NJBAS

Available online at http://www.ajol.info/index.php/njbas/index
Nigerian Journal of Basic and Applied Science (Sep.-Dec., 2014), 22(3&4): 67-72
DOI: http://dx.doi.org/10.4314/njbas.v22i3.3

ISSN 0794-5698

Full Length Research Article

# Physicochemical Flux and Phytoplankton diversity in Shagari Reservoir,Sokoto, Nigeria

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**ABSTRACT:** Nutrients availabilty is one of the major contributors to distribution and growth of phytoplankton species. Physicochemical properties and phytoplankton species and their distribution in Shagari Reservoir were evaluated. Standard methods of UNEP were used to determine monthly physicochemical flux properties, diversity and distribution of phytoplankton species were also determined. Phytoplankton classes identified included Bacillariophyceae, Chlorophyceae, Cynophyceae and Dinophyceae. Class Chlorophyceae had the highest annual percentage distribution (37.55%) with four species identified. The least monthly percentage (7.64%) was recorded in November by Dinophyceae. *Anabaena wisconsineae* (Dinophyceae) had the highest frequency of occurence (96.6%). August, September and October were the most turbid months using Secchi disc measurement with 8.30, 9.0 and 9.8cm respectively. The monthly variation in the physicochemical parameters may be due to seasonal changes and human activities. The levels of nitrogen and phosphorus ranged from 0.30-7.30 Mg/l and 0.1-0.8Mg/l respectively. The reservoir has low species of phytoplankton, which may be due to low levels of nutrients and age of the reservoir.

**Keywords:** *Phytoplankton, Physicochemical, Reservoir, Chlorophyceae, Shagari, Sokoto, Nigeria*

## INTRODUCTION

Lentic water bodies are considered favourable environments for the development of phytoplankton communities, which may establish diverse assemblages in relatively short periods of time (Rocha *et al.,* 1999). Several factors contribute to the establishment of phytoplankton communities in reservoirs, among which are good water quality, presence of nutrients, hydrological features and reservoir ageing (Carpenter and Kitchell, 1993). Phytoplankton plays an important role as it is the primary producer sustaining the lacustrine food web (Zohary *et al.*, 1994). Phytoplankton are also at the base of aquatic food web and are the most important factor for production of organic matter in aquatic ecosystems. Most reservoirs will require significant amount of plankton to have productive and sustainable fisheries. The interplay of physical, chemical and biological properties of water most often, lead to the production of phytoplankton, while their assemblages are structured by these factors. Thus, any perturbations in these factors may affect their assemblage which could have a significant impact on water quality (Carpenter and Kitchell, 1993).

Phytoplankton studies of shallow, tropical Nigerian reservoirs such as Shagari reservoir could provide management guide to the reservoir water quality and its fisheries, since most of these reservoirs are constructed solely for drinking water supply, but with fish production often superimposed on them. Such study could reveal information on phytoplankton that could play an impact on the water quality (Muller *et al.,* 1982) According to Bucka (1998), there is great interest in preventing or reducing the growth of planktonic algae and cyanobacteria in water bodies. The aim of this paper was to evaluate the physicochemical flux and phytoplankton diversity in Shagari reservoir Sokoto State, Nigeria.

## MATERIALS AND METHODS

Shagari reservoir is located at Shagari Local Government Area of Sokoto State, Nigeria. It was commissioned on the 20th of March 2007. It is located between latitude 12° 35´N and 12°45´N, and between longitudes 5°00´E and 5°30´E. It is situated across river Gawon gulbe which originates partly from River Rima in the northern part of Shagari, and flows through Illela, downstream to Jabaka. The reservoir was constructed for the purpose of providing drinking water, irrigation and with the aim of improving fishing activities in the area (SHSL, 2007).

### Sample Collection

Water samples were collected in one litre capacity plastic bottles, between 9 to 10 am, from all the sampling locations, for a period of 12 months. Each sample collected was analysed for physicochemical parameters. Temperature, transparency and depth were determined *in situ*. The phytoplankton were collected from six locations with standard plankton net (25µm mesh size) which were transferred to 1 litre capacity plastic bottles containing 4% Lugo's iodine solution.

**Determination of Physicochemical Parameters**

Transparency of water samples was determined using Secchi disc of 25 cm by disappearance and reappearance method. The transparency was computed according to UNEP (2004).

Temperature was determined with a mercury thermometer, and depth was measured with mushroom string both determined according to Panday *et al.* (2005). The pH was determined with JENWAY pH meter 3015 Model at 25°C. Electrical Conductivity was measured with WINDAUS Electrical Conductivity metre (Model 9008) calibrated at 35°C (UNEP, 2004). Nitrogen was determined as described by UNEP, (2004). OPTIMA Spectrophotometer (Model 300) at 660 nm wavelength was used to determine phosphorus (UNEP, 2004). CORNING's Flame Photometer (Model 400) was used to determine Sodium and Potassium (UNEP, 2004). Ethylene diamine tetra-acetate acid (EDTA) method was used to determine Calcium and Magnesium (UNEP, 2004).

**Identification of phytoplankton**

The phytoplankton were identified to species level and each was compared with the phytoplankton identification charts of Hotzel and Croome (1999); Botes (2003); Perry, (2003); Janse van *et al*. (2006); Yamaguchi, and Gould (2007); Bellinger and Sigee, 2010), before the species name was counted and recorded. The data was subjected to analysis of variance using MINITAB 10.1 Statistical package.

**RESULTS AND DISCUSSION**

Temperature ranged from 20.1-38.6°C and Nitrogen ranged from 0.30-7.30mg/l. Nitrogen and phosphorus (Table1) are important elements that may regulate biological productivity in aquatic ecosystem and may be applicable to Shagari reservoir (Edmondson, 1991).

**Table 1:** Monthly Physicochemical Parameters in Shagari Reservoir, Sokoto, Nigeria

| MONTH | Tem (⁰C) | Turb (cm) | Depth (m) | pH | N (mg/L) | P (mg/L) | Ca (mg/L) | Mg (mg/L) | E.C µs/cm | Na (mg/L) | K (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 21.6 | 12.3 | 1.8 | 6.9 | 0.60 | 0.13 | 0.6 | 3.3 | 471.4 | 0.5 | 2 |
| DEC | 22.1 | 11.5 | 1.7 | 7.9 | 1.00 | 0.13 | 1.2 | 1.15 | 471.6 | 6.8 | 1.9 |
| JAN | 20.2 | 10.3 | 1.6 | 6.3 | 1.00 | 0.13 | 0.45 | 2.7 | 505.6 | 0.8 | 2.3 |
| FEB | 20.1 | 12.8 | 1.5 | 7.7 | 1.05 | 0.11 | 0.47 | 1.14 | 621.1 | 0.5 | 1.9 |
| MAR | 38.6 | 12.2 | 1.5 | 8.1 | 1.06 | 0.11 | 0.45 | 0.33 | 493.9 | 0.6 | 2.3 |
| APR | 32.0 | 12.9 | 1.5 | 6.4 | 1.00 | 0.19 | 0.39 | 0.43 | 641.0 | 0.6 | 0.22 |
| MAY | 30.5 | 14.0 | 1.6 | 7.8 | 0.30 | 0.89 | 0.45 | 0.81 | 678.4 | 0.6 | 2.2 |
| JUN | 30.0 | 14.3 | 2.8 | 7.6 | 1.06 | 0.13 | 0.44 | 0.45 | 585.9 | 0.7 | 2.3 |
| JUL | 30.5 | 16.0 | 3.1 | 7.4 | 0.30 | 0.12 | 0.55 | 0.55 | 547.1 | 0.7 | 2.4 |
| AUG | 30.0 | 09.0 | 3.4 | 7.6 | 7.30 | 0.13 | 0.4 | 0.65 | 627.2 | 0.5 | 2 |
| SEP | 31.0 | 9.80 | 3.9 | 7.4 | 0.50 | 0.10 | 0.32 | 0.82 | 566.8 | 0.5 | 2.1 |
| OCT | 30.0 | 8.30 | 4.3 | 7.4 | 0.40 | 0.10 | 0.36 | 0.77 | 846.8 | 0.6 | 2.1 |

**Footnote**: Tem: Temperature, Turb: Turbidity

**Physical Parameters**

The temperature of Shagari reservoir varied monthly as the weather changes according to season. The least temperature obtained was 21.6°C in November and the maximum recorded was 38.6°C in March. The measured temperature reveals monthly fluctuations with rapid increase from February to March (Table 1), while decrease in temperature was observed from October to February. During the rainy season (May- October) the temperature was more or less steady. This fluctuation is therefore due to change in the weather especially during rainy season when cloud cover reduces the intensity of the solar radiation, that means limited light rays reach the water surface (Adokole, 2003).Turbidity of the reservoir also varied according to the season though it ranged from 8-14.3cm and was during the rainy season. The water was turbid at this period, which is related to cloudiness of liquid as a result of particulate matter being suspended within it (Asano, 2007). The 14.3cm as the highest turbidity may not affect fish as reported by Ayodele and Ajani (1999). Depth of aquatic ecosystem increases as water volume increases. The present study had an increase from 1.5-4.3 meter (Table 1). The major increase in depth was observed from Juneto October during the rainy season. The depth decreases from November to February, while it was uniform from March to May.

**Table 2:** Monthly Distribution (%) of Phytoplankton classes in Shagari Reservoir Sokoto, Nigeria

| Month | Bacillariophyta | Chlorophyta | Cynophyta | Dinophyta |
|---|---|---|---|---|
| **Nov** | 35.98 | 39.02 | 17.36 | 07.63 |
| **Dec** | 25.08 | 29.48 | 17.07 | 38.37 |
| **Jan** | 17.55 | 34.09 | 29.27 | 19.09 |
| **Feb** | 20.57 | 32.46 | 24.84 | 22.13 |
| **Mar** | 14.90 | 35.64 | 27.31 | 22.15 |
| **Apr** | 21.93 | 41.51 | 17.00 | 19.56 |
| **May** | 22.72 | 30.66 | 23.97 | 22.65 |
| **Jun** | 22.18 | 49.27 | 16.07 | 12.48 |
| **Jul** | 23.02 | 52.01 | 13.81 | 11.16 |
| **Aug** | 19.39 | 46.49 | 17.04 | 17.08 |
| **Sep** | 18.29 | 23.73 | 33.20 | 24.78 |
| **Oct** | 17.97 | 36.28 | 26.46 | 19.29 |

**Chemical Parameters**

The range of pH was 6.9-8.1, the reservoir was more or less alkaline, except for January and April when it was slightly acidic and November when it was neutral .The highest of 8.1 was obtained in March. The present findings are similar with to the findings of Akindele *et al.* (2013) who obtained minimum pH of 6.4, mean pH 7.17 and maximum of 7.8 while assessing water quality of Lake Tiga. Therefore the recorded pH values are suitable for aquatic animals such as fish (Jahangir *et al*., 2000). Nitrogen level in the reservoir was low, but increased in August (7.30 mg/l). Phosphorus level was lower than nitrogen in the reservoir, which ranged from 0.11-0.89 mg/l in February and May respectively. The low level of phosphorus in surface water was due to the fact that decomposed organic matter is permanently fixed in the sediment or recycles back in overlying water as available nutrients (Goldeman and Horne, 1994). Sodium, potassium, Calcium and Magnesium concentrations fluctuated monthly. Though the ranged as follows; Na 0.5-6.8 mg/l, K 0.22-2.4 mg/l, Ca 0.32-1.2 mg/l and Mg 0.33-3.30 mg/l (Table 1). The monthly variations of these elements were as a result of significant seasonal and spatial variation in the weather and other human activities near the reservoir such as irrigation and other farming activities (Wetzel, 2001). The electric conductivity values in the reservoir were typical of freshwater, since the electric conductivity of most freshwater range from 0.1-1000 (Chapman and Kimstach, 1996). Vajrapp and Singh (2005) reported that water with conductivity below 750 µs/cm is satisfactory for aquatic biota, as the highest recorded was 846.8 µs/cm in October.

**Phytoplankton**

Four classes of phytoplankton (Table 2) were represented in the reservoir and twelve species were identified (Table 3) Availability of natural food is an important factor governing fish and productivity of a water body and there is a close link between the quality of water and abundance, composition of plankton in aquatic ecosystems (Ovie, 1995).. Reservoirs are considered favourable environments for developments of plankton communities, which may establish diverse assemblages in relatively short periods of time after impoundment (Rocha *et al*., 1999). In the present study, *Chlorophyceae* had the highest percentage distribution (37%) followed by *Bacillariophyceae* and *Dinophyceae* with 22 and 19% respectively (Figure 1.) This differs slightly with the findings of Moshood (2010) who reported 75.3% for *Bacillariophyceae* and 12.2% for *Chlorophyceae*. This may be due to age difference of the two reservoirs (Carpenter and Kitchel, 1993).

The monthly percentage distribution of the phytoplankton classes reveals Chlorophyceae as the highest (52.%) in July, the least was obtained under Dinophyceae with 07.63% in November (Table 2), while the specie percentage distribution reveals *Palmella mucosa* with 39% as the highest, other species that also recorded high percentage distribution (Table 4) *Oscillatoria chlorine* 35%, *Spirogyra dubia* 32%, *Ceratium hirndinella* 28%. The abundance of Chlorophyceae may be due to the concentration of nitrogen, phosphorus and other elements are known to limit the phytoplankton growth (Talling and Lemoalle, 1998). The present status of the reservoir reveals limited nutrients concentration.

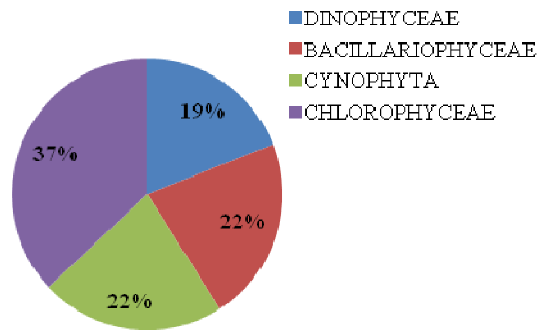


Figure 1: Percentage distribution of Phytoplankton identified in Shagria Reservoir

**Table 3:** Species Composition of Phytoplankton in Shagari Reservoir

| Bacillariophyceae | Chlorophyceae | Cynophyceae | Dinophyceae |
|---|---|---|---|
| *Microcystis holsatica* | *Spirogyra dubia* | *Anabaena oscillariode* | *Ceratium hirndinella* |
| *Oscillatoria chlorine* | *Palmella mucosa* | *Anabaena wisconsineae* | *Ceratium teridenella* |
| *Cymbella tumida* | *Oocystis solitaria* | | |
| *Oscillatoria Formosa* | *Oocystis cystis* | | |

**Table 4:** Monthly Percentage Distribution of Species in Shagari Reservoir

| Month | Bacillariophyceae | Chlorophyceae | Cynophyceae | Dinophyceae |
|---|---|---|---|---|
| **Nov.** | *Microcystis holsatica* (20)<br>*Oscillatoria chlorina (35)* | *Spirogyra dubia* (20)<br>*Palmella mucosa* (39) | **** | **** |
| **Dec.** | *Oscillatoria chlorina* (29.5) | **** | **** | *Ceratium hirndinella* (20)<br>*Ceratium teridenella* (28) |
| **Jan.** | **** | *Spirogyra dubia* (20) | *Anabaena oscillariode* (20)<br>*Anabaena wisconsineae* (21) | **** |
| **Feb.** | **** | *Spirogyra dubia* (25) | *Anabaena wisconsineae* (24) | *Ceratium teridenella* (22.7) |
| **Mar.** | **** | *Spirogyra dubia* (23)<br>*Palmella mucosa* (35.6) | *Anabaena wisconsineae* (21.1) | *Ceratium teridenella* (22.6) |
| **Apr** | **** | *Spirogyra dubia* (28) | **** | **** |
| **May** | *Oscillatoria chlorina* (27.7) | *Spirogyra dubia* (20) | *Anabaena wisconsineae* (23.9) | *Ceratium teridenella* (22.8) |
| **Jun.** | *Oscillatoria chlorina* (35) | *Spirogyra dubia* (30) | **** | **** |
| **Jul.** | *Oscillatoria chlorina* (33) | *Spirogyra dubia* (32)<br>*Palmella mucosa* (20) | **** | **** |
| **Aug.** | **** | *Spirogyra dubia* (30) | **** | **** |
| **Sept** | **** | **** | *Anabaena oscillariodes* (20)<br>*Anabaena wisconsineae* (22.8) | *Ceratium hirndinella* (20) |
| **Oct.** | **** | **** | *Anabaena wisconsineae* (20.6) | **** |

**Footnote:** Percentage in parenthesis, ****: Not in high percentage or absent.

## CONCLUSION

Shagari reservoir undergoes flux according to season, weather changes, anthropogenic influences etc. However, the oligotrophic status of the reservoir needs to be improved. Low levels of nutrients caused low number of species.

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