Research in Biotechnology, 4(5): 20-23, 2013 ISSN: 2229-791X
www.researchinbiotechnology.com

Short communication

Decolourization of synthetic dyes using free and immobilized *Aspergillus* species

J. Joel Gnanadoss* and G. Roseline Jebapriya

Microbial and Environmental Biotechnology Research Centre, Department of Plant Biology and Biotechnology, Loyola College (Autonomous), Chennai – 600 034
* Corresponding Author Email: joelgna@gmail.com

The aim of the present investigation was to study the biosorption and decolourization of congo red and erichrome black T by *Aspergillus* sp. (*A. niger* LCJ 1 and *A. nidulans* LCJ 2). Decolourization of both the dyes was determined on free and immobilized cell of *Aspergillus* sp. in culture media containing 25 mg/L of the respective dyes. The amount of decolourization was determined by monitoring the decrease in absorbance of each dye. Spectrophometric data revealed that, the maximum decolourization of congo red and erichrome black T was in immobilized mycelium of *Aspergillus* sp. on polyurethane foam (PUF). This study showed that fungal biomass (*A. niger* and *A. nidulans*) could effectively be used as an alternative to the conventional physico-chemical methods.

Keywords: Dye decolourization; biological method; free and immobilized cells; *Aspergillus* species.

The effluent released by the textile industry is one of the important pollutant among all industrial effluents and these effluents contain strong colour, suspended particles, high BOD, COD and pH. Worldwide it is estimated that, more than 100, 000 commercial dyes are available (Robinson *et al*., 2001) and nearly 10 to 15% of the dyestuffs are discharged as industrial effluents in the environment, these dye containing effluents causes serious environmental problem and a public health concern because they are carcinogenic and toxic to humans and aquatic life (Pappic *et al*., 2000). Due to these concerns, the removal of dyes from wastewater has received important consideration. The conventional methods for treatment of dye containing effluents are usually ineffective, expensive and slightly adaptable to a wide range of dyes (Stolz 2001).

Robinson *et al*. (2001) reviewed current treatment technologies including biosorption with proposed alternatives for removal of dyes in textile effluent. Numerous researchers have focused on biosorption of dyes by microorganisms which include algae, fungi, bacteria and yeast. Among these, fungal biomass appears to be most appropriate, inexpensive and effective biological agent in the treatment of dye containing wastewater (Ezeronye and Okerentugba, 1999). When compared with freely suspended cells, immobilized microbial cell systems could provide additional advantages, which include

Received: 22.7.2013; Revised: 17.9.2013; Accepted: 23.9.2013

efficient and effective regeneration and reuse of the biomass, easier solid–liquid separation (Bayramoglu *et al*., 2003). So far, few fungal biosorbents were studied which includes *Aspergillus* (Fu and Viraraghavan, 2002), *Penicillium* (Iscen *et al* 2007) and *Rhizopus* (Aksu and Cagatay, 2006). Keeping all this in view, the present investigation was aimed to decolourize congo red and erichrome black T using free and immobilized cells of *A. niger* LCJ 1 and *A. nidulans* LCJ 2.

Materials and methods

Dyes and chemicals

Congo red and erichrome black T was obtained from Hi-media and Merck (India). All the other chemicals were procured from Hi-media (India).

Microorganism

The fungi used for this study were isolated from soil and purified. The pure cultures were maintained on Potato Dextrose Agar (PDA) slants at 4 °C.

Preparation of free and immobilized cells

The culture medium used for decolourization studies composed of Glucose – 5 g, KNO_3 – 1 g, KH_2PO_4 – 0.3 g, $MgSO_4$ – 0.7 g, K_2HPO_4 – 1 g and Distilled water – 1000 mL. The dyes were added at a concentration of 25 mg/L. The culture medium containing the respective dyes was autoclaved at 121 °C for 15 minutes. The mycelial discs of the fungi were inoculated into the conical flasks under sterile condition. They were then incubated on the rotary shaker at 120 rpm and maintained at room temperature.

Poly urethane foam (PUF) was used as immobilization support material. PUF was cut into 1×1×1 cm cubes and these cubes were thoroughly washed with distilled water and sterilized in autoclave prior to use. Flask containing culture medium, dyes (25 mg/L.) and sterile PUF cubes were sterilized. After sterilization, the flasks were inoculated with fungal mycelia disc and then incubated on a rotary shaker set at 120 rpm, and maintained at room temperature.

Dye decolourization studies

The efficacy of free and immobilized cell on the decolourization of the dyes was examined in culture medium containing actively grown fungal biomass (free and immobilized). The OD of each of the sample was taken at the respective absorption maxima of each of the dyes (495 and 530 nm) at different time intervals. The percentage of decolourization was calculated as per the following equation:

$$\text{Decolorization (\%)} = \frac{(\text{Initial Absorbance - Final Absorbance})}{\text{Initial Absorbance}} \times 100$$

Result and discussion

During the last few decades, decolourization of dyes using white rot fungi have been extensively studied and reviewed (Harazono and Nakamura, 2005; Radhika *et al*., 2013; Jebapriya and Gnanadoss, 2013) but so far only few studies are available for decolourization of dyes using brown rot fungi (Ali *et al*., 2008; Husseiny, 2008). The present study was carried out to examine the decolourization of dyes (25 mg/L) using free and immobilized *Aspergillus* sp. (*A. niger* LCJ 1 and *A. nidulans* LCJ 2) on cubes of polyurethane foam (PUF). The free cells of *A. niger* LCJ 1 were able to decolourize congo red (24 to 36%) and erichrome black T (1 to 4%) after 12 h of incubation (Figure 1 and 2). Whereas, *A. nidulans* LCJ 2 effectively decolourized congo red (28 to 38%) and erichrome black (2 to 9%) (Figure 3 and 4). Immobilized mycelium of *Aspergillus* sp. (*A. niger* LCJ 1 and *A. nidulans* LCJ 2) showed maximum percentage of decolourization of respective dyes (congo red, 36 and 48% and erichrome black T, 41 and 43%) under same condition (Figure 1; 2; 3; 4). Our results clearly emphasize that the decolourization ability of immobilized cells on cubes of

polyurethane foam (PUF) are more efficient than free cells and this is due to biosorption mechanism of fungal biomass.

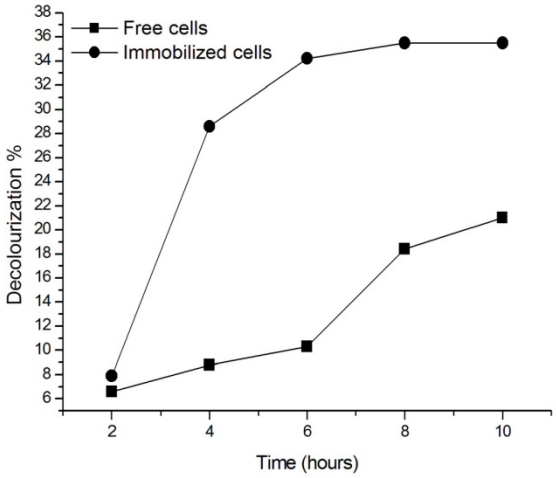

Figure 1: Decolourization of Congo red by free and immobilized mycelia biomass of *A. niger* LCJ 1

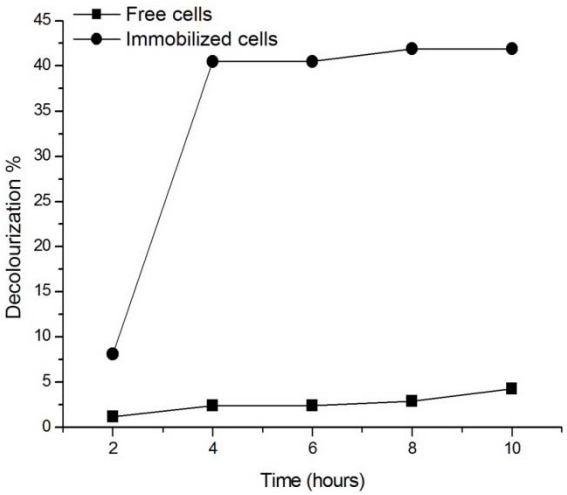

Figure 2: Decolourization of Erichrome black T by free and immobilized mycelia biomass of *A. niger* LCJ 1

Generally fungal cell wall is composed of polysaccharides, proteins, lipids with several functional groups capable of binding the dye molecules (Fu and Viraraghavan, 2002; Bayramoglu and Arica, 2006). Kumari and Abraham (2006) studied biosorption of nonviable biomass of four fungi (*R. nigricans, R. arrhizus, A. niger* and *A. japonica*) and one yeast (*S. cerevisiae*) for treating five different reactive dyes. Similarly, Khalaf (2008) focused on textile wastewater treatment by non-viable biomass of *Aspergillus niger* and the alga *Spirogyra*. Another study made by Fu and Viraraghavan (2000 and 2002) showed that biomass of *A. niger* had higher biosorption capacity compared to living biomass.

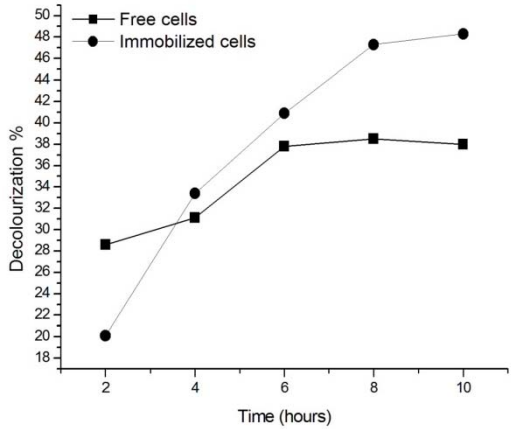

Figure 3: Decolourization of Congo red by free and immobilized mycelia biomass of *A. nidulans* LCJ 2

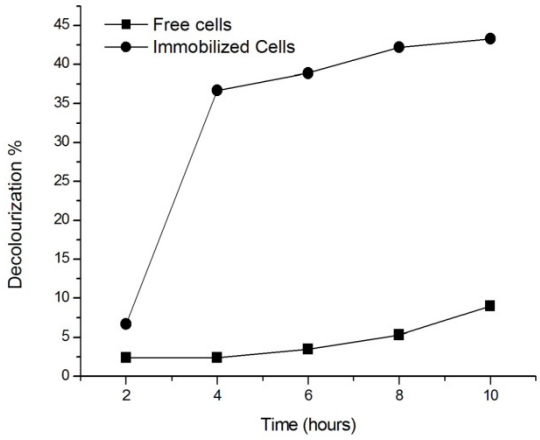

Figure 4: Decolourization of Erichrome black T by free and immobilized mycelia biomass of *A. nidulans* LCJ 2

In conclusion, present observation showed that *A. niger* LCJ 1 and *A. nidulans* LCJ 2 could effectively decolourize congo red and erichrome black T. Removal of synthetic dyes in the present study was seen merely due to biosorption of free and immobilized

biomass. Thus, the present results provide a simple, eco-friendly and cost effective method for removal of synthetic dyes.

References

Aksu Z, Cagatay SS. 2006. Investigation of biosorption of gemasol turquise blue-G reactive dye by dried *Rhizopus arrhizus* in batch and continuous systems. Separation and Purification Technology 48: 24-35.

Ali H. 2010. Biodegradation of synthetic dyes: A review. Water, Air and Soil Pollution 213: 251-273.

Bayramoglu G, Arica YM. 2006. Biosorption of benzidine based textile dyes "Direct Blue 1 and Direct Red 128" using native and heattreated biomass of *Trametes versicolor*. Journal of Hazardous Materials 143: 135–143.

Bayramoglu G, Bektas S, Arica MY. 2003. Biosorption of heavy metal ions on immobilized white-rot fungus *Trametes versicolor*. Journal of Hazardous Materials 101, 285–300.

Ezeronye OU, Okerentugba PO. 1999. Performance and efficiency of a yeast biofilter for the treatment of a Nigerian fertilizer plant effluent. World Journal of Microbiology and Biotechnology 15: 515-516.

Fu Y, Viraraghavan T. 2000. Removal of a dye from aqueous solution by the fungus *Aspergillus niger*. Water Quality Research Journal of Canada 35: 95- 111.

Fu Y, Viraraghavan T. 2002. Dye biosorption sites in *Aspergillus niger*. Bioresource Technology 83: 139 – 145.

Harazono K, Nakamura K. 2005. Decolorization of mixtures of different reactive textile dyes by the white-rot basidiomycete *Phanerochaete sordid* and inhibitory effect of polyvinyl alcohol. Chemosphere 59: 63-68.

Husseiny SM. 2008. Biodegradation of the Reactive and Direct Dyes Using Egyptian Isolates. Journal of Applied Sciences Research 4(6): 599–606.

Iscen CF, Kiran I, Ilhan S. 2007. Biosorption of Reactive black 5 dye by *Penicillium restrictum*: The kinetic study. Journal of Hazardous Materials 143: 335-340.

Jebapriya GR, Gnanadoss JJ. 2013. Bioremediation of textile dye using white rot fungi: A review. International Journal of Current Research and Review 5(3): 1-13.

Khalaf MA. 2008. Biosorption of reactive dye from textile waste water by non-viable biomass of *Aspergillus niger* and *Spirogyra* sp. Bioresource Technology 99: 6631 – 4.

Kumari K, Abraham TE. 2006. Biosorption of anionic textile dyes by nonviable biomass of fungi and yeast. Bioresource Technology 98: 1704-1710

Pappic S, Koprivanac N, Metes A. 2000. Optimizing polymer induced flocculation process to remove the active dyes from wastewater. Environmental Technology 21: 97-105.

Radhika R, Jebapriya GR, Gnanadoss JJ. 2013. Decolourization of synthetic textile dyes using the edible mushroom fungi *Pleurotus*. Pakistan Journal of Biological Science. 1-6.

Robinson T, McMullan G, Marchant R, Nigam P. 2001. Remediation of dyes in Textile effluent: A critical review on current treatment technologies with a proposed alternative. Bioresource Technology 77: 247- 255.

Stolz A. 2001. Basic and applied aspects in the microbial degradation of azo dyes. Applied Microbiology and Biotechnology 56 (1-2): 69-80.