VARIATION IN THE CONCENTRATION OF DISSOLVED OXYGEN (DO) AND HYDROGEN ION (PH) AT THE SURFACE OF A TROPICAL RESERVOIR: A CASE STUDY OF LOWER USUMA RESERVOIR IN BWARI, ABUJA, NIGERIA

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ABSTRACT

The variations in the concentration of dissolved oxygen (DO) and hydrogen ion (pH) at the surface of Lower Usuma Reservoir, Bwari, Nigeria were investigated monthly from July 2009 - June 2010 as its relates to aquatic life and for domestic consumption using standard methods and procedures. Five sampling stations (Duste, Berger, Mpape, Shere and Saddle) were established around the central basin to be representative of various habitats existing within the Reservoir. The name of each station represents the entry points of Major River and streams in to the main reservoir as well as the exit point. The mean monthly concentrations showed peak in July, August, September and October which coincided with wet months for dissolved oxygen but, there was no significant fluctuation in the concentration of hydrogen ion throughout the sampling period. However, the ranges of DO (1.60-12.34mg/l) and pH (5.77-7.70) were found to be within tolerable limit for aquatic life, domestic consumption and were also comparable to those reported for other tropical Reservoirs.

Key words: Variation, DO, pH, Usuma Reservoir, Aquatic life, Domestic consumption.

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INTRODUCTION

Dissolved oxygen concentration and pH of water bodies are important parameters that determine the spatial as well as temporal distribution of organisms particularly the fish fauna

(Araoye, 2009). Dissolved oxygen is required for respiration by most aquatic animals and apart from this, dissolved oxygen combined with other important elements such as Carbon, Sulphur, Nitrogen and Phosphorous that could have been toxicants in the absence of oxygen in the water bodies to form carbonate, sulphate, nitrate and phosphate respectively that constitute the required compounds for aquatic organisms for survival (Araoye, 2009). Sensitivity to low levels of dissolved oxygen is species specific; however, most species of fishes are distressed when DO falls to 2-4 mg/l. Mortality usually occurs at concentrations less than 2 mg/l and usually larger fishes are affected by low DO than smaller fishes. The depletion of oxygen in aquatic environment has many effects on the biota particularly fishes which include mortality, reduce growth rate, impaired reproductive activity and also fish become more susceptible to diseases. The concentration of DO and pH in any water body varies over time and is usually affected by other factors such as temperature, salinity and conductivity which are very important parameters that form the basis for an enlightened fisheries and water resources management (Araoye *et al*., 2007).The pH scale is a scale which is used to measure the acidity or alkalinity of a substance. Most biological processes operate between pH ranges of 6.5 to 8.5, outside this range, biological activity declines or ceases (Lind, 1979; Tarzwell, 1954). Huet (1972) recommended a value of 7 to 8 as being best for fish. However, Winger (1981) recommended a pH range of 5 to 9.5 as good for aquatic life. pH influences the uptake of metals by phytoplankton (Nagase *et al*., 1997; Zang and Xu, 2001). There are documented works on limnological characteristics of tropical water bodies. For example in Nigeria, it include the works of Mustapha (2008) in Oyun Reservoir, Offa; Ibrahim *et al*., (2009) in Kontagora Reservoir. Achionye-Nzeh and Isimaikaiye (2010) in Ilorin Reservoir; Olasehinde and Abeke (2012) in Ikere Gorge Reservoir, Iseyin south-western Nigeria. While, in India include the works of Saha *et al*. (2001) in Brackish water ecosystem in Sundarbans, West Bengal; Nirmal-Kumar *et al*. (2009) in estuarine system in Tapi; Lena *et al* (2012) in Yercaud Hills; Nayak *et al*. (2012) in Chilika Lagoons and in Ghana include the work of Quarcoopome et al (2008) in Northern Ghana Reservoir. Although, Lower Usuma Reservoir was constructed primarily for domestic purposes within Abuja metropolis and its environment, but most of the limnological characteristics as it affect aquatic life are not given due consideration. Notable among the documented works in the Reservoir is that of Dankishiya and Chiaha (2012). It is in view of these that the present research work was undertaking to document baseline information on the dissolved oxygen and

hydrogen ion concentration of the Reservoir as it relates to aquatic life particularly fish production and also if it is safe for drinking.

MATERIALS AND METHODS

Study area

Lower Usuma Reservoir is constructed across River Usuma at Bwari Area council. The area council has the highest elevation than any of the settlement areas in Abuja the federal capital territory (FCT) of Nigeria. The Reservoir lies between the latitude of $9^o10"$ and $9^o14"N$ and longitude $7^o24"$ and 7^o 28"E with a surface area of $8km^2$, crest length of 1300metres, crest width of 10metres, maximum depth of 45metres and a maximum storage capacity of 100million cubic meters of raw water (Fig.1)

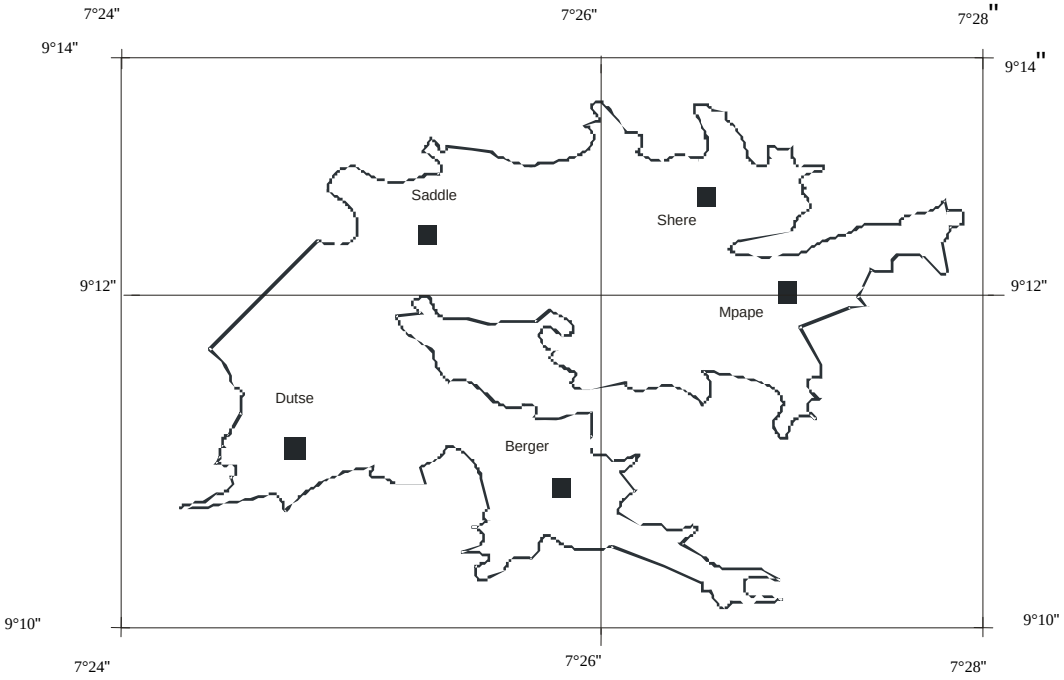

Fig. 1: Map of Lower Usuma Reservoir showing sampling stations.

Stations and Sampling

Five sampling stations (Duste, Berger, Mpape, Shere and Saddle) were established around the central basin to be representative of various habitats existing within the Reservoir. The name of each station represents the entry points of Major River and streams in to the main Reservoir besides numerous tributaries as well as the exit point. The Usuma river which is the major river enters the reservoir through Shere axis at Ushafa town and the major streams enters the reservoir through Dutse, Berger and Mpape axis while the only exit of the reservoir is through saddle dam station.

Water Quality Analysis

Data on water samples were obtained monthly throughout the sampling periods for all the sampling stations in *situ* for pH using Automatic Temperature - pH Meter Model 51-New Japan by immersion of the electrode at the surface of the water and allowed to stabilize for between 1-2 minute(s) before the values were recorded and Dissolved oxygen was determined tritimetrically using the modified Winkler method (APHA, 1980).

RESULTS

The mean, minimum, maximum and seasonal values in the concentration of dissolved oxygen (DO) and Hydrogen ion (pH) of Lower Usuma Reservoir is as shown in Table 1. The DO range between 1.60 - 12.34mg/l throughout the sampling periods. The highest concentration was recorded in Shere station (6.27± 3.33mg/l). This was followed by Mpape (6.22±1.56), Saddle (6.08±2.02) and Berger (5.99±2.00). While, Dutse had the least concentration of 5.47± 2.13mg/l. The mean monthly concentration showed peak in July, August, September and October which coincided with wet months (Fig.2). While seasonal variation showed higher concentration during the wet season in Shere station (7.97±3.09mg/l). This was followed by Berger, Dutse, Saddle and Mpape stations with 7.43±1.12, 6.78±1.59, 6.76±2.10 and 6.22±1.90mg/l respectively. A lower concentration was recorded during the dry season in all the stations except at Mpape were concentration of 6.21±1.11 mg/l was recorded. The mean value of hydrogen ion concentration

(pH) of the Reservoir range between 5.77 and 7.70 throughout the sampling periods. The highest pH was recorded in Mpape station (7.01±0.53). This was followed by Saddle (6.90±0.48) and Shere with a value of 6.72±0.52. While, Dutse and Berger stations had 6.50±0.46 and 6.50±0.44 respectively. The mean monthly pH value did not show significant fluctuation through out the study period except for the sharp drop (5.88) in the month of December (fig.3). While seasonal variation showed the wet season concentration ranging from 6.00 - 7.70 and dry season range of 5.77-7.60.

Table 1: mean, minimum, and seasonal values of DO and pH of each of the five sampling stations during the 12 months of study at the surface of Lower Usuma Reservoir, Bwari

Stations	Parameters					
	DO (mg/l)			pH		
	Mean	Wet	Dry	Mean	Wet	Dry
Dutse	5.47 ±2.13	6.78±1.59	3.64±1.20	6.50 ±0.46	6.51±0.45	6.48±0.53
	2.00 – 8.76	4.00-8.76	2.00-5.20	5.91 - 7.10	6.00-7.10	5.91-7.01
Berger	5.99 ±2.00	7.43±1.12	3.97±0.62	6.50 ±0.44	7.00±0.30	6.97±0.63
	3.00 – 8.40	5.00-8.4	4.00-4.70	5.95 – 7.50	6.50-7.50	5.95-7.50
Mpape	6.22 ±1.56	6.22±1.90	6.21±1.11	7.01 ±0.53	7.03±0.48	6.98±0.64
	3.20 – 8.80	3.20-8.80	4.78-7.80	5.93 – 7.70	6.21-7.70	5.93-7.60
Shere	6.27 ±3.33	7.97±3.09	3.88±1.98	6.72 ±0.52	6.68±0.52	6.77±0.56
	1.60– 12.34	4.50-12.34	2.00-5.30	5.77 – 7.30	6.00-7.30	5.77-7.10
Saddle	6.08 ±2.02	6.76±2.10	5.13±1.66	6.90 ±0.48	6.95±0.47	6.83±0.55
	2.40 – 9.47	3.29-9.47	2.40-6.50	5.86 – 7.50	6.12-7.50	5.86-7.28

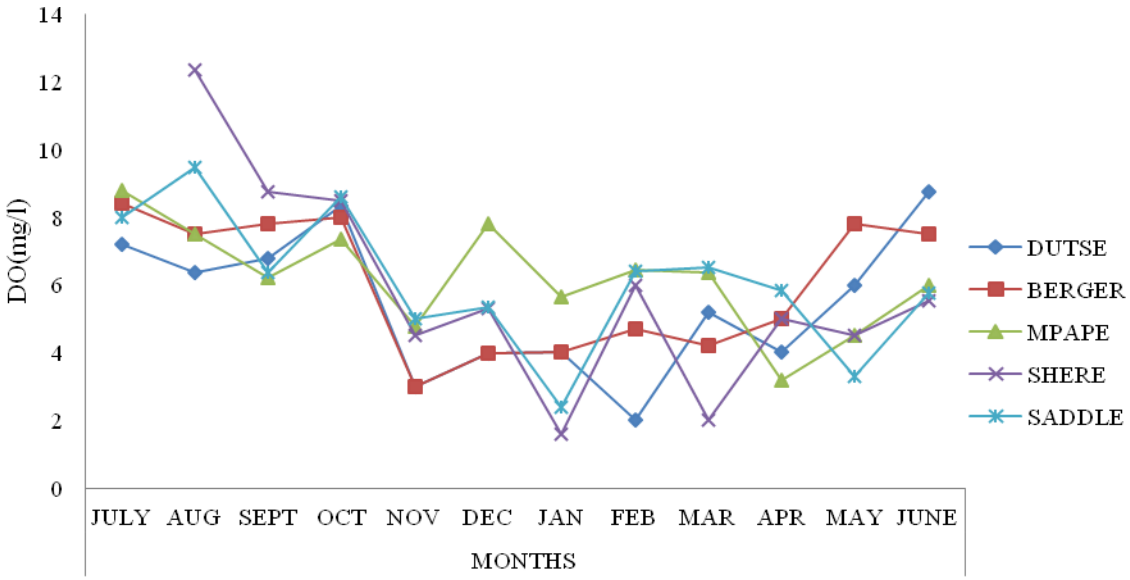

Fig 2: mean monthly concentration of dissolved oxygen of Lower Usuma Reservoir, Bwari from July 2009- June 2010

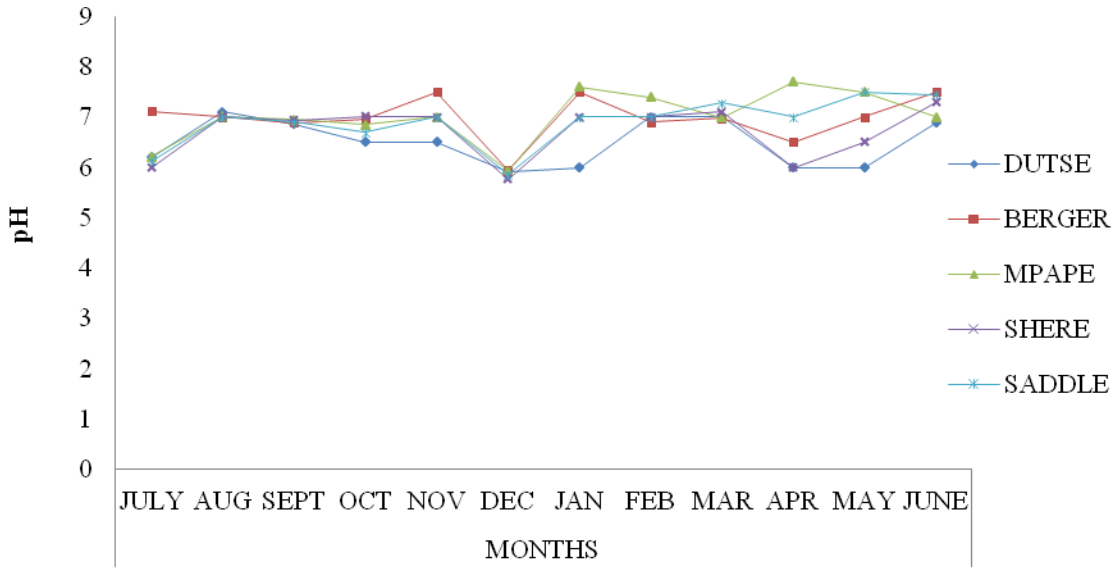

Fig. 3: mean monthly hydrogen ion concentration of lower usuma Reservoir, Bwari from July 2009- June 2010

DISCUSSION

Dissolved oxygen concentration and pH of water bodies are important parameters that determine the spatial as well as temporal distribution of organisms particularly the fish fauna (Araoye, 2009). Dissolved oxygen is required for respiration by most aquatic animals and apart from this, dissolved oxygen combined with other important elements such as Carbon, Sulphur, Nitrogen and Phosphorous that could have been toxicants in the absence of oxygen in the water bodies to form carbonate, sulphate, nitrate and phosphate respectively that constitute the required compounds for aquatic organisms for survival (Araoye, 2009). Sensitivity to low levels of dissolved oxygen is species specific; however, most species of fishes are distressed when DO falls to 2-4 mg/l. Mortality usually occurs at concentrations less than 2 mg/l and usually larger fishes are affected by low DO than smaller fishes. The depletion of oxygen in aquatic environment has many effects on the biota particularly fishes which include mortality, reduce growth rate, impaired reproductive activity and also fish become more susceptible to diseases. The mean concentration of dissolved oxygen in Lower Usuma Reservoir range between 1.60 and 12.34 mg/l with peak period during the wet months. Low concentration was observed in all the dry months throughout the sampling periods. The higher DO record in all the wet months in the present study was attributed to increase mixing of water in the Reservoir. Maitland (1978) reported that the amount of oxygen in a water body depends on the extent of contact with the atmosphere. The Lower Usuma Reservoir exhibits lotic characteristics during the wet season which create constant movement as well as turbulences and a resultant exposure of the water to atmospheric air with a resultant increase in the dissolved oxygen content of the Reservoir during wet season. Similar results were reported in some tropical Reservoirs such as Tepe and Mutlu (2005) in Turkey Reservoir and Mustapha (2008) in Oyun Reservoir, Offa, Nigeria. The low DO in the present study in the dry months was attributed to high rate of decomposition as reported in Oyun Reservoir (Mustapha, 2008).

The range of pH value (5.77 – 7.70) in Lower Usuma Reservoir was an indication of good buffering capacity of the Reservoir. Dankishiya and Chiaha (2012) recorded pH value ranging from 6.00 – 7.50 in the Reservoir. This suggests that the reservoir water is good for fish production since it is within 5.0 - 9.5 considered good for aquatic life (Huet, 1972; Winger, 1981) and productive waters (Tarzwell, 1954). Hydrogen ion concentration in all the stations exhibited appreciable stability. It has been 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 and will have profound influence on pH concentrations (Winger, 1981) even though, most of the inputs to the Reservoir ware autochtonous, but, the stations pH was unresponsive to the cycles in the inputs of precipitation, surface run-off effluents and garbage as reported by Hynes (1960).

However the range of DO and pH in the present study is within limit for aquatic life (Boyd, 1979; Winger, 1981; Aguigwo, 1998; Mustapha, 2008; Dan-kishiya and Chiaha, 2012) and also for domestic consumption (WHO, 1997).

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