



## Assessment of water quality and algal distribution of selected ponds in Jalingo Metropolis, Taraba, Nigeria

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### Abstract

This study was carried out on water quality and algal distribution of selected ponds in Jalingo. Algal and water samples were collected, preserved and analysed over a six-week period using standard methods. A total of five taxonomic groups were identified; Chlorophyta, Bacillariophyta, Cyanophyta, Euglenophyta, and Chrysophyta. The division Chlorophyta has the highest percentage composition in all the ponds. Physicochemical properties studied include water temperature, pH, transparency, electrical conductivity, dissolved oxygen and biological oxygen demand. Temperature was fairly constant ranging from 15.4°C to 27.80°C in the ponds throughout the study period. pH which ranged from 6.24 to 9.15 in all ponds was optimum for algal growth and development. Transparency revealed a significant difference throughout the study period and it ranged from 27.00cm to 10.10cm. Electrical conductivity recorded the highest value (543µS/cm) in week six of Pond A. Pond C recorded the highest value of dissolved oxygen (10.50mg/l) and also recorded the highest value for biological oxygen demand (7.00mg/l). It is material to note that the diversity of algae in these systems is greatly influenced by the physical and chemical parameters operating within the ponds. Thus, forming a useful tool for further ecological assessment and monitoring of freshwater habitats in Sub-Sahara Africa.

**Keywords:** algae, electrical conductivity, oxygen, temperature, transparency, pH, pond

### 1. Introduction

The abundance of water is a major reason earth is habitable [1]. All organisms are made mostly of water and live in a world where water dominates climate and many other features of the environment [2]. Here on earth, water is the biological medium – the substance that makes life possible [3]. Life began in water and evolved there for three billion years before spreading onto land. Modern life, even terrestrial life, remains tied to water. Earth's surface is also wet, with water covering three-quarters of the planet [4, 5].

Due to population explosion and moderate to rapid urbanization, people rely heavily on water sources of doubtful quality in the absence of better alternatives [6]. The scarcity of clean water and pollution of fresh water has led to a situation in which one-fifth of urban dwellers in developing countries and three-quarter of their rural dwelling population do not have access to reasonably safe water supply [7]. More so, hardly does any body of water or moist spot on the face of the earth is devoid of algae. They are almost as nearly ubiquitous as are the bacteria which are perhaps the most widely distributed organisms in the world [8, 9]. The variety of form and color exhibited by the algae is seemingly endless [10].

Similarly, each species of algae has an optimum and tolerance range beyond which it may not survive [11]. Since algae are bio-indicators, they provide valuable insights into water quality, indicating how fit or unfit a water body is for usage [12]. Algae are frequently found in polluted and unpolluted water and due to this behaviour they are generally considered useful to determine the quality of water. It is with this view that the researchers aimed to

investigate the occurrence of algae in relation to the various physicochemical parameters of three water bodies (specifically ponds) in Jalingo Metropolis [13].

### 2. Materials and Method

#### 2.1 Study sites

The three ponds (A, B, and C) selected for this study is located within Jalingo Metropolis and are all eutrophic in nature. Pond A is located at Nukkai between the coordinates of latitude 8°54.753'N and longitude 11°19.153'E. The pond is round, dark green in appearance; it is surrounded halfway by houses and farmlands used for subsistence agriculture. It is an enclosed pond with artisan fishing taking place. The ponds also serve as important sources of drinking water for animals (especially cattle) and domestic water usage. The pond is a natural pond and a perennial pond.

Pond B is located at Mile Six Bye-pass between the coordinates of latitude 8°57.084'N and longitude 11°21.779'E. It is surrounded halfway by houses. The pond is light green in appearance, and the source of water is principally rainfall, run-off from domestic discharge and urban run-offs. It is polluted as a result of organic content and inorganic pollutants from domestic sewage. The pond appears unused; however, it serves as an important breeding ground for mosquitoes, which could create health issues to the settlers around the area.

Pond C is located at Ramin Tipper, Jekadafari between the coordinates of latitude 8°53'N and longitude 11°22.449'E. The pond is greyish-green in appearance and the source of water is principally rainfall and urban run-offs. The pond water is an important source of drinking water for cattle and

it is also used for moulding blocks.

## 2.2 Physicochemical analysis

All field equipment were checked and calibrated according to the manufacturer's specification.

### 2.2.1 Determination of temperature

Temperature is a physical factor that alters water characteristics and considered as an important factor in controlling the fluctuation and functioning of aquatic ecosystem <sup>[11]</sup>. Temperature readings were determined directly at the sampling site using a temperature probe. The probe was rinsed with distilled water and wiped dry. The probe was placed in the pond water and held in water for two minutes to achieve a stabilized reading as described by <sup>[14]</sup>. After the measurement of each sample, the probe was rinsed with deionized water to avoid cross contamination among different samples.

### 2.2.2 Determination of pH

pH is defined as the intensity of the acidic or basic character of a solution at a given temperature. pH values of the ponds were obtained on site using a portable Hanna pH metre (model no. HI 98130) as described <sup>[15]</sup>. The electrode of the metre was calibrated with three standard buffer solutions (pH 4.0, 7.0 and 10.0). The electrode was washed in distilled water and wiped with soft tissue. The sensitive electrode of the metre was dipped into the water sample for about two minutes for equilibration, and the read knob on the metre was pressed. After one minute, the pH value of the pond water was taken. The electrode was rinsed with deionized water to avoid cross contamination of different samples after the measurement had been concluded.

### 2.2.3 Determination of transparency

The transparency of water was measured in-situ using a secchi disc painted with black and white quadrants which was lowered into water with a graduated cord. The depth at which the disc disappears from sight was recorded, and the depth at which it reappears was also recorded. The average of the two depths in cm was recorded as the water transparency <sup>[16]</sup>

### 2.2.4 Determination of conductivity

Electrical conductivity (EC) is a numerical expression of the ability of an aqueous solution to carry electric current. Conductivity was determined on site using a portable Hanna conductivity metre (model no.: HI98130) as described <sup>[15]</sup>. The unit of measurement was expressed in  $\mu\text{S}/\text{cm}$  which is the SI unit. The electrode was standardized using a buffer solution. The electrode was rinsed with distilled water and wiped dry. The metre was inserted into the pond, the metre was switched on and the conductivity reading was taken. After the measurement, the electrode was rinsed with deionized water to avoid cross contamination of different samples.

### 2.2.5 Determination of dissolved oxygen (DO)

Dissolved oxygen reading was taken on site by using portable Lutron dissolved oxygen metre (model no. DO-5509). The electrode was rinsed with distilled water and wiped with soft tissue. The electrode was inserted into the water column, the metre was switched on and dissolved oxygen reading was taken from the scale <sup>[15]</sup>.

### 2.2.6 Determination of biological oxygen demand (BOD)

Biological Oxygen Demand (BOD) is the measure of the amount of dissolved oxygen required by microorganisms while breaking down organic matter. BOD is an index of organic enrichment of pond water. 250ml BOD bottles were filled with water samples and brought to the laboratory. The samples were placed in a dark cupboard for five days. The dissolved oxygen reading of the water after a five-day incubation period was determined using dissolved oxygen metre. The BOD (mg/l) values were calculated by subtracting the mass of dissolved oxygen obtained in a day. Thus,

$$BOD = DO1 - DO5$$

Where

*DO1* = Dissolved oxygen concentration prior to incubation, and

*DO5* = Dissolved oxygen concentration after a five-day incubation period <sup>[15]</sup>.

### 2.3 Collection of algae

Water samples were collected for algal analysis using 250ml sample bottles. The sample bottles were pre-cleaned by washing with detergent and rinsed three times with distilled water, the sample bottles were also rinsed with the pond water before the actual sampling was done. The sampling was done midstream by dipping each sample bottle at 20cm below the water surface, projecting the mouth of the container against the direction of flow. Each sample bottle was marked with the site's nomenclature (that is, A for pond A, B for pond B, and C for pond C), date and time of collection <sup>[17]</sup> and then transported from the field to the laboratory. Algal samples were also collected from scrapings of algal biofilms from immersed objects (such as stones) found in the water column. These scrapings were immediately transferred to 100ml plastic containers and fixed with 4% buffered formalin to preserve algal cells <sup>[15]</sup>. A drop of the sample about 0.02ml was used for the preparation of algae (wet mounts) according <sup>[15, 18]</sup>. Direct microscopic cell counts using the drop count technique <sup>[19]</sup> were used to determine algal cell density (no. of cells per ml) and analytical process was achieved in line with <sup>[20]</sup>.

Algal cell density=

$$\frac{\text{(Total number of individuals found in 1ml of sample)}}{\text{(Number of drops per ml)}}$$

## 3. Results and Discussion

### 3.1 Temperature

From figure 1, water temperature ranged from 21.60°C to 24.60°C for pond A, 17.70°C to 27.50°C for pond B and 15.40°C to 27.80°C for pond C. The weekly mean water temperature value for the three ponds ranged from 20.25°C to 23.13°C for the three ponds. Water temperature ranging between 13.5°C and 32°C is reported to be suitable for the development of planktonic organisms. Low water temperature of these ponds could be as a result of seasonal changes in air temperatures associated with the cool dry North-East trade winds (Harmattan). This finding agrees with those of <sup>[1, 5]</sup> who observed low water temperatures in dry months of their research studies. It is also evident from the three ponds (figure 1) that the overall temperature was within the range of 15.4°C to 27.80°C. The highest value obtained was in the first week of pond C and lowest value was obtained in the fifth week of pond C.

### 3.2 pH

The weekly pH readings of the pond water ranged from 6.24 to 9.15 (figure 2). Highest pH value of 9.15 was recorded in the fourth week of pond A and the lowest pH value of 6.24 was recorded in the first week of pond C. The weekly pH readings of the pond which was near neutral (6.24 to 8.53) encouraged algal formation. According to [9] cyanobacteria tend to form more in hard waters with a pH range of 7.9 to 9.0. The results of pH obtained throughout the study were optimum for fish culture which corresponds with [14] report (pH range of 5.5 to 10) and recommendation for tropical fish culture. The pH values varied significantly ( $P < 0.05$ ) throughout the study period.

### 3.3 Transparency

The weekly transparency readings ranged from 27.00cm to 10.10cm (figure 3). The highest transparency reading was recorded in the sixth week of pond A and the lowest in the second week of pond C. The weekly transparency value ranged from 10.10cm to 27.00cm. High transparency readings in the ponds resulted in increased light penetration, which in turn increased photosynthesis and hence encouraged algae development. This corresponds with the result of [9] which revealed that light is required for photosynthesis by Algae and Cyanobacteria. In the same line, high secchi visibility is due to increased evaporation in the ponds during the study period. One way analysis of variance revealed that transparency varied significantly with weeks in the ponds.

### 3.4 Electrical conductivity

The electrical conductivity of the ponds ranged from 543.00 $\mu$ S/cm to 26.90 $\mu$ S/cm (figure 4). The highest conductivity value was obtained in the sixth week of Pond A and the lowest value in the fifth week of pond B. The electrical conductivities of the ponds have a mean value ranging from 54.88 $\mu$ S/cm to 168 $\mu$ S/cm. The highest value of 543 $\mu$ S/cm obtained in the sixth week of pond A may be due to high rate of evaporation associated with dry season, this also explains increase in alkalinity level (pH reading of 8.73) in the sixth week of pond A. [15] observed that high level of evaporation led to decrease in water level, increase in salt concentration and increased conductivity. The conductivity values obtained in this study is similar to the findings of [8] who observed high conductivity values in Opa Stream, Ile-Ife during dry months and [2] who obtained high conductivity values in dry months while working on four manmade ponds in Zaria.

### 3.5 Dissolved oxygen

As shown in figure 5, the weekly readings of dissolved oxygen in the ponds ranged from 10.50mg/l to 0.60mg/l with the highest value obtained in the first week of pond C and the lowest value obtained in the last week of pond C. Dissolved oxygen readings ranged from 2.50mg/l to 10.50mg/l. Higher dissolved oxygen values were recorded in pond A with a mean value of 4.72mg/l. This finding is in conformity with the work of [21] who recorded higher values of dissolved oxygen with a decline in water temperature while working on ponds in Tamilnadu.

The fluctuation of dissolved oxygen during the study period might be due to decomposition of organic matter resulting in the competitiveness use of oxygen [5]. He also reported that high levels of bacteria or large amounts of rotting plants

decreases dissolved oxygen percentage saturation resulting to large fluctuations in dissolved oxygen throughout the day which can affect the ability of plants and animals to thrive. The highest value of dissolved oxygen (10.50mg/l) was observed in the first week in pond C; this explains the high density of algae observed in this pond in the first week. This is in line with the findings of [6] who reported that, water with high dissolved oxygen usually have greater biotic community.

### 3.6 Biological oxygen demand

According to the result presented above (fig. 6), the weekly readings of Biological oxygen demand ranged from 7.00mg/l to 0.20mg/l in the ponds. The highest value was obtained in the first week of pond C and the lowest value obtained was in the fourth week of pond A. The weekly readings of biological oxygen demand ranged from 0.20mg/l to 7.00mg/l in the three ponds. The highest value was obtained in pond C. This may be due to the high rate of decomposition of organic matter by aerobic organisms in the water. This is in line with the findings of [6] who reported that mixing of water leads to an increase in dissolved oxygen, raises the activities of organisms in the water, and consequently raise the biological oxygen demand values. [22] Reported that the greater the biological oxygen demand (BOD), the greater the degree of pollution.

### 3.7 Algal composition

From fig. 7, Chlorophyta division was the most significant group contributing about 50% in all the ponds. The sequence of percentage composition of algal division in all the ponds was Chlorophyta > Bacillariophyta > Cyanophyta > Euglenophyta > Chrysophyta. The present result is almost in conformity with the findings of [6]. More so, among the five algal divisions, Chlorophyta density was greater in all the ponds and lowest density was observed in Chrysophyta division.

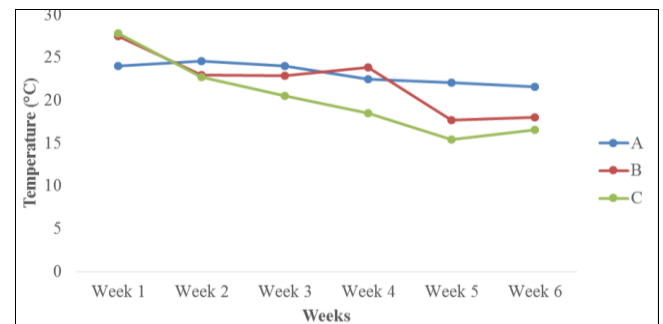


Fig 1: Weekly Temperature (°C) values of ponds A, B and C water sample

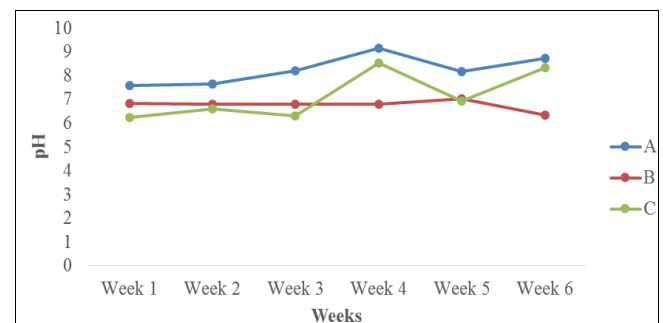
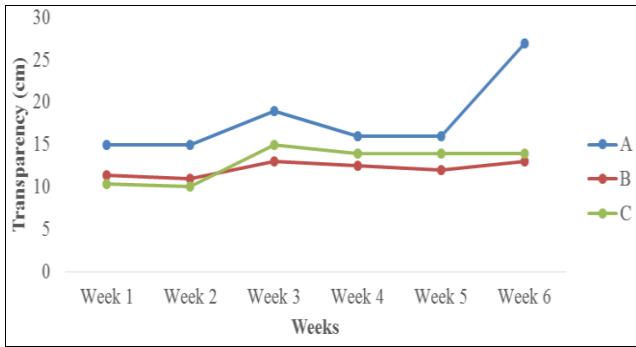
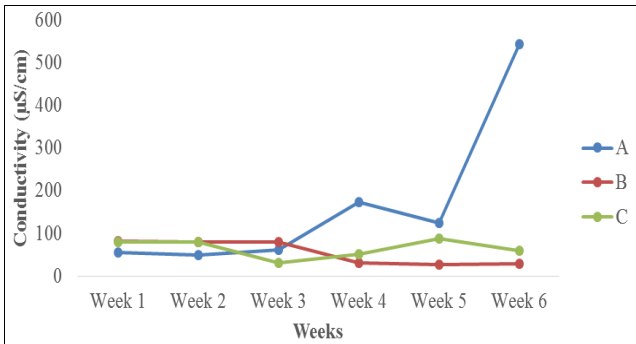


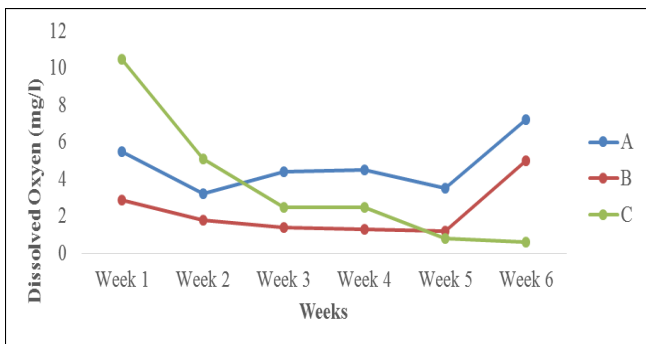
Fig 2: Weekly pH values of ponds A, B and C water sample



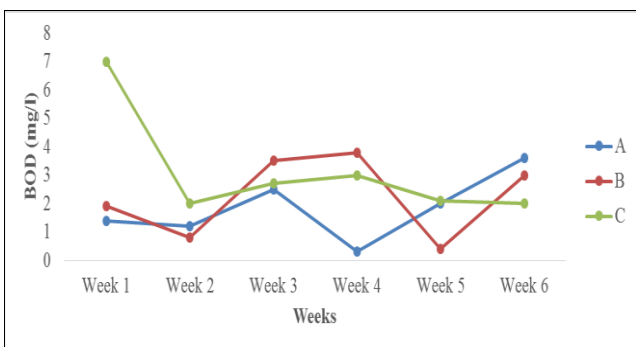
**Fig 3:** Weekly Transparency (cm) values of ponds A, B and C water sample



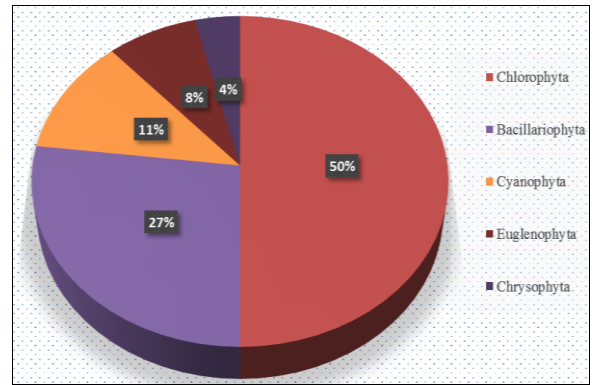
**Fig 4:** Weekly Conductivity (µS/cm) values of ponds A, B and C water sample



**Fig 5:** Weekly Dissolved Oxygen (mg/l) values of ponds A, B and C water sample



**Fig 6:** Weekly Biological oxygen demand (mg/l) values of ponds A, B and C water sample



**Fig 7:** Percentage composition of the different algal divisions in ponds A, B and C.

**4. Conclusion**

The abundance and diversity of algae of the three ponds understudied are influenced by many physicochemical factors and also depend upon the interaction among biological factors. Threats to global freshwater falls into five categories namely over exploitation, water pollution, flow modification, destruction of habitat and invasion of exotic species. The ponds’ algal species were identified as belonging to the following divisions; Chlorophyta, Bacillariophyta, Cyanophyta, Euglenophyta and Chrysophyta. The three ponds recorded high algal diversity. The three ponds also recorded fairly high physicochemical parameters. So the diversity of algae in these systems is greatly influenced by the physical and chemical parameters operating within the ponds. These data on water quality assessment and algal distribution of selected ponds in Jalingo Metropolis therefore forms a useful tool for further ecological assessment and monitoring of freshwater habitats in Jalingo.

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