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THE STUDY OF ALGAE: THE NON-VASCULAR AQUATIC WEEDS FROM VARIOUS FRESH WATER BODIES OF PESHAWAR PAKISTAN

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ABSTRACT

The study of algae is very attractive due to their prehistoric and cosmopolitan nature. Algae are capable to survive in uncertain environment. Peshawar has many rivers and lakes i.e. River Kabul, Adezai, Naguman, Shah Alam and Bara River, where fresh water algae may exist abundantly, but very little notice has been paid to the algal diversity of all these rivers of Peshawar. To investigate the algae of Sheikh Muhammadi area of District Peshawar, a comprehensive study was conducted during 2013. A total of 22 algal species belonging to 10 families were recorded. Among them Oedogoniaceae appeard as the dominant family with 5 species followed by Stegeoclonium (3 spp.) while Cladophoraceae and Bulbochaete having two species each. Characiaceae, Scenedesmaceae, Oocystaceae, Centritractaceae, Coleochaetaceae, Tetrasporaceae Aphanochaete, Gongrosira, Characium, Cenedesmus, Closteriopsis, Centritractus, Coleochaete and Chaetopeltis got one species each. Some of the algal species are very useful for medicinal purpose, while others can be used as feed or food. Still most of the filamentous are noxious weeds of water bodies and hinder the intended use of water body. This study covers only a small portion of algae and a lot of species are still to be discovered, hence further studies are suggested to be undertaken in this regard.

Keywords: Algae, aquatic weeds, freshwater bodies, Sheikh Muhammadi area.

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from various fresh water bodies of Peshawar Pakistan. Pak. J. Weed Sci. Res. 21(1): 111-122.

INTRODUCTION

Algae are monoecius, group of organism having no sterile cells around their sex organs and are not true embryophyte (Shameel, 2003). Algae are the primary producers in any natural and aquatic ecosystem (Shameel, 2002). But on the other side they are noxious weeds too in certain situations. For example in stagnant or slow moving waters or in the water bodies with more nutrients due to fertilizer run off and with waste water discharge and industrial effluents, algae grow rapidly to cause water blooms. They cause the death of the flora and fauna occurring in the infested water bodies. Algae are universal in their occurrences that are present almost in every moist habitat including soil throughout the year. The water bodies passing through the city and big towns are particularly prone to the devastating effects of eutrophication due to the enormous addition of nutrients in the form of sewage waters. The species of algae causing water bloom must be identified and pointed out for avoiding the deadly effect of water bloom on the beneficial fauna of the water body. Many studies have identified algae from variety of soils and fresh water habitats (Hussain*et al*., 2003). More than 500 genera and 8000 species of green algae are discovered and large numbers is yet to be discovered. *Spirogyra* is well known green algae and has rounded chloroplast. Some algae are reproducing asexually as well as sexually. Algae are has alternation of generation in which gametophyte produce sporophyte and vice versa. Peshawar is very historic and ancient city and capital of Khyber Pakhtunkhwa Province. Peshawar is the gate way to Khyber Pass. The fresh water bodies of Peshawar are much diverse in the algal flora but due to lack of study they are still unexplored. There are no previous records from the sheikh Muhammadi River in the field of algae. So this study will be a milestone for further study in this direction. Some of the algae species might be endemic to this area and must be conserved as the pace of pollution of the water bodies may not destroy them before they are identified and conserved.

MATERIALS AND METHODS

The research includes the study of various species present in different localities of Sheikh Muhammadi area of Peshawar. Study also includes the determination of water quality in which the aforesaid algae existed. 10 prominent location of Sheikh Muhammadi area of District Peshawar were selected for the present study. These areas were Bara Khwar, Abdul Khel, Safon Canal, AkhoonSalaq Baba, Khanan Field, Khyber Field, Sarband, ShahabKhel, Grid Station and

Qazi Abad. Samples of algae and water were collected from the research areas. Four percent Formalin solutions was use for preservation of specimens. Identification of algae was made under microscope. Identification was made with available literature i.e Prescott 1969. Sketches were drawn with the help of Camera Lucida. The specimens were preserved in Department of weed science, The University of Agriculture Peshawar, Khyber Pakhtunkhwa. Physical and chemical properties of water were studied at PCSIR Laboratory Peshawar (Table 2).

RESULTS AND DISCUSSION

Fourteen genera with 23 species of algal flora (Table-1) were identified from the collected samples of Sheikh Muhammadi area Peshawar. The most common genus was *Oedogonium* with 5 species making 34.28 % of the total algal flora identified. The other genera were *Stegeoclonium*, 3 species (14.28%), *Chaetophora,* 2 species (12.85%), *Chladophora,* 2 species (12.85%), *Bulbochaetes,* 2 species (7.14%), *Spirogyra,* 2 species (5.71%), *Characium,* 1 species (5.71%), *Gongrossira,* 1 species (2.85%), *Scendesmus,* 1species (2.85%) the rarely occurring species were *Coleochaete, Chaetopeltis, Apanochaete*, *Centritractus* and *Closteriopsis*with 1 species each (1.42%). The pH of the water at different sites ranged from 6.78-8.12. While the temperature of water ranged from 14^{o}C-17^{o}C and that of air ranged between 23^{o}C– 34^{o}C.

The research area was dominated by the unicellular and green algae. Most of these species were vigorous in the present scenario. All of these Algae are capable for making their organic food substance and also they show their rapid growth in the water. Most of the species are also responsible for the algal bloom and spoil the nature and smell of the water and threat for the aquatic life. There was no exotic species found in the study area, the reported area were dominated by native species.

These findings are supported by the work of Sheath & Steinman (1982) who prepared similar checklist of the freshwater algae from the Northwest Territories of Canada from 44 studies included 279 bodies of water. A large diversity of algae were found in various water bodies from clean water to polluted waters, cold to warm waters, stagnant to fast running waters etc. The collection consisted of 212 genera and 1577 species. The major algal classes represented in the list were Bacillariophyceae (761 taxa), the Chlorophyceae (481 taxa), and the Cyanophyceae (173 taxa). Similarly Khan *et al*., (2011) studied morpho-taxonomic description of 73 fresh water algae belonging to 34 genera, 25families, 17 orders and 09 classes in Kalpani stream and

adjoining area of district Mardan. Among them 65.75% belongs to Chlorophyta and 12.33% belongs to Cyanophyta.

In another study, 138 Chlorophycean species were recorded. Among these 74 species (53.6%) belong to Chlorococcales. 3% belong to Cladophorales and Chaetophorales each. While one species to Sphaeropleales (Ali *et al.*, 2010). Likewise Leghari (2001) worked on some fresh water green filamentous algae from Lakes and Ponds of Sindh and reported 31 species of the Chlorophyta and Chrysophyta from fresh waters and Riverin ponds.

Zarina*et al*. (2010) reported 211species of various types of blue-green algae from unexplored freshwater habitats in Punjab and NWFP of Pakistan and AJK during 1978-2000. Among them, 88 species are recorded for the first time from Pakistan. *Nostocophyceae* with 158 species were found to be more prevalent than other classes like *Chroocophyceae* and *Oscillatoria.*

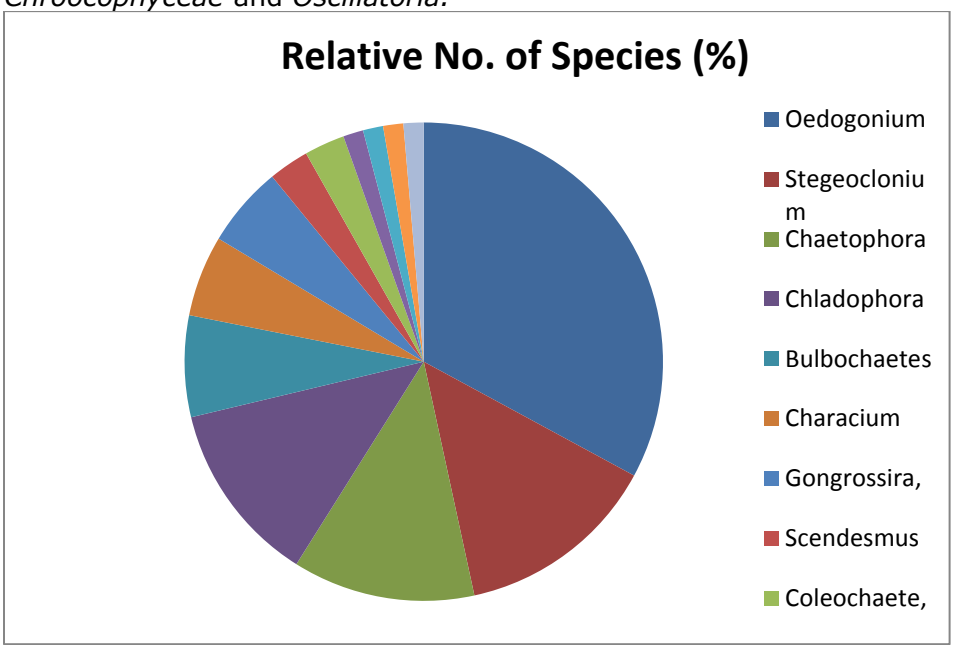

Figure 1. Relative number of the various species occurring in the study area

The species diversity of the different sites of the Project area IN Peshawar was as under:

1. Abdul Khel and Sarband

The genera recorded from various sites of Abdul Khel were:

Oedogonium, Stegeoclonium, Chaetophora, Gongrossira, Scendesmus, Coleochaete, Coleochaete, Chaetopeltis, Closteriopsis, Chladophora, Bulbochaetes, Characium, Apanochaete & *Centritractus.*

The pH of water in Agra Payan is 7.735, conductivity is 699.00 µS/cm, TDS is 447.00 mg/L, TSS is 4.00 mg/L , Total hardness as $CaCO_3$ is 324.00mg/L, Calcium as $CaCO_3$ is 168.00 mg/L, Magnesium as $MgCO_3$ is 156.00 mg/L (greater than normal value 150 mg/L), M-alkalinity as $CaCO_3$ is 308.00mg/L, P-alkalinity as $CaCO_3$ is nil, Chloride as Cl^{-1} is 26.00mg/L, Sulphate as SO_4^{-2} is 180.00 mg/L, sodium as Na^{+1} is 45.00 mg/L, Potassium as K^{+1} Nitrate is 3.50mg/L,NO_2^{1} is nil.

The results are in conformity with the work of Hussain (2010) from other regions of district Peshawar. There was close resemblance in the chemical analysis for water with Rehman (2012) whose study envisaged different localities of Peshawar valley.

2. ShahabKhel and Bara Khwar

The total recorded species of the various sites of ShahabKhel and Barra Khwar are enumerated as under:

Chaetopeltis, Closteriopsis, Stegeoclonium, Chaetophora, Gongrossira, Scendesmus, Centritractus, *Closteriopsis,* and *Gongrossira;* where the pH of water is 7.05, conductivity is 670 µS/cm, TDS is 428 mg/L, TSS is 3 mg/L , Total hardness as $CaCO_3$ is 336 mg/L, Calcium as $CaCO_3$ is 172 mg/L, Magnesium as $MgCO_3$ is 164 mg/L (greater than normal value 150 mg/L), M-alkalinity as $CaCO_3$ is 332 mg/L, P-alkalinity as $CaCO_3$ is nil, Chloride as Cl^{-1} is 40 mg/L, Sulphate as SO_4^{-2} is 146 mg/L, sodium as Na^{+1} is 32 mg/L, Potassium as K^{+1} Nitrate is 4.20 mg/L,NO_2^{-1} is nil.

The results are in agreement with the work of Hussain (2010) from other regions of district Peshawar. There was close resemblance in the chemical analysis for water with Rehman (2012) and Hussain (2010) whose studies pertained to different localities of Peshawar valley.

3. Qaziabad and Khyberi Field

The diversity of species recorded from Qaziabad and Khyberi field were as under:

Gongrossira, Stegeoclonium, Gongrossira, Chaetophora, Centritractus, *Closteriopsis , Chaetopeltis, Closteriopsis,* and*Scendesmus.*

The water pH is 6.78, conductivity is 855 µS/cm, TDS is 548mg/L, TSS is 9 mg/L (greater than the normal value 5.00 mg/L),Total hardness as $CaCO_3$ is 308 mg/L, Calcium as $CaCO_3$ is 184 mg/L, Magnesium as $MgCO_3$ is 124 mg/L, M-alkalinity as $MgCO_3$ is 320 mg/L, Chloride (Cl^{-1}) is 72 mg/L, Sulphate as SO_4^{-2} is 132 mg/L,

sodium as Na^{+1} is 50 mg/L, Potassium as K^{+1} and Nitrate is 14 mg/L when recorded.

4. Siphon Canal and Grid Station

The species identified from various sites of Siphon canal and Sheikh Muhammadi Grid Station included *Chladophora, Chaetophora, Scendesmus, Coleochaete, Coleochaete, ,Chaetopeltis, Closteriopsis, , Bulbochaetes, Gongrossira, Characium, Oedogonium, Stegeoclonium,, Apanochaete* & *Centritractus;* whereas the pH of water is 8.12, conductivity is 1016 µS/cm, TDS is 650 mg/L, TSS is 14 mg/L (greater than the normal value 5.00 mg/L),Total hardness as $CaCO_3$ is 352 mg/L, Calcium as $CaCO_3$ is 192 mg/L, Magnesium as $MgCO_3$ is 160 mg/L (greater than normal value 150 mg/L), M-alkalinity as $CaCO_3$ is 436 mg/L, P-alkalinity as $CaCO_3$ is nil, Chloride as Cl^{-1} is 190 mg/L, Sulphate as SO_4^{-2} is 18 mg/L, sodium as Na^{+1} is 70 mg/L, Potassium as K^{+1} Nitrate is 27 mg/L during the collection of the specimen when recorded.

5. AkhoonSalaq Baba and Khanan Field

The total species identified from various sites of AkhoonSalaq Baba area and Khanan field are presented as under:

Chaetophora, Chladophora, Gongrossira, Scendesmus, Coleochaete, Chaetopeltis, Closteriopsis, Bulbochaetes, Coleochaete and *Characium.* The pH of water is 7.25, conductivity is 681 µS/cm, TDS is 453 mg/L, TSS is 7 mg/L (greater than the normal value 5.00 mg/L),Total hardness as $CaCO_3$ is 319 mg/L, Calcium as $CaCO_3$ is 173 mg/L, Magnesium as $MgCO_3$ is 134 mg/L , M-alkalinity as $CaCO_3$ is 323 mg/L, P-alkalinity as $CaCO_3$ is nil, Chloride as Cl^{-1} is 36 mg/L, Sulphate as SO_4^{-2} is 170 mg/L, sodium as Na^{+1} is 43 mg/L, Potassium as K^{+1} Nitrate is 4.70 mg/L,NO_2^{-1} is nil.

The results are corroborated with the work of Rehman (2012) and Hussain (2010) from other regions of district Peshawar. There was close resemblance in the chemical analysis for water with Hussain (2010) from different localities of Peshawar valley.

Key to the genera

Stigeoclonium (Plate 1)

1. Walls of main axial cells 1.5-2.5-(4)At thick; branching very irregular, with long and tapering, as well as short, arbuscular or rhizoidal branches produced throughout the length of the main axis….*S. pachydermwn*

2. Walls of main axial cells thinner; branching regular, the branches gradually attenuated toward the apices

3. Plants short-tufted; apices of branches not tapering to setae but short-pointed....*S. nanum*

4. Plants not short-tufted; branches elongate, gradually attenuate, … *Stigeocloniumlubricum*

5. Plants mostly prostrate and creeping; filaments with a few short vertical branches….*S*. *polymorphum*
6. Plants mostly erect, branched filaments; horizontal portion of the thallus reduced 2
7. Branching mostly alternate - 3
8. Branching mostly opposite.

Chaetophora (Plate 2)

1. Branches fasciculate toward the outer limits of the thallus; cells 3-6 times the diameter in length.…*C. pisiformis*
2. An elongate, cartilaginous, branching thallus, sometimes short and arbuscular when young or when growing in warm water …*C. incrassata*

Aphanochaete (Plate 3)

1. Cells bearing but 1 seta (rarely 2), 8—10m in diameter…*A. repens*
2. Thalluspseudoparenchymatous, stouter; cells 15-30,a in diameter, forming horizontal, but not downward-growing, filaments ….*G. Debaryana*

Cladophora (Plate 4)

1. Filaments very crooked and bent; cells ovate or pyriform, or irregularly swollen….. *C. fracta*
2. Branching increasing toward the upper portions of the frond to form dense terminal tufts.... *C. glomerata*

Bulbochaete (Plate 5)

1. Oogonia 28-32-(33)ai in diameter…*B. hiloensis*
2. Vegetative cells 15-20,u. in diameter; oospores (37) -44m in diameter ….. *B. pohjandria*

Oedogonium (Plate 6)

1. Pore superior or supramedian 4
2. Pore median or inferior 19
3. Oospore wall layers smooth - 5
4. Oospore wall layers decorated (ribs, spines, scrobiculations)…. (Fig. 2d)…*O. austral*
5. Dwarf male plants present (nannandrous sp.), attached on/near oogonia (rarely scattered). -2
6. Dwarf male plants absent, antheridia in filaments approximately the same size as those bearing oogonia (macrandrous species) 50
7. Oogonia opening by a pore (poriferous) 3
8. Oogonia opening by a lid (operculate) …(Fig. 2a)….*O. Boscii*
9. Oogoniaglobose or subglobose 6
10. Oogoniaobovoid, quadrangular or sexangular-ovoid or ellipsoid 10
11. Vegetative cells 10-20/a in diameter 8
12. Vegetative cells more than 11-20 in diameter 7……(Fig. 2c)….*O. globosum*
13. Dwarf male plants present (nannandrous sp.), attached onoogonia (rarely scattered)- 2

14. Dwarf male plants absent, antheridia in filaments approximately the same size as those bearing oogonia (macrandrous species) 50
15. Pore superior or supramedian 4
16. Pore median or inferior. 19
17. Vegetative cells 10-20/a in diameter 8
18. Vegetative cells more than 20-11 in diameter 7
19. Idioandrosporous; oospores ellipsoid-globose to angular-globose …..*O. idioandrosporum*
20. Gynandrosporous; oospores ellipsoid to globose …. *O. crassiusculum*

Characium (Plate 7)

1. Cells fusiform or slightly crescent-shaped, on a long, needle-like stipe without a holdfast at the base ….*C limneticum*

Scenedesmus (Plate 8)

2. Cells subquadrate, lateral walls of inner cells concave; attached only at the corners …*S. perforatus*

Spirogyra (Plate 9)

1. Spore ellipsoid, 35-44m in diameter …*S. daedaleoides*
2. Median spore wall scrobiculate…*S. scrobiculata*

Centritractus (Plate 10)

Spines as long as the cell body or nearly so; cells cylindrical (cylindric-ovoid when young)……*C. belanophorus*

Coleochaete (Plate 11)

1. Thallus a cushion-like mass of regularly branching filaments radiating from a common center …*C. pulvinata*

Chaetopeltis (Plate 12)

1. Cells smaller, 12-15/x in diameter; thallus a horizontal disc with a regular outline…

The algae have a great economic importance, the local vegetation are seriously affected by the algae due to eutrophication. The algae spoil the lower vegetation which is present in water and specially the ponds of research area.

CONCLUSION

Study and research on algae in the water bodies of Peshawar is the most ignored area of aquatic botany. Although Peshawar has many rivers, lakes and other fresh water bodies where algae exists in abundance. This study investigated the algae of Sheikh Muhammadi area of District Peshawar and found a total of 22 algal species belonging to 10 families in which Oedogoniaceae was the dominant family with 5 species followed by *Stegeoclonium* (3 spp.). These un-noticeable aquatic plants might have medicinal, food or feed values but need proper investigation. Similarly some of them are noxious

weeds of water bodies. Hence further studies are suggested to be undertaken in this regard.

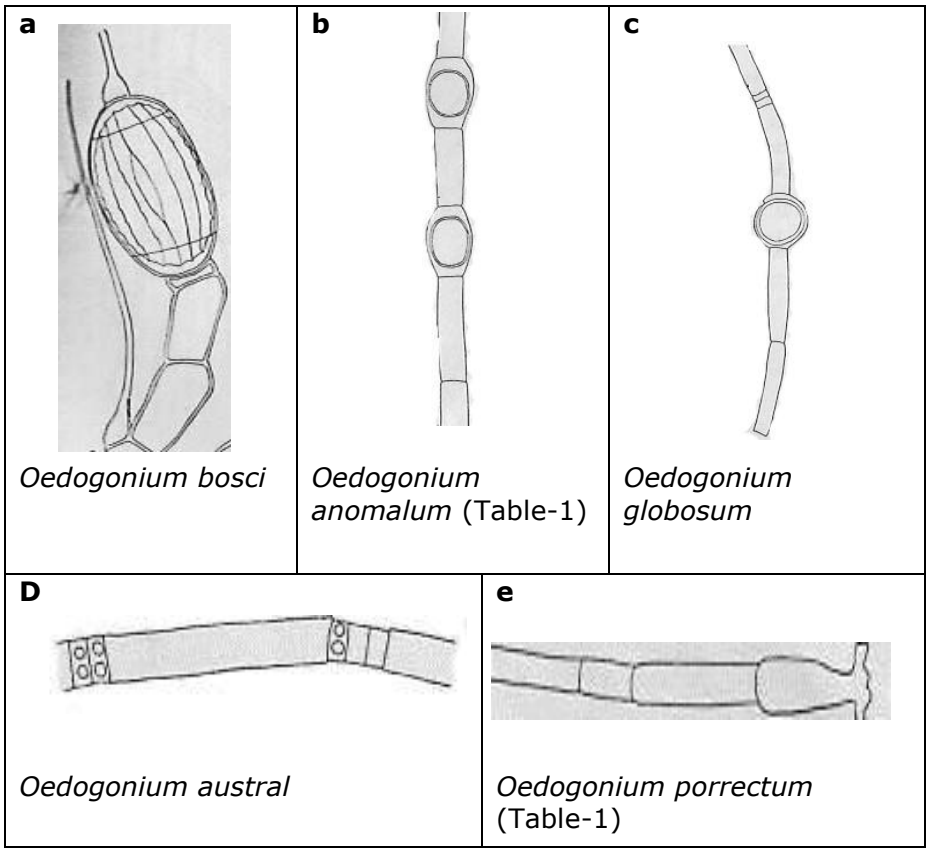

Figure 2. Images of the most algal species found most abundantly in the study area.

Table-1. List of species showing relative distribution among different sites of Sheikh Muhammadi district Peshawar

S.NO.	**General**	Bara Khwar, Abdul Khel	Safon Canal, AkhoonSalaq	Khanan, Khyber Field	Sarband, ShahabKhel	Grid Station, Qazi Abad
1	*Charcium limneticum*	+	+	+	+	+
2	*Aphanochate repens*	+	+	+	+	+
3	*Bulbochaete hilonesis*	+	+	-	+	+
4	*Bulbochaete poltjandria*	+	+	-	-	-
5	*Centritractus belanophorus*	-	-	+	+	+
6	*Chaetopeltis orbicularis*	-	-	-	-	-
7	*Chaetophora incrassate*	+	-	-	-	-
8	*Chaetophora pisiformis*	+	+	_	+	+
9	*Cladophora fracta*	-	+	_	_	+
10	*Cladophora glomerata*	_	_	+	+	_
11	*Cloteriopsis longissima*	+	-	+	-	_
12	*Coleochaete pulvinata*	-	-	-	+	+
13	*Gongrosirde baryana*	-	-	-	-	_
14	*Odogonium anomalum*	+	+	-	-	+
15	*Odogonium austral*	+	+	+	+	+
16	*Odogonium globosum*	+	+	+	-	-
17	*Odogonium porrectum*	+	+	+	-	-
18	*Scenedesmus perforatus*	-	-	-	+	+
19	*Spirogyra daedaleoides*	-	+	-	+	+
20	*Stigeoclonium lubricum*	+	+	-	-	+
21	*Stigeoclonium suhsecundum*	-	-	+	-	+
22	*Stigeoclonium pachydermum*	+	+	+	+	+

Table-2. Chemical analysis of water samples taken from various algal water bodies.

Parameters	Method no.	Units	Collection Sites						WHO limits for drinking water
			1	2	3	4	5	6	
Ph	4500-H+.B	-	7.835	7.35	6.28	8.14	7.52	7.75	6.5-9.20
Conductivity	2510.B	µS/cm	699.00	670.00	855.00	1016.00	681.00	695.00	-
Total dissolved solids (TDS)	2540.C	mg/L	447.23	428.24	548.23	650.24	453.25	441.23	1000.00
Total suspended solids (TSS)	2540.D	mg/L	4.01	3.02	9.01	14.11	7.02	5.01	5.00
Total Hardness as $CaCO_3$	2340.C	mg/L	322.01	333.02	318.01	349.03	318.01	319.01	499.00
Calcium as $CaCO_3$	3500-Ca.B	mg/L	170.00	177.00	187.00	190.00	172.00	164.00	248.00
Magnesium as $CaCO_3$	3500-Mg.B	mg/L	154.00	162.00	120.00	155.00	129.00	139.00	150.00
M-alkalinity as $CaCO_3$	2320.B	mg/L	310.00	318.00	310.00	420.00	315.00	300.00	500.00
P-alkalinity as$CaCO_3$	2320.B	mg/L	-	-	-	-	-	-	30.00
Chloride as Cl^{-1}	4500-Cl.B	mg/L	26.00	40.00	72.00	190.00	36.00	24.00	250.00
Sulphates as SO_4^{-2}	329	mg/L	180.00	146.00	132.00	18.00	170.00	164.00	250.00
Sodium as Na^{+1}	3500-Na	mg/L	45.00	32.00	50.00	70.00	43.00	40.00	200.00
Potassium as k^{+1}	3500-K	mg/L	3.50	4.20	14.60	27.00	4.70	3.30	75.00
Nitrates as NO_2^{-1}	4500-NO_2^{-1}.B	mg/L	-	-	-	-	-	-	.10

Table-3. Composition and analysis of the soil samples taken from the various algal water bodies

S. No	Minor Elements			Textural Class	Organic Matter Contents	Calcium Carbonate	Major Elements in ppm			EC in mS/cm	pH
	Clay (%)	Silt (%)	Sand (%)				Nitrogen (N)	Phosphorus (P)	Potassium (K)		
1	4.30	23.1	57.11	Sandy Loam	0.13	18.40	0.006	7.81	125	0.11	7.6
2	9.61	13.1	74.38	Loamy Sand	0.19	14.0	0.013	9.20	116	0.31	8.0
3	2.77	5.1	81.30	Sand	0.11	10.0	0.016	9.30	130	0.11	8.10
4	19.7	17.0	53.41	Sandy Loam	1.21	10.73	0.055	12.31	188	0.16	8.0

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