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**Research Article**

# Physico-Chemical Characteristics of a Fresh Water Pond of Orai, U. P., Central India

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**ABSTRACT**

**In the present study an attempt has been made on physico-chemical characteristics of Mahil pond, located in Orai in Jalaun district of Uttar Pradesh. The study was carried out for a period of one year i.e. July 2009 to June 2010. Monthly details have been collected and were represented seasonally along with standard deviation. Different parameters were taken in the study were Rainfall, Cloud cover, Humidity, Atmospheric and water temperature, Secchi Transparency, pH, Electrical Conductivity, Total Dissolved solids, Dissolved oxygen, Biochemical Oxygen Demand, Total alkalinity, Bicarbonate Alkalinity, Total Hardness, Calcium Hardness, Chloride, Nitrate-Nitrogen and Phosphate, The results of the present study indicated that the water of the pond lies just below the level of eutrophication.**

## INTRODUCTION

Ponds are important wetlands located in and around human habitations as they are generally semi natural ecosystems constructed by man in landscape suitable for water stagnation. Ecosystem services rendered by these wetlands are innumerable including tangible and non -tangible ones. Besides acting as a source of fresh water, they lower the ambient temperature, raise the water table, increase the diversity of flora and fauna, and provide aesthetic ambience.

Due to uncontrolled increase in human population and development of township at large, these freshwater bodies are under tremendous pressure owing to their overuse on one hand and enrichment due to nutrients and organic matter on the other, leading to the cultural eutrophication. Erosion of catchment and direct pouring of domestic effluents along with sewage are threatening these wetlands all over the world. In view of the above, the present study deals with the assessment of physico-chemical characteristics of a freshwater pond located in the middle of township of Orai, Uttar Pradesh, India.

## MATERIALS AND METHODS

### Study site characteristics

The pond selected under investigation is known as “Mahil Ka Talab”. It is situated on the south east part of the city Orai, U.P. Orai city is also known as city of the King Mahil who was the ruler of this region during 18$^{th}$ century AD. It is located at 25°98' N latitude and 79°47' E longitude. The Pond is somewhat elliptical in outline having granite steps and raised concrete walls on all sides. Maximum depth of the pond at full water level is about 4.0m and the average depth is about 2.0m. The surface area is about 10,000sq.m.

**Sampling and Sample Processing**

Observation for of the present study were carried for a period of one year (July 2009 to June 2010). Observation and analysis were done every month however, the results are expressed on seasonal basis as variation was of less magnitude. Since the climate of the region is tropical monsoonic, three clearly defined seasons were identified viz, rainy (July - October), winter (November - February) and summer (March - June). The sampling was done during morning hour (8:30 to 10:30 am) and the water samples were collected using modified Hal's sampler. Physico-chemical parameters like temperature, pH, electrical conductivity, dissolved oxygen, total dissolved solids, nitrate nitrogen, phosphate were analyzed with the help of thermometers and Elico Water Quality Analyser PE 138. Transparency was measured by Secchi disc. For analysis of other chemical parameters, the samples were collected in glass bottles and transported to laboratory and were analyzed as per procedure given by Adoni *et al.*, (1985) and APHA (1998).

## RESULTS AND DISCUSSION

Results of physico-chemical attributes of water and a few climatic parameters are presented in table 1.

**Rainfall**

Carter (1960) stated that in tropics, the amount of rainfall play's a significant role in regulating the seasonal biological rhythms. Monthly rainfall variation showed that the average monthly rainfall ranged from 12.93mm to 251.81mm. Usually heavy rainfall occurs only in monsoon period. Seasonal variation in rainfall during the study period influences other hydrological features. Fluctuations in the quantity of nutrient due to rain water are of great importance in tropical regions (Subba Rao and Govind, 1964; Adoni, 1975; Chaurasia and Adoni, 1985; Hulyal and Kaliwal, 2011).

**Cloud Cover**

The data envisaged that percentage of cloud cover was maximum during August (53.42%) and minimum (22.46%) in the month of November. During rainy season the cloud cover influence atmosphere temperature which in turn has a bearing on temperature of water and solubility of gases and other nutrients.

**Humidity**

Maximum humidity was recorded during the month of August i.e. 81% and minimum in April i.e. 29%. It is a typical trend in tropical regions where hot and humid rainy season prevails.

**Atmospheric and Water Temperature**

Temperature is a physical factor that alters the water characteristics and considered as an important factor in controlling the fluctuation of plantation and functioning of aquatic ecosystem. (Wetzel, 1975; Dwivedi and Pandey, 2002 ; Singh and Mathur , 2005). In the present investigation seasonal variability of atmospheric and water temperature have been observed. It was maximum during summer comparatively less during monsoon and minimum during winter. Kannan and Job (1980) also found similar results as observed in the present study.

Interestingly the magnitudes of variation in atmospheric and water temperatures were of less during summer. Surface temperature closely reflected to ambient air temperature. This is particularly true for shallow lakes and ponds like in presents study (Efford, 1967; Moss, 1969). It may probably due to smaller bodies of water. It is now a well known fact that smaller the body of water, more quickly it reacts to the changes in the atmospheric temperature (Welch, 1952; Ghosh and Basu, 1968; Young, 1975; Sehgal, 1980; Jayanti, 1994; Joshi and Singh, 2001).

**Secchi Transparency**

Water transparency is an important factor that controls the energy relationship at different trophic levels. The results of transparency ranged between 25 cm. to 60 cm. during the study period. It was low during the summer and higher during the winter season. The transparency was lower in the summer season due to high planktonic population, while it was low in the rainy season because of increase in the suspended matter brought in through surface run off. The maximum transparency was recorded in winter season attributed to the sedimentation of suspended matter (Chaurasia and Adoni, 1985; Sinha *et al.*, 2002; Kadam *et al.*, 2007; Shah and Pandit, 2012).

**pH**

Welch (1952) states that the limnological value of pH is a limiting factor and works as an index of general environmental condition. The pH value of the pond showed alkaline trend with a few variations. The maximum pH value were in the month of April i.e. 9.4 and minimum in the month of October i.e. 8.88. It is evident from the data that the pH declines during the rainy and increases during summer. Sharma *et al.*,(1984) states that in India, many small confined water pockets are particularly alkaline in nature.

**Table 1:** Seasonal variation in physico-chemical characteristics of water of Mahil pond from July 2009 to June 2010.

| S.No. | Parameters | Seasons | | |
|---|---|---|---|---|
| | | **Rainy** | **Winter** | **Summer** |
| **1** | Rainfall (mm.) | 130.45±104.47 | 10.95±4.99 | 12.93±20.50 |
| **2** | Cloud cover (%) | 53.42±21.47 | 22.46±5.58 | 33.89±11.59 |
| **3** | Humidity (%) | 72.75±8.26 | 45.75±4.11 | 39.50±12.79 |
| **4** | Atmospheric Temperature (°C) | 28.91±2.44 | 18.02±2.55 | 31.52±4.52 |
| **5** | Water Temperature (°C) | 29.03±2.19 | 19.11±2.86 | 31.25±4.63 |
| **6** | Secchi Transparency (cm.) | 37.37±13.01 | 55.12±4.55 | 35.75±5.69 |
| **7** | PH | 8.99±0.12 | 9.02±0.14 | 9.26±0.14 |
| **8** | Electrical Conductivity ($mScm^{-1}$) | 2.64±0.41 | 2.26±0.09 | 2.47±0.07 |
| **9** | Total Dissolved solids($mgl^{-1}$) | 1258.81±133.17 | 1007.69±142.8 | 1378.75±86.80 |
| **10** | Dissolved Oxygen($mgl^{-1}$) | 7.30±0.36 | 9.23±0.91 | 6.74±1.17 |
| **11** | Biochemical Oxygen Demand($mgl^{-1}$) | 2.82±0.22 | 2.21±0.60 | 2.81±0.45 |
| **12** | Total Alkalinity($mgl^{-1}$) | 560.31±19.99 | 469.24±25.55 | 438.90±34.82 |
| **13** | Bicarbonate Alkalinity($mgl^{-1}$) | 468.39±15.78 | 334.57±18.97 | 335.26±50.10 |
| **14** | Total Hardness($mgl^{-1}$) | 246.96±12.05 | 270.64±13.07 | 273.62±12.38 |
| **15** | Calcium Hardness($mgl^{-1}$) | 44.16±8.60 | 50.07±6.62 | 42.32±6.87 |
| **16** | Chloride ($mgl^{-1}$) | 104.63±26.88 | 83.93±3.54 | 96.84±5.71 |
| **17** | Nitrate- Nitrogen($mgl^{-1}$) | 0.89±0.27 | 1.43±0.45 | 2.67±0.53 |
| **18** | Phosphate($mgl^{-1}$) | 0.04±0.014 | 0.038±0.014 | 0.048±0.009 |

Values are mean ± standard deviation.

Seasonal fluctuations are small indicating good buffering capacity. It has been suggested that the high pH is normally associated with a high photosynthetic activity in water (Goel *et al.*, 1986; Wani and Subla, 1990). High value also promote the growth of algae and results heavy bloom of phytoplankton (George, 1962; Nandan and Patel, 1992).

**Electrical Conductivity**

Electrical conductivity of the water depends on the nature and concentration of salts. In the present study high values of conductivity, could be due to high ionic concentration, pollution status, trophic levels, some domestic effluents and other organic matter in water (Ahluwalia, 1999; Fokmare and Musaddique, 2001).

The range of electrical conductivity in the present study was between 2.13 $mScm^{-1}$ and 3.23 $mScm^{-1}$. The values of electrical conductivity showed marked seasonal variation being maximum during rainy and minimum during winter season. Similar results were observed by various workers (Datta and Bhagwati, 2007; Hulyal and Kaliwal, 2011; Ramulu and Benarjee, 2013). The water during the summer decreases as a result of death and decay of plants and animals.

**Total dissolved solids**

Water is a universal solvent and has a large number of salts dissolved in it which largely govern in physico-chemical properties. The maximum value of total dissolved solids were recorded in July (1449.50 $mgl^{-1}$) and minimum were recorded in January (816.50 $mgl^{-1}$). Seasonal variations showed maximum values in summer followed by rainy season and minimum during the winter season. The high value of TDS during rainy may be due to addition of domestic waste water, garbage and sewage etc. in the natural surface water body (Verma *et al.*, 2012). Increased high concentration of TDS increases the nutrient status of water body which was resulted into eutrophication of aquatic bodies (Swarnlata and Narsigharao, 1998; Singh and Mathur, 2005). The water containing more than 500 $mgl^{-1}$ of TDS does not qualify for drinking purposes. Hence, 500$mgl^{-1}$ is desirable limit and 1500 $mgl^{-1}$ maximum possible limit for domestic use (ICMR, 1975).

**Dissolved Oxygen**

Oxygen content is important for direct needs of many organisms and affects the solubility of many nutrients and therefore the periodicity of aquatic ecosystem (Wetzel, 1983). Fritsch (1907) stated that the oxygen contents in tropical water would be low considering their high temperature. The results of the present study showed that highest peak value of dissolved oxygen was recorded during the month of January i.e. 10.50 $mgl^{-1}$ and least in the month of June i.e. 5.15 $mgl^{-1}$. The value increased from July to January and then decreased from February to June. Results of the present study are similar to those reported by other (Prasad *et al.*, 1985; Hulyal and Kaliwal, 2011; Ramulu and Benarjee, 2013).

**Biochemical Oxygen Demand**

BOD is dissolved oxygen required by micro organism for aerobic decomposition of organic matter present in water. Jain and Dhanija (2000) have considered BOD as an important parameter in aquatic ecosystem to establish the status of pollution. The observation of present study showed that highest value of BOD (3.26 $mgl^{-1}$) during the June and lowest (1.55 $mgl^{-1}$) in January. Seasonally, the BOD was highest during late summer /early rainy season. High BOD during late summer / early rainy season may be due to the presence of several microbes in water bodies which accelerate their metabolic activities with the increase in concentration of organic matter in the form of municipal and domestic waste pouring into the pond with run off (Kaushik and Saksena,1999). Prasanna Kumari *et al.*, (2003) also stated that the higher values of BOD during rainy was also due to input of organic wastes and enhanced bacterial activity. High temperatures do play an important role by increasing rate of oxidation.

The BOD of unpolluted water is less than 1.00 $mgl^{-1}$ moderately polluted water 2.00-9.00 $mgl^{-1}$ while heavily polluted water have BOD more than 10.00 $mgl^{-1}$ (Adakola, 2000). The BOD in different season in the present study fluctuated between 1.55 and 3.26 $mgl^{-1}$ indicating pond status as moderately polluted.

**Total Alkalinity**

Alkalinity in most natural water is the function of bicarbonate and carbonates. Their salts get hydrolyzed in solution and produced hydroxyl ion. It is also used as a measure of productivity (Jhingran, 1982; Hulyal and Kaliwal, 2011). Natural water bodies in tropics usually show wide range of fluctuations in their total alkalinity value depending upon the geography and season.

In the present study the total alkalinity ranged between 418.25 to 583.01 $mgl^{-1}$. It is gradually decreased from July to September and then increased in the month of October reaching to 549.90 $mgl^{-1}$ again followed by a decrease in November and December. Seasonally highest value was recorded during rainy and lowest during the summer season. Increases in total alkalinity during rainy season were due to input of water and dissolution of calcium carbonate ion in

the water column (Padma and Periakali, 1999). The degradation of plants and other organism and organic waste might also be one of the reason for the increase in carbonate and bicarbonate thereby the alkalinity (Jain *et al.*, 1997; Chaurasia and Pandey, 2007).

**Bicarbonate Alkalinity**

Carbonate in aquatic bodies is thought to be of paramount importance because of its buffering capacity and role in primary production. The maximum bicarbonate alkalinity was recorded in October (486.85 $mgl^{-1}$) and minimum in the month of May (290.78 $mgl^{-1}$). It is also observed that the bicarbonate alkalinity increased from July to October. Highest average seasonal value was recorded during the rainy and lowest during the winter season. Chourasia and Adoni (1985) also found higher bicarbonate alkalinity in rainy season and lower in summer. Low bicarbonate alkalinity during the rainy season may be attributed to the decreased role of evaporation coupled with influx of the large volume of water responsible for dilution of carbonates.

**Total Hardness**

Hardness of water is principally due to salts of $Ca^{++}$ and $Mg^{++}$ mainly the carbonates and sulphates (Wadia, 1961). In the present study the total hardness of water ranged from 236.57 $mgl^{-1}$ to 290.25 $mgl^{-1}$. Seasonally, highest value was recorded during summer and lowest during the rainy season. Similar observations were found by various workers (Kumar, 1995; Naiak and Purohit, 1996; Kaur *et al.*, 2000; Nair, 2002). Hulyal and Kaliwal (2011) found that higher value in summer and lower in winter season. They attributed is to decreases in water volume and increases in rate of evaporation at high temperature.

Kiran (2010) reported that water can be categorised according to degree of hardness as soft (0-75 $mgl^{-1}$) moderately (75-150 $mgl^{-1}$) hard, hard (150-300 $mgl^{-1}$) and above 300 $mgl^{-1}$ as very hard. On the basis of the observation, the water of the present pond appears to be hard.

**Calcium Hardness**

Calcium is an essential and important nutrient for aquatic organisms being a cell wall constituent and regulatory factor for physiological function. It is commonly found in all water bodies (Chourasia and Adoni 1985; Ansari and Prakash, 2000). Calcium content of pond water ranged from 32.05 $mgl^{-1}$ to 58.11 $mgl^{-1}$. It was observed that the value of calcium gradually decreases from July to December (32.05 to 58.11 $mgl^{-1}$) and then slightly decreased from January to March (46.12 to 32.55 $mgl^{-1}$). Seasonal mean values indicate that it was higher during the winter and lower during the summer. Munawar (1970) also noted higher value of calcium during winter season. The decrease in the amount of calcium may be due to its absorption by living organism. Hulyal and Kaliwal (2011) found that the calcium content was higher in summer and lower in monsoon season. However, Verma *et al.*, (2012) observed maximum calcium content in the water of Chandlodia lake during monsoon and minimum during winter.

Goldman and Horne (1983) reported that any value above 25 $mgl^{-1}$ indicate calcium rich water. Higher calcium content in drinking water cause incrustation in water supply structure and adversely affect on domestic used (Raghvendra, 1992). The values of present study are found to desirable limit for the domestic use.

**Chloride**

In the present study chloride content ranged between 74.40 $mgl^{-1}$ to 128.62 $mgl^{-1}$. Variations in chloride content were irregular as they declined from July to September (128.62 to 74.40 $mgl^{-1}$) and then increased in October and again gradually decreased from November reached to 80.10 $mgl^{-1}$ during January. The chloride content showed marked seasonal variation being maximum during rainy and minimum during winter season, which is the agreement with the observation made by Saha and Pandit, (1985) and Hulyal and Kaliwal, (2011). However, higher concentration of chloride during the summer and lower during the winter was also reported (Sharma *et al.*, 2007; Verma *et al.*, 2012; Ramulu and Benarjee, 2013). Higher concentration of chloride content was found during the rainy season may be attributed to increasing the organic waste of human origin with runoff water. Munawar (1970) suggested that higher value of chloride in water as an index of pollution of animal origin. Higher concentration also be associated with frequently runoff loaded with contaminated water from surrounding (June and Fred, 1987; Sunder, 1988).

**Nitrate- Nitrogen**

Nitrates are contributed to fresh water through discharge of sewage, industrial wastes and runoff from agricultural fields. The concentration and rate of supply of nitrate in the land use practices of the surrounding watershed. Results of the present study envisaged that the value of NO3-N varied from 0.69 $mgl^{-1}$ to 3.08 $mgl^{-1}$. Lower values were recorded during rainy and higher values were found during summer season. Higher oncentration may be due to influx nitrogen rich flood water and bring about large amount of sewage. The rainy season was period with the highest nitrate-nitrogen concentration which is known to support the formation of blooms (Shai and Sinha, 1969; Anderson, *et al.*, 1998).

**Phosphate**

Phosphate is the key nutrient also causing eutrophication leading to extensive algal growth. The results of present study showed that maximum phosphate concentration was observed in the month of August i.e. 0.061 $mgl^{-1}$ and minimum in January i.e. 0.020 $mgl^{-1}$. It is evident from the data that seasonally phosphate concentration in the pond was more in summer followed by rainy followed by a decline in winter season. Highest seasonal values were reported during rainy and lowest during winter is in the conformity with the findings of various workers (Kaur *et al.,* 1997; Khurshid *et al.,* 1997; Hulyal and Kaliwal 2011; Verma *et al.*, 2012).

The increase in the concentration of phosphate during rainy season is the results of incoming water from the catchment area of human settlements and the entry of domestic sewage. The occurrence of less nutrients during winter may be due to their utilization in macrophytic growth. Increase in nutrients during summer is related with the decrease in water level effecting concentration and the release of nutrient during decomposition, which increase with rise in temperature (Chaurasia and Adoni, 1985).

Comparatively higher values of total alkalinity may be attributed to the hardness. Philipose (1960) has classified freshwater ponds of India into four categories on the basis of alkalinity. Ponds receiving effluents have been reported to show alkalinity from 462 to 505 $mgl^{-1}$. He further endorsed that polluted ponds may have even higher alkalinity. In another study Prasad *et al.* (1985) given a range of alkalinity from 128 to 730$mgl^{-1}$. Similarly Kumari *et al.* (2007) obtained remarkable differences in the total alkalinity in different months (140-370$mgl^{-1}$) in two tropical ponds of India. They have further correlated the higher pH values with alkalinity.

Higher levels of chlorides in the present investigation are unusual. However even greater concentrations of chlorides have been reported by Chowdhury and Mamun (2006). Munawar (1970) suggested that higher chlorides in water is an index of pollution of animal origin. It has also been observed during the present investigation that the pond under observation has been under constant pressure of animal bathing, receives a variety of effluents from municipal discharge, as well as organic and inorganic wastes from a number of temples surrounding the water body.

## CONCLUSION

Present study provides a base line data for the conservation and monitoring of the pond. Data envisaged that the current status of the pond lies just below the levels of eutrophication. A few efforts like diversion of sewage, presentation of leaching of nutrients from catchment area through plantations would definitely yield good results.

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