

BIOSORPTION OF REACTIVE DYE FROM TEXTILE INDUSTRY EFFLUENT BY *ASPERGILLUS FUMIGATUS*

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ABSTRACT

Reactive dyes are important chemical pollutants from textile industries. The dye decolorizing fungal strain was isolated from reactive dye effluent contaminated soil. It was identified as *Aspergillus fumigatus* based on lactophenol cotton blue staining. *A.fumigatus* could tolerate and biosorp reactive dye under optimized conditions. Maximum decolorization was observed at 3rd day of incubation at 40°C and the optimum inoculum concentration was found to be 3% at pH 8. These results suggest that *A.fumigatus* is more effective for color removal from reactive dye effluent.

KEY WORDS: *Aspergillus fumigatus*, Biosorption, Textile effluent

INTRODUCTION

The textile industry accounts for two-thirds of the total dye stuff market. During the dyeing process approximately 10-15% of the used dye is released into the waste waters, causing serious environmental and health hazards (Chen *et al.*, 2003). Presence of dyes in aqueous ecosystem diminishes the photosynthesis by impeding the light penetration into deeper layers thereby deteriorating the water quality and lowering the gas solubility. Further more, the dyes and /or their degradation products may be toxic to flora and fauna (Talarposhti *et al.*, 2001).

The traditional physical or chemical decolorization techniques include membrane filtration, ion exchange, ozonation, flocculation and floatation are quite effective in decolorization of dyes (Aksu, 2005). However the application of the above mentioned techniques in the large scale are usually restricted due to several disadvantages such as relatively high price, high operating cost, regeneration problem, formation of hazardous by-products and intensive energy requirements (Gong *et al.*, 2005; Padmesh *et al.*, 2005; Crini, 2006). Therefore, there is a growing interest to find cheap, renewable, locally available and effective alternative materials for the decolorization of colored effluents (Aksu and Tezer, 2000; Gong *et al.*, 2005).

Adsorption has been found to be superior to

other techniques for dye waste water treatment in terms of cost, simplicity of design, ease of operation and insensitivity to toxic substances (Garg *et al.*, 2004). A wide variety of microorganisms, such as bacteria, fungi, algae, either in their living or inactivated form and various materials such as coal, fly ash, wood, silica gel, rice husk, cotton waste, bark, sugar industry mud, palm fruit brunch, etc., have been investigated to remove dyes from aqueous solutions with varying success for colour removal Fu and Viraraghavan, 2001 and Ozer *et al.*, (2005).

Currently, most of the research deals with the biosorption and bio accumulation of azo dyes using living fungal biomass Fu and (Walker and Weatherly 2000; Donmez, 2002; Viraraghavan, 2002; and Aksu and Donmez, 2003). Hence the present study was carried out to investigate the potential of fungus *Aspergillus fumigatus* as biosorbent for the removal of color in reactive dye effluent.

MATERIALS AND METHODS

Collection of samples

Textile effluent containing reactive dye and soil contaminated with textile dye effluent was collected from a dyeing unit at Tirupur, Tamil Nadu, India in a sterile polythene container as per Manivasagam (1995) and stored at 4°C until analysis was done.

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Screening, isolation and identification of reactive dye effluent decolorizing fungi

One gram of soil sample was mixed with 10 mL of distilled water and serial dilution was made up to 10^{-9} on potato dextrose agar to isolate fungal strains. The well grown fungal colonies were screened for their dye decolorizing effect by inoculating them in 100 mL of reactive dye effluent in 250 mL Erlenmeyer flask. Per cent decolorization was determined by measuring the absorbance of the effluent at 290 nm in UV- visible spectrophotometer.

$$\text{Per cent decolorization} = \frac{\text{Initial absorbance} - \text{Observed absorbance}}{\text{Initial absorbance}} \times 100$$

Based on the per cent decolorization, the fungal strain which showed maximum decolorization percentage was selected for the present study. The selected fungal strain was identified by lacto phenol cotton blue staining method (Sekar *et al.*, 2008).

Optimization of different parameters for reactive dye effluent decolorization using *Aspergillus fumigatus*

Effect of inoculum concentration

Hundred ml of the effluent was taken in five different 250 mL Erlenmeyer flasks. The flasks were inoculated with varying inoculum concentrations such as 1, 2, 3, 4 and 5 per cent (v/v) and incubated for 5 days at room temperature. After incubation period, the per cent decolorization was determined. The optimum inoculum concentration was fixed for subsequent experiments.

Effect of incubation period

To determine the effect of incubation period, 100 mL of the effluent was taken in five different 250 mL Erlenmeyer flasks. The dye effluent inoculated with *A. fumigatus* at a concentration of 3% was incubated for different time intervals (1, 2, 3, 4, 5, 6 and 7 days).

Effect of pH

To determine the optimum pH for decolorization, 100ml of the reactive dye effluent was taken in different 250 mL Erlenmeyer flasks. The pH of the effluent was adjusted from 5-9 at an interval of 1 unit using 1 N HCl or 1 N NaOH. The flasks were inoculated with *A. fumigatus* at a concentration of 3% and incubated for 3 days at room temperature. After incubation period, per cent decolorization was determined.

Effect of temperature

To evaluate the optimum temperature, 100mL of the effluent was taken in five different 250 mL Erlenmeyer flasks. The flasks were inoculated with *A. fumigatus* at a concentration of 3%. The inoculated flasks were incubated at different temperatures such as 30, 40, 50, 60 and 70°C for 3 days. After incubation period, per cent decolorization was determined.

RESULTS AND DISCUSSION

Screening, isolation and identification of reactive dye effluent decolorizing fungi

About seven morphologically distinct fungi were isolated from the reactive dye effluent contaminated soil by serial dilution technique. Among them, the fungal isolate which showed higher per cent decolorization (Table 1) was selected.

Table 1. Decolorization of reactive dye effluent by different fungal strains

Fungal isolates	Rate of decolorization (%)
<i>Rhizopus</i> sp	25
<i>Penicilium</i> sp	30
<i>Trametes</i> sp	35
<i>Aspergillus</i> sp	67
<i>Trichoderma</i> sp	39
<i>Fusarium</i> sp	23
<i>Flavodon</i> sp	15

Based on the colony morphology and staining, the fungal strain was identified as *Aspergillus fumigatus*. Mature colonies were yellow brown in texture and the surface was powdery or granular and the hyphae were septate in nature. The conidial head was columnar and compact, the conidiophores appeared green and sterigma was uniseriate in nature.

Optimization for decolorization

Effect of inoculum concentration

The effect of inoculum concentration on decolorization was determined and the results are presented in Fig. 1 Increase in inoculum concentration from 1% to 3% increased per cent decolorization, with optimum decolorization at 3%. However increase in inoculum concentration above 3% results in decrease in decolorization.

High per cent decolorization was due to dye sorption by mycelium of fungi as well as reduction

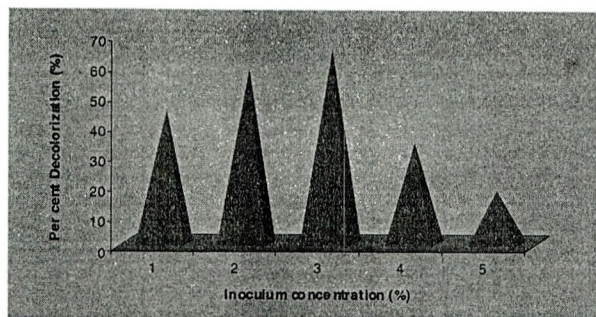


Fig. 1. Effect of inoculum concentration on decolorization by *Aspergillus fumigatus*.

of dye intensity in solution because of changes caused by them (Balan and Monterio, 2001).

Effect of Incubation period

The effect of incubation period on decolorization of reactive dye effluent by *A. fumigatus* is presented in Fig. 2. Maximum decolourization was observed at third day of incubation period. Similar result was observed by Ramya *et al.* (2007) who has reported 95% decolourization of reactive blue by *Aspergillus* sp. at third day of incubation.

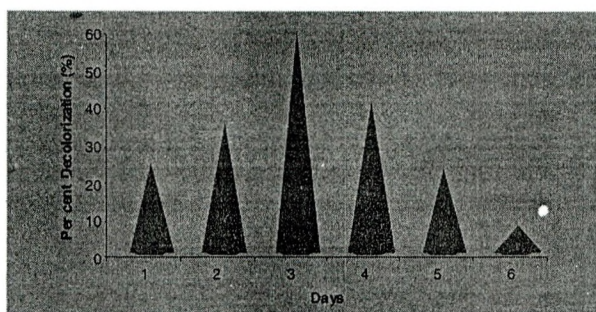


Fig. 2. Effect of incubation period on decolorization by *Aspergillus fumigatus*

Effect of pH

pH has a significant effect on dye-binding capacity of fungus. The medium pH affects the surface charge of the biosorbent, the ionization state of the functional groups on the fungal cell wall and the solubility of the dye. Fig. 3 shows that highest colour removal was detected in alkaline pH (8) with 56.14% decolorization. The obtained results provides an information that alkaline pH is required for decolorization. This results are in agreement with Xian *et al.* (2006), who has reported that the strain of *A. fumigatus* decolorize the effluent color at pH 8. However Fu and Viraraghavan (2000, 2001) and O'Mahony *et al.* (2002) have reported that dye

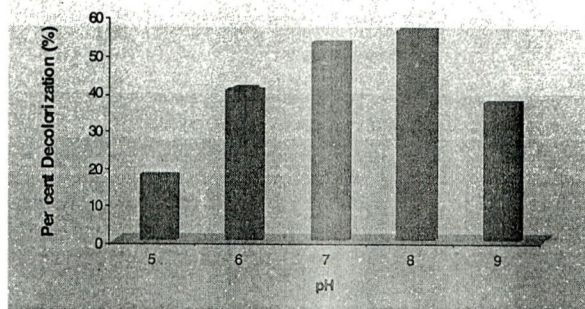


Fig. 3. Effect of pH on decolorization by *Aspergillus fumigatus*

anions present in the dye solution are being adsorbed by positively charged cell surfaces due to the electrostatic attraction at lower pH.

Effect of temperature

Temperature is well known to play an important role in both biosorption rate and equilibrium uptake of dyes by microorganisms. The effect of temperature was investigated in the temperature range of 30 to 70° C (Fig. 4). Decolorization at different temperatures showed 40° C as an optimum temperature. However with increasing the temperature above 40° C, biosorption capacity of the fungal mass lessened (Aksu and Karabayir, 2008). The reduction may be due to thermolabile nature of *A. fumigatus*. Similar trend was observed by Parshetti *et al.*, (2007) who showed 85% of decolorization of Reactive blue 25 at 40° C by *Aspergillus ochraceus*.

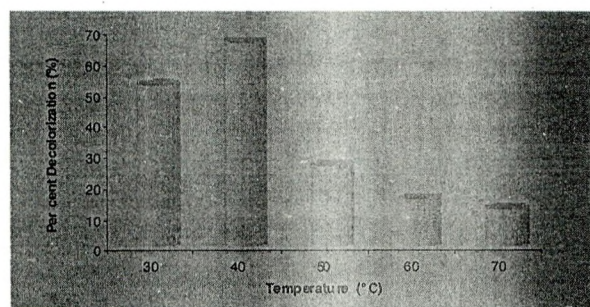


Fig. 4. Effect of temperature on decolorization by *Aspergillus fumigatus*

CONCLUSIONS

In the present investigation, reactive dye effluent was decolorized by *A. fumigatus*, isolated from textile dye contaminated soil. *A. fumigatus* was

found to be effective in the biodecolorization of reactive dye effluent during the growth of the fungus. Maximum decolorization was obtained at the pH of 8, inoculum concentration of 3% at. From the above results, *A. fumigatus* appears to be a useful living biosorbent for removal of reactive dye from effluent produced by textile industries.

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