Bioremoval of Carpet dye from effluent by *Aspergillus niger*

Karuna Singh
Department of Botany, Udai Pratap College, Varanasi, India
Department of Chemical engineering, IIT, BHU, India

Abstract

Dyes used in various industries is discharged into the environment and pose major environmental problem. In the present study investigation, *Aspergillus niger* was used for bioremoval of dye from a effluent of carpet industry from Bhadohi near Varanasi U.P India.. The effect of time, dye concentration and pH were examined in this study. The results showed that the *A. niger* decolorized effluent water up to 99.7% with increasing time, pH also play significant role in decolorization with increasing time. Substantial decrease in chemical oxygen demand (COD) also reported in seven days by *A.niger*.
KEYWORDS: *Aspergillus niger*, Bioremoval, Carpet dye.

1. INTRODUCTION

Textile industries discharge a huge amount of colored waste water are, rated as the most polluted in all industry sector. There are 100,000 commercially available dyes ..Mullan et al., 2001). Annual global dye production reaches almost 7×10^7 tons. Azo dyes comprise about 70% of total dye production. In India, it accounts for the largest consumption of dyestuffs at ~80%, taking in every type of dye and pigment produced, this amounts to close to 80,000 tons (Mathur et al. 2003). India is the second largest exporter of dyestuffs, after China. Worldwide, ~10^6 tons of synthetic dyes are produced annually, of which 1–1.5 × 10^5 tons are released into the environment in wastewaters (Koyani et al 2013).

Dyes extensively used in many industries e.g., various branches of textile industry, the leather tanning industry, paper production, pharmaceuticals and medicines, cosmetics, hair coloring, wood staining, agriculture, biological, and chemical research, light harvesting arrays, and photochemical cells (kuhad et al. 2004; Couto 2009). Because imperfection of dyeing process, approximately 10-15% of synthetic dyes released into industrial waste, causing serious environmental problem (koyani et al. 2013; Singh et al. 2013). Untreated coloured waste water may lead to contamination of surface water. The consequence is inhibition to penetration of sunlight, which may result reduction of photosynthesis activity and oxygen deficiency (Vishwakarma et al. 2012). Synthetic origin of dyes and complex aromatic structure cause that many of them are toxic, mutagenic and carcinogenic, some dyes are resistance to biological degradation and may be accumulated in food chain (Forgas et al.2004; Hamid and Rehman 2009; and Koyani et al. 2003).

Textile dyes uses a large amount of dyes, consequently increase of their concentration in the environment and requires the development of new and economically acceptable treatment technology. Various physiochemical and biological methods are used for treating waste water. Physiochemical methods (reverse osmosis, adsorption, flotation, precipitation, coagulation, ozonation, and chemical oxidation (Tony et al.2009). Biological methods have been gaining much attention due to their low cost and ecofriendly nature. (Ali et al. 2010). In addition, it would be cheaper as compared to other different physiochemical methods. The main mechanism of both live and dead forms of cells in the treatment process is biodegradation, followed by biosorption (Fu and Viraraghavan 2001). Biological methods include various types of microbial biomass such as bacteria, fungi, actenomyctes and algae (Kaushik and Malik 2009; Gupta and Rastogi 2008). Various fungual strains that have proved more efficient in declourization of textile dyes mostly belonged to the group of fungi by biosorption (Fu and Viraraghavan 2000) and enzymatic minerlization (degradation) [Lignin peroxidase, manganese peroxidas (MnP), manganese independent peroxidase (MiP), laccase] (Pointing and Vrijmoed 2000; Vishwakarma et al. 2012). Several fungi, such as *Asepergillus flavus* (Ali et al. 2010), *Aspergillus niger* (Zope et al. 2007), *Phanerochaete chrysosporium(*Arora and chader 2009*) and Cyathus bulleri* (wang et al.2012), has been reported as potential biodegraders of pollutend compounds. It was proven that the efficiency of any type of textile waste water depends upon on the type of microorganism and the process condition. The most important factors are temperature, oxygen level, p^H additional carbon and nitrogen sources as well as the concentration of dye and chemical structures (Younes et al 2012).

In the present work, we have investigated the potential of a fungus i.e.*Aspergillus niger*, for microbial declourization of waste water containing carpet dyes. The effect of dye concentration, time and P^H of waste water were studied.

2. MATERIAL AND METHODS

2.1 Chemicals

Waste water used in this study was collected from a local carpet industry in Bhadohi near to Varanasi, India. Theses waste water was collected in a sterilized plastic container.

2.2 Cultures and its maintenance

The pure culture of *Aspergillus niger* was procured from Institute of Agricultural Science, BHU, Varanasi. Throughout the study, cultures were maintained on malt extract agar medium at 28^0C and subculture at the regular interval of three weeks.

2.2 Preparation of inoculums

The *Aspergillus niger* was grown in 250 ml Erlenmeyer flask on optimized media (2.5% malt extract in distilled water). (Christian et al. 2003)The flasks were incubated in a shaker- incubator at 200 rpm and 27°C for 5 days and this fungal biomass were used as inoculums in the experiment.

2.3 Biosorption of dyes

All the experiments were performed to optimize concentration of dye water at 5ml, 10 ml, 20 ml 30 ml, 40 ml (Karthikeyan et al., 2009) with 1 ml inoculums concentration and agitation speed at 200 rpm in a triplicate manner. Media used throughout this study were malt extract containing media. Up to 50 ml of volume maintained in all flasks.

3. RESULTS AND DISSCUSSION

In present study different physicochemical parameters of dye containing effluent were estimated and obtained data are given in table 1. The physiochemical properties like temperature, pH, conductivity, TDS, TSS, TS, DO, COD, Hardness and absorbance of the effluent waste water was estimated by standard method.

3.1 Effect of ph on different concentration of dyes

Media without dye water showed pH 6.59 in the beginning of experiment, subsequently it decreased to 4.20 on 7th day of incubation. It was observed that pH decreased significantly in all concentrations of dye water. pH of 5 ml of dye water containing media was recorded 1.62 on 7th day of incubation whereas 10, 20,30 and 40 ml dye water containing media, pH recorded on 7th day were 1.40, 1.61,1.60 and 1.46 respectively. From obtained data during present study, it is clear that, in the beginning of experiment, media was slight acidic but after continuous incubation pH get decreased significantly. *Aspergillus* produces citric acid, due to this media become acidic. *Aspergillus* biomass production was increasing on incubation period. On 7thday of incubation culture medium appeared full of *Aspergillus* mycelium, meant for more biomass and consequently more acid production and; main reason behind the lowering of pH of experimental media. which is clearly show in fig.1

3.2 Effect of COD in different concentration of dyes

In addition to dyes, many other molecules, i.e., additives and surfactants are also present in the textile wastewater, which constitute up to 70% of the final dry weight. The removal of these molecules cannot be monitored by decolorization of the effluent. The chemical oxygen demand (COD) is an important parameter to determine the total oxidizable substances present in the waste water. 5 ml, 10 ml, 20, 30, and 40 ml of dye water containing media showed COD after 3 day of incubation were 126.6, 68.8, 101.67, 200 and 206 respectively, whereas after 5 days of incubation 50, 26.6, 18.34, 90 and 85 respectively. Finally when full growth of *Aspergillus* occur COD value decreased to at its lowest level i.e. 16.67, 10, 11.67, 35 and 30 respectively. COD of 20 ml dye water containing flask recorded more than 88% decreased.

3.3 Effect of % degradation rate on dye concentration

Decolorization was monitored by scanning the absorbance between 400 and 750 nm using PerkinElmer UV–Visible spectrophotometer and the maximum absorption of dye effluent recorded at 596 nm. Reductions in the absorbance at 596 nm showed that decolorization have taken place. Dye concentrations were calculated from the calibration curve of absorbance and

The declourization percentage of dye effluent was calculated as follows:

$$\text{Decolorization (\%)} = \frac{C_T - C_0}{C_0} \times 100$$

Where, C_0 refer to the absorbance of control, C_t refer to the absorbance of sample, and t refer to the incubation time (h).

In the preliminary phase of the current study, the ability of *A. niger* to decolorize dye effluent of carpet industry belonging to several different chemical structural groups was analyzed. It was easily analyzed that on subsequent days of incubation absorbance get decreased, which is shown in fig n.3.Initially dyes dissolved in water showed higher absorbance as *A. niger* grown in medium it started metabolize the dye compounds and break into simpler forms consequently absorbance get decreased. After 7th day of incubation dye water appearance was almost colorless. Increase of declourization percentage on subsequent day of incubation suggests that dye declourization is increased with decrease in pH (Bakshi et al., 2006 and Akar et al., 2009, Sarim et al., 2017). The decrease or increase in adsorption with pH maybe explained on the basis of aqua-complex formation and its subsequent acid–base dissociation at the solid–solution interface (Khare et al., 1987). In acidic medium, a positive charge develops on the surface (oxides) of adsorbents which is suitable for adsorption of dye anions, which decreases with increase in pH, hence decreasing the binding of anion dyes. On the other hand in alkaline medium the adsorbent surface becomes negatively charged, hence is suitable for adsorption of dye cations. Hence the extent of absorbance not only depends on pH but also on the acidic or basic character of dye to be adsorbed.

4. CONCLUSION

Decolorization is a challenging process to both the textile industry and the wastewater treatment plants.The result of present study shows that *Aspergillus niger* had led into higher levels of declourization and degradation potential for the removal of dye containing waste water. Under optimum condition it decolorized colored waste water up to 99.7%. The colored waste water is degradable under aerobic conditions with a concerted effort of fungus isolated from an effluent disposal site. Physiochemical parameters (pH, carbon source, dye concentration and agitation) had a significant effect on dye declourization. Further, it can be suggested that the potential of the fungus need to be demonstrated in its application for treatment of dye bearing waste water using appropriate practice, through biotechnological approaches to color removal.

Conflict of Interests- The authors have no conflict of interests.

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Table 1: Physiochemical analysis of waste water

S.N.	Parameter	Value
1	Temperature	80ºC*
2	pH	6.8
3	Conductivity	1.24ms
4	TDS	0.16 mg/l
5	TS	292.72mg/l
6	TSS	292.56mg/l
7	DO	4.1ms/cm
8	COD	250mg/l
9	Total hardness	980mg/l
10	Absorbanc	340.8

(*Initial reading of temperature at the sampling site)

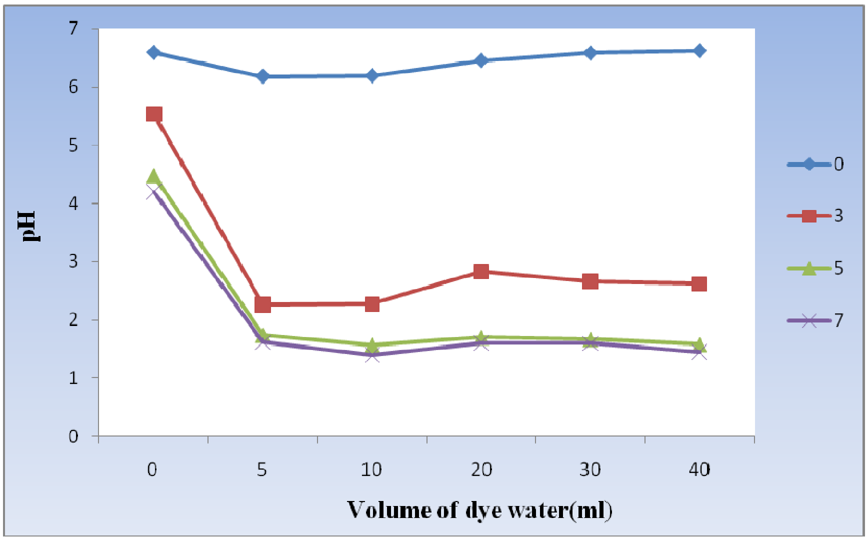

Fig. 1 Infuence of pH on different concentration of waste water

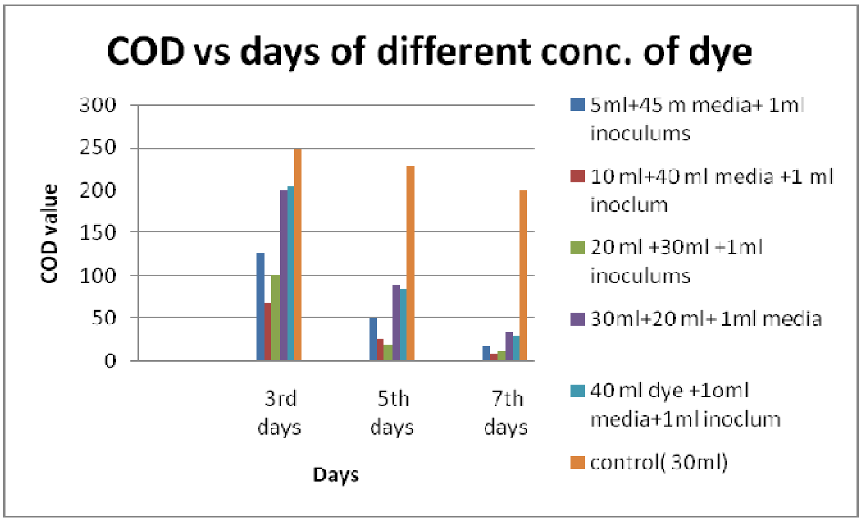

Fig. 2 Influence of Chemical oxygen demand (COD) on different conc. of waste water dye concentration (mg/L).

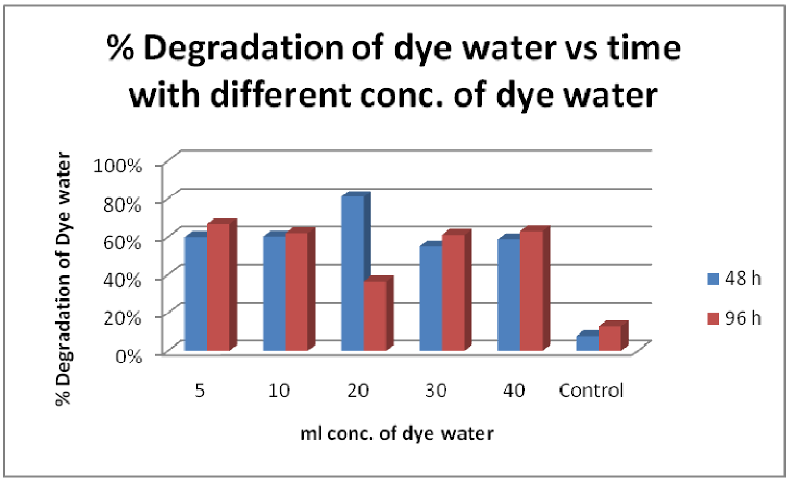

Fig.3 % Degradation of waste water at different conc.