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# Studies on cyanobacterial population in industrial effluents

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**Abstract**

Cyanobacterial populations from three different industrial effluents such as chemical, distillery and oil refinery have been isolated and identified .Their diversity has been correlated with physico-chemical characteristics of the effluents. Altogether 63 species of cyanobacteria were recorded from these effluents. Among the effluents, distilleries contained the maximum number species (63) followed by chemical (52) and oil refinery (43). Except oil refinery effluent, others recorded heterocystous cyanobacteria. Totally 34 common species were observed in all the effluents. Of them,*Oscillateria* with 14 species was the dominant genus followed by *Lyngbya* (7), *Phormidium* 6, *Chroococcus* ,*Aphanocapsa, Aphanotheca, Synechocystis* and *Plectonema* with single species each. The results of this study reveals that higher amount of phosphates and nitrates, with sufficient amount of oxidizable organic matter and limited DO contents played a vital role in their distributional pattern .

Key words: Cyanobacteria, chemical effluents, distillery, oil refinary effluent.

## Introduction

Cyanobacteria, also known as blue green algae, are colonizing microorganisms that are found throughout the world. These organisms are remarkably well adapted to a wide range of environmental conditions. They are oxygenic photosynthetic and some of them are able to fix atmospheric nitrogen. Ecologists started giving them importance as primary producers and realized that without them no animal population exists. Cyanobacteria are by far the largest group of photosynthetic prokaryotes as judged by their widespread occurrence, frequency, abundance and morphological diversity.

During the recent past, studies on cyanobacteria have emphasized their important role in ecosystem. They grow at any place and in any environment where moisture and sunlight are available. However, specific algae grow in specific environment and therefore their distributional pattern, ecology, periodicity, qualitative and quantitative occurrence differs widely.

The abundance and composition of blue green algal population in surface waters of ponds and lakes have been discussed by many workers (Ganapati, 1940; Philipose, 1960; Vijayakumar *et al*., 2005; Muthukumar et *al*., 2007). Many reports are also available on the occurrence of algae in polluted waters (Palmer, 1969; Tarar *et al.*, 1990; Vijayakumar *et al*., 2007; Boominathan *et al*., 2007). However, their diversity in industrial effluents has not been studied thoroughly. Physico-chemical characteristics of industrial effluents varied from each other. A thorough knowledge of the physical, chemical and biological characteristics of an industrial waste is a preliminary and essential requirement for the treatment of effluent. Hence, the present investigation is focused on the physic-chemical characteristics of the effluents and their influence on the diversity of cyanobacterial populations

## .Materials and methods

For the present study, samples (both effluents and cyanobacteria) were collected from three different industrial effluents such as Chemical Industry, Mannargudi, Tamil Nadu, India; Distillery Industry, Tricky, Tamil Nadu,India and Oil refinery Ariyalure, Tamil Nadu, India. Effluents samples and cyanobacteria were collected in large sterilized containers and polythene bags respectively.

Physico-chemical characteristics of waste waters were carried out according to standard methods (APHA, 2000). Standard microbiological methods were followed for the isolation of cyanobacteria. Algal samples were microscopically examined and plated on solid agar medium. The inoculated plates were incubated in culture room maintained at 25+ 2 c fitted with cool white fluorescent tube emitting 2500 lux for 18 hrs a day. Cyanobacteria were identified using the standard manuals of Geitler (1932), Desikachary (1959), and Anand (1998) and subculture in BG11 medium (Rippka *et al*., 1979) under the above said culture conditions.

**Results and Discussion**

A total of 63 species of cyanobacteria was recorded in three different effluents (Table 2). Of the effluents studied, distilleries recorded the maximum number of species (63) followed by chemical (52) and oil refinery (43). In total 34 species of cyanobacteria were recorded in common to all the effluents analysed. Of them *Oscillatoria* with 14 species was the dominant genus, which was followed by *Lyngbya* (7), *Phormidium* (6), *Chroococcus, Aphanocapsa, Apanotheca, Synechocystis* and *Plectonema* with single species each. Among the effluents, heterocystous forms were identified in distilleries and chemical but not in oil refinery effluent. Heterocystous cyanobacteria such as *Anabaena fertilisima , Nostoc paludosum* and *N. microscopium* were recorded in distilleries and chemicals, on the other hand distilleries effluent recorded only *Nostoc communae* .

Heterocystous cyanobacteria have not been recorded in polluted water rich in nitrogen (Boominathan, 2005, and Kasthuri, 2008). However, Vijayakumar *et al* (2005) and Kannan (2008) reported that heterocystous cyanobacterium was identified from dye and coirpith effluents. Vijayakumar *et al* (2007) and Boominathan (2007) reported that *Oscillatoria* and *Phormidium* have been found to be very tolerant to pollution which frequently inhabits the dye and dairy effluent respectively. Present study also confirmed their observations as *Oscillatoria,* and *Lyngbya* along with *Phormidium* were found dominating all the effluents studied (Table 2).) Palmer (1980) and Senthil (2011) emphasized use of algae as reliable indicator species observed in different effluents, *O.* willie and *P. laminosum* were found more than 75 per cent representation n all the effluents and thus considered as the indicators of the effluents analysed. Their findings were supported by Vijayakumar et al. (2007). Who reported that their higher representation indicate their capacity to thrive in this type of manmade habitat.

The abundance of cyanobacteria is attributed to favorable contents of nutrients. The physic-chemical parameters are given in Table 1. pH is one of the important parameters as it plays an important role in the acid-base neutralization and water softening. Maximum pH was observed in distilleries in summer and minimum in oil refinery effluent in winter. This is in coincidence with the report of Milind (2008). The present data in all the three effluents showed that calcium is possibly one of the factors (Table 1). Whether it plays its role individually or in combination with other factor complexes can only be understood by culture studies. Besides calcium, high amounts of oxidizable organic matter, traces of dissolved oxygen, considerable amounts of nitrate and phosphates in all the effluents investigated were probably the factors favoring the growth of cyanobacteria as suggested by Rai and Kumar (1977), Venu et al. (1984), Anand (1998), Boominathan (2005), Murugesan (2005), Vijayakumar et al.(2007) and Gomathi (2011). Palmer (1969), Singh et al., (1969) and Nazneen (1980) reported that high values of BOD, COD, phosphates and nitrates with very low DO favoured the growth of cyanobacteria. Their findings were supported by the observations of Boominathan (2005), Vijayakumar et al. (2007), Sanjay et al. (2011) and Gomathi (2011). Palmer (1969), Singh (1969) and Nazneen (1980) reported that high values of BOD, COD, phosphates and nitrates with very low DO favored the growth of cyanobacteria. Their findings were supported by the observations of Boominathan (2007), Vijayakumar et al. (2007), Gopalakrishnan (2008 in dairy, dye and sugar industry effluents respectively. In the present study also, all the effluents showed a considerable amounts of nitrates and phosphates, with increased level of BOD and COD along with very low DO level. This could be reason for the flourishing growth of cyanobacteria in the effluents investigated. From the above discussion, it is concluded that the physico-chemical parameters along with diversity of cyanobacteria, will be used in future to continuous monitoring of the sewage pollution and changing status of this freshwater environment.

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**Table 1. Characteristics of industrial effluents**

| Sl.No. | Parameters | Various industrial effluents | | |
|---|---|---|---|---|
| | | Chemical | Distilleries | Oil refinery |
| 1. | Colour | Yellowish brown | Dark brown | Blackish brown |
| 2. | pH | 6.8 | 7.6 | 6.2 |
| 3. | Temperature | 38◦c | 29◦c | 30◦c |
| 4. | Free CO2 | Nil | 100 | 100 |
| 5. | Carbonate | 90 | Nil | Nil |
| 6. | Bicarbonate | 380 | 158 | 280 |
| 7. | BOD | 190 | 327 | 267 |
| 8. | COD | 672 | 232 | 436 |
| 9. | DO | 1.86 | 1.2 | 1.4 |
| 10. | Nitrate | 296 | 583 | 340 |
| 11. | Nitrate | 70 | 115 | 126 |
| 12. | Ammonia | 332 | 423 | 386 |
| 13. | Total phosphorus | 51 | 59 | 64 |
| 14. | Inorganic phosphate | 22 | 36 | 31 |
| 15. | Organic phosphate | 29 | 23 | 33 |
| 16. | Calcium | 130.0 | 84.10 | 96.2 |
| 17. | Magnesium | 98.0 | 62.36 | 74.32 |
| 18. | Chloride | 259.9 | 179.9 | 369.9 |

Except pH, temperature all other parameters are in $mgl^{-1}$.

**Table 2. Cyanobacterial flora of various industrial effluents**

| Sl.no | Name of the organism | Various industrial effluents | | | | | |
|---|---|---|---|---|---|---|---|
| | | Chemical | % | Distilleries | % | Oil refinery | % |
| *1.* | *Chroococcus micrococcus* | | 0 | + | 41 | + | 41 |
| *2.* | *C.minor* | + | 8 | + | - | + | 33 |
| *3.* | *Myxosarcina spectabillis* | + | 16 | + | 8 | - | 0 |
| *4.* | *Microcystis aeroginosa* | + | 75 | + | 25 | - | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *5.* | *M.flos aquae* | + | 66 | + | 16 | + | 8 |
| *6.* | *M. viridis* | + | 50 | + | 8 | - | 0 |
| *7.* | *Aphanotheca pallid* | + | 66 | + | 41 | + | 16 |
| *8.* | *Aphanotheca pallid* | + | 58 | + | 58 | + | 25 |
| *9.* | *Synechocystis aquatilis* | - | 0 | + | 75 | + | 41 |
| *10.* | *S.pevaleki* | + | 16 | + | 66 | + | 33 |
| *11.* | *Synechococcus elongatus* | + | 66 | + | 50 | - | 0 |
| *12.* | *Oscillatoria acuminata* | + | 100 | + | 33 | + | 75 |
| *13.* | *O. acuta* | + | 41 | + | 16 | - | 0 |
| *14.* | *O. animalis* | - | 0 | + | 8 | + | 66 |
| *15.* | *O. brevis* | + | 50 | + | 41 | + | 50 |
| *16.* | *O.chalybea* | + | 16 | + | 25 | - | 0 |
| *17.* | *O. corallinae* | + | 25 | + | 33 | + | 66 |
| *18.* | *O. cortiana* | + | 8 | + | 75 | + | 50 |
| *19.* | *O. curviceps* | + | 33 | + | 100 | + | 75 |
| *20.* | *O. earlei* | + | 41 | + | 100 | + | 91 |
| *21.* | *O. late-virens* | + | 66 | + | 91 | + | 75 |
| *22.* | *O. limosa* | + | 50 | + | 50 | + | 0 |
| *23.* | *O. okeni* | - | 0 | + | 25 | + | 41 |
| *24.* | *O. perornata* | + | 8 | + | 9 | + | 50 |
| *25.* | *O. proboscidea* | - | 0 | + | 49 | - | 0 |
| *26.* | *O. priniceps* | + | 58 | + | 25 | + | 41 |
| *27.* | *O. pseudogeminata* | + | 100 | + | 33 | + | 33 |
| *28.* | *O. rubescens* | - | 0 | + | 25 | + | 25 |
| *29.* | *O. salinia* | + | 33 | + | 41 | + | 66 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *30.* | *O. splendid* | + | 25 | + | 8 | + | 33 |
| *31.* | *O. subbrevis* | + | 41 | + | 6 | - | 0 |
| *32.* | *O. tereberiformis* | + | 50 | + | 75 | + | 25 |
| *33.* | *O. tenuis* | + | 75 | + | 8 | + | 16 |
| *34.* | *O. willei* | + | 100 | + | 91 | + | 75 |
| *35.* | *Phormidium anomala* | + | 91 | + | 75 | + | 0 |
| *36.* | *Ph. ambigum* | + | 66 | + | 25 | + | 50 |
| *37.* | *Ph. bohneri* | - | 0 | + | 33 | - | 0 |
| *38.* | *Ph. calcicola* | + | 25 | + | 16 | + | 66 |
| *39.* | *Ph. corium* | + | 33 | + | 100 | + | 50 |
| *40.* | *Ph. incrustatum* | + | 50 | + | 66 | + | 66 |
| *41.* | *Ph. laminosum* | + | 91 | + | 75 | + | 91 |
| *42.* | *Ph. fragile* | + | 16 | + | 33 | + | 100 |
| *43.* | *Ph. pachydermaticum* | - | 0 | + | 8 | - | 0 |
| *44.* | *Ph. mucosum* | + | 8 | + | 41 | + | 16 |
| *45.* | *Ph. tenue* | + | 16 | + | 75 | + | 8 |
| *46.* | *Ph. unicinatum* | - | 0 | + | 25 | + | 25 |
| *47.* | *Ph. subincrustatum* | + | 8 | + | 16 | - | 0 |
| 48. | *Lyngbya aeroginosa* | + | 25 | + | 25 | + | 33 |
| 49. | *L. confervoides* | + | 75 | + | 08 | + | 41 |
| 50. | *L. connenctans* | + | 58 | + | 75 | + | 50 |
| 51. | *L. digueti* | + | 66 | + | 33 | + | 66 |
| 52. | *L. infixa* | + | 25 | + | 41 | + | 33 |
| 53. | *L. majuscula* | + | 33 | + | 50 | - | 0 |
| 54. | *L. martensiana* | + | 66 | + | 66 | - | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 55. | *L. polysiphonia* | + | 41 | + | 75 | + | 75 |
| 56.. | *L. spiralis* | + | 100 | + | 33 | - | 0 |
| 57. | *L. trunicola* | + | 33 | + | 25 | + | 100 |
| 58. | *Plectonema wolli* | + | 25 | + | 50 | - | 0 |
| 59. | *P. radiosum* | + | 50 | + | 41 | + | 75 |
| 60. | *Nostoc communae* | - | 0 | + | 75 | - | 0 |
| 61. | *N. paludosum* | + | 66 | + | 66 | - | 0 |
| 62. | *N. microscopium* | + | 75 | + | 25 | - | 0 |
| 63. | *Anabaena fertilisima* | + | 91 | + | 66 | - | 0 |

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