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Research Article

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Assessment of Physico-chemical Characteristics of Receational Lake Tilyar, Rohtak (Haryana) India

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ABSTRACT

The present study was conducted to demonstrate the physico-chemical parameters of recreational Lake Tilyar in the summer and monsoon months. On the basis of lake morphology, lake was divided in to three sampling stations. Water samples were collected fortnightly from each sampling station and analyzed for estimation of pH, total dissolved solids, turbidity, conductivity, total hardness, calcium, magnesium, chlorides, free carbon dioxide, dissolved oxygen, BOD, ortho-phosphate, ammonia, sulphate and alkalinity. Air temperature, water temperature, and weather conditions were also recorded. The observed values of various physico-chemical parameters of water samples were compared and analyzed.

Key words*: Lake Tilyar, water, physico-chemical characteristics, monthly variations.*

INTRODUCTION

Study of the physico-chemical characteristics of an aquatic ecosystem is essential for understanding of its biological productivity and diversity. Lakes and rivers play a significant role in maintenance of the natural heritage. They have been widely utilized by human beings over the centuries, to the extent that very few, if any are now in a natural condition[1]. In India, rivers, lakes and ponds are used for domestic purposes and in agriculture. Water is one of the most important and precious natural resource available to mankind. Better quality of water is described by its physical, chemical and biological characteristics. Water quality give current status of the concentration of the various solutes at a given area and time.

Water quality parameters provide information about the suitability of water for its uses and for the betterment of the existing conditions. Water quality programmes provide the current information which is required for the development and management for the beneficial uses[2, 3]. A regular monitoring of water quality is required for the determination of extent of pollution in our lakes. The quality of water may be described by physico-chemical parameters and micro-biological characteristics[4]. Due to exponential growth of human population, increased industrialization, excessive use of fertilizers in agriculture and many anthropogenic activities, the natural aquatic resources are suffering from heavy and varied pollution. Seasonal variation will affect the parameters like temperature, DO, BOD and other parameters of lake[5, 6]. Among physico-chemical factors influencing the aquatic productivity; temperature, pH, total alkalinity, dissolved gases like oxygen, carbon dioxide and dissolved inorganic nutrients like nitrate and phosphorus are considered to be important[7]. Present study was designed to assess the monthly variations if any, in physico-chemical water quality parameters and if so whether or not they are within desirable limits.

STUDY AREA:

Tilyar Lake is situated five kilometer away from Rohtak city, Haryana. It lies at 76°637' east latitude and 28° 882' west longitude. Tilyar lake complex has an area of 132 acre (0.53 km^2). The lake has an area of about 18-20 acre, 10-12 feet deep and well constructed. This lake is stagnant and perennial. Its area has huge flora in the form of trees, jungles with bushes around it (Fig-1). It is among the important tourist complexes in Haryana, came in to existence in 1976 for the public recreational use. Basic information of the lake is provided in Table A.

MATERIALS AND METHODS

Collection and Storage of Water Samples

On the basis of lake morphology, three sampling spots were selected (station-1, station-2 and station-3). The study period consisted of six months (April 2009-September 2009). Samples were collected fortnightly from each station at the depth of 0.5m in plastic bottles of 2.0L capacity. The sampling was done between late morning and early evening. The air and water temperatures were recorded on the sampling site itself. The bottles were air sealed with screw cap and brought to the laboratory for the analysis. For the assessment of dissolved oxygen, BOD bottles were used for the collection of water samples and the oxygen was fixed by adding MnSO4 and alkaline potassium iodide at the sampling site before being carried to the laboratory. Almost care was taken, so that no bubbling should observe during sampling, which avoids influence of the dissolved oxygen.

The solutions were prepared in distilled water. The pH of water sample was measured with the help of pH meter (EUTECH 35624-02 pH meter) with a glass electrode. The pH meter was calibrated using buffer of pH 4.0 and 7.0. The conductance of water samples was measured using conductometer (EUTECH ECCON 603K conductivity meter). TDS (mg/L) were analyzed with the help of TDS meter. Total hardness (mg/L), calcium (mg/L), magnesium (mg/L), chloride (mg/L), Dissolved Oxygen (mg/L), BOD (mg/L), ammonia (mg/L), Ortho phosphates (mg/L), sulphate (mg/L) and total alkalinity (mg/L) were determined separately, for three samples, in the laboratory, employing standard methods described in APHA (American Public Health Association, 1998)[8]. Fortnightly data obtained were compiled to get the seasonal mean and standard deviation.

Fig.1: Map of India and Haryana showing the study site

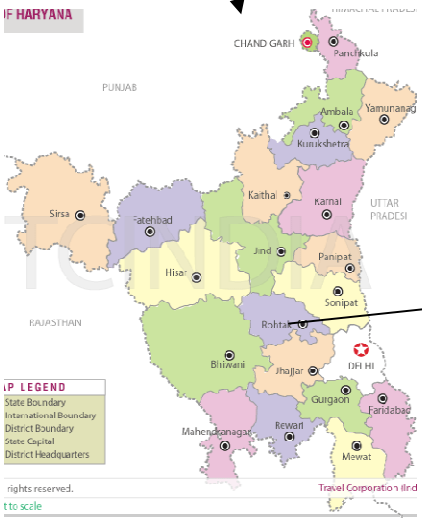


TABLE A: Basic information of the lake		
Sr. No.	Details	
1	Location	Haryana, India
2	Latitude	76°637’ east
3	Longitude	28° 882’ west
4	Total area	18-20 acres
5	Max. Depth	10-12 feet
6	Primary inflows	Canal water
7	Primary outflows	Nil

RESULTS

The monitored values of physicochemical parameters of Tilyar lake water samples had been mentioned in the Tables 1, 2 and 3 and represented in graphs (Figures 2, 3 and 4).

Table 1: Temporal variations of different physico-chemical parameters in Tilyar Lake (Station-1)

S. No.	Parameters	April	May	June	July	August	September	Unit
1	**Water Temp**	27.35	30.25	31.35	31.55	29.95	28.45	°C
2	**pH**	8.295	8.65	8.678	8.3	8.332	8.545	-
3	**TDS**	162.50	156.0	156.0	120.05	110.30	154.35	mg/L
4	**Turbidity**	9.945	9.15	12.15	24.6	21.35	28.50	NTU
5	**Conductivity**	300.25	260.75	304.50	197.40	473.0	307.50	$\mu mhos Cm^{-1}$
6	**Total Hardness**	108.50	80.50	74.0	93.50	81.50	89.50	mg/L
7	**Calcium**	18.92	21.02	23.55	18.93	20.61	22.29	mg/L
8	**Magnesium**	15.30	14.89	3.41	10.01	30.05	34.0	mg/L
9	**Chloride**	19.37	18.86	20.18	21.08	11.07	22.99	mg/L
10	**Free CO_2**	4.0	00	00	5.0	00	00	mg/L
11	**DO**	2.95	3.70	3.30	5.0	4.50	4.30	mg/L
12	**BOD**	1.70	1.90	2.10	2.50	1.90	1.80	mg/L
13	**Ortho-phosphate**	0.35	0.11	0.15	0.33	0.06	0.07	mg/L
14	**Ammonia**	0.14	0.26	0.30	0.48	0.62	0.40	mg/L
15	**Sulphate**	0.68	1.0	0.68	0.51	0.66	0.49	mg/L
16	**Alkalinity**	67.0	80.0	78.0	47.63	57.50	71.0	mg/L

All the values of results are represented as Mean. The entire statistical calculations are done using statistical software SPSS package.

Table 2: Temporal variations of different physico-chemical parameters in Tilyar Lake (Station-2)

S. No.	Parameters	April	May	June	July	August	September	Unit
1	**Water Temp.**	29.85	30.15	30.5	29.25	29.45	28.25	°C
2	**pH**	8.61	8.27	8.51	7.98	8.82	8.55	-
3	**TDS**	168.50	147.0	152.0	118.0	120.80	145.40	mg/L
4	**Turbidity**	12.73	12.55	12.86	13.80	24.25	33.15	NTU
5	**Conductivity**	389.50	381.50	235.50	193.90	365.0	290.50	$\mu mhos Cm^{-1}$
6	**Total Hardness**	105.0	82.50	79.0	73.50	88.0	101.50	mg/L
7	**Calcium**	21.44	23.13	25.22	18.50	18.93	23.97	mg/L
8	**Magnesium**	51.45	24.75	16.0	27.30	40.75	41.65	mg/L
9	**Chloride**	16.0	17.98	20.65	14.23	11.93	13.97	mg/L
10	**Free CO_2**	3.0	00	00	5.0	00	00	mg/L
11	**DO**	2.85	3.05	3.40	4.35	3.90	5.25	mg/L
12	**BOD**	1.75	1.95	1.60	2.15	2.05	2.45	mg/L
13	**Ortho-phosphate**	0.34	0.12	0.17	0.60	0.57	0.08	mg/L
14	**Ammonia**	0.17	0.04	0.29	0.84	0.19	0.32	mg/L
15	**Sulphate**	0.55	0.74	0.78	0.62	0.62	0.53	mg/L
16	**Alkalinity**	54.0	72.0	58.0	41.74	60.0	52.0	mg/L

All the values of results are represented as Mean. The entire statistical calculations are done using statistical software SPSS package.

Table 3: Temporal variations of different physico-chemical parameters in Tilyar Lake (Station-3)

S. No.	Parameters	April	May	June	July	August	September	Unit
1	**Water Temp.**	28.60	28.75	30.65	31.15	28.65	28.15	℃
2	**pH**	8.48	8.74	8.55	8.02	8.80	8.48	-
3	**TDS**	153.50	139.40	151.50	123.80	112.80	141.0	mg/L
4	**Turbidity**	8.18	8.47	9.20	12.10	32.55	30.90	NTU
5	**Conductivity**	384.0	355.0	242.5	200.0	340.0	339.50	μmhosCm^{-1}
6	**Total Hardness**	96.50	80.0	75.0	81.0	77.50	83.0	mg/L
7	**Calcium**	18.50	25.23	21.87	18.16	15.93	23.55	mg/L
8	**Magnesium**	12.27	10.38	6.805	4.60	11.36	24.20	mg/L
9	**Chloride**	18.69	19.49	19.97	15.55	9.445	15.95	mg/L
10	**Free CO_2**	5.0	00	00	5.0	00	00	mg/L
11	**DO**	2.70	3.05	4.0	4.90	4.50	5.20	mg/L
12	**BOD**	1.70	1.80	2.10	2.30	2.30	2.0	mg/L
13	**Ortho-phosphate**	0.32	0.10	0.16	0.62	0.50	0.13	mg/L
14	**Ammonia**	0.18	0.23	0.39	0.48	0.19	0.32	mg/L
15	**Sulphate**	0.48	0.94	0.63	0.51	0.54	0.47	mg/L
16	**Alkalinity**	63.0	68.0	56.0	68.0	71.0	69.0	mg/L

All the values of results are represented as Mean. The entire statistical calculations are done using statistical software SPSS package.

Fig.2: Physico-chemical analysis of water sample from Tilyar Lake (Station-1)

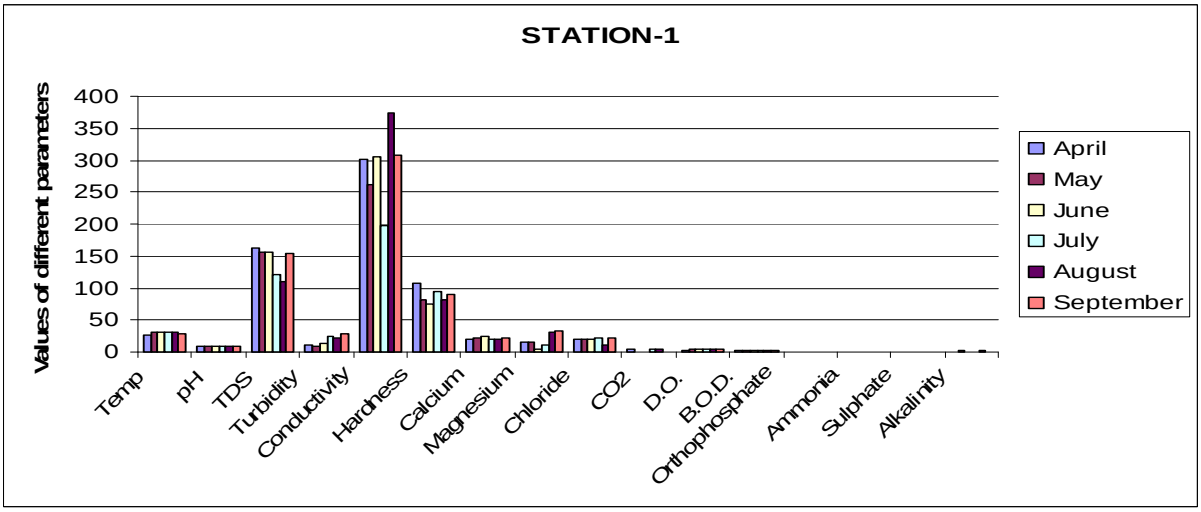


Fig.3: Physico-chemical analysis of water sample from Tilyar Lake (Station-2)

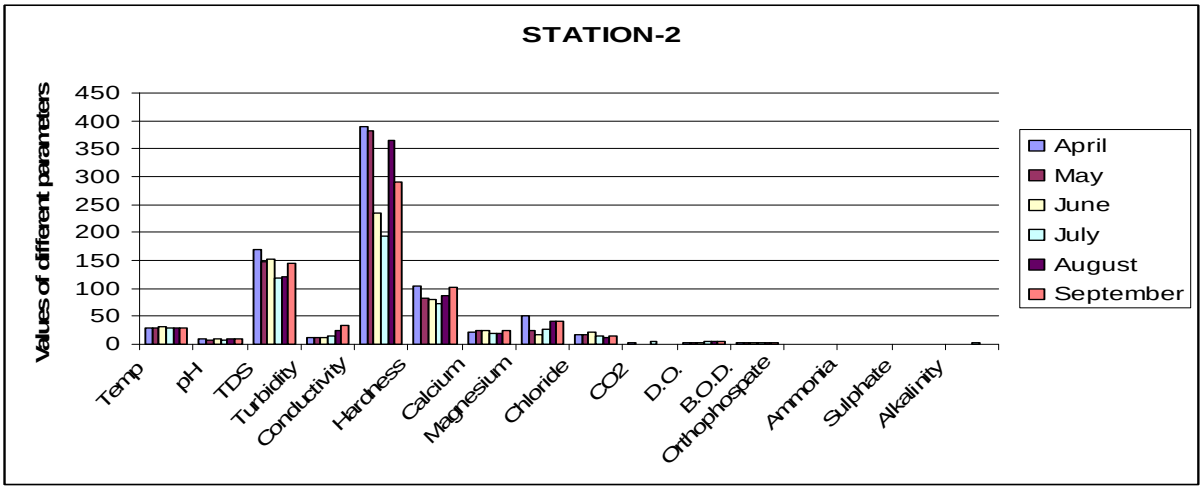
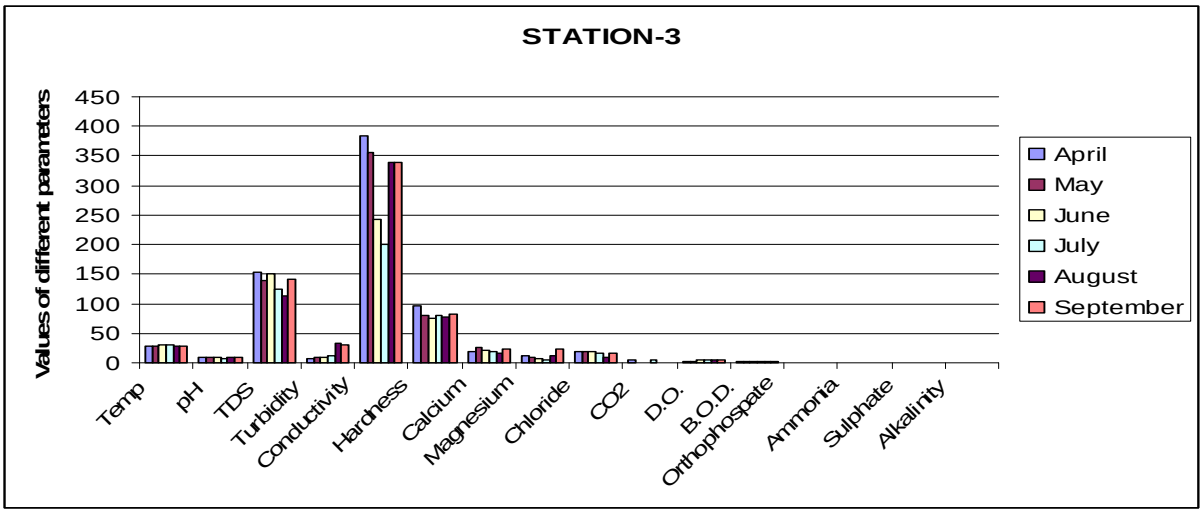


Fig.4: Physico-chemical analysis of water sample from Tilyar Lake (Station-3)



Lowest water temperature (27.35°C) was recorded in the month of April at station-1 while the highest (31.55°C) in the month of July at station-1. The minimum value of pH (7.98) was observed in the month of July at station-2 while maximum value (8.82) in the month of August station-2. The lowest concentration of total dissolved solids was observed in the month of August (110.3 mg/L) at station-1 and highest concentration was recorded in the month of April (168.5 mg/L) at station-2. The minimum turbidity (8.18 mg/L) was observed in the month of April at station-3 while maximum (33.15 mg/L) in the month of September station-2. The maximum electric conductivity (389.5 µmhosCm^{-1}) was observed in the month of April at station-2 and minimum (193.9 µmhosCm^{-1}) in the month of July at station-2. The minimum turbidity (73.5 mg/L) was observed in the month of July at station-2 while maximum value (108.5 mg/L) in the month of April station-1.

The lowest concentration of calcium (15.93 mg/L) was observed in August at station-3 and highest (25.23 mg/L) in May at station-3. The maximum value of magnesium concentration (51.45 mg/L) was observed in the month of April at station-2 and minimum (3.41 mg/L) in the month of June at station-1. The minimum chloride concentration (9.45 mg/L) was observed in August at station-3 while maximum value (22.99 mg/L) during September station-1. The lowest concentration of free carbon dioxide (00) was observed in May, June, August and September at all the three sampling stations and highest (5.00 mg/L) during April and July. The maximum value of dissolved oxygen (5.25 mg/L) was observed in the month of September at station-2 and minimum (2.70 mg/L) in the month of April at station-3. The minimum BOD value (1.60 mg/L) was observed in June at station-2 while maximum value (2.50 mg/L) in July station-1.

The lowest concentration of ortho-phosphate (0.06 mg/L) was observed in the month of August at station-1 and highest (0.62 mg/L) in the month of July at station-3. The maximum concentration of ammonia (0.04 mg/L) was observed in the month of May at station-2 while minimum concentration (0.84 mg/L) in the month of July at station-2. The minimum value of sulphate (0.47 mg/L) was observed in September at station-3 while maximum value (1.00 mg/L) in May station-1. The maximum concentration of alkalinity (80.0 mg/L) was observed in the month of May at station-1 while minimum concentration (41.74 mg/L) in the month of July at station-2.

DISCUSSION

Freshwater ecosystems of the world are collectively facing qualitative and quantitative degradation[9]. At present world's precious water resources are in violent situation because of increasing pollution and

contamination due to rapidly growing industrialization, exponential population growth, urbanization, modern agricultural activities and other anthropogenic activities[10, 11, 12]. Fluctuations in the water temperature are closely associated with ambient temperature[13] and it is certainly important for its effects on different chemical and biological activities in organisms in the ecosystem of different water bodies. The variations in temperature of Tilyar Lake water did not show wide spatial difference the range being 27.35°C to 31.55°C. Any variation in water temperature was observed to be in general pattern of fluctuations in air temperature. In natural waters, the pH ranges from 0 to 14. A pH value of 7 is neutral; pH less than 7 is acidic and greater than 7 represents alkalinity. The main components that regulate the pH in natural waters are the carbonate, which comprises Co_2, H_2Co_3 and HCo_3 (APHA, 1995) [14]. In the present study, pH ranged from 7.98 to 8.82, reflecting alkaline nature of lake water. This is in accordance with earlier study done by Wetzel (1975) [15] who reported that in Indian waters, value of pH ranges from 8 to 9[7, 16, 17].

High concentration of total dissolved solids indicated more ionic concentration in the water, which can be unsafe for drinking and can induce an unfavorable physicochemical reaction in the consumers. Increase in concentration of TDS indicates pollution by extraneous sources[18]. TDS concentration varied from 110.3 to 168.5 mg/L in the sampling sites. The concentration of TDS at all the sampling stations was relatively lower in the month of August and first half of September, probably due to dilution by precipitation during the monsoon period. The transparency of water determines the depth at which light can penetrate and at which photosynthesis can take place. Turbidity is a visual property of water and indicates a reduction of clarity that may be because of suspended particles. The turbidity of water is caused by suspended matter like clay, silts, organic and inorganic matter, plankton and other microscopic organisms[19]. During the study period, water turbidity was found to be higher during the monsoon season which may be due to heavy load of silt into the lake water from the feeder canal[20].

The term hardness is frequently used as an assessment of the quality of water supplies. The hardness of water is governed by the content of calcium and magnesium salts, largely combined with bicarbonate and carbonate (temporary hardness) and with sulphates, chlorides, and other anions of mineral acids (permanent hardness) [19]. Kannan (1991)[21] has classified water on the basis of hardness values in the following manner; 0-60 mg/L-soft, 61-120 mg/L-moderately hard, 121-160 mg/L-hard and greater than 180 mg/L-very hard. Total hardness on many occasions was found to be less than alkalinity, thus indicating that the hardness is due to carbonates or bicarbonates[22]. The hardness at the three sites was within the permissible limits[23, 24].

Calcium is one of most important ions, in the assessment of water quality and calcium concentration above 25 mg/L is classified as calcium rich water. Calcium influence the growth and population dynamics of fresh water flora and fauna both directly and indirectly. High concentration of calcium favors rich growth of diatoms when followed with high temperature. Calcium is a required nutrient of normal metabolism of higher plants as well as of prokaryotes[16, 25]. The calcium content of all the sampling stations was within the acceptable limits[26].

Because of magnesium solubility's characteristics and lower biotic demand, concentration of magnesium is relatively conservative and varies little in fresh water lakes[27]. On the contrary high fluctuations in magnesium were observed in the present study. Magnesium content also adds to the hardness of water and along with calcium ions posses the problem of scale formation[16]. In natural surface water the concentration of chloride is normally low. Chloride concentration influences the general osmotic salinity balance and ion exchange, but metabolic utilization does not produce large variations in the spatial and seasonal distribution within most lakes[19]. The concentration of chloride ions were in the range which are typically found in fresh water with few exceptions[23, 28]. The free carbon dioxide concentration of the water depends upon the equilibria established among atmospheric carbon, the bicarbonate system, external loadings, contribution from metabolic respiration and utilization in photosynthesis. Because of free carbon's reactions in the carbonate equilibria and exchange with the atmosphere it is mainly present in small quantities in most water bodies[19]. The present study further confirms the findings of Wetzel (2001) [19] as the free carbon dioxide was absent in most of the months during study period.

Dissolved oxygen reflects the physical and biological process in water, shows the metabolic balance and DO level acts as an indicator of water body[16]. Relatively low concentration of DO was recorded in second half of May and in the month of June may be due to higher metabolic rate at increased temperature[29]. The concentration of dissolved oxygen was found to be low in summer months[30]. This can be due to higher rate of decomposition of organic matter and limited flow of water, leading to consumption of oxygen from water[31]. The higher concentration of DO was recorded in monsoon months. It may be due to the low solubility at high temperature and high degradation of organic substances[24, 32]. Biological Oxygen Demand (BOD) is an important parameter for the assessment of water quality. It is helpful in determination of organic loading on water bodies. The BOD values reflect high concentration of biodegradable matter and high oxygen consumption by heterotrophic organisms[33]. At all the sampling sites, higher BOD levels were recorded during summer months which might be due to high temperature which favors microbial activity[24, 34, 35]. The most significant inorganic phosphorus in aquatic ecosystems is orthophosphate (inorganic soluble phosphorus) which is probably considerable <5% in most natural waters[36, 37]. At all the sampling sites comparatively higher content of phosphate was recorded during monsoon months (July and August). It might be due to rain water came from agricultural fields and mixed with the influent water of the Lake[24, 38].

Ammonia in water is present primarily as ammonia and undissociated ammonium hydroxide. The later being highly toxic to aquatic organisms, especially fish[39]. The distribution of ammonia in fresh water is highly variable regionally, seasonally and spatially within lakes depends on the level of productivity and the extent of pollution from organic matter. The relatively low concentration of ammonia was observed in post monsoon period might due to their consumption by biological activities at higher temperature. Sulphate helps in determination of water quality. Sulphar is utilized by all living organisms in both inorganic and organic forms. Sulphate is reduced to sulphydryl (-SH) groups in proteins synthesis with a contaminant product of oxygen that is utilized in oxidative metabolic reactions[19]. At all the sampling stations, comparatively higher concentration of sulphate was assessed during the summer months (April to June) which might be due to low water level during these months[24, 38, 40]. Alkalinity represents the buffering capacities of water; high alkalinity values are indicative of the entropic nature of the water bodies, and unsafe for ecosystem as well as for potable use[33]. Throughout the study period alkalinity was mainly due to bicarbonates but higher concentration was recorded in the monsoon months. It may be attributed to the presence of carbonates and absence of free carbon dioxide[41, 42, 43, 44, 45, 46].

CONCLUSION

The Physico- Chemical Analysis of the water samples from the three sampling sites revealed that the water of Tilyar Lake is alkaline. The overall water quality of the study site remained within the safe limits throughout the months of study period which shows that water of Tilyar Lake is fit to support the biodiversity. It is further recommended that the authorities should regularly monitor for physico-chemical assessment for seasonal variations and prevent every possible source of pollution around the lake.

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