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Physicochemical Properties and Diversity of Microalgae in Dukku River, Birnin Kebbi, Kebbi State, Nigeria

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***Abstract*—**The physiochemical parameters are factors that determine the biodiversity of microalgae and water quality. This study aimed to determine the diversity of microalgae and monthly variations of some physicochemical parameters in Dukku river using standard methods for the period of six months. A total of seven (7) species were identified viz; *Cyclotella* sp, *Navicula* sp, *Skeletoma* sp, *Chlamadomonas* sp, *Spirogyra* sp, *Tribonema* sp and *Proprocentrum* sp belongs to four phylum Bacillariophyceae, Chlorophyceae, Chrysophyceae and Phyrrophyceae. Bacillariophyceae were relatively abundant as compared to all other groups with 3 species that accounted for 82.5% of phytoplankton followed by Chlorophyceae 2(14.43%) species, Chrysophyceae (2.43%) and Phyrrophyceae (0.61%) with 1 species each. Based on physical parameters analyzed, temperature in the month of April had reached 32.66±0.57 highest, depth 46.66±15.27 in May and turbidity 26.50±1.80 February. Among all these parameters May and June had the least values on turbidity 6.00±0.00 each. The change in the weather, anthropogenic and usage of fertilizer, insecticides and pesticides application within the water body by famers could have caused the slight variations in physicochemical parameters as well as distribution of microalgae. Therefore, government should enforce law on way forward to handle aquatic environment and mindful not to overuse chemicals near the water body for irrigation or farming by farmers as this may lead to eutrophication.

***Keywords*—**Microalgae, Diversity, Physicochemical parameters and Dukku river

I. INTRODUCTION

River is an ecosystem that supports a wide range of different plants ranging from lower to higher plants. Dukku river is well known to the inhabitants of Kebbi state more especially Birnin Kebbi, Mekare town, Tarasa, Gulma, Kangiwa, Tilli, Bunza, Argungu, Yauri among other communities. These river served as source of water for domestic uses, transportation, finishing and agricultural purposes (irrigation and farming of rice) to the many communities within the study area as well as drinking water to the domestic animals e.g. cow, sheep and goat during Bazara period. In majority of developing countries river water used for domestic activities such as washing of cloths, bathing and sometimes as a drinking water to human and terrestrial animals [1]. Algae are primary producers and widely present in freshwater environments, such as streams, lakes and rivers [2]. The distribution and abundance of microalgae in water bodies are controlled by physical, chemical and biological factors. It has been reported that above 200,000 to 800,000 species of microalgae in different genera exist but only 50,000 species are described [3]. They are not chemically or biologically degraded but can be bio-accumulated along the food chain and undergo changes in nature for aquatic systems [4, 5].

Agitations of Human within the catchment areas affect the concentration of trace elements in water, there by rising the normal levels beyond tolerable limit for the survival of aquatic species. However, micro algal have the ability of tolerate trace metals which served as microelements to them at low concentration but at higher concentrations may be harmful. Some of this species could act as bio-indicator of water quality such as *Chlorococcum* spp, *Hormidium* spp and *Stigeoclonium* spp. which are sensitive to zinc, mercury, copper and cobalt depending on the individual species and preference. According to Anyinkeng *et al*. [2], fresh water ecosystem have three categories of phytoplankton as Bacillariophyta (diatoms), Chlorophyta (green algae), and Cyanobacteria.

The rapid increase of phytoplankton in any water body is achieved by optimum level of physicochemical factors [6, 7]. Microalgae are microscopic species that are invisible to

see with the naked eyes. But are also known as the "pastures of water body" which are the major source of primary production in water bodies and it is responsible for one quarter of the world's plants photosynthesis. These species are very sensitive to environmental changes and may act as the major biological component of food chain through which the energy is transferred to the higher organisms. Thus, they have unique short life cycle with rapid reproduction, these enable them to have short environmental phyto-indicator**.** [8], many effect of hydrographical factors in individual microalgae species undergoes spatial-temporal changes in their distribution. The quality of microalgae to be diverse in the water bodies varies with the seasonality, nutrients content, temperature, light, other aquatic found in the water, activities of human/animal around the catchment area or in the water and types of water. In both developing and developed countries, water environment are facing challenges; various management responses have been adapted to address these challenges. The quality and quantity of water resources can be determine by the types and abundant biota and productivity of water body. Therefore, focusing on algae from small static water bodies are less reported compared to larger lenthic water bodies all over the world. This study aimed to determine the impacts of physicochemical parameters on the distribution and abundance of microalgae by providing more insight into their relationship with physiochemical parameters in Dukku river, Kebbi State.

II. RELATED WORK

The importance of River in impact the life of human beings cannot be over emphasized worldwide. Moreover, the quality of river water, known the types of microalgae species in them as well as monthly variations in the waters could be due to some changes in the weather or anthropogenic activities that would provide insight to the field of phyto-indicators of new habitants which may give the microalgae the ability to adapt for their survival and for the water safety. More withal, a better conservation of microalgae species and monitoring of physiochemical parameters could be very important in the area of aquaculture more especially in recent times. Diversification of different water bodies all over the world and quality management, have lead the studies and discoveries of various physiochemical properties and phytoplankton species on the water from different locations around the world [9, 10, 11].

III. MATERIALS AND METHODS

Study Area

Dukku River is a huge and popular river that is situated in Birnin Kebbi, Kebbi State. This river connects and flow through several villages and Local Government areas like, Argungu through Zauro, Birnin Kebbi, Tilli, Kalgo, Bunza, Yauri and soon. It had synonymous climatic condition which obtain in Kebbi state. The major activities occurs in this area are washing of clothes, washing of vehicles, washing of motorcycle, farming, irrigation, fishing and animal rearing.

Sample Collection

Samples were collected at Dukku River in three replicates within the period of six months, from 28 January to 28 June 2021. The water samples were collected in a sterilized plastic bottles while microalgae samples were collected using planktonic net of 20 micrometer (lm) mesh size preserved in 4% formalin for further analysis and future use. All the samples collected were taken to the Department of Plant Science and Biotechnology for further analysis.

Identification and determination of phytoplankton density

Direct microscopic cell counts using the drop count technique were used. A drop of the concentrate was placed on a glass slide and the total number of individuals in that drop were counted and identified using phytoplankton identification key as adopted by [12] with little modification.

Determination of Physicochemical Parameters

Physical parameters such as water temperature, turbidity and depth were determined on the spot using thermometer, sec chi disc and mushroom string by following standard protocol of [13]. Chemical parameters like, hydrogen ion concentration of the water samples was determined *in-situ* using a pH mobile 3015 pH meter, Jenway. Others such as., dissolve oxygen (DO), Biological oxygen demand (BOD), sodium, nitrogen, phosphorus, calcium, magnesium and chloride were done according to the procedures described by [13]. Each measured were recorded and taken in three replicates.

Statistical analysis

Descriptive statistics (mean and standard error) were used in presenting the data, while correlation was used to test the significant difference with the help of SPSS computer application.

IV. RESULTS AND DISCUSSION

Results of physical parameters shows that the highest temperature values were obtained on the months of April 32.66±0.57, followed by March 30.33±0.57, May 29.66±0.57, February 29.33±0.57 and January with the least 22.40±1.96 (Table 1). However, the highest depth was obtained in May with value 46.66±15.27 due to rainfall and surface runoff, the lowest value was observed in the month of April (22.00±12.28) while the highest value of turbidity was recorded on February (26.50±1.80), followed by 24.33±1.52 in January and the lowest value was obtained in May and June with 6.00±0.00 each as (Table 1).

The results of the chemical parameters shows that the highest pH value was obtained in April (7.06±0.15). The highest dissolve oxygen (DO) was found in the month of April with 4.83±0.57mg/L and the lowest in February (2.90±0.55), in March, January and May the range of

turbidity were recorded between 3.20±0.34 to 3.73±0.57mg/L Table 2. The month of January had the highest biological oxygen demand (BOD) value 25.03±1.30 mg/L and the lowest value was obtained in May 14.63±0.56 mg/L. Moreover, the highest value of Sodium (Na) was recorded in April (1.03±0.05mg/L while June had 0.50±0.00 as the lowest among all the months. Calcium (Ca), Phosphorus (P) and Nitrogen (N) were found to be highest at the month of June (1.15±0.10mg/L), January (0.73±0.16), February 1.93±0.46 and lowest value 0.56±0.02 in March, 0.20±0.00 in May and June and Nitrogen (N) 0.33±0.11 April (Table 2) respectively.

In this study, the phytoplankton was represented by four dominant groups namely; Bacillariophyceae, Chlorophyceae, Chrysophyceae and Phyrrophyceae. Bacillariophyceae was found to be relatively abundant as compared to all other groups with 3 species, followed by Chlorophyceae with two (species), Chrysophyceae and Pyrrophyceae one species each Table 3.

Among all the classess encounter, Bacillariophyceae was relatively abundant as compared to all other groups with 3 species which accounted for 82.5% of phytoplankton followed by Chlorophyceae 2(14.43%) species, Chrysophyceae 1(2.43%) species, Phyrrophyceae also 1 species (0.61%). At 1st site *Cyclotella* sp had the highest percentage of 75.42% followed by *Spirogyra* sp 9.50%, *Navicula* sp 7.52%, *Chlamydomonas* 5.03% and *Proprocentrum* sp with 2.51% which was the lowest. While at 2nd site *Cyclotella* sp had the highest percentage 76.20%, *Skelotoma* sp 10.51%, *Spirogyra* 4.76%, *Navicula* sp 3.81%, *Tribonema* 2.86% and *Chlamydomonas* 1.90% which had the lowest percentage. *Spirogyra* sp had the highest percentage of 40.91%, *Cyclotella* sp 36.40%, *Navicula* sp and *Chlamydomonas* sp 9.09% and *Tribonema* sp had 2.51% which was the lowest as seen in 3rd site Table 4 respectively.

Table 1: Physiochemical Parameters Concentration Value Obtained

Parameters	January	February	March	April	May	June
Temperature	22.40±1.96	29.33±0.57	30.33±0.57	32.66±0.57	29.66±0.57	28.66±0.57
Depth	27.66±2.08	34.00±9.53	29.00±10.14	22.00±12.28	46.66±15.27	46.00±13.74
Turbidity	24.33±1.52	26.50±1.80	24.00±1.00	17.00±5.29	6.00±0.00	6.00±0.00

Table 2: Chemical Parameters of Dukku River Analyzed

Parameters	January	February	March	April	May	June
pH	6.66±0.72	6.49±0.35	6.75±0.23	7.06±0.15	6.86±0.15	7.00±0.00
DO (mg/l)	3.66±0.11	2.90±0.55	3.20±0.34	4.83±0.57	3.73±0.57	4.03±0.11
BOD (mg/l)	25.03±1.30	19.73±1.19	22.66±2.45	16.53±0.16	14.63±0.56	14.93±0.20
Ca (mg/l)	0.60±0.50	0.76±0.76	0.60±0.02	0.56±0.02	1.03±0.02	1.15±0.10
Na (mg/l)	0.80±0.10	0.73±0.23	0.96±0.05	1.03±0.05	0.53±0.05	0.50±0.00
Mg (mg/l)	0.73±0.16	0.68±0.02	0.56±0.10	0.60±0.50	0.61±0.57	0.45±0.18
P (mg/l)	0.73±0.16	0.28±0.00	0.18±0.00	0.16±0.00	0.20±0.00	0.20±0.00
N (mg/l)	1.53±0.50	1.93±0.46	1.40±0.40	0.33±0.11	0.46±0.11	0.53±0.11
Cl (mg/l)	1.00±0.45	1.00±0.34	1.60±0.30	1.13±0.57	0.90±0.10	0.63±0.05

Table 3: Phytoplankton Species Identified in Dukku River

Family	Species
Bacillariophyceae	*Cyclotella* sp
	Navicula sp
	Skeletoma sp
Chlorophyceae	*Chlamadomonas* sp
	Spirogyra sp
Chrysophyceae	*Tribonema* sp
Pyrrophyceae	*Proprocentrum* sp

Table 4: Percentage of Phytoplankton Abundance in Dukku River

Classes	Microalgae Species	1st Site	2nd Site	3rd Site
Bacillariophyceae	*Cyclotella*	270 (75.42%)	720 (76.20%)	72 (31.40%)
	Navicula	27 (7.52%)	36 (3.81%)	18 (9.09%)
	Skeletoma	-	99 (10.51%)	-
Chlorophyceae	*Chlamydomonas*	18 (5.03%)	18 (1.90%)	18 (9.09%)
	Spirogyra sp	34 (9.50%)	45 (4.76%)	81 (41.91%)
Chrysophyceae	*Tribonema*	-	27 (2.82%)	9 (2.51%)
Pyrrophyceae	*Proprocentrum*	9 (2.53%)	-	-
Total	**7**	**358 (100%)**	**945 (100%)**	**198 (100%)**

Discussion

The physical parameters have impact on the biodiversity of microalgae and also served as indicator of portability of water for other uses such as drinking, irrigation, fisheries and industrials uses. The temperature obtained in this study shows some stability with significantly increased from month of February – April, but by May – June it began to drop. This results are somehow similar to the findings of [14], who reported the increase of temperature from months of April to August in some sites of Kakuri industrial base settlement Kaduna state, Nigeria. [15], reports that temperatures in tropics area varies between 21^0C and 32^0C, this support our findings. However, the highest depth obtained in May could be probably due to rainfall and surface runoff while turbidity increased on January 24.33±1.52 to February (26.50±1.80) and least in May and June 6.00±0.00 each. These justified that arising and decreasing of temperature, amount of rainfall play a vital role in adjustment of turbidity of the water due increase of waste matters. The reduction of temperature in the study area might occurred due to the presence of clouds in the sky preventing the direct sunlight to earth and surface water. Water temperature was found low during the period of heavy rainfall, this could be due to cooling effects of the rains and high relative humidity which is known to reduce evaporation on water.

From the results of the chemical parameters analysed, the results revealed that in the monthly variations of each parameters, there was either increase or decrease in value (Table 2). This current study showed that pH varied from 6.49±0.35 as month of February to 7.06±0.15 to the month of April with slightly different changes in alkaline and this was similar to the range as was reported in many studies [16, 11]. According to Omstedt *et al*. [17], the marginal changes in the pH values of water from one month to another was as a result of excessive buffering activity. Many activities or river influence factors within the water body such domestic sewage, uses of chemical fertilizers or agricultural activities which containing accumulated metals and other activities may be attributed in monthly fluctuation of pH within this river in the study area. However, in our present study, the level of DO in April was found to increased due to the increase in temperature to 4.83±0.57mg/l while the decrease was observed in the month of February 2.90±0.55mg/l. These results however showed similarities but with slightly difference with the work of [16]. This could be as results of differences in monthly variations as discussed in temperature of the water body and other activities that occurred within the study area.

The highest BOD obtained was as 25.03±mg/l in the month of January while the least was recorded in the month of May 14.63±056mg/l. Moreover, in a similar study conducted by [10] showed that, BOD level of reservoir water in Nasarawa state was higher only during the dry season compared to rainy season. In addition to the present study, a similar study was reported by [18] which was in agreement with our current finding. This similarly found out that the higher level of BOD level in our study could be due to the degradation of organic matter which utilizes oxygen in the body water as the low BOD supports lower organic enrichment of the rive [19, 20]. Some of the other parameters obtained in our present study on monthly period were found to significantly decrease when the temperature was lower but as the concentration values showed increase as the temperature increases (Table 2). Similar, other studies reported similar findings [21, 22]. Majority of the physiochemical parameters could be the agent that could be used to determining and measure the standard water quality for any domestic uses and other beneficial uses that is why monitoring of physiochemical is a vantage. In other ways, agricultural activities such as use of chemical fertilizers, herbicides with washing activities that were all discharged into the water body may all be attributes to the rise in nitrite and phosphate values above the permissible limit.

This findings revealed the presences of seven species of microalgae that belong to four classes of Bacillariophyceae, Chlorophyceae, Chrysophyceae and Pyrrophyceae the same species were documented and reported by [14, 23, 2]. According to Ariyadej *et al*. [24] the species of phytoplankton diversified in any nature is a fundamental biological indicator of the water condition. However, this species are essential primary producers and the backbone of the food chain in river body but maybe harmful to other animals include human beings due to the insidious compounds they discharge. The most predominant species in this study were recorded in class of Bacillariophyceae with three species viz, *Cyclotella, Navicula* and *Skeletoma* when compared with other types or other classes of Chlorophyceae, Chrysophyceae and Pyrrophyceae documented. This agreed with the findings of [2]. Many changes in physiochemical parameters and other activities that occurred in the river might have effects on the adaption and distribution of these least encountered microalgae species. [25] anthropogenic activities and physiochemical parameters have significant impact in survival and reproduction of microalgae.

V. CONCLUSION AND FUTURE SCOPE

The monitoring and determination of physiochemical parameters and other biological indicators are key to establishing status and water quality for a long time period. However, from the obtained results in this our present study, it can be deducted that, monthly changes in weather and anthropogenic activities had increment the variations in physicochemical parameters. Moreover, these variations could be as a result of usage of fertilizer, insecticide and pesticide applications at the study area by farmers. While biotic and other factors were likely to have caused the observed spatial effects on diversity of these documented phytoplankton species. Therefore, if these anthropogenic activities increase, the Dukku river may face challenges of algal bloom. Dukku River is not within water quality standard based on this study and thus requires a special attention. Government should enforce law on way people should handle aquatic environment as well as community should be mindful not to overuse chemicals such as

pesticides, fertilizers for agricultural use near the river as this may lead to eutrophication.

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REFERENCES

[1] A.M. Chia, Occurrence and abundance of algae species in relation to heavy metals contents and physico-chemical parameters of selected ponds in Zaria, Nigeria. M. Sc. Thesis Unpublished, Ahmadu Bello University, Zaria. Nigeria. **2007**

[2] N. Anyinkeng A.M. Mih, T.A. Suh and C.C. Awah. Phytoplankton diversity and abundance in water bodies as affected by anthropogenic activities within the Buea municipality, Cameroon. *Journal of Ecology and the Natural Environment*. Vol. 8(7), **pp. 99-114, 2016**

[3] S. Starckx,. A place in the sun algae in the crop of the features, according to researchers in Geel flanders. **2012**

[4] Rai, L.C., Gaur, J.P., and Kumar, H.D. Phycology and heavy metal pollution. Research *Journal of Environmental Toxicology* **3**: **Pp. 170-178, 1981**

[5] W.G. Sunda, N.M. Price, and F.M.M. Morel, Trace metal ion bufferes and their use in culture studies. *In Algal Culturing Techniques* (R.A. Andersen, ed.). Elsevier Academic Press, London, **pp**: **35-64, 2005**.

[6] V.R.P. Sinha, and H.C. Srivastava. Aquaculture productivity. Oxford and IHB Publishing Co. Pvt. Ltd. New Delhi. **1991**

[7] Muhammad A, Abdus S, Sumayya I, Tasveer ZB, Kamran AQ. Studies on monthly variations in biological and physico-chemical parameters of brackish water fish pond, Muzaffar Garh, Bahauddin Zakariya University, Multan, Pakistan. Pak. J. Res. Sci. 16: **Pp. 27-38, 2005**

[8] M.P. Rajkumar, V. Perumal, N, Ashok Prabu, N., Vengadesh, and Thillai Rajasekar, K. Phytoplankton diversity in Pichavaram mangrovewaters from south-east coast of India. *Journal of Environmental. Biology.*, **30**: **Pp. 489-498, 2009**.

[9] M. Vajravelu, Y. Martin, S. Ayyappan, and M. Mayakrisnan. Seasonal influence of physicochemical parameters on phytoplankton diversity, community structure and abundance at Parangipettai coastal water, Bay of Bengal, South East Coast of India. **2017**

[10] Z.H. Yusuf. Phytoplankton as bioindicators of water quality in Nasarawa reservoir, Katsina State Nigeria. *Acta Limnologica Brasiliensia*, **2020**, vol. **32**, e4.

[11] H.M. Adande, Pauline Houdagba, Rodrigue C Landeou and Expédit W Vissin. Physico-chemical and microbiological characteristics of water for domestic use in Cotonou in the republic of Benin. *International Journal of Science and Research Archive*, 04(01), **pp. 188–197, 2021**

[12] J. Bartram, and G. Rees. Monitoring bathing waters – A practical guide to the design and implementation of assessments and monitoring programmes. World Health Organisation, Boundary Row, London. **2000.**

[13] Apha. Standard methods for the examination of water and waste water, 20th addition. USA, Washington DC. **1998**

[14] Suzie K.Z. Study of Phytoplanktonin Relation to Physicochemical Properties of a Drainage in Kakuri Industrial base Settlement in Kaduna, Nigeria. *Science World Journal* Vol 10 (No 2): **Pp.6-12, 2015**.

[15] A.A, Ayoade, S.O. Fagade, and A.A. Adebisi. Limnological Features of two Man-Made lakes in relation to Fish Production. Dynamics of A*frican Journal of Biotechnology* **5(**10**)**: **1013-1021, 2006**.

[16] A. Verma, S.K. Bourasi, and N.A. Khore, Case Study of Physicochemical and bacteriological analysis of Ajnal River at Harda (M.P) During Monsoon Season. International *Journal of Trend in Scientific and Development* (IJTSRD), vol. 2(6):**1107-1110, 2018**

[17] A. Omstedt, M. Edman, L.G. Anderson, H. Laudon. Factors influenceing the acid–base (pH) balance in the Baltic Sea: a sensitivity analysis. Tellus **62**: Pp. **280–295, 2010**.

[18] V.N. Murulidhar and V.N.Yogananda Murthy. Ecology, Distribution and Diversity of Phytoplankton in Teetha Wetland, Tumakuru District, Karnataka, India. *International Journal of Environment and Pollution Research* Vol.3, No.**2, pp.1-12, 2015**

[19] E.O. Idowu. & A.A.A. Physical, Chemical and benthic Faunal Characteristics of a south Nigeria reservoir. The Zoologist3:**15-25, 2005**

[20] O.A. Idowu. Review of the hydrologic processes of interaction between surface water and groundwater, ASSET, Series B, 6, (1), **2007**

[21] D.S. Malik and U Bharti. Status of plankton diversity and biological productivity of Sahastradhara stream at Uttarakhand, India. *Journal of Applied and Natural Science* 4(**1**): **Pp. 96-103, 2012**

[22] B.B. Otene, J.F. Alfred-Ockiya, & F. Amadi, Physicochemical Properties and Zooplankton Community Structure of Okamini Stream, Port Harcourt, Nigeria *International Journal of Research and Innovation in Applied Science* (IJRIAS) | Volume IV, Issue X, October, **2019**

[23] R.C. Sharma, and V Tiwari. Phytoplankton diversity in relation to physicochemical environmental variables of Nachiketa Tal, Garhwal Himalaya. *Biodiversity International Journal.* 2(2):**102-110, 2018**

[24] C, Ariyadej, R. Tansakul, P. Tansakul, and S. Angsupanich. Phytoplankton diversity and its relationship to the physico-chemical environment in the Banglang reservoir, Yala province. *Songklanakarin Journal of Science and Technology*, 26, **595-607,2004**

[25] A. Celekli, and O. Kulkoyluoglu. On the relationship between ecology and phytoplankton composition in a karstic spring (*Cepni, Bolu*). *Ecol. Indic*. 7:**497-503, 2006**

