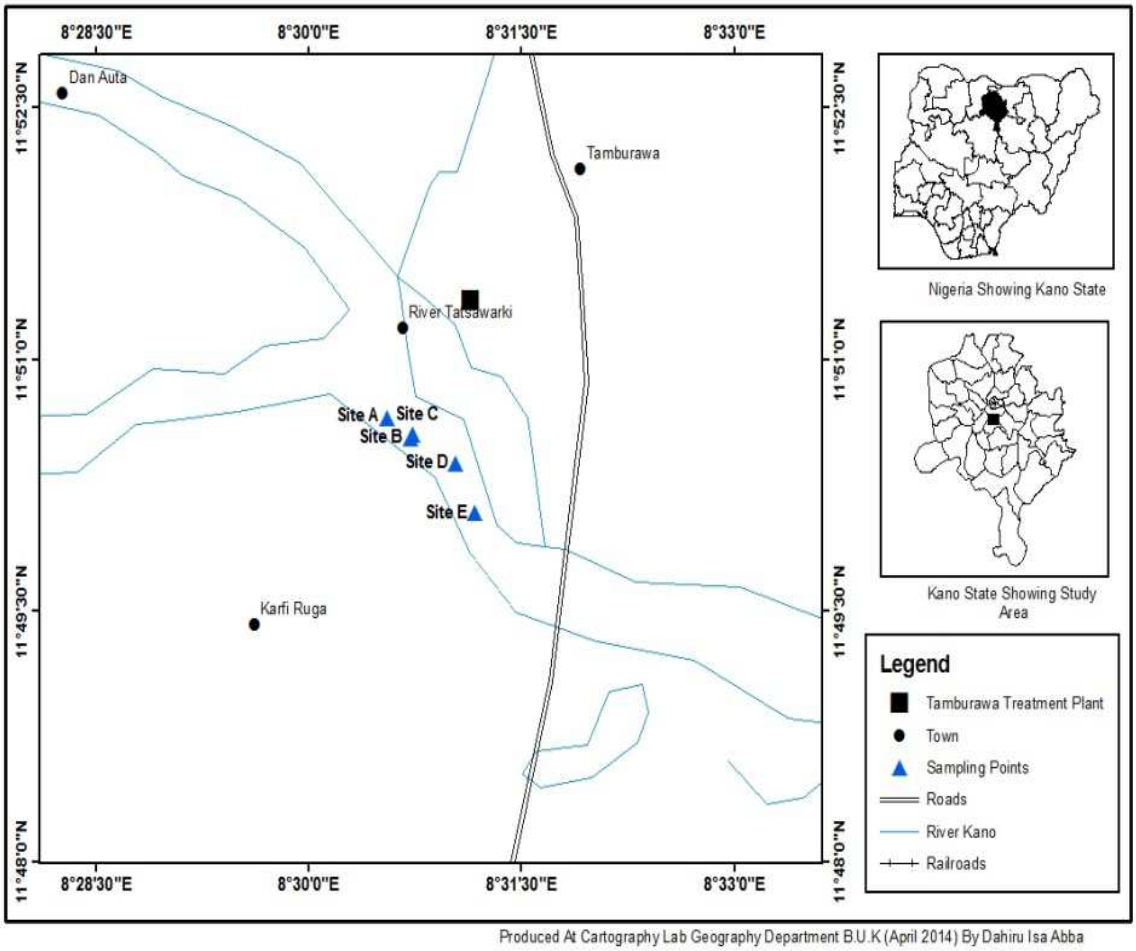

Fig 1: Map of Kano River showing sampling sites

Sample collection

Water sample was collected using 250ml dark brown bottles as described by Indabawa (2012). The sampling bottles were sterilized in the laboratory. On reaching to the field, for each sampling site, each bottle was rinsed several times with the water to be sampled. Each bottle was opened at a depth of 30cm from the surface in the direction of water current. After each bottle was filled, it was removed from the water and closed tightly. Finally, the bottles were labeled with full details of the site of the sample and date of collection. The bottles were then placed in a sampling box containing ice and taken to the laboratory for further analysis.The phytoplanktons were collected using plankton net with a collecting bottle (100ml) at the base. At each of the site, the net was immersed just below the water surface and then towed through a distance of 4.5meters along the side of the boat. The content of the bottle was poured into a sampling bottle of the same capacity and preserved for further laboratory analysis. Formalin solution was used to preserve the sample (Beveridge, 1985; APHA, 1985).

Determination of Physico-chemical Parameters

Six (6) physico-chemical parameters were determined from the river. Temperature was determined *in situ* using thermometer as described by APHA (1992), pH was determined using dip-in mobile battery operated pH meter, dissolved oxygen was determined using modified Wrinkler's titration method, biochemical oxygen demand was determined using five days incubation method as described by Okafor (1985), Electrical Conductivity was determined using EC/TDS bench meter, turbidity, nitrate and phosphate were determined using DR/2010 Spectrophotometer.

Identification and Counting: Algal species were identified under Compound microscope (hund, H600). Standard phycological keys describe by Palmer (1980), Edward and David (2010) were used to determine species. Algal cell count was done using haemacytometer as described by Schoen (1988) and Guillard (1978). A coverslip was used to cover the grids of the haemacytometer and then a pipette was used to fill the haemacytometer chamber. The pipette was placed at the tip of the haemacytometer and the sample flows into the chamber by capillary action. Cells were allowed to settle and checked under microscope for satisfactory distribution of cells.

The grid is divided into 9 large squares, each large square is divided into 25 medium squares and each medium square is further divided into 16 small squares. For fundamental measurement, the average number of cells of the centre large square was counted, the procedure was repeated twice. The cell density was obtained by multiplying the average cell count for each specie by conversion factor for Neubauer ($x10^4$)

Statistical analysis

Raw data was subjected to ANOVA using General Linear Model (GLM) in SAS VERSION (9.3) means were separated using SNK (Student-Newman-Keuls Test) at 5%.The data was also subjected to Pearson's correlation coefficient using SAS.

RESULTS

The surface water temperature and pH for the sampling sites throughout the study period are presented in (Table 1). The range of temperature was 22^0C to 28^0C with the lowest value recorded at Site A in August and the highest at Site E in May and June. The range of pH values was 6.10 to 9.20 with the lowest value recorded at Site C in June and the highest at Site A in March respectively. Significant variation ($P<0.05$) on values of temperature and pH at both sites occur monthly and within the wet and dry season.

The values for dissolved oxygen and biochemical oxygen demand are shown in (Table 2). The DO values range between 2.00 to 9.83mg/l with the lowest and highest values recorded at Site E in May and Site A in August respectively. The range of the BOD was 0.50 to 4.93mg/l; the lowest value was recorded at Site D in June and the highest at Site E in August.

The result shows significant difference ($P<0.05$) at both sites for each month and between wet and dry season.

Water turbidity and conductivity values varied considerably during the study period (Table 3). The turbidity value ranges between 67.00 to 2060.70 FAU with the lowest value recorded at Site C in March and the highest at Site E in August. The range of conductivity value was 38.20 to 135.30µs/cm with the lowest value recorded at Site C in August and the highest at Site A in march respectively. There was a significant variation ($P<0.05$) in the values among the sites and also significant variation regarding their monthly fluctuation in each site.

The phosphate and nitrate values for the sampling sites are presented in (Table 4). Phosphate ranges between 0.01 to 6.65mg/l, the lowest value was recorded at Site C in April and Site D and E in May while the highest value was recorded at Site E in August respectively. The value of the Nitrate ranges between 0.00 to 14.40mg/l, the lowest value was recorded at Site E in March and the highest at Site D in August. The result shows significant difference ($P<0.05$) at both sites and between the seasons.

The number of Algal species identified from the river and the total cell counts are presented in (Table 5). A total of Fifty six (56) species were identified out of which Thirty seven (37) species belongs to the class Bacillariophyceae with *Nitzchia* spp having the highest cell counts, Seventeen (17) species belongs to the class Chlorophyceae with *Spirogyra* spp having the highest cell counts. Two species belongs to the class Cyanophyceae with *Oscillatoria* sp having the highest cell count.

The relationship between the Algal species and physico-chemical parameters of Kano river is presented in (Table 6). Algae had positive correlation with DO, BOD, Turbidity, Nitrate and Phosphate. However, it had negative correlation with Temperature, pH and Conductivity.

Table 1: Mean of some Physico-chemical Parameters of the Five sampling sites in Kano River

	Temperature (°C)						pH					
Months	**A**	**B**	**C**	**D**	**E**	**SE**	**A**	**B**	**C**	**D**	**E**	**SE**
March	23.66^{b}	24.06^{bba}	23.66^{b}	25.13^{aa}	25.30^{aa}	±0.3349	9.20^{a}	7.66^{b}	7.96^{bb}	7.96^{bb}	8.00^{bb}	±0.1414
April	26.00^{c}	26.20^{ccb}	25.10^{d}	26.40^{bb}	26.83^{a}	±0.0745	7.73^{aa}	7.16^{aa}	7.86^{aa}	7.30^{aa}	7.10^{aa}	±0.2816
May	27.00^{b}	27.86^{aa}	27.20^{bb}	27.86^{a}	28.00^{aa}	±0.0666	8.20^{aa}	7.73^{bba}	7.80^{bbaa}	7.80^{bbaa}	7.66^{b}	±0.1145
June	26.30^{d}	26.66^{c}	26.93^{b}	27.00^{bb}	28.00^{a}	±0.0802	7.80^{a}	7.10^{d}	6.10^{e}	7.20^{c}	7.40^{b}	±0.0000
July	25.00^{e}	26.20^{c}	25.83^{d}	27.00^{b}	27.30^{a}	±0.0745	7.20^{bb}	7.30^{a}	7.30^{aa}	7.20^{b}	7.10^{c}	±0.0000
August	22.00^{e}	23.20^{c}	22.50^{d}	24.00^{b}	24.66^{a}	±0.0745	6.70^{c}	7.20^{bb}	7.30^{a}	7.20^{b}	7.30^{aa}	±0.0000

Means followed by the same letter(s) superscript in the same row are not significantly different using SNK at 5%

KEY

SE……Standard error

Table 2: Mean of some Physico-chemical Parameters of the Five sampling sites in Kano River

	Dissolved Oxygen (mg/l)						5-days Biochemical Oxygen Demand (mg/l)					
Months	**A**	**B**	**C**	**D**	**E**	**SE**	**A**	**B**	**C**	**D**	**E**	**SE**
March	4.40^{c}	4.63^{b}	4.70^{a}	4.30^{d}	4.20^{e}	±0.0149	1.50^{d}	1.10^{e}	2.00^{c}	3.20^{a}	3.00^{b}	±0.0000
April	4.80^{d}	5.10^{c}	5.40^{b}	5.90^{aa}	5.86^{a}	±0.0537	3.00^{d}	2.90^{e}	3.20^{b}	4.20^{a}	3.10^{c}	±0.0000
May	3.73^{b}	4.10^{aa}	2.60^{c}	3.93^{a}	2.00^{d}	±0.0614	2.10^{b}	2.70^{a}	1.50^{c}	2.73^{aa}	1.00^{d}	±0.0596
June	8.93^{a}	5.00^{bb}	4.93^{b}	3.90^{c}	3.10^{d}	±0.0557	3.80^{a}	2.40^{b}	0.90^{d}	0.50^{e}	1.20^{c}	±0.0447
July	6.80^{a}	5.93^{b}	4.80^{c}	3.80^{e}	4.40^{d}	±0.0471	4.66^{a}	3.10^{b}	0.80^{dd}	0.70^{d}	1.10^{c}	±0.0745
August	9.83^{a}	7.86^{cc}	8.90^{b}	7.86^{c}	7.20^{d}	±0.1095	4.10^{b}	3.30^{e}	3.50^{d}	3.70^{c}	4.93^{a}	±0.0298

Means followed by the same letter(s) superscript in the same row are not significantly different using SNK at 5%

KEY

SE……Standard error

Table 3: Mean of some Physico-chemical Parameters of the Five sampling sites in Kano River

	Turbidity (FAU)						Conductivity (µs/cm)					
Months	**A**	**B**	**C**	**D**	**E**	**SE**	**AB**	**CDE**	**SE**			
March	94.33^{a}	74.00^{d}	67.00^{e}	85.00^{c}	91.00^{b}	±0.2981	89.66^{b}	63.20^{d}	57.86^{e}	83.10^{c}	91.00^{a}	±0.1605
April	120.33^{bb}	105.66^{c}	84.00^{d}	132.00^{a}	114.66^{ccb}	±3.2863	81.20^{c}	61.30^{d}	45.10^{e}	87.86^{a}	84.30^{b}	±0.0596
May	168.00^{e}	232.66^{d}	252.00^{c}	325.33^{b}	347.00^{a}	±0.6146	135.30^{a}	70.30^{e}	75.10^{d}	102.00^{c}	120.30^{b}	±0.0000
June	1319.00^{c}	1015.33^{e}	1421.00^{b}	1258.00^{d}	2041.67^{a}	±15.617	40.20^{d}	45.10^{c}	39.83^{e}	59.10^{b}	61.60^{a}	±0.0745
July	299.66^{d}	262.00^{e}	366.66^{c}	906.00^{b}	991.00^{a}	±0.2108	40.96^{d}	42.10^{c}	40.30^{e}	58.10^{a}	56.86^{b}	±0.0614
August	821.70^{c}	1179.00^{bbcc}	1150.00^{bcc}	1742.00^{bba}	2060.70^{aa}	±158.35	39.20^{d}	45.30^{a}	38.20^{e}	40.20^{c}	43.83^{b}	±0.0745

Means followed by the same letter(s) superscript in the same row are not significantly different using SNK at 5%

KEY

SE……Standard error

Table 4: Mean of some Physico-chemical Parameters of the Five sampling sites in Kano River

	Phosphate (mg/l)						Nitrate (mg/l)					
Months	**A**	**B**	**C**	**D**	**E**	**SE**	**A**	**B**	**C**	**D**	**E**	**SE**
March	0.22^{d}	2.49^{a}	0.24^{c}	0.20^{e}	1.42^{b}	±0.0014	0.80^{c}	1.70^{a}	1.60^{b}	0.50^{d}	0.00^{e}	±0.0000
April	0.51^{a}	0.09^{d}	0.01^{e}	0.10^{c}	0.21^{b}	±0.0000	1.30^{a}	0.90^{b}	0.20^{e}	0.80^{c}	0.60^{d}	±0.0000
May	0.12^{b}	0.29^{a}	0.08^{c}	0.01^{dd}	0.01^{d}	±0.0000		1.60^{d}	4.80^{a}	2.60^{b}	1.80^{c}	1.50^{e} ±0.0000
June	2.13^{a}	1.13^{d}	1.04^{e}	1.14^{c}	2.10^{b}	±0.0000	4.60^{a}	3.50^{c}	1.30^{e}	2.66^{d}	3.90^{b}	±0.0745
July	1.17^{b}	0.35^{d}	0.24^{e}	1.02^{c}	1.50^{a}	±0.0059	2.60^{a}	1.20^{e}	2.40^{c}	1.50^{d}	2.50^{b}	±0.0000
August	3.99^{bb}	1.20^{d}2.49^{c}	3.79^{b}	6.65^{a}	±0.0769		12.93^{c}	13.40^{b}	11.93^{d}	14.40^{a}	12.00^{dd}	±0.0918

Means followed by the same letter(s) superscript in the same row are not significantly different using SNK at 5%

KEY

SE……Standarderror

Table5: Algal Species Identified in the Samples of Kano River (March-August, 2013)

Algae	**Estimated (cells/ml)**	**Algae**	**Estimated (cells/ml)**
Class:Bacillariophyceae(Diatoms)		**Class: Chlorophyceae (Green algae)**	
Amphipleura sp	4.0X10^{4}	*Ulothrix* sp	3.2X10^{5}
Caloneis sp	8.0X10^{4}	*Spirogyra* spp	5.0X10^{5}
Coscinodiscus sp	3.0X10^{4}	*Oedogonium* spp	1.4X10^{5}
Craticula sp	9.0X10^{4}	*Haematococcus* sp	5.0X10^{4}
Diatoma spp	1.5X10^{5}	*Cosmarium* spp	6.0X10^{4}
Encyonema sp	8.0X10^{4}	*Closterium* sp	1.0X10^{4}
Eunotia arcus	6.0X10^{4}	*Chlorococcum* sp	3.0X10^{4}
Fragilaria sp	1.6X10^{5}	*Penium* sp	1.4X10^{5}
Frustulia sp	7.0X10^{4}	Desmid	1.0X10^{4}
Gomphonema spp	7.0X10^{4}	**Class: Cyanophyceae(Blue-green algae)**	
Melosira sp	1.2X10^{5}	*Oscillatoria* sp	1.7X10^{5}
Nitzschia spp	7.5X10^{5}	*Chroococus* sp	4.0X10^{4}
Nitzschia linearis	8.0X10^{4}		
Navicula spp	3.2X10^{5}		
Navicula subtilissima	7.0X10^{4}		
Navicula tripuntata	8.0X10^{4}		
Pinnularia sp	8.0X10^{4}		
Surirella elegans	6.0X10^{4}		
Synedra spp	1.0X10^{5}		

Table 6: Correlation Coefficients of Algal Species and Physico-chemical Parameters of Kano River.

	Temp. (°C)	pH	DO (mg/l)	BOD_5 (mg/l)	Cond. (µs/cm)	Turbidity (FAU)	NO_3^- (mg/l)	PO_4^- (mg/l)	Algae
Temp.	1.00000								
pH	-0.04065	1.00000							
DO	-0.68495**	-0.31434	1.00000						
BOD_5	-0.42954**	-0.05213	0.71227**	1.00000					
Cond.	0.41315**	0.51886**	-0.61502**	-0.21239	1.00000				
Turb.	-0.03385	-0.44285**	0.34130*	0.03675	-0.49832 **	1.00000			
NO_3^-	0.56302**	-0.29802	0.71118**	0.44137**	-0.47365**	0.63505**	1.00000		
PO_4^-	-0.44100**	-0.29207	0.57447**	0.38844*	-0.47032**	0.70525**	0.74359**	1.00000	
Algae	-0.29726	-0.21302	0.49330**	0.42387**	-0.34335*	0.37090*	0.47305**	0.59616**	1.00000

** Significant at p<0.0001

*Significant at p<0.001

DISCUSSION

Sleigh (1991) opines that there are six ecological factors that are important to the life of aquatic organisms. They include water, temperature, oxygen, light, pH and salinity. The temperature measurements of Kano river corresponds to the work of Adeniyi and Ovie (1982) who reported that temperature range for the survival and optimum growth of aquatic organisms including planktons, fish and macroinvertebrates etc. is between 22^0C to 31^0C. The range is also in line with the findings of Abdullahi and Indabawa (2004) who carried out a research at River Hadejia and find out a temperature range of 21^0C to 34^0C recorded in August and May respectively. The variation in temperature throughout the research period may be associated to changes in climatic condition of the environment.

The result of the water pH in this study is in harmony with the research of Haruna (2003) who reported that conducive surface water pH for aquatic life is in the range of 6.6 to 9.3. Similarly, the mean pH value of all sites were within the acceptable limit of 6.5-8.5 recommended for inland and drinking water quality(WHO,1996) except at Site A in March (9.20) and Site C in June (6.10).For Site A, the high pH value is due to infiltration of Challawa river receiving effluents from surrounding industries into Kano river. It could also be as a result of antropogenic activities taken place regularly. The low pH value in Site C is as a result of agricultural runoffs (with varying pH conditions) into the river. This is because Site C is located close to Site B where individuals source water for irrigation activities.The Dissolved Oxygen concentrations observed in this study are however, below the recommended value by USEPA(1970) (40-60mg/l).Thus; this indicates high level of anthropogenic activities within the area. It was observed during the research that the amount of Dissolved Oxygen increases when Algal cells increases. According to (Titman, 1976) phytoplankton increase the water oxygen concentration during the process of photosynthesis which evolves oxygen for respiration.

In the present study, the values for Biochemical Oxygen Demand fluctuates within the sampling Sites, but it falls within the FEPA (1991) regulated limit of <4mg/l. Except at Site D in April, A in July and Site A&E in August. The high level of Biochemical Dissolved Oxygen in these Sites is as a result of pollutants discharged into the river due to antropogenic activities taken place regularly irrespective of the season including washing, bathing, discharge of agricultural wastes e.t.c. Abdullahi and Indabawa(2004) support the view. Besides, the high level of Biological Dissolved Oxygen could be as a result of industrial pollutants from Challawa river because Site D and E are places where river Challawa forms a confluence with Kano river. At site A, infiltration of the river occurs, the site also receives high agricultural wastes.The turbidity of the present study falls within the USEPA (1970) limit range of 1-2000 except at Site E in June and August.

The high value in this site is due to heavy rainfall leading to increase surface runoff from upper land which carries a lot of suspended materials into the river leading to high turbidity values (Anhwange *et al*., 2012) support this view. The electrical conductivity observed in this study falls within the Conductivity range for Nigerian inland water bodies as reported by Deeker *et al*., (2010).

Results of the present study revealed the phosphate level of 0.01 to 6.65mg/l. The high level of phosphate indicates eutrophication in the area; this is as a result of high rate of decomposition of organic matter, agricultural runoff, farming and other activities taken place in the area (Anhwange *et al*., 2012) support this view. The high rate of algae observed as a result of high phosphate concentration from this research is supported by earlier work of Abdullahi and Indabawa (2004),Horn and Viner (1971). The Nitrate value of this study falls within the USEPA range of <10mg/l except for August at both Sites. The high nitrate level is due to anthropogenic activities such as agricultural practices like irrigation near the river banks, excessive use of fertilizers coupled with continuous discharge of organic wastes from neighboring settlements. High algal number in relation to high nitrate concentration observed from the research is also in accordance with the work of Keeney (1972).

Fifty six (56) species of algae were identified from Kano River. Thirty seven (37) belong to the class Bacillariophyceae, Seventeen (17) belong to Chlorophyceae while Two (2) belong to Cyanophyceae. The result of this study varies with some study in Nigeria, 29 species were identified from river Hadejia (Abdullahi and Indabawa, 2004), 15 species from river Wudil (Abdullahi and Ahmed, 2013). Also Chinda and Keremah(2001) reported 89 species from Bonny estuary, Abowie *et al*., (2008) reported 43 species from lower Sombreiro river.

CONCLUSION

In conclusion, Kano River is a eutrophied water body as a result of the anthropogenic activities taking place regularly, which leads to the growth of high species of Algae. The river also receives effluents from neighbouring river (Challawa) which results in pollution of the river water. Diatoms being the predominant flora in the aquatic environment serves as indicators of pollution in the water body.

RECOMMENDATION

Industries near Challawa river should be advised to treat their effluents before discharging. This is because both River Kano and Challawa River are the major sources of water supply to Kano metropolitant and at a point, River Challawa forms a confluence with Kano River. Hence, receiving pollutants from the river which is hazardous to humans and other aquatic flora and fauna.

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