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Temporal Variation in Physico-Chemical and Phytoplankton Analysis of Madhav Sagar Pond, Sikar (Rajasthan)

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Abstract: ***The research paper reports on study carried out from January 2018 to December 2019 in Madhav Sagar pond. The study emphasizes the local and regional climatic influence on phytoplankton species composition, diversity and density variation in the pond ecosystem. In this study Nitrate, Inorganic phosphorous, Temperature, pH, Conductivity, Dissolve oxygen, Chloride, Total hardness, Calcium and Sodium parameters were analyzed. The result obtained indicates that a significant difference in abundance of phytoplankton groups was found between year 2018 and 2019. Though the highest phytoplankton abundance was observed in July 2018 and February showed the highest number of taxa (highest diversity). Chlorophytes were the major dominant group in both periods.***

Keywords: Algae, phytoplankton, Sikar, Rajasthan, ecology

1. Introduction

Water is an essential commodity for human beings which is required by them in its pure form. The physicochemical properties of any aquatic ecosystem are largely dependent on the meteorological conditions of the area. Contamination of water bodies might lead to a change in their trophic status and render them unsuitable for aquaculture, agriculture and drinking purpose. Water is present in ponds, lakes, rivers, dams etc. which is used by man for Industrial, domestic and agricultural purposes1. India receives about 600-1000 mm of average rainfall annually. About 96% of this water is used for agriculture, 3% for domestic use and 1% for industrial activity. An analysis revealed that about 70% of all the available water in our country is polluted due to the discharge of effluents from the industries, domestic waste, land and agricultural drainage. This results in the degradation of water quality of these water resources due to use of contaminated drinking water, human population suffers from water borne diseases. Also due to increased human population, use of fertilizers in the agriculture and manmade activities, the natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to depletion of aquatic biota. Mahananda[1]. analyses for physical, chemical and botanical parameter were carried out by using the method suggested by APHA (1985)[2]; Kumar and Ravindranath (1998)[3] and Trivedy and Goel (1984)[4]. The counting of phytoplankton filament was done by using Sedgwick Rafter counting cell and phytoplankton were identified by using the book "The Fresh Water Algae" by Prescott (1970)[5].

2. Materials and Methods

Study Area: Madhav Sagar also known as 'bada talab' is situated at the west side of Sikar city which is a symbol of architect as well as traditional heritage. It is embanked with cemented stairs in semicircle form and surrounded by lavish green and deciduous trees. Children do play and bath frequently in this talab. The water turns greenish slowly in summer by eutrophication and enriched zoo and phytoplanktons.

Photo: Madhav sagar talab Sikar

(b) Geography and climate of Sikar: Sikar city of Rajasthan is situated between the east longitude 75˚ 16' and north latitude 27˚ 30'. It is a north eastern part of the state of Rajasthan. It is bounded by Jhunjhunu to North, by Churu district to north east and by Nagaur to south west and by jaipur to south east. It has an average elevation of 427 meters. The natural climatic conditions in this region is hot summer, scanty rainfall, a chilly winter season and general dryness of the air, except in the brief monsoon season. The temperature range is from 0˚C in winter to more than 49˚C in summer.

(c) Sample collection: The study of various parameters of the water were carried out for a period of 24 months (January 2018 to December 2019). The samples were collected in the BOD bottle during morning hours and were analyzed monthly for different parameter. The closed bottle was dipped in the lake at the depth of 0.5 to 0.7 m, and then a bottle was opened inside and was closed again to bring it out at the surface. The samples were collected from five different points and were mixed together to prepare an integrated sample. From the time of sample collection to the time of actually analyses, many physical, chemical and biochemical reactions would change the quality of the water

sample, therefore to minimize this change the sample were preserved soon after the collection.

Photo 2: People bathing in Madhav Sagar

Map-1 Geographical location of Madhav sagar

(d) Physico-Chemical Analysis: The water samples were preserved by adding chemical preservatives and by lowering the temperature. The water temperature, pH, DO, EC and TDS were analyzed immediately on the spot after the collection, whereas the analyses of remaining parameters were done in the laboratory. The study was carried for a period of 2 year. The collected water samples were brought to the laboratory and relevant analysis was performed. pH was determined electrometrically using digital pH meter, electrical conductivity was measured by conductivity meter, dissolved oxygen is measured by DO meter, total dissolve solid was measured by using TDS meter and similarly turbidity is measured by Nepthalo turbidity meter. Alkalinity, chloride, TDS, calcium, magnesium, total hardness, nitrate and phosphate were determined by method suggested by APHA (1985)[2]; Kumar and Ravindranath (1998)[3]; Trivedy and Goel (1984)[4]. Estimation of sodium was done by Flame Photometric method. The botanical methods used for assessing water quality include collection, counting and identification of phytoplankton. Plankton net number 25 of mesh size 20 µm was used for collecting samples. 100 liters of water was measured in a graduated bucket and filtered through the net and concentrated in a 100 ml bottle. The collected sample were preserved by adding Lugol solution or by adding 4 % formalin. Finally the sample was concentrated to 30 ml by decanting, and 1 ml of concentrated sample was added to Sedgwick Rafter counting cell and were counted. The phytoplanktons were identified by using the key given in the book "The Fresh Water Algae" by Prescott (1970)[5].

3. Results & Discussion

(A) Physico-Chemical Parameters

Temperature: The temperature of Madhav sagar ranges from 29˚C to 07˚C the higest temperature was noted during the summer season and the lowest was recorded during the winter season. Generally water temperature was corresponding with air temperature. Samples collected from shallow zone have direct relevance with air temperature as given by Welch (1952)[6] as shallow water reacts quickly with changes in atmospheric temperature. Whereas according to Desai (1995)[7] water temperatures may be depending on the season, geographic location and sampling time.

Electrical Conductivity: Electric conductivity recorded in Madhav sagar ranges 2.25 mho/cm to 3.10 mho/ cm. the high value of conductivity was recorded during the summer season were as low value was recorded during monsoon season. According to Trivedy *et al*., (1989)[8] the variation in the conductivity values seasonally is mostly due to increased in the concentration of salts, because of evaporation; the dilution resulted from precipitation brings down its values.

Turbidity: Suspension of particles in water interfering with passage of light is called turbidity. Madhav sagar ranges from 40 NTU to 110 NTU. The high value was recorded during monsoon season and low value was recorded during winter season. According to Saxena *et al*., (1966)[9] ; Ansari and Prakash (2000)[10] and Solanki (2001)[11]; the maximum values of turbidity in monsoon may be due to rainfall and surface runoff of water bringing a lot of sediments from the surrounding area.

Total Dissolve Solid: Total dissolved solids are the solids present in water in the dissolved state. In Madhav sagar the amount of total dissolve solid recorded ranges from 668 ppm to 942 ppm. The high amount of TDS was recorded during summer season were as low amount of TDS was recorded during monsoon season. Gonzalves and Joshi (1946)[12] also observed maximum concentration of total dissolved solids during summer, which decrease during rainy seasons due to dilution of rainwater.

pH: The water of Madhav sagar remain alkaline throughout the year. The pH value recorded ranges from 7.9 to 8.3. The highest value of pH was recorded during summer season and the lowest was recorded during monsoon season. The low value during monsoon may be due to dilution of rain water. A fall in pH value in monsoon season was also recorded by Shardendu and Ambasht (1988)[13]. Whereas Venkateswarlu (1969)[14] and Jana (1973)[15] observed high pH values during summer and winter months.

Total Alkalinity: The value of alkalinity provides idea of natural salts present in water (Gawas *et al*., 2006)[16]. The alkalinity recorded for different season in Madhav sagar ranges from 152 ppm to 168 ppm . The high value of

alkalinity was recorded during monsoon and the low value of alkalinity was recorded during summer season. According to Solanki and Pandit (2006)[17] the changes in alkalinity depends on carbonates and bicarbonates and also depends upon release of Life. Whereas Tiseer *et al*., (2008)[18] reported that change in carbonates and bicarbonates also depend upon release of CO2 through respiration of living organisms.

Total Hardness: According to Kumar and Ravindranath (1998)[3] the hardness of water is the measure of the capacity of water to react with soap. The amount hardness in the water of Madhav sagar recorded, ranges from 238 ppm to 284 ppm. The maximum value was recorded during summer and minimum value was recorded during monsoon season. The amount of hardness recorded in Madhav sagar is within the desirable limit. Udhayakumar *et al*., (2006)[19] reported that the hardness of water is due to excessive presence of calcium and magnesium.

Calcium: Sirsath *et al*., (2006)[20] reported that calcium and magnesium are the principal cation that impart hardness. The amount of calcium recorded in Madhav sagar ranges from 57 ppm to 74 ppm. The amount of calcium recorded was maximum during summer season were as minimum during winter season. According to Billore (1981)[21] the amount of calcium increases during summer season due to rapid oxidation /decomposition of organic matter. Ohle (1938)[22] classified water bodies into: (i) poor (ii) medium and (iii) rich water body with regard to calcium content. The desirable value of calcium as per BIS (1991)[23] is 75ppm, which shows that water of Madhav sagar is within a desirable limit.

Magnesium: The magnesium amount recorded in the water of Madhav sagar ranges from 17 ppm to 32 ppm. The maximum amount was recorded during winter season were as minimum amount was recorded during monsoon season. Venkatasubramani and Meenambal (2007)[24] reported that magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium. According to Dagaonkar and Saksena (1992)[25] magnesium is essential for chlorophyll growth and it also acts as a limiting factor for the growth of phytoplankton.

Dissolve Oxygen: Vijayan (1991)[26] reported that the measurement of dissolved oxygen is a primary parameter in all pollution studies. The amount of dissolve oxygen is higher in those places where there is a good aquatic life. In Madhav sagar the amount of dissolve oxygen recorded ranges from 5.6 ppm to 6.8 ppm. The maximum value of dissolve oxygen was recorded during monsoon season and the minimum value was recorded during summer season. According to Singh *et al*., (1991)[27] Low dissolve oxygen during summer may be due to higher temperature and low solubility of oxygen in water consequently affecting the BOD.

Biological Oxygen Demand: BOD refers to the amount of oxygen used by microorganism in the aerobic oxidation of organic matter. The BOD recorded in Madhav sagar ranges between 1.3 ppm to 2.1 ppm. The maximum values was recorded during summer season were as the minimum value was recorded during monsoon season. Sankar *et al*., (2002)[28] suggested that high BOD may be due to the increase demand of oxygen for the degradation of the organic wastes dumped into the water. But in Madhav sagar the amount of DO is more in compare to BOD which shows that water of the pond is free from organic waste showing less microbial activity.

Chloride: The chloride concentration was used as an important parameter for detection of contamination by sewage. Freeda *et al*., (2006)[29] reported that chlorides usually occur as NaCl, $CaCl_2$, $MgCl_2$, and in widely varying concentration in all natural water. The value of chloride recorded in Madhav sagar ranges between 68 ppm and 86 ppm. The high amount of chloride was recorded during summer season and low value was recorded during winter season. Many worker like Laxminarayana (1965)[30]; Singh (1965)[31]; Verma *et al.*, (1978)[32]; Billore (1981)[21]; Venkateswarlu (1969)[14] and Jana (1973)[15] reported an increase in chloride content of water during summer seasons.

Sodium: The sodium amount recorded in Madhav sagar ranges between 23.42 ppm to 42.14 ppm. The high amount of sodium was recorded during summer season and the lowest amount was recorded during winter season. According to Solanki (2001)[11] the highest volume of sodium during summer is due to shrinkage of water volume.

Nitrate: The amount of nitrate recorded in Madhav sagar ranges from 1.26 ppm to 3.28 ppm. The high amount of nitrate was recorded during monsoon season and the low amount was recorded during winter season. Similar observations were made by Das (2000)[33]; Das (2003)[34] and Sehgal (2003)[35]. According to Kumar and Ravindranath (1998)[3] nitrate concentration of more than 5 mg/l in water usually indicate pollution made by human and animal wastes or fertilizer runoff.

Phosphate: The amount of phosphate recorded in Madhav sagar ranges between 0.12 ppm to 0.56 ppm. The maximum amount was recorded during the winter season and minimum amount was recorded during monsoon season. Hastler (1947)[36] observed that the constant addition of even low levels of nitrogen and phosphorous to an aquatic environment could greatly stimulate algal growth. According to Patel and Ragothaman (2005)[37], the decrease in Phosphate values in monsoon was due to absorption by planktons.

(B) Botanical Parameter

CYANOPHYCEAE

This is distinctive group of algae in which the pigment are localized in the peripheral portion of protoplast and include chlorophyll a, Carotene, distinctive Xanthophyll, blue pigments (C–Phycocyanin) and a red pigment (C–Phycoerythrin). Another unique feature of cyanophyceae is the primitive type of nucleus, which lack nucleolus and nuclear membrane. These algae can tolerate very high range of temperature and form the dominant group. In the present study in Madhav sagar 13 genera of cyanophyceae algae were recorded [Table – 2]. In the present study algal unit of cyanophyceae class recorded for Madhav sagar ranges from

45 unit/ml to 60 unit/ml [Table – 3]. In this sagar the maximum unit of cyanophyceae was recorded during monsoon season followed by summer and winter [Graph – 1.1]. Smith (1983) had discussed the role of phosphate in the formation of bloom. Probably, higher amount of nitrate and phosphate are pre-requisite for the luxuriant growth of this group of algae. The importance of nitrate and phosphate in ecology of cyanophyceae have been emphasized by Fruh (1966), Lannineer *et al*., (1982)[40] and Henry *et al*., (1984)[41]. Temperature has been found to play a very important role in periodicity of this group, as emphasized by many worker (Pearsall, 1932[40]; Pearsall *et al*., 1946[41]; Hutchinson, 1967[44]; Chakrarobarty *et al*., 1959[43]; Harmer, 1964[44]; Venkateshwarlu, 1969[14]; Munawar, 1974[45] and Singh 1979)[46] Which has been further supported by Unni (1984)[48], who have stressed more on the significance of bright sunshine than temperature.

CHLOROPHYCEAE

The chlorophyceae is a group of algae having their photosynthetic pigments localized in chromatophores which are grass-green because of the predominance of chlorophyll – a and b over the carotene and xanthophylls. Photosynthetic reserves usually stored as starch. Algae of this class grow at high temperature and also at low temperature. In the present study in Knakaria lake 17 genera of chlorophyceae class were recorded throughout the year [Table – 2]. The algal unit of chlorophyceae class in Madhav sagar ranges from 54 unit/ ml to 97 unit/ml [Table – 3]. The minimum unit of algae of chlorophyceae class were recorded during monsoon season and maximum units were recorded during winter season (Graph – 1). In Madhav sagar it was found that chlorophyceae algal growth is dominated over bacillariophyceae, cyanophyceae and euglenophyceae (Graph – 1). Chlorophyceae was widespread and the most dominant group among the plankton. The dominance of chlorophyceae might be due to high dissolved contents Dhakar (1979) had also observed that the green algae prefer water with higher concentration of dissolve oxygen. Monthly variation of chlorophyceae show bimodel distributions with one peak during summer and other peak during winter. The decline in phytoplankton density during rainy season appears to be caused by increase in water volume. High turbidity has adverse effect on phytoplankton abundance by absorbing solar energy in the surface layer on water and thus impairing photosynthesis which cause a sharp fall in phytoplankton density. High rain fall dilution and overflooding in the waterbodies, water are also playing devastating role in the phytoplankton growth. This finding was also made by Vyas (1968), Trivedy (1993), Unni (1996)[48] and Singh (1987).

BACILLARIOPHYCEAE

This group includes a large number of unicellular and colonial genera which differ from other algae in the shape of their cells. The main characteristic feature of diatoms is the presence of highly silicified cell wall which is composed of two overlapping values. In the present study in Madhav sagar total 6 genera of bacillariophyceae class were recorded throughout the study [Table – 2]. The diatoms unit recorded in Madhav sagar of bacillariophyceae class ranges from 49 unit/ml to 57 unit/ml [Table – 3]. The minimum units were recorded during winter season and maximum unit were recorded during summer season (Graph – 1). Seasonal fluctuation of diatoms registered maximum in summer and minimum during winter and monsoon season. Pahwa and Mehrotra (1966) also observed similar trend in the water body, which has been further supported by Rao (1979)[49] and Sengar and Sharma (1982). A number of factors influenced the distribution of diatoms in water body, such as change in water temperature (Aykulu, 1978; Saad and Abbas, 1985 and Descy *et al*., 1987) light and irradiance of water.

EUGLENOPHYCEAE

Euglenophytes are free-swimming algal flagellates found in a variety of freshwater and marine environments. Despite the fact that they are of common occurrence, its taxonomy still is problematic. Euglenoid algae (Euglenophyceae) are relatively large and diverse. Few species are truly planktonic. In the present study, in Madhav sagar 3 genera of eugleophyceae class were recorded throughout the study [Table -2]. The euglenoid recorded ranges from 6 unit/ml and 9 unit/ml [Table – 3]. The minimum unit of euglenod were recorded during winter and maximum during monsoon. This group as a whole facultatively heterotropic and generally abundant in water rich in Organic matters. The ecological distribution of euglenoids has been studied by Munawar (1970) and Singh and Swarup (1979). Munawar (1970 and 1972) advocated that more amount of CO_2, phosphate, Nitrate and low content of dissolve oxygen favoured the growth of euglenoids. Singh (1979)[48] concluded that sewage contamination characterized by low transperancy, low dissolve oxygen, high carbonates, total alkalinity, chlorides, total hardness, calcium, magnesium, free and saline ammonia and albuminoid ammonia were favourable for the growth of euglenophyceae.

Statistical analysis: Interrelationship studies between different variables are very helpful tool in promoting research and opening new frontier of knowledge. The study of correlation and standard errors of mean reduces the range of uncertainty associated with decision making. The correlation coefficient analysis is done by using SPSS statistical tool and the data are depicted in table-1.

Table 1: Various parameters for water sampling

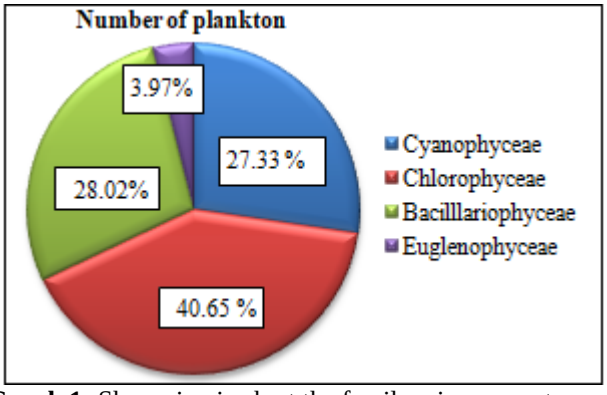
SN	Parameters	Year 2018-2019		
		Summer Mean ± S.E.	Monsoon Mean ± S.E.	Winter Mean ± S.E.
1	Temperature in ˚C	29 ± 0.82	22 ± 1.41	16 ± 0.82
2	Electrical conductivity In mhos/cm	3.10 ± 0.26	2.25 ± 0.27	2.75 ± 0.16
3	Turbidity in NTU	80 ± 0.41	110 ± 0.91	40 ± 0.41
4	TDS in ppm	942 ± 6.48	668 ± 19.2	824 ± 5.89
5	pH	8.3 ± 0.07	7.9 ± 0.18	8.2 ± 0.14
6	Alkalinity in ppm	152 ± 3.65	168 ± 4.32	163 ± 4.51
7	Total hardness in ppm	284 ± 2.86	238 ± 5.48	272 ± 5.87
8	Calcium in ppm	74 ± 2.86	68 ± 2.58	57 ± 3.7
9	Magnesium in ppm	24 ± 1.08	17 ± 1.58	32 ± 2.35
10	DO in ppm	5.6 ± 0.42	6.8 ± 0.32	6.2 ± 0.23
11	BOD in ppm	2.1 ± 0.16	1.3 ± 0.30	1.8 ± 0.31
12	Chloride in ppm	86 ± 3.37	74 ± 1.83	68 ± 3.19
13	Sodium in ppm	42.14 ± 1.47	38.46 ± 2.86	23.42 ± 3.4
14	Nitrate in ppm	2.24 ± 0.1	3.28 ± 0.18	1.26 ± 0.18
15	Phosphate in ppm	0.38 ± 0.05	0.12 ± 0.02	0.56 ± 0.04

Table 2: Seasonal variation of phytoplankton in Madhav sagar

Class	GENERA	Summer mean	Monsoon mean	Winter mean
Cyanophyceae	*Anabaena sp.*	5	8	5
	Spirulina sp.	4	2	0
	Aphanocapsa sp.	0	3	0
	Aulosira sp.	3	4	0
	Calothrix sp.	2	4	0
	Phormidium sp.	9	7	10
	Microcystis sp.	8	6	8
	Oscillatoria sp	5	7	4
	Nostoc sp.	4	7	0
	Nodularia sp.	2	4	4
	Cylinderospermum sp.	5	8	9
	Lyngbya sp.	4	0	2
Chlorophyceae	*Closterium sp.*	4	3	6
	Pediastrum sp.	8	5	10
	Stigeoclonium sp.	4	0	2
	Chlorella sp.	6	4	7
	Ankistrodesmus sp.	7	4	9
	Tetraedon sp.	4	2	5
	Palmella sp.	7	4	7
	Cosmarium sp.	10	6	12
	Scendesmus sp.	7	4	7
	Zygnema sp.	6	3	7
	Mieospora sp.	4	2	6
	Desmidium sp.	7	4	5
	Pandorina sp.	2	0	4
	Euastrum sp.	0	4	0
	Cladophora sp.	3	2	4
	Sphaerocystis sp.	3	6	4
	Volvox areus	2	1	2
Bacillariophyceae	*Cymbella sp.*	13	11	9
	Fragillaria sp.	7	8	5
	Navicula sp.	16	13	10
	Pnnularia sp.	6	9	8
	Melosira sp.	4	6	2
	Synedra sp.	11	9	15
Euglenophyceae	*Euglena sp.*	4	3	3
	Peranema sp.	2	2	3
	Phacus sp.	2	4	0
Total Phytoplankton Count /ml		202	179	197
Total phytoplankton count/litre		60600	53700	59100

Table 3: Summary of phytoplankton count

No.	Class	Summer Mean ± SE	Monsoon Mean ± SE	Winter Mean ± SE	Total
1	Cyanophyceae	53 ± 0.147	60 ± 3.16	45 ± 2.97	158
2	Chlorophyceae	84 ± 3.16	54 ± 2.58	97 ± 2.65	235
3	Bacillariophyceae	57 ± 4.93	56 ± 2.94	49 ± 2.89	162
4	Euglenophyceae	8 ± 0.91	9 ± 0.41	6 ± 1.08	23



Graph 1: Shows in pie chart the family wise percentage of plankton

4. Conclusion

During the study it was found that maximum number of physical and chemical parameter were beyond the desirable limit for drinking water, as suggested by WHO (1971)[50] and BIS (1991)[21]. In Madhav sagar not free from pollution and can be counted as most polluted water body as the maximum amount of phytoplankton recorded were *Cylinderospermum* sp. *Microcystis* sp., *Phormidium* sp., *Pediastrum* sp., *Cosmarium* sp., *Ankistrodesmus* sp., *Cymbella* sp., *Navicula* sp., and *Synedra* sp are found over the limit. During the study it was also found that chlorophyceae algal growth is dominated over cyanophyceae, bacillariophyceae and euglenophyceae which indicates for eutrophication. Therefore it was concluded that Madhav sagar is very unsafe and must be used only after suitable treatment process.

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