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Research Article

INCIDENCE OF PINK WATER IN CHENNAI, INDIA- AN ALARMING BLOOM

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Abstract: The aim of the current investigation is to encounter the causative agent for the pink coloration of water along with the nature of water quality in Chennai, Tamil Nadu. The pink water sample was collected near Perungudi garbage dump yard in Chennai. Water quality parameters for the sample including Appearance, Odour, Turbidity, Temperature, pH, Salinity, Dissolved Oxygen, TDS, TSS, Total solids, Electrical Conductivity, BOD, COD, Total Hardness, Alkalinity, Total ammonia, Nitrite-nitrogen, Nitrate-nitrogen, Calcium-hardness, Magnesium-hardness, Inorganic Phosphate, Oxidation-reduction potential were analysed. While analysing the algal composition, 22 algal species were identified from the sample. Cyanobacteria (blue-green algae) dominated the pink water. The commonly occurring genus identified in this study were *Merismopedia, Oscillatoria, Chroococcus*. Various pigments such as Chlorophyll a, Chlorophyll b, Carotenoid, total Chlorophyll, Phycocyanin and Phycoerythrin were also estimated. Abundant of Phycoerythrin (pink colour pigment) in sample water clearly depicts that the Cyanobacterial stood as the major contributor for pink colouration of water in that area.

Keywords: *Cyanobacteria, Algal bloom, Pink water, Perungudi garbage yard*

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Introduction

The two-third of the earth surface is covered by oceans and aquatic ecosystems, which is the habitat for several aquatic flora and fauna. Algae are the first plant on our earth and even now flourish in various aquatic environments. Devoid of roots, leaves and some other structures confined to true plants are some characteristic natures of algae. Photo autotropism is the prime special feature of algae, by which it acts as a basis of every food web, especially in aquatic systems. These are photosynthetic organisms living in both fresh and marine water. Depending on the transparency of water, they might be able to survive deep down to the depth of 150 meters. Freshwaters are also populated by enormous varieties of phytoplankton. Algal bloom is defined as the sudden rise in algal communities in a region of freshwater or marine water, leading to water discoloration. Various kinds of bloom forming plankton in freshwater are primarily influenced by the nature of water. The occurrence of algal blooms in freshwater is rising globally and poses risks for the healthy life of humans, animals and other organisms. It also stands as a threat to aquatic ecosystems, their sustainability and economic vitality. Nutrient input in a vigorous manner, global warming and decreasing flow rates are primary causes of increasing incidence [1]. The algal bloom on the east coast of India is dominated by Diatoms whereas the west coast of India prevailed by Dinoflagellates [2]. The aim of the current investigation is to encounter the causative agent for the pink coloration of water along with the nature of water quality.

Materials and Methods

The water sample for algal and water quality studies were collected near Perungudi garbage dump yard at Chennai, Tamil Nadu, India in the July month. Perungudi garbage yard in Chennai spread across the radius of 6 km comprising landfill of 225 acres. The coordinates of sampling station are 12.95°196 N, 80.23°474 E.

One hundred litre of water was filtered through 20-micron plankton net for the collection of phytoplankton. Immediately after collection, algal samples were preserved with 4% formalin. Water quality parameters were analysed as per standard protocols [3]. Observations on formalin fixed phytoplankton samples were made using light microscope. Identification of phytoplankton was carried out using standard literatures [4-6]. Chlorophyll a, Chlorophyll b, total chlorophyll and total Carotenoid were estimated [7]. Phycoerythrin and phycocyanin concentration were also calculated as per [8,9]. Sampling station was represented in [Fig-1].

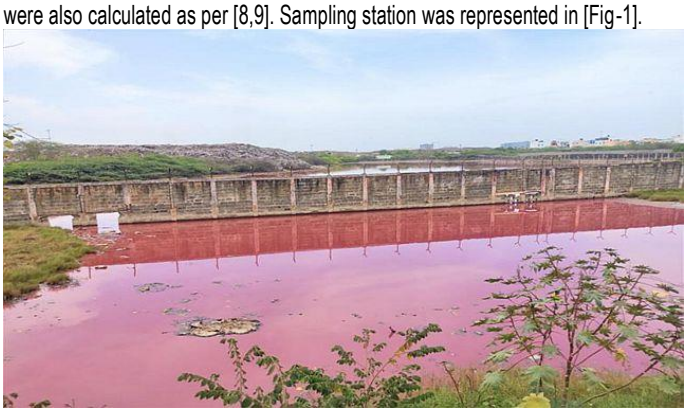

Fig-1 Sampling station in Chennai, Tamil Nadu

Result and Discussion

A total of 22 algal species were identified, comprised of 16 species of Cyanophyceae, followed by Bacillariophyceae and Chlorophyceae with 2 species each whereas Trebouxiophyceae and Euglenophyceae with 1 species each. The identified algae are listed in [Table-1].

Table-1 *List of algae in the pink water sample*

SN	Class	Order	Species
1	Cyanophyceae	Chroococcales	*Merismopedia convoluta*
2	Cyanophyceae	Chroococcales	*Merismopedia elegans*
3	Cyanophyceae	Chroococcales	*Merismopedia punctata*
4	Cyanophyceae	Chroococcales	*Chroococcus turgidus*
5	Cyanophyceae	Chroococcales	*Chroococcus tenax*
6	Cyanophyceae	Chroococcales	*Chroococcus minor*
7	Cyanophyceae	Chroococcales	*Chroococcus cohaerens*
8	Cyanophyceae	Chroococcales	*Chroococcus schizodermaticus*
9	Cyanophyceae	Oscillatoriales	*Arthrospira platensis*
10	Cyanophyceae	Oscillatoriales	*Arthrospira jenneri*
11	Cyanophyceae	Oscillatoriales	*Oscillatoria curviceps*
12	Cyanophyceae	Oscillatoriales	*Oscillatoria nigra*
13	Cyanophyceae	Oscillatoriales	*Oscillatoria hamelii*
14	Cyanophyceae	Oscillatoriales	*Oscillatoria lacustris*
15	Cyanophyceae	Chroococcales	*Coelosphaerium sp.*
16	Cyanophyceae	Chroococcales	*Synechocystis sp.*
17	Chlorophyceae	Sphaeropleales	*Selenastrum sp.*
18	Chlorophyceae	Chlorococcales	*Monoraphidium arcuatum*
19	Euglenophyceae	Euglenales	*Phacus sp.*
20	Bacillariophyceae	Fragillariales	*Synedra sp.*
21	Bacillariophyceae	Naviculales	*Navicula sp.*
22	Trebouxiophyceae	Chlorellales	*Chlorella vulgaris*

Class wise distribution of algae is portrayed in [Fig-2]. It clearly evident that the bloom was dominated by the cyanobacteria group and the genus Merismopedia was encountered in a frequent manner. The Merismopedia genus is characterized as picoplankton, having a diameter less than 1 µm. These species are under the order of Synechococcales, represented by sphere-shaped cells.

Cyanobacteria (blue-green algae) belong to the class Cyanophycea and comprise prokaryotes from unicellular to multicellular. Blue-green algae are found all over the world in land and aquatic ecosystems even in extreme weather conditions, up to 71°C [10]. A cyanobacterial bloom sometimes leads to the production of toxins, an unpleasant odour and taste. In many cases, it paves way for anoxic conditions of water and poses a threat to the life of aquatic fauna. Cyanobacterial blooms are stimulated by higher temperatures [11]. Ten acres of Perungudi garbage dump yard were fired in the month of April. Following this event, the lake adjoining the landfill turned pink due to cyanobacterial blooms.

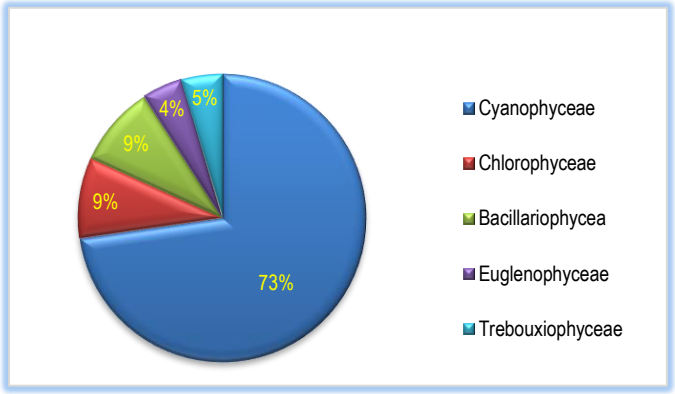

Fig-2 Class wise distribution of algae

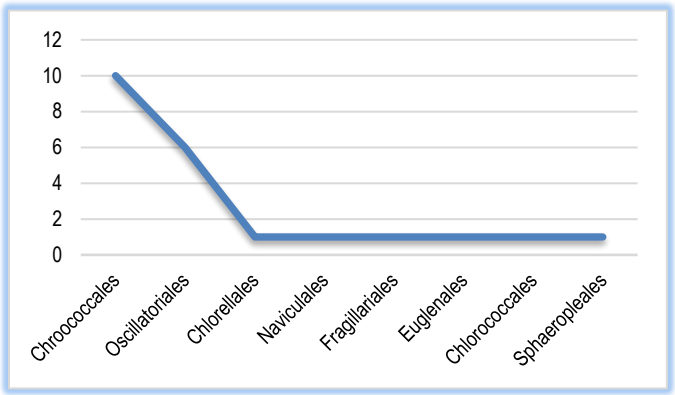

Fig-3 Order wise distribution of algae

Table-2 *Physico-chemical parameters in the pink water sample*

SN	Parameter	Concentration
1	Appearance	Reddish pink
2	Odor	Rotten egg
3	Temperature	31°C
4	pH	9.2
5	Electrical conductivity	39.8 mS/Cm
6	Salinity	20 ppt
7	Turbidity	Highly turbid
8	Dissolved Oxygen	Nil
9	Total Hardness	6550 ppm
10	Ammonia	2.11 mg/L
11	Calcium hardness	200 mg/L
12	Magnesium hardness	1500 mg/L
13	Organic Phosphate	101.37 mg/L
14	Total dissolved solids	64.2 g/L
15	Total suspended solids	2.6 g/L
16	Total solids	66.8 g/L
17	Nitrite-nitrogen	17.262 µg/L
18	Nitrate-nitrogen	18.780 µg/L
19	Bio-chemical Oxygen Demand	44.8 mg/L
20	Chemical Oxygen Demand	47.6 mg/L
21	Total Alkalinity	800 mg/L
22	Oxidation-reduction potential	1400 mV

This event acted as the indisputable evidence of a cyanobacterial bloom triggered by warmer temperatures. The history of cyanobacteria has been as long as 3.5 billion years. This lengthy chronicle made some species among them thrive in all possible wet environments, such as thermophile, psychrophile and halophile. Environmental consequences due to blooms are commonly recognized [12]. The most pernicious effect of these blooms is cyanotoxin production, which further leads to detrimental consequences for aquatic living organisms in that water. These blooms decrease the freshwater ecosystem services, including water for drinking and recreational activities. The orderly distribution of phytoplankton in pink water portrayed in [Fig-3], indicates that the bloom is dominated by Chroococcales and the cyanobacterial bloom in pink water is persistent over months due to the special characteristic nature of blue-green algae. Blue-green algae have the capacity to surpass other freshwater algae and excel in the aquatic ecosystem in a firm manner due to their ability to grow at higher temperatures and pH, forbearance at low light and N/P ratio. It also limits herbivore plankton growth.

Freshwater aquatic ecosystems offers commendable and countable ecosystem services [13]. Freshwater ecosystem serve as harbingers of chemical biological assaults inflicted on aquatic systems on a global scale. Along with these agents, manmade stressors on climatic patterns also reinstative of considering freshwater systems as monitors [14].

Table-3 *Concentration of various pigments in pink water*

SN	Pigment	Values
1	Chlorophyll a	7.941 µg/mL
2	Chlorophyll b	1.688 µg/mL
3	Total Chlorophyll	9.629 µg/mL
4	Total Carotenoid	1.487 µg/mL
5	C-Phycoerythrin	15 µg/mL
6	C-Phycocyanin	8 µg/mL

On a comparison with the marine and terrestrial environment, biodiversity in the freshwater environment is declining faster worldwide. In the present situation, freshwater environments are more prone to harmful algal blooms [15]. Climate change and eutrophication have made the lentic environments, especially lakes and reservoirs, the place for more rigorous algal blooms [16,17]. Adverse changes in aquatic systems are provoked by intense algal blooms Reid, *et al*., (2019). In most cases, toxic cyanobacteria are the sole reason for intense algal blooms [18]. This poses a risk to the aquatic ecosystem as well as living organisms who use this water [19]. The physico-chemical conditions of a pink water sample are shown in [Table-2]. The water appears as a reddish pink colour along with a rotten egg odour. A pink water sample exhibited alkaline condition. The salinity of the sample was around 20 ppt. The pH of the water was found to be 9.2 with a highly turbid condition of water. This substantiated the results of Visser, *et al.,* (2016) [20]. Cyanobacterial blooms produce an unfavourable odor and taste, making the water unfit for the service of mankind [21].

In the present study, a rotten egg odour analysed from the sample may be associated to the presence of hydrogen sulfide and traces of methane. Anoxic conditions and devoid of aquatic fauna in the current observation are supported by the results of Rabalais, *et al.,* (2010) [22]. High electrical conductivity (39.8 mS/Cm) favours cyanobacterial blooms in the current study agreed with results of Amorim & do Nascimento Moura (2021) [23].

Cyanobacterial blooms aggravated the detrition through higher eutrophication, high pH and low transparency [23]. The raised turbidity resulted in the migration of aquatic animals to clear water. The algal blooming areas devoid of aquatic flora and fauna is substantiated by the results of Sukenik, *et al.,* (2015). Cyanophycean blooms discharge more nutrients and augment photosynthesis [24]. Consequently, it promotes eutrophication and rise in pH. This kind of pattern is also followed in pink water cyanobacterial bloom. Furthermore, it hinders the growth and survival of other aquatic flora and fauna in that water which are susceptible to high nutrient levels, high pH and turbidity.

Human activities in agriculture, urban and industrial sectors in an awful manner lead to nutrient level increases in water associated with these activities, making cyanobacterial blooms widespread throughout the world as obnoxious [25]. Turmoil in the balance of the aquatic system due to excess nutrients results in Cyano-Harmful algal blooms, which pave way for pathetic condition of water quality by reducing light, dissolved oxygen on an annex with undesirable odour, colour and taste. This case is applicable to current observation by which leaching of chemicals from garbage yard increases the nutrient load in associated water, especially total ammonia, nitrate-nitrogen, nitrite-nitrogen and organic phosphate with concentration 2.11 mg/L, 18.780 µg/L, 17.262 µg/L and 101.37 mg/L respectively. Magnesium hardness level was at 1500 ppm. Results of pH, electrical conductivity, and salinity of current observation were substantiated by the results of Keliri, *et al*., (2021) [26].

The concentration of various pigments in pink water is estimated and it is given in [Table-3]. A higher concentration of pigments in pink water sample clearly indicates the algal bloom along with organic pollution in that water. Along with Chlorophyll a and Phycobilin, blue green algae also comprise water soluble pigments like allophycocyanin, phycocyanin and phycoerythrin. Cyanobacteria have photosynthetic pigments excelled by phycocyanin. In cyanobacteria, Phycobiliproteins is the major photosynthetic pigments. The composition of pigments phycocyanin and phycocyanin determines the colour of the cyanobacterial bloom from blue green to red. The concentration of Chlorophyll a, Chlorophyll b and total Chlorophyll in present observation was at 7.941 µg/mL, 1.688 µg/mL and 9.629 µg/mL respectively. In the present study we observed that higher amounts of chlorophyll a and insignificant amount of chlorophyll b. It is because of the absence of chlorophyll b in cyanobacteria and the little may be from other groups of co-occurrences. Phycoerythrin and phycocyanin in current observation are concentrated at 15 µg/mL and 8 µg/mL respectively. Phycoerythrin masked other pigments in the present investigation.

Phycoerythrin pigment was responsible for the pink colour bloom [27]. From this evidence, it could be deducted that phycoerythrin pigment in cyanobacteria is a major contributor to the pink colouration of water near Perungudi garbage dump yard in Chennai. Persistent algal blooms sequels in eutrophication, bloom decomposition and changing climate that leads to discharge of more nutrients and greenhouse gases [28,29]. Current study also supports the results of Amorim and do Nascimento Moura, (2021), that the cyanobacterial blooms cause adverse deterioration of water quality and lead to rigorously turbid water with higher amounts of salinity, turbidity and Chlorophyll a content.

Conclusion

The study revealed that the presence of abundant phycoerythrin pigment in cyanobacterial bloom turned the water to pink colour with the deteriorated quality. Cyanobacterial bloom triggered after a massive fire in Perungudi garbage yard is also one of the indirect key contributors for pink colouration of water. Leaching of chemicals and nutrients from the adjoining land fill is responsible for eutrophication of water and the fire outbreak increased the temperature of water paring way for cyanobacterial bloom.

Application of research: This research article will create awareness among the people regarding ill effects of wastes on the environment. Furthermore, it will ignites more researchers to investigate on the biological pollution across various peculiar places.

Research Category: Aquatic Environment Management

Abbreviations: COD-Chemical oxygen demand, BOD-Biochemical oxygen demand, TDS-Total dissolved solids, TSS-Total suspended solids.

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Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Pallikaranai marshland, Chennai, Tamil Nadu

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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