Available online at www.easletters.com

ISSN No: 2349-2864

Entomology and Applied Science Letters, 2014, 1, 3:43-48

# Physico-chemical parameters in relation to fish abundance in Daberam Reservoir, Katsina State, Nigeria

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*(Received: 10-7-14 )* *(Accepted:1-8-14)*

**ABSTRACT**

*A survey of physico-chemical parameters in relation to fish abundance in Daberam reservoir Katsina state was conducted for a period of seven months, from March-September,2009. Physico-chemical parameters studied include temperature, water transparency, pH, dissolved oxygen, ammonia and nitrate. Eleven fish species were identified namely; Clarias gariepinus, Tilapia zilli, Oreochromis niloticus, Schilbedea micropogon, Sarotherondon galilaeus,Tilapia guntheri, Lates niloticus, Schilbe micropogan, Alestes nurse, Protepterus annectens and Mormyrus rume. The result of physical parameters studied showed that temperature ranges from 25.8$^{o}$C-30.8$^{o}$C. The $_{P}$H ranges from 7.3-8.9. Electrical conductivity (E.C.) ranges from 0.02-0.13 (µs/cm) while transparency ranges from 0.18m-0.69m.The chemical parameters analysis showed that, Dissolved Oxygen (D.O), Biological oxygen demand ($BOD_{5)}$, Ammonia and Phosphate concentrations in the reservoir ranges between 6.37-10.93mg/l, 3.16-5.15mg/l, 1.5-2.5mg/l and 2.0-5.0mg/l respectively. All the results obtained were within the results obtained in African freshwater bodies and can sustain survival of both fish and other aquatic fauna in the reservoir.*

**Key Words**: Physico-chemical, Dissolved Oxygen, Fish, Daberam Reservoir.

## INTRODUCTION

Fish is a very important source of protein which is needed by the body for growth, repairs and replacement of worn out tissues. Therefore, inland capture fisheries for sustainable development are a priority to Nigeria today because it provides employment, income and food security [1].

A survey of the freshwaters of Nigeria including the wetlands was estimated at 743, 100ha representing about 3.4% of the total area of Nigeria. An estimate of 230 fish species inhabiting the various fresh-water ecosystems was made indicating the potential and fish diversity in the rivers, lakes and reservoirs in Nigeria [2]. The overall contribution of the fresh water species to the total domestic fish production in Nigeria was estimated at 248,000 metric tons representing about 47.8% of the total fish catches mainly by artisan fishermen all over the rivers, lakes and reservoirs [2].

Water as a habitat for fish must have favorable quality parameters such as dissolved oxygen, biological oxygen demand, minerals, ammonia, nitrate, nitrite, phosphate etc in such amounts that are not harmful to fishes. However, the habitat also consists of physical features, the contours of the lake basins ridges, rocks, depth, bottom deposits, fallen trees and stumps. Also a growth of aquatic invertebrate's fauna and a few kinds of vertebrate other than fish, which provide food. Some are predators of smaller fishes and later as these same fishes grow they change to become their food. The quality of water which is based upon physical and chemical characteristics of the water and includes

dissolved oxygen, and other gases, suspended solids, temperature, pH, mineral contents and any pollutants influences the reproduction and growth performance of fishes [3].

## MATERIALS AND METHODS

### The study Area

The research areas were Daberam Reservoir and Biology Department, Umaru Musa Yar'adua University; Katsina. Daberam Reservoir is located on rivers Kigo and Riniyal which are seasonal rivers, as its sources of water and River Dan-nakola as its tributary at Daura and Dutsi local government, Katsina state, at latitude $13^{0}2^{1}$N and longitude $8^{0}2^{1}$E.

The reservoir lies in northern sudan savannah zone the climate is characterized by distinct wet and dry seasons with an annual rainfall of 600 – 640mm. The reservoir has a total storage capacity of about 400 hectares of land, but because of siltation, only 200 hectares is fully been utilized. The depth of the reservoir is 42.6meter with a crest length of 2377.44 meters [4].

Water samples and fish were collected at the following sampling stations; station A (Hayin Daura) station B (Hayin Dutsi), and station C (Madawa).

### Sampling Sites

i. Station A :Hayin Daura is located at the entry of the reservoir on the channel of Kigo River.
ii. Station B: Hayin Dutsi is located at the middle of the reservoir where human activity is minimal except agricultural and irrigational activities.
iii. Station C: Madawa is located at the extreme end of the reservoir and a lot of fishing activities take place there and also there is a presence of fish market .

### Fish sampling

A fleet of gill nets made up of nine (9) multifilament nets of the following stretched mesh size of 1", 1 ½" 2", 2 ½", 3", 3 ½", 4", 5", 7", were used with the assistance of the fishermen to sample shore, surface and bottom of the reservoir. Each net measured 30m long and 3m deep. The nets was set at approximately 2 hours before sunset and lifted 2 hours after sunrise. Samples were collected fortnightly from both experimental fish sampling nets and artisanal fishermen, for a period of seven months (March 2009 – September, 2009).

The fish samples collected were transported to the laboratory in ice-cooled buckets in order to prevent fish spoilage.

### Fish identification

The fish samples were identified in the laboratory from genus to species level using dorsal and anal fin counts, gill rakers counts, body shape, size, and shape of caudal fin, anal papillae with the help of standard texts such as fish and fisheries of Northern Nigeria [5] and 'A field guide to Nigerian freshwater fishes [6].

### Determination of some Physico-chemical parameters

The physical and chemical parameters tested during this research were temperature, hydrogen ion concentration (pH), transparency, electrical conductivity, Dissolved oxygen, five day biochemical oxygen demand ($BOD_5$), concentration of Ammonia, phosphate. The surface water temperature was measured using Hannah H198129 Digital tester. pH Was read off on the field using Hannah portable meter model Hi 98129. Transparency of the water was measured using white/black paint 30cm secchi disc and a ruler as described by [7]. Electrical conductivity was measured using Hannah portable meter model HI98130 in situ. The dissolved oxygen was measured on the site using Hannah model HI9146 portable waterproof micro-processor dissolved oxygen meter. Five days Biochemical Oxygen Demand was measured after keeping the water sample in the laboratory for five days using Hannah model HI9146 portable microprocessor dissolved oxygen meter (Alsokikoto, Hungary). Ammonia level in water was determined using Hannah HI 3824 test kit. Phosphate level in the water was determined using Hannah HI 3833 test kit.

## RESULTS AND DISCUSSION

**Fish species identification**

Eight (8) genera consisting of eleven (11) different species were caught from the three different sampling stations and identified (Table 1). The species are *Clarias gariepinus,Oreochromis niloticus, Schilbedea micropogon, Tilapia zilli, Petrocephalus bovei, Protopterus annectens, Alestes nurse, Mormyrus rume, Tilapia guntheri, Sarotherodon galileaus* and *Lates niloticus*.

**Physico-chemical parameters of Daberam Reservoir**

Surface water temperature was highest in April (30.8$^{o}$c) and lowest in June (25.8$^{o}{}_{C}$) in all the sampling stations. Water transparency was highest in September (0.69m) and lowest in April (0.18m). Electrical conductivity ranged between 0.02µs/cm – 0.13µs/cm in May and April respectively. The water pH was slightly Neutral (7.3) in August (Table 2).

Similarly, as shown in Table 3, the values of dissolved oxygen ranged between 6.37mg/l – 10.93mg/l in August and June respectively. The biochemical oxygen demand ($BOD_5$) values were highest in June (6.23mg/l) and lowest in September (3.16mg/l). The values of Ammonia and phosphate concentration were fluctuating in all the three sampling stations throughout the study period in the range of 1.5mg/l – 2.5mg/l and 0.2mg/l – 0.6mg/l for ammonia and phosphate respectively (Table 3).

## DISCUSSION

**Fish composition**

Eight genera consisting of eleven species were encountered during the study period and the dominant species was *C.gariepinus* while the rare species was *P.bovei*. Generally C*ichlids* dominated the reservoir. This could be attributed to their breeding habits, physico-chemical parameters and food availability of the reservoir. This aggress with the finding of [8], who observed cichlids as the dominant fish in IITA lake in Ibadan, Nigeria. The finding is also in accordance with the reports by several workers such as [9] in Wateri lake, [10] in Tomas lake and [11] in Jakara lake.

**Physico-chemical parameters**

The surface water temperature of the reservoir fluctuated between 25.80$^{o}$C in the month of June a period characterized by rainfall, solar radiation to 30.60$^{o}$C in September a period of hot humid air. The surface water of the reservoir is within the favorable temperature range of 16$^{o}$C- 30$^{o}$C as reported by [12] and also [13] who reported that the normal range of temperature in the tropics to which fish is adapted is between 8$^{o}$C and 30$^{o}$C and these make the critical thermal minimum and maximum respectively. As such temperatures obtained in this study, fish growth and development could be favored, with very low concentration of pollutants.

Maximum transparency of 0.69m was recorded in the months of the dry seasons (September). When associated with a high temperature and low dissolved oxygen concentration, a high turbidity can be disadvantageous to fish production [14]. . Lowest value of transparency (0.18m) was recorded in month of April due to depositions of waste because of lack of rain. According to [15] transparency tends to be lower during the rainy season in reservoirs than in the dry season, but is usually not as clear as in rivers and streams. The values of electrical conductivity varied according to seasons. The value is lower during the month of May (0.02µs/cm) and highest in the month of April (0.13µs/cm). The difference could be due to dilutions of the reservoir during the rainy seasons and possibly the precipitation of the metallic ion during this period coupled with the low water level in the dry seasons period. This conforms to the findings of [16], who obtained a result of 0.34µs/cm and 0.67µs/cm in the rainy and dry seasons respectively. It has been established by [17] that the mineral content of the water expressed as total dissolved salts can be used as a rough indicator of the edaphic condition which play a fundamental role in determining the biological productivity of water bodies. Thus, the wide variation in the total dissolved salts for the three stations could be due to the allochtonous and autochthonous contribution to the reservoir. The high Total dissolved solids (TDS) at station C (0.12ppt) in the month of March, apart from the low level of water, could also be due to allochtonous input from the agricultural land drainages from farmlands that bordered the station. The Main effect of pH seems to be on the inhibition of $0_2$ uptakes at the gills of fishes. The world quality standard [18] stipulates that pH of water must be maintained between the values of 6.5 and 9.0. Values of pH above 9.0 are adverse to fish. Accordingly, pH has an indirect effect on the forms of chemicals present. The productivity of fish is believed to be

higher in freshwater bodies with a pH of 6.5 – 9.0 [17]. In this study, the obtained water pH varied between months of sampling as well as the stations and ranged from 7.3 – 8.9, that is from slightly neutral to slightly alkaline. Previous research findings [12] and [7] showed that, a change in water pH indicate the presence of certain agricultural and domestic effluents. Similarly, [19] Indicated that decay and decomposition of aquatic weeds can cause accumulation of acidic gases in a lake, these may consequently affect the water $_{P}$H. In this survey, dissolved oxygen concentration ranged from 6.37mg/l in August to 10.93mg/l in June. The dissolved oxygen concentration within Daberam Reservoir is satisfactory for most species. It was recommended by [20] that dissolved oxygen below level of 5.0mg/l impairs the growth and reproduction of fishes as well as made them to become more susceptible to diseases and parasitic attack. Hence, [7] reported that Dissolved oxygen (DO) value of < 2mg/l is deleterious.

Dissolved oxygen concentrations in all stations were generally higher than 6.mg/l saturation. Thus, according to the report by [21], oxygen saturation percentage is influenced by phytoplankton densities and organic matter decay. The high DO concentration obtained in this research especially in the month of June could be attribute to the effect of mixing of upper and lower layers in the reservoir column thereby increasing the dissolved oxygen. Moreover, [22] observed that water current causes mixing of the upper and lower layers in a river column thereby increasing dissolved oxygen. The value of DO concentration in this research is in agreement with the finding of [3] who recorded 4.3 – 8.88 mg/l in Lake Alau. Similarly, [10] recorded 3.9 – 8.0mg/l in Wateri Lake. But our findings were in contrast with the report by [11] who recorded 0.3 – 3.2 mg/l in Jakara Lake. The organic matter quantified by its biochemical oxygen demand, that is, the ability of a water body to absorb dissolved oxygen, was observed to be higher in June (6.23mg/l) and lower in September (3.16mg/l). The higher $BOD_5$ which was lower than the obtained DO during the same period could be due to the presence of rains which brought in biogenous materials into the reservoir. These findings agreed with those of [23, 24, 25], who noted that higher $BOD_5$ in water system was due to biogenous materials that were brought in by rainfall.

The lower $BOD_5$ value of 3.16mg/l was obtained in the month of September. This is in consistence with [26] who observed that moderately polluted water bodies have a $BOD_5$ in the range of 2mg/l to 8mg/l. Ammonia and Phosphates were among the chemicals detected from the water of the reservoir. There were variations in the concentrations of these chemicals from the various stations and from month to month. Their concentrations may be attributed to the nature of the catchment area, municipal or domestic wastes, urban storm-water run-offs, agricultural wastes (fertilizers) solid waste dump and geological weathering of parent rocks. In nature, ammonia and phosphates levels in water can vary from time to time. However the fluctuation of concentration of 1.5mg/l to 2.5mg/l throughout the study period in all the stations may be evidence of sanitary pollution due to wastes discharged or natural causes. This agrees with the finding of [27] who reported anthropogenic chemical nutrients enrichment of the phosphates in Lagos Lagoon with ammonia implicated land based domestic waste sources.

A high level of phosphate stimulates the growth of photosynthetic organisms which may contribute to eutrophication of lakes, rivers and ponds (www.hannainst.com).This may be evident in Daberam reservoir. It can therefore be concluded that physico –chemical parameters of the reservoir are favourable to the growth of fish and other aquatic flora and fauna.

**Table 1: Families and species of fish identified in Daberam reservoir during the study period**

| FAMILY | SPECIES |
|---|---|
| MORMYRIDAE | *Petrocephalus bovei*, Cuvier & Valenciennes 1846 |
| CICHLIDAE | *Tilapia zilli*, *Gervis 1848*<br>*Oreochromis niloticus*, Linnaeus 1758<br>*Sarotherondon galilaeus*, Pellegrin 1906<br>*Tilapia guntherii*, Sauvage 1882 |
| CLARIDAE | *Clarias Gariepinus*, Burchell 1822 |
| CENTROPOMIDAE | *Lates niloticus*, Linnaeus 1758 |
| SCHILBEDEA | *Schilbe micropogan*, Linnaeus 1758 |
| CHARACIDAE | *Alestes nurse*, Ruppell 1832 |
| LEPIDOSIRENIDAE | *Protopterus annectens*, Owen 1839 |
| MORMYRIDAE | *Mormyrus rume*, Cuvier & Valenciennes 1846 |

**Table 2: Mean monthly variation of physical parameters of Daberam Reservoir**

| Months/ Sample sites | Temperature (°C) | | | Transparency (m) | | | Elec. Conductivity (µs/cm) | | | $P^H$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | A | B | C | A | B | C | A | B | C |
| March | 28.9 | 30.2 | 29.8 | 0.35 | 0.38 | 0.40 | 0.09 | 0.10 | 0.08 | 0.10 | 0.09 | 0.12 |
| April | 30.8 | 30.6 | 28.6 | 0.18 | 0.21 | 0.27 | 0.11 | 0.13 | 0.10 | 0.05 | 0.006 | 0.07 |
| May | 30.2 | 29.8 | 30.0 | 0.23 | 0.41 | 0.19 | 0.05 | 0.04 | 0.02 | 0.02 | 0.03 | 0.03 |
| June | 25.8 | 26.5 | 26.5 | 0.41 | 0.48 | 0.31 | 0.12 | 0.13 | 0.04 | 0.06 | 0.08 | 0.04 |
| July | 27.7 | 27.4 | 27.3 | 0.46 | 0.50 | 0.62 | 0.06 | 0.08 | 0.09 | 0.03 | 0.04 | 0.02 |
| August | 27.4 | 28.0 | 28.9 | 0.58 | 0.56 | 0.58 | 0.04 | 0.03 | 0.04 | 0.02 | 0.02 | 0.05 |
| September | 30.0 | 30.3 | 30.6 | 0.69 | 0.67 | 0.63 | 0.09 | 0.10 | 0.06 | 0.04 | 0.07 | 0.01 |

**Table 3: Mean monthly variation of Chemical parameters of Daberam Reservoir**

| Months/ Sample sites | D.O.(mg/L) | | | $BOD_5$ (mg/L) | | | Ammonia (mg/L) | | | Phosphate (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | A | B | C | A | B | C | A | B | C |
| March | 9.65 | 8.77 | 7.95 | 3.47 | 3.86 | 3.50 | 2.00 | 2.50 | 2.50 | 5.00 | 4.00 | 5.00 |
| April | 7.86 | 7.63 | 7.68 | 4.39 | 3.22 | 3.95 | 2.00 | 2.00 | 2.50 | 4.00 | 5.00 | 5.00 |
| May | 7.07 | 10.51 | 10.37 | 3.81 | 3.48 | 4.81 | 2.50 | 2.50 | 2.50 | 4.00 | 4.00 | 4.00 |
| June | 10.89 | 10.93 | 8.63 | 6.23 | 4.93 | 5.32 | 1.50 | 1.50 | 1.50 | 4.00 | 3.00 | 4.00 |
| July | 10.47 | 8.38 | 7.45 | 5.17 | 4.05 | 4.63 | 2.50 | 2.50 | 2.00 | 3.00 | 2.00 | 2.00 |
| August | 6.37 | 7.44 | 7.11 | 3.98 | 3.75 | 3.68 | 2.50 | 2.00 | 2.00 | 2.00 | 2.00 | 4.00 |
| September | 7.30 | 6.58 | 8.91 | 3.16 | 3.21 | 4.33 | 1.50 | 1.50 | 2.50 | 2.00 | 2.00 | 4.00 |

**Acknowledgement**

The authors wish to express their sincere thanks to the Laboratory staff of Departments of Biological Sciences, Bayero University Kano, Nigeria and Umaru Musa Yar'adua University, Katsina Nigeria for their support during laboratory analyses. We also wish to thank the management of Umaru Musa Yar'adua University, Katsina, for providing the opportunity and funds to conduct the research.

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