Journal of Materials Science & Surface Engineering, 6(6): 881-883
ISSN (Online): 2348-8956; 10.jmsse/2348-8956/6-6.1

Investigation on the Removal of Direct Red Dye using Aspergillus Niger

Ayushi Verma · Meenu Agarwal · Deeksha Bhati · Himanshi Garg

Department of Biotechnology, Noida Institute of Engineering and Technology, Greater Noida, U.P., India.

ABSTRACT

Environmental pollution is one of the major problems of the modern world. Synthetic dyes are extensively used in textile dyeing, paper printing, colour photography, pharmaceutical, food, cosmetics and other industries. Conventional wastewater treatment plants are unable to perform a complete dye removal, 90 % of reactive textile dyes persist after activated sludge treatment. Currently, various chemical, physical and biological treatment methods are used to remove color. This study focuses on the biological decolorization of textile effluents containing direct red dye using a fungal strain, *Aspergillus niger*. The effect of pH, temperature, dose, initial dye concentration and shaking conditions were studied and these parameters were optimized to obtain maximum decolorization of the direct red dye using the fungal colonies. Above 97 % decolorization was achieved with *Aspergillus niger* at pH 5, in presence of 200 mg/L of dye during 3 days at 25°C under 150 rpm shaking speed. This study brings out the ability of *Aspergillus niger* to degrade reactive dyes and reinforces the potential of this group of fungi for the decolorisation of textile effluents.

ARTICLE HISTORY
Received 12-03-2019
Revised 25-03-2019
Accepted 26-03-2019
Published 01-12-2019

KEYWORDS
Direct Red Dye
Aspergillus Niger
Decolorization
Industry Effluent

Introduction

Water pollution is of major concern due to the effluents from textile industries. Synthetic dyes are of great importance in textile and paper industry. The inadequate treatment of these dyes from waste water results into water pollution and environmental toxicity. The effluent is highly colored and if they get disposed without treatment, it can be highly destructible for our water habitat. Most of the dyes are carcinogenic and mutagenic. The shortage of clean drinking water is the most important and recent issue in many countries. It has been estimated that 1.2 billion people have been drinking the unclean water. So, the exploitation of safe water resources has increased to overcome the scarcity of clean water. The release of the effluent from the textile industries has become more meticulous. The removal of dye has become an important step because the government legislation has set the permissible limit for the dye effluent release from the textile industries. Therefore, it is necessary to treat industrial wastewater before disposal in order to protect environment [1]. There are various methods for treating the dye containing waste water such as physical, chemical, and biological processes that includes flocculation, membrane separation, anaerobic microbial degradation, adsorption, advance oxidation [2-5]. The chemical and physical methods are not widely accepted in textile industries due to high cost and maintenance problems. So, it is a need of hour to adapt green technologies to deal with this existing problem that includes the adsorption of dye on fungal and bacterial biomass. Bioremediation is the removal of contaminants and pollutants from soil and water using living microorganisms. It has increased sustainability and is less expensive than any other alternatives.

Dye removal can be done by using algae, fungi, and plants and they show good dye removal efficiency [6]. The cell wall of fungi is made of glycoprotein, glucan and chitin. It consists of various binding site for the interaction of bio sorbent and dye. *Aspergillus niger* is the dark color fungi which is seal at moldering food. It's a saprophytic fungus used for the removal of dyes and heavy metals in terrestrial environment.

The aim of this study is to evaluate the activity of a fungal species (*A.niger*) for decolorization of direct red dye from synthetic wastewater and to examine optimized process parameters (contact time, initial dye concentration, solution pH, and temperature) for maximal removal of direct red dye.

Experimental

Materials

Direct red dye which is commonly used in textile industries was selected for this study. The absorbance value for direct red dye was measured using UV-visible spectrophotometer. All chemicals such as potato dextrose agar and potato dextrose broth used were of highest purity available and of analytical grade.

Biomass

The culture of *A. niger* were isolated from soil collected from different areas by serial dilution method. The serial dilution of collected sample was done by series of dilutions using distilled water. From each diluted sample, 1ml volumes were added onto potato dextrose agar and maintained it at 25°C for 2 weeks. The periodically sub-culturing of *A. niger* was done to maintain their viability for further use. Fig. 1 showing a flow diagram for batch experiments performed for the removal of direct red dye using *A. niger*.

Batch study

The decolorizations of direct red dye using A.niger were carried out in batch mode. The stock solutions of direct red dye (1000 mg/L) were prepared. The spores used were

Corresponding Author: Ayushi Verma, Tel: +91 9634844960
Email: ayushi.mtech@gmail.com
Contents lists available at http://www.jmsse.in/ & http://www.jmsse.org/

isolated from the cultured colonies of *A.niger* and inoculated in each flask containing direct red dye. The conical flasks were incubated under different conditions. The effect of varying initial concentrations of direct red dye solution (200-400 mg/L), dosage (0.5-2.0 g/L), pH (2.0-8.0), and temperature (20-40 °C) was investigated. Different concentration of dye solution was taken from the pre-prepared stock solution and then kirk's medium was added into 250 mL conical flask containing dye solution. The conical flasks containing solutions having different concentrations were placed in incubator shaker at 150 rpm at for 5 days. The absorbance was noticed to investigate % of direct red dye decolorization using U.V Spectrophotometer (Shimadzo, Japan). The removal efficiency of direct red dye was determined by using the following equation:

$$\% \, Removal = (C_i - C_e / C_i) \times 100$$

where 'C_i' is initial concentration of metal ion and 'C_e' is equilibrium concentration of metal ion (mg/L).

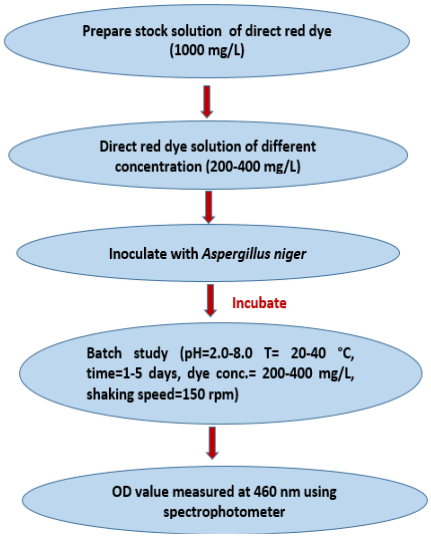

Figure 1: Schematic diagram of batch study for removal of direct red dye using *Aspergillus niger*

Results and Discussion

Effect of pH

The influence of different pH values on decolorization of direct red dye has an important role as it defines the surface charge of the biosorbent and the degree of speciation and ionization of the dye solution. Experiments were performed with 200 mg/L of initial concentration of direct red dye, 2.0 g of biosorbent dose, 25°C of temperature and 150 rpm stirring speed for 120 min at different pH values ranging from 2.0 to 8.0. Fig. 2 shows that the optimum pH for the growth of *A.niger* was obtained as 97 % of the removal efficiency have been achieved using *A. niger*.

Effect of dye concentration

To investigate the effect of different initial dye concentrations, experiments were performed at pH 4.5, 2.0 g/L of *A. niger* dose, 25°C temperature and 150 rpm stirring speed using different initial direct red dye concentrations (200-400 mg/L). Fig. 3 shows that the decolorization rate decreased with increasing the initial dye concentration. This may be due to the decrease in the adsorption sites on the adsorbent surface. The maximum decolorization achieved was 97 % at 200 mg/L after 24 hours for direct red dye.

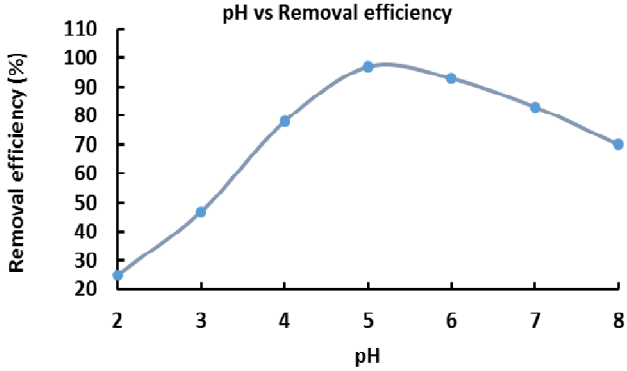

Figure 2: Effect of pH on removal efficiency of direct red dye using *Aspergillus niger*

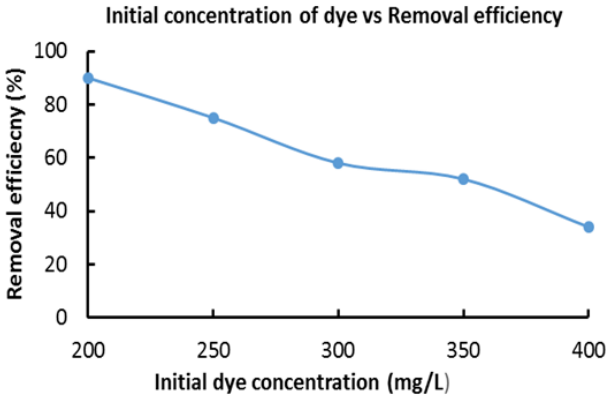

Figure 3: Effect of initial dye concentration on removal efficiency of direct red dye using *A. niger*

Effect of time

The effect of contact time on direct red dye decolorization was studied. Experiments were conducted at pH 4.5, initial dye concentration 200 mg/L, 2.0 g/L of *A. niger* dose and stirring speed of 150 rpm at different contact times (1-5 days). As shown in Fig. 4, the rate of color uptake increased rapidly until reaching the maximum dye removal of 97 % after 24 hrs. With the time the nutrients were consumed by *A.niger* as the quantity of nutrients decreased at certain stage there is lack of nutrients that are necessary for growth and working of *A. niger*.

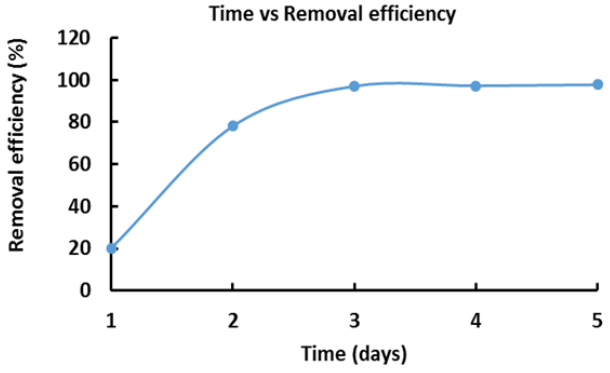

Figure 4: Effect of time on removal efficiency of direct red dye using *A. niger*

Effect of temperature

The removal efficiency of *A.niger* after a regular interval of time at different temperature (20-40°C) with constant pH, dosage, and *A. niger* concentration was examined (Fig. 5). Initially there was a bit increase in decolorization process but as the temperature increases and reaches the value of (25°C) maximum decolorization was observed of (97 %) after that the removal efficiency of *A.niger* decreases as the temperature increases. As the best suited temperature for the growth of *A.niger* is 25°C after that the growth in the colonies of *A.niger* suddenly starts decreasing that results in lowering of dye decolorization rate. The fact that the biosorption decreases with an increase in temperature indicates that lower temperature is in favor of biosorption.

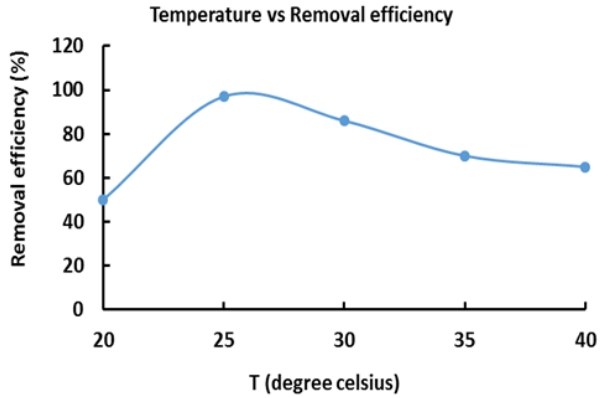

Figure 5: Effect of temperature on removal efficiency of direct red dye using *A. niger*

Conclusions

In this study, the removal of direct red dye using *A.niger* was examined in batch experiments. *A. niger* showed a strong ability to decolorize reactive dye (direct red). Currently, there is a growing interest in the study of brown rot fungi (*A. niger*) for the decolorization and degradation of many different dyes because of their biomass that can be used as an adsorbent for efficient decolorization.

Acknowledgement

Authors are thankful to NIET, Greater Noida to provide financial support and lab facility for this research work.

References

1. Yagub, M. T., Sen, T. K., Afroze, S., & Ang, H. M.. Dye and its removal from aqueous solution by adsorption: a review. Advances in colloid and interface science, 2014, 209, 172-184.
2. Yeap, K. L., Teng, T. T., Poh, B. T., Morad, N., & Lee, K. E. Preparation and characterization of coagulation/flocculation behavior of a novel inorganic–organic hybrid polymer for reactive and disperse dyes removal. Chemical Engineering Journal, 2014,243, 305-314.
3. Zhao, R., Wang, Y., Li, X., Sun, B., & Wang, C. Synthesis of β-cyclodextrin-based electrospun nanofiber membranes for highly efficient adsorption and separation of methylene blue. ACS applied materials & interfaces, 2015, 7(48), 26649-26657.
4. Quan, X., Zhang, X., & Xu, H. In-situ formation and immobilization of biogenic nanopalladium into anaerobic granular sludge enhances azo dyes degradation. Water research, 2015, 78, 74-83.
5. Särkkä, H., Bhatnagar, A., & Sillanpää, M. Recent developments of electro-oxidation in water treatment—a review. Journal of Electroanalytical Chemistry, 2015, 754, 46-56.
6. Rangabhashiyam, S., Suganya, E., Selvaraju, N., & Varghese, L. A. Significance of exploiting non-living biomaterials for the biosorption of wastewater pollutants. World Journal of Microbiology and Biotechnology, 2014, 30(6), 1669-1689.