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EFFECT OF SEASONAL VARIATION ON PHYSICOCHEMICAL PARAMETERS AND PHYTOPLANKTON IN KITORO RESERVOIR

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ABSTRACT

Phytoplanktons constitute the first circle of the food chain in aquatic systems, producing high-energy organic compounds from carbon dioxide and inorganic substances by photosynthesis with light. As is well known, the food chain starts with phytoplankton and continues with zooplankton, small fish, big fish, and ends with a human. This cannot be achieved without good water quality management. This research aims to reveal the effect of seasonal variation on phytoplankton composition in the Kitoro reservoir. The phytoplankton samples were collected using a silk bolting phytoplankton net with a mesh size of 20 µm. Samples were preserved in 10 % formalin in the field and were taken to the Laboratory for analysis using the inverted binocular microscope (Olympus). The samples for physicochemical parameters were collected monthly using a 250 ml glass sampling bottle. The samples were examined at the Limnology Laboratory using standard methods. Conductivity was determined using a conductivity meter, pH using a pH meter, depth, and turbidity using a calibrated Secchi disc, DO and BOD using Winkler Azide Modification Method, Alkalinity using a titration method, and temperature using Mercury in glass thermometer. The result was subjected to statistical analysis using a T-test. The result shows a significant difference ($P < 0.05$) in pH, water temperature, dissolved oxygen, turbidity, alkalinity, and depth, while there was no significant difference ($P > 0.05$) in biological oxygen demand and water conductivity. Chlorophyceae dominated the group of phytoplankton in the wet season (79%), followed by Cyanophyceae (12%) and Bacillariophyceae (9%). In the dry season, chlorophyceae (58%) dominated the group, Cyanophyceae (25%) was next, then Bacillariophyceae (17%). The significant difference in turbidity of the water could be the reason for higher phytoplankton in wet season. This could be because light penetration increases with higher turbidity and thus increases photosynthesis. Finally, seasonal variation affects water quality parameters and phytoplankton abundance in the Kitoro reservoir.

KEYWORDS:

Water quality, phytoplankton. Kitoro reservoir, season

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INTRODUCTION

Phytoplanktonic organisms have a significant role in feeding animals that sustain their life in freshwaters and form the basis of primary production in aquatic environments. Also, they are one of the biological indicator organisms used extensively in many water pollution investigations worldwide (Caroppo *et al.,* 2018). The phytoplankton in a freshwater source is an important biological indicator of the water quality. Phytoplankton studies and monitoring helps control the physicochemical and biological conditions of the water in any freshwater (Naselli-Flores, 2000). Therefore, certain groups of phytoplankton, mainly blue-green algae, can degrade the recreational value of surface water, particularly thick surface scum, which reduces the use of amenities for contact sports or large concentrations, which cause deoxygenation of the water leading to fish death (Whitton and Potts, 2000). Phytoplankton demonstrates water quality through changes in its community composition, distribution, and proportion of sensitive species (Gharib *et al.,* 2011).

The primary producer compartment is the first to be affected by eutrophication. Enhanced primary producer biomass affects each element of the trophic network with consequences for biogeochemical cycles and community dynamics, ultimately impacting the evolution of the aquatic ecosystem (Pinay *et al.,* 2017). Phytoplanktons are governed mainly by light, nutrients, temperature, community structure, life-cycle history, stratification, vertical mixing, and tides (Alvarez-Góngora and Herrera-Silveira, 2005). It is known that Cyanobacteria, Bacillariophyta, and Chlorophyta members are used as available taxonomic groups to determine biological conditions in aquatic systems. The targeted use of suitable water quality indices and eutrophication indicators for monitoring purposes (Hanžek *et al.*, 2021) is of great importance for the future conservation and management of freshwater systems. In this study, the purpose was to specify the phytoplankton diversity and specific physicochemical parameters of Kitoro Reservoir in Niffr Estate, Niffr, New Bussa, Niger State, across both the wet and dry season.

METHODOLOGY

Study Area

The study area was the Kitoro reservoir located at Niffr estate, New Bussa, Niger State. The reservoir was constructed in 2008. It is located at latitude N9^{0}52'44'' and longitude E4^{0}32'20''. It has a distinct rainy season from April to October and a dry season from November to March.

Sampling for Physicochemical Parameters

The sampling was conducted once a month (from May 2020 to February 2021). The samples were collected in the morning using a water sampling bottle between 09:30 am and 10:30 am and were all analysed within 24 hr after collection. The experiment was carried out at Limnology Laboratory in National Institute for freshwater fisheries research (NIFFR), New Bussa, Niger State. The physicochemical parameters of the water samples were analysed following the standard methods for examining water and wastewater (APHA, 2005). Water temperature was taken *in situ.*

Data Analysis

Data were statistically analysed using a T-test

Sampling for Phytoplankton

Phytoplankton samples were collected using a silk bolting phytoplankton net with a mesh size of 20 µm. Samples were preserved in 10 % formalin in the field. The concentrated sample was shaken for uniform distribution, 100 ml of it was poured into a 100 ml measuring cylinder, 1 ml of lugol solution was added to make the volume 101 ml, and was allowed to stand vertically undisturbed for over 24 hr on a flat surface to allow organisms settle. After that, the sample volume was reduced to about 10 ml by siphoning with a pipette fitted with a flexible rubber tubing of 5 mm diameter. The pipette tip was also fitted with a 20 µm mesh-size phytoplankton net to prevent accidental loss of organisms during siphoning. 1 ml of the 10 ml was taken into the SEDGEWICK-RAFTER counting chamber for identification and counting under a microscope.

RESULTS AND DISCUSSION

Table 1: Mean value of parameters of Kitoro Reservoir. There was no significant difference ($P > 0.05$) in BOD, turbidity, and water conductivity, while there was a significant difference ($P < 0.05$) in pH, water temperature, DO, alkalinity, and depth.

PARAMETERS	WET SEASON MEAN±S.D	DRY SEASON MEAN±S.D
pH	7.03±0.05*	7.13±0.05**
BOD (mg/l)	4.12±0.49*	3.77±2.43*
Water Temperature (oC)	27.25±1.89*	29.37±0.58**
D.O (mg/l)	12.33±2.66*	5.67±1.37**
Turbidity (m)	0.25±0.07*	0.14±0.08**
Alkalinity (mg/l)	10.00±0.00*	19.67±8.98**
Water Conductivity (µs/cm)	65.67±5.54*	71.08±29.61*
Depth (m)	0.79±0.20*	0.32±0.14**

BOD- Biological Oxygen Demand, DO- Dissolved Oxygen, SD- Standard Deviation, Mean with the same * shows no significant difference while mean with different ** shows a significant difference

Table 2: Species Composition in Wet Season

Species Composition	Station 1	Station 2	Station 3
Chlorophyceae (79 %)			
Chlorella sp.	640	624	656
Microspora sp.	144	-	128
Closterium sp.	16	64	-
Cosmarium sp.	16	32	16
Ulothrix sp.	16	16	-
Spyrogyra sp.	16	8	16
Staurastrum rotula	32	128	64
Bacillariophyceae (9 %)			
Flagelaria sp.	16	-	8
Diatomella	16	32	8
Synedira sp.	16	48	48
Tabellaria sp.	16	8	16
Melosira granulate	32	8	8
Cyanophyceae (12 %)			
Anacytis sp.	64	80	32
Oscillatoria sp.	16	16	8
Anabeana sp.	32	16	64
Athrospira sp.	16	32	16
NB: - Absent			

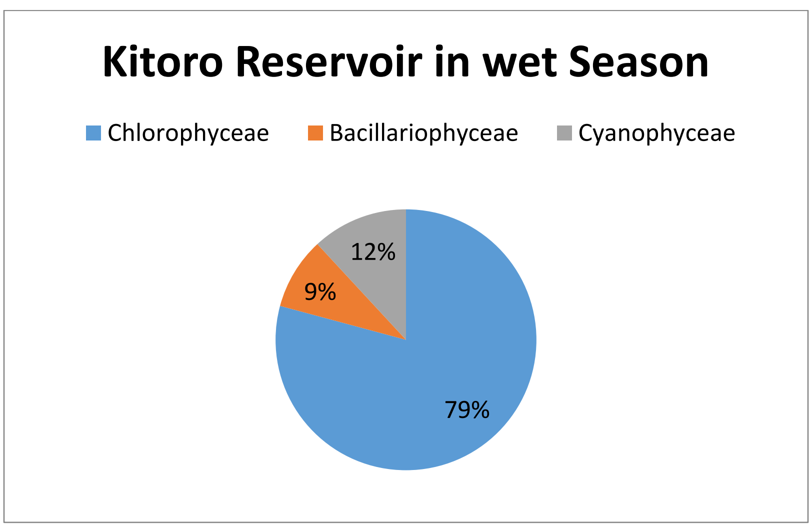

Figure 1: Percentage composition of Phytoplankton in wet season

Table 3: Species Composition in Dry Season

Species Composition	Station 1	Station 2	Station 3
Chlorophyceae (58 %)			
Microspora sp.	32	48	56
Chlorella sp.	80	64	56
Bacillariophyceae (17 %)			
Diatomella	32	-	16
Melosira	-	48	-
Cyanophyceae (25 %)			
Anacytis sp.	48	16	32
Oscillatoria sp.	-	16	8
Anabeana sp.	-	8	8

NB: - Absent

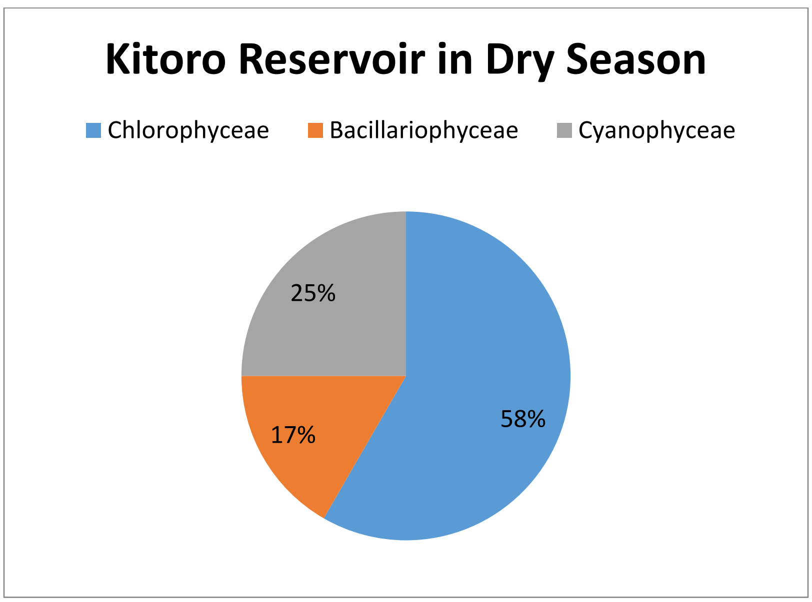

Figure 2: Percentage composition of Phytoplankton in dry season

DISCUSSION

The pH of the Kitoro reservoir was significantly higher ($P < 0.05$) in the dry season (7.13±0.05) than in the wet season (7.03±0.05); the decreased pH value in the wet season may be due to the effect of lower pH in the rain and runoff water from the tributaries. Water temperature in the dry season was significantly higher in the dry season (29.37±0.58) than in the wet season (27.25±1.89); this may be due to the cool weather conditions in the wet season while the weather is harsh during the dry season, this could lead to significant raise of water temperature in the dry season. Alkalinity was significantly higher in the dry season (19.67±8.98) than in the wet season (10.00±0.00); this could be in relation to the high temperature in the dry season, which increases evaporation of water and leaving behind high salt materials within turns increases the alkalinity in the dry season.

The DO of the Kitoro reservoir was significantly higher in the wet season (12.33±2.66) when compared to the dry season (5.67±1.37); this may be due to the cool weather condition, and this condition promotes the solubility of oxygen in water, thereby making more oxygen available in the wet season than in dry season. The turbidity of the Kitoro reservoir was significantly higher in the wet season (0.25±0.07) than in the dry season (0.14±0.08). This may be due to the settling effect of the suspended materials and fewer human and animal activities around the reservoir. The reservoir depth was significantly higher in the wet season (0.79±0.20) than in the dry season (0.32±0.14). This could result from more water coming into the reservoir through flooding in the wet season than in the dry season, and because the water temperature in the wet season is cool, little or no evaporation occurs, meaning little or no water was lost to the atmosphere. There was no significant difference ($P > 0.05$) in BOD and water conductivity in both seasons, which means that seasons do not affect the water body's water conductivity and biological oxygen demand.

Phytoplankton of Kitoro reservoir in the wet season shows that only three (3) phytoplankton groups were present during the study (Chloropyceae, Bacillariophyceae, and Cyanophyceae). Chlorophyceae (79 %) was the most dominant group and had more species diversity than any other group (*Chlorella sp., Microspora sp., Closterium sp., Cosmarium sp., Ulothrix sp., Spirogyra sp.,* and *Staurastrum rotula*). The most dominant species among them all was *Chlorella sp.* Cyanophyceae (12 %) was the next dominant group after Chlorophyceae, with species dominated by *Anacytis sp.* 0ther species were *Oscillatoria sp., Anabeana sp.,* and *Athrospira* the least populated were Bacillariophyceae (9 %), the species here were evenly distributed, the species were *Fragelaria sp., Diatomella, Synedira sp., Tabellaria sp.* and *Melosira granulate.*

It shows the composition of Phytoplankton in the dry season of the Kitoro reservoir, with Chlorophyceae (58 %) the most populated group in the dry season, *Microspora sp.* and *Chlorella sp.* the only species present in the group at the time of this study. Cyanophyceae (25 %) was a less populated group, with Diatomella and Melosira being the only species present. Basillariophyceae (17 %) was the least populated group in times of species diversity. Bacillariophyceae has more species than any other group in the dry season (*Anacytis sp.*, *Oscillatoria sp.*, and *Anabeana sp.*). In both wet and dry seasons, Chlorophyceae was the most dominant group; next was Cyanophyceae, then Bacillariophyceae. Chlorophyceae and Cyanophyceae were dominant in both seasons because they are suitable for growing in warm water (Zhang *et al.*, 2019). Therefore, Chlorophyceae and Cyanophyceae can adapt to high temperatures, and the optimal temperature is 25–35 °C (Lurling *et al.*, 2013).

Chlorophyceae dominated the group in wet and dry seasons because of light penetration, favouring Chlorophyceae. Bacillariophyceae was less dominant because of the significant difference in pH; the increased pH value in the dry season may prevent it from recovering its dominance. This inhibits the growth rate and diatom silicon deposition (Zepernick *et al*., 2021). Although phytoplanktons were more dominant and had more species in the wet season than in the dry season, the reason for this difference could be that turbidity was significantly higher in the wet season than in the dry season, and this implies more light penetration in wet season than in dry season, leading high photosynthesis which in turns increases the population and diversity of phytoplankton in wet season than in dry season. The significant difference in turbidity could be the reason for the dominance of the Chlorophyceae group in wet season because high light penetration favours the population of Chlorophyceae.

CONCLUSION

The study showed a significant difference in most water quality parameters (depth, DO, pH, turbidity, and alkalinity) except for BOD and water conductivity. The Chlorophyceae group dominated the phytoplankton group in both wet and dry seasons; next was the Cyanophyceae group, then Bacillariophyceae. The phytoplankton population was higher in the wet and dry seasons. This may be due to the significant difference in turbidity as it increases photosynthesis and, in turn, increases the phytoplankton population.

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