

Original Research Article

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Occurrence and Abundance of Cyanobacterial Strains and Physico-chemical Properties of Water Bodies

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ABSTRACT

Keywords

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The current work was involved in the occurrence and abundance of the cyanobacteria strains present in the predominant water outlets present in the city Prayagraj, for analysing the types of strains found during the different seasonal interims. The cyanobacteria distribution in water from water samples are collected from above mentioned locations during the January, May and September months in the year of 2013 and 2014. The cyanobacteria population in the vicinity was analyzed using the physico-chemical factors like pH, temperature, electrical conductivity, total phosphorus, inorganic phosphorus, ammoniacal nitrogen, nitrate, nitrite, iron, zinc, Manganese, Copper and arsenic and algal flora (qualitative) were also studied and compared their variations among the three different freshwater bodies. In addition, biological parameters such as primary production gross primary productivity, net primary productivity and community respiration rate were also studied. Total 11 species of cyanobacteria were isolated. It was observed that the distributional patterns of the cyanobacteria were related with that of the physico-chemical parameters of the water sample. Since there was no significant difference in the parameters of the sampling sites, a few cyanobacterial strains were found to be dominating, followed by co-dominating and peripheral species which were found to be common in all the sampling sites. This ultimately shows that there is no significant change in the distribution of the cyanobacterial strains in the current area of study under the same equatorial region.

Introduction

Cyanobacteria also known as the blue-green algae, Cyanoprokaryotes, Cyanophytes are an ancient group of photosynthetic microorganisms which occur in aquatic bodies and that can have major effects on the water quality and functioning of aquatic ecosystems. They include about 2000 species in 150 genera, with a wide range of shapes and sizes. Cyanobacteria have a variety of cell

types, cellular structures, and physiological strategies that contribute to their ecological success in the plankton, metaphyton, or periphyton. Cyanobacteria are aquatic and photosynthetic prokaryotes, which possess mainly chlorophyll-*a*. Cyanobacteria are of special interest to water quality managers because many produce taste and odour compounds, several types of toxins, and noxious blooms. Ecologically, the three most important groups of cyanobacteria found in

inland waters are mat-formers, which form polysaccharide-rich crusts, films, and thicker layers over rocks, sediments, and plants; bloom-formers, which occur in eutrophic lakes and cause food web disruption as well as produce toxins and surface scums; and picocyanobacteria, minute species that are often the main photosynthetic cell type in oligotrophic (nutrient-poor) lakes and their microbial food webs. Considering the economic importance of cyanobacteria is very large in both negative and positive senses. In negative side, many cyanobacterial strains appear to be toxic blooms, cause harmful significance to livestock and human life. In contrast, cyanobacteria are also having an increasingly positive economic importance, forming the basis of new food industries and their widely use as biofertilizers in agriculture. Cyanobacteria produce secondary metabolites with diverse chemical structures and biological activities of industrial and pharmaceutical interest. The secondary metabolites of cyanobacteria are produced during the life cycle. Many of the industrially important antibiotics and secondary metabolites produced by different species have been well studied; therefore by isolating cyanobacteria from an environment such as nearby river Yamina of Prayagraj district have the potential of discovering novel secondary metabolites of industrial significance is increased. Cyanobacteria play an important role in the rhizosphere region where they influence plant growth and protect plant roots against invasion by pathogenic fungi. Cyanobacterial populations are reported to inhabit diverse aquatic environments like nutrient rich lakes, rivers ponds and others water sources. The vulnerability of cyanobacteria to environmental impact and their possible depletion or extinction like other microalgae necessitated the understanding of the distribution of cyanobacterial population in selected aquatic bodies which are important to

economic, recreational and religious activity of people. It was also considered important to characterize cyanobacterial population in relation to physico-chemical parameters of water bodies.

Materials and Methods

Water samples are collected from above mentioned locations during the January, May and September months. The collected water samples from each aquatic site were subjected to physico-chemical analysis and also used for the isolation of cyanobacterial strains. Three aquatic sampling sites were identified for the collection of water samples. These aquatic bodies are located around Prayagraj district of Uttar Pradesh. Mainly the sampling sites are located nearby the SHUATS, campus (Table 1).

Results and Discussion

Physico-chemical analysis of water samples

Data presented in table 3 and figure 1 show that the value of pH in 2013 and in year 2014 is ranges between 6.9 to 8.3 and 6.96 to 8.23 respectively and found suitable for the growth of the blue green algae in the all sampling sites. Perusal of data also revealed that the pH exhibited positive and highly significant variation at different sites in year 2013 and 2014. The maximum pH value was recorded at siteS2 followed by siteS1 and site S6 whereas minimum value was found at siteS5 in the both year (Table 2).

Electrical conductivity (EC) (dS/m)

It is a measure of material's ability to conduct electric current through it or in case of an aquatic sample, electrical conductivity means the total amount of solids dissolved in water which is also called as TDS (Total Dissolved Solids). Data presented in table 4 and figure 2

shows that the value of EC in 2013 and in year 2014 is ranges between 0.34to0.70 and 0.35 to 0.683 respectively and found suitable for the growth of the blue green algae in the all sampling sites. Perusal of data also revealed that the EC exhibited positive and

highly significant variation at different sites in year 2013 and 2014. The maximum EC value was recorded at siteS1 followed by siteS2and site S5 whereas minimum value was found at siteS6 in the both year.

Table.1 Methodology used for the parameters studied in water samples

Parameters	Methods for determination	References
pH	pH meter	APHA, 2005
Electrical Conductivity	Conductivity meter	APHA,2005
Nitrogen as Ammonia (NH ₃)	Nesslerization method	APHA, 2005
Nitrogen as Nitrites(NO ₂)	Spectrophotometer	APHA, 2005
Phosphorus(PO ₄)	Stannous chloride method	APHA, 2000
Heavy metals	AAS	Burell,1975;Slavin,1968

Table.2 Occurrence and abundance of cyanobacterial strains with physico-chemical properties of water bodies

Species	pH	EC	NO ₂	NH ₃	PO ₄
<i>Chalmydomonas</i>	0.09	-0.42	0.07	0.29	-0.31
<i>Chlorella</i>	0.35	0.79	0.56	0.43	0.69
<i>Volvox</i>	0.72	0.61	0.45	0.45	0.5
<i>Nostoc</i>	-0.08	0.16	-0.14	-0.17	0.29
<i>Spirogyra</i>	0.17	0.001	-0.29	-0.2	0.14
<i>Microcystis</i>	0.03	0.08	0.07	-0.05	-0.06
<i>Anabaena</i>	-0.1	-0.21	-0.41	-0.34	-0.02
<i>Oedogonium</i>	-0.16	-0.33	-0.57	-0.44	-0.18
<i>Ulothrix</i>	-0.22	0.15	-0.37	-0.44	-0.11
<i>Anabaena fertilissima</i>	-0.71	-0.49	-0.26	-0.45	-0.53
<i>Phormidium</i>	0.02	-0.54	-0.14	0.11	-0.47

Table.3 pH value of water samples collected from different study sites

Sampling Site	pH value 2013	pH value 2014
Old Yamuna Bridge (Yamuna)	7.3	7.2
Saraswati Ghat (Yamuna)	8.3	8.2
College of Forestry (SHUATS)	7.3	7.3
Naini Agriculture Institute (SHUATS)	7.3	7.2
University Central Canteen) (SHUATS)	6.9	6.9
Girls Hostel campus (SHUATS)	7.3	7.2
C.D.	0.29	0.37
SE(m)	0.09	0.11
SE(d)	0.13	0.16

Table.4 EC (dS/m) value of water samples collected from different study sites

Sampling Site	EC(dS/m) value 2013	EC (dS/m)value 2014
Old Yamuna Bridge (Yamuna)	0.700	0.683
Saraswati Ghat (Yamuna)	0.580	0.603
College of Forestry (SHUATS)	0.390	0.423
Naini Agriculture Institute (SHUATS)	0.420	0.427
University Central Canteen) (SHUATS)	0.470	0.450
Girls Hostel campus (SHUATS)	0.340	0.350
C.D.	0.053	0.069
SE(m)	0.016	0.021
SE(d)	0.023	0.030

Table.5 Availability of Nitrogen as Ammonia (ppm/L) in different water sample from different sites

Sampling Site	2013	2014
Old Yamuna Bridge (Yamuna) S ₁	39.200	39.267
Saraswati Ghat (Yamuna) S ₂	28.400	27.300
College of Forestry (SHUATS) S ₃	5.400	6.900
Naini Agriculture Institute (SHUATS) S ₄	2.100	3.367
University Central Canteen) (SHUATS) S ₅	1.800	2.567
Girls Hostel campus (SHUATS) S ₆	19.400	18.333
C.D.	1.730	3.239
SE(m)	0.542	1.015
SE(d)	0.766	1.435

Table.6 Availability of Nitrogen as Nitrites (NO₂) in different water sample

Sampling Site	Available N (mg/L) 2013	Available N (mg/L) 2014
Old Yamuna Bridge (Yamuna) S ₁	5.700	5.433
Saraswati Ghat (Yamuna) S ₂	3.500	3.567
College of Forestry (SHUATS) S ₃	0.100	0.133
Naini Agriculture Institute (SHUATS) S ₄	0.300	0.343
University Central Canteen) (SHUATS) S ₅	0.800	0.797
Girls Hostel campus (SHUATS) S ₆	1.300	2.033
C.D.	0.429	0.751
SE(m)	0.134	0.235
SE(d)	0.190	0.333

Table.7 Availability of Phosphorus as Phosphate (mg/L) in different water sample

Sampling sites	2013	2014	Pooled
Old Yamuna Bridge (Yamuna)	0.38	0.42	0.40
Saraswati Ghat (Yamuna)	0.42	0.49	0.455
College of Forestry (SHUATS)	0.17	0.20	0.185
Naini Agriculture Institute (SHUATS)	0.10	0.17	0.135
University Central Canteen (SHUATS)	0.02	0.09	0.55
Girls Hostel campus (SHUATS)	1.40	1.42	1.41

Table.8 Availability of Heavy metals in different water sample

Sampling sites	Iron (Fe) (mg/l)			Copper (Cu) (mg/l)			Manganese (Mn) (mg/l)			Arsenic (As) (mg/l)			Zinc (Zn) (mg/l)	
	2013	2014	Pool	2013	2014	Pool	2013	2014	Pool	2013	2014	Pool	2013	2014
S ₁ (River)	1.0	1.6	1.3	0.7	0.3	0.5	0.02	0.06	0.04	0.01	0.01	0.01	-	-
S ₂ (S.Ghat)	0.19	0.13	0.16	0.2	0.0	0.1	0.01	0.05	0.03	0.0	0.0	-	-	-
S ₃ (C.F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S ₄ (H.Field)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S ₅ (Canteen)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S ₆ (G.H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Fig.1 pH of water samples collected from different selection sites

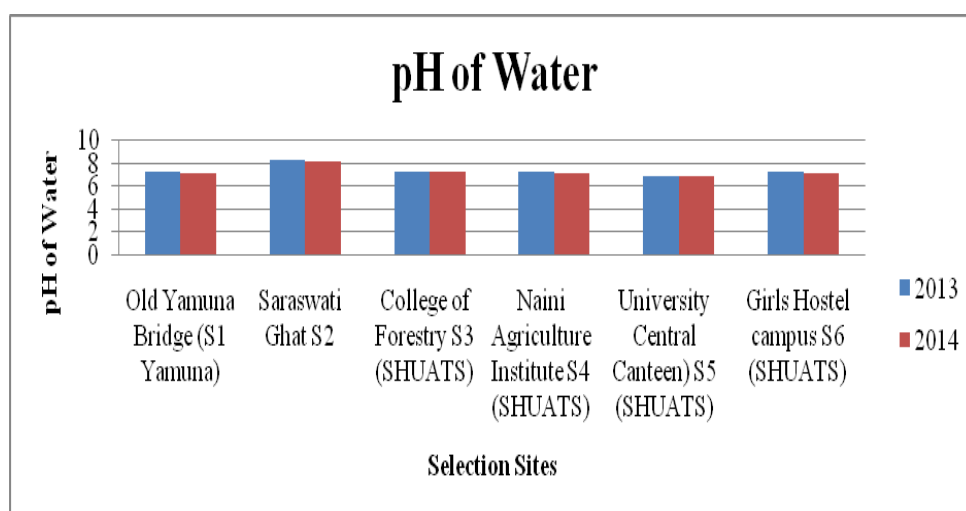


Fig.2 Level of electrical conductivity (dS/m) in different water samples

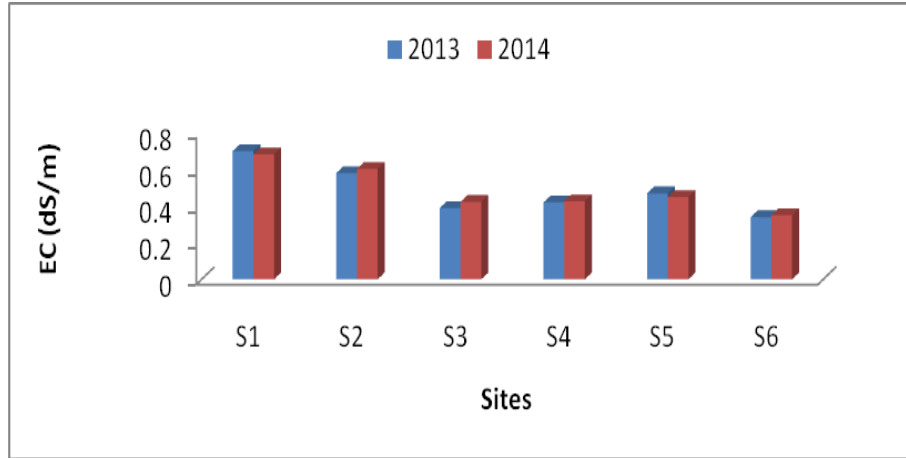


Fig.3 Availability of Nitrogen as Ammonia (ppm/L) in different water sample

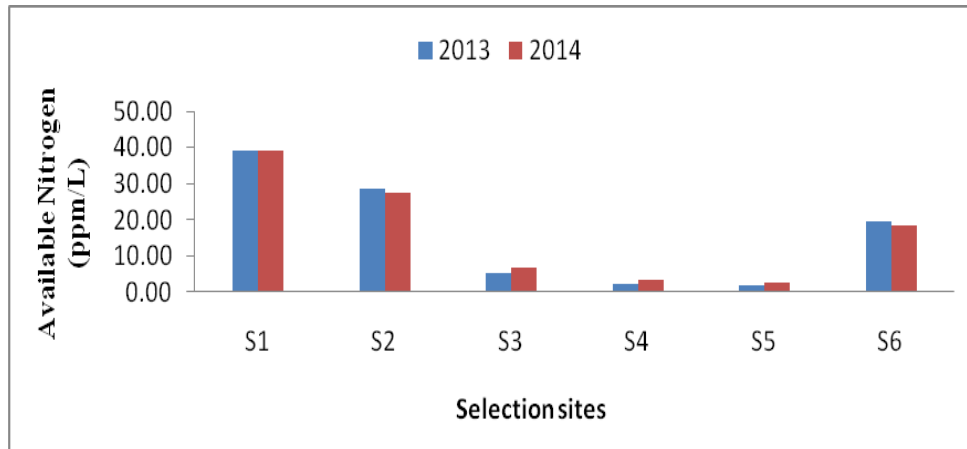


Fig.4 Availability of Nitrogen as Nitrate (NO₂) in different water sample

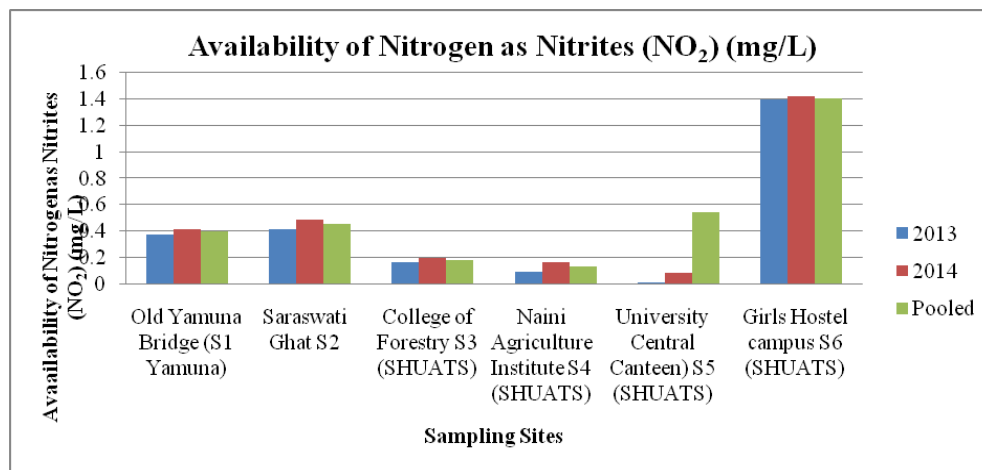


Fig.5 Availability of Phosphorus as Phosphate (mg/l) in different water sample

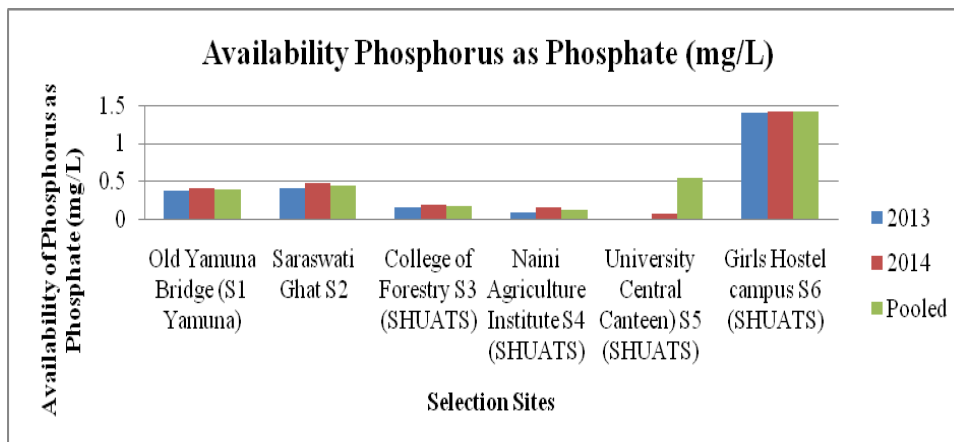
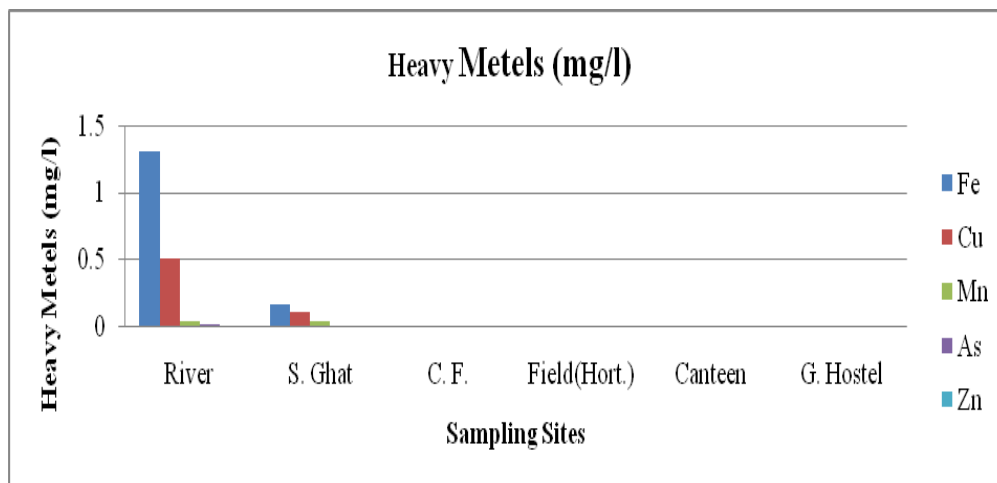


Fig.6 Level of Heavy metels (mg/l) in different water sample



Availability of Nitrogen as Ammonia (ppm/L)

Data presented in table 5 and figure 3 shows that the value of Ammonia in 2013 and in year 2014 is ranges between 1.8 to 39.2 and 2.56 to 39.26 respectively. Perusal of data also revealed that the Ammonium in exhibited positive and highly significant variation at different sampling sites in year 2013 and 2014. The maximum Ammonium in value was recorded at siteS1 followed by siteS2 and site S6 whereas minimum value was found at siteS5 in the both year.

Nitrogen as Nitrites (NO₂) (mg/l)at different sites

Data presented in table 6 and figure 4 shows that the value of NO₂ in the year 2013 and in year 2014 is ranges between 0.1 to 5.7 and 0.133 to 5.433 respectively. Perusal of data also revealed that the NO₂ in exhibited positive and highly significant variation at different sampling sites in year 2013 and 2014. The maximum NO₂ in value was recorded at siteS1 followed by siteS2 and site S6 whereas minimum value was found at siteS3 in the both year.

Data presented in table and figure shows that the value of NO₂ in the year 2013 and in year 2014 is ranges between 0.1 to 5.7 and 0.133 to 5.433 respectively. Perusal of data also revealed that the NO₂ in exhibited positive and highly significant variation at different sampling sites in year 2013 and 2014. The maximum NO₂ in value was recorded at siteS1 followed by siteS2 and site S6 whereas minimum value was found at siteS3 in the both year.

Available Phosphorus (mg/L) –

Olsen colorimetric method (Olsen *et al.*, 1954).According to Landon(1991), soils with Olsen phosphorus of less than 5 ppm are low, 5 -15 ppm P is medium and more than 15 ppm are high in available phosphorus. The values of available P may be high in agricultural land due to the application of P fertilizer sources for a long time in vicinity of woodlands. Richards *et al.*, (1995) and Juo *et al.*, (1996) have also reported that application of P fertilizer would increase the available phosphorus forms. Data presented in table 7 and figure 5 shows that value of available phosphorus is ranges between 1.40 to 0.02 and 1.42 to 0.09 in 2013 2014 respectively and pool data varies from 1.41 to 0.40 and it is favourable for the growth of the blue green algae for all sampling sites. Perusal of data also revealed that the available phosphorus exhibited highly significant variation at different sites in year 2013 and 2014. The maximum available phosphorus was recorded at site 6 followed by site 2 and site1 (1) whereas minimum value was found at site 4.

Heavy metal (mg/l) analysis

Heavy metals such as Fe, Cu, Mn, As and Zn were determined by using AAS (Atomic Absorption Spectrophotometer) using standard reagents in mg/l. Heavy metals cause adverse effects in the living organisms mainly

Pb, Cu, Cd, As. The heavy metals could not be detected in a sufficient amount in the samples that were located in the college campus, which could be measured in units i.e. they were found rarely in this area. The range of copper was found to be higher than the limits because it may cause adverse effect on consumption so, not suitable for drinking and domestic purposes. Arsenic was found in quite less quantity than the given permissible limit, so adverse effects are not expected (Table 8).

In conclusion the present study, it was observed that there was no significant variation in the occurrence and distribution of cyanobacteria and it was correlated with the physico-chemical parameters of water bodies. According to the ecobiological analysis revealed many dominant, co-dominant and ephemeral species from all the sample sites. The biological parameters showed that were was a site variation in the gross productivity compared to net productivity and community respiration rate in all the sampling sites.

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