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# Decolorization of Cibacron Yellow S-3R Using *Coriolus Versicolor* (MTCC 138)

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**Abstract**

The aim of the present study is to analyze the ability of the white rot fungi *Coriolus Versicolor* (MTCC 138) in the decolorization of Cibacron Yellow S-3R, a recalcitrant azo reactive textile dye. The influencing parameters that affect the percentage of decolorization rates are optimized in batch mode. The optimal values of the parameters such as mycelia age, temperature, pH, initial dye concentration and carbon source concentration are found to be 7 days, 30°C, 5.4, 100 mg/l and 2 mg/l respectively. The maximum percentage of decolorization at the optimized conditions is found to be 90%. It is also conferred that there is substrate inhibition to fungal decolorization when initial dye concentration is greater than 100 mg/l.

**Keywords:** Decolorization, Textile dye, White rot fungi, Percentage decolorization

## 1. Introduction

Textile dyeing industries is one of the fast growing, major export oriented industrial sectors in India. Dyeing, the fundamental unit operation during textile fiber processing, is gifted with large amounts of structurally diverse dyestuffs which are classified as azo dyes, anthraquinone dyes, phthalocyanine dyes etc., based on the chemical structure of the chromophoric group. Amongst them utilization of azo reactive dyes has been consistently increasing, as they provide ease of application, high wet fastness profiles, brilliant color shades and less energy consumption. These dyeing operations result in the production of more or less colored wastewaters (Rodrigues et al., 1999), depending on the degree of fixation of the dyestuffs on the substrates, which varies with the nature of the fabrics, the desired intensity of coloration, and the application method (Pearce et al., 2003). The presence of unfixed dyes in such waste waters is much higher than the allowable limits and extremely harmful to aquatic flora, fauna and human beings through food chains (Pierce, 1994). The textile dyeing process consumes large quantities of water and due to increasing global water scarcity, total or partially reuse of effluent after the necessary treatments becomes mandatory. Therefore, color removal criteria are more and more demanding attention. The conventional physical and chemical effluent treatment methods such as adsorption, chemical precipitation and flocculation are inefficient as they result either in large volumes of sludge or in the release of toxic substances (Spadaro et al., 1992). All the methods possess significant differences in color removal results, volume capability, operating time and capital costs. White rot fungi have been studied for their ability to degrade recalcitrant organo-pollutants such as polycyclic aromatic hydrocarbons (Bogan & Lamar, 1996), chlorinated phenols (Ruckenstein & Wang, 1994), PCBs (Sasek et al., 1993, Beaudette et al., 1998), dioxins (Takada et al., 1996), pesticides (Kullman & Matsumura, 1996), explosives (Gorontzy et al., 1994), dichloroaniline (Arjmand & Sandermann, 1985) and dyes (Kirby et al., 1995, Shin et al., 1997, Rodriguez et al., 1999). From the analysis of literature it is found that many authors used white rot fungi for decolorization of textile effluents (Chagas & Durrant, 2001, Swamy & Ramsay 1999, Yesilada et al., 2002, Kirby et al., 1995, Shin et al., 1997, Rodriguez et al., 1999, Wesenberg et al., 2003).

Though the number of studies on the biodegradation of dyestuffs have been steadily increasing in recent years, very few researches are reported for biodegradation of azo dyes, such as Cibacron Yellow S-3R using white rot fungi (Yesilada et al., 1998) and hence in this present research an attempt has been made to investigate the biological decolorization of the azo dye Cibacron Yellow S-3R using *Coriolus Versicolor* (MTCC 138).

## 2. Material and Methods

The organism used for decolorization *Coriolus Versicolor* (MTCC 138) is purchased from the Microbial Type Culture Collection and Gene Bank, Institute of Microbial Technology, Chandigarh, India. The fungus is cultured at 30°C on slant Sabouraud's Dextrose Agar and after a week a conidial suspension is prepared and utilized for the cultivation of the inoculums. 5 ml of the suspension is transferred to 250 ml flask containing 100 ml Sabouraud's Dextrose Broth. It is incubated at 30°C for 5 days in a shaking incubator at 130 rpm.

Batch experiments are performed in 250 flasks containing fresh SDB (2 ml homogenate / 100 ml SDB) along with desired concentration of dye (Yesilada et al., 2002). The contents of the flasks are sterilized for 20 min (1.5 atm, 121°C) and incubated in shaking incubator at 130 rpm. Samples are collected for every time interval and they are centrifuged at 1200 rpm, 20 min and supernatant is used for analysis. Absorbance measurements are done at maximum absorbance ($\lambda_{max}$ = 472nm) of dye using UV-Visible Spectrophotometer 119. Percentage decolorization efficiency is calculated according to the following formulation:

$$\text{Percentage of Decolorization} = \frac{A_b - A_a}{A_b}$$

Where $A_b$ is the absorbance at the maximum absorption wavelength of dye before decolorization and $A_a$ is the absorbance at the maximum absorption wavelength of dye after decolorization

## 3. Results and Discussion

### *3.1 Effect of mycelia age*

The effect of mycelia age on percentage of decolorization is studied using different days of culture growth, namely 5 days, 7 days 8 days and 9 days. From the results shown in Figure 1, it is found that 5 days of growth culture requires 48 hours to achieve maximum decolorization, whereas 7 days of growth culture takes only 24 hours for decolorization. Further increasing days of culture growth doesn't make any appreciable change in the percentage of decolorization and hence 7 days of culture growth is found to be optimum for further studies. The same trend is also observed by Duygu et al., (2005) for bio decolorization of Brilliant Blue using *Funalia trogii*

### *3.2 Effect of carbon source concentration*

Addition of a carbon source such as glucose at different concentrations has an effect on the percentage of decolorization and it is shown in Figure 2. The concentration of glucose is varied from 0.5mg/l to 5mg/l. From the analysis of Figure 2 it is found that the percentage of decolorization increases with the increase in concentration of glucose upto maximum glucose concentration of 2 mg/l and after which there is not much appreciable increase in percentage of decolorization (Swamy et al., 1999).

### *3.3 Effect of temperature*

The operating temperature of the incubation process is varied between 20°C and 60°C, to study the effect of temperature on the decolorization process that is shown in Figure 3. It clearly shows that at temperatures below 30°C, the growth of the fungi was too slow, that it took more days for decolorization and at temperatures above 30°C the activity of *Coriolus Versicolor* (MTCC 138) is reduced and hence percentage of decolorization decreases. From the analysis of the results it is found that optimal temperature for decolorization occurs at 30°C.

### *3.4 Effect of pH*

The effect of pH is studied by incubating the reaction mixtures with the pH varying from 3.5 – 7. The fungus is able to decolorize the dye during the pH range of 4.5 – 7 which is shown in Figure 4**.** The optimum pH is found to be 5.5 at which the maximum decolorization has occurred. For pH values below 5.5 there is no appreciable growth of fungi and hence percentage of decolorization decreases. Increase in pH greater than 5.5 resulted in the fragmentation of mycelia pellets and hence percentage of decolorization decreases.

### *3.5 Effect of initial dye concentration*

The effect of initial concentration of the dye is studied by varying the concentration from 50mg/l to 300mg/l with the optimal values of temperature, pH and glucose concentration at 30°C, 5.5 and 2mg/l respectively. The results show that in all initial dye concentrations, *Coriolus Versicolor* (MTCC 138) could effectively decolorize Cibacron Yellow dye. From the plot (Figure 5), it can be seen that though the percentage of decolorization increases with the initial dye concentrations and it reaches the maximum of 90 percentage of decolorization at 100 mg/l of initial concentration. There is a decrease in the percentage of decolorization for initial dye concentrations above 100mg/l, and it is mainly due to substrate inhibition.. (Al-Sabti, 2000, Chen, 2002, Gottlieb et al., 2003, Marlasca et al., 1998, Rosa et al., 2001, Walthall & Stark, 1999, Yesilada et al., 2003, Yun & Qi-xing, 2002).

**4. Conclusion**

From the study of decolorization of Cibacron Yellow S3-R by *Coriolus Versicolor* (MTCC 138), it is found that the optimal mycelia age is 7 days and optimal initial dye concentration is 100 mg/l and also the optimum temperature, pH and glucose concentration are found to be 30°C, 5.5 and 2 mg/l respectively. The potential ability of fungi shows that it can be used for the biodegradation of textile effluents. This study has to be further improved for continuous treatment of textile effluents.

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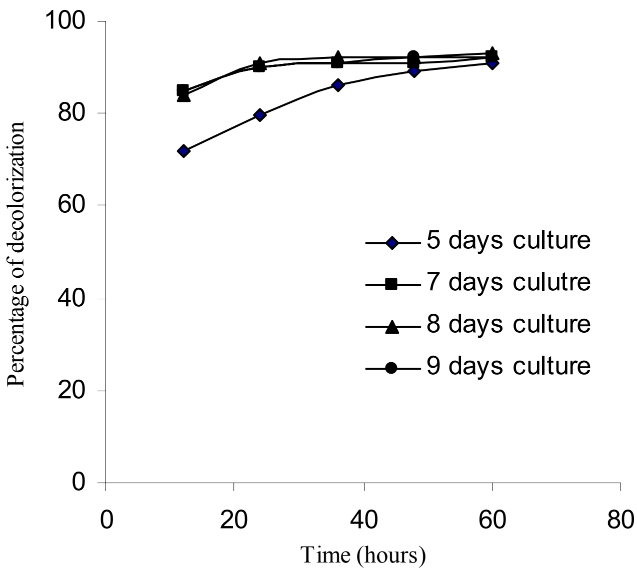


Figure 1. Effect of mycelia age on percentage of decolorization

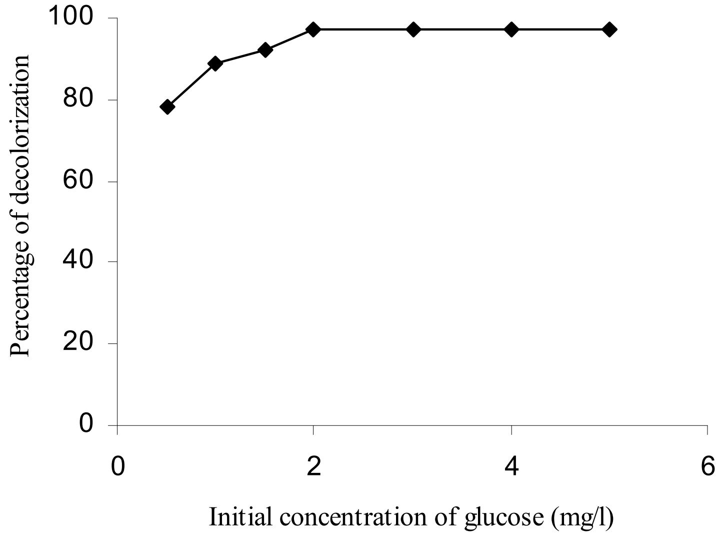


Figure 2. Effect of initial concentration of glucose on percentage of decolorization

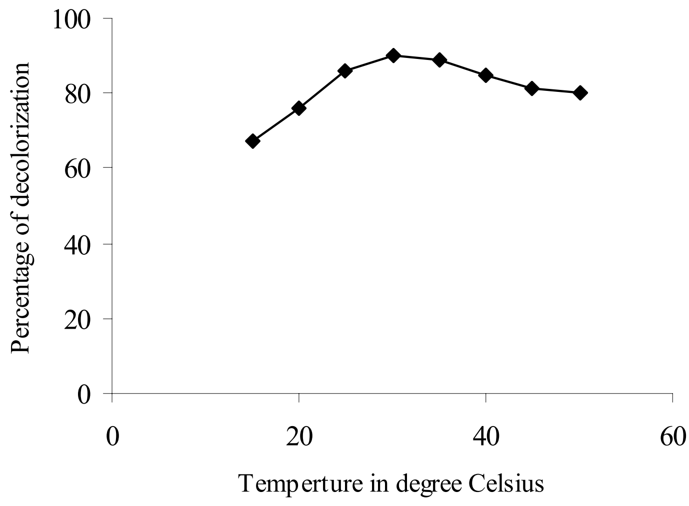


Figure 3. Effect of temperature on percentage of decolorization

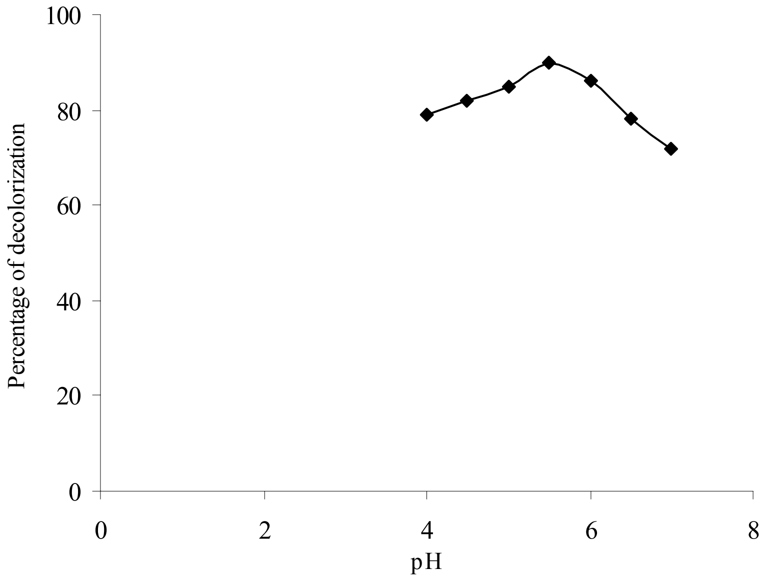


Figure 4. Effect of pH on percentage of decolorization

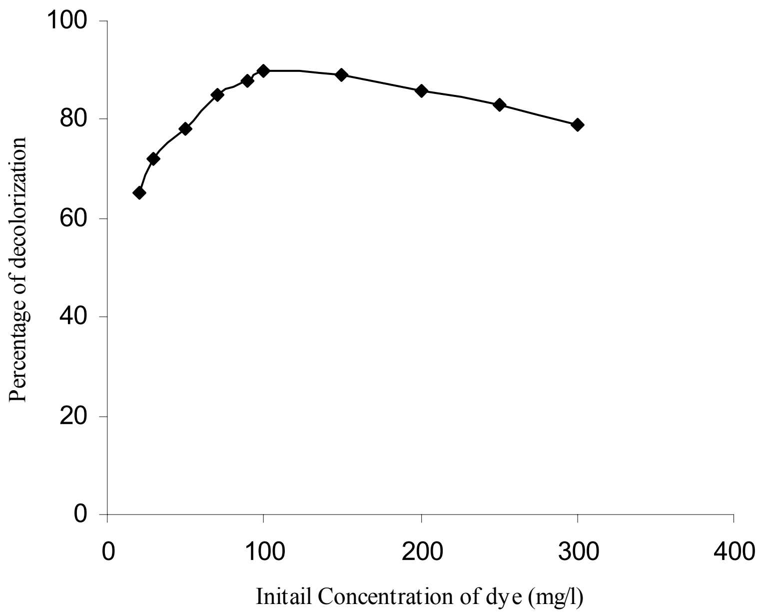


Figure 5. Effect of initial concentration of dye on percentage of decolorization