“Bioremediation and detoxification of textile dyes using algal cultures isolated from dye effluent contaminated sites for bio-usability”

This is a
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By
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Right off the bat, I might want to offer my earnest thanks to my counselor Prof. Veena Sharma for the constant help of my PhD ponder and related research, for her understanding, inspiration, and massive learning. Her direction helped me in all the season of research and composing of this theory. I couldn't have envisioned having a superior counselor and coach for my PhD think about.

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Last however not the minimum; I might want to thank my family: my folks for their unflagging affection and unlimited help for the duration of my life and my investigations. You influenced me to experience the most novel, enchantment and joyful adolescence that have made me my identity now!
I, Ms. Preeti Kaushik represents the thesis paper with the title named, “Bioremediation and detoxification of textile dyes using algal cultures isolated from dye effluent contaminated sites for bio-usability” is unique and has not been submitted to any university or institution for any diploma or degree.

Place: Jaipur
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Figure 2: Bioremediation of dyes at 0.05% concentration by Osillatoria under shaking and stationery condition

Figure 3: Bioremediation of dyes at 0.5% concentration by Osillatoria under shaking and stationery condition

Figure 4: Bioremediation of dyes at 1% concentration by Osillatoria under shaking and stationery condition

Figure 5: Effect of temperature on dye decolorization at 0.05% concentration by oscillatoria

Figure 6: Effect of temperature on dye decolorization at 0.5% concentration by oscillatoria

Figure 7: Effect of temperature on dye decolorization at 1% concentration by oscillatoria

Figure 8: Bioremediation of dyes at (0.05%) by algae 2 under shaking and stationery condition

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Figure 11: Effect of temperature on dye decolorization at 0.05% concentration by algae 2

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1. INTRODUCTION

1.1 RECENT ENVIRONMENT TREND

1.2 Problem associated with industry and pollution

The two rate limiting factors for industrialization are environmental pollution and Over population. Industries, of the world the clock to fulfill the demand of population are working continuously. But this continuous activity adds on a bonus of environmental pollution. One of the most characterizing features of this development is the greatest concerns for the environment is the quantity and qualities of these pollutants release to environment on daily basis, these pollutants are also indicates economic growth of the country. The process of recycling of pollutants is at very low levels and their production and release to the nature is at very high level have and this is the difference point where major problem of environmental problem arises. These pollutants build up everywhere in huge quantities and amazingly some of them will never be used again. Species of today to convert and to produce which actually does not exist in the nature. Out of them most compounds are recalcitrant. In general phenomena as compare to its destruction which is easy but as far as pollutants are concern the, construction of pollutants are easy but heir destruction is very difficult process. That is why, waste management of hazardous compound.

In present time, the very sensitive biosphere is affected by the activity of anthrosphere indirectly because the lithosphere, hydrosphere and atmosphere is modulated by the anthrosphere which ultimately affect the biosphere. Raising our living style pollutes the environment.
This evolution occur under the influence of polluted environment. If the same problem of environmental pollution exists as it is now, those species which are resistance against the pollution will dominate the earth in future and non dominating species environment and living things, we have to not only stay away from the sensitive network of environment processes and also stops or decreases our interference in the nature’s activity. In short all of us must found all the possible and effective ways of reducing all types of environmental pollution, in order to maintain our life supporting earth.

Pollution of hydrosphere

In present environment suffers by the invasion of unique pollutants including the conventional pollutants and these pollutants disturbs all the three components of environment. As we very well known that water is essential for all living beings exists in natures and it also covers major part of the earth's surface area i.e. 71% and 65 % of our bodies consist of water by keeping all these unignorable role of water in nature and human beings life, control by the scientist. Clean or unpolluted water is the need of everyone; either it is used for agriculture, drinking, recreation, industry or just to entertain or to enjoy. Polluted water in either means has no aesthetical or economical value, also directly or indirectly has dangerous effect on the health and survival of living beings. Human being and their involvement with nature is the major cause of water pollution. Effect of human’s on water systems have been looked many ways by the scientists. Various human activities generate different kinds of pollutants or polluting substances that either may change chemical makeup of the water or causes disruption of water and it also directly affect the aquatic environment. Agricultural runoff, domestic and other sewage and various effluents produced by industries that releases fluids of different quality and quantity into water bodies are the major sources of water pollution. Polluted water releases from production.

Increase in industrialization increases the pollution of water bodies from the last few decades and also polluting the aquatic part of the earth. Industries which cause maximum water pollution are textile industries, distilleries, thermal power stations, sugar mills and leather processing industries. Large scale industries have proper treatment facilities of effluents or waste water discharge, not happen in due to less profit margin and investments, they are not ready or afford investment in pollution controlling equipment.

Unbalanced aquatic ecosystems, poisonous drinking water, poisonous food animals, deforestation from acid rain, change in biological diversity, and many others are the various effects of water pollution. These effects are obviously due to the different pollutants. No one can leave unaffected by the effects of water pollution. Need or importance of unpolluted and safe drinking water can only be realized by Society and
also there main concern is on water pollution and its effect on society. Possible harmful effects of all kind of contaminants on human beings and others have been studied, and studies were also made to see the effects of these contaminants on other aquatic life. Pathogenic organisms that use water as a carrier put at higher risk and pollution. After seeing the effect of water pollution on society scientists begin to control water pollution. These pollutants structurally complexes in nature. This fact helped in the increase of awareness, to change the policies and programmes for environmental regulations. Water pollution and are very harmful to human as well as animal and other forms of life that exists on earth. From the last few decades, people have started to notice its serious effects. The only solution to the problem; we need to prevent this problem on a serious note. Preventing environment from pollution is not a single man’s job but everyone needs to play their role to make environment pollution free. Government should also crack down the large scale industries. There are so many agencies and NGOs who work for pollution. It is the duty of every one to contribute in prevention of pollution and also to stay worthy for the continued health of our planet.

**Water pollution by dye industries**

Due to rapid industrialization India and many other South Asian countries are facing serious environmental pollution problems. Different kind of pollutants are dropped into nearby water bodies by industries like leather tanning, sugar manufacturing etc. Industrial discharge specially the colored effluent causes severe water pollution like of surface water pollution, soils pollution and ground water pollution. Out of all industries discussed above, textile industries and dye manufacturing industries is the largest source of water pollution, the dye containing effluent discharged from these industries produces serious environmental threats. These industries are functioning on very small, system are very poor or weak.

**Textile industrial discharge**

Increase in civilization or fashion, colored fabrics are in constant demand human populations. To fulfill such demands textile or dye manufacturing industries produce more durable and colorful. Toxic organic residues containing mixed chemically versatile dyes as liquid effluents are released from these industries as a result of equipment cleaning after batch operation. 1–700 liters/kg of product is the rate of
wastewater generation except the vat dyes. Other dyes values like, BODs, 6 kg/kg BOD; 25 kg/kg COD; suspending solids in the order of 6 kg/kg; and grease and oil, at the rate of 30 kg/kg of product. Filtration sludge’s, container residues, process and effluent treatment are the major concern of solid wastes. Treatment of effluent mainly includes flocculation, settling, coagulation, neutralization. Toxic include spent acids, wastewater treatment sludge’s are considered as the examples of wastes. Carbon exhausted by the adsorption processes is sent to regeneration or combustion. To recover and concentrate the process intermediates ultra filtration, Reverse osmosis, and other filtration techniques may be used. From the effluent dyes may be removed by treatment, the levels of effluent should be achieved which is shown presented in Table 1.1 but most of the dye industries.

Table : 1 The Dye Manufacturing Effluents

(all values in mg/l except for pH)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum value after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>30</td>
</tr>
<tr>
<td>COD</td>
<td>150</td>
</tr>
<tr>
<td>Phenol</td>
<td>0.5</td>
</tr>
<tr>
<td>pH</td>
<td>6–9</td>
</tr>
<tr>
<td>TSS</td>
<td>50</td>
</tr>
<tr>
<td>Zinc</td>
<td>2</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>10</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>0.1</td>
</tr>
<tr>
<td>Copper</td>
<td>0.5</td>
</tr>
<tr>
<td>Toxic organics</td>
<td>0.05</td>
</tr>
<tr>
<td>AOX</td>
<td>1</td>
</tr>
</tbody>
</table>

Depending upon the raw material used types of dye and process to be used for dyeing will determine by the fabric type that causes various kinds of water pollution and also pollutes different water bodies. A large volume of energy and water consumes by this textile industry and also releases large amount of waste water into the water bodies. The process for the operation during the fiber to textile fabric
conversion decides the consumption of water as well as generation of wastewater from a these textile industry.

A common approach of textile mill effluent industries which was followed by biological treatment. Control of pH carefully which was used to further reduce the BOD, if required which removed upto 95% of BOD from water sources contaminated by the effluents. Table 2 represent the level of effluent achieved after the treatment but maximum textile industries remains cannot achieve these levels.

Table 2 Textiles Industry effluents
(mg/l, except for the level of pH, bacteria and temperature)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum value after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOX</td>
<td>8</td>
</tr>
<tr>
<td>TSS</td>
<td>50</td>
</tr>
<tr>
<td>BOD</td>
<td>50</td>
</tr>
<tr>
<td>COD</td>
<td>250</td>
</tr>
<tr>
<td>pH</td>
<td>6–9</td>
</tr>
<tr>
<td>Oil &amp; grease</td>
<td>10</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>0.5</td>
</tr>
<tr>
<td>Pesticides (each)</td>
<td>0.05</td>
</tr>
<tr>
<td>Zinc</td>
<td>2</td>
</tr>
<tr>
<td>Sulfide</td>
<td>1</td>
</tr>
<tr>
<td>Cobalt</td>
<td>0.5</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.5</td>
</tr>
<tr>
<td>Temperature increase</td>
<td>&lt; 3°Ca</td>
</tr>
<tr>
<td>Copper</td>
<td>0.5</td>
</tr>
<tr>
<td>Phenol</td>
<td>0.5</td>
</tr>
<tr>
<td>Coli form bacteria</td>
<td>400</td>
</tr>
<tr>
<td>MPN/100ml</td>
<td></td>
</tr>
</tbody>
</table>

Requirements of effluent for direct discharge to nearby surface water

Table 3 Intermediate Industry: Disposal of wastewater Standards

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concentration not to exceed, mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH, color and bio-assay test</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>as Cu 2.0</td>
</tr>
<tr>
<td>BOD</td>
<td>(27°C, 3 days)</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>10.0</td>
</tr>
<tr>
<td>Phenol</td>
<td>as C6H5OH 1.0</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>100</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Substance</th>
<th>Symbol</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>Cd</td>
<td>0.2</td>
</tr>
<tr>
<td>Color, hazen unit</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn</td>
<td>2.0</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb</td>
<td>0.1</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr</td>
<td>0.1 (2.0)</td>
</tr>
<tr>
<td>Mercury</td>
<td>Hg</td>
<td>0.01</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni</td>
<td>2.0</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>6.0 to 9.0</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Bioassay test
90% survival in 95-96 hours

Discharge of Effluent from dyestuff and textile is now produces very crucial environmental and health concerns to agencies of environmental regulatory. Recalcitrant and hydrophilic compounds like textile dyes easily may gets enter into the hydrosphere and disturb the ecosystem balance in minute quantity of dyes in the water even below than 1 ppm.

In most of the developed and even in developing countries government legislation is becoming stricter in order to remove dyes releases from industries as pollutants that in contrary become a setback for various textile industries. Agencies made for environment protection are promoting prevention environment. To treat their own effluent before discharging into nearby water bodies there is the development of onsite or in plant facilities by most dye manufacturing industries and textile industries. Removal of dye from the colored effluent has become major area of scientific research and interest now a day as shown by them related research reports.

Cosmetic, food, plastics and textile industries. There are so many of environmental problems which are related with the release of these dyes into the near water bodies or environment after use and have a great area of concern for both. Textile industries design the dyes in such a way that it resists fading on exposing to temperature, microbial growth, oxidizing chemicals, water and sunlight. Convectional biological method for wastewater treatment is unable to treat dye containing effluents. Use of synthetic dyes results in specially skin allergy, dermatitis, irritation of skin and they are also reported to be toxic, carcinogenic and mutagenic in humans. There is an adverse effect of these dyes shown in terms of COD (chemical oxygen demand) and also reduce visibility in water.
Methods like ion-exchange, adsorption, ozonation, irradiation, coagulation and oxidation are some commonly employed to degrade textile dye effluents but they have their own disadvantages like they are not cost effective, inefficient and sometimes the degraded product are even more harmful and produce hazardous by-products and sludge generation. Therefore, chemical or physical-chemical methods are very costly, waste productive and less efficient. (Enayatzamir et al., 2009; Jin et al., 2007; Ren et al., 2006; Sirianuntapiboon and Srisornak, 2007). On the other hand, microorganisms for example; bacteria, algae and fungi have the power to decolorize these synthetic dyes and also considered to be cheap, eco-friendly and sustainable source for biodegradation of the dyes used in these industries (Bhatti et al., 2008). Moreover, because of their effectiveness, low cost, ability to produce less sludge and production of non toxic by-products biological processes are more approachable (Ali et al. 2011).

Degradation or Removal of different dye containing pollutants like unwanted xenobiotics and various kinds of nutrients from wastewater by using algae (macro and microalgae) is known as phycoremediation (Mohan and Karthikeyan, 2000). Removal of nutrients from waste water, acidic and metal wastewater treatment, degradation and transformation of recalcitrant compounds, toxic compound detection by using algal-based biosensors are some of the key application of Phycoremediation.

Despite ubiquitous distribution of algae, algae have a major role in the fixation of nitrogen, utilization of nutrient elements and recognition of their heterotrophic abilities and turnover of carbon. Algae remain in poor contact with environmental microbiologist as compared to bacteria and fungi and their role in the biodegradation of organic pollutants in wastewater (Parikh and Mademwar, 2005). Work done on the biodegradation of recalcitrant compound by algae is less compared to the work done on bacteria and fungi. Information gathered on phycoremediation of dyes suggested that in addition to bioaccumulating pesticides, algae were also capable of biotransformation of environmental pollutants to a great extent (Shah et al. 1999).
Wastewater treatment by algae

Algae have capability to perform photosynthesis so they may be considered as photosynthetic microorganism and may survive in almost every environmental condition. Macro and micro algae have been employed in treatment of wastewater from various industries and there are numerous other reasons for which macro and micro algae are grown and also utilized for bioremediation purpose (Ali et al., 2011).

In the natural environment, the blue green algae are Omni present (Thajuddin and Subramaniyan, 2005, Singh et al., 2008), but how they biodegrade xenobiotic compounds including chemicals having artificial dyes and what is their role in polluted ecosystem management, is not that clear and have to be work out (Vijayakumar et al., 2007, Nagasathya and Thajuddin, 2008). The complex structures of dyes may be converteded into colorless amines by a number of genera of bacteria (Banat, 1996, Chung 1993). The marine blue green algae *Phormidium valderianum*, can biodegrade dyes from wastewater by producing hydrogen. In bioremediation process, the microorganism uses a reduced carbon compound as a growth substrate to breakdown the azo bond which is considered as an unreasonable process (Patricia et al., 2004). The process of bioremediation is in demand due to its simple design, application and low cost compared to other conventional treatment methods are preferred by most of the scientists.

Cyanobacteria: characteristics and life history

Cyanobacteria are very crucial part to come into existence our oxygen atmosphere by their photosynthetic activities (photosynthesis that broken H2O to produce O2 specifically). Before the *archaean* and *proterozoic* period the atmosphere had a very different chemistry, quite wrong for living as we have knowledge. Various bacteria broken H2S in place of water (H2O) as a source of electrons during the photosynthesis
Cyanobacteria were among the first organisms on earth to utilize two photosystems i.e. photosystems I and II. Cyanobacteria do not have a great diversity of form in nature, and also they are very small in size (microscopic in nature), but they are very rich in terms of chemical diversity. Because of their superficial similarity with eukaryotic green algae that’s why autotrophic cyanobacteria were classified as "blue green algae" (BGA). However, both the groups are photosynthetic in nature, cyanobacteria lack internal organelles, discrete nucleus and the histone proteins connected with eukaryotic chromosomes like in case of prokaryotes and are distantly related. Their cell walls like other eubacteria consist of peptidoglycan, but not contain cellulose as may present in case of many algae and all plants. Cyanobacteria form a good monophyletic taxon as per the studies of ribosomal RNA sequence and metabolic similarities.

It does not matter that cyanobacteria are truly prokaryotic in nature, but they have well defined and highly organized internal membranes system which function in photosynthetic process. Phycoerythrin and phycocyanin), chlorophyll a and various other accessory pigments are embedded in photosynthetic lamellae, which resembles the eukaryotic thylakoids membranes. cyanobacteria were likely part of a process of endosymbiosis by eukaryotic cells, coming out in the chloroplasts discovered in plant and algal cells.

Blue -green pigment “phycocyanin” give cyanobacteria its common name, which in combination with chlorophyll a gives blue-green appearance to cyanobacteria. Phycocyanin of cyanobacteria is that protein who works as the photosynthetic pigment of photo system II, moreover in case of plants chlorophyll b is the pigment as in photosystem II. Cyanobacteria exhibit wide variety of habitats which ranges from acidic bogs, deserts, frozen lakes to oceans and volcanoes. Cyanobacteria possess a number of unique characteristics features that are responsible for wide variety of habitats and diversity.

Cyanobacteria have a wide range of organization along with a great variety of habitats. They can vary from unicellular- multicellular, non filamentous to filamentous and to colonial. Cyanobacteria can also survive in some pretty extreme environments and they are also the Bio 1C supplemental reading primary colonizers of new area. Being the primary colonizers they play an important part by adding organic matter to the soil. In cyanobacteria, cells of a colony are generally undifferentiated from one other except in the case heterocyst and akinetes. To prevent
erosion some colonial forms of cyanobacteria known to form mats on the surface of the soil. The filamentous organization in cyanobacteria is composed of chain of cells with their enveloping sheath. Due to the environment changes this organization can be modified or lost.

Mostly, cyanobacteria are photoautotrophic in nature (but some are also photo heterotrophic in nature, which implies that they need light to produce ATP and also obtain carbon in organic form) which fix CO₂ by releasing O₂. To survive in low CO₂ concentrations cyanobacteria developed a special environmental adaptation commonly known by the CO₂ concentrating mechanism (CCM). By this mechanism inorganic carbon (HCO₃ and CO₂) actively transports and accumulates.

Some cyanobacteria have another unique characteristic. Nitrogenase is the enzyme complex responsible for this nitrogen fixation. In adverse condition (like low N₂ environments) cyanobacteria will develop heterocyst, which are thick-walled cells, larger in size that are better in nitrogen fixation. They are among the rare groups of microorganisms that are done by rhizobium bacteria present in soil and also by bacteria present on some plant roots. In the presence of oxygen nitrification cannot occur, that is why heterocyst are thick walled and anaerobic in nature. In cyanobacteria, heterocyst present as larger, thick -walled cells in the filaments as in the case of Nostoc or Anabaena. Ability of cyanobacteria to fix elemental nitrogen makes it a very important agricultural property. They also were used as nitrogen fertilizer in the rice and beans cultivation.

Cyanobacteria may either of single-celled or colonial celled type. Coccoid is the single celled forms of cyanobacteria and these are one of the most abundant phytoplankton in the mid of tropical oceans and where level of nutrient are extremely very low i.e. small size requires high surface area for maximum absorption. Moreover, single celled forms i.e. coccoid form is most prevalent form among some invertebrates, specially is seen in case of sponges, as symbionts etc. Cyanobacterial colonies may be of filamentous, individual chains or complex mats type depending upon the environmental conditions as well as species type. Symbiotic relationship with a large variety of plant hosts like rice, ferns, mosses, lichens, cycads, diatoms is seen in case of filamentous cyanobacteria. Filamentous colonies of cyanobacteria have the capacity to differentiate into three different types of cell in some cases. Under favorable growing conditions photosynthetic cells are formed and vegetative cells are the normal cells.
Cyanobacteria relationship with chloroplasts

Eukaryotes, algae and plants have chloroplasts have been arise from an endosymbiotic which shows relation with cyanobacteria (Deusch, O.; et al. 2008, Ochoa de Alda; et al. 2014). The theory of endosymbiotic is supported by a number of structural and genetic similarities (Cavalier-Smith, T. 2000). Species varies from sea lettuce to evergreens and flowers may have chlorophyll b- whereas in glaucophytes, marine species and red algae phycobilins are found, primary chloroplasts are seen among the "true plants" or green plants. These chloroplasts probably appears from a single origin, which have ancestors of the clade called Archaeplastida. However, this is not a necessary origin of cyanobacteria, microbiology under the supervision is still undergoing profound changes in classification and whole domains (like Archaea) which are weekly mapped and understood. Other form of algae rarely took their chloroplasts from these forms with the help of secondary endosymbiosis or ingestion.

Portrayal

Cyanobacteria live in a wide assortment of damp soils and water either uninhibitedly or a harmonious relationship alongside plants or lichen-shaping parasites as in the lichen sort Peltigera and have a gathering of photosynthetic, nitrogen settling microscopic organisms (Dodds et al; 1995). They extend from unicellular to filamentous which additionally incorporate the provincial specie. Provinces may either frame sheets, fibers or even empty circles. A few animal groups which are filamentous can be separate into a few diverse cell sorts: like

- Vegetative cells - the ordinary, photosynthetic cells that are framed under great developing conditions;

- Akinetes - atmosphere safe spores that may shape when natural conditions wind up plainly brutal;
• thick-walled heterocysts - which contain the protein nitrogenase, indispensable for nitrogen obsession

Nitrogen obsession by cyanobacteria

Heterocysts is those specific cells by which cyanobacteria can settle climatic nitrogen in anaerobic conditions. At the point when settled nitrogen is in rare, heterocysts may frame under the great natural conditions (anoxic). Species who frame heterocyst are particular for nitrogen obsession and furthermore ready to settle nitrogen (N2) gas into NH3 (smelling salts), NO2 (nitrites) or NO3 (nitrates), which on retention by plants get changed over into protein and nucleic acids. Environmental nitrogen isn't promptly accessible to all plants, with the exception of just the individuals who having endosymbiotic nitrogen-settling microbes, exceptionally found in the Fabaceae family and some others microscopic organisms too.

Those cyanobacteria who are free-living in nature are found in the water of rice paddies. Cyanobacteria can likewise be developed as epiphytes on the green alga surfaces, Chara also, where they can settle environmental nitrogen. Cyanobacteria for instance Anabaena as symbionts of the oceanic plant Azolla, can ready to give rice manors along biofertilizer.

Morphology of cyanobacteria

Hormogonia are the motile fibers of cells found in cyanobacteria, that move away to shape new provinces as a bud anyplace from the fundamental biomass. The cells in a hormogonium are by and large more slender in contrast with the vegetative condition of the same, and the cells introduce on either side of the motile chain might be decreased when contrasted with opposite side. To get isolated from the
parent settlement or the primary biomass, a hormogonium typically should break separated as a weaker cell in a fiber, frequently called a necridium.

Every individual cell of cyanobacterium for the most part has a thick and a coagulated cell divider. Cyanobacteria don't have flagella, yet hormogonia exhibit in a few animal groups can give motility by floating along surfaces. Oscillatoria are fit for a waving movement with the assistance of numerous multicellular filamentous; the fiber wavers forward and backward development. In water sections, a few types of cyanobacteria can likewise coast by shaping gas vesicles, as found if there should arise an occurrence of archaea. These gas vesicles are not organelles thusly. They are not encompassed by the lipid films, but rather by a protein envelope.

Biology

Cyanobacteria can be seen in practically every amphibian and earthbound natural surroundings like new water, seas, incidentally soaked shakes in deserts, moist soil, exposed shake and soil, and even likewise found on Antarctic rocks. They can likewise shape phototrophic biofilms or happen as a board tonic cells. Cyanobacteria are by and large found in each endolithic biological system. Barely any cyanobacteria are endo-symbionts in plants, lichens, different protists, or wipes that give vitality to the host. Some cyanobacteria additionally live in the sloths, giving a type of cover.

Cyanobacteria dependably incline toward unmoving waters, for example, those gave by lakes and lakes. Life cycles of blue green growth are blocked by the agitating streams caused by the streaming water or the stirring water of wellsprings or when the water normally or misleadingly blends. Thus, sprouts of cyanobacteria by and large found or happen in waterways where there is no development of water or the water is running gradually. More often than not, the cyanobacteria originate from the outfall of lakes upstream from the examining point if the microscopic organisms are found in streams.
Drinking water necessities for the individuals who utilize lakes and streams as their real wellspring of water cyanobacteria are a developing concern. This microscopic organisms indicate impediment with treatment in a few routes, significantly by stopping the channels (most regularly huge beds of sand and comparable media), and they likewise create cyanotoxins, which have the limit of causing genuine sickness if devoured by the general population or creatures. For wet handling of materials, material ventures use generous volumes of water and chemicals. The real utilization of chemicals is for scouring, desizing, fading, printing, coloring and wrapping up. Their range is from inorganic compound, components to natural items and polymers. A high convergence of overwhelming metal particle segments in color containing effluents have been distinguished by Srivastava, P. N. what's more, Prakash, A., (1991). There are more than 8000 synthetic items connected with the coloring procedure, while more than 100, 000 monetarily accessible colors exist (Meyer, U., 1981; Zollinger, H., 1987). Assistant chemicals nearness in material plant emanating adversely influences the development and digestion of microorganisms and furthermore impedes the procedure of decolorization or debasement of color. Henceforth, physical and additionally compound examination of color containing effluents before the treatment is compulsory.

Some of these cyanobacteria or blue green growth assume a huge part in worldwide environment and in the oxygen cycle. The little marine cyanobacterium i.e. Prochlorococcus was found in 1986 and perform the greater part of the photosynthesis movement of the untamed sea (Nadis; et al 2003). Countless additionally deliver the circadian rhythms that were thought to exist just on the off chance that eukaryotic cells.

Amphibian cyanobacteria are by and large known for their very obvious and broad sprouts that can be shape in freshwater and marine situations both. These sprouts can have the appearance like of blue-green paint or filth. These sprouts might be harmful in nature, and for the most part prompt the conclusion of recreational waters. Bacteriophages that are marine are essential parasites of unicellular marine cyanobacteria. (Schultz et al; 2009)

"Cyanobacteria are arguably the most successful group of microorganisms on earth. They are the most genetically diverse; they occupy a broad range of habitats across all latitudes, widespread in freshwater, marine, and terrestrial ecosystems, and they are found in the most extreme niches such as hot springs, salt works, and hypersaline bays. Photoautotrophic, oxygen-producing cyanobacteria created the conditions in the planet's early atmosphere that directed the evolution of aerobic metabolism and eukaryotic
photosynthesis. Cyanobacteria fulfill vital ecological functions in the world's oceans, being important contributors to global carbon and nitrogen budgets." (Stewart and Falconer, 2008)

**Cellular Characteristics of blue green algae**

Cyanobacteria were generally classified as blue-green algae (In French known as les algues bleues, and in Spanish as algas azules) because they are algal like in appearance, they possess chlorophyll instead of bacteriochlorophyll, and their photosynthetic production of O\textsubscript{2} is similar as in algae and higher plants i.e. by a two photosystem (photosystem I and photosystem II) process. International Botanical Code is the widely used taxonomic schemes for these micro and macro organism who separates according to classic morphological criteria.

However ultra structural studies clearly show that the Cyanobacteria are prokaryotic in nature; i.e., they don’t have true nuclei and other organelles and they also consist of a peptidoglycan cell wall that is resembles with cell wall of gram-negative Eubacteria. Cyanobacteria also possess various features that make them different from other bacteria, especially presence of photosynthetic apparatus and production of oxygen. In the water quality management area and the media the term ‘blue-green algae’ is still widely and commonly used.

The present taxonomic separation of species, especially the coccoid and non heterocystous taxa, is thought to be artificial and not reflective in terms of evolutionary relationships, and will have to be revised as soon as the genetic data become available. All cyanobacteria species along with chlorophyll a also contain the blue phycobilin-proteins, allophycocyanin and phycocyanin; this gives the cyanobacterial cells their characteristic blue-green color. Many taxa also contain the Phycoerythrin, phycobiliprotein, making the cells of this taxa red, or sometimes black in color. Phycobilisomes is that structure where phycobiliproteins and this phycobilisomes present on the thylakoids or photosynthetic membranes, and these are very effective ‘light guides’ to transfer the captured solar energy i.e. excitation energy to the photosynthesis reaction centers, specifically to photosystem II. Photosynthetic microbes group are often classified as a separate phylum of prokaryote (the Prochlorophyta), it contains chlorophyll b in addition to chlorophyll a, but it completely lacks phycobiliproteins and phycobilisomes.

Organic treatment frameworks because of its exceptionally factor nature and particularly material effluents, there are bunches of components which may influence the rate of azo colors biodegradation process. Specialists have been examined issues connected with color biodegradation that might possibly be expected, all through the writing. Temperature, pH, nitrate focuses, broke down oxygen and
wellspring of decrease reciprocals like microbes consortium, and cell porousness are some non-color related parameters that would all be able to influence the biodegradation of material effluents and azo colors. All color related parameters like class and azo color sort for instance responsive monoazo, color fixation, decrease metabolites, color side-gatherings, and natural color added substances could likewise influence the biodegradability of azo color wastewaters.

The pH of wastewater can influence the best possible working of oxygen consuming and anaerobic life forms both (Grady et al., 1999). Impact of pH on color decrease rates additionally researched by the Wuhrmann et al. in 1980, however he was not able decisively set up a relationship

On the genetic data basis specially, the gene sequence for 16S ribosomal RNA, this group is now placed in the Cyanobacteria. The species Prochlorococcus marinus is included in the group, it is the one of the most commonly found phototrophs in the sea, also a filamentous phytoplankton species of freshwater, Prochlorothrix. Cyanobacteria do not have membrane-bound organelles, but they have a large variety of cellular structures and inclusions that have specialized functions and these organelles contribute in their ecological success. These organelles include the photosynthetic thylakoid membranes having phycobilisomes, and the centroplasm or nucleoid region in the center of the cell.

Table 4 Cyanobacterial five orders recognized by classic botanical taxonomic scheme

<table>
<thead>
<tr>
<th>Order</th>
<th>Characteristics</th>
<th>Illustrative genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chroococcales</td>
<td>Coccoid cells that reproduce by binary fission or budding</td>
<td>Aphanocapsa, Microcystis, Synechococcus, Synechocystis</td>
</tr>
<tr>
<td>2. Pleurocapsales</td>
<td>Coccoid cells, aggregates or pseudo-filaments that reproduce by baecocytes</td>
<td>Chroococcidiopsis, Pleurocapsa</td>
</tr>
<tr>
<td>3. Oscillatoriales</td>
<td>Uniseriate filaments, without heterocysts or akinetes</td>
<td>Lyngbya, Leptolyngbya, Oscillatoria, Phormidium, Planktothrix</td>
</tr>
</tbody>
</table>
4. Nostocales  Filamentous cyanobacteria that divide in only one plane, with Anabaena, Calothrix, heterocysts; false branching in genera such as Scytonema, Nostoc, Scytonema, Odor, Taste and Production of Toxin

5. Stigonematales  Division in more than one plane; true branching, and Mastigocladus, multiseriate forms; heterocysts, Stigonema

Odor, Taste and Production of Toxin

Assortment of mixes deliver by cyanobacteria unequivocally influences the nature of water; these mixes incorporate those atoms that influence the taste and smell of water, uniquely 2-methylisoborneol and geosmin, both of these particles grant a gritty or smelly scent to the water. Cyclocitrals is an extra cyanobacterial gathering of mixes, which are breakdown results of carotenoid and give a green smell to the water. Three classes of poisons delivers by cyanobacteria i.e. hepatotoxins, which assault the liver; dermatotoxins, which cause skin bothering and neurotoxins, which assault the sensory system is of more noteworthy worry to water asset directors. These three poisons are created by some planktonic species uncommonly. A sprout framing animal types for instance Microcystis aeruginosa, which is more typical in eutrophic lakes and repositories in the entire world, produces microcystin. Microcystin is a cyclic peptide that is a hepatotoxin. There are two other sprout shaping genera i.e. Anabaena and Aphanizomenon which may happen in relationship with Microcystis which creates the alkaloid neurotoxin anatoxin. A tropical animal categories (cylindrospermopsis), which has been watched ceaselessly in mild lakes, contains the most intense hepatotoxin known as cylindrospermopsin, additionally considered as an alkaloid. Different benthic species produces poisons, for example, anatoxins and in addition the aplysiatoxins, dermatotoxins and lyngbyatoxin. Cyanobacterial poisons have been involved in the demise of creatures, canines, cultivate stock, including winged animals and modest number of people. The nearness of poison created by cyanobacteria in drinking repositories and additionally recreational lakes is of awesome concern, and for the most part brings about the transitory turn off of such water supplies. These poisons are solvent in water and are not obliterated even in
bubbling water before drinking. There is issue in the administration of such blossoms. These sprouts aggravated by the substantial fluctuation in the poison generation, which is among the strains of similar species, and with natural conditions.

Photosynthesis

To drive photosynthesis, cyanobacteria utilizes vitality of the daylight, which is where the light vitality is utilized to deliver natural mixes from CO2. They regularly utilize different systems which are by and large known as a "carbon concentrating component" to help in the procurement of inorganic carbon (CO2 or bicarbonate) since they are amphibian life forms. The more particular procedures are the pervasiveness of the carboxysomes by and large known as bacterial small scale compartments. Hexameric shell proteins that together makes the icosahedral structures are amass into confine like structures and these icosahedral structures are a few many nanometers in breadth. It is believed that these structures having the compound known as RuBisCO, this is a CO2 settling catalyst, in the internal of the shell, and additionally the protein carbonic anhydrase, using the metabolic directing (worldview) to build the convergences of neighborhood CO2, along these lines increment the limit of the RuBisCO chemical. (Long; et al, 2007)

Electron transport

In comparison of chloroplast containing eukaryotes, cyanobacteria do not have thylakoid membranes compartmentalization, which results in the contiguous of the plasma membrane. The protein complexes present in the metabolism of respiratory energy share various moving energy carrier pools for example; cytochrome c, the Quinone pool and ferredoxins, so that the respiratory metabolism and photosynthetic interact with each other. Moreover, there is a great diversity among the respiratory components between species. Thus cyanobacteria can have a "branched electron transport chain", which analog to the situation in purple bacteria.

High energy electrons generate from water mostly used by the cyanobacterial cells for their personal needs, a fraction or part of these electrons may also be donated to the external environment with the help of electrogenic activity (Pisciotta JM et al, 2010)

Organelles and metabolism

Cyanobacteria do not have true nuclei or an internal membrane system as present in prokaryotes. In most of the forms, thylakoids seen which is the photosynthetic machinery embedded into the external cell
membrane into folds. The bluish pigment phycocyanin is used to capture light for photosynthesis by cyanobacteria and they also used this pigment to get their color. Generally, cyanobacteria in photosynthesis uses water as an donor of electron and as a byproduct oxygen is produces, some cyanobacteria may also use hydrogen sulfide as a electron donor (Cohen Y; et al,1986). Cyanobacteria are also found as symbionts along with other groups of organisms for example angiosperms (Gunnera), fungi (lichens), corals, pteridophytes (Azolla) etc.

Under aerobic conditions, cyanobacteria are able to reduce nitrogen and carbon dioxide (CO2), this is the fact that are responsible for their evolutionary and ecological success. The thylakoid membrane hosts an interlinked photosynthetic and respiratory electron transport chain. The enzyme terminal oxidases is present in the thylakoid membrane of respiratory/photosynthetic electron transport chain and are very essential for survival to rapid light changes. Maintenance under dark conditions where cells are not light stressed.(Lea-Smith; et al,2013)

Phycobilisomes go about as light-reaping radio wires for the photosystems when joined to the thylakoid layer (Grossman; et al, 1993). In most cyanobacteria the phycobilisome parts (phycobiliproteins) are in charge of the blue-green pigmentation of. This varieties is because of the carotenoids and phycoerythrins that give the cells red-caramel hue. The shade of light in some cyanobacteria is impacts by the structure of phycobilisomes. In red light they create more phycocyanin while in green light the cells deliver more phycoerythrin. Along these lines, the cyanobacteria seems green in red light and red in green light. Correlative chromatic adjustment is a path for the cells to expand the utilization of light for the photosynthesis procedure.

Barely any genera in cyanobacteria needs phycobilisomes rather they have chlorophyll b for instance Prochloron, Prochlorococcus, Prochlorothrix. They were initially joined together as the prochlorophytes or chloroxybacteria and seem to created in various lines of cyanobacteria. This is the reason, they are considered as a piece of the cyanobacterial gathering.

Order of Cyanobacteria:
Rippka (1979) have proposed an advanced plan of cyanobacteria arrangement taking essentially their physiology, cell constituents and DNA qualities into thought. They have made five sub-bunches called 'areas'. (Table 6.5)

Table 5: Rippka et al; arrangement of characterization of cyanobacteria

Generation in Cyanobacteria:

Like microorganisms, the cyanobacteria additionally replicate abiogenetically and the commonest method of generation in them is transverse paired splitting. Likewise, there are sure specific structures, for example, akinetes, hormogonia, hormocysts and spores, which are incompletely associated with the procedure of propagation. So far as the sexual proliferation in its actual sense is concerned, it is missing in them and the prerequisites of sexuality are thought to be met by some option pathways alluded to as parasexual-pathways.

Akinetes:

In unfriendly condition the greater part of the filamentous cyanobacteria create structures or lethargic structures. These perennating structures are bigger in estimate than the vegetative cells and are outfitted with thick dividers, and are called akinetes. In positive conditions, they sprout and create new fibers.

Hormogonia:
To frame short pieces each comprising of 5-15 cells, all filamentous cyanobacteria imitate by the procedure of discontinuity of their fibers or trichomes at pretty much consistent interims. The term hormogonia allude to these short bits of fibers. They demonstrate floating moement and form into new undeniable fibers later.

Hormocysts:

Some cyanobacteria are known to create hormocysts, which are multicellular structures having a thick and huge sheath. They are in intercalary or terminal in position, may sprout from any end or both the finishes to deliver the new fibers.

Spores:

Cyanobacteria that are non-filamentous are referred to deliver spores, for example, endospores, nanocysts and exospores which contribute by sprouting and offering ascend to new vegetative cells when the ominous condition is finished. Endospores are delivered endogenously like those in microscopic organisms; exospores are the outcome to exogenous maturing of cells, and the nanocysts are created endogenously like endospores.

The distinction between an endospore and a nanocyst is that in endospore arrangement the parent cell concomittantly augments in estimate, though in nanocyst development there is no such broadening of the cell.

Parasexuality in Cyanobacteria:

The learning of cyanobacterial hereditary qualities is generally new and was spearheaded by Kumar in 1962 who acquired penicillin and streptomycin safe strains of Anacystis nidulans, crossed them, and
effectively showed the presence of a third sort of recombinant strain impervious to both the anti-infection agents. Be that as it may, the systems of hereditary recombination in cyanobacteria are believed to be the same as those in microbes.

The presence of the procedure of change in cyanobacteria was set up tentatively of every 1979 by Doolittle. Stevens and Porter in 1980 has effectively shown this procedure in Agmenellum quadruplicatum. The changing standard was appeared to be DNA. Some cyanobacteriologists, notwithstanding, have discovered that the change is intervened now and again by edifices of DNA and RNA.

The principal give an account of conjugation in a cyanobacterium, to be specific, Anacystis nidulans was by Kumar and Ueda in 1984. The recurrence of conjugation is low (around 1 of every 106 cells) and cells conjugate by methods for a conjugation tube.

The learning of transduction in these microorganisms at show is limited to some preparatory reports. Be that as it may, the event of various cyanophages, e.g., LIP 1-7, SM-1, N-1 and contamination of a few cyanobacteria by them prompts one to envision that the infection interceded strategy for hereditary exchange (transduction) in cyanobacteria might be definitively settled sooner rather than later.

Heterocyst in Cyanobacteria:

As expressed before, the cyanobacteria are just living beings that perform oxygenic photosynthesis and can likewise settles nitrogen. Greatest, yet not all, are vivacious nitrogen fixers.

The conjunction of the oxygenic photosynthesis forms and characteristically anaerobic nitrogen obsession process in a solitary living being available an undeniable Catch 22 since nitrogenase, the key catalysts, which are rapidly and non-reversibly inactivated by an introduction even at low weight of oxygen.

In any case, the nitrogen settling cyanobacteria deliver a specific sort of cell known as heterocyst, inside which nitrogen is settled. Filamentous types of cyanobacteria, for example, Anabaena shape extensive unmistakable growth like cells, the heterocysts, at interims along the trichome (fiber), (Fig. 6.12). The last create from ordinary vegetative cells especially in conditions inadequate in NH +3 or NO– 3, and are
thought to be the site of nitrogen obsession. For wet handling of materials, material ventures use generous volumes of water and chemicals. The real utilization of chemicals is for scouring, desizing, fading, printing, coloring and wrapping up. Their range is from inorganic compound, components to natural items and polymers. A high convergence of overwhelming metal particle segments in color containing effluents have been distinguished by Srivastava, P. N. what's more, Prakash, A., (1991). There are more than 8000 synthetic items connected with the coloring procedure, while more than 100, 000 monetarily accessible colors exist (Meyer, U., 1981; Zollinger, H., 1987). Assistant chemicals nearness in material plant emanating adversely influences the development and digestion of microorganisms and furthermore impedes the procedure of decolorization or debasement of color. Henceforth, physical and additionally compound examination of color containing effluents before the treatment is compulsory.

The change of air nitrogen to smelling salts happens under exceedingly anaerobic conditions, that exclusive the heterocysts can give. For example, the oxygen-developing piece of the photosynthetic instrument (photosystem II) is obstructed in heterocysts, and the staying photosynthetic apparatus ends up noticeably intended to give vitality to the lessening of nitrogen to NH3+.

Financial Importance of Cyanobacteria:

1. Cyanobacteria are one of the early colonizers of exposed and fruitless territories and produce such conditions that support the development of different living beings even in the most unfriendly condition.

2. They are great nourishment hotspot for a few sea-going creatures. Also, the cyanobacteria are presently the-days abused as nourishment for creatures including people. Spirulina, a filamentous cyanobacterium, is currently joined in sustenance supplement and in addition creature sustain through 'single cell protein' make in light of its high protein content (upto 70%).

Some Indian dishes, for example, similar to 'puri' 'idli' and 'sandwich' arranged by supplementing 5-10% S. fusiformis have been observed to be satisfactory. In parts of Rajasthan Anabaena and Spirulina are gathered from Sambar lake and utilized as grain and fertilizer.

3. N2-obsession is the trademark highlight of numerous cyanobacteria and this capacity is performed by heterocysts introduce in them. Aulosira, Nostoc, Anabaena, and so on are some such cyanobacteria that
are presently frequently vaccinated in the rice fields for nitrogen supply. This spares utilization of nitrogen composts.

4. N2-settling cyanobacteria (e.g., Nostoc, Anabaena) are frequently utilized for recovery of 'client' soils. They deliver acidic chemicals for neutralizing alkalinity of the dirt and they supply nitrogen mixes which are by and large inadequate in these dirts.

5. Types of Anabaena and Aulosira don't permit mosquito hatchlings to become adjacent. Such cyanobacteria can be vaccinated in town lakes to keep the development of mosquitoes.

6. Concentrates of Lyngbia are utilized to produce anti-microbial like mixes.

7. Some cyanobacteria for instance Microcystis aeruginosa (= Anacystis cyanea), Anabaena flos-aquae and Aphanizomenon flos-aquae deliver poisons hurtful to most sea-going creatures. These poisons may demonstrate similarly destructive to people drinking or showering in such water.

8. Cyanobacteria by and large develop on dividers and tops of structures amid the stormy seasons and cause discolouration, erosion, and spillage.

2. Survey OF LITERATURE

Due to the dangerous and stylish effects on waters the treatment of material effluents is of incredible intrigue. To grow best advancements for the treatment of wastewaters containing azo colors, much research have been preformed no single arrangement has been found for remediating the wide decent variety of material water squanders, likewise worries of human and natural medical problems urging the legislature to control or treat material gushing releases to have progressively bring down shading and nitrogen levels. In the wake of monitoring the issue, makers from numerous material enterprises have been neglected to expel azo color mixes from the wastewaters they deliver. The issue in treating these color squanders can't achieve treatment offices until makers of color and material ventures can create effective advancements, which expands holding between color fiber and furthermore bring down color house misfortunes (Lewis, 1999).

This chapter will deals with the current problem caused by textile effluents and azo dyes.
Dyes are utilized to give colour to materials due to which it becomes an imperative role in human life. The physico-chemical methods of industrial effluent treatment do not take away the dyes successfully. Recent promising investigates on biological decolorization of textile effluent has showed that a large number of microorganisms as well as plants able to decolorize a wide range of anionic and cationic dyes. A variety of biological treatment methods are set up to be the top for decolorization of dye. Due to its cost effectiveness and less regeneration by microorganisms such as algae, bacteria, fungi, and plants biological decolorization of dye effluent is receiving much consideration. Current status of biological decolorization and remediation of dye effluents, and deals with the most deliberate part on the effects of various parameters like pH, temperature and dye concentrations. (V Karthik et al, 2014)

Synthetic dyes are widely and more commonly used in a large number of industries like paper, textile, color photography, printing, and also in the food industry (Meyer, U., 1981). Constitute of dyes is very essential part for our civilization, but the environmental pollution cause by these industries.

**Azo Dyes and Intermediates**

Diazotization of a primary aromatic amine involves in the synthesis of most azo dyes which is followed by coupling of one or more than one nucleophiles. Groups commonly used as coupling components are amino and hydroxyl groups (Zollinger, 1991). Just because, diversity of the dye components are available for synthesis process, a huge number of azo dyes that are structurally different exist and are also used in industry (McCurdy, 1991). Production of organic dyes worldwide is currently estimated nearly approx 450,000 tons, out of which 50,000 tons approx lost as a effluents during application and manufacture process(Lewis, 1999).

![Congo red azo dye structure](image)

**Figure 1:** Congo red an azo dye structure.
### Aromatic Amine Group

<table>
<thead>
<tr>
<th>Aromatic Amine Group</th>
<th>Evidence Of Human Carcinogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>3, 3’-Dichlorobenzidine</td>
<td>Slight or Mixed</td>
</tr>
<tr>
<td>1-Naphthylamine</td>
<td>Slight or Mixed</td>
</tr>
<tr>
<td>2-Naphthylamine</td>
<td>Good</td>
</tr>
<tr>
<td>4-Biphenylamine</td>
<td>Good</td>
</tr>
<tr>
<td>2, 5-Diamotoluene</td>
<td>Slight</td>
</tr>
<tr>
<td>3, 3’-Dimethoxybenzidine</td>
<td>Slight or Mixed</td>
</tr>
<tr>
<td>4, 4’-Methylenebis(2-chloroaniline)</td>
<td>Slight</td>
</tr>
<tr>
<td>3, 3’-Dimethylbenzidine</td>
<td>Slight</td>
</tr>
<tr>
<td>4-Nitrobiphenyl</td>
<td>Slight or Mixed</td>
</tr>
<tr>
<td>Magenta</td>
<td>Slight</td>
</tr>
<tr>
<td>Auramine</td>
<td>Slight</td>
</tr>
<tr>
<td>N,N-Bis(2-chloroethyl)-napthylamine</td>
<td>Good</td>
</tr>
<tr>
<td>Benzidine</td>
<td>Good</td>
</tr>
<tr>
<td>N-Phenyl-2-napthylamine</td>
<td>Some</td>
</tr>
</tbody>
</table>

### Factors Affecting Dye Biodegradation

Organic treatment frameworks because of its exceptionally factor nature and particularly material effluents, there are bunches of components which may influence the rate of azo colors biodegradation process. Specialists have been examined issues connected with color biodegradation that might possibly be expected, all through the writing. Temperature, pH, nitrate focuses, broke down oxygen and wellspring of decrease reciprocals like microbes consortium, and cell porousness are some non-color related parameters that would all be able to influence the biodegradation of material effluents and azo colors. All color related parameters like class and azo color sort for instance responsive monoazo, color fixation, decrease metabolites, color side-gatherings, and natural color added substances could likewise influence the biodegradability of azo color wastewaters.
The pH of wastewater can influence the best possible working of oxygen consuming and anaerobic life forms both (Grady et al., 1999). Impact of pH on color decrease rates additionally researched by the Wuhrmann et al. in 1980, however he was not able decisively set up a relationship. Wuhrmann express that an exponential increment in rate of the decolorization was seen by diminishing the pH, yet this relationship relied upon the color being tried. A backhanded increment in the rate of decolorization of Navy-106, with diminished pH esteems in anaerobic clump tests saw by Loyd (1992). To check this outcome no measurable information was performed, be that as it may.

Organic WWTP have an exceedingly factor nature. The impacts of pH, temperature, grouping of breath substrates, sort and oxygen strain on the rate of organic diminishement of an assortment of azo colors researched by Wuhrmann et al. (1980). A consortium of microorganism was utilized including Sphaerotilus natans, Bacillus cereus, and two others segregated from sewage-initiated slop. Initiated slime was utilized as a part of trials with blended biocenoses. Temperatures, it is possible that it are too high or too low, can prompt the avoidance of a particular gathering of microorganisms. By utilizing enacted muck, Wuhrmann et al. (1980) demonstrated that temperature has an expanding relationship that is additionally straight with the decrease rate of Orange II and Lanasyl violet up to 28 ºC of temperature. By and large, the majority of the investigations have been performed at set temperatures, offering negligible information on temperature impacts. For wet handling of materials, material ventures use generous volumes of water and chemicals. The real utilization of chemicals is for scouring, desizing, fading, printing, coloring and wrapping up. Their range is from inorganic compound, components to natural items and polymers. A high convergence of overwhelming metal particle segments in color containing effluents have been distinguished by Srivastava, P. N. what's more, Prakash, A., (1991). There are more than 8000 synthetic items connected with the coloring procedure, while more than 100, 000 monetarily accessible colors exist (Meyer, U., 1981; Zollinger, H., 1987). Assistant chemicals nearness in material plant emanating adversely influences the development and digestion of microorganisms and furthermore impedes the procedure of decolorization or debasement of color. Henceforth, physical and additionally compound examination of color containing effluents before the treatment is compulsory.

The cell penetrability and the cell divider adsorption is a last non-color related factor of azo colors. The effects of color retention by the cell divider is explored by Wuhrmann et al. in 1980 and finished up the accompanying:
(1) Dye adsorption process dependably takes after Freundlich adsorption isotherms at low color burdens per weight of biomass, however it displays a high inconstancy;

(2) Subsequent decrease may happen yet it relying upon the color, or the color may stay in the cell divider;

(3) Adsorption does not stop the decrease rate of organisms that can diminish azo colors. Nonetheless, these conclusions are restricted in view of the procedure of test performed, they additionally give a sign of the inconstancy that is conceivable when managing natural treatment frameworks and azo colors. Ganesh (1992) inferred that when put in a landfill almost no of the color added to an organic reactor will be drained from the biomass. This may propose that the color is proficiently decreased after the cell divider adsorption or that next to no color is really adsorbed.

Porousness of cell may assume a critical part during the time spent color biodegradation. Wuhrmann et al. (1980) led an investigation and proposed that all colors that were not decreased by entire cells were proficiently debased by both facultative anaerobes and commit aerobes cell removes. This examination additionally proposes that numerous cells may be fit for color biodegradation, yet are constrained by the penetrability of their cell dividers.

Structure of an azo color can assume a huge part in the biodegradation rate of color. A few colors will biodegrade more quickly than others, contingent upon the number and arrangement of the azo linkages. By and large, the more azo linkages that must be broken will cause the diminishment rate to be slower. There are not a colossal number of concentrates that exceptionally address this factor, when contrasted with four monoazo and six diazo colors just two poly-azo colors demonstrated direct to variable biodegradation according to Brown and Laboureur perception (1983). This demonstrates poly-azo colors are more outlandish corrupts as contrast with mono- or diazo color sorts.

Colors that are anthraquinone based are most impervious to debasement because of its intertwined sweet-smelling structures, and stay hued for long time. Organic treatment frameworks because of its exceptionally factor nature and particularly material effluents, there are bunches of components which may influence the rate of azo colors biodegradation process. Specialists have been examined issues connected with color biodegradation that might possibly be expected, all through the writing. Temperature, pH, nitrate focuses, broke down oxygen and wellspring of decrease reciprocals like microbes consortium, and cell porousness are some non-color related parameters that would all be able to
influence the biodegradation of material effluents and azo colors. All color related parameters like class and azo color sort for instance responsive monoazo, color fixation, decrease metabolites, color side-gatherings, and natural color added substances could likewise influence the biodegradability of azo color wastewaters. The pH of wastewater can influence the best possible working of oxygen consuming and anaerobic life forms both (Grady et al., 1999). Impact of pH on color decrease rates additionally researched by the Wuhrmann et al. in 1980, however he was not able decisively set up a relationship.

Initially contaminant to be perceived in wastewater is the shading and it ought to be evacuate before discharge either into water bodies or ashore. For the most part hued natural mixes gives just a smaller scale division of the natural load to squander water, however their shading renders them tastefully unsatisfactory. The expulsion of shading from wastewaters is considerably more vital when contrasted with the evacuation of dissolvable natural substances that are lackluster, and it as a rule contribute the significant portion of the biochemical oxygen request i.e. Body. Generally colors have a low rate of expulsion proportion for biochemical oxygen request (BOD) to concoction oxygen request (COD) (BOD/COD under 0.1) (De Angelis, F. E. and Rodrigues, G. S., 1987). The expulsion of BOD from a large portion of the effluents is genuinely settled and has numerous techniques; however colors are hard to treat because of their manufactured starting point and complex fragrant sub-atomic structures. These structures are deliberately built to overlook blurring on presentation to cleanser, water, sweat, light or different other oxidizing specialists.

Most worthy shading in material industry

As per Johnson, R. F., et al., 1978 azo colors is the biggest class of colors utilized as a part of material industry. Arrival of these colors into the earth as waste has brought about a contamination issue around the world. These azo colors must contain some sweet-smelling structures that recognized by at least one azo linkages, for example, R1-N=NR2. Around 700,000 - 750,000 metric huge amounts of colors every year delivered around the world. Amid the assembling procedure and utilization, an expected 10-18% is discharged into the earth (Anliker, R., 1979). Indeed, even at minute color focuses, azo colors that are water-dissolvable may make squander streams turn out to be exceptionally shaded. Aside from negative tasteful impacts of these azo colors certain colors and their biotransformation items additionally end up being dangerous and deadly, and at times these mixes are mutagenic and cancer-causing as well (Chung, K. T. and Cerniglia, C. E., 1992). Consequently, arrival of these contaminations must be maintained a
strategic distance from and productive methodologies must be sought out to debase those colors that have been discharged in nature.

2.3 Auxiliary chemicals: Additional poisons of material factory profluent

For wet handling of materials, material ventures use generous volumes of water and chemicals. The real utilization of chemicals is for scouring, desizing, fading, printing, coloring and wrapping up. Their range is from inorganic compound, components to natural items and polymers. A high convergence of overwhelming metal particle segments in color containing effluents have been distinguished by Srivastava, P. N. what's more, Prakash, A., (1991). There are more than 8000 synthetic items connected with the coloring procedure, while more than 100,000 monetarily accessible colors exist (Meyer, U., 1981; Zollinger, H., 1987). Assistant chemicals nearness in material plant emanating adversely influences the development and digestion of microorganisms and furthermore impedes the procedure of decolorization or debasement of color. Henceforth, physical and additionally compound examination of color containing effluents before the treatment is compulsory. Due to the dangerous and stylish effects on waters the treatment of material effluents is of incredible intrigue. To grow best advancements for the treatment of wastewaters containing azo colors, much research have been preformed no single arrangement has been found for remediating the wide decent variety of material water squanders, likewise worries of human and natural medical problems urging the legislature to control or treat material gushing releases to have progressively bring down shading and nitrogen levels. In the wake of monitoring the issue, makers from numerous material enterprises have been neglected to expel azo color mixes from the wastewaters they deliver. The issue in treating these color squanders can't achieve treatment offices until makers of color and material ventures can create effective advancements, which expands holding between color fiber and furthermore bring down color house misfortunes (Lewis, 1999).

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Dyes are utilized to give colour to materials due to which it becomes an imperative role in human life. The physico-chemical methods of industrial effluent treatment do not take away the dyes successfully. Recent promising investigates on biological decolorization of textile effluent has showed that a large number of microorganisms as well as plants able to decolorize a wide range of anionic and cationic dyes. A variety of biological treatment methods are set up to be the top for decolorization of dye. Due to its
cost effectiveness and less regeneration by microorganisms such as algae, bacteria, fungi, and plants. Biological decolorization of dye effluent is receiving much consideration. Current status of biological decolorization and remediation of dye effluents, and deals with the most deliberate part on the effects of various parameters like pH, temperature and dye concentrations. (V Karthik et al, 2014)

Synthetic dyes are widely and more commonly used in a large number of industries like paper, textile, color photography, printing, and also in the food industry (Meyer, U., 1981). Constitute of dyes is very essential part for our civilization, but the environmental pollution cause by these industries.

Ventures for material color decolorization

Novel creative medicines and advances coordinated especially towards the decolorization of colors in effluents are currently looking the two enterprises and researchers. Different physico-compound corruption methods have been considered from the previous two decades. From the different physico-substance methods buoyancy. Some of these systems are acknowledged by the material enterprises and appeared to be compelling. They are need executed because of low effectiveness, high cost, abundance measures of synthetic utilization, and age of extensive measure of slop with clear transfer issues and in addition exorbitant plant necessities, absence of successful shading diminishment working costs, inapplicability to a wide assortment of colors, especially for sulfonated azo colors; and affectability to a variable wastewater input. Organic treatment frameworks because of its exceptionally factor nature and particularly material effluents, there are bunches of components which may influence the rate of azo colors biodegradation process. Specialists have been examined issues connected with color biodegradation that might possibly be expected, all through the writing. Temperature, pH, nitrate focuses, broke down oxygen and wellspring of decrease reciprocals like microbes consortium, and cell porousness are some non-color related parameters that would all be able to influence the biodegradation of material effluents and azo colors. All color related parameters like class and azo color sort for instance responsive monoazo, color fixation, decrease metabolites, color side-gatherings, and natural color added substances could likewise influence the biodegradability of azo color wastewaters. The pH of wastewater can influence the best possible working of oxygen consuming and anaerobic life forms both (Grady et al., 1999). Impact of pH on color decrease rates additionally researched by the Wuhrmann et al. in 1980, however he was not able decisively set up a relationship. Some treatment plans may likewise pertinent for material plants utilizing maybe a couple sorts of colors, however not for different factories or color
blends. Different procedures incorporate substance oxidation by utilizing sodium hypochlorite to evacuate shading. Be that as it may, they discharge a lot of sweet-smelling amines, which are cancer-causing, or poisonous exacerbates; these therefore bother the issue.

**Biosorption**

Biosorption is a potential and minimal effort substitute for shading expulsion from material profluent, it likewise been utilized effectively for the recuperation and expulsion of lethal metals from modern emanating. This procedure fundamentally utilizes the colors hard-headed and furthermore indicates liking to cling to surfaces because of expelling. Certain sorts of microbial biomass displays solid biosorption conduct towards metallic particles and different poisons likewise, similar to material colors, is a component of the synthetic cosmetics of the microbial cells of which the biomass comprises. Different compound gatherings in biomass could pull in and sequester charged poisons, portrayed by case of such synthetic gatherings are amino, acetamide gathering of chitin, sulphhydril, phosphate bunches in nucleic acids, amido and carboxyl gatherings in proteins and furthermore hydroxyl in polysaccharides. In addition this utilization of biomass will prompt muck age which may again require promote treatment, for example, utilization of strong state maturation (SSF). A substantial number parasitic animal varieties is equipped for doing SSF for instance white decay organisms, which have additionally been appeared to be fit for material color. Such utilize be that as it may, required additionally. Due to the dangerous and stylish effects on waters the treatment of material effluents is of incredible intrigue. To grow best advancements for the treatment of wastewaters containing azo colors, much research have been preformed no single arrangement has been found for remediating the wide decent variety of material water squanders, likewise worries of human and natural medical problems urging the legislature to control or treat material gushing releases to have progressively bring down shading and nitrogen levels. In the wake of monitoring the issue, makers from numerous material enterprises have been neglected to expel azo color mixes from the wastewaters they deliver. The issue in treating these color squanders can't achieve treatment offices until makers of color and material ventures can create effective advancements, which expands holding between color fiber and furthermore bring down color house misfortunes (Lewis, 1999 ).

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Corruption of material colors by utilizing natural process

The debasement of wastewater discharge from material and different businesses by totally natural procedures might be conceivable escalated inquire about as of late. Prior such circumstance was anticipated by McKay, G. (1979), and he presumed that, "organic frameworks interceded decolorization process would get more consideration later on". Because of their general effortlessness and relatively modest advancements late research into material emanating decolorization and corruption has been centered around natural strategies as it were.

Ecological foragers additionally alludes as microorganism, for example, microbes, molds, yeasts, green growth and protozoa, they reuses common heap of dead and rotting natural too inorganic materials. Microorganisms are genuine ecological scroungers on the grounds that…

1. They have biodegradative exercises which support them to pick up vitality for development, rivalry, proliferation and other natural capacities.
2. Environments of microorganisms permit the variety of, Gratuitous digestion Central digestion and Co-digestion, among microbial consortia: aftereffects of the joint endeavors are the biodegradation of natural.

3. Microbial respiratory are effectively lessen or oxidize diverse mixes under oxygen consuming, anaerobic and facultative condition.

Henceforth, microbial decent variety demonstrating hereditary and metabolic assorted variety is the solid segment of condition for rummaging the tarnished material.

This investigation is to assess how the variety of sub-atomic structures and utilitarian gatherings introduce in our models, monoazo color (Tartrazine) and diazo color (Ponceau), influences decolorization abilities of green growth, cyanobacteria and diatoms. The outcomes uncovered that the evacuation of azo colors was quick at the underlying time of study (3 days) and turned out to be gradually with the time (6 days). The most extreme decolorization was seen at 5 ppm Tartrazine with S. bijugatus (68%) and N. muscourm following 6 days hatching. The diminishment of shading evacuation seems, by all accounts, to be identified with the sub-atomic structure of the colors and types of green growth utilized. The way of life of the diatom Nitzschia perminuta was totally passed on following 2 days of hatching. Azo reductase of green growth, which is in charge of debasement of azo colors into fragrant amine by breaking the azo linkage, was assessed. IR spectra spoke to another crest at 3300 cm\(^{-1}\) and a diminishment in the azo band at 1642-1631 cm\(^{-1}\). Keeping in mind the end goal to research the sorption conduct of green growth, Langmuir balance show was tested.(hanan hafez omar, 2008)

While the material ventures have and will keep on playing an indispensable part in the monetary development of India one awful notable reaction has been the universal utilization of manufactured azo colors which posture potential risk to amphibian ecological biological communities if gushing from such enterprises is left untreated. In this examination, of the ten cyanobacterial strains tried, six were found to endure presentation to a test methyl red (MR) color well as demonstrated great cell development. Assist examination of the centralization of different photosynthetic shades, and the creation of phenol debasing laccase compounds in the microbes within the sight of MR color demonstrated that each of the six tolerant strains (Spirulina-C5, Spirulina-C10, Spirulina-C11, Lyngbya, Phormidium and Synechocystis) displayed an essentially higher focus (P<0.05) of colors and fundamentally higher generation (P<0.05) of extracellular proteins within the sight of color. The best performing strain, Spirulina-C11, created fundamentally more noteworthy measures of laccase (59.57 mU/ml) at 10 days in respect to every other strain which was additionally upgraded (71.52 mU/ml) following option of guaiacol as an inducer. Guaiacol additionally initiated expanded protein content that may was credited to an expansion in de

Cyanobacteria are generally circulated in nature and might be a compelling and financial option for expelling colors from material industry effluents. The present work researched the capability of six cyanobacterial strains in decolorizing eleven sorts of material colors. The greatest absorbance of each color was confirmed utilizing a spectrophotometer. Mass spectrometry was utilized to check the expulsion and conceivable corruption of colors by the cyanobacteria. The outcomes demonstrated that the majority of the assessed cyanobacteria could expel indigo, palanil yellow, indanthrene yellow, indanthrene blue, dispersol blue, indanthrene red and dispersol red by over half. The Brazilian seclude Phormidium sp. CENA135 could decolorize and totally expel indigo blue BANN 30. This examination affirmed the limit of cyanobacteria to decolorize and conceivably to fundamentally corrupt diverse material colors, proposing the likelihood of their application in bioremediation contemplates. (Maria Estela Silva-Stenico et al, 2012)

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Colors are headstrong aggravates that oppose customary organic medicines. The debasement of three material colors (Indigo, RBBR and Sulfur Black), and the color containing fluid gushing and strong waste from the Municipal Treatment Station, Americana, São Paulo, Brazil, by the cyanobacteria Anabaena flos-aquae UTCC64, Phormidium autumnale UTEX1580 and Synechococcus sp. PCC7942 was assessed. The color corruption effectiveness of the cyanobacteria was contrasted and anaerobic and anaerobic–oxygen consuming frameworks as far as discoloration and lethality assessments. The staining was assessed by retention spectroscopy. Poisonous quality was measured utilizing the creatures Hydra attenuata, the alga Selenastrum capricornutum and lettuce seeds. The three cyanobacteria demonstrated the possibility to remediate material gushing by expelling the shading and diminishing the lethality. Be that as it may, the development of cyanobacteria on ooze was moderate and staining was not productive. The cyanobacteria P. autumnale UTEX1580 was the main strain that totally debased the indigo color. An assessment of the mutagenicity potential was performed by utilization of the micronucleus examine utilizing Allium sp. No mutagenicity was seen after the treatment. Two metabolites were created amid the corruption, anthranilic corrosive and isatin, however lethality did not increment after the treatment. The cyanobacteria demonstrated the capacity to debase the colors display in a material profluent; thusly, they can be utilized as a part of a tertiary treatment of effluents with stubborn mixes. (Priscila Maria Dellamatrice et al, 2016)

Laccase is copper containing polyphenol oxidase that follows up on extensive variety of substrates. It is otherwise called "Green Catalysts" or "Ecofriendly" compounds. Laccase has numerous potential applications including material color decolourization, delignification of mash and profluent detoxification. In the present examination, the cyanobacterial strains were screened for laccase creation and color decolorization capability of unrefined laccase were explored. Among every single chose strain Lyngbya NCCU-102 demonstrated movement (34 mU/ml), Synechocystis NCCU-370 remained at second position (31 mU/ml). Most extreme laccase generation was found on 7thday. Laccase movement of examined strains extended from was 24.9 to 34 mU/ml. In all strains under typical condition cyanobacteria indicated low laccase movement however what's more of inducer (guaiacol) it was intensified different time (60%-80%). However, under ordinary condition most elevated laccase movement was displayed by Synechocystis NCCU-370 yet most astounding laccase action enlistment was appeared by Lyngbya NCCU-102. The unrefined laccase of Lyngbya and Synechocystis uncovered a promising outcome on the decolorization of manufactured colors. Around 74.1% of receptive blue 4 were adequately
decolorized by Synechocystis and 59.45% by Lyngbya inside 144 hr of hatching. This is first report of freshwater cyanobacteria for the laccase generation and its decolorization capacity and this will give a conceivable approach to take care of ecological issues. (Sumbul Afreen, et al.)

Cyanobacterial societies disengaged from destinations dirtied by mechanical material effluents were screened for their capacity to decolorize cyclic azo colors. Gloeocapsa pleurocapsoides and Phormidium ceylanicum decolorized Acid Red 97 and FF Sky Blue colors by over 80% following 26 days. Chroococcus minutus was the main culture which decolorized Amido Black 10B (55%). Chlorophyll a blend in all societies was unequivocally restrained by the colors. Obvious spectroscopy and TLC affirmed that shading evacuation was because of debasement of the colors. (Amit Parikh, et al; 2005)

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Lyngbyasp. BDU 9001 with coir essence and cyanobacterium culture with profluent alone were utilized to decolorize the material color emanating. The precision of 73% decolorization effectiveness was performed through the ghostly investigation at the fifteenth day of hatching in cyanobacteria and coir substance culture. The physiochemical parameters, for example, OD, pH, Temperature, Nitrite, Nitrate, Calcium, Magnesium, chlorophyll 'a', Protein were investigated. The chlorophyll 'an' and protein content were expanded and decolorized movement was additionally affirmed by the standard methods of Dissolved Oxygen (DO) and, natural oxygen request (BOD). (Henciya. S, et al; 2013)

Use of Cyanobacteria in the remediation of material industry emanating can be a financially savvy and a best option for expensive and arduous physical and substance techniques for gushing treatment. This paper manages the use of four local types of Cyanobacteria in the lessening of different physico-synthetic parameters from the untreated material industry profluent. Profluent tests gathered from material industry situated in Chinnalapatty, Dindigul area, Tamil Nadu, India, were subjected in display examination. Local Cyanobacteriel species, for example, Nostoc muscorum, Anabaena variabilis, Lyngbya majuscula and Oscillatoria salina were utilized for biotreatment which were refined in BG11 media and vaccinated onto the untreated gushing. A huge bring up in pH esteem and lessening in COD, BOD, Ca, Mg, sulfate, zinc, nickel and Color was seen in 25 days of treatment. From the outcomes, it is clear that Cyanobacteria can viably remediate the contaminations from material industry emanating. (David Noel S, et al; 2014)

Ten distinct strains of marine cyanobacteria were tried for their capacity to decolourise and debase an obstinate diazo color, C.I. Corrosive Black 1. Of them, Oscillatoria curviceps BDU92191 could grow up to a tried grouping of 500 mG L−1. The living being debased 84% of the color at 100 mG L−1 in 8 days in a medium free of combined nitrogen. The color corrupting capacity is credited to the exercises of the compounds: laccase, polyphenol oxidase and azoreductase. The nonattendance of the doublet amine top notwithstanding the general lessening of
retention in the IR spectra affirmed the mineralisation of the tried azo color. The nitrogen acclimatizing catalyst thinks about alongside nitrogenase examine emphatically recommended the capacity of the non-heterocystous, filamentous marine cyanobacterium, O. curviceps BDU92191 to utilize C.I. Corrosive Black 1 as a nitrogen source in an oligotrophic situation. (Balakrishnan Priya, et al; 2011)

Material and method

1. Collection, Identification and characterization of algal species from dye effluent contaminated sites

Algal samples will be collected from different dye effluent contaminated sites of textile industries named Kumar industries E-22,23, Udyogpuram, Dist- Meerut-250103, Shree Bharat Textile, 74-A, Mohkampur II, Meerut 116, 250001 and Deekay textiles Private Limited, 104, Shyam Nagar, Pilokhari Rd, Meerut. Identification will be done by morophological and microscopic examinations.
2. Azo dyes

Three Azo dyes Malachite green, Congo red, Nigrosin will be selected for color removal studies.

<table>
<thead>
<tr>
<th>Dye Name</th>
<th>Chemical Structure</th>
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3. Dye solution

Commercially available dye solution of Malachite green, Congo red, Nigrosin will be used in the experiments.

4. Experimental procedure
Experiments will be designed in batch mode in a 100 ml flask with control of particular dye in both conditions (shaking and stationary) at room temperature under aerobic condition (Mohan et al. 2002). The flask will be filled with 25 ml of media and 250 µl of dyes and further same procedure will be applied on industrial effluent by adding the known algal sample. Decrease or reduction in dye color will be observed.

5. Analytical assay

Decrease in dye concentration will be monitored after regular interval of time during experiment. Concentration of experimental dye will only be measured by filtering the sample by using spectrophotometer to check the optical density of the sample at the given wavelength of the dye. To check turbidity, filtration of the sample is not required and turbidity will be measured by using turbidimeter and employing distilled water as a blank.

6. Instrumentation

Analysis by infrared spectrophotometer will be done on sample before and after the degradation of dyes. Significant changes may be observed in the form of peak like formation.

7. Study on in vitro bioremediation of textile dyes under shaking and stationary conditions by individual algae species and their consortium

The percent of the decolorization by algae species and their consortium in liquid media will be calculated by the following formula.

\[
\text{Dye decolorization (\%)} = \frac{\text{absorbance of control at given wavelength} - \text{Absorbance of inoculated sample at given wavelength}}{\text{Absorbance control}} \times 100
\]

8. Optimization of culture conditions for dye decolorizing algae sp. in shaking and stationary flask.

I. Effect of incubation temperature on algae:

Effect of incubation temperature on the growth of algae and in dye decolorization will be observed at following temperatures (27±2), 37 and 40 C±2.

II. Effect of incubation time

The effect of different incubation periods such as 2-15 days on the growth of algal cultures and their effect on dye decolorization will be evaluated.

Seed germination bioassay will be done to test the biosusability of dye solutions after bioremediation by different species and their consortium.

In seed germination bioassay filter paper will be placed in Petri plates and soaked with controlled dye solution and bioremediated dye solution. Equal number wheat seeds will be kept in both type of plates & incubated for germination. Percent seed germination will be observed. Observation on seed germination was taken for four days. The experiment was conducted at room temperature of 25 ± 1 °C.

RESULT AND DISCUSSION

1 screening of dye decolorizing blue green algae

The isolation of blue green algae (cyanobacteria) from different cultures led to the screening of required blue green algae which was further used in the experiment. These two strains were tested and compared for their ability to decolorize malachite green, Congo red, Nigrosin dye in shaking as well as stationery condition and at various temperatures like room temperature (25±1), incubation (27°C) and at 4°C.

Culture isolates oscillatoria and ........ within 24 h of shaking incubation decolorized dyes upto 40% which gradually decreases as the concentration of dyes increases the dyes upto 20% which were also decreased as 3 dye concentration moves upto 1%. The affect of various factors like shaking and stationery and temperature (RT, Incubation and 4°C) affect the decolorization process. As compared to stationery incubation, shaking incubation favored higher degradation of dyes by removing the color upto 94% and same happened in the case of temperature degradation of dyes were higher in incubator in comparison of room temperature and 4°C.

Effect of temperature

Different temperature was for both the blue green algae. Different temperature used were 37°C±1 (temperature of incubator), room temperature (37°C±1), 4°C±1. Both the blue
green algae showed remarkable degradation in dyes, but maximum degradation were seen in temperature of incubator i.e on 37°C±1.

Development and decolorization
Decolorization of colors by static and shaking society of blue green growth in manufactured medium were observed for increment in development saw amid algal development. However stationary stage was begun after 4 h of hatching.

**Effect of increasing concentrations of dyes**

Three concentration of dyes (0.05%, 0.5%, 1%) were used during the course of study.

Dye decolorization study

The blue green algae were well studied morphologically. Analysis of concentration [H+] was initially done by measuring the pH value before the setup of experiment. The pH is basic (>7) in nature. In between the study the pH was decreased due to the anionic nature of functional group making up the cell wall; blue green algae have negative charges on their surface. The main reason of drop in pH was the production of acids and enzymes to the medium for the reduction of dye (Shah *et al.* 2001).

**Effect of shaking and stationery condition on dye decolorization**

Both the algae showed a remarkable degradation of dyes as compared to other convectional method. Rate of decolorization were much higher in shaking condition as compared to stationery condition and also in lower concentration. The percent degradation of dyes was maximum in 0.05% dye concentration and minimum in 1% of dye concentration. The following table (Table.1,2,3,4,5,6) explain the decolorization of all three dyes by both algae at shaking and stationery condition. In shaking condition both the blue green algae degrades dye upto 90%. Malachite green and Congo red degrades 90% and 75% by oscillatoria and which was 90.9% and 65% by algae 2. Nigrosin as compared to other two dyes degrades at lower rate even in lower concentration. The complete degradation of all three dyes in 0.05% 0.5% and 1% are shown in the below data.
Table 7: Decolorization of dyes at (0.05%) by oscillatoria with shaking and stationery conditions of incubation. The results are means of duplicate experiments documented with standard deviations.

<table>
<thead>
<tr>
<th>Dyes</th>
<th>Degradation in shaking condition</th>
<th>Degradation in stationery condition</th>
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<tr>
<td></td>
<td>$I_0$</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green</td>
<td>0.22</td>
<td>0.01</td>
</tr>
<tr>
<td>(λ = 610 nm)</td>
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<tr>
<td>Congo red</td>
<td>0.20</td>
<td>0.05</td>
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<tr>
<td>(λ = 497 nm)</td>
<td></td>
<td></td>
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<tr>
<td>Nigrosin</td>
<td>0.50</td>
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<tr>
<td>(λ = 610 nm)</td>
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Table 8: Decolorization of dyes at (0.5%) by oscillatoria with shaking and stationery conditions of incubation. The results are means of duplicate experiments documented with standard deviations.

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<tr>
<th>Dyes</th>
<th>Degradation in shaking condition</th>
<th>Degradation in stationery condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_0$</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green</td>
<td>1.53</td>
<td>0.50</td>
</tr>
<tr>
<td>(λ = 610 nm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congo red</td>
<td>1.69</td>
<td>0.80</td>
</tr>
<tr>
<td>(λ = 497 nm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nigrosin</td>
<td>1.00</td>
<td>0.48</td>
</tr>
<tr>
<td>(λ = 610 nm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9: decolorization of dyes at (1.0%) by oscillatoria with shaking and stationery conditions of incubation. The results are means of duplicate experiments documented with standard deviations.

<table>
<thead>
<tr>
<th>Dyes</th>
<th>Degradation in shaking condition</th>
<th>Degradation in stationery condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_0$</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green ($\lambda = 610$ nm)</td>
<td>1.84</td>
<td>0.82</td>
</tr>
<tr>
<td>Congo red ($\lambda = 497$ nm)</td>
<td>1.74</td>
<td>0.95</td>
</tr>
<tr>
<td>Nigrosin ($\lambda = 610$ nm)</td>
<td>1.80</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Table 10: decolorization of dyes at (0.05%) by algae 2 with shaking and stationery conditions of incubation. The results are means of duplicate experiments documented with standard deviations.

<table>
<thead>
<tr>
<th>Dyes</th>
<th>Degradation in shaking condition</th>
<th>Degradation in stationery condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_0$</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Dyes</td>
<td>Degradation in shaking condition</td>
<td>Degradation in stationery condition</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td></td>
<td>$I_0$</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green ($\lambda = 610$ nm)</td>
<td>1.53</td>
<td>0.24</td>
</tr>
<tr>
<td>Congo red ($\lambda = 497$ nm)</td>
<td>1.69</td>
<td>0.57</td>
</tr>
<tr>
<td>Nigrosin ($\lambda = 610$ nm)</td>
<td>1.00</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Table 11: decolorization of dyes at (0.5%) by algae 2 with shaking and stationery conditions of incubation. The results are means of duplicate experiments documented with standard deviations.

<table>
<thead>
<tr>
<th>Dyes</th>
<th>Degradation in shaking condition</th>
<th>Degradation in stationery condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_0$</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green ($\lambda = 610$ nm)</td>
<td>1.53</td>
<td>0.24</td>
</tr>
<tr>
<td>Congo red ($\lambda = 497$ nm)</td>
<td>1.69</td>
<td>0.57</td>
</tr>
<tr>
<td>Nigrosin ($\lambda = 610$ nm)</td>
<td>1.00</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Table 12: decolorization of dyes at (1%) by algae 2 with shaking and stationery conditions of incubation. The results are means of duplicate experiments documented with standard deviations.
Effect of temperature in decolorization of dyes

Variation in temperature also plays a crucial role in decolorization of textile dyes, as blue green algae also requires a specific temperature to show its best action that is to degrade the dyes. Three different temperatures were used during the experiment to check the best decolorization of the dyes by BGA. Temperature used during the experiment were 37°C (incubation), 25°C±1 (room temperature) and 4°C. maximum of 98% degradation is seen in case of malachite green. Temperature of incubation showed maximum degradation of dyes during the experiment. At 0.05% concentration of dye malachite green degrades 95.5% at 37°C, 919% at RT and 22.7% at 4°C. Congo red degrades 90%, 1% and 35% respectively and Nigrosin showed 92%, 14% and 18% of dye degradation at 0.05% concentration. Similarly algae 2 degrades malachite green 86.4% at 370C, 31.8% at RT and 36.4% at 40C at a concentration of 0.05% which was gradually slow down as concentration of dyes goes up.

Table 13 Effect of temperature on the decolorization of dyes at (0.05%). The results are means of duplicate experiments documented with standard deviations. ALGAE 1

<table>
<thead>
<tr>
<th>DYES</th>
<th>$I_0$</th>
<th>AT INCUBATOR (37°C)</th>
<th>AT ROOM TEMPERATURE(25°C)</th>
<th>AT 4°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F_0$</td>
<td>PDD</td>
<td>$F_0$</td>
<td>PDD</td>
</tr>
<tr>
<td>DYES</td>
<td>$I_0$</td>
<td>AT INCUBATOR (37°C)</td>
<td>AT ROOM TEMPERATURE(25°C)</td>
<td>AT 4°C C</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
<td>---------------------------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$F_0$</td>
<td>PDD</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green ($\lambda= 610$ nm)</td>
<td>1.53</td>
<td>0.3</td>
<td>80.3%</td>
<td>0.30</td>
</tr>
<tr>
<td>Congo red ($\lambda= 497$ nm)</td>
<td>1.69</td>
<td>0.54</td>
<td>68.1%</td>
<td>0.54</td>
</tr>
<tr>
<td>Nigrosin ($\lambda= 610$ nm)</td>
<td>1.00</td>
<td>0.3</td>
<td>70.0%</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Table 14 Effect of temperature on the decolorization of dyes at (0.5%). The results are means of duplicate experiments documented with standard deviations. ALGAE 1

<table>
<thead>
<tr>
<th>DYES</th>
<th>$I_0$</th>
<th>AT INCUBATOR (37°C)</th>
<th>AT ROOM TEMPERATURE(25°C)</th>
<th>AT 4°C C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$F_0$</td>
<td>PDD</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green ($\lambda= 610$ nm)</td>
<td>0.22</td>
<td>0.01</td>
<td>95.4</td>
<td>0.20</td>
</tr>
<tr>
<td>Congo red ($\lambda= 497$ nm)</td>
<td>0.20</td>
<td>0.02</td>
<td>90</td>
<td>0.19</td>
</tr>
<tr>
<td>Nigrosin ($\lambda= 610$ nm)</td>
<td>0.50</td>
<td>0.04</td>
<td>92</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Table 15 Effect of temperature on the decolorization of dyes at (1%). The results are means of duplicate experiments documented with standard deviations. ALGAE 1
<table>
<thead>
<tr>
<th>DYES</th>
<th>(I_0)</th>
<th>AT INCUBATOR (37°C)</th>
<th>AT ROOM TEMPERATURE(25°C)</th>
<th>AT 4°C</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(F_0)</td>
<td>PDD</td>
<td>(F_0)</td>
<td>PDD</td>
</tr>
<tr>
<td>Malachite green ((\lambda = 610\ nm))</td>
<td>0.22</td>
<td>0.03</td>
<td>86.4</td>
<td>0.15</td>
<td>31.8</td>
</tr>
<tr>
<td>Congo red ((\lambda = 497\ nm))</td>
<td>0.20</td>
<td>0.05</td>
<td>75</td>
<td>0.17</td>
<td>15</td>
</tr>
<tr>
<td>Nigrosin ((\lambda = 610\ nm))</td>
<td>0.50</td>
<td>0.19</td>
<td>62</td>
<td>0.41</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 16: Effect of temperature on the decolorization of dyes at (0.05%). The results are means of duplicate experiments documented with standard deviations. ALGAE 1

Table 17: Effect of temperature on the decolorization of dyes at (0.5%). The results are means of duplicate experiments documented with standard deviations. ALGAE 1
Table 18 Effect of temperature on the decolorization of dyes at (1%). The results are means of duplicate experiments documented with standard deviations. ALGAE 1

<table>
<thead>
<tr>
<th>DYES</th>
<th>$I_0$</th>
<th>AT INCUBATOR (37°C)</th>
<th>AT ROOM TEMPERATURE(25°C)</th>
<th>AT 4°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$F_0$</td>
<td>PDD</td>
<td>$F_0$</td>
</tr>
<tr>
<td>Malachite green</td>
<td>1.53</td>
<td>0.3</td>
<td>80.3%</td>
<td>1.18</td>
</tr>
<tr>
<td>(λ= 610 nm)</td>
<td></td>
<td>0.3</td>
<td>80.3%</td>
<td>1.18</td>
</tr>
<tr>
<td>Congo red</td>
<td>1.69</td>
<td>0.54</td>
<td>68.1%</td>
<td>1.45</td>
</tr>
<tr>
<td>(λ= 497 nm)</td>
<td></td>
<td>0.54</td>
<td>68.1%</td>
<td>1.45</td>
</tr>
<tr>
<td>Nigrosin</td>
<td>1.00</td>
<td>0.3</td>
<td>70.0%</td>
<td>0.73</td>
</tr>
<tr>
<td>(λ= 610 nm)</td>
<td></td>
<td>0.3</td>
<td>70.0%</td>
<td>0.73</td>
</tr>
</tbody>
</table>
Fig 2: Bioremediation of dyes at 0.05% concentration by Oscillatoria under shaking and stationery condition

<table>
<thead>
<tr>
<th>Dye</th>
<th>Percent degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malachite green</td>
<td>~90%</td>
</tr>
<tr>
<td>Congo red</td>
<td>~70%</td>
</tr>
<tr>
<td>Nigrosin</td>
<td>~20%</td>
</tr>
</tbody>
</table>

Shaking condition
Stationery condition

Fig 3: Bioremediation of dyes at 0.5% concentration by Oscillatoria under shaking and stationery condition

<table>
<thead>
<tr>
<th>Dye</th>
<th>Percent degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malachite green</td>
<td>~60%</td>
</tr>
<tr>
<td>Congo red</td>
<td>~50%</td>
</tr>
<tr>
<td>Nigrosin</td>
<td>~40%</td>
</tr>
</tbody>
</table>

Shaking condition
Stationery condition
Fig 4: Bioremediation of dyes at 1% concentration by Osillatoria under shaking and stationery condition

Percent degradation

Shaking condition
Stationery condition

Dye
Malachite green Congo red NIGROSIN

Fig 5: Effect of temperature on dye decolorization at 0.05% concentration by oscillatoria

Percent degradation

Incubator room temperature 40°C

Dye
Malachite green Congo red Nigrosine
Fig6: Effect of temperature on dye decolorization at 0.5% concentration by oscillatoria

Fig7: Effect of temperature on dye decolorization at 1% concentration by oscillatoria
Fig 8: Bioremediation of dyes at (0.05%) by algae 2 under shaking and stationery condition

![Bar chart showing percent degradation of dyes (Malachite Green, Congo red, Nigrosin) under shaking and stationery condition.]

Fig 9: Bioremediation of dyes at 0.5% concentration by algae 2 under shaking and stationery condition

![Bar chart showing percent degradation of dyes (Malachite green, Congo red, Nigrosin) under shaking and stationery condition.]

Dyes: Malachite Green, Congo red, Nigrosin

Conditions: Shaking condition, Stationery condition
Fig 10: Bioremediation of dyes at 1% concentration by algae 2 under shaking and stationery condition

Fig 11: Effect of temperature on dye decolorization at 0.05% concentration by algae 2
Congo red at 0.05 % concentration degrades by 90, 1, 35% respectively by oscillatoria which was 75, 15, 50% respectively at 37°C, RT and 4°C. 0.5% concentration showed 68.1% and 29.6% of decolorization by algae oscillatoria while it was 68.1%, 14.2% and 29.6% by algae 2. Nigrosin showed maximum degradation of 92% at a concentration of
0.05% by oscillatoria and minimum of 5% degradation by the same at 1% dye concentration.

**Biousability test by seed germination assay**

Effect of bioremediated and untreated dye solution was observed on wheat seed germination. Seed germination examination showed the effect of untreated and treated dyes on germination of seeds. It was found that germination percentage was higher upto 90% by treated dye, while the untreated (control) dye inhibited the germination of wheat seeds due to its toxicity. All three dyes i.e malachite green, Congo red and Nigrosin at three concentrations (0.05%, 0.5% and 1%) were unable to grow but after treating the dye with both the algae i.e. bioremediated dyes showed germination of seed at good extent. Growth of seeds were good at 0.05% of dye concentration which was little slower at 0.5% concentration and 1% respectively.

![Germination assay of wheat seeds by treated and untreated dyes.](image)

(After 2 days of experiment)

(After 4 days of experiment)

**Fig 14 : Germination assay of wheat seeds by treated and untreated dyes.**
Conclusion

Due to the dangerous and stylish effects on waters the treatment of material effluents is of incredible intrigue. To grow best advancements for the treatment of wastewaters containing azo colors, much research have been preformed no single arrangement has been found for remediating the wide decent variety of material water squanders, likewise worries of human and natural medical problems urging the legislature to control or treat material gushing releases to have progressively bring down shading and nitrogen levels. In the wake of monitoring the issue, makers from numerous material enterprises have been neglected to expel azo color mixes from the wastewaters they deliver. The issue in treating these color squanders can't achieve treatment offices until makers of color and material ventures can create effective advancements, which expands holding between color fiber and furthermore bring down color house misfortunes (Lewis, 1999).

This chapter will deals with the current problem caused by textile effluents and azo dyes.
Dyes are utilized to give colour to materials due to which it becomes an imperative role in human life. The physico-chemical methods of industrial effluent treatment do not take away the dyes successfully. Recent promising investigates on biological decolorization of textile effluent has showed that a large number of microorganisms as well as plants able to decolorize a wide range of anionic and cationic dyes. A variety of biological treatment methods are set up to be the top for decolorization of dye. Due to its cost effectiveness and less regeneration by microorganisms such as algae, bacteria, fungi, and plants biological decolorization of dye effluent is receiving much consideration. Current status of biological decolorization and remediation of dye effluents, and deals with the most deliberate part on the effects of various parameters like pH, temperature and dye concentrations. (V Karthik et al, 2014)

Synthetic dyes are widely and more commonly used in a large number of industries like paper, textile, color photography, printing, and also in the food industry (Meyer, U., 1981). Constitute of dyes is very essential part for our civilization, but the environmental pollution cause by these industries.

**Enzymatic Decolorization**

In nature biological degradation of synthetic dye occur due to release of laccase, lignin peroxidase, magnese peroxidase [1, 2]. They use molecular oxygen to oxidise a wide range of aromatic and non aromatic compounds by a radical catalysed mechanism [3, 4]. Due to its low specificity for the reducing substrate its commercial and biotechnological significance is greater [5]. Cyanobacteria, the wide-adapting photo-oxygenic prokaryotes, which are self dependent for carbon and nitrogen (certain species), have rarely been investigated for their ligninolytic activity and bioremediation ability. Laccase production was observed in all the cyanobacterial strains that peaked in 7 day old culture day ranged from 6 mU/ml to 24 mU/ml.

Addition of inducer (guaiacol) in culture medium on zeroth day of inoculation resulted in induction of laccase activity (Fig.2) The differences in laccase activity among different strain are likely because of
their genotypic variations. Enzyme based decolorization is an efficient method and of current interest in industrial effluent treatments [18]. However, no study has been reported in cyanobacteria. In the present study, the dye decolorization ability of crude laccase from both the experimented algae was assayed using synthetic dyes malachite green, congo red and nigrosin. Most previous studies focused on the use of crude laccase for treatment of synthetic dyes [20].

Fig. 14. Laccase activity in cyanobacterial culture filtrate in control condition
Fig. 15 Laccase activity in cyanobacterial culture filtrate with guaiacol induction
Various workers have investigated the biosorption of various organic pollutants and color from wastewaters (Tsezos and Bell 1989; Fu and Viraraghavan 2001). Biomass of some natural microbial species, including bacteria, fungi, and algae, is capable of removing the
different textile dyes by biosorption, biodegradation, or mineralization (Carliell et al. 1995).

Biosorption mechanisms are therefore various (physical adsorption, chemical binding of ionic groups, ion exchange, etc.) and in some cases they are still not very well understood (Veglio and Beolchini 1997). Cell walls of microbial biomass mainly composed of polysaccharides, proteins, and lipids, offer abundant functional groups such as carboxyl, hydroxyl, phosphate, and amino groups, as well as hydrophobic adsorption sites such as aliphatic carbon chains and aromatic rings (Ringot et al. 2005). This physicochemical phenomenon is quick and can be reversible.

Experiment conducted to decolorize the textile dyes by cyanobacteria shows that both the algae (oscillatoria and algae 2) act as good adsorbent. Biosorption of dyes occur essentially either through complexation, adsorption by physical forces, precipitation, entrapment in inner spaces of fungal mycelium, ion exchange due to surface ionization, and by formation of hydrogen bonds (Yeddou-Mezenner, 2010). Due to an increased cell-surface ratio, cyanobacteria have a greater physical contact with the environment. Thus, some blue green algae have demonstrated better dye adsorption potential.
Fig 16 decolorization of Nigrosin by oscillatoria via (biosorption)

Fig 17 decolorization of congo red by oscillatoria via (biosorption)
Fig 18: decolorization of Malachite green by Oscillatoria via (biosorption)

Fig 19: decolorization of Nigrosin by algae 2 via (biosorption)
Detoxification of all the dyes (Malachite green, Congo red, Nigrosin) was confirmed by the wheat seed germination (biosability Test). The untreated dyes inhibited the seeds germination observed after four days of incubation, while the seed germination was observed after 48 hours in treated dyes. This biosability study test, suggest that detoxify or treated dyes can be efficiently used for detoxification and bioremediation of harmful dyes.
Conclusion

Decolorization of three dyes was studied under shaking and stationery conditions and the effect of temperature of on degradation was also studied. Encouraging results were obtained, after 2 days. Maximum degradation of all the dyes was obtained after 5-6 days of experiment. Temperature also played a crucial role in decolorization of dyes. The percent of dye decolorization increased noticeable at 37°C.

In this study, higher decolorization was observed under shaking condition at a temperature of 37°C. Percentage of decolorization was also higher at 0.05% of dye concentration as compared to other two dye concentrations. Both the algae shows higher rate of decolorization at 37°C and shaking condition which could be due to the better oxygenation of the cyanobacteria and regular contact of secreted enzyme with the dye due to regular shaking. Biosorption also plays a important role in decolorization of dye. After 6 days of incubation, both the algae were found to absorb the dye. So, biosorption and secreted enzymes found to be the major factor in the bioremediation of dyes by cyanobacteria. Decolorization of dye may be due to the biodegradation of chromophore because of the extracellular enzymes and the biosorption.

Because it is a environmental friendly technique of dye degradation and its low cost bioremediation has been characterized as a soft technology. Moreover, this technology causes little or no disturbance to the environment this made this technique attractive and method of choice.

Summary

The recognizable proof and research of new strains with the assistance of atomic system will emphatically enhance down to earth utilization of cyanobacteria and it is foreseen that cyanobacterial remediation will be soon a solid and focused procedure and the treated water can be utilizes for different reason. In any case natural strategies, being shoddy and easy to utilize, have been the principle concentrate of late examinations on color decolorization and debasement. Late basic work has uncovered the presence of a wide assortment of microorganisms equipped for decolorizing a similarly extensive variety of colors.

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