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Research Article

AN ACCOUNT OFABIOTIC AND BIOTIC PARAMETERS OF FOUR LENTIC WATER BODIES OF JAMMU DISTRICT, J&K

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ABSTRACT

The present studies were carried to investigate the current limnological conditions of four lentic water bodies of Jammu, J&K viz., Mansar lake, Surinsar lake, Dilli pond and Athem pond. The various physico-chemical parameters as temperature, depth, pH, dissolved oxygen, free carbon dioxide, calcium, magnesium, chloride, biochemical oxygen demand, carbonates, bicarbonates, phosphate, nitrate and sulphate were analysed whereas biotic parameters included the estimation of zooplankton. Well marked seasonal variations in the values of physico-chemical parameters were observed. Rich diverse species recorded belonging to protozoa, rotifera, cladocera and copepoda. The results revealed that out of the various water bodies studied, Dilli pond was the most polluted as indicated by abiotic parameters and various pollution tolerant zooplankton species.

INTRODUCTION

Limnological investigations on water bodies play a very important role in assessing the water quality and its interaction with biotic and abiotic factors. The role of water in nature is unique not only from the point of human consideration but also numerous organisms make aquatic medium as their habitat. The quality of aquatic life depends on the water quality. In order to utilize fresh water bodies successfully, it is very important to study the physico-chemical factors which influence the biological productivity of the water body. The requirement of water to biota is a serious challenge today because most of the water resources are under stress due to unplanned urbanization and industrialization (Kamat and Sima, 2000; Shiddamallay and Pratima, 2008). This makes them vulnerable for human consumption. The measuring of the parameters would probably give a clear picture about the pollution stress on them (Raja *et al.,* 2008). The present study is an attempt to assess the water quality of four lentic water bodies including 2 lakes and 2 ponds of Jammu district, J&K by analyzing the status of abiotic and biotic parameters.

MATERIALS AND METHODS

Tha sampling was done from four lentic water bodies of Jammu viz. Mansar lake, Surinsar lake, Dilli pond and Athem pond.

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They were analysed for both abiotic (Physico-chemcial parameters) and biotic parameters (Zooplankton).

Abiotic parameters

Water: Sampling and Analysis

For the analysis of physico-chemical parameters, monthly collection of water samples done from the selected stations. Estimation of some physico-chemical parameters viz., temperature, depth, pH, dissolved oxygen, free carbon dioxide and carbonates were done on the spot while for rest of the chemical parameters such as bicarbonates, chloride, calcium, magnesium, nitrates, phosphates and sulphates, water samples were collected in the glass bottles and brought to the laboratory for further analysis.

Physical parameters

Air temperature and water temperature: It was recorded with the help of a mercury bulb thermometer while avoiding its direct exposure to the sunlight (Welch, 1952).

Depth: A graduated meter rod was used for recording the depth (Adoni, 1985).

Chemical Parameters

1. **pH:** pH of the water samples was determined with the help of a portable field pH meter(Hanna) by lowering its bulb directly into the water.

2. **Dissolved Oxygen (DO):** It was determined by Sodium Azide modification of Winkler's Method (APHA, 1985).
3. **Free carbon Dioxide (FCO_2):** Titrimetric method was adopted for the estimation of free carbon dioxide (APHA, 1985).
4. **Calcium and Magnesium**: The estimation of calcium and Magnesium was done by the EDTA-Titrimetric method as suggested in APHA, 1985.
5. **Chloride:** Argentometric method was used for the estimation of chloride in which Potassium chromate was used as an indicator (APHA, 1985).
6. **BOD (Biochemical Oxygen Demand):** It was estimated following APHA, 1985.
7. **Carbonates and Bicarbonates**: These were estimated following APHA, 1985.
8. **Phosphate:** It was determined by Stannous Chloride method using spectrophotometer (Adoni, 1985).
9. **Sulphate**: Turbiditimetric method using spectrophotometer was used to estimate sulphate content of the water samples (APHA, 1985; Adoni, 1985).
10. **Nitrate**: Nitrate was determined by Phenol disulphonic acid method using spectrophotometer (APHA, 1985; Adoni, 1985 and Chopra and Kanwar, 1991).

Collection of Zooplankton

Zooplankton were collected by filtering 50 litres of water through planktonic net of standard bolting silk cloth no. 25 (mesh size 0.003-0.004 microns). Finally the volume of zooplankton samples was adjusted to 20 ml and preserved by adding 5% formalin. The preserved zooplankton samples were then brought to the laboratory and observed under the Compound microscope.

Qualitative analysis of zooplankton

The identification was done using the keys by Ward and Whipple (1959),Pennak (1978) and Adoni (1985).

Quantitative analysis of Zooplankton

Total number of zooplankton counted by using Drop count method and calculated using formula:

Organisms /litre = $A \times 1/L \times n/v$

where A = number of organisms per drop.
L = volume of original sample (l).
n = total volume of concentrated sample (ml).
v = volume of one drop (ml).

RESULTS AND DISCUSSION

Physico-chemical parameters

Various physico-chemical parameters (Table 1 & 2) were analysed for the study period extending from May, 2013 to April, 2015. The analysis of two years data (first year, 2013-14 and second year, 2014-15) revealed well marked seasonal variations which were discussed as-

Air Temperature for the first year (2013-14) was observed maximum (36.5^0C) in Dilli pond in the month of June and minimum was observed in Athem pond (14^0C) in month of December. For the second year (2014-15), it was again maximum in Dilli pond with value 35^0C in June and minimum for Athem pond with 16^0C in month of December. Water Temperature followed the trend of air temperature. In the first year, it was maximum in Dilli pond with 33.5^0C in June and minimum in Athem pond with value 14^0C in December. In the second successive year, it was found to be maximum again in Dilli pond with value 32.5^0C in June but minimum was recorded in Surinsar lake with value 15^0C in month of December.

Table 1 Abiotic parameters for the year 2013-14

Stations		Mansar lake		Surinsar lake		Dilli pond		Athem pond	
Parameters		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Air temperature	^{0}C	34	16	34	15	36.5	18	33.5	14
Water temperature	^{0}C	30	17.2	31	14.5	33.5	17	31	14
Depth	cm	107	39	96	51	58	32	48	22
pH		8.1	6.5	8.1	6.4	8.2	6.3	7.8	6.4
DO	mg/l	8.4	3.2	8.4	4.2	6.4	3.2	7.2	4
FCO_2	mg/l	28	0	24	0	46	0	36	6
Calcium	mg/l	40.3	14.3	42	11.7	40.2	21	43.5	14.6
Magnesium	mg/l	42	17.2	54.37	9.95	48	18.70	38.96	16.05
Chloride	mg/l	78	19	75	18	91	22	73	19
BOD	mg/l	3.8	1.5	3.9	1.2	2.8	1.5	3.2	1.9
Carbonates	mg/l	10.2	-	14.4	-	9.6	-	-	-
Bicarbonates	mg/l	166.5	48.8	185.4	53.68	212.2	97.6	140.69	60.28
Phosphate	mg/l	.009	-	.0261	-	.174	-	.026	-
Sulphate	mg/l	.0018	.0017	.0021	.0017	.0028	.00172	.0020	.00171
Nitrate	mg/l	.5726	.5724	.5726	.5724	.57266	.5724	.57269	.5724

Table 2 Abiotic parameters for the year 2014-15

Stations		Mansar lake		Surinsar lake		Dilli pond		Athem pond	
Parameters		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Air temperature	^{0}C	33	17.5	32	17	35	17	33	16
Water temperature	^{0}C	29	18	30	15	32.5	16	29.5	16
Depth	cm	119	44	99	55	64	35	53	24
pH		7.9	6.4	7.9	6.3	7.9	6.4	7.6	6.3
DO	mg/l	8.4	3.2	8	3.6	5.8	3.2	7.6	4.2
FCO_2	mg/l	24	8	28	10	44	10	28	8
Calcium	mg/l	42	14.3	39.5	11.7	43.5	25.2	42.05	17.6
Magnesium	mg/l	48	16.05	42.1	18.70	48.02	18.7	42.1	17.1
Chloride	mg/l	75	19	71	19	73	30	75	19
BOD	mg/l	3.2	1.6	3.6	2.1	3.2	1.2	3.4	1.8
Carbonates	mg/l	-	-	-	-	-	-	-	-
Bicarbonates	mg/l	160.2	70.8	185.4	87.8	212.3	85.4	141.5	68.2
Phosphate	mg/l	.016	-	.026	-	.17	-	.026	-
Sulphate	mg/l	.0021	.0017	.002	.00171	.0020	.0017	.0028	.001
Nitrate	mg/l	.5726	.572	.5726	.5724	.5726	.572	.5726	.5724

Maximum temperature (air and water temperature) observed in the summer months may be the consequence of greater insolation (Ahmed, 2004) and longer photoperiods that resulted in heating up of atmosphere (Manjhare *et al*., 2010 and Kouser, 2015).

Depth is the vertical distance of water body at a point from the surface to the solid substratum beneath. For the first year, it was maximum in Mansar lake (107 cm) during monsoon (September) and minimum in Athem pond (22cm) during summer (May). For the second year, depth was found to be maximum again in Mansar Lake with little higher value of 119 cm during monsoon in month of August and minimum for the same pond, A them pond with value 24 cm during summer in the month of May. Maximum value of depth obtained in summer season may be related to the rains.

The analysis of pH values showed that in the first year, maxima was observed in Dilli pond during the month of December (8.2) and minima (6.3) in the same pond during June. During the second year, maximum pH value was 7.9 recorded in Mansar lake, Surinsar lake and Dilli pond during winters and minimum

6.3 was observed in Surinsar lake and Athem pond during summers. The pH minima in summer may be attributed to the increased decomposition rate leading to acidification (Sharma, 2013) and maxima in winter due to decreased rate of decomposition (Singh, 2004) and low free carbon dioxide shifting pH to alkalinity.

Dissolved oxygen (DO)*:* During the first year, maximum value of dissolved oxygen, 8.4 mg/l was recorded in Mansar lake and Surinsar lake in the months of December and November, respectively whereas mimimum value 3.2 mg/l was observed in Mansar lake and Dilli pond in June. In second year, maxima (8.4 mg/l) was observed in Mansar lake during November and minima (3.2 mg/l) in Mansar lake and Dilli pond during June and May, respectively. Increased solubility at low temperature and decreased rate of decomposition in winter season served to be the plausible factors for higher values of dissolved oxygen in winter season (Sharma and Rathore, 2000; Ravindra *et al.*, 2013, Sharma *et al.*, 2016, Gupta, 2017).

Free carbon dioxide (FCO_2)*:* During the first year, maximum value (46 mg/l) was reported in Dilli pond in May and minimum value was its absence in the study stations except Athem pond during winter months. During the second year, maxima 44 mg/l was recorded in Dilli pond in the month of May and minima 8 mg/l was observed for Mansar lake and Athem pond during winters. The raised values of FCO_2 in summer may be due to increased decomposition of dead organic matter at high temperature liberating more carbon dioxide (Singh and Gupta, 2010 and Matta, 2015) and increased respiratory activities of aquatic organisms (Singh, 1999 and Saksena *et al.,* 2008).

As far as calcium content is concerned, it was observed maximum for Athem pond (43.5 mg/l) during winter (November) and minimum for Surinsar lake (11.7 mg/l) during summer (May) for the first year. In the second year, maxima (43.5 mg/l) was reported for Dilli pond during winter (December) and minima (11.8 mg/l) for Surinsar lake in summer (June). The rise in calcium content during winter may be due to low temperature that increases its solubility (Borana *et al.,* 2013)

The analysis of magnesium content in the first year of study recorded maximum value of 54.4 mg/l for Surinsar during winter (January) and minimum value 9.9 mg/l observed in the same station during summer season (April). The second year revealed maximum value 48.02 mg/l for Dilli pond during winter (January) and minimum value 16.05 mg/l was recorded for Mansar during summer (March).Magnesium followed the pattern of calcium in the present study. Similar winter maxima of both calcium and magnesium has also been witnessed by Mukherjee *et al.* (2003); Patra *et al.* (2011); Kulkarni and Tapase (2012); Kouser (2015); Sharma (2015) and Saini (2016). They associated greater solubility of ions at low temperature and reduced depth in winter season.

During the first year of study, chloride maxima (91 mg/l) was observed in Dilli pond in May and minima (18 mg/l) in Surinsar lake in January. The second year recorded maxima (75 mg/l) in Mansar lake and Athem pond in May and June, respectively whereas minima (19 mg/l) was observed during winter months in Mansar lake, Surinsar lake and Athem pond.Seasonal variations in the chloride concentration showed maximum values in summer season which may be associated with the increased evaporation at high temperature and high BOD concentration (Jindal and Sharma, 2011). A positive correlation between BOD and chlorides has already been recorded by Mohan and Omana (2007).

BOD (Biochemical Oxygen Demand)*:* For the first year, maxima (3.9 mg/l) was recorded in Surinsar lake in April and minima (1.2 mg/l) in the same lake in December. The second year observed the maxima for same lake whereas minima (1.2 mg/l) was reported in Mansar lake and Dilli pond during the months of January and February, respectively. The raised BOD values in summer may be ascribed to high decomposition of organic matter with increase in temperature (Garg *et al.,* 2009).
The analysis of carbonates showed that in the first year, maximum value of 14.4 mg/l was observed in Surinsar during winter (December). As far as minimum value is concerned, the parameter found to be absent. In the second year, there was complete absence in all the stations. The carbonates found to be inversely related to FCO_2 in the water bodies. Similar relation of carbonates and FCO_2 also reported by Adoni, 1985 and Sharma, 2002.

The first year analysis of bicarbonates showed its maxima (212.2 mg/l) in Dilli pond in February and minima (48.8 mg/l) in Mansar lake in June. The second year recorded its maxima in same pond (Dilli pond) and minima (68.2 mg/l) in Athem pond in April. Maxima in winter season may be due to reduced photosynthetic rate leading to decline in HCO_3^- uptake (Sharma, 2013).

Dilli pond recorded maximum value of phosphate with value 0.173 mg/l (first year) and 0.17 mg/l (second year) during summerand minimum value was indicated by its absence. Increased phosphate content in summer may be ascribed to raised temperature which further increases decomposition rate, thereby releasing phosphate ions (Ahwange *et al*., 2012).

The first year data recorded sulphate maxima (0.0028 mg/l) in Dilli pond during monsoon (September) and minima observed was 0.0017 mg/l in all the study sites. The second year showed maximum value 0.002 mg/l in Athem pond in the month of September and minimum observed value was 0.001 mg/l. Maxima in monsoon may be pertained to run off (Chernogaeva, 1994).

The observed values of Nitrate showed that for the first as well as the second year, maximum value 0.5726 mg/l was observed in the study stations during summer and minimum recorded value was 0.5724 mg/l. Presence of high contents of nitrates in summer season may be ascribed to increased decomposition at high temperature (Paulose and Maheshwari, 2007).

Biotic Parameters

Four stations viz., Mansar lake, Surinsar lake, Dilli pond and Athem pond were visited monthly during the study period (2013-15) and analysed for different zooplanktonic groups. Rich diverse species (Table 3) were observed belonging to protozoa, rotifera, cladocera and copepoda. The group protozoa represented by 8 species belonging to 5 genera and 4 families whereas group rotifera contributed by 14 species belonging to 9 different genera and 5 families. Cladocera revealed 6 species belonging to 5 genera and 3 families; and copepoda contributed by 7 species belonging to 6 species and 2 families. The analysis

of the study period recorded 36 different species of zooplankton.

Table 3 Biotic parameters of four stations

Species	Mansar lake	Surinsar lake	Dilli pond	Athem pond
Protozoa				
Centropyxis ecornis	+	+	+	+
Centropyxis aculeata	+	+	+	+
Difflugia oblonga	+	+	+	+
Difflugia lebes	+	+	+	+
Difflugia acuminata	+	-	+	+
Arcella sp.	+	+	+	+
Paramecium sp.	-	-	+	-
Astramoeba radiosa	+	-	-	+
Rotifera				
Brachionus calyciflorus	+	+	+	+
Brachionus bidentata	+	-	+	+
Brachionus caudatus	+	-	-	-
Brachionus falcatus	+	+	+	+
Brachionus plicatilis	-	-	-	+
Keratella tropica	+	+	+	+
Platyias patulus	-	+	+	-
Euchlanis sp.	+	+	+	-
Lecane sp.	+	+	+	+
Monostyla sp.	+	+	+	+
Asplanchna sp.	+	+	+	+
Filinia longiseta	+	-	+	-
Filinia opoliensis	+	-	+	-
Philodina sp.	+	+	++	+
Cladocera				
Daphnia sp.	+	-	-	-
Ceriodaphnia sp.	+	+	+	+
Diaphanosoma sp.	+	-	+	+
Chydorus sphaericus	+	+	+	+
Chydorus sp.	+	+	+	+
Alona sp.	+	+	+	+
Copepoda				
Cyclops sp.	+	+	+	+
Mesocyclops sp.	+	+	-	+
Mesocyclops leuckartii	+	+	+	+
Macrocyclops sp.	-	-	+	-
Tropocyclops sp.	+	-	+	+
Halicyclops sp.	+	+	+	-
Diaptomus sp.	+	+	++	+

Mansar lake

The lake revealed rich diverse species inhabiting its waters. It recorded 7 species of Protozoa with absence of *Parameciumsp*., 12 species of Rotifera with absence of *Brachionusplicatilis* and *Platyiaspatulus*, 6 species of cladocera and 6 species of copepoda with absence of *Macrocyclops* sp. The order of different groups based on their abundance observed as-
For 2013-14
Rotifera>Copepoda>Cladocera> Protozoa
For 2014-15
Rotifera>Copepoda>Cladocera> Protozoa

Surinsar lake

The lake recorded 5 species of Protozoa with absence of *Difflugia acuminata, Parameciumsp.* and *Astramoebaradiosa*, 9 species of Rotifera with absence of *Brachionusbidentata, Brachionuscaudatus, Brachionusplicatilis, Filinialongiseta* and *Filiniaopoliensis*, 4 species of cladocera with absence of *Daphniasp*. and *Diaphanosomasp*. and 5 species of copepoda with absence of *Macrocyclopssp.* and *Tropocyclopssp*. The various groups recorded their order of abundance as-
For 2013-14
Rotifera>Copepoda>Cladocera> Protozoa
For 2014-15
Rotifera>Copepoda>Cladocera> Protozoa

Dilli pond

The pond was found to inhabit rich microscopic fauna in its waters. It recorded 7 species of Protozoa with absence of *Astramoebaradiosa*, 12 species of Rotifera with absence of *Brachionuscaudatus* and *B. plicatilis*, 5 species of cladocera with absence of *Daphniasp*. and 6 species of Copepoda with absence of *Mesocyclops*sp. The order of different groups recorded in the water body as-
For 2013-14
Rotifera>Copepoda>Cladocera> Protozoa
For 2014-15
Rotifera>Copepoda>Cladocera> Protozoa

Athem pond

It recorded 7 species of Protozoa with absence of *Parameciumsp.*, 9 species of Rotifera with absence of *Brachionuscaudatus, Platyiaspatulus, Euchlanissp., Filinialongiseta* and *F. opoliensis*, 5 species of cladocera with absence of *Daphniasp*. and 5 species of copepoda with absence of *Macrocyclopssp.* and *Halicyclopssp*. The order of various groups observed after calculating abundance was-
For 2013-14
Rotifera>Copepoda>Cladocera>Protozoa
For 2014-15
Rotifera>Copepoda>Cladocera> Protozoa

CONCLUSION

The present studies revealed well-marked seasonal variations in physico-chemical parameters. The biotic parameters also recorded good diversity of zooplankton species. Careful investigation of abiotic parameters showed that the studied water bodies are under stress which was further corroborated by the presence of many pollution indicator species viz., *Centropyxis sp., Difflugia sp., Brachionus sp., Filinia sp., Asplanchna sp., Philodina sp., Mesocyclops sp.* and *Diaptomus sp.* Out of the four lentic water bodies, Dilli pond recorded highest diversity and abundance of pollution indicator species with comparatively higher values of free carbon dioxide, chloride, bicarbonates, phosphate, sulphates and nitrates.

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