Physico-Chemical Parameters of Some Selected Stations in Lower Usuma Reservoir Bwari, Nigeria

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Absract: Physico-chemical parameters of Temperature, Dissolved oxygen, pH, Transparency, Conductivity, and free carbon dioxide of lower Usuma Reservoir was carried out from April to October 2010 in two selected sampling stations to ascertain the effect of human activities on water quality for fish production. The stations were selected based on the degree of human activities, station 1 have a high degree of human activities and station 2 with little or no human activities. The water temperature ranged between 26.13°C – 31.00°C, dissolved oxygen ranged between 3.29mg/l – 10.50mg/l. The pH, transparency, conductivity and free carbon dioxide were 6.00 –7.50, 1.20m – 2.43m, 0.21µs/cm – 0.98µs/cm and 2.00mg/l – 9.00mg/l respectively. There was significant difference ($P < 0.05$) between all the parameters measured and the stations but all the recorded values were within the limit for fish production.
[Dan-kishiya, A.S. and Chiaha, N. Q. **Physico-Chemical Parameters of Some Selected Stations in Lower Usuma Reservoir Bwari, Nigeria.** Report and Opinion 2012;4(2):1-6]. (ISSN: 1553-9873). http://www.sciencepub.net/report. 1

Key Words: Physico-chemical parameters, Reservoir, Stations, Fish Production

1. Introduction

The study of physico-chemical parameters of water is a basic aspect of limnology, which is defined as the study of the functional relationship and productivity of freshwater or marine ecosystems as they are regulated by the dynamics of their chemical, physical and biotic environment (Boyd, 1982). Therefore, the quality of a given water body is controlled by its physical, chemical and biological factors, all of which interact with one another to influence its productivity. In order to assess the productivity of such aquatic ecosystem for their essential management and effective utilization, there is the need to study these parameters with a view to controlling and maintaining them within optimum range (USEPA, 1989). Environmental quality directly or indirectly affects species abundance, composition and diversity (Balarabe, 1998). Nigeria is blessed with over 15 million hectares of inland freshwater bodies hence, the need for limnological studies (FISON, 2001). Furthermore, Nigeria's population of about 130 million peoples means that there must be a good readily available animal protein source to the teaming population. The food and Agricultural Organization (F.A.O., 2003) projected that Nigeria requires 13.0 kg/head of animal protein, it thus becomes imperative to study the limnological characteristics of our water bodies so as to improve on their fisheries potentials. Some limnological studies carried out earlier include Limnological studies of the Eleyiele and Kainji Reservoir (Adeniji, 1993), Shiroro Reservoir (Kolo and Oladimeji, 2004), Kontagora Reservoir, Niger State (Ibrahim *et al.*, 2009) and selected Ponds in Zaria metropolis (Chia, 2007; Balarabe, 2001). Lower Usuma Reservoir was constructed primarily for domestic consumption within Abuja metropolis and its environment. But most of the physico-chemical parameters as it affect aquatic life are not given due consideration. It is in view of these that the present research work was undertaking to document baseline information on the limnological characteristics of the Reservoir as it relates to fish production.

2. Materials and methods

2.1 Study Area

Lower Usuma Dam is located in Bwari Area council, FCT, Abuja. Abuja is located in the center of Nigeria with a land area of 8,000 square kilometers. It lies between the latitude of 8°25 and 9°25N and longitude 6°45 and 7° 45E. It is bounded to the North by Kaduna and Niger State to the South by Kogi state, to the East by Nasarawa State and to the west by Niger state (F.C.D.A, 2006). From its central location, its vegetation combines the savannah grassland type of the north and middle belt with the tropical rain forest type of the south of Nigeria. The overall effect of this is that Abuja has rich soil for agricultural cultivation and enjoys an equable climate that is neither too hot (35°C) nor too cold (22°C) all year round (F.C.D.A., 1979). Meteorological records have shown that rainfall start as late as April in some years and peak between August and September, annual rainfall of about 1000 – 1600m have been recorded in F.C.T. dry season begins in November and last till March. The season months of December and January are usually cold and dry due to the influence of the North- East winds which usher in the hamattan. There are two main seasons in F.C.T. These are the dry and wet seasons. The wet season begins toward the end of March and ends towards the end of October. The dam was constructed in 1987 and since then, it has been the main source of drinking water for the city. It is located at about highest point of the territory and feeds the treatment plant by gravity. It is sited on a virgin location where human activity is minimal. It is free from industrial impurities. The dam is a homogenous earth filled with an upstream face of a rock fill while the downstream is grassed with a grout out wall with vertical and horizontal filters. The reservoir has a maximum capacity of 100 million m^3. The main dam is 1,300 meters long with a saddle dam of 350 meters long. The maximum depth of the Reservoir and saddle is 45 meters and 10 meters respectively. The dam is provided with a pumping station in order to pump raw water from the main dam reservoir to the water works in the event of extreme drought.

2.2 Stations and Sampling

Surface water samples were collected fortnightly from two stations for seven months between April and October 2010. Station 1 was the fish landing site with a lot of human activities such as washing and bathing take place (Figure 1). Station 2 has little or no human activities (Figure 2). Surface water temperature, pH and transparency was measured *in situ* using automatic temperature-pH meter model 51- new Japan and Secchi disc with diameter 15.50cm (Aguigwo,1998). Electrical conductivity (EC) was measured in the field using portable electronic conductivity meter (Model; LF 90) and expressed in µs/cm while dissolved oxygen was measured using the modified winkler methods (APHA,1980). Carbon dioxide was also titrimetically measured (APHA, 1980).

Figure 1: Sampling station 1 in Lower Usuma Reservoir

Figure 2: Sampling station 2 in lower usuma reservoir

3. Results

The mean monthly variation in the physico-chemical parameters of the two stations are presented in Figure 3-8. The temperature ranged between the lowest values of 26.13±5.11°C obtained from Station 1 in July and the highest of 31.00±5.57°C obtained from Station 2 in March (Fig.3). There was no significant difference among the stations ($P>0.05$). Dissolved oxygen fluctuated between the lowest monthly mean of 3.29±1.81 mg/L obtained in March from Station 1 and the highest monthly mean of 10.50±3.24 mg/L recorded in July from Station 2 (Fig.4). Statistical difference at $P<0.05$ was noticed in the dissolved oxygen concentration among the stations, (with Station 2 having the highest concentration). The surface water pH fluctuated between slight acidity and moderate alkalinity. The lowest monthly mean pH was 6.00±2.45 obtained at Station 2 in the month of April, while the highest was 7.50±2.74 obtained from Station 1 in May (Fig. 5). ANOVA ($P<0.05$) showed pH of Station 1 was significantly higher than in station 2. Secchi disc transparency was the highest at Station 2 with a mean value of 2.38±1.54 m obtained in September. Station 1 recorded the least Secchi disc transparency value with a mean of 1.20±1.10 m obtained in August. Station 2 had significantly higher transparency ($P<0.05$) as shown in Fig. 6. There was slight variation in electrical conductivity of the two Stations as shown in Figure 7. The monthly mean variations in electrical conductivity recorded the lowest value of conductivity (0.21±0.46 µs/cm) in October in station 1 and Station 2 recorded the highest variation of conductivity value in May (1.30±1.14 µs/cm). Carbon dioxide ranged between monthly mean of 2.00±1.41 mg/L to 9.00±3.00 mg/L (Fig.8).

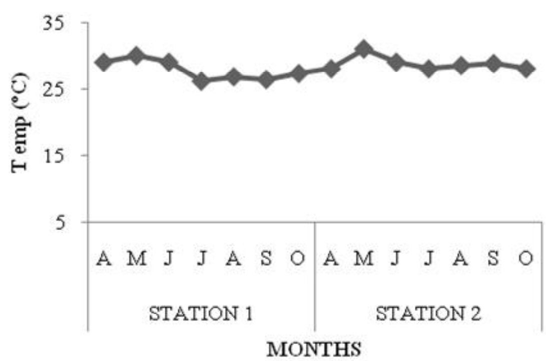

Figure 3. Mean monthly variations in the surface water temperature of Lower Usuma Reservoir.

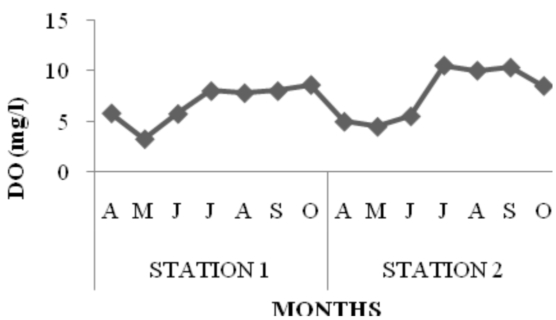

Figure 4. Mean monthly variations in dissolved oxygen concentration of Lower Usuma Reservoir.

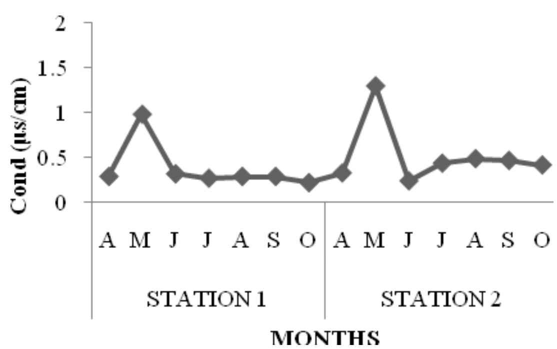

Figure 5. Mean monthly variations in pH of Lower Usuma Reservoir.

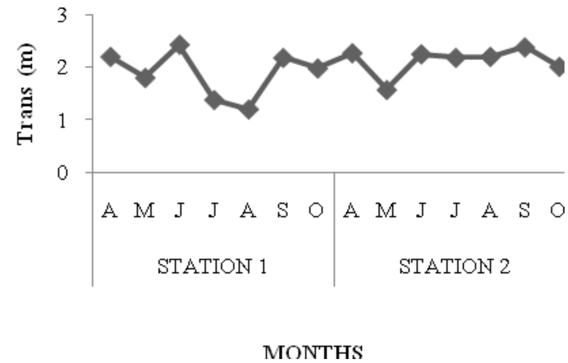

Figure 6. Mean monthly variations in Secchi disc transparency of Lower Usuma Reservoir

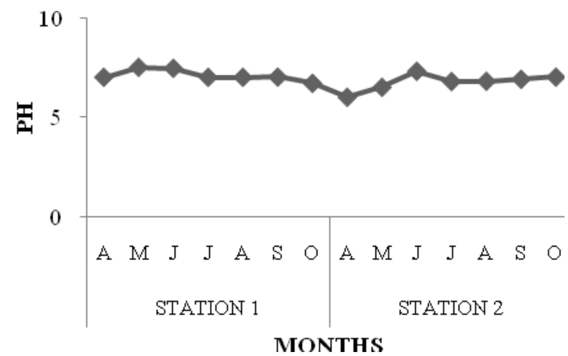

Figure 7. Mean monthly variations in conductivity of Lower Usuma Reservoir.

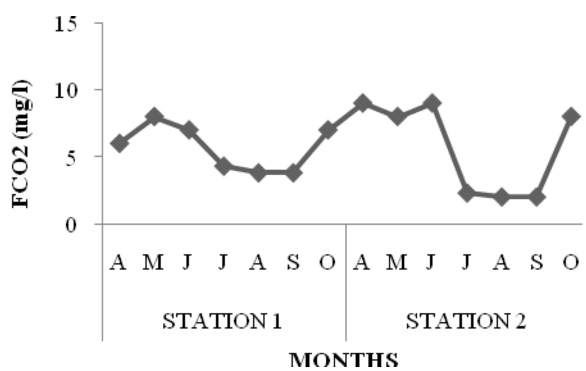

Figure 8. Mean monthly variations in carbon dioxide concentration of Lower Usuma Reservoir.

4. DISCUSSION

The result obtained from the studies shows that there was significant difference between the temperature of the two stations, the narrow significant difference in temperature between the two stations could be alluded to the rainy season period in which the studies was conducted, station 1 shows highest mean temperature in May (30.00^{o}C) and lowest mean temperature in July of (26.13^{o}C) while station 2 shows the highest mean temperature in May (31.00^{o}C) and the lowest mean temperature in August, July and October (28.00^{o}C), the relatively increased temperature in the month of May is due to the increase in surface water absorption of solar heat radiation since it was the beginning of rainy season. The mean monthly temperature values of the two sampling stations in this study tallies with the recorded values obtained in Oyun reservoir (Mustapha, 2008). The findings of Aguigwo (1998) on the studies of physicochemical parameters and Plankton productivity of a productive stream further collaborates with this studies with a recorded temperature range of 23.40^{o}C to 30.20^{o}C from January to December 1998. Although, station 1 shows relatively lower temperature (27.80^{o}C) than station 2 (28.76^{o}C), these reduction may be as a result of accumulation of run-off water, human activities as well as the presence of inorganic substances which usually lowers the temperature of water body.

There was significance difference in the dissolved oxygen concentration of the two stations. The monthly mean dissolved oxygen of station 2 is slightly higher (7.76 mg/l) than that of station 1 (6.75 mg/l). Station 2 appeared cleaner compared with station 1 because there was less human activities such as washing, bathing and domestic sewage. This is known to increase the dissolved oxygen of station 2. While the absent of the aforementioned condition as well as excessive run-off water carrying various types of inorganic chemicals which may likely ionize with dissolved oxygen content of water may cause low level of dissolved oxygen of station 1 and this agreed with Aguigwo (1998), Kemdirin and Ejike (1992). Although the recorded values of dissolved oxygen are within limit for aquatic productivity including fish production as reported by King (1998) and Aguigwo, (1998).

The pH value was an indication of good buffering capacity of the reservoir. An alkalinity is indicative of high free carbon dioxide values and probably high content of organic materials. Winger (1981) reported that run-offs into water due to excessive land use and other human activities strongly influenced the amount of organic nutrients that enter the receiving water. Hydrogen ion concentration tends to be slightly higher in station 1. However, both stations exhibited appreciable stability, this was attributed to the fact that most of the hydrogen ions are autochtonous; thus the stations pH was unresponsive to cycles in the inputs of precipitation, surface run-off effluents and garbage. Thus the stability in pH concentration agreed with what was obtained in Kigera reservoir (Abohweyere, 1990). A pH value of 6.50 – 8.50 has been associated with productive water (Tarzwell, 1959) while pH range of 5 - 9.50 is recommended as good for aquatic life (Winger, 1981).

There was significant difference in the transparency of the two stations. Station 1 had a lower transparency than station 2 due to increase surface run off and human activities of the station. Generally, during the rainy months there is tendency of accumulation of high-suspended matter due to surface run off and human activities into the water bodies giving little opportunity for light penetration resulting in reduce transparency and this agreed with the findings of Abohweyere (1990) in Kigera attributing low transparency to agent of disturbance as well as Karr and Dubley (1981) in modified land water streams in Eastern North America.

There was slight variation in electrical conductivity of the two Stations but conductivity range of between 0.21-0.98 µs/cm is low and will support aquatic life as reported for other reservoirs in Nigeria (Imevbore, 1970). The two stations exhibited higher electrical conductivity in the month of May which was attributed to the influence of run off due to rains resulting in increase concentration of salts in the stations while the increase utilization of the salt by phytoplanktons and macrophyte might have lower the conductivity in the subsequent months and this agreed with the findings of Mustapha (2008) in Oyun Reservoir Offa, Nigeria. Using electrical conductivity as water quality index (Moore, 1989), the reservoir can be described as having good water quality for domestic usage and also for fish production.

Human activities, photosynthesis, run-offs, respiration, diffusion and decomposition could account for the variations seen in the carbon dioxide levels of the two stations. However, the mean range of CO_2 is within tolerable limit for fish production since it did not exceed 10 mg/L (APHA, 1995).

5. Conclusion

The ranges of physico-chemical characteristics of the two selected stations of Lower Usuma Reservoir are comparable to those found in non-polluted African reservoirs, and are within the limits for domestic consumption as well as for fish production (WHO, 1997). But, there is the need for monitoring, control and surveillance of human activities particularly in station 1 and the reservoir in general.

Acknowledgement
We are sincerely grateful to the following for field and laboratory assistance: Akbak Engr and Tech. Services, Engr Dike, Ali Gambo and laboratory technologies of the Dept. of Biological Sciences, University of Abuja, Nigeria.

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