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Decolourization of Textile Dye Effluent by Non-Viable Biomass of *Aspergillus fumigatus*

K. Kalaiarasi*, A. Lavanya, S. Amsamani and G. Bagyalakshmi
Department of Textiles and Clothing; Avinashilingam University for Women; Coimbatore - 641 043; Tamil Nadu - India

ABSTRACT

The aim of this work was to study the decolourization of textile dye effluent by non-viable biomass of Aspergillus fumigates. The dried non-viable fungal biomass exhibited maximum dye removal at pH 7.0 with temperature of 30°C and 3 g/l (w/v) biomass concentration, after 24 h contact time. The results showed that the non-viable biomass possessed high efficiency for dye removal from textile effluent.

Key words: *Aspergillus fumigatus*, decolourization, textile effluent

INTRODUCTION

Contamination of water sources by many organic pollutants is a major factor of global environmental pollution for number of years (Akthar et al. 2006). Two major sources of dye pollution are the textile and dye stuff manufacturing industries. Effluents of these industries are highly colored and very difficult to treat since the dyes used are synthetic complex molecules that are resistant to aerobic digestion and stable to light, heat and oxidizing agents (Fu and Viraraghavan 2001; Radha et al. 2005; Crini 2006).

Worldwide over 10,000 different dyes and pigments are used in dyeing and printing industries. The total world colorant production is estimated to be 8, 00,000 tons per year and at least 10% of the used dyestuff enters the environment through waste (Levin et al. 2004; Palmieri et al. 2005). It is estimated that 2,80,000 tons of textile dyes are discharged in such industrial effluents every year worldwide (Maas and Chudhari 2005).Improper textile dye effluent disposal in aqueous ecosystems leads to the reduction in sunlight penetration which in turn decreases the photosynthetic activity, dissolved oxygen concentration, water quality and depicts acute toxic effects on aquatic flora and fauna, causing severe environmental problems world-wide (Vandevivere et al. 1998). Hence, treatment of such dye containing waste water is essential to prevent the deterioration of ecosystem.

Several physicochemical methods such as absorption, membrane filtration, photo catalytic degradation, ion exchange, precipitation, flocculation, floatation and ozonation are quite effective in decolorization of dyes, have some disadvantages such as high cost / unit volume of waste water treated, unfriendly for nature or unreliability in operation (Aksu 2005). Therefore, there is a need to develop alternative and cost effective treatment process for colored effluents.

The microbial decolourization and degradation has been of considerable interest since it is

*Author for correspondence: kalaiarasik@rediffmail.com

inexpensive, eco-friendly and produces a less amount of sludge (Kalyani et al. 2008).

Both living and dead biomass can be used to remove the hazardous organics. Dead cells are obviously preferable for waste water treatment since they are not affected by toxic waste and chemicals and do not pollute the environment by releasing toxins (Aksu 2005).They also do not require a continuous supply of nutrients and can be regenerated and reused for many cycles (Sumathi and Manju 2000; Volesky 2001; O'Mahony et al. 2002; Aksu 2005; Maurya et al. 2006; Vijayaraghavan and Yun 2006; Won et al. 2006).

Dead and dried biomass can be stored for longer periods at room temperature with little risk of putrefaction. This makes it easier to use and transport. Dead biomass is also generated as a waste product from established industrial process (Kapoor and Viraraghavan 1998).

Rhizopus arrhizus (Aksu and Cagatay 2006), *Aspergillus niger* (Fu and Viraraghavan 2002), *Neurospora crassa* (Akar et al. 2006) *Penicillum chrysosporium* (Radha et al. 2005) and *Aspergillus fumigatus* (Wang et al. 2008) are some of low cost fungal materials which have been used as biosorbent for dyes. Hence, in present study, the feasibility of using dead biomass of *A. fumigatus* for colour removal from textile dye effluent was examined.

MATERIALS AND METHODS

Collection of samples

Textile effluent containing reactive dye and soil contaminated with textile dye effluent were collected from a dyeing unit in a sterile polythene container following Manivasagam (1995) and stored at 4°C until analysis was done.

Screening, isolation and identification of textile 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 the fungal strains. The well-grown fungal colonies were screened for their dye decolorizing effect by inoculating them in 100 ml of textile 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. The fungal strain which showed maximum decolorization percentage was selected for the present study. The selected fungal isolate was identified by lacto phenol cotton blue staining method.

Preparation of dead biomass of *A. fumigatus*

The mat formed by *A. fumigatus* grown in Sabaroud dextrose broth was separated by filtration, autoclaved and washed with distilled water to remove the colour and impurities and dried in an oven. The dried biomass was powdered (Engade and Gupta, 2007).

Optimization for decolorization

Effect of different concentrations of dead biomass

One hundred milliliter of textile dye effluent was taken in 250 ml Erlenmeyer flasks. The flasks were added with various concentrations of dried and powdered biomass such as 0.2, 0.4, 0.6, 0.8, 1.0, 1.2 and 1.4 % (w/v) and incubated at 28° C for five days. After incubation period, per cent decolorization was determined.

Effect of incubation period

To determine the impact of incubation period on decolorization, 0.6g of dead biomass of *A. fumigatus* was added to 100 ml of textile dye effluent. The flasks were incubated at different time intervals such as 24, 48, 72, 96 and 120 h. After each incubation period, per cent decolorization was calculated.

Effect of pH

To determine the optimum pH for decolorization, the pH of the effluent was adjusted to 5.0-9.0 at an interval of one unit using 1N Hcl and 1N NaOH and per cent decolorization was calculated.

Effect of temperature

The inoculated flasks were incubated at different temperatures such as 20, 30, 40, 50, 60, 70 and 80° C for 24 h. After the incubation period, percent decolorization was calculated.

RESULTS AND DISCUSSION

Screening, isolation and identification of textile dye effluent decolorizing fungi

Seven morphologically distinct fungi were isolated from the textile dye effluent contaminated soil by serial dilution technique. Among them, the fungal

isolate which showed highest per cent decolorization (Table 1) was selected.

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.

Table 1 - Decolourization of textile dye effluent by different fungal strains.

Fungal isolates	Rate of decolourization (%)
Rhizopus sp.	25
Penicillium sp.	30
Cladosporium sp.	35
***Aspergillus* sp.**	**67**
Trichoderma sp.	39
Fusarium sp.	23
Flavodon sp.	15

Optimization for decolorization

Effect of different concentrations of dead biomass

Maximum decolorization was observed at 0.6 % (w/v) of biomass concentration (Fig 1.). It is widely known that the number of available biosorption sites increase with an increase in biosorbent concentration. Further increment in biomass concentration above 0.6 % did not improve biosorption. This was due to the fact that almost all the ions were bound to the biomass at the establishment of equilibrium between the dye molecules bound to the biomass and those remaining un-adsorbed in the solution (Vasanthkumar et al. 2006).

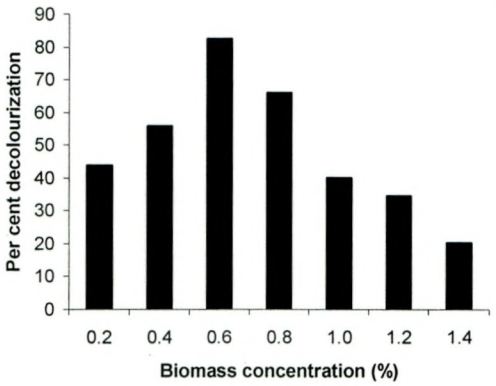

Figure 1 - Effect of non-viable biomass concentration of *A. fumigatus* on decolourization.

Effect of incubation period

Maximum decolourization was observed at 48 h of incubation (Fig. 2). However, Prigione et al. (2008) reported maximum decolourization at 24 h of incubation by autoclaved biomass of three mucorales fungi of *C.elegans, R. pusillus* and *R. stolonifer.*

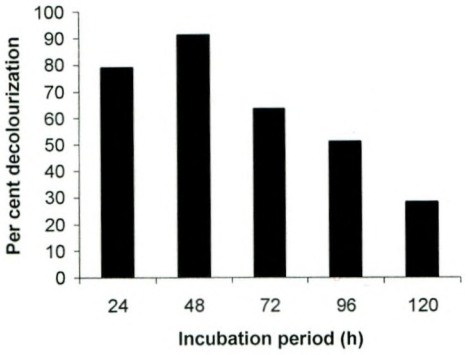

Figure 2 - Effect of incubation period on decolourization by dead biomass of *A.fumigatus.*

Effect of pH

Per cent decolourization was increased with increase in pH and reached maximum at pH 7.0 (Fig. 3). Above this pH 7.0, there was a decline in per cent decolorization. The result was in accordance with Yatome et al, (1991) for decolourization of triphenylmethane dyes by *Pseudomonas pseudomallei.* Similarly, Kwasniewsaka (1985) found that *Rhodotorula* sp. decolorized crystal violet maximum at pH 7.0. However, Wang et al. (2008) reported that the optimum pH for biosorption of azo dye by *A. fumigatus* was 2.0.

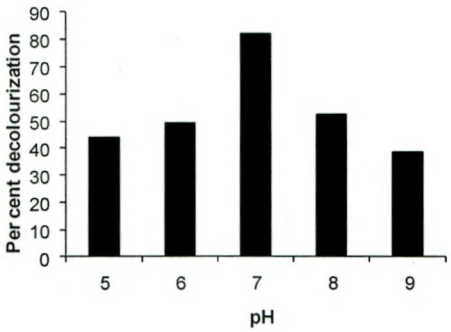

Figure 3 - Effect of pH on decolourization by dead biomass of *A.fumigatus.*

Effect of temperature

The optimum temperature for decolourization was 30°C (Fig. 4). Increase in temperature above this resulted in decrease in per cent decolourization. Similar trend was observed by Khalaf (2008) for biosorption of reactive dye from textile dye effluent by non-viable biomass of *A.niger* and *Spirogyra* sp. Increase in temperature above 30°C may alter the surface activity of biomass which results in a decrease in removal value, indicating that this process is exothermic in nature. The exothermic nature of dye biosorption has also been reported for the biosorption of Ramazol Black B and Acid Red 274 dyes by *Rhizopus airhizus* and *E. prolifer,* respectively. (O'Mahony et al. 2002; Ozer et al. 2005). A similar observation has been reported for ramazol brilliant blue on eucalyptus bark, where adsorption decreased at higher temperatures; similar trend was observed for comparative studies on removal of Congo red by native and modified mycelial pellets of *Trametes versicolor* in various reactive modes (Binupriya et al. 2008).

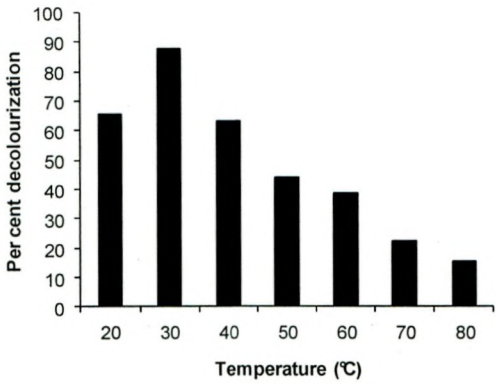

Figure 4 - Effect of temperature on decolourization by dead biomass of *A.fumigatus.*

CONCLUSIONS

The present study revealed the ability of the dead biomass of *A. fumigatus* to remove the reactive dye from textile dye effluent. The results obtained from this work showed that the fungal biomass possessed high decolourization efficiency. The findings offer potential for the development of a cost effective and robust technology for biosorption of reactive dye effluents.

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