Bioremediation of Textile Dyes by using Blue Green Algae

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Abstract— Excessive use of synthetic dyes by textile industries and its discharge to the nearby water bodies is a major concern for all environmentalists due to their low biodegradable nature and health problem like skin allergy, dermatitis, skin irritation and also has toxic, carcinogenic and mutagenic nature, it also lead to low water visibility. To solve this problem one species of algae was isolated from pond water. Oscillatoria inoculated in batch culture in shaking as well as stationery condition for fifteen days. The studies reveal the potential effect in dye degradation by degrading the color of textile dyes up to 95%.

Key words: Bioremediation, Blue Green Algae, Dyes, Effluent

I. INTRODUCTION

Synthetic dyes are widely used in many industries like textile, paper, food, plastics and cosmetics. There are a number of environmental problem associated with the discharge of these dyes into the environment after use and have concerned for both industrial and academic scientists (Mahmoodi et al., 2009). On an average, 0.7-0.8 million tons of dyes are annually produced throughout the world. In industry, 10,000 dyes and pigment are used (Park et al., 2007; Revankar and Lele, 2007; Murugesan et al., 2007). Dyes used in textile industries design 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. These dyes show their adverse effect in terms of chemical oxygen demand and also reduce visibility in water (Wesenberg et al., 2003; Dos Santos et al., 2007; Ofomaja, 2009).

Removal or degradation of pollutants like unwanted nutrients and xenobiotics 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, their central role in the nitrogen fixation, 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)

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, physico-chemical or chemical methods are costly, less efficient and waste productive. (Enayatzamir et al., 2009; Jin et al., 2007; Ren et al., 2006; Sirianuntapiboon and Srisornak, 2007). On the other hand, microorganisms (bacteria, fungi, algae) have the ability to decolorize these synthetic dyes and are considered to be sustainable, cheap and eco-friendly source for biodegradation of the dyes used in these industries (Bhatti et al., 2008). Moreover, biological processes are more approachable because of their low cost, effectiveness, ability to produce less sludge and production of non toxic by-products. (Ali et al. 2011).

II. MATERIALS AND METHOD

A. Algal Collection

Oscillatoria species was collected from a pond in the area of Modipuram, Meerut (India). The microscopic examination of isolated algal species shows that the algae was filamentous, septate etc. Freshly isolated algae was cleaned with distilled water and dried before the starting the experiment. Algae inoculum was weighed known quantities and inoculated prior to the dye removal process.

B. Dye Used

Three dyes were used during the experimentation named Congo red, Nigrosin, Malachite green and there λ_{max} is 497, 580 and 610 nm respectively. Stock solution (1000 mg/L) of Congo Red, Malachite green and Nigrosin were prepared according to the experiment requirement. The concentration of dye in the experimental sample was quantified before and after experimentation using UV spectrophotometer at a maximum absorbance (λ_{max} is 497, 580 and 610 nm respectively). Stock solution were stored in refrigerator and used as required.

C. Experimental Set Up

Experiment was carried out in duplicate with control (without algae) by adopting batch culture in 100 ml of wide bottle for 15 days at room temperature (27°C ± 1°C) under shaking and stationery condition. The bottles are filled with 50 ml of dye media and desired concentration (0.05%, 0.5% and 1.0%) and 50 mg of algal was inoculated in each bottle except the control. pH of the reaction mixture was adjusted to (7.0 ± 1) after the inoculation of algae. Experimental set up and algae were placed near a window to provide natural light condition of water body system.

Degradation of dye was observed at regular interval throughout the experimental period. Dye concentration was measured by filtering (Whatman No. 42) the sample and optical density (OD) was measured at the corresponding maximum wavelength using spectrophotometer. Degradation of dye is used by the following formula.

$$\% \text{ degradation} = \frac{\text{Initial concentration} - \text{Final concentration}}{\text{Initial concentration}} \times 100$$

III. Result and Discussion

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].

A. Dye Decolorization Study

A higher rate of decolorization were observed in malachite green and congo red (0.05 and 0.5% of dye concentration) but it was comparatively low in Nigrosin. As the concentration moved to 1% the rate of decolorization decreased.

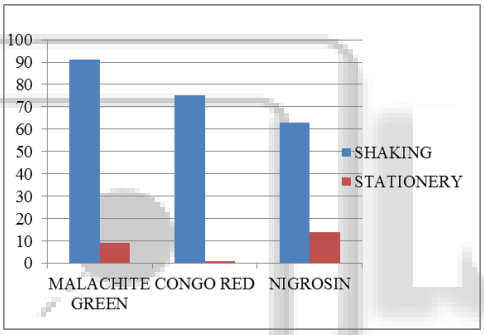

Fig. 1: Bioremediation of dyes at (0.05%) by algae under shking and stationery condition

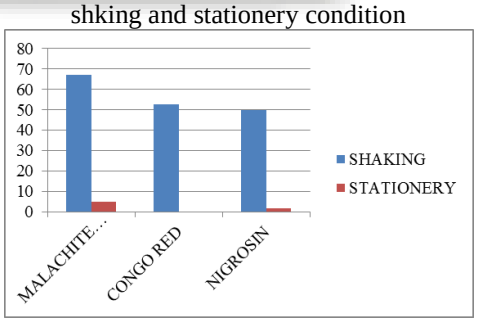

Fig. 2: Bioremediation of dyes at (0.5%) by algae under shaking and stationery condition

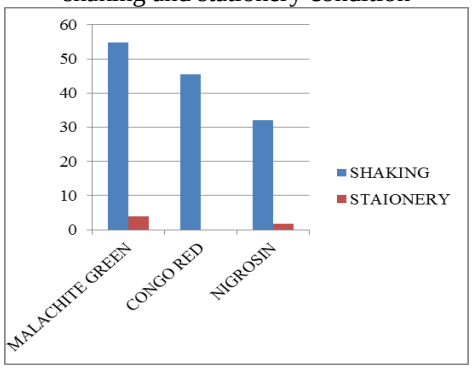

Fig. 3: Bioremediation of dyes at (0.1%) by algae under shaking and stationery condition

B. Spectrometer dye decolorization study

After the spectrometer study of textile decolorization. It was clearly revealed that the intensity was decreased after the blue green algae treaetment.

The textile dye treated with algae at 0.05 and 0.5% of concentration showed greator amount of decolorization in malachite green and congo red as compared to Nigrosin.

Degradation in textile dye was 91% in malachite green, 75% in congo red and 23% in Nigrosin dyes at the cocncentration of 0.05 %. At 0.5% of dye concentration, malachite green shows 67% degradation which was 52.7% in congo red and 52% in Nigrosin.

Cell wall of microbes (cyanobacteria) degrades and impart additional functional groups and solubelizes certain cell constituents such as lipids (Nagase et. al.1997) in basic condition. This catalyse the decolorization process by the organism. The technique of bioremediation by using microbes (cynobacteria) proves to be more effective in terms of dye degradation in comparison to other convectional method. Moreover biological remediation is more approachable because of their low cost, effectiveness, ability to produce less sludge and production of nontoxic byproducts (Ali et al. 2011).

Hence we can say that oscillatoria is an efficient blue green algae which may be used in the bioremediation of textile dyes.

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