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Limnological profile of Kolayat Lake, Bikaner with special reference to seasonal fluctuation and correlative interaction

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Key words: Limnology, Physico-chemical characteristics, Seasonal variations, Correlation, Kolayat Lake

Abstract

In this study, an attempt was made to investigate the seasonal variations in physico-chemical characteristics and correlation among these parameters of Kolayat Lake, Bikaner for a period of one year from July 2006 to June 2007. The physico-chemical characteristics were found to be highly fluctuated with seasonal variations during the present investigation. High value of dissolved oxygen recorded during winter season and it showed negative correlation with water temperature and free carbon dioxide. Free carbon-dioxide, alkalinity, Biological oxygen demand (BOD), total hardness, calcium, magnesium and chloride concentration were reported maximum in summer and minimum in winter season. Hardness, phosphate and nitrate- nitrogen content which indicates that of Kolayat lake is eutrophicated and medium polluted.

Introduction

Water is one of the most precious and important natural resources and considered as an essential component for the existence of life on the earth. The environment of aqueous system contains a large number of interacting physico-chemical parameters with organic and inorganic substances in dissolved and suspended state. The hydrological study is a prerequisite in any aquatic system for the assessment of its potentialities and to understand the realities between its different trophic level and food webs. Further the environmental conditions such as topography, water movement, salinity, oxygen, temperature and nutrients characterizing particular water mass also determine the composition of its biota. Thus, the nature and distribution of flora and fauna in an aquatic system are mainly controlled by the fluctuation in the physico-chemical parameters of the water body.

The lake selected under investigation is known as “Kapil Sarowar”. It is situated about 55 km from Bikaner city in the south-west. It lies at 27°50' N latitude and 73°57' E longitude. The depth of this lake varies from 3 feet to 20 feet with maximum towards south, and it has a capacity of 100 mcft. of water. Once, lake was a main source of drinking water in the area where even the people of remote villages also use this water for drinking. Due to increasing urbanization and human activities, natural quality of water has been changed and deteriorated to great extent. Present study therefore, has been aimed to study the interrelationship and seasonal fluctuation in the physico-chemical characteristics of lake water.

Material and methods

The water samples were collected from Kolayat lake at monthly intervals from July 2006 to June 2007. All the sample collection and field observations were conducted during morning hour (8:30 to 10:30), throughout the study period. Eighteen different parameters were analyzed in shallow and deep water zone of the lake. Air and water temperature were measured by a standard grade thermometer. Transparency was measured by Secchi disc (of 20 cm. diameter) at respective sampling zones (Welch, 1948). pH was estimated using systronic digital pH meter and turbidity by Toshniwal turbidity metre. Specific conductivity (mMhos/cm) was measured by Systronic Direct Reading Conductivity Metre [Type 303]. The azide modification of Winkler’s method was used for dissolved oxygen determination. Free carbon dioxide, alkalinity, hardness, calcium, magnesium and chloride were determined by titrimetric methods (APHA, 1998). For determination of BOD, dilution method and five days incubation at specified temperature ($20^{O}C$) was followed (APHA, 1998). Sodium and potassium concentration was determined by Systronic Digital Flame Emission Photometer. Stannous chloride reduced phosphomolybdate method was used to estimate phosphate concentration and phenol disulphonic acid method was followed for the determination of nitrate concentration in the water sample.

Results and discussion

Results of limnological attributes and correlation among different water parameters of Kolayat lake, obtained during the investigation are presented in table no. 1 to 3. Temperature is one of the essential and driving variables in the environment since it influence the growth and distribution of flora and fauna of an aquatic ecosystem. It also play crucial role in physico-chemical and metabolic behavior of an aquatic ecosystem (Abir, 2014 and Mahajan and Billore, 2014). In the present study, air temperature was observed to be ranged between 12.8 °C (December) to 36.0 °C (June) in the area studied. The values for minimum and maximum water temperature were found in a range of 16.5 °C (December) and 28.5 °C (June) for shallow water zone while 16.4 °C (December) and 27.8 °C (June) for deep water zone. This suggests that fluctuations of temperature in an aquatic environment are less violent than those in the aerial. Water temperature of both the zone was observed to be shown positive correlation with turbidity, total alkalinity, specific conductivity, pH and negative correlation with dissolved oxygen. An inverse relationship between transparency and water temperature has been reported by Adoni (1975) and Dhakar (1979). A similar inverse correlation between transparency and water temperature in shallow water zone (r = -0.726) and deep water zone (r = -0.785) was also recorded in the present study.

Transparency and turbidity mainly depend on the amount of suspended and dissolved matter in the water. Transparency specifies light penetration and thereby restricts the photosynthetic zone. Turbidity is a measure of the resistance of water to the passes of light through it. In shallow water zone, transparency was observed to be maximum (1.05 m) in January and minimum (0.34 m) in June. In deep water zone, it was maximum (1.35 m) in January and minimum (0.42 m) in July. In respect of seasonal behaviors, its values were maximum during winter followed by summer and minimum during rainy season in both the zone. Similar findings were observed by Diwedi *et al*. (2000), Devaraju *et al.* (2005), Shah and Pandit (2012), Yadav *et al*. (2013) and Mahajan and Billore (2014). The turbidity values in shallow water zone ranged from a minimum (16.8%) in December to a maximum (39.2%) in July. In deep water zone, maximum (30.8%) and minimum (18.2%) turbidity values were observed in July and January, respectively. In respect of seasonal variation in turbidity, observations suggested that both the zone followed a similar trend, being maximum during rainy season and minimum during the winter. An inverse correlation between turbidity and transparency has been observed by Billor (1981), Shekhawat (1983) and Gupta (1992). In present study, a similar inverse relationship between turbidity and transparency was observed in both shallow water zone (r = -0.802) and deep water zone (r = -0.928). A direct correlation between turbidity and water temperature, r = 0.605 (shallow water zone) and r = 0.635 (deep water zone) as recorded in the present study finds support to the work of Jain (1978) and Abir (2014).

pH is one of the most important parameter in water chemistry and measured as intensity of acidity or alkalinity. In the present study, pH remained alkaline throughout the year in both the zone. It ranged between 7.52 to 8.62 and 7.50 to 8.38 in shallow water zone and deep water zone, respectively. In the present investigation, higher concentration of pH was observed during summer season and minimum during monsoon. Similar results were observed by Rasool *et al.* (2003) and Harney *et al*. (2013) and explained this by correlating rise of temperature with increase in rate of photosynthesis which results in higher consumption of carbon dioxide. The significant positive correlation between pH and water temperature was obtained in the present investigation, is in conformity with the earlier observation made by Sankhla (1981) and Shukla (1986). Similarly, positive correlation of pH with specific conductivity and total alkalinity observed in the present study finds support to the work of Datta Munshi and Singh (1991).

Conductivity is the numerical expression of the capacity of water to conduct an electric current. It denotes the total amount of ionisable or dissolved salts in water. Rawson (1960) categorized oligotrophic water having specific conductivity value less than 0.10 mMhos/cm, intermediate water between 0.10 to 0.12 mMhos/cm and eutrophic water having specific conductivity above 0.20 mMhos/cm. In the present study, it ranged between 0.24 mMhos/cm to 0.39 mMhos/cm in shallow water zone and 0.22 mMhos/cm to 0.37 mMhos/cm in deep water zone. Both the zone had specific conductivity similar to level of eutrophic category. Seasonally, Shallow water and deep water zone showed similar trend of monthly variation in specific conductivity being maximum in rainy season and minimum in winter season. Higher value of electrical conductivity during rainy season indicated the surface runoff. Similar trends were observed by Hulyal and Kaliwal (2011) and Yadav *et al*. (2013). However, Narayan *et al*. (2005) and Abir (2014) reported higher value of specific conductivity during summer season. In present study, specific conductivity showed positive correlation with pH, water temperature, calcium, chloride and total hardness in both the zone of lake. Similarly, positive correlation of specific conductivity with calcium and total alkalinity were observed by Billore (1981) and Shekhawat (1983).

Dissolved oxygen is the fundamental fuel of life in water. It is a vital element in water since, it is obviously essential for metabolism of aquatic organism. Unfortunately, oxygen is only slightly soluble in water (9.1 mg/lit. at 20 °C). Pollution of water by organic matter rapidly utilizes the dissolved oxygen by biological oxidation, and thus water may become depleted of oxygen. The dissolved oxygen values varied from 1.8 ppm to 9.4 ppm and 1.1 ppm to 7.1 ppm in shallow water zone deep water zone, respectively. In respect of season, its concentration was found to be maximum during winter season and minimum during summer season in both the

zone. This can be explained on the ground that rise in water temperature reduced the solubility of oxygen in water, enhance the bacterial activity and the metabolic rate in most of the species resulting in a reduction in oxygen supply. Results of the present study are similar to those reported by Salve and Hiware (2006) and Ramulu and Benarjee (2013). Dissolved oxygen and water temperature showed highly negative correlation in both shallow water zone (r = -0.782) and deep water zone (r = -0.814) of the lake. Shukla (1983), Mahajan and Billore (2014) and Abir (2014) also observed significant negative correlation between water temperature and dissolved oxygen.

Carbon-dioxide in natural water is mostly because of bacterial decomposition of organic matter and respiration. In the present investigation, free carbon-dioxide was recorded in all the months of study period except December and January in both the zone. It ranged from 1.5 ppm to 8.9 ppm and 1.0 ppm to 8.2 ppm in surface water zone and deep water zone, respectively. Concentration of free carbon-dioxide showed seasonal variation, being maximum during summer season and minimum during winter. These observations of the present study also find supports the work of Mahajan and Billore (2014). An inverse correlation between dissolved oxygen and free carbon-dioxide was reported by Patel and Nandan (1984) and Gupta and Sharma (1994). In the present study too, the dissolved oxygen showed highly negative correlation with free carbon-dioxide in both shallow water zone (r = -0.782) and deep water zone (r = -0.903) of the lake.

Total akalinity measures the buffering capacity of water and imparted by presence of carbonates, bicarbonates and hydroxide in various combinations. The amount of carbonate alkalinity was observed to be comparatively much lower in both the zone thus, the total alkalinity was mainly contributed by bicarbonate. Philipose (1960) classified water of India in three broad categories on the basis of alkalinity values, viz., 4 - 50 ppm alkalinity as low, 50 - 100 ppm alkalinity as moderate and 100 - 600 ppm alkalinity as high. In present study, alkalinity ranged between 109.00 ppm to 141.15 ppm and 111.12 ppm to 140.48 ppm in shallow water zone and deep water zone of the lake, respectively so, the lake could be placed in “high” category of alkalinity type. It showed seasonal variation, being observed higher during summer followed by rainy and least during winter season in both the zone. High temperature accelerates the process of decay of organic matter and consequently large quantities of free carbon-dioxide become available to form bicarbonates. However, Abir (2014) observed lower value of alkalinity during summer season. In the present study, significant positive correlation between alkalinity and water temperature was recorded.

B.O.D. is a measure of the oxygen required by micro-organisms for stabilizing biologically decomposable organic matter in water under aerobic conditions. It is a good index of the degree of organic pollution, hence it helps in the determination of the suitability of water for use. Biological oxygen demand was observed to be ranged between 2.8 ppm to 7.2 ppm in shallow water zone and 1.80 ppm to 5.60 ppm in deep water zone with maximum values during the summer months and minimum during winter months in both the zone. Similar findings were observed by Abir (2014). A significant negative correlation between BOD and dissolved oxygen was observed in both shallow water zone (r = -0.849) and deep water zone (r = -0.899) of the lake, finds supports to the work of Sekhawat (1983) and Abir (2014).

Hardness in water is mainly due to calcium and magnesium salts. In present study, total hardness was observed to be maximum during summer and minimum during winter season in both the zone. The higher value of total hardness in summer may be due to higher temperature which increases the concentrations of salts by excessive evaporation. According to Spence (1964), water having hardness values above 60 ppm are nutrient rich type. From this criterion, shallow water zone and deep water zone of the lake showing hardness value between 158.3 ppm to 328.6 ppm and 160.5 to 335.8 ppm, respectively may be labeled as nutrient rich. In both the zone, total hardness was observed to be show a direct positive correlation with calcium and magnesium. Similar positive correlation has also been reported by Adoni and Joshi (1985).

Most of calcium is probably derived from calcareous dust, limestone and gypsiferous shale. Calcium content of the water ranged between 15.77 ppm to 26.15 ppm and 16.18 ppm to 26.20 ppm in shallow water zone and deep water zone, respectively. In the present study, values of calcium hardness were recorded to be significantly low during winter months. A similar observation has also been made by Shukla (1986) and Mahajan and Billore (2014). A decline in the values of calcium during winter season was observed to correspond with phytoplankton and other algal population peak. The magnesium content was observed to be ranged between 5.00 ppm to 16.12 ppm in shallow water zone and 5.00 ppm to 16.00 ppm in deep water zone. Its seasonal behavior was observed to follow exactly an identical pattern and also showed high positive correlation with that of calcium.

Chloride is considered as one of the most important inorganic anion in water. It occurs naturally in all types of water due to its high solubility. Chloride is normally found in very low amount in fresh water bodies and when present in higher concentration, it is usually assigned to pollution by human agencies[5]. In the present study, concentration of chloride in water ranged between 22.98 ppm to 58.18 ppm in shallow water zone and between 20.52 ppm to 52.65 ppm in deep water zone, are indicative of medium pollution. It was observed to be

maximum during summer which can be attributed to constant evaporation resulting in a consequent decrease in the volume of water in the lake. Such explaination has also been offered by Verma *et al.* (2012) and Ramulu and Benarjee (2013). In both the zone, chloride had shown a significant positive correlation with specific conductivity, sodium and potassium. These findings are quite in conformity with the work of Billore (1981) and Shukla (1986). Sodium and potassium showed similar trend of variation in all the months in both the zone. Maximum concentration of both these inorganic nutrient was to be observed during summer and minimum during rainy season. Sodium showed a significant positive correlation with potassium.

The natural source of the origin of phosphate is the mechanical and chemical weathering of rocks, and other important sources include excreta, detergent, sewage disposal and drainage of fertilizers from the agriculture field of catchment area. Values of phosphate ranged between 0.18 ppm to 0.72 ppm and 0.18 ppm to 0.65 ppm in shallow water zone and deep water zone, respectively. Phosphate also showed seasonal variation being maximum during rainy season and minimum during summer. Yadav *et al.* (2013), Mahajan and Billore (2014) and Abir (2014) also reported high amount of phosphate during rainy months.

For maintenance and productivity of community, nitrate is extremely important as a nutrient in supplying nitrogen for protein synthesis. In nitrate form, nitrate - nitrogen is most easily taken by green plants. Wastes from human body and cattle, farm land runoff and leaching from soil are important source of nitrogen. Values of nitrate-nitrogen ranged from 0.24 ppm to 0.65 ppm and 0.22 ppm to 0.64 ppm in shallow water zone and deep water zone, respectively. It showed seasonal variation being maximum during rainy season and minimum during summer. A similar observation has also been made by Abir (2014). An inverse relation was observed between temperature and nitrate - nitrogen content.

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Table - 1
Monthly Variation in Physico-chemical Characteristics in Shallow Water Zone of Kolayat Lake, Bikaner, During 2006-2007.

SN	Parameters	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
1.	Air Temperature (°C)	33.5	29.5	28.5	23.5	23.2	12.8	13.2	20.1	25.5	31.5	35.8	36.0
2.	Water Temperature (°C)	27.8±0.40	25.1±0.36	24.5±0.29	21.0±0.52	19.4±0.66	16.5±0.46	16.8±0.30	18.5±0.32	22.4±0.60	27.2±1.28	28.4±1.10	28.5±0.89
3.	Transparency (m)	0.35±3.55	0.65±1.32	0.75±1.52	0.40±2.00	0.85±1.32	0.95±0.82	1.05±0.59	0.60±0.52	0.65±0.08	0.60±0.11	0.55±0.12	0.34±0.12
4.	Turbidity (%)	39.2±3.60	29.7±1.32	25.2±1.70	32.2±1.35	22.4±2.01	16.8±0.62	18.8±0.80	24.2±0.51	24.5±2.79	25.2±1.46	25.4±1.56	26.0±1.98
5.	pH	8.50±0.06	8.20±0.05	7.90±0.02	8.00±0.03	7.80±0.06	7.52±0.02	7.54±0.01	8.00±0.03	7.90±0.06	8.18±0.02	8.42±0.02	8.62±0.07
6.	Specific conductivity (mMhos/cm)	0.39±0.00	0.37±0.00	0.35±0.01	0.38±0.01	0.28±0.00	0.26±0.02	0.24±0.01	0.29±0.00	0.33±0.01	0.35±0.01	0.37±0.02	0.38±0.04
7.	Dissolved oxygen (ppm)	5.4±0.70	5.6±0.67	5.9±0.30	7.4±1.15	7.8±0.38	9.2±0.33	9.4±0.40	5.8±0.35	3.2±0.45	2.0±0.15	1.8±0.12	5.0±0.15
8.	Free Carbon-dioxide (ppm)	7.5±0.30	3.4±0.42	5.3±0.44	3.2±0.52	1.5±0.20	-	-	2.5±0.21	5.8±0.26	7.5±0.22	8.9±0.19	7.8±0.06
9.	Carbonate alkalinity (ppm)	3.12±0.60	4.80±0.50	5.38±0.45	2.48±0.66	-	-	3.32±0.10	5.65±0.13	8.90±0.36	8.86±0.42	10.45±0.12	5.80±0.49
10.	Bicarbonate alkalinity (ppm)	119±2.35	118±3.85	120±1.90	112±2.25	109±1.48	110±0.74	117±2.15	121±2.32	123±2.75	125±3.50	131±1.70	124±3.95
11.	Total alkalinity (ppm)	122.12±4.20	122.8±2.33	125.38±2.20	114.48±2.30	109.00±1.50	110.00±0.70	120.32±2.20	126.65±3.25	131.90±2.50	133.86±3.54	141.15±1.38	129.80±4.35
12.	BOD (ppm)	5.7±0.25	4.9±0.20	3.2±0.15	3.9±0.20	3.2±0.19	2.8±0.15	2.9±0.06	3.6±0.12	5.2±0.39	5.5±0.20	7.2±0.42	5.9±0.45
13.	Total Hardness (ppm)	310.6±5.45	290.08±4.50	282.2±7.95	272.6±4.10	178.6±4.55	158.3±3.35	160.0±4.20	185.5±3.25	248.6±6.26	305.7±4.05	328.6±6.05	312.4±3.50
14.	Calcium (ppm)	26.15±0.85	22.56±0.44	21.25±0.70	20.15±4.30	18.90±0.15	15.77±0.25	16.48±0.20	17.02±0.25	20.85±0.50	24.52±0.22	24.98±0.29	24.01±0.62
15.	Magnesium (ppm)	13.35±0.78	13.12±0.16	12.02±0.20	12.52±0.52	8.50±0.18	5.26±0.31	5.00±0.14	5.08±0.18	9.32±0.20	12.65±0.47	16.12±0.19	14.81±0.33
16.	Chloride (ppm)	42.31±0.94	41.55±0.85	38.28±1.28	30.18±2.62	26.27±0.24	24.48±0.47	22.98±0.55	42.58±1.15	46.30±0.53	50.00±0.64	58.18±0.50	48.32±1.25
17.	Sodium (ppm)	7.21±0.25	7.38±0.34	7.40±0.36	8.12±0.30	8.25±0.25	8.92±0.17	9.12±0.28	9.20±0.21	9.72±0.33	11.42±0.36	11.82±0.33	10.62±0.22
18.	Potassium (ppm)	3.00±0.32	3.12±0.37	3.10±0.23	3.48±0.24	3.52±0.27	4.32±0.19	4.48±0.32	4.85±0.31	4.80±0.21	5.06±0.21	6.00±0.17	5.58±0.30
19.	Phosphate (ppm)	0.72±0.02	0.62±0.03	0.48±0.08	0.65±0.03	0.48±0.01	0.38±0.01	0.36±0.02	0.36±0.03	0.34±0.00	0.24±0.01	0.18±0.01	0.32±0.00
20.	Nitrate-nitrogen (ppm)	0.60±0.01	0.65±0.02	0.48±0.02	0.58±0.00	0.52±0.00	0.41±0.01	0.28±0.00	0.26±0.03	0.34±0.00	0.34±0.01	0.36±0.01	0.24±0.00

- not occurred

Table – 2. Monthly Variation in Physico-chemical Characteristics in Deep Water Zone of Kolayat Lake, Bikaner, During 2006-2007.

SN	Parameters	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
1.	Air Temperature (°C)	33.5	29.5	28.5	23.5	23.2	12.8	13.2	20.1	25.5	31.5	35.8	36.0
2.	Water Temperature (°C)	26.0±0.98	24.5±0.87	24.0±0.22	21.8±0.55	19.0±0.32	16.4±0.40	16.5±0.36	18.0±0.65	20.0±0.90	24.4±1.41	25.0±1.32	27.8±1.36
3.	Transparency (m)	0.42±0.07	0.74±0.09	0.85±0.08	0.42±0.10	1.10±0.05	1.20±0.08	1.35±0.11	0.80±0.08	0.78±0.09	0.72±0.11	0.70±0.09	0.50±0.09
4.	Turbidity (%)	30.8±3.55	24.2±2.20	23.8±2.05	30.0±2.00	19.2±1.50	19.0±0.78	18.2±0.95	23.5±2.10	23.2±3.20	23.0±2.20	23.0±1.95	25.2±3.49
5.	pH	8.38±0.04	8.08±0.07	7.85±0.04	7.90±0.02	7.78±0.01	7.50±0.01	7.54±0.02	7.85±0.03	7.82±0.04	8.00±0.05	8.20±0.04	8.35±0.05
6.	Specific conductivity (mMhos/cm)	0.37±0.00	0.36±0.01	0.35±0.02	0.36±0.00	0.28±0.02	0.25±0.01	0.22±0.01	0.25±0.02	0.33±0.02	0.32±0.00	0.35±0.02	0.36±0.01
7.	Dissolved oxygen (ppm)	3.8±0.82	4.0±0.72	4.1±0.80	4.8±0.19	6.2±1.39	7.0±0.42	7.1±0.30	5.0±0.58	2.9±1.24	2.2±0.61	1.1±0.16	2.0±0.19
8.	Free Carbon-dioxide (ppm)	7.0±0.42	3.2±0.60	4.9±0.32	3.0±0.39	1.0±0.43	-	-	2.1±0.38	4.5±0.29	7.1±0.27	8.2±0.18	7.3±0.13
9.	Carbonate alkalinity (ppm)	3.80±0.52	5.00±0.41	5.52±0.33	2.65±0.75	1.12±0.40	1.16±0.19	4.12±0.21	5.80±0.10	9.12±0.46	9.12±0.36	10.48±0.23	6.08±0.26
10.	Bicarbonate alkalinity (ppm)	124±3.60	120±4.00	120±3.01	114±5.45	110±1.50	110±2.75	120±2.16	125±1.60	125±2.35	127±3.90	130±4.80	128±2.82
11.	Total alkalinity (ppm)	127.80±3.77	125.00±3.46	125.52±1.99	116.65±5.20	111.12±2.53	111.16±1.49	124.12±2.61	130.80±3.12	134.12±2.79	136.12±4.98	140.48±3.52	134.08±2.70
12.	BOD (ppm)	3.2±0.39	2.5±0.26	2.2±0.28	2.1±0.22	1.9±0.10	1.8±0.12	2.0±0.15	2.5±0.17	3.8±0.13	3.9±0.40	5.6±0.20	5.2±0.48
13.	Total Hardness (ppm)	316.2±5.20	304.2±5.41	285.4±6.52	282.5±5.18	185.6±5.30	160.5±2.75	165.8±2.78	187.2±3.05	250.4±6.35	305.2±4.10	335.8±4.11	316.8±4.19
14.	Calcium (ppm)	26.20±0.98	22.60±0.68	21.40±0.72	20.80±0.39	19.38±0.22	16.18±0.15	16.65±0.16	17.50±0.20	20.90±0.47	24.85±0.50	25.00±0.38	24.30±0.99
15.	Magnesium (ppm)	13.30±0.70	13.10±0.66	12.10±0.28	12.55±0.49	8.48±0.30	5.00±0.15	5.10±0.17	5.00±0.10	9.35±0.23	12.60±0.40	16.00±0.38	14.05±0.33
16.	Chloride (ppm)	35.48±1.20	35.28±0.80	30.00±1.48	26.32±1.05	22.18±0.38	22.00±0.32	20.52±0.28	38.78±0.39	42.98±1.02	47.34±0.78	52.65±0.74	46.29±0.76
17.	Sodium (ppm)	7.48±0.32	7.65±0.45	7.70±0.37	8.36±0.46	8.30±0.19	9.00±0.21	9.25±0.25	9.32±0.38	10.12±0.48	11.75±0.44	12.22±0.50	10.70±0.52
18.	Potassium (ppm)	3.65±0.45	3.89±0.36	3.92±0.47	4.26±0.28	4.42±0.39	5.08±0.22	5.22±0.32	5.32±0.34	5.30±0.49	5.65±0.38	6.25±0.31	6.20±0.29
19.	Phosphate (ppm)	0.65±0.02	0.58±0.03	0.40±0.01	0.59±0.02	0.47±0.02	0.32±0.01	0.30±0.03	0.34±0.03	0.34±0.00	0.22±0.01	0.18±0.01	0.24±0.02
20.	Nitrate-nitrogen (ppm)	0.58±0.02	0.64±0.00	0.48±0.01	0.57±0.01	0.50±0.02	0.40±0.01	0.27±0.00	0.25±0.02	0.34±0.01	0.34±0.02	0.35±0.01	0.22±0.01

- not occurred

Table – 3

Correlation coefficient (r) among different Physico-chemical characteristics of Kolayat Lake, Bikaner, During 2006 -2007.

S.No.	Factors of correlation	"r" value		
		Shallow Water Zone	Deep Water Zone	
1.	pH v/s Water Temperature	0.907		0.919
2.	pH v/s Specific Conductivity	0.853	0.799	
3.	pH v/s Total Alkalinity	0.587	0.579	
4.	Water Temperature v/s Free Carbon-dioxide	0.902	0.809	
5.	Water Temperature v/s Total Alkalinity	0.680	0.548	
6.	Water Temperature v/s Dissolved Oxygen	-0.782	-0.814	
7.	Water Temperature v/s Specific Conductivity	0.546	0.889	
8.	Water Temperature v/s Transparency	-0.726	-0.785	
9.	Water Temperature v/s Turbidity	0.605	0.635	
10.	Specific Conductivity v/s Sodium	0.017	-0.028	
11.	Specific Conductivity v/s Potassium	-0.073	-0.223	
12.	Specific Conductivity v/s Calcium	0.875	0.850	
13.	Specific Conductivity v/s Chloride	0.667	0.507	
14.	Specific Conductivity v/s Total Hardness	0.951	0.927	
15.	Specific Conductivity v/s Total Alkalinity	0.457	0.457	
16.	Turbidly v/s Transparency	-0.802	-0.928	
17.	Dissolved Oxygen v/s Free Carbon-dioxide	-0.782	-0.903	
18.	Total Hardness v/s Calcium	0.947	0.943	
19.	Total Hardness v/s Magnesium	0.962	0.971	
20.	Calcium v/s Magnesium	0.918		0.923
21.	Chloride v/s Sodium	0.572	0.715	
22.	Chloride v/s Potassium	0.528	0.573	
23.	Sodium v/s Potassium	0.954	0.929	
24.	BOD v/s Dissolved Oxygen	-0.849	-0.899	