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COMPARATIVE STUDIES OF SOME PHYSICO-CHEMICAL PARAMETERS OF WATER IN TWO TROPICAL RESERVOIRS

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ABSTRACT

Some physico-chemical parameters of Oba reservoir accessed through Ibese, in Ogbomoso North local government, Oyo state, Nigeria and Erinle reservoir accessed through Oree, in Odo-otin local government, Osun state, Nigeria, were investigated over a two year period (2016-2018). The selected parameters were water temperature, hydrogen ion concentration (pH), dissolved Oxygen (DO), biochemical Oxygen demand (BOD), and electrical conductivity. Standard methods were used for the determination of these values. Seasonal variation of mean values of all the parameters studied except temperature, showed significant differences in seasons (dry and raining seasons). Although the mean values for all the parameters in the two reservoirs fell within standard aquaculture values, there were significant differences ($p < 0.05$) between the two reservoirs in some parameters. These suggested that Oba reservoir is probably, relatively polluted than Erinle reservoir. The values recorded in Oba reservoir showed a sharp deviation from values of previous studies in the reservoir. This indicated the possibility of introduction of polluting agentsin recent past as a result of increased anthropogenic activities around the tributaries feeding the reservoir.

KEYWORDS: *Anthropogenic, Parameters, Physico-Chemical, Pollution*

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INTRODUCTION

Water quality plays a role in the distribution of fish (Welcomme, 1979). The importance of measuring physical, chemical and biological variables was enumerated by Marshall and Moses(1994). The Physico-chemical characteristics of water are important parameters; they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals (Moses, 1983). Ademoroti, (1996) was of the opinion that water from market stalls and slaughter houses, streets washing and flushing of sewage which flow through drains into rivers altered the chemical composition of the water body thereby causing pollution. Temperature, turbidity, light intensity, pH, dissolved ions such as NO_3 and PO_4 are reported to marshal the activities and composition of organisms Mukhtar and Deeni, (1998).

Lucinda and Martin (1999) defined temperature as the degree of hotness or coldness in the body of a living organism either in water or on land. It is very important in waters because it determines the rate of metabolism of aquatic organisms. The growth, feeding, reproduction and migratory behavior of aquatic organisms are greatly influenced by the temperature of water (Crillet and Quetin, 2006). Aquatic organisms have their own tolerance limits to temperature which affects their distribution. Under stress from increased temperature, shallow water ecosystems can undergo a state of change, characterized by the rapid loss of macrophytes and subsequent dominance of phytoplankton. Water temperature can strongly affect the feeding patterns, growth rates and breeding seasons of fish. Increase in temperature increases metabolic activities which can lead to death, temperature thereby influences water quality and the distribution and abundance of aquatic organism, (Prasad, 2000).

Hydrogen ion concentration in natural waters is measured in terms of pH, which was defined by Boyd, (1979), as the negative logarithm of hydrogen ion concentration. This concentration is the pH of neutrality and is equal to 7. When the pH is higher than 7.0, it indicates increasing salinity and basicity while values lower than 7.0 tend towards acidity i.e. increase in hydrogen ion concentration. Accurate measurement of pH may be taken *in situ,* using electronic glass electrode. The pH of natural waters is greatly influenced by the concentration of Carbon (IV) oxide which is an acidic gas (Boyd, 1979). Phytoplankton and other aquatic vegetation deplete carbon (IV) oxide in the water as a result of photosynthesis, so the pH of a water body rises during the day and decreases at night. Ibiebele *et al*., (1983) opined that changes in the acidity of water can be caused by acid rain, run-off from surrounding rocks and waste water discharges. Waters with pH values of 6.5 to 9.0 are considered best for fish production, while the acid and alkaline death points are 4.0 and 11 respectively, (Swingle, 1969; Boyd, 1982). Low pH values or acidic waters are known to allow toxic elements and compounds such as heavy metals to become mobile thus producing conditions that are inimical to aquatic life (Gietema, 1992).

The amount of dissolved oxygen in water is very important for aquatic organisms; dissolved oxygen affects the growth, survival, distribution, behavior and physiology of aquatic organisms (Solis, 1988). Oxygen distribution also strongly affects the solubility of inorganic nutrients since it helps to change the redox potential of the medium, it can also determine whether the environment is aerobic or anaerobic (Beadle, 1981). The principal source of oxygen that is dissolved in water is by direct absorption at the air-water interface which is greatly influenced by temperature (Kutty, 1987), at low temperature more oxygen diffuses into the water. Surface agitation of water helps to increase the solubility of dissolved oxygen in water. Oxygen concentration in water is controlled by four factors: photosynthesis, respiration, exchanges at the air-water interface, and supply of water to the water body or pond (Erez *et al*., 1990). A major part of dissolved oxygen is observed to come from photosynthetic processes and only a small part originates from the atmosphere (Milstein *et al*., 1989). Dissolved oxygen concentration of 5.0 mg/L and above are desirable for fish survival (Boyd and Lichtokoppler, 1979). Low dissolved oxygen concentrations are known to be one of the major problems to faunal and floral survival in the aquatic environment (Erkk *et al*. 1996). Low concentration of dissolved oxygen created anoxic condition within the water body (Saiz- Salinas, 1997) and the problems of anoxia are the major causes of faunal depletion in aquatic ecosystems.

The Biochemical Oxygen Demand (BOD) of an aquatic system is the amount of oxygen needed to completely decompose the organic matter present in the water to simplest molecules, carbon (IV) oxide and water. The greater the BOD, the higher the degree of pollution. Biochemical oxygen demand is used as a measure of the quantity of oxygen required for oxidation of biodegradable organic matter present in a water sample by aerobic and anaerobic biochemical action. Biochemical Oxygen Demand (BOD) is thus one of the measures of organic loads in an aquatic system as well as an indicator of levels of organic pollution (Odukuma and Okpokwasili, 1990; Bagariano, 1992). Clerk (1986) reported that BOD range of 2mg/L – 4mg/L does not show pollution while levels beyond 5 mg/L are indicative of serious pollution. Water bodies with BOD levels between 1.0 mg/L and 2.0 mg/L were considered clean; 3.0 mg/L fairly clean; 5.0 mg/L doubtful and 10.0 mg/L definitely bad and polluted (Moore and Moore, 1976; Chinda *et al*., 1991).

Variations of dissolved solids in water could affect the relative quantities of the various components. There is a relationship between conductivity and total dissolved solids in water. As more dissolved solids are added, water's conductivity increases (Abowei *et al*., 2010). Conductivity of salt water is usually higher than that of freshwater because the former contains more electrically charged ions than the latter (Ezekiel, *et al.,* 2011).

Water quality monitoring in most countries used to be based on measuring the physical and chemical variables of a water body, physico-chemical parameter values therefore remains an indicator of water quality in an aquatic ecosystem. Oba and Erinle reservoirs are depended upon for domestic use by human population in many towns and villages; they also serve as habitat for many aquatic organisms and due to incessant anthropogenic disturbances it is important to constantly monitor the water quality in the reservoirs from time to time.

MATERIALS AND METHODS

The study areas were Oba reservoir accessed through Ibese in Ogbomoso North local government area, Oyo state, Nigeria and Erinle reservoir accessed through Oore in Odo–otinlocal government area of Osun state, Nigeria..

Oba reservoir was impounded in 1964 and the tributaries are Idekun, Eeguno, Akanbi Kemolowo, Omoogun and Yakun streams with a catchment area of 321 sq. km. It extends overLatitude 8° 3" N to 8° 12" N and Longitude 4° 6" E to 4° 12" Eand the elevation is 310m above sea level, in Oyo state Nigeria. The impounded area is 138 hectares of water surface with maximum and minimum depth of 16.36 and 0.83 meters respectively.The Erinle dam was completed in 1989; its coordinates are 7.754543° N and 4.450087° E. The tributaries are Oyan, Otin, and Erinle rivers. It has an area of 598 sq. km located 330 meters above sea level;it has a storage capacity of 94 million cubic meter of water the dam is used for water supply, flood control and fishing (Ladejo and Ofoezie, 2006) in Osun state Nigeria.

Water samples were taken from the two reservoirs ten times each in the dry and raining seasons (between 6am and 8am); this was repeated yearly for the two years of the research.

The physico-chemical parameters investigated were water temperature, hydrogen ion concentration (pH), dissolved Oxygen (DO), biochemical Oxygen demand (BOD), and electrical conductivity. The methods used were as described by Golteman *et al*., (1978) and Clesceri *et al*., (1998).

The water temperature was measured in the field using simple mercury in glass thermometer (0-110ºC) graduated at 0.1ºC intervals. Two readings were taken and the mean of the two readings was calculated and recorded as the subsurface water temperature.

The water hydrogen ion concentration (pH) was determined *in situ,* using a standardized HACH portable electronic pH meter model EC10. The mean of two such readings was calculated and recorded as the pH of the water in the reservoir for that visit.

The Dissolved Oxygen (DO) contents of the water samples from the two reservoirs measured in mg/L were determined in the laboratory using the iodometric (Winkler's) method (Golteman *et al*., 1978, and Clesceri *et al*., 1998).

The Biochemical Oxygen Demand (BOD) was calculated using the 5-day BOD test adapted from Golteman *et al*., (1978) and Clesceri *et al*., (1998). The results were recorded as BOD mg/l of water sample for each reservoir.

The electrical conductivity of the water from the two reservoirs was determined *insitu* using a model cm-21 Lovibond conductivity meter; the readings were taken in µS/cm.

Statistical Analysis

The analyses of the physico-chemical parameters were carried out using SPSS version 16, adopting independent samples t-test, the means of all the parameters were statistically compared to determine if there were significant differences. The results have been expressed as mean ± SE at $p = 0.05$.

RESULTS

Tables 1 and 2, showed the results of the statistical interpretations of the physico- chemical analysis of water from the two reservoirs.

Table 1: Seasonal Variation of Mean Values of Physico-Chemical Parameters in Oba and Erinle Reservoirs

Seasons Erinle Reservoir Oba Reservoir
Temp. DO. BOD. pH. Cond. Temp. DO. BOD. pH. Cond
DRY 27.75^{a} 5.00^{b} 2.20^{a} 7.10^{b} 18.30^{b} 27.87^{b} 4.504 ^{b}3.60 ^{a} 6.90 ^{b} 19.63 ^{b}
±0.04 ±0.15 ±0.01 ±0.10 ±0.03 ±0.03 ±0.02 ±0.01 ±0.02 ±0.03
Raining 27.34 ^{a} 6.40 ^{a} 2.60 ^{b} 6.80^{a} 15.28 ^{a} 27.47 ^{a} 5.17 ^{a} 4.30 ^{b} 6.70 ^{a} 16.20 ^{a}
+0.16 +0.03 +0.02 +0.02 +0.01 +0.05 +0.04 +0.03 +0.01 +0.07
Temp.–Temperature (^{0}C); DO–Dissolved Oxygen (mg/l); BOD–Biochemical Oxygen demand (mg/l); Cond–Conductivity (µS/cm).

*Means with the same superscripts in a column are not significant at $p = 0.05$.

Table 2: Variation of Mean Values of Physico-Chemical Parameters in Dry and Rainy Seasons

Reservoirs Dry Season Raining Season
Temp. DO. BOD. pH. Cond. Temp. DO. BOD. pH. Cond.
Erinle 27.75^{a} 5.00^{b} 2.20^{a} 7.10^{a} 18.30^{a} 27.34 ^{a} 6.40^{b} 2.60^{a} 6.80^{b} 15.28 ^{a} ±0.04 ±0.15 ±0.01 ±0.10 ±0.03 ±0.16 ±0.03 ±0.01 ±0.02 ±0.01
OBA 27.87^{a} 4.50^{a} 3.60^{b} 6.90^{a} 19.63 ^{b} 27.47 ^{a} 5.17 ^{a} 4.30 ^{b} 6.70 ^{a} 16.20 ^{b}
±0.03 ±0.02 ±0.02 ±0.02 ±0.03 ±0.05 ±0.04 ±0.03 ±0.01 ±0.07
Temp.–Temperature (^{0}C); D–Dissolved Oxygen (mg/l); BOD–Biochemical Oxygen demand (mg/l); Cond.–Conductivity (µS/cm).

*Means with the same superscripts in a column are not significant at $p = 0.05$.

DISCUSSIONS

The variation of physical and chemical parameters in the reservoirs and season showed that in Erinle reservoir, mean values for dissolved Oxygen (DO), biochemical Oxygen demand (BOD), pH, and electrical conductivity, (Cond.) were significant ($p<0.05$) in seasons, while temperature values were not significant. In Oba reservoir all the values were significant, which suggested that the seasonal variations in the abiotic conditions of the reservoirs would likely play an important role in determining the seasonal biotic components in the reservoirs. Temperature values were not significantly different between the two reservoirs, while all the remaining parameters were significant ($p<0.05$).

The means of Temperature in the two reservoirs were between 27.34^{o}C±0.16 and 27.87^{o}C±0.03, these values agreed with Alabaster and Lloyd, (1980) who stated that the temperature of natural inland waters in the tropics generally range from 25 – 35^{o}C and Fawole, (2000), also reported a mean value of 27.90^{o}C±2.3 in Oba reservoir. This study did not show any significant difference in seasonal variation in temperature in Erinle reservoir, but it showed significant difference in Oba reservoir (Table 1). Edokpayi and Nkwoji (2007) opined that temperature may not be a major factor in tropical aquatic systems. The mean temperature that was higher in the dry season than the rainy season in the two reservoirs may be due to heat from sunlight which increased surface water temperature while the fall in the rainy season can be attributed to rainfall. Welcomme, (1979) was of the opinion that physical parameters in African running waters are influenced by rainfall and flood cycles. The temperature values in the two reservoirs were not significantly different in the two seasons (Table 2).

The pH from both reservoirs showed significant differences in seasons (Table 1), and the values were still within the tolerable limits. Abowei, (2010) opined that a pH higher than 7.0, but lower than 8.5 is ideal for biological productivity while pH lower than 4.0, is detrimental to aquatic life Most organisms do not tolerate wide variations of pH over time and if such conditions persist death may occur, therefore, waters with little change in pH were generally more conducive to aquatic life. The mean pH values for the two reservoirs in both seasons ranged between 6.7 ± 0.01 and 7.10 ± 0.10, which shows that the water from the two reservoirs was good for fish production. Fawole, (2000), reported a range of 7.09 - 7.42 and a mean value of 7.24 ± 0.17 for the pH of Oba reservoir. With a difference of more than seventeen years period in between the two studies, such change in the acidity of the water body can be caused by acid rain, run-off from surrounding rocks and waste water discharges (Ibiebele *et al*., 1983). Fawole, (2000) also reported that the reservoir was situated very close to some commercial farms and was thus exposed to waste waters from these farms. These farms were still in existence during the period of this study, with increased activities and may likely be a contributory factor in increasing the acidity of the water in the reservoir over the years.

The dissolved oxygen (DO) values in Erinle and Oba reservoirs were significantly different ($p<0.05$) in both seasons (table 1). Oba reservoir had less DO values than Erinle reservoir in raining and dry seasons of study. The standard valuesof DO in an aquaculture are between 5 – 10mg/l (Chaudhary, *et al.,* 2004; UNESCO/WHO/UNDP, 1992). The values recorded in Erinle in the two seasons fell within the required values, but that of Oba in the dry season fell short. Fawole (2000), reported an average value of 4.37mg/l$\pm$1.14 for the DO in Oba reservoir, he went further to suggest that the dissolved oxygen requirement for fish varied with species. A major part of dissolved oxygen was opined to come from photosynthesis processes and only a small part originated from the atmosphere (Milstein *et al*., 1989).The high activities of the living organisms coupled with degradation in Oba reservoir may have depleted the dissolved oxygen in the reservoir. Low DO values that was significant across seasons between the two water bodies was an indication of pollution, hence Oba reservoir may likely be more polluted than Erinle reservoir. However, increment in values of DO in the rainy season (and a significant difference in seasons) over that of dry season (in both reservoirs) maybe as a result of inflow of fresh water from feeder streams and as a result of the rains. Generally the water quality for any fish cultured in the tropical region must be such that the dissolved oxygen concentration must not be less than 2 mg/l. (Robert and Davies, 1979). The DO values in Oba and Erinle reservoirs were greater than the lower lethal limit of the oxygen tolerance of most of its resident fish species.

The biochemical oxygen demands (BOD) for both reservoirs were also significant ($p<0.05$) in both seasons. Values for Oba reservoir in dry and rainy seasons were higher than those of Erinle reservoir in the same period (Table 1). The biochemical oxygen demand followed the same pattern as the dissolved oxygen, with higher values obtained in rainy seasons and those of Oba reservoir higher in both seasons than Erinle reservoir. The mean BOD values of the reservoirs indicated that they were not polluted. Clerk, (1986) opined that BOD range of $\geq 2 \leq 4$ does not show pollution while levels beyond 5 mg/L was indicative of serious pollution. Moore and Moore, (1976) and Chinda *et al*., (1991) reported that water bodies with biochemical oxygen demand levels of between 1.0 and 2.0 mg/L were considered clean; 3.0 mg/L fairly clean; 5.0 mg/l doubtful and 10.0 mg/L bad and polluted. Statistically, BOD values from the two reservoirs were significant ($p<0.05$) (table 2) with Oba reservoir on the high side. A value of 4.30 ± 0.03 mg/l in the dry season was an indication that it was more polluted than Erinle reservoir. This may be due to the higher number of living organisms, higher activities, and degradation going on in Oba reservoir.

Electrical conductivity values showed significant difference ($p < 0.05$) between the two reservoirs (Table 2) in both dry and rainy seasons (Table 1). Egborge, (1994b) and Ogbeibu and Victor, (1995) reported that conductivity was an index of the total ionic content of water, and therefore indicated freshness or otherwise of the water. The means of the conductivities measured in Oba reservoir is higher than the means in Erinle reservoir, which indicated that water in Erinle reservoir was likely to be fresher than water in Oba reservoir. Verheust, (1997) stated that conductivity can be used as indicator of primary production (chemical richness) and thus fish production. Gerrarth and Denny (1978) recorded conductivity value of 8.1µS/cm for a coastal lake in Sierra Leone, Moses, (1979) reported a range of 6µS/cm - 25 µS/cm in the Cross Rivers system in Nigeria. Values recorded in the dry season from both reservoirs were higher than those recorded in the rainy season, Petr (1983) attributed dry season rise in conductivity to the concentration of ions by evaporation, coupled with increased mineralization of organic matter. This result followed the same pattern as the dissolved Oxygen and biochemical oxygen demand values, all indicated that the physico-chemical conditions of the water in Erinle reservoir was likely to be less polluted than that of Oba reservoir.

CONCLUSIONS

The physico – chemical parameters values obtained from Erinle and Oba reservoirs were significantly different in seasons. Though they fell within standard aquaculture values, there was an indication of significant difference ($p < 0.05$) between the two reservoirs and these values indicated Oba reservoir to probably be relatively polluted than Erinle reservoir.

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