African Journal of Basic & Applied Sciences 3 (1): 09-13, 2011
ISSN 2079-2034

Efficiency of Textile Dye Decolorization by Marine Cyanobacterium, *Oscillatoria formosa* NTDM02

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Abstract: Cyanobacteria are the Gram negative, oxygen evolving photosynthetic prokaryotes and have wide variety of application in biotechnological research. Releasing of textile dye effluents into general water bodies is a major environmental and health problem. Micro algae and cyanobacteria are considered as an important source for decolorizing dye and textile effluent. The dye Amido Black and textile dye effluent is chosen for this investigation and the marine cyanobacterium, *Oscillatoria formosa* NTDM02 was used for the decolorization process. Chlorophyll-a content of this organism was tested before and after the treatment. The experimental results showed that the marine cyanobacterium, *Oscillatoria formosa* NTDM02, which decolorize the textile effluent efficiently in short period of time. This can be used for the bioremediation of dye effluents.

Key words: *Oscillatoria* · Effluent · Dye · Chlorophyll-a · Cyanobacteria · Bioremediation

INTRODUCTION

Microorganism, as bioremediation agents in the treatment of waste water containing textile dyes [1]. Cyanobacteria have a ubiquitous distribution [2-5] but their role in functioning of ecosystems, including degradation of recalcitrant compounds including dyes [6-9]. Azo-aromatic dyes are the major group of textile dye stuffs. When these colored effluents enter water bodies they may either inhibit the biological activity or cause water-borne disorders such as nausea, hemorrhage, ulceration of skin and mucous membrane, dermatitis, perforation of nasal septum, severe irritation of respiratory tract or cancer [10]. These structures can be reductively cleaved into colorless amines by several bacterial species [11, 12]. The cleavage of azo bonds is a gratuitous process which can occur when the micro organisms using a reduced carbon compounds as the growth substrate [13]. The marine cyanobacterium, *Phormidium valderianum* produces hydrogen and can remove dyes from the solution [14]. Microbial decolorization processes have the advantage of being simple in design and low cost compared with conventional treatments.

MATERIALS AND METHODS

Culture Conditions: The marine cyanobacterium, *Oscillatoria formosa* NTDM02 (obtained from the Microbial Culture Collections of Microbiology Department at Bharathidasan University, Tamilnadu, India) was maintained at 25°C in MN III [15] medium with light/dark cycle of 16/8 h under 6000 Lux illumination. For the experiment, 7-day-old logarithmic growing cells of *Oscillatoria formosa* NTDM02 was used.

Analysis of [H^+] concentration (pH): pH of the medium and effluent were monitored at every stages of the study using pH meter (Elico) to analyze the variation during the decolorization process.

Estimation of Chlorophyll-*a*: Chlorophyll *a* was measured spectrophotometrically at 665nm from the cell mass before and after the treatment to compare the growth [16].

Study of Dye Decolorization: The dye effluent was collected from textile industry at Karur, Tamilnadu, India and Amido Black G200 was used for the study of decolorization control. For this study five set of

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experiment were carried out. Firstly, 50 ml of MN III media and marine cyanobacterium, *Oscillatoria formosa* NTDM02 was inoculated and kept for incubation used as growth control. Secondly, 50ml of MN III media and Amido Black (100 mg^{-1}) as dye control. Thirdly, 50ml of textile effluent was kept for textile effluent control. Fourthly, 50 ml of MN III media amended with Amido Black (100 mg^{-1}1) and marine cyanobacterium, *Oscillatoria formosa* NTDM02 (0.5 mg of culture in wet weight) and finally 50ml of textile effluent inoculated with *Oscillatoria formosa* NTDM02 (0.5 mg of culture in wet weight). All the experimental flasks were kept for incubation at 25°C for 15 days at 6000 Lux and alternative illumination (16/8hr L and D) was given.

UV-Visible Spectroscopic Study: After incubation period, the supernatant was collected and analyzed in all experiments and tested in *UV*-Visible spectrometer (Model Lambda 35). Percentage of decolorization was analyzed from the absorbance values obtained at range of 200nm-750nm.

RESULTS AND DISCUSSION

Culture Condition: The marine cyanobacterium, *Oscillatoria formosa* NTDM02 was well studied morphologically [17] Microphotograph of *Oscillatoria formosa* NTDM02 in fresh growth media showed in Figure 1.

Analysis of [H^+] Concentration: Initial pH values were measured in all the experiments. It was in alkali in nature in range of 11±0.2. During the course of study the pH range was decreased to 7.5±0.2. Finally the pH is about 7.2. Most microorganisms including cyanobacteria have net negative charges on the surface because of the anionic nature of the functional groups making up the cell wall. The pH was decreased due to the production of acids and enzymes to the medium for the reduction of dye [18].

Estimation of chlorophyll-a: All photosynthetic organism uses chlorophyll for the metabolic process. This can also be used for the measuring the growth of the culture. The initial Chlorophyll-*a* content in the cyanobacteria was about 0.5 mg/ml, after the treatment it was slightly decreased in all the experiment except in control. Chlorophyll-*a* synthesis in all treated cultures was strongly inhibited by the dyes [19].

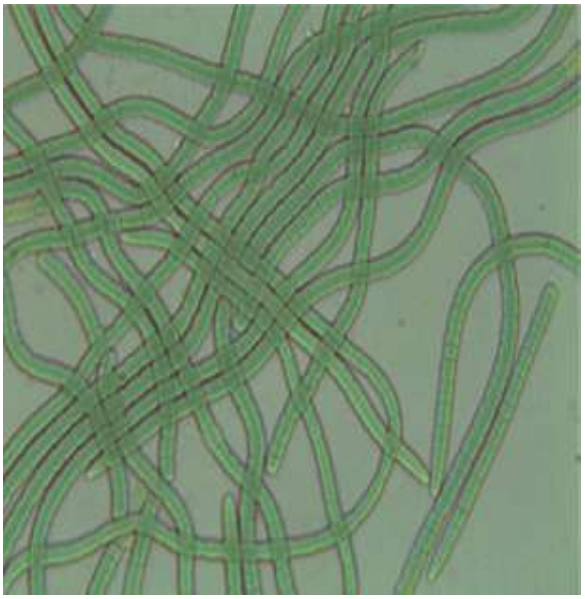

Fig. 1: Microphotograph of Marine cyanobacterium, *Oscillatoria formosa* NTDM02 (X 420)

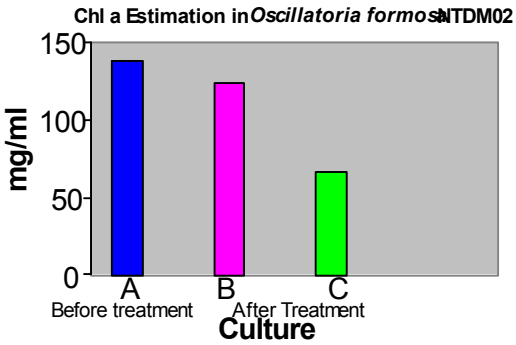

Fig. 2: Chlorophyll-a estimation. A-Before the effluent and dye treatment, B and C-after treatment with effluent and dye respectively.

Study of Dye Decolorization: A slower rate of decolorization were observed in the experiment 4 and 5 which has Amido black and textile dye effluent respectively. The apparent decolorization was comparatively monitored with corresponding dye and effluent control (Figure 2).

UV-Visible Spectroscopic Study: An absorbance band was showed that the intensity was decreased after the cyanobacterial treatment. The effluent treated with marine cyanobacterium, *Oscillatoria formosa* NTDM02 was showed greater amount of decolorization than the amido black (Fig 3 and 4). It may be due to the production of reductase enzymes for the dye removal.

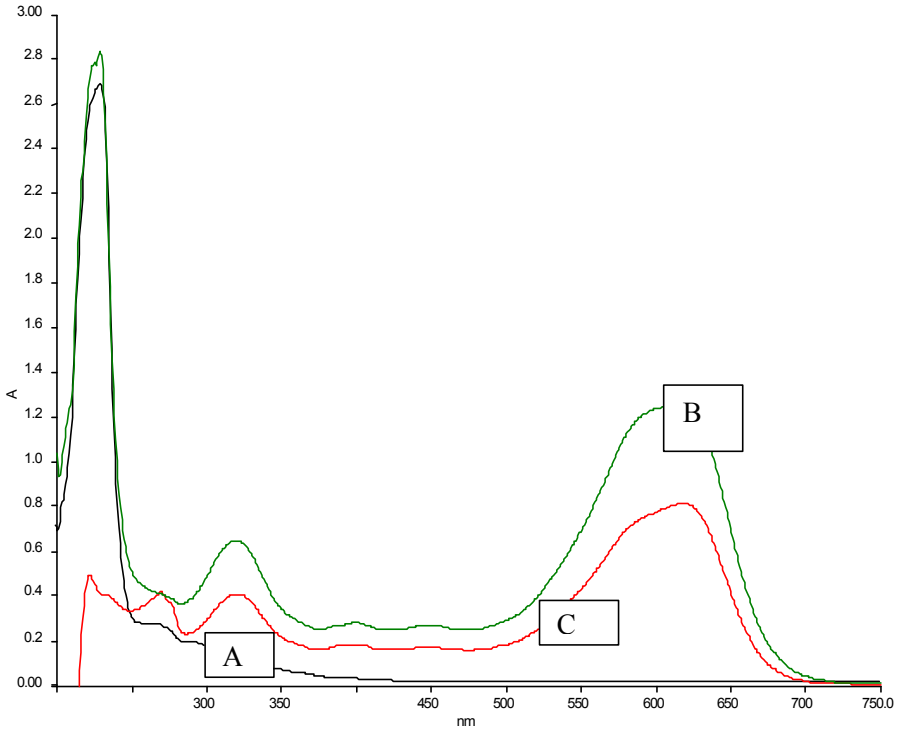

Fig. 3: UV-Vis Spectrum of cyanobacteria treated with effluent. A-represents the normal growth control. B-effluent control, C. Effluent treated with *Oscillatoria formosa* NTDM02

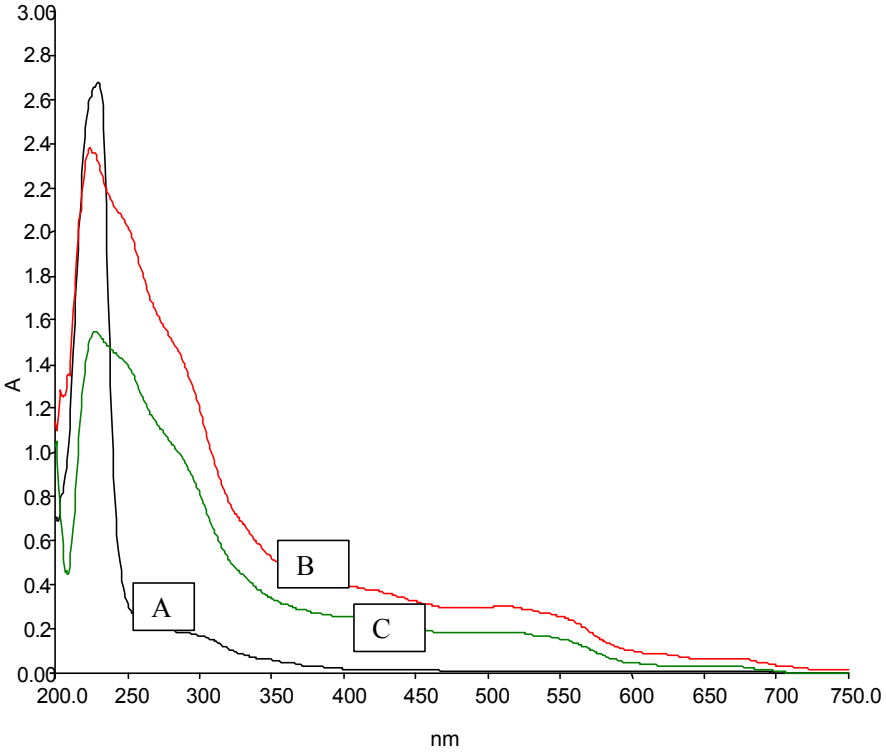

Fig. 4: UV-Vis Spectrum of cyanobacteria treated with dye. A-Represents the normal growth control B-dye control, C-dye treated with *Oscillatoria formosa* NTDM02

In alkaline conditions rupture the cell walls of microbes and expose additional functional groups and also solublize certain cell constituents such as lipids [20]. This enhances the decolorization process by the organisms. Hydrogen production by cells grown in presence of dyes in any phase of their growth was found [18]. It is known that biomass adsorption is effective when conditions are not always favorable for the growth and maintenance of the microbial population, because the use of biomass has its advantages, especially if the dye containing effluent is very toxic [21]. Such a biological process could be adopted as a cost-effective, safer and efficient approach for decolorization of effluents [22]. Microalgae could be used for the dye decolorization [23]. They found that *Oscillatoria* sp and C*hlorella* sp. completely mineralized aniline to CO_2 on extended incubation.

We found that *Oscillatoria formosa* NTDM02 can be regarded as an important candidate from the group of marine cyanobacteria, applicable to efficient removal of synthetic dyes from effluents. Parallel studies on physiology and biochemical aspects of cyanobacterial cultivation and novel methods of immobilization including co-immobilization of various efficient species are required to be done for symbiotic interactions among themselves which will result in synergistic enhancement of removal capabilities.

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