Pond water quality testing in an institutional campus of Nagaland University, Lumami, India

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Abstract

This study evaluated the physico-chemical status of pond water in Lumami campus, Zunheboto district, Nagaland, to understand its suitability for domestic and livestock use with reference to BIS (2012) and WHO (2017) guidelines. Pond water samples were collected in dark bottles following standard protocols, and key parameters: pH, electrical conductivity (EC), total dissolved solids (TDS), water temperature, dissolved oxygen (DO) and free CO_2 were analyzed. The pond water was slightly alkaline (pH 7.3) with low EC (138 μS/cm) indicating low ionic load, and very low TDS (25 ppm), suggesting minimal dissolved solids. Water temperature during sampling was 17 °C. However, DO was 4.0 mg/L, which is below the commonly recommended range for well-oxygenated waters, indicating potential oxygen stress during certain periods (especially early morning or under higher organic load). Free CO_2 was elevated (26.4 mg/L), which can reflect higher respiration and organic decomposition and may contribute to depressed DO dynamics. Overall, the results indicate that while the pond shows acceptable pH and low salinity characteristics, the low DO and high free CO_2 highlight the need for management interventions such as reducing organic inputs, periodic removal of debris, and improving aeration/plant balance to maintain healthier pond functioning.

Keywords: Pond water; Physico-chemical parameters; Dissolved oxygen; BIS; WHO.

Introduction

Freshwater ponds are small but ecologically significant water bodies that support biodiversity, regulate local microclimate, and provide water for domestic use, livestock, and small-scale irrigation [1]. In campus and peri-urban landscapes, ponds also function as important social-ecological resources, yet they are highly vulnerable to degradation because they often receive runoff, organic debris, detergents, and other anthropogenic inputs [2]. Even low-intensity human disturbance can alter pond functioning by changing nutrient status, oxygen balance, and microbial activity, ultimately influencing the suitability of water for human and animal use [3].

Water quality is determined by interacting physical, chemical, and biological factors, and changes in these parameters can provide early warning signals of ecosystem stress. Physico-chemical indicators such as pH, electrical conductivity (EC), total dissolved solids (TDS), temperature, dissolved oxygen (DO), and free carbon dioxide (CO_2) are widely used for rapid evaluation of pond condition because they reflect ionic content, buffering environment, metabolic processes, and oxygen availability [4]. Among these, DO is particularly important for sustaining aerobic aquatic life and is strongly influenced by temperature, organic matter decomposition, and photosynthesis–respiration cycles. Likewise, free CO_2 is linked to respiration intensity and can increase under conditions of organic loading and limited aeration, often interacting with DO dynamics [5, 6].

Regular monitoring of pond water is therefore essential not only to safeguard ecosystem health but also to reduce health risks associated with poor water quality. Standard guideline frameworks such as the Bureau of Indian Standards [7] and the World Health Organization [8] provide benchmark limits for interpreting water suitability for drinking and domestic purposes. However, water quality characteristics can vary substantially between localities depending on climate,

watershed inputs, and site-level management, and baseline data for many small pond systems in Northeast India remain limited [9].

Lumami campus in Zunheboto district, Nagaland, contains pond systems that are frequently used and influenced by surrounding land use and seasonal environmental conditions. Generating site-specific baseline information is important for evaluating the present condition, identifying potential risks, and guiding simple management actions. Hence, the present study assessed key physico-chemical parameters of pond water in and around Lumami campus, Zunheboto district, Nagaland, and compared the observed values with BIS [7] and WHO [8] guidelines to understand overall water quality status and implications for sustainable use and pond health.

2. Materials and Methods

2.1. Study Area

The present study was conducted at Lumami campus of Nagaland University, located in Zunheboto district, Nagaland, India (approximately 26°01′N, 94°31′E). The campus lies within the humid subtropical hill region of Northeast India and is characterized by seasonal rainfall, moderate temperatures and mixed vegetation cover. The selected pond is situated within the campus area and experiences minimal direct industrial influence, although periodic anthropogenic activities such as runoff input, organic debris accumulation, and domestic usage may influence water quality characteristics.

2.2. Sampling Collection

Pond water samples were collected from selected points of the campus pond during the study period (July, 2021) using clean, dark-colored polyethylene bottles to minimize light-induced chemical changes. Prior to sampling, the bottles were rinsed thoroughly with pond water. Samples were transported to the laboratory immediately and analyzed following standard procedures.

2.3 Physico-Chemical Analysis

Key physico-chemical parameters, including pH, EC, TDS, water temperature, DO, and free CO_2 were analyzed using standard methods [9, 10]. pH was measured using a digital pH meter (Systronics µ pH system 316- pH). EC was determined using a conductivity meter (LMCM-20). TDS were recorded using a digital TDS meter. Water temperature was measured in situ using a mercury thermometer. DO was determined by Winkler's titrimetric method. Free CO_2 was estimated by titration with standard NaOH solution using phenolphthalein as indicator. All measurements were expressed in standard units and compared with the recommended permissible limits of the BIS [7] and WHO [8] to assess water quality suitability.

3. Results and Discussion

Physico-chemical Analysis

The physico-chemical characteristics of the pond water recorded during the study period are presented in Table 1. The results indicate that most of the measured parameters were within the acceptable limits [7, 8], although certain deviations were observed for DO and free CO_2.

The pH of the pond water was 7.3, indicating a slightly alkaline condition that falls within the recommended range (6.5–9.0) for freshwater ecosystems. Such near-neutral to slightly alkaline pH conditions are generally favorable for aquatic organisms and microbial activity [11]. EC (138 µS/cm) was comparatively low, suggesting limited dissolved ionic content and minimal influence of salinity or mineral loading [4]. Similarly, the TDS concentration was recorded at 25 ppm, reflecting low levels of dissolved inorganic and organic materials, which indicates relatively low contamination by external inputs [12].

Water temperature during the sampling period was 17 °C, which is suitable for the survival of many freshwater organisms and also contributes to maintaining moderate oxygen solubility in the water column. However, despite the relatively favorable temperature conditions, dissolved oxygen was found to be 4.0 mg/L, which is lower than the commonly recommended range (5–7 mg/L) for well-oxygenated freshwater systems. Reduced DO concentrations may be associated with the decomposition of organic matter, limited water circulation, or increased respiration by aquatic organisms, particularly in stagnant pond environments [13].

Free CO_2 concentration was observed to be relatively high (26.4 mg/L) compared to the normal recommended range (5–10 mg/L). Elevated CO_2 levels often result from intensified respiration and microbial decomposition processes [14] and may contribute to decreased oxygen availability, as both parameters are closely interrelated in aquatic systems. The combined occurrence of high free CO_2 and reduced DO suggests moderate organic loading or insufficient aeration within the pond ecosystem [15]. Overall, the observed water quality parameters indicate that the pond maintains generally acceptable physico-chemical characteristics; however, the comparatively low dissolved oxygen and elevated carbon dioxide concentrations highlight the need for periodic monitoring and basic management practices such as removal of organic debris, control of nutrient inputs, and enhancement of natural aeration to sustain ecological balance and water usability.

Table 1: Physico-chemical parameter of pond water during the study period

Parameters	Permissible limit	Observation
pH	6.5 -9.0	7.3
Free CO_2	5-10 mg/L	26.4 mg/L
DO	5.0-7 mg/L	4.0 mg/L
Electrical conductivity (EC)	750µ S/cm	138 µ S/cm
Temperature	30-35 °C	17 °C
Total Dissolved Solids(TDS)	500 mg/L	25 mg/L

Ecological Implications and Management

While the pond maintains generally acceptable physical characteristics (pH and TDS), the gas-phase imbalance identifies it as an unstable ecosystem. The low DO and high CO_2 suggest that the pond is currently "heterotrophic" meaning it is consuming more energy and oxygen than it is producing through photosynthesis.

To prevent further deterioration or the potential for fish kills, management practices should focus on:

1. Removal of Organic Debris: Reducing the "fuel" for microbial decomposition.

2. Nutrient Control: Preventing excess algal growth which eventually contributes to organic loading upon death.

3. Mechanical Aeration: If feasible, increasing water movement to facilitate gas exchange with the atmosphere.

Conclusion

The present investigation assessed the physico-chemical characteristics of pond water in the Lumami campus, Zunheboto district, Nagaland, to determine its overall quality status and suitability for domestic and livestock use. The results indicated that most of the analyzed parameters, including pH, electrical conductivity, temperature, and total dissolved solids, were within the acceptable limits recommended by BIS and WHO, suggesting generally favorable water quality conditions. The pond water exhibited slightly alkaline nature (pH 7.3), low ionic concentration (EC 138 µS/cm), and low dissolved solids (TDS 25 ppm), indicating minimal mineral and salinity influence. However, the dissolved oxygen concentration (4.0 mg/L) was found to be lower than the desirable range for well-oxygenated freshwater systems, while the free CO_2 concentration (26.4 mg/L) was comparatively high. These observations suggest moderate organic decomposition processes and limited natural aeration within the pond environment, which may influence aquatic ecosystem functioning if prolonged over time. Overall, the pond water can be considered suitable for general non-potable uses and livestock purposes, but regular monitoring and simple management interventions—such as periodic removal of organic debris, prevention of nutrient-rich runoff entry, and improvement of aeration conditions—are recommended to maintain ecological stability and prevent further deterioration of water quality. Continuous baseline monitoring of such small freshwater bodies is essential for sustaining their ecological and utilitarian value in campus landscapes.

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