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Limnological Assessment of Physicochemical Parameters and Phytoplankton Composition in Chamera Lake, Himachal Pradesh, India

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Abstract
Lake ecosystem is an example of lentic ecosystems in which interlinkage between biotic factors (microorganisms, plants and animals) and abiotic factors (physicochemical parameters) takes place. The present research was to determine the physicochemical properties and community of phytoplankton in Chamera lake (Himachal Pradesh). Phytoplankton plays an important role in the aquatic food chain particularly for zooplanktons. Water samples were collected from Chamera lake from July 2024 to June 2025. Temperature, Sodium, Potassium, Phosphate, free CO2, Acidity, Nitrate, pH, Conductivity, Chlorides, Total Hardness, BOD, DO, Alkalinity all fourteen parameters were analyzed. During the current study investigation fourteen species of phytoplankton were recorded, Bacillariophyceae (seven species), Chlorophyceae (four species), Cyanophyceae (three species). From the present investigation, Species wise most dominant group was observed Bacillariophyceae followed by Chlorophyceae. Palmer's algal pollution index value varied between 4.00 and 29.00 from bottom to top. Occasionally analyzing phytoplankton communities can help us comprehend the health of aquatic system and effects of environmental change.
Keywords: *Chamera lake, phytoplankton, Bacillariophyceae, Palmer's algal pollution index, environmental health*

INTRODUCTION

Aquatic ecosystem is home of various flora and fauna. There are a vast number of small organisms in an aquatic ecosystem, which are perhaps the most important of all life forms on the planet. These small organisms are called plankton. Plankton are of two different types such as Zooplankton (animal plankton) and Phytoplankton (plant plankton). Phytoplankton are the producers of the aquatic food chain [1]. The diversity of aquatic life is highly dependent on phytoplankton. In majority of aquatic ecosystems, phytoplankton play a major role. They form the important source of energy as primary producers and give out a direct source of food to other aquatic organisms. Nutrient rich sunlight, water and carbon dioxide give these small single celled creatures all they need to grow and reproduce. They use it dramatically and multiply in billons and contribute to the productivity of the ecosystem. These small organisms act the life sustaining process of photosynthesis by releasing oxygen. Oxygen is very important to all organisms in land, water or in the air and one of the major factors which regulates the dynamics of lake [2].

Lake ecosystem is an example of lentic ecosystems in which interlinkage between biotic factors (microorganisms, plants and animals) and abiotic factors (physicochemical parameters) takes place. Lakes are highly valued for their aesthetic; recreational and scenic qualities and the water they contain is one of the precious to our natural resources [3]. Lakes comprise important habitats and food resources for a diverse array of aquatic life, and wildlife. Due to anthropogenic activities, many lakes throughout the world are undergoing accelerated aging or eutrophication. This happens due to the influences of industrial, agricultural domestic pollution which lead to deteriorating water quality, phytoplankton blooms, oxygen deficiency, kills aquatic organisms [4].

Phytoplankton are effective indicators of water quality because of their fast turnover rate and vulnerability to environmental changes. Diversity and density of phytoplankton are biological indicators for evaluating water quality and the degree of eutrophication. Temperature, light penetration, nutrient enrichment, toxic substances, heterotrophic microorganism and mixing of water activities influence the phytoplankton growth [5].

The present study aimed to evaluate the nutrient levels and the impact of water physicochemical properties on the phytoplankton populations in Chamera lake. Quantitative and qualitative analyses of different organism groups have facilitated the development of bioindicators, indices, and assessment systems that are majorly used to examine the trophic status and pollution levels of aquatic ecosystems. Biomonitoring has now become an important component of water quality assessment and pollution studies. This study aimed to investigate whether changes in phytoplankton communities could serve as reliable indicators of the trophic status of water bodies. Emphasis was placed on the observation of species absence, presence, and abundance, with mainly focus on biological indicators over physicochemical parameters.

MATERIALS AND METHODS

Study area

The present study was conducted on Chamera Lake, which is a beautiful man-made reservoir located in the Chamba district of Himachal Pradesh, India. It was formed as part of the Chamera Hydroelectric Project which was on the Ravi River [6]. This lake is a popular tourist destination, known for its scenic beauty and water-based activities. Its altitude is ~763 meters above sea level. Tourism activities include boating, kayaking, fishing, and nature sightseeing.

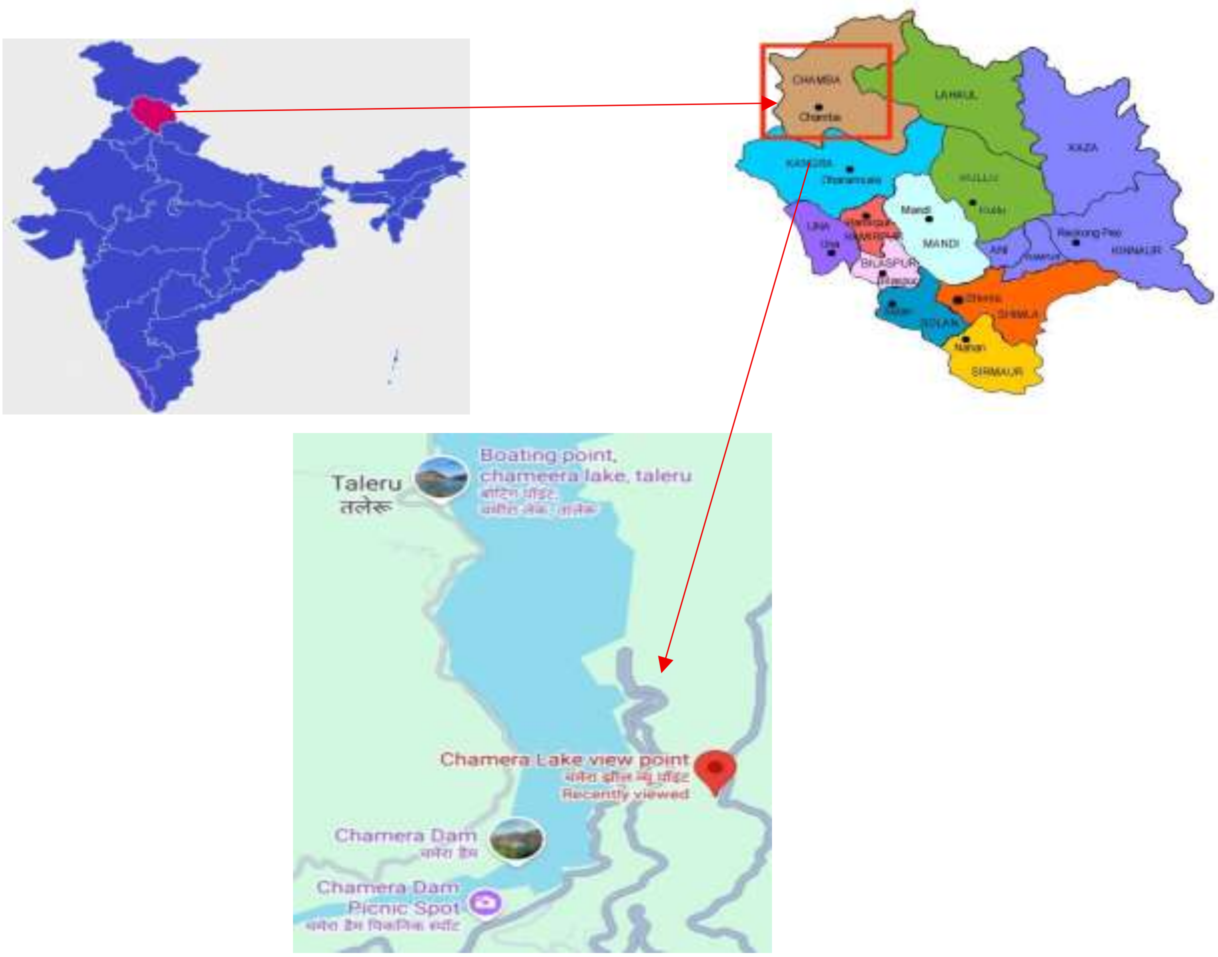

Figure 1: Map Representation of Chamera Lake

Figure 2(a,b): View of Chamera Lake

Table 1: Chamera Lake's Coordinates

S. No.	Coordinates of Chamera Lake	
1.	Latitude	32.5869° N
2.	Longitude	76.0953° E

METHODOLOGY

Water samples were collected from selected lake between July 2024 to June 2025. For the recent study, two sampling points were selected in Chamera lake, site 1 near the shore and site 2 mid of the lake. During selection of sampling sites various important factors considered like, inlets, outlets, growth of aquatic vegetation, morphometric features etc. Every time samples were collected from the same location.

Physicochemical Analysis

Water samples were collected from two sampling points of lake and for the collection of sample glass sampling containers were used. Firstly, the containers were washed thoroughly with sampling water. After filling the containers, they were fixed and transferred to the laboratory for various physicochemical analysis. Few parameters were analyzed on the spot such as temperature and pH of water and for the other parameters one Liter water samples was carried out to the laboratory and assessment for Chlorides, Conductivity, Total Hardness, free CO2, BOD, DO, Alkalinity, Sodium, Potassium, Phosphate, Acidity, Nitrate (APHA 2005) [7].

Phytopalnkton Analysis

The water samples were collected from Chamera lake from July 2024 to June 2025. Phytoplankton samples were collected using a bolting silk plankton net with a mesh size of 50 µm, which served as the filtering cone. From each sampling points samples were collected and filtrate was immediately preserved using 5% Lugol's iodine solution [8]. The samples were then kept in ice box and transported to the laboratory for further analysis. The plankton samples(30ml) were stored in dark at low temperature.

Qualitative analysis

Qualitative analysis of phytoplankton was done in laboratory using a compound microscope at 40x or 100x magnification. Identification of phytoplankton up to the species level was done using manuals, monographs and research articles.

Quantitative analysis

Quantitative analysis of phytoplankton was done using Sedgwick Rafter Cell [9]. Plankton sample was put into the Sedgwick Rafter Cell and covered with cover slip, it was then observed under at 40x or 100x power of microscope. The concentration of phytoplankton was calculated using the following method [10]:

Phytoplankton Org/L= $n \times v / V \times 1000$

n = No. of phytoplankton counted in 0.1 ml of concentrate.
v = Total vol. of concentrate in mL.
V = Total vol. of water passed through the net.

Palmer's algal pollution index

This index is used for observation and evaluation of water pollution and is computed based on the degree of abide of organic pollution of algal genera [11]. A pollution index number is assigned to each genera on the basis of pollution tolerance level and this value is summed up to get overall score organic pollution level of the water body. On basis of total get score, water body is classified as: 0-10 (Lack of organic pollution), 10-15 (Moderate pollution), 15-20 (Possibly high organic pollution), 20 or more (Confirms high organic pollution) [12].

RESULT AND DISCUSSION

In current investigation, study of fourteen physical and chemical parameters was analyzed following standard methods as given in APHA (2005).

Table 2: Average and standard deviation values of various physico-chemical parameters of Chamera lake from July 2024 to June 2025.

S.No.	Parameters	Chamera Lake			
		Site-I (Min. value observed)	**Site-I (Max. value observed)**	**Site-II (Min. value observed)**	**Site-II (Max. value observed)**
1	Temperature	16.60±0.24℃	19.22±0.05℃	15.65±0.15℃	18.90±0.08℃
2	Conductivity	174.19±0.48 μScm^{-1}	232.45±1.45μScm^{-1}	172.26 ±1.08 μScm^{-1}	225.40 ±0.55 μScm^{-1}
3	Chlorides	8.06±0.14 mgL^{-1}	10.45±0.08 mgL^{-1}	7.16 ±0.12 mgL^{-1}	09.08±0.06 mgL^{-1}
4	DO	8.08±0.16 mgL^{-1}	10.92±0.06 mgL^{-1}	7.12 ±0.04 mgL^{-1}	10.06±0.02 mgL^{-1}
5	BOD	2.06±0.12 mgL^{-1}	3.94±0.08 mgL^{-1}	2.02±0.02mgL^{-1}	3.08±0.04 mgL^{-1}
6	Total hardness	162.45±8.14 mgL^{-1}	196.14±8.30 mgL^{-1}	143.29±8.02mgL^{-1}	151.24±8.08mgL^{-1}
7	pH	7.52±0.19	9.04 ±0.00	7.55±0.05	8.85±0.15
8	Free CO2	0.00 ±0.00 mgL^{-1}	3.00±0.16 mgL^{-1}	0.35±0.35 mgL^{-1}	3.00 ±0.35 mgL^{-1}
9	Sodium	12.06±2.14 mgL^{-1}	14.09 ±2.08 mgL^{-1}	11.06 ±2.02 mgL^{-1}	12.08±2.04 mgL^{-1}
10	Potassium	1.06 ±0.14 mgL^{-1}	2.09 ±0.18 mgL^{-1}	1.02 ±0.02 mgL^{-1}	2.02±0.04mgL^{-1}
11	Alkalinity	85.35±3.53 mgL^{-1}	122.17±1.82 mgL^{-1}	85.13±3.23 mgL^{-1}	121.03±2.83 mgL^{-1}
12	Acidity	42.50±3.23 mgL^{-1}	48.17±2.94 mgL^{-1}	41.24±5.23 mgL^{-1}	45.03 ±2.63 mgL^{-1}
13	Nitrate	0.22±0.00 mgL^{-1}	0.26±0.00 mgL^{-1}	0.13±0.00 mgL^{-1}	0.22±0.01 mgL^{-1}
14	Phosphate	1.06±0.14 mgL^{-1}	2.09±0.18mgL^{-1}	0.02±0.01 mgL^{-1}	0.08±0.01mgL^{-1}

Temperature: At S1 the average water temperature was minimum 16.60±0.24℃ during November and the maximum 19.22±0.05℃ during June. The average water temperature at S2 varied from 15.65 ±0.15℃ during December to 18.90±0.08℃ during June.

EC: The average minimum and maximum EC at S1 were observed from 174.19 ±0.48 $\mu Scm^{-1}$and 232.45±1.45μScm^{-1}, respectively. The average EC at S2 varied from 172.26 ±1.08 to 225.40 ±0.55 μScm^{-1}.

Chlorides: The average chlorides concentration at S1 was minimum 8.06 ±0.14 mgL^{-1} and the maximum 10.45 ±0.08 mgL^{-1}. The average chlorides conc. at S2 varied from 7.16 ±0.12 to 09.08±0.06 mgL^{-1}.

DO: The average DO at S1 was minimum 8.08±0.16 mgL^{-1} and the maximum 10.92±0.06 mgL^{-1}. The average DO at S2 varied from 7.12 ±0.04 to 10.06±0.02 mgL^{-1}.

BOD: The average BOD at S1 was minimum 2.06±0.12 mgL^{-1} and the maximum 3.94±0.08 mgL^{-1}. The average BOD at S2 varied from 2.02±0.02 to 3.08±0.04 mgL^{-1}.

Total Hardness: Total hardness observed at S1 was minimum 162.45±8.14 mgL^{-1} and the maximum 196.14±8.30 mgL^{-1}. The average hardness at S2 varied from 143.29±8.02 to 151.24±8.08 mgL^{-1}.

pH: The average pH at S1 was minimum 7.52±0.19 during December and the maximum 9.04 ±0.00 during June. The average pH at site 2 varied from 7.55±0.05 during December to 8.85 ±0.15 during June.

Free CO2: Monthly variation in free CO2 content at both sites were recorded maximum during December and minimum or absent during May and June. The average minimum and maximum CO2 at site 1 were 0.00 ±0.00 mgL^{-1} and 3.00±0.16 mgL^{-1}, respectively. The average CO2 at S2 varied from 0.35 ±0.35 to 3.00 ±0.35 mgL^{-1}.

Sodium: The average sodium value observed at S1 was minimum 12.06 ±2.14 mgL^{-1} and the maximum 14.09 ±2.08 mgL^{-1}. The average sodium at S2 varied from 11.06 ±2.02 to 12.08±2.04 mgL^{-1}.

Potassium: The average potassium at S1 was minimum 1.06 ±0.14 mgL^{-1} and the maximum 2.09 ±0.18 mgL^{-1}. The average potassium at S2 observed from 1.02 ±0.02 to 2.02±0.04 mgL^{-1}.

Alkalinity: The average minimum and maximum alkalinity at S1 were 85.35±3.53 mgL^{-1} and 122.17±1.82 mgL^{-1}. The average alkalinity at S2 varied from 85.13±3.23 to 121.03±2.83 mgL^{-1}.

Acidity: The average minimum and maximum acidity at site 1 were 42.50 ±3.23 mgL^{-1} and 48.17 ±2.94 mgL^{-1}. The average acidity at S2 varied from 41.24±5.23 to 45.03 ±2.63 mgL^{-1}.

Nitrate: The average nitrate conc. at S1 was minimum 0.22 ±0.00 mgL^{-1} during December and maximum 0.26±0.00 mgL^{-1} during the month of May. The average nitrate conc. at S2 varied from 0.13 ±0.00 mgL^{-1} during November to 0.22 ±0.01 mgL^{-1} during June.

Phosphate: The average phosphate conc. at site 1 was minimum 0.06±0.01 mgL^{-1} during December and maximum 0.12 ±0.01 mgL^{-1} during May. The average phosphate at S2 varied from 0.02 ±0.01 mgL^{-1} during December to 0.08 ±0.01 mgL^{-1} during May-June.

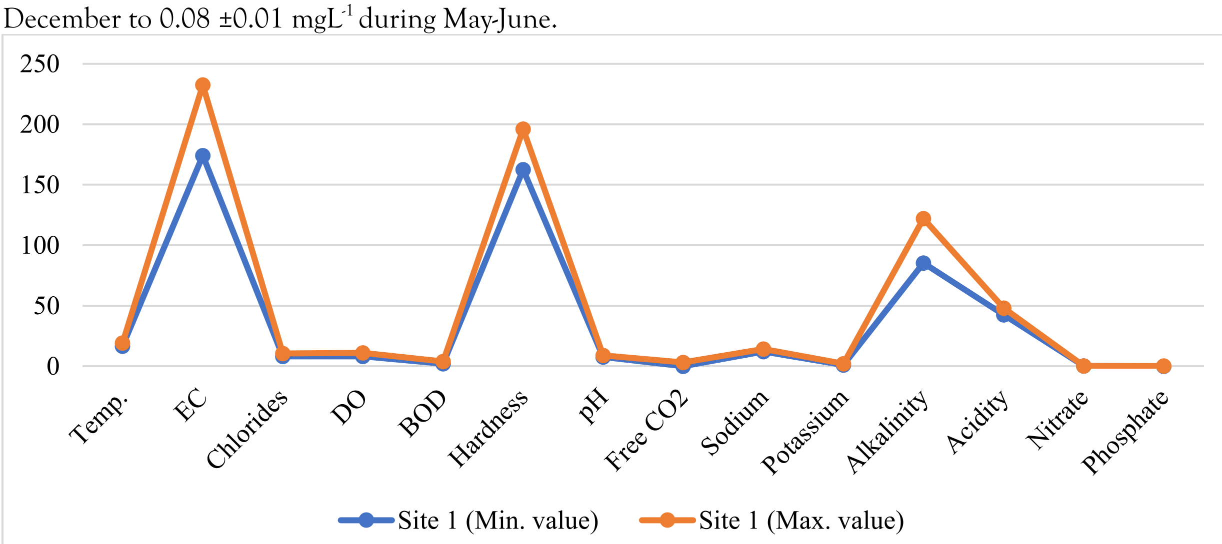

Figure 3: Minimum and maximum values of physicochemical parameters observed at site 1 of Chamera Lake

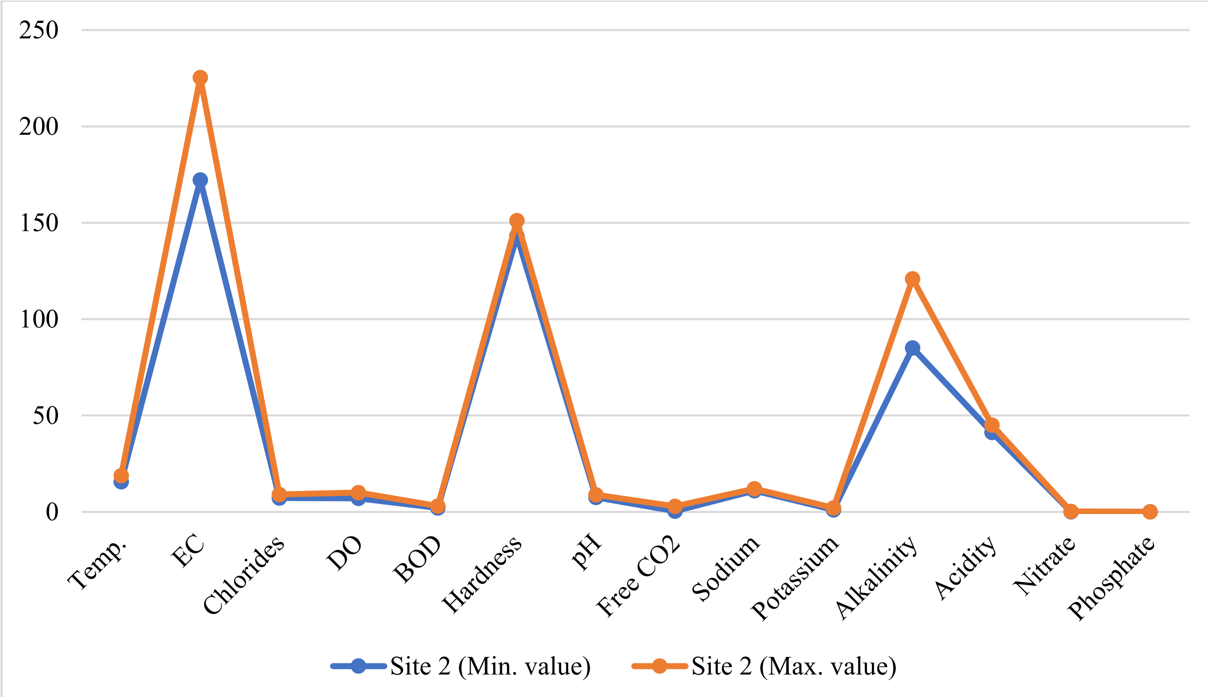

Figure 4: Minimum and maximum values of physicochemical parameters observed at site 2 of Chamera Lake

Phytoplankton

In Chamera lake, total fourteen species of phytoplankton were recorded under 3 groups; Bacillariophyceae (maximum percent composition) with 7 species, Chlorophyceae with a total of 4 species and Cyanophyceae with 3 species (Table 3). Some of them were present seasonally and some were present throughout the study period. *Navicula sp.*, *Synedra sp.*, *Spirogyra sp.*, *Chlorella vulgaris*, *Anabaena sp.* was recorded throughout the study period. Most abundant Bacillariophyceae members were *Navicula sp.*, *Cymbella sp.*, *Synedra sp.* Among Chlorophyceae *Chlorella vulgaris*, *spirogyra sp.*, *Scenedesmus quadricauda* were found to be dominant. Cyanophyceae group was represented by *Anabaena sp.*, *Spirulina sp.* and *Microcystis aeruginosa*. Species wise most dominant group was examined Bacillariophyceae followed by Chlorophyceae. The list of phytoplankton collected during the study period is given in the Table 3.

Table 3: Seasonality, appearance of species and abundance of phytoplankton in Chamera lake at different sampling sites.

S.No.	Name of species	Chamera Lake		Seasonality
		Site I	Site II	
Bacillariophyceae				
1	*Cymbella sp.*	++	+	P
2	*Caloneis louisiana*	+	-	S-PM
3	*Fragilaria crotonensis*	+	-	P
4	*Navicula sp.*	++	++	P
5	*Synedra sp.*	++	+	P
6	*Melosira granulate*	+	+	W
7	*Pinnularia sp.*	+	-	PM
Chlorophyceae				

8	*Chlorella vulgaris*	++	++	S-M-PM
9	*Pediastrum simplex*	+	-	S
10	*Spirogyra sp*	++	+	S-M-PM
11	*Scenedesmus quadricauda*	++	+	S-M-PM
Cyanophyceae				
12	*Anabaena sp.*	++	+	S-PM
13	*Spirulina sp.*	++	-	M-PM
14	*Microcystis aeruginosa*	+	+	W-PM

+ present, — absent, ++ abundant, S summer, W winter, M monsoon, P perennial, PM post-monsoon

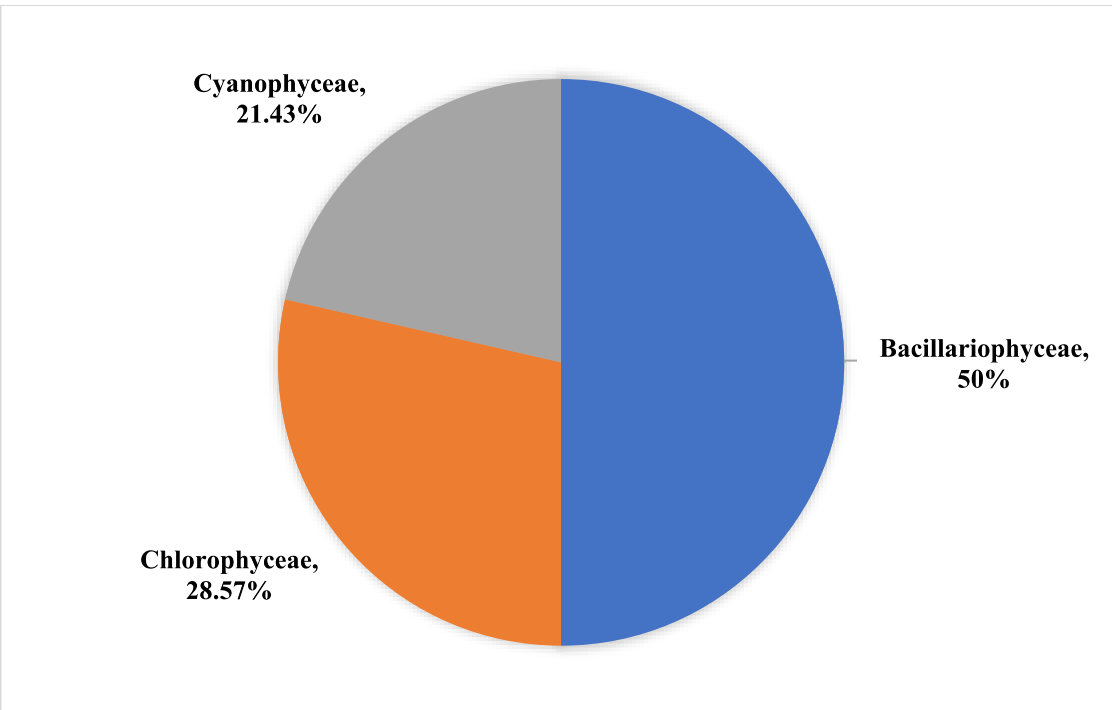

Figure 5: Phytoplankton species percentage reported with respect to their families at S1 and S2 of Chamera Lake

Palmer's algal pollution

Palmer's algal pollution index value observed between 29.00 to 4.00 from top to bottom in Table 4.

Table 4: Palmer's algal pollution index based on site wise monthly changes in abundance of phytoplankton in Chamera Lake

Months (July 2024- June 2025)	Chamera Lake	
	Site 1	Site 2
July	26.77 ±0.88	12.00 ±2.00
August	22.42±1.63	11.00 ±2.00
September	19.77 ±1.23	09.00 ±2.00
October	19.77 ±1.23	10.00 ±1.00
November	18.77 ±0.77	6.00 ±1.00
December	20.00 ±1.63	4.00 ±1.00
January	29.00 ±0.00	4.00 ±1.00

February	28.67 ±1.23	8.50 ±0.50
March	24.43±2.13	10.00 ±2.00
April	28.77 ±0.08	11.00 ±2.00
May	23.77 ±1.08	11.00 ±2.50
June	24.77 ±1.08	8.00 ±0.00

CONCLUSION

The present study was conducted in Chamera Lake, which is a beautiful man-made reservoir located in the Chamba district of Himachal Pradesh, India. This lake is a popular tourist destination, known for its scenic beauty and water-based activities. Tourism Activities include Boating, fishing, kayaking etc. An investigation for a period of one year (July 2024 to June 2025) was done to understand the phytoplankton community structure along with various physicochemical parameters of the lake. All physico-chemical parameters of Chamera lake are beyond BIS and WHO permissible limits. So, the water of lake unfits for both human health and aquatic ecosystems. Increasing pollution load, reduced oxygen levels, and increased toxins can lead to the death of various aquatic organisms.

During the present investigation period, total 14 species of phytoplankton were observed under 3 groups; Bacillariophyceae (maximum percent composition) with 7 species, Chlorophyceae with a total of 4 species and Cyanophyceae with 3 species. Some of them were present seasonally and some were present throughout the study period. *Navicula sp., Synedra sp., Spirogyra sp., Chlorella vulgaris, Anabaena sp.* was recorded throughout the study period. Most abundant Bacillariophyceae members were *Navicula sp., Cymbella sp., Synedra sp.* Among Chlorophyceae *Chlorella vulgaris, spirogyra sp., Scenedesmus quadricauda* were found to be dominant. Cyanophyceae group was represented by *Anabaena sp., Spirulina sp.* and *Microcystis aeruginosa.* Species wise most dominant group was observed Bacillariophyceae followed by Chlorophyceae. Palmer's algal pollution index value varied between 4.00 and 29.00 from bottom to top. In conclusion, time to time monitoring phytoplankton communities can help us understand the health of aquatic system and impacts of environmental change.

CONFLICT OF INTEREST

The author(s) declares no conflict of interest.

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