Decolorization of Textile dye effluent by Marine cyanobacterium Lyngbya sp. BDU 9001 with coir pith

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ABSTRACT

Lyngbya sp. BDU 9001 with coir pith and cyanobacterium culture with effluent alone were used to decolorize the textile dye effluent. The accuracy of 73\% decolorization efficiency was performed through the spectral analysis at the 15\textsuperscript{th} day of incubation in cyanobacteria and coir pith culture. The physiochemical parameters such as OD, pH, Temperature, Nitrite, Nitrate, Calcium, Magnesium, chlorophyll ‘a’, Protein were analyzed. The chlorophyll ‘a’ and protein content were increased and decolorized activity was further confirmed by the standard techniques of Dissolved Oxygen (DO) and, biological oxygen demand (BOD).

Keywords: Decolorization, Lyngbya with coir pith, textile dye effluent, analysis.

1. Introduction

Dyes are the widely used important things in textile industries. The effluent which is released from the industries are mostly affect the environment and cause severe problem to the plants, animals, aquatic habitats and human beings. Microorganisms are act as the bioremediation agent to treat the waste water containing textile dyes (Chung \textit{et al}., 1993, Ramaldho \textit{et al}., 2002, 2004). Microalgae can decolorize the textile dye effluent (Mustafa \textit{et al}., 2009). Compared with some physical, chemical treatment the biological treatment has high significance due to its cost effectiveness and eco-friendliness. Among this the marine cyanobacteria have a unique function system in the removal of colors from textiles (Thajuddin 2005 Singh \textit{et al}., 1969). Coir pith is one of the important wastes which are highly exposed into the environment in tropical countries due to the cultivation of coconut tree. This is most difficult to remove it from the environment, because of its lignocellulosic nature (Malliga \textit{et al}., 1996). But the cyanobacteria can degrade the coir pith (Anadaraj \textit{et al}., 2008) and which is degraded the coir pith may have the ability to decolorize the textile dye effluent. This paper exploited the decolorization of textile dye effluent by using Lyngbya sp. BDU 9001 with coir pith.

2. Material and methods

2.1 Sample source

The pure marine cyanobacterium Lyngbya sp. BDU 9001 cultures and the dye effluent used in this study were taken from National facility for Marine cyanobacteria, Bharathidasan University, Trichy, India. And textile effluent was collected from Karu r unit, Tamil Nadu, India. The samples were collected in sterile borosilicate bottles protected from sunlight during transportation. After dye effluent sample was sterilized at 121°C for 15 mins.
2.2 Screening assay

The cyanobacterium and coir pith 0.1:1g ratio was taken, and grown into the 100% dye effluent under the photoperiod of 1500 Lux. These cultures were kept for 15 days to observe the growth and efficiency of decolorization.

2.3 Analysis of physiochemical parameters

The parameters like pH (APHA 1989), OD, Temperature, Chloride (APHA 1989), Salinity (APHA 1989), Chlorophyll 'a' (Mac Kineey, 1941), Protein (Lowry et al., 1951), nitrite (APHA, 1995), nitrate (APHA, 1976), calcium and Magnesium (Govindaraju et al., 2001) were analyzed before and after treatment as triplicates. The percentage of decolorization was performed by using the calculation as follows;

\[
\text{Percentage of decolorization} = \frac{\text{Initial absorbance} - \text{Final absorbance}}{\text{Initial absorbance}} \times 100
\]

2.3.1 Estimation of Dissolved Oxygen (DO)

The dissolved oxygen (APHA 1995) was performed to all the test samples as triplicates. The initial dye effluent non-sterilized, sterilized treated effluent with coir pith, cyanobacterium, cyanobacterium with coir pith samples were poured into the bottles. The sea water was filled into the bottom of the bottle. The reagents of 1ml alkaline iodide and Manganous sulfate were added respectively without bubbles, the white precipitates were formed. Finally 1 ml of Sulfuric acid reagent was added to this and kept it for half an hour, to separate the white precipitates. 50 ml of sample was taken from this solution and it was titrated against the Sodium thiosulfate titrant in the burette.

The reading were noted and calculated by using as follows:

\[
0.\text{mg/l} = \frac{CD \times M \times E \times 1000 \times 0.698 \times V_t}{V_s}
\]

Whereas:

CD= Correction for displacement of sample when reagents are added, M=Molarities of thiosulfate, E= Equivalent weight of O₂, 1000= to express per liter, 0.698= to convert ppm to mg of O₂, Vt = Titer value, Vs= volume of the sample used in titration

2.3.2 Estimation of Biological oxygen demand (BOD)

The Biological Oxygen Demand (Young et al., 1981) was analyzed to the initial dye effluent (nonsterilized), sterilized treated effluent with coir pith, cyanobacterium, cyanobacterium with coir pith and these samples were poured into the BOD bottles. The dilution water was kept at 20°C before usage. And it was aerated with organic free water. The suitable volume of water were also be added to the bottle and 1 ml of following reagents was added respectively 1ml of Phosphate buffer, MgSO₄, FeCl₂, and seeding of water. All these Samples were kept at the room temperature at 20°C. After the incubation period the following solutions was added into the BOD bottles, 1 ml of MgSO₄, Alkali iodide solutions sulfuric acid solution were added for the formation of brown color. After the addition of all these reagents it was
titrated against NaSO\(_4\) and the readings were noted and calculated by using the formula as follows:

\[
\text{BOD mg/l} = \frac{\text{DO Depletion}}{\text{Sample fraction}}
\]

Whereas:

DO Depletion=Initial DO-Final DO, Sample fraction 5ml/300ml (volume of sample/volume of BOD Bottle)

3. Results and discussion

The cyanobacterium *Lyngbya* sp. with coir pith was exhibited the higher percentage of decolorization under 1500Lux Photoperiod, when compared to only cyanobacterium and coir pith individual treatments. A considerable decolorization 46.34% was noticed in the dye effluent with cyanobacterium. Significantly the cyanobacterium with coir pith showed increased percentage of decolorization 78.04% at 15\(^{th}\) day. Compared to cyanobacterium culture alone in the effluent, coir pith with cyanobacterium was obtained the increased percentage of decolorization (Figure. 1).

![Decolorization at %](image)

**Figure 1**: Decolorization efficiency of cyanobacterium with coir pith in the effluent.

Which is slightly similar to Gurulakshmi *et al.*., 2008? When compared to other individual treatments, the pH was decreased in the combined treatment of cyanobacterium with coir pith. This could be due to the secretion of enzymes to degrade the cir pith by cyanobacterium and thereby decreased pH was noticed. According to Shah *et al.*, 2001 and Mubarak *et al.*, 2011 the pH values were changed from alkaline to acidic due to the secretion enzymes. This similar pattern was observed in OD level also and there were no temperature variations in all treated effluents (Table.1).
Table 1: Physiochemical characteristics of treated effluent with cyanobacterium and coir pith at 15th day.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Initial (Unsterilized)</th>
<th>Textile dye (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>CP (1g)</td>
</tr>
<tr>
<td>Color</td>
<td>Dark green</td>
<td>Dark green</td>
</tr>
<tr>
<td>OD(540nm)</td>
<td>0.41 ±0.02</td>
<td>0.42 ±0.01</td>
</tr>
<tr>
<td>Temperature(°C)</td>
<td>35±0</td>
<td>29±2</td>
</tr>
<tr>
<td>pH</td>
<td>8.91 ±0.3</td>
<td>8.93 ±0.2</td>
</tr>
<tr>
<td>Nitrite (mg/l)</td>
<td>45±0.7</td>
<td>45±0.4</td>
</tr>
<tr>
<td>Nitrate (mg/l)</td>
<td>61±1.07</td>
<td>59±1.09</td>
</tr>
<tr>
<td>Calcium (mg/l)</td>
<td>0.38 ±0.04</td>
<td>0.37 ±0.02</td>
</tr>
<tr>
<td>Magnesium (mg/l)</td>
<td>8.15 ±0.9</td>
<td>8.13 ±0.6</td>
</tr>
</tbody>
</table>

Note: Mean± standard deviation (n=5); CB = Cyanobacteria; CP = Coir pith.

Besides calcium, high amounts of oxidizable organic matter, traces of dissolved oxygen, considerable amounts of nitrate and phosphates in all the effluents were probably the factors favoring the growth of Cyanobacteria as suggested by Singh and Saxena, 1969, Venkateswarlu 1969b, 1976, Burch et al., 2001, Murugesan and Sivasubramanian, 2005, and Ozer et al., 2006. The nutrient contents like nitrate, nitrites were present more in the sterilized control. According to Akan et al., 2007 the concentration of nitrite, nitrate was found to be increasing in the control and it might be due to the discharge of effluent from the textile and tannery industries, where as in the present investigation the nitrate and nitrite concentration were significantly reduced in treated effluents of Cyanobacterium with coir pith, 18% of nitrate and 73.91% of nitrite were removed in the treated effluents of cyanobacterium with coir pith (Table. 1). Like wise Subramanian et al., 2012 nitrate utilization by cyanobacteria is a significant process during stress conditions, the cyanobacteria have to synthesize the enzyme called nitrite, nitrate reductase to transport the nitrate into the cellular component systems. At beginning the usual mechanism of cyanobacteria contain the conversion of ammonia into nitrite is a simple process which is integrated into the cell molecules. So the nitrate can be removed rapidly and nitrate was removed slowly. Ca was found to be a fewer element in dye effluent sample, the cyanobacterium with coir pith was utilized this fewer amount of Ca. This is comparable with Mishra et al., 2010. Mg was also removed slowly in the effluent by cyanobacterium with coir pith (Table. 1) which indicates the minor role of Mg in effluent.

The photosynthetic pigment chlorophyll plays a significant role in the photoautotrophic organisms. Cyanobacterium contains the rate of chlorophyll ‘a’ 5.01 mg/g in 1500 lux photoperiod. Ultimately the treated effluent of cyanobacterium with coir pith showed the increased rate of chlorophyll ‘a’ which was found 7.29 mg/g. This increased rate of chlorophyll ‘a’ was noticed that it could be due to the organism may able to grow or have the tendency to grow in presence of textile dye in the effluent, and this effluent may not inhibit
the growth of the organism. This is negatively correlated with Shashirekha et al., 1997, Swaminathan palanisami et al., 2010 and Mubarak et al., 2011 (Figure. 2).

**Figure 2:** Effect of Chlorophyll ‘a’ in treated effluent of cyanobacterium with coir pith.

**Figure 3:** Effect of protein in treated effluent of cyanobacterium with coir pith

The Protein concentration of cyanobacteria was found to be 118.0 mg/g. The cyanobacterium when decomposed the coir pith the content of protein was increased as 148.0 mg/g (Figure. 3). This indicates the decomposition of coir waste by cyanobacterium exposed the highest concentration of protein this could be due to the secretion of proteins, uptake of nutrients from coir pith and dye effluent and this protein was used to degrade the coir pith. The content of chloride was reduced apparently when the cyanobacterium decomposed the coir pith (Figure. 4). According to Subramanian et al., 2012 the content of chloride was decreased due to the metabolic activity of cyanobacterium for the decolorization process, this similar pattern was observed in this result in decolorization and decomposition of the effluent and coir pith by cyanobacterium.
Decolorization of Textile dye effluent by Marine cyanobacterium Lyngbya sp. BDU 9001 with coir pith

The initial salinity was found to be higher when compared to other treated effluents. When the chloride content was decreased, simultaneously the content of salinity was also decreased in all treated effluents (Figure.5). This is coinciding with the research work of Haiping Luo et al., 2012, in the desalination of waste water using microbial cells.

The dissolved O\textsubscript{2} of the dye effluent sample control showed low level of O\textsubscript{2}. The combined culture of cyanobacterium with coir pith showed increased rate of dissolved O\textsubscript{2} (Figure. 6) the photosynthesis process were higher rate in the presence of light intensity and this could be due to the decomposition of coir pith by cyanobacterium the effluents gets increased from 1.51 to 2.21(mg/l) which is slightly similar to Shashirekha V et al., 2008.

**Figure 4:** Effect of Chloride in treated effluent of cyanobacterium with coir pith.

**Figure 5:** Desalination activity of cyanobacterium with coir pith in textile dye effluent.
Decolorization of Textile dye effluent by Marine cyanobacterium Lyngbya sp. BDU 9001 with coir pith

Figure 6: Level of Dissolved O₂ in effluent and treated effluent with cyanobacterium and coir pith.

Figure 7: Level of Biological Oxygen Demand in effluent and treated effluent with cyanobacterium and coir pith.

The biological Oxygen demand shows the decreased rate of BOD in the treated effluent of cyanobacterium with coir pith. Compared to other individual treatment, the abasement of BOD was measured in the combined culture of cyanobacterium with coir pith (Figure 7). This is similar with the work of Manoharan et al., 1992 and Patnaik et al., 2001. This could be due to the reduction available of Carbon for the mineralization of the medium to decolorize the dye effluent by the cyanobacteria to breakdown the material. So the biological oxygen demand was reduced from initial to treated effluents.

4. Conclusion

It is concluded from our results the cyanobacterial treatment is one of the good bioremediation agent to degrade the coir pith and to remove the color from the textile dye effluent. This contribution of cyanobacteria clearly exhibited its good growth appearance at pH 7 and the temperature 29°C. Which was shows the normal behavior of the cyanobacteria with the environment. The traditional polluted water treatment requires cost and high effect
of chemicals, which is cause new more problem to the environment. These blue green algae are a suitable factor due to its cost effectiveness and eco-friendliness. This is a cheap and best friend of our environment.

References


