



Research Article

Water Quality and Phytoplankton Composition of River Ngadda, Northeast, Nigeria

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Water quality parameters and phytoplankton abundance of River Ngadda in Maiduguri, Borno State, Nigeria, were evaluated between February and March 2021. Water and phytoplankton samples were collected from six different stations (A-F). Temperature ranged between 16-25°C, pH between 7.3-8.3, and dissolved oxygen (DO) between 7.8-25.0 mg/L. Total dissolved solids (TDS) ranged between 180.0-760.0 NTU. The concentrations of nitrate (NO₃⁻), phosphate (PO₄²⁻), and sulphate (SO₄²⁻) were 0.52-0.92 mg/L, 0.22-0.71 mg/L, and 29.0-97.0 mg/L, respectively. A total of 25 species of phytoplankton were identified at the six stations. The Chlorophyceae were the dominant and most abundant class in the aquatic community.

ABSTRACT

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INTRODUCTION

Agricultural runoff is the major source of water pollution as it contains nitrogen compounds and phosphorus from fertilizers, pesticide salts, poultry droppings and washes down from the abattoir contamination is usually of varied composition from simple organic substances to complex inorganic compounds with varying degrees of toxicity (Alan *et al.*, 2007).

The first stage in managing and conserving aquatic environments is water quality monitoring

(Alprol *et al.*, 2021). Different environmental and behavioural factors of biotic communities can influence species diversity indices in various ways, leading to recent research focusing on understanding how these indices are affected (Shekhar *et al.*, 2008). The presence of aquatic plant species in lakes is strongly influenced by the water's chemical composition, lacustrine topography, variations in water level and depth, substrate composition, and interactions with other plant or animal communities all influence the

dispersion of a plant community in lentic water bodies (Takamura *et al.*, 2003). Poor management techniques and a variety of contaminated or suboptimal water physicochemical characteristics (dissolved oxygen, pH, total nitrogen, total phosphorus, nitrite, nitrate, ammonia, and COD, Mn, etc.) can impair an aquatic animal's ability to thrive and even survive (Alprol *et al.*, 2021).

Phytoplankton forms the base of the aquatic food for zooplankton fish, crustaceans, herring and their larvae (Onyema, 2008). Phytoplanktons are recognized worldwide as bioindicator organisms in the aquatic environment (Yakubu *et al.*, 2000). The abundance of phytoplankton growth in the water column reflects the influence of the environmental factors and their process (Surthers *et al.*, 2008; Bwala, 2019). In tropical and temperate climates, there are typically seasonal variations in the quality of plankton populations found in water bodies (Shekhar *et al.*, 2008). Due to its sensitivity to changes in the water environment, phytoplankton, a significant primary producer in aquatic environments such as ponds, lakes, and rivers, can also be utilized as biological indicators in water quality monitoring (Alprol *et al.*, 2021).

Water pollution affects species composition and health of aquatic ecosystems; hence the aim of this study was to assess of water quality and phytoplankton composition of the arid zone aquatic ecosystem, River Ngadda, Maiduguri, Nigeria.

MATERIALS AND METHODS

Study Area

River Ngadda originates from rivers Yedzeram and Gombole which meet at the confluence in Sambisa, both in Nigeria and flows as river Ngadda into Alau dam, and stretches down across Maiduguri Metropolis, then empties into Lake Chad.

Sampling stations

Water samples were collected from 6 points along river Ngadda designated as station A-F. Point of discharge of wastewater from water treatment plant (11°47'28.1N and longitude

013°11'33.8E) as station A, Fori bridge (11°48'14.6N and 013°11'52.9E) as station B, Lagos bridge lies between 11°49'10.2N and 013°10'18.9E as (station C) Anguwan Doki (11°49'52.0N and 013°09'28.9E) as station D, Gwange bridge (11°49'49.2N and 013°09'31.3E) as station E and the point of discharge of Abattoir water into river Ngadda (11°51'29.8N and 013°11'01.0E) as station F.

Sampling of water

Sampling was carried out 3 times within 45 days in February 2016 and March 2016. Phytoplankton sampling periods were usually between 8:00 am and 12:00 noon. Water quality parameters and nutrients were analyzed using standard operation procedure (SOP) as described by (APHA, 1998).

Physiochemical parameters

The parameters analyzed include pH, Temperature, (Celsius Thermometer), total dissolved solids (TDS) using gravimetric methods and dissolved oxygen (DO) using the Winkler method. Nutrients measured include nitrate (NO₃⁻), phosphate (PO₄³⁻) and Sulphate (SO₄²⁻) which were determined by spectrophotometer.

Sampling of phytoplankton

Phytoplankton samples were collected by pouring 20 L of surface water through plankton net of 40µm-mesh size and 30 cm diameter. The filtrate was concentrated to 100ml for each sampling station and 4% formalin was added to each sample to preserve the organisms. The samples were transported to the laboratory for analysis.

In the laboratory, 1 ml of the preserved sample was taken as a sub-sample using a pipette. The collected samples were put on a slide and viewed under a light binocular microscope (Nikon 400) using a low magnification of ×10. A duplicate specimen was collected and analyzed for comparison and double-checking. The observed Phytoplankton was identified using relevant literature references.

Determination of Relative Abundance of Phytoplankton

Relative abundance (%Ra) was determined using the formula; (George *et al.*, 2012).

$$\%Ra = \frac{n(100)}{N}$$

Where n=total number of Plankton species under consideration.

Where N= total number of all the species of the Plankton group

RESULTS

The physiochemical parameters of the different stations show that water temperature ranged between 16°C in station D and 25°C in station F. pH ranged between 7.340 mg/L at station A to

8.286 mg/L at station C. DO ranged between 7.8 mg/L at station D to 25.0 mg/L at station B. total dissolved solids of the water samples ranged between 180.0 mg/L at station B to 760.0 mg/L at station F (Figure 1).

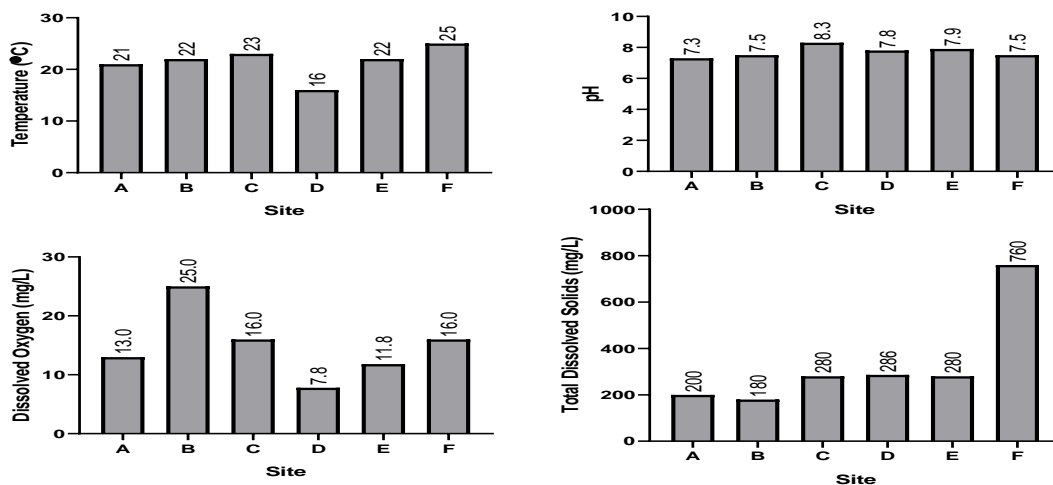


Figure 1: Some water quality parameters of different sampling stations in River Ngadda, Maiduguri, Nigeria

Table 1 shows the composition of 8 genera of Chlorophyceae (green algae), 6 genera of Bacillariophyceae (diatoms), 2 genera of Euglenophyceae (euglenoids), 2 genera of Chrysophyceae (golden-brown algae), and 1

genus each of Cryptophyceae (cryptomonads), Cyanophyceae (blue-green algae), Rhodophyceae (red algae), and Xanthophyceae (yellow-green algae).

Table 1: Phytoplankton encountered in different stations in River Ngadda, Maiduguri, Northeast Nigeria

Family	Site					
	A	B	C	D	E	F
Chlorophyceae	46	49	18	33	142	13
Cryptophyceae	6	11	0	2	4	0
Chrysophyceae	0	1	0	29	2	0
Cynophyceae	16	9	0	0	2	0
Euglenophyceae	24	23	6	0	0	0
Bacilariophyceae	21	21	31	9	11	0
Rhodophyceae	7	12	0	9	0	0
Xanthophyceae	0	0	0	3	0	0

The highest nitrate value is 0.92 mg/L at station B and the least (0.52 mg/L) occurred at station F. Phosphate concentration ranged between 0.22 mg/L at station A to 0.71 mg/L at station E.

sulphate content of water samples was found to fluctuate between 29.0 mg/L at station E to 97.0 mg/L at station F (Figure 2).

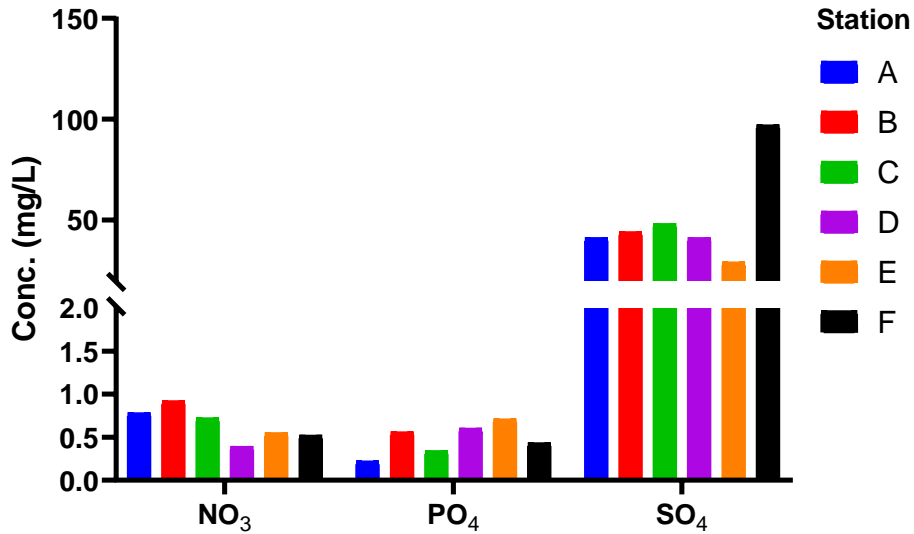


Figure 2: Non-metallic oxides in water from different sampling stations in River Ngadda, Maiduguri, Nigeria.

The result indicates that the water body is dominated by chlorophyceae in most of the stations except station C, which has bacillariophyceae the most phytoplankton

abundance. In station F, only one class of phytoplankton was encountered Chlorophyceae (100%) (Table 2).

Table 2: Relative abundance of different classes of phytoplankton in River Ngadda, Maiduguri, Nigeria

Class	Relative Abundance (%) /Station					
	A	B	C	D	E	F
Chlorophyceae	38.3	38.9	32.7	38.8	88.2	100.0
Cryptophyceae	5.0	8.7	0.0	2.4	2.5	0.0
Chrysophyceae	0.0	0.8	0.0	34.1	1.2	0.0
Cynophyceae	13.3	7.1	0.0	0.0	1.2	0.0
Euglenophyceae	20.0	18.3	10.9	0.0	0.0	0.0
Bacillariophyceae	17.5	16.7	56.4	10.6	6.8	0.0
Rhodophyceae	5.8	9.5	0.0	10.6	0.0	0.0
Xanthophyceae	0.0	0.0	0.0	3.5	0.0	0.0

DISCUSSION

Station A was polluted with wastewater discharged from the Maiduguri Water Treatment

Plant (MWTP). This is because there are fewer anthropogenic activities at this point than at other points. Station B has a higher concentration of

pollutants compared to station A, such pollutants are agricultural runoffs from irrigation sites along the river course and wastewater from residential areas.

Station C has a higher concentration of pollutants compared to stations A and B, this is because this point is located near Lagos bridge where high anthropogenic activities take place there such as tie and dye, cattle drinking, refuse dumping and also the discharge of sewage from residential houses. Station D was located near Maiduguri Monday market, where the discharge of wastewater from both residential and market areas occurs. However, a large quantity of garbage from the Monday market is discharged into these points which eventually contribute to high concentrations of pollutants. Station E was polluted with a load of refuse, sewage and wastewater from residential houses along the river course.

As for station F, the concentrations of almost all the parameters measured in this study were higher compared to the ones in stations A – E. Such levels are because this point is located at the immediate discharge of abattoir wastewater into river Ngadda.

Hence, abattoir effluents could increase the levels of nitrogen, phosphorus, and total dissolved solids in the receiving water body. Excess nutrients cause the water body to become choked with organic substances and organisms. When organic matter exceeds the capacity of the microorganisms in water that break down and recycle the organic matter, it encourages rapid growth or blooms of algae, leading to eutrophication. Improper management of abattoir waste and subsequent waste disposal either directly or indirectly into river bodies portends serious environmental and health hazards to aquatic life (Akan *et al.*, 2010).

The temperature values for station A were within the optimum temperature range of surface water between 4° C to 30° C. Although, the temperature of hot springs may exceed 40° C. At a higher temperature plants grow and die faster, leaving behind matter that requires oxygen for decomposition.

The pH values for station A-F were within the stipulated values of 6.0-9.0 according to the WHO guidelines. The pH values obtained for river Ngadda in station A-F fell within this range.

Therefore the parameter does not give cause for concern in the present study. Dissolved oxygen (DO) is a measure of the degree of pollution by organic matter, the destruction of organic substances as well as self-purification capacity of the water body. The (NESREA, 2011) guideline value for DO was 4.0-6.0 mg/L. All samples analyzed were above the minimum and maximum guideline values for the protection of fisheries and aquatic life. An extremely high level of DO result from photosynthesis by a large amount of plants, and great uncontrolled plant growth especially algal blooms is often the result of fertilizer runoff. Total Dissolved Solids (TDS) is a measure of the concentration of dissolved constituents in water. Changes in TDS can be harmful to aquatic organisms affecting the density of water. Excess TDS can reduce water temperature and water clarity and hinder photosynthesis (USEPA 1995; Mason 1998; Bwala, 2019). The TDS levels recorded in the entire sampling stations were higher than the WHO guideline limit of 100.0 mg/L for the protection of fisheries and aquatic life, probably due to agricultural and residential runoff.

Nitrate is an inorganic compound of nitrogen which is bioavailable for plant uptake and is essential to plant growth (Mason, 1998; Cameron *et al.*, 2003). Natural levels of nitrate in water bodies are typically lower than 1 mg/L. The nitrate water quality guideline established by the Canadian Council of Ministers of the Environment (CCME) for the protection of aquatic life is 13mg/L. Nitrate is virtually harmless with direct toxic effects typically not observed until concentration greater than 45mg/L. The nitrate levels observed in the entire sampling station were less than the WHO limit of 45 mg/l. Five of the sampling stations had a nitrate concentration of less than 1.0 mg/L which is natural; sampling station D has a nitrate concentration of 1.3 mg/L indicating a sign of eutrophication. Phosphorus is essential for all life as a component of nucleic acids and universal energy molecules. Excess phosphorus triggers eutrophication which involves the prolific growth of algae and other aquatic plants. The levels of phosphate in all the sampling stations were less than the WHO's maximum permissible limit of 5

mg/L. Sulphate is a non-metallic element that occurs naturally in numerous minerals including Barite, Epsomite and Gypsum. To protect freshwater organisms in British Columbia, a water quality guideline of 50 mg/L. Therefore a water body with a concentration of dissolved sulphate that exceeds 50 mg/L is a result of anthropogenic sources. The sulphate levels observed in the entire sampling station were below the guideline limit of 50 mg/L except in station F where the sulphate concentration is 97.0 mg/L. this is an indication of water pollution in the sampling station F.

A total of 25 phytoplankton species were recorded in this finding. The dominance of algal flora from the 6 different stations in river Ngadda was represented by green algae (Chlorophyceae). However, similar findings with diatom dominance have been reported by Emmanuel and Onyema (2007), Adesulo and Nwankwo (2008), Davies *et al.* (2008), Olomukoro and Oronsaye (2009) and Mustapha (2010),

The diatoms have been used by ecologists to indicate pollution in water bodies and variations in ecological conditions. A diatom is a useful indicator in eutrophication. Other diatoms like *Synedramelosira* and *Navicular* when in large numbers are indicators of sewage pollution and eutrophic conditions (Kamran *et al.*, 2003). Some euglenoids can tolerate various levels of organically polluted waters and therefore can be used as indicators of organic pollution, Euglenoids include *Euglena* and *Phacus* (Nweze and Domrufus, 2006).

REFERENCES

Adesalu T. A. and D. I. Nwankwo (2008). Effect of water quality bi indicator Phytoplankton of a sluggish tidal creek in Lagos. Niger. Pak. J. bio. Sci, 11: 836-844.

All these species were encountered in river Ngadda during the study period. All these potential indicators of water pollution, apparent from the physiochemical conditions of the river, signal that river Ngadda is tending towards being eutrophic as a result of organic pollution, which may pose a hazard to aquatic life.

The large phytoplankton observed (Chlorophyceae) was dominated by *Botryococcus* forms. Diatoms were dominated by the *Suivirella* forms. The order of dominance of the Phytoplanktons group was Chlorophyceae (54.627) > Bacillariophyceae (16.518%) > Rhodophyceae (9.414%) > Chrysophyceae (5.684%) > Cyanophyceae (4.769%) > Euglenophyceae and Xanthophyceae (3.375%) > Chryptophyceae (1.243%).

CONCLUSION

From the result of this study, the level of pH, DO, TDS and Nutrients in all the sampling stations were higher than the WHO and CCME regulatory limits for aquatic life. This is an indication that urban and residential waste, abattoir wastewater and solid waste discharged into River Ngadda have had a significant effect on the ecological balance of the river.

RECOMMENDATION

It is recommended that regular monitoring of water quality and other indicator organisms of River Ngadda is observed for environmental quality and sustainability for the communities that depend on the water body. Further studies that will include other sites and parameters will provide a more detailed status of the aquatic community.

Akan, J. C., Abdulrahman, F. I., Sodipo, O. A., Ochanya, A. E., & Askira, Y. K. (2010). Heavy metals in sediments from river Ngada, Maiduguri Metropolis, Borno state, Nigeria. *Journal of Environmental*

- Chemistry and Ecotoxicology*, 2(9), 131-140.
- Alan J.B. Islam M.R, Muyen Z, Mamum M, Islam S (2007). Water quality parameter along rivers, *International Journal Environmental Science and Technology*. 4,159 – 167.
- Alprol, A. E., Ashour, M., Mansour, A. T., Alzahrani, O. M., Mahmoud, S. F., & Gharib, S. M. (2021). Assessment of water quality and phytoplankton structure of eight alexandria beaches, southeastern mediterranean sea, Egypt. *Journal of Marine Science and Engineering*, 9(12), 1328.
- APHA (1998.) Standard methods for the examination of waters and waste waters. 19th Edition American public health Association Washington DC, pp. 4800.
- Bwala, M. N. (2019). The abundance of phytoplankton in River Nggada and River Ngadda-Bul, Maiduguri Metropolis, Borno State, Nigeria. *Global Educational Research Journal*, 7(7), 820-829.
- Davies, O. A., Abolude, D. S., &Ugwumba, A. A. A. (2008). Phytoplankton of the lower reaches of Okpoka creek, Port Harcourt, Nigeria. *Journal of Fisheries International*, 3(3), 83-90.
- Emmanuel, B. E., & Onyema, I. C. (2007). The Plankton and fishes of a tropical creek in South-western Nigeria. *Turkish Journal of Fisheries and Aquatic Sciences*, 7(2), 105-113.
- George, E. E., Samuel, I. U., &Andem, A. B. (2012). Composition and Abundance of Phytoplankton of Adiabo River in Calabar River System, South-East, Nigeria. *European Journal of Zoological Research*, 1(4), 93-98.
- Kamran Tassaduqe, K. T., Muhammad Ali, M. A., Abdus Salam, A. S., Muhammad Latif, M. L., &Tasveer Zahra, T. Z. (2003). Study of the seasonal variations in the physico chemical and biological aspects of Indus River Pakistan.
- Mustapha, M. K. (2010). Seasonal influence of limnological variables on plankton dynamics of a small, shallow, tropical African reservoir. *Asian Journal of Experimental Biological Sciences*, 1(1), 60-79.
- NESREA(2011):National Environmental (Surface and Groundwater Quality Control) Regulation. National Environmental Standards and Regulation Agency. 2011.
- Nweze, N. O., &Domrufus, N. A. (2006). Limnological studies on nike lake, enugu, enugu state—the metaphyton and some physic-chemical aspects. *Nigerian Journal of Botany*, 19(2), 396-404.
- Onyema I. C and Ojo A. A (2008.) The zooplankton dynamic and chlorophyll a concentration of a tropical tidal creek in relation to water indices. *Life Science Journal*. 54: 7-14.
- Shekhar, T. S., Kiran, B. R., Puttaiah, E. T., Shivaraj, Y., & Mahadevan, K. M. (2008). Phytoplankton as index of water quality with reference to industrial pollution. *Journal of Environmental Biology*, 29(2), 233.
- Takamura, N., Kadono, Y., Fukushima, M., Nakagawa, M., & Kim, B. H. (2003). Effects of aquatic macrophytes on water quality and phytoplankton communities in shallow lakes. *EcologicalResearch*, 18, 381-395.
- U.S Environmental Protection Agency (1995). National water quality inventory report to congress 2011. Reporting cycle October 2011. (EPWashington DC Document NO – EPA 841-r-07-001.
- Yakubu, A. F., Sikoki, F. D., Abowei, J. F. N., & Hart, S. A. (2000). A comparative study of phytoplankton communities of some rivers creeks and borrow pits in the Niger Delta Area. *Journal of applied science, Environment and Management*, 4(2), 41-46.