



RESEARCH PAPER

Water Quality and Algal Biodiversity of River Gbako Badeggi, Niger State, Nigeria

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ABSTRACT

Algae are significant component of biological monitoring programs for assessing water quality. They are eligible to water quality assessment due to their nutrients requirements, rapid reproduction rate, and very short life cycle. The physico-chemical and algal characteristics of River Gbako, Badeggi, Niger State Nigeria were studied in three stations over a period of six months from May to October 2017. Standard methods were used to determine the physico-chemical parameters such as temperature, depth, transparency, pH, [Electrical conductivity (EC), Total dissolved solids (TDS), Biological oxygen demand (BOD₅), Dissolved oxygen (DO), phosphate and nitrate, while published keys were used to identify the algal distribution. The mean values of all the physicochemical parameters determined for the three sampling stations differ significantly ($P \leq 0.05$) except for BOD₅, TDS and water temperatures which were not significantly different between the stations sampled. Algal abundance showed the following decreasing order: Heterokontophyta>Cyanophyta>>Chlorophyta>Euglenophyta>Cryptophyta. The algal frequency of occurrence for the three sampled stations were Sp1 of 327 (individuals/ml), Sp2 of 563 (individuals/ml) and Sp3 335 (individuals/ml) with the total algal density of 1215 individuals/ml. The surface water in the six sampling stations studied revealed the fluctuations of the investigated parameters along the sampling stations, which could be attributed to both anthropogenic and natural activities, consequently the diverse algal distribution. Cyanophyta have detrimental effects on various uses of water, hence there is the need to prevent River Gbako, natural water supplies from being taken over by the Cyanophyta.

Keywords: River Gbako, Algae, biodiversity

INTRODUCTION

Rivers as water bodies are important in maintaining a balance in the ecosystem through supporting diverse plankton (phytoplankton and zooplankton) and other organisms in the food chain. Recently, there has been a growing necessity for the conservation of natural resources, especially water due to, increasing populations, progressive industrialization and series of agricultural practices leading to increased pollution of our surface waters (Mohammad and Saminu, 2012). Sufficient and safe water supply is a pre-requisite for significant socio-economic development of any community (Chenoweth, 2008). Unfortunately, in many areas of the world, especially developing countries including Nigeria, it is difficult to obtain a steady source of clean water for drinking and for agricultural uses. Rivers constitute one of the major sources of water

supply in the world (Dadi-Mamud, *et al.*, 2012). Rivers are equally useful in generating electricity, fisheries, irrigation and for domestic animals (Zakariya *et al.*, 2011). River Gbako is the major source of water to Badeggi community, as a source drinking and other purposes. However, anthropogenic activities that include bathing, washing, indiscriminate disposal of wastes and refuse in the river, fishing and farming using pesticides and herbicides around the river can all serve as sources of pollution. In addition, domestic animals such as cattle come around to drink water, which also could lead to faecal contamination, hence posing health concern to

Received 17 June, 2018

Accepted 22 July, 2018

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the people of the community. The assessment and continuous monitoring of the quality of water sourced from rivers can be used to define existing conditions, detect trend and or establish sources of pollution. The quality of water is often affected by rocks, soil and surface through which it flows and anthropogenic e.g. Industrial, agricultural and mining activities (Ibeto and Onianwa, 2011).

Several studies revealed that these activities coupled with atmospheric factors affect the suitability of water for all purposes (Hulyal *et al.*, 2008). Algae are eligible to water quality assessment due to their nutrients requirements, rapid reproduction rate and very short life cycle. They are important indicators to environmental situation since they respond immediately to both qualitative and quantitative composition of species in wide range of water situation due to alters in water chemistry (Gokce, 2016).

Algal abundance can be affected by turbidity levels, and other physicochemical factors High turbidity affects primary productivity, as it reduces the amount of light penetration which in turn reduces photosynthesis and hence primary productivity (APHA, 2005). Nutrient limitation is important in the regulation of algal abundance (Hirose *et al.*, 2003). Therefore, evaluating the physico-chemical and algal constituents of surface waters is essential in appraising their quality and suitability for various purposes (Nweze, 2009).

METHODOLOGY

Study Area

Badeggi is in Katcha Local Government area of Niger State, Nigeria, with its' headquarter in Bida. It coordinates are 9° 3' 0" North and 6° 9' 0" East. River Gbako is located in Badeggi area and has the characteristic tropical climate of two distinct seasons, a dry season (November to April) and a wet season (May to October).

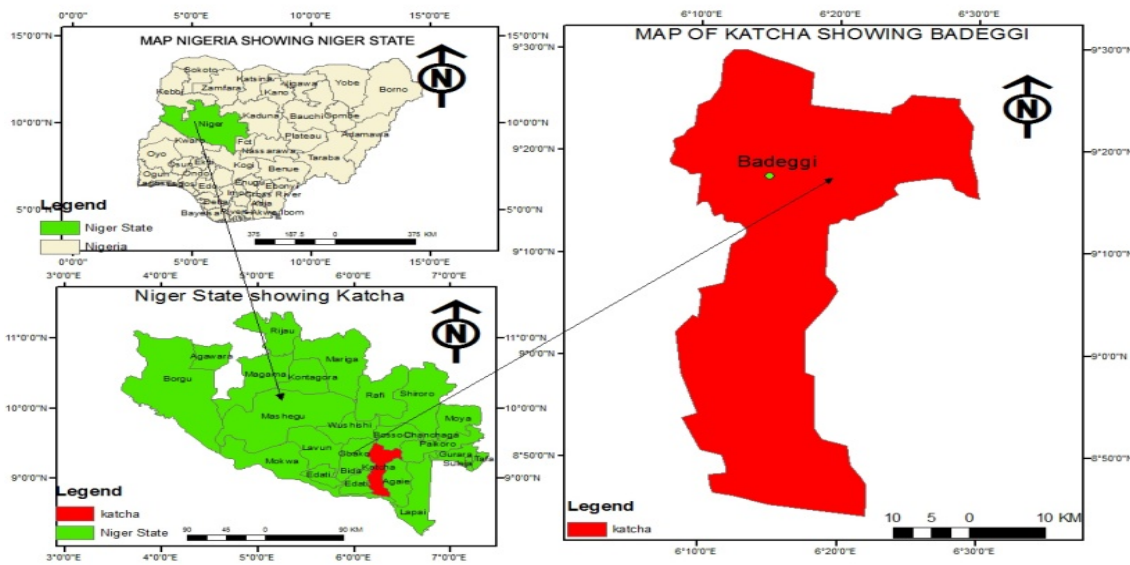


Figure 1: Showing Map of Badeggi in Katcha LGA of Niger State Nigeria, the sampling area

Sampling Stations

Samples for analyses of the physico-chemical and algal diversity were collected once in a month for six (6) months during wet season (May to October) from three (3) sampling station along the course of River Gbako. The sampling points were; along the bridge, conflict of Egba stream and River Gbako labeled as SP1, SP2 and SP3 respectively.

Sampling position (Sp1) experiences anthropogenic activities which include collection of sand for construction, occasional bathing and washing of clothes. (Sp2) experiences no anthropogenic activities, and it is shaded by bridge, designated as control, while (Sp3) experiences moderate anthropogenic activities; but exposed to

sunlight due to no shading by vegetation and has a tributary. There are also farmlands along the banks where cassava, garden egg, pepper and maize are cultivated.

Samples Collection

Water samples for physico-chemical analyses were collected with two liter plastic bottles for laboratory analyses. Sample for algal studies were collected in bottle (0.75litre volume) from the side of river after the methods of Nweze (2009). Physico-chemical analyses were carried out using the methods described by the America Public Health Association (APHA, 2005) as modified by Dadi-Mamud (2014). Subsurface samples for phytoplankton studies were collected using 1000 ml container filled to 800 ml mark. Algae from mud or water sediment for photo -benthos were collected by scooping mud from the river bed into transparent plastic container and The algae attached on base of river and on stones were brushed into 1 L of container. Samples for algal analyses were preserved with 2.4 ml Lugol's iodine in 800 ml of sample and the samples were kept in the dark (APHA, 2005) All samples collected were transported to the Biology laboratory Ibrahim Badamasi Babangida University Lapai in a plastic container. Identification was carried out using the dichotomous key of Bellinger and Sigeo, (2010), in addition, standard texts used by Huynh and Serediak (2006). Algal enumeration was done using "Drop count method" as described by Ramanchandra and Solanki (2007).

Statistical Analysis

Paleontological Statistics (PAST) version 3.01 was used for the Analysis of Variance (ANOVA), and post hoc test diversity for the physico-chemical characteristics and determination of the diversity of the algal species in each Sampling stations.

RESULTS

Physico-chemical parameters

Monthly variations of the physico-chemical parameters of sp1 are presented in Table 1. The mean water temperature value were higher in station 1 than the other two stations, while the mean depth of the three sampling stations were highest in station one followed by station 2 and station 3 had the least depth. The mean transparency highest values were recorded in station 1 while the least in station 2. The mean pH values were 6.92 ± 0.24 , 6.70 ± 0.13 and 6.00 ± 0.46 for Sp1, Sp2 and Sp3 respectively. River Gbako mean values for total dissolved solids (TDS) for the three sampling sites were highest in station 3 followed by station 1 and sampling station 2 had the lowest value recorded in this study. The electrical conductivity (EC) mean values for Sp1, Sp2 and Sp3 were recorded in the values of 130.00 ± 0.24 , 120.06 ± 5.01 and 140.00 ± 4.56 respectively. Biochemical Oxygen Demand (BOD₅) mean values for Sp1, Sp2 and Sp3 were lowest in station 2 and highest in station 1, while the Dissolved oxygen (DO) mean values were lowest in station 1 and highest in station 2, with high values of the DO when the BOD₅ is low and high values of BOD₅ when the DO is low, as determined in the study. The macronutrients of Phosphate (PO₄-P) and Nitrate (NO₃-N) mean values were recorded to be $1.45 \pm 0.02 \text{mg/l}$, $1.23 \pm 0.04 \text{mg/l}$ and $3.75 \pm 0.01 \text{mg/l}$ and $116.36 \pm 2.31 \text{mg/l}$, $85.45 \pm 4.21 \text{mg/l}$ and $74.55 \pm 2.01 \text{mg/l}$ respectively. All the mean values of the physicochemical parameters determined for the three sampling stations differ significantly ($P > 0.05$) except for BOD₅, TDS and Water temperatures which are not significantly different within the stations sampled as revealed by post hoc test.

Table1: Monthly Mean variations in physico-chemical parameters of River Gbako from May to October August for the three sampled stations

Physicochemical Properties	Sp1 Mean SED	Sp2	Sp3
pH	6.92±0.24 ^b	6.70±0.13 ^{ab}	6.00±0.46 ^a
Phosphate (mg/l)	1.45±0.02 ^b	1.23±0.04 ^a	3.75±0.01 ^c
Nitrate (mg/l)	116.36±2.31 ^b	85.45±4.21 ^c	74.55±2.01 ^c
D.O (mg/l)	0.06±0.01 ^a	1.04±0.01 ^b	0.08±0.01 ^c
BOD5 (mg/l)	0.10±0.00 ^a	0.01±0.02 ^a	0.06±0.01 ^a
TDS (mg/l)	85.80±0.34 ^c	79.2±2.04 ^c	92.4±4.57 ^c
E.C.	130.00±0.24 ^c	120.06±5.01 ^c	140.00±4.56 ^c
Water temp. (oC)	29.60±0.02 ^a	29.00±0.27 ^a	29.00±1.78 ^a
Depth (cm)	31.00±0.04 ^a	29.00±1.57 ^a	100.00±4.57 ^{ab}
Transparency (cm)	30.05±0.56 ^b	14.00±0.31 ^a	15.50±0.98 ^a

Values are mean ± SEM of 3 determinations. Values along the same row with different superscripts are significantly different ($p < 0.05$).

Algal biodiversity

Monthly variations of algal density in (SP1) measured as individuals per milliliters are showed in Table 2. There were temporal variations in the algal density. The algal diversity for the three sampled stations were Sp1 of 327 (individuals/ml), Sp2 of 563 (individuals/ml) and Sp3 335 (individuals/ml) with the total algal density of 1215 individuals/ml. Algal abundance showed: Heterokontophyta > Cyanophyta > Chlorophyta > Euglenophyta > Cryptophyta in decreasing order, while the percentage abundance of the species determined were Heterokontophyta had the highest percentage individuals/ml with

35.03%, followed by Cyanophyta which had 27.05% per Individuals/ml with Chlorophyta with percentage individuals/ml of 24.32.43% then Euglenophyta following with Individuals/ml of 11.76%, while Chryptophyta had the least percentage of 1.64% Individuals/ml. The most dominant organism in Sp1 was *Anabaena aequalis* Borge, while the least was *Pinnul aria*. *Oscillatoriarubescens* Dec was the most dominant species in Sp2 and Sp3 while the least species in Sp2 was *Pinnul aria* and *Navicula sp 1* in Sp3 respectively. *Navicula sp 1*, *Navicula sp 2*, *Pinnul aria* and *Nitzschia sp* from the order Heterokontophyta were the most evenly distributed, while the remaining algal species were not evenly distributed.

Table 4: Composition, relative abundance and distribution of Algae in three stations in River Gbako, BadeggiNiger State from May, 2017 to October, 2017

Organisms Order	Genus/species	Sampling stations				
		Sp1	Sp2	Sp3	Total	Percentage
Cyanophyta	<i>Anabaena aequalis</i> Borge	74	20	-	84	6.91
	<i>Cylindrospermummajus</i> Kuet	32	10	-	42	3.45
	<i>Oscillatoria rubescens</i> Dec	-	101	72	173	14.23
	<i>Lyngbya aestuarii</i> Liebman	-	-	30	30	2.46
					27.05	
Cryptophyta	<i>Cryptomonas acuta</i> Butcher	-	20	-	20	1.64
					1.64	
Chlorophyta	<i>Closterium parvulum</i> Nägeli	17	-	25	42	3.45
	<i>Spirogyra fluviatilis</i> Hilse	11	4	-	15	1.23
	<i>Ankistrodesmus falcatus</i> Ralfs	11	71	18	100	8.23
	<i>Cosmarium panamense</i> Presc	-	95	40	135	11.11
	<i>Ulothrix aequalis</i> Kuet	-	5	-	5	0.41
					24.43	
Euglenophyta	<i>Euglena acus</i> Ehrenb	35	35	-	70	5.76
	<i>Euglena sanguinea</i> Ehrenb	36	37	-	73	6
					11.76	
Heterokontophyta	<i>Navicula sp. 1</i>	42	28	9	79	6.5
	<i>Navicula sp. 2</i>	18	18	12	48	3.95
	<i>Navicula sp. 3</i>	-	42	17	59	4.85
	<i>Pinnularia</i>	3	2	18	23	1.89
	<i>Nitzschia sp</i>	8	10	9	27	2.22
	<i>Diatoma sp</i>	40	60	-	100	8.23
	<i>Cymbella sp</i>	-	-	54	54	4.44
	<i>Eunotia tetraodon</i> Ehrenb	-	5	20	25	2.05
	<i>Stauroneis sp</i>	-	-	11	11	0.9
					35.05	
Total		327	563	335	1215	100

DISCUSSION

This present study revealed that physico-chemical and algal characteristics of Gbako River showed spatiotemporal variations. Based on the results of the physico-chemical parameters, the water quality in Gbako River was slightly acidic but not highly polluted. Temperature results observed in this study agree with the reports of Dadi-Mamud *et al*, (2014) that minimum and maximum temperature of 24.5 – 29.5°C is normal for

tropical waters for optimal growth of organisms. Depth values recorded in this study are lower than those recorded by Aghoghovwia (2011) of 780 – 1500 cm on Warri River, Nigeria. Depth values tend to increase as a result of influx of flood which consequently increases the volume of water in the basin. Transparency is largely determined by suspended solids and tended to be high when suspended solids were low (Mohammad and Saminu, 2012), as obtained

in this study. The pH values recorded in this study indicated that the water was slightly acidic with occasional slight alkaline condition and this is in consonance with the report by Morris, (2003) that rivers flowing through forest are acidic with pH ranging from 4 to neutrality. Anthropogenic impacts involving the use of soaps and detergents may have also contributed to the acidic pH observed (Abubakar, 2007), though it falls within WHO permissible standard of 6.5 – 9.5. The variations in the mean TDS between months indicated that rainfall might have brought in nutrients that caused high values recorded. Flood from the rain dissolve solids from lands surrounding the river to increase TDS values during the rainy season (Abubakar, 2007). TDS mean value recorded in this study is below the WHO maximum permissible limit of 1000 mg/l. The high BOD₅ occurred in stations with low dissolved oxygen, this might be attributed to organic, inorganic and oxygen demanding pollutants present in the water sources (Mohammad and Saminu, 2012). The dissolved oxygen values recorded in this study is comparable to the values recorded by Mohammad and Saminu (2012) on Salanta River, Kano, Nigeria, and Dadi-Mamud (2014) on River Ndakotsu Lapai, Niger State Nigeria. Phosphate values recorded in this work is higher than the one recorded in River Ndakotsu Lapai, Niger State Nigeria by Dadi-Mamud et al, (2014). The values of nitrate recorded in this work are lower compared to the values obtained on Otamiri River by Akubugwo and Duru (2011). The concentration of phosphate observed is higher than the WHO limit and this could have been caused by rain, surface run-offs, agriculture run-off and laundry activities (Manjare et al., 2010). However, the composition, abundance and distribution of the algal species show that the Gbako River is moderately polluted. As noted by Mustapha, (2008), high nitrate levels (> 1 mg/l) are not good for aquatic life; hence the River Gbako may not likely support a rich biota.

The lowest mean algal density of algal species in Sp1, could be attributed to the impact of anthropogenic activities taking place around and within the river. The distribution of algal species in Sp2 is higher than the two other stations sampled. It could also be attributed to low light intensity and absence of other

physical and chemical factors which promote algal growth (Zakariya et al., 2011). The absence of anthropogenic activities in Sp2 the control station could have contributed to its increased in algal population. Heterokontophyta having the highest species number, represented majorly by diatoms, could be due to the fact diatoms seemed to have wider tolerance range for pH fluctuations. There are members of the Chlorophyta that serve as indicator organisms, such as desmids e.g. *Cosmarium* sp. And *Ankistrodesmus* sp., these desmids are found especially in oligotrophic environments (Yasmin et al., 2011). The presence of certain desmids, even in low numbers is considered to be a good indicator of mildly acidic, oligotrophic conditions (Wetzel, 2001). The results of the diversity indices showed also that the River Gbako is moderately polluted. Cyanophyta have detrimental effects on various uses of water (Zakariya et al., 2011), hence there is the need to prevent River Gbako, natural water supplies from being taken over by the Cyanophyta. The high density of algae in station 2 could be attributed to the high dissolved oxygen and macronutrients recorded in this station. Dadi-Mamud et. al., reported high occurrence of Cyanobacteria in aquatic environments and tied it to physicochemical parameters.

REFERENCES:

- Abubakar, M. M. (2007). The phytoplankton community of Nguru Lake, Kano. *Journal for Science Education*, 4(1): 16-21.
- APHA, (2005). *Standard methods for the examination of water and Wastewaters* 21st edition American Public Health Association American Water works Association Water Environment Federation American Public Health Association, Washington. 1056pp.
- Chenoweth J., (2008). Minimum water requirement for social and economic development, *Science direct* Vol. 229 issues 1-3: 245-256.
- Belcher, H. and Swale, E. (1976). *A Beginner's Guide to Freshwater Algae*. Her Majesty Stationery Office, London, 47 pp. Bellinger, E. G. and Siegel, D. C.

- (2010). Freshwater Algae Identification and Uses as Bioindicators. *John Wiley and Sons Ltd.* West Sussex, United Kingdom, 285 pp
- Dadi-Mamud, N. J., Oniye, S. J., Auta, J. and Ajibola, V. O (2014). Community Pattern and Diversity Index of Macro-Invertebrates in Relation to Surface Water Interface of River Ndakotsu, Lapai Nigeria. *Asian Journal of Science and Technology* Vol. 5, Issue 9 pp 546-552, ISSN: 0976-3376. Available Online at <http://www.journalajst.com>.
- Dadi-Mamud N. J., Oniye, S.J., Balarabe, M.L., Auta J. and Gudugi, I.A.S (2012). Toxicological Implications of Polluted Water from Makera Drain, Kaduna on Some Cereals and Horticultural Crops *Mediterranean Journal of Social Sciences* ISSN 2039-9340 Vol 3: (16):180-185.
- Gokce D., (2016). Algae as an indicator of water quality, <http://dx.doi.org/105772/62916>.
- Ibeto, C. N. and Onianwa, P.C. (2011). Preliminary study of the impact of poor wastemanagement on the physico-chemical properties of ground water in some areas of Ibadan. *Research Journal of Environmental Science*, 5: 194-199.
- Hirose, M., Nishibe, Y. and Nakano, S. (2003). Seasonal change in the phytoplankton and environmental factors in hypereutrophic Furnike pond. *Aquatic Ecology*, 37:37-43.
- Hulyal, S. B. and Kaliwal, B. B. (2008). Dynamics of phytoplankton in relation to physico-Chemical factors of Almathi Reservoir of Bijapur District, Karnataka State. *Environmental Monitoring Assessment*, 153(1-4): 45 – 59.
- Huynh, M. and Serediak, N. (2006). Algae Identification Field Guide. Agriculture and Agri-food, Canada. 40 pp. Ibeh, L. M. and Mbah, C. N. (2007). Surface water characteristics of urban rivers in Enugu, Southeastern Nigeria. *World Journal of Biotechnology*, 8(8): 1412-1417.
- Manjare, S. A., Vhanalakar, S. A. and Muley, D. V. (2010). Analysis of water quality using physico-chemical parameters of Tamdalge Tank in Kolhapur District, Maharashtra. *International Journal of Advanced Biotechnology and Research*, 1(2): 115 – 119.
- Mohammad, M. A. and Saminu, M. Y. (2012). Water quality and phytoplankton of Salanta River, Kano, Nigeria. *Journal of Biological Sciences and Bioconservation*, (4):65-73.
- Morris, T. (2003). Harmful Algal blooms in North Carolina: Blue-greens and Human health. Division of Public health, *North Carolina Department of Health and Human Services*. 7 pp.
- Mustapha, M. K. (2008). Assessment of the water quality of Oyun Reservoir, Offa, Nigeria, using selected physico-chemical parameters. *Turkish Journal of Fisheries and Aquatic Sciences*, 8: 309-319.
- Nweze, N.O. (2009a). Algal diversity of Adada River, Nigeria. 1. Chlorophyta (Green Algae) and Euglenophyta (Euglenoids). *Plant Products Research Journal*, 13: 24-30.
- Ramanchandra, T.V. and Solanki, M. (2007). Ecological Assessment of Lentic Water Bodies of Bangalore. Technical Report. *Environmental Information System (ENVIS)*. India, 98 pp.
- Wetzel, R. G. (2001). Limnology: Lake and River Ecosystems. 3rd edition, Academic Press, San Diego, 1006 pp. Whitton, B. A. (1975). River Ecology. *Blackwell Scientific Publications*, London. 725 pp.
- Yasmin, F., Buragohain, B. B. and Medhi, K. K. (2011). Planktonic desmid flora of South of the Eastern Himalayas: A systematic approach on algae-1. *International Journal of Botany*, 7: 154 – 161.
- Zakariya, A. M., Adelanwa, M. A. and Tanimu, Y. (2011). Physico-chemical characteristics and phytoplankton diversity of the lower Niger River in Kogi State, Nigeria. Proceedings of the 5th International Conference of Research and Development. *Pan African Book Company*, Cameroun, 3 (3): 10-19.