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Degradation of some textile industry effluent dyes by *Ganoderma applanatum*

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Abstract

The fungi were used for the decolourization of Azo dyes. Textile industry effluent such as Congo red, Rhodamine 6G and Malachite green accentuate environmental problems. *Ganoderma applanatum* mycelia has performed the highest percentage of azo-dye degradation after 6 days of its growth. It has exhibits 84 and 88 degradation percentage of 50 and 100ppm, respectively. PH value 6.0 was the best medium pH value for azo dye degradation, where it produced the highest percentage of dye degradation. Current results were interpreted that the color removal by the basidiomycetes fungi was mainly due to adsorption of the dyes to the mycelial surface, and also due to metabolic breakdown. These results suggest that *G. applanatum* vegetative mycelial form might be used for the treatment of azo dyes and textile dye industry effluent.

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Introduction

Nowadays, there are a lot of chemicals used in different fields of our life welfare. The process of chemical disposal is numerous such as soils, ground waters as well as surface water by running supply. Chemicals pollutant's bioaccumulation has resulted in severe repercussions, including mutagenic effects, the loss of food sources, and carcinogenic effects to mankind (Christian *et al.* 2005).

Worldwide, the textile industries are one of the largest liquid effluent pollutants producers, due to the large quantities of water used in the dyeing processes. Furthermore, the processing types of synthetic dyes applied during this conversion determine the variable wastewater Physio-chemical characteristics in terms of pH, dissolved oxygen, organic and inorganic chemical contents (Banat *et al.* 1996). The textile industry releases about 10 to 15% of the dye, which finds its way into waste water (Rodríguez *et al.* 1999). The isolation of efficient species able to degrading the dyes used in the textile manufacturing process is about large priorities (Chen *et al.* 2008). A wide variety of microorganisms are capable of decolorizing a wide range of dyes (Dawkar *et al.* 2008), moreover, these are even capable of completely memorializing many azo dyes under certain environmental conditions. Several other white rot fungi have also been well characterized for degradation of various industrial dyes and treatment of dye effluent (Wesenberg *et al.* 2002).

The textile dyes and effluents have toxic effects on living organisms such as its effect on the germination rates and biomass of several plant species which have important ecological and human functions. Saving the soil for wildlife and protecting it from pollution produce organic matter that is so significant to soil fertility (Cripps *et al.* 1990). Therefore, treatment of industrial effluents containing azo dyes and their metabolites is necessary prior to their final discharge to the environment. The present study was conducted with *Ganoderma applanatum* in vegetative mycelial form to investigate its ability as a dye decolorizing basidiomycete organism.

Materials and methods

Studied fungal strains

The studied fungal strain was *Ganoderma applanatum* which was collected from Salix stem trees located in different parts of Alhashas and Khaira villages, Albaha, Saudi Arabia (Alghmadi, 2016).

Isolation of Ganoderma applanatum

Fresh collected *Ganoderma applanatum* fruiting body was used to isolate its mycelia from the hymenium layer that was picked up with sterilized forceps. The fresh basidiospore part of hymenium layer was inoculated with sterilized malt agar media (Malt 20 g and yeast extract 1g. It was made up to 1 L of distilled water and inoculated at 28°C for 9 days.

Growing of G. applanatum on media with Azo dye

G. applanatum mycelial discs was collected from a well-grown culture (5 mm id) and inoculated in potato dextrose agar (Peeled Potato, 250g, Dextrose, 20 g and azo dyes (Congo red, Rhodamine 6G and Malachite green) was added at a concentration of 50 and 100 ppm and made up to 1 Liter of distilled water. Inoculated flasks were shaken at 150 rpm for different time course.

Samples were withdrawn at regular time intervals and filtered through a G3 sintered glass filter. The optical density of the clear filtrate was measured at 497, 524 and 620 nm, respectively for Congo red, Rhodamine 6G, and Malachite green in a spectrophotometer (Shimadzu, TCC 240), (Selvam *et al.* 2012).

Analysis of degradation

The percentage dye degradation efficiency was determined using the formula,

Cf = Absorbance/Calibration Slope Value

% Degradation= [(Ci -Cf)/Ci] ×100

Where, Ci = Initial Concentration of dye (ppm)

Cf = Final Concentration of dye (ppm)

Determination of Microbial Biomass

Microbial biomass was determined for the samples at regular intervals. Samples were centrifuged at 10,000 rpm for 15 min. The growth of biomass was monitored.

Statistical Analysis

All data values are expressed as Mean (±SD). Statistical analyses were performed using Graph Pad In Stat version 3.0, (Graph Pad Software, San Diego, CA).

Results

Ganoderma applanatum mycelia have produced the highest percentage of azo dyes degradation after 6 days of its growth. It has exhibits 84 and 88 degradation percentage of 50 and 100 ppm, respectively. Degradation ability of *G. applanatum* was decreased after 6 days of its growth. However, the experimental organism recorded the lowest degradation percentage at 2 days of growth, where this might have attributed to the organism synthesizing of degradation enzymes (Table 1). Fig. 1 show *G. applanatum* growth at 100 ppm of azo dyes. The maximum dry weight was obtained after 6 days (700 mg/ml). To investigate whether the pH value has an effect on azo dyes degradation or not; different values were tried ranged from 5.5 to 8.5 (Table 2). pH value 6.0 was the best medium pH value for azo dyes degradation, where it produced the highest value of dye degradation (Fig. 2).

Table 1. Biodegradation of Azo dye by *G. applanatum* at 50 and 100 ppm.

Time (day)	Dye degradation percentage at 50 ppm	Dye degradation percentage at 100 ppm
2	30 ± 2.0	28 ± 3.0
4	62 ± 5.0	64 ± 5.0
6	84 ± 6.0	88± 6.2
8	60 ± 6.5	56 ± 7.0
10	52 ± 7.1	48 ± 4.5

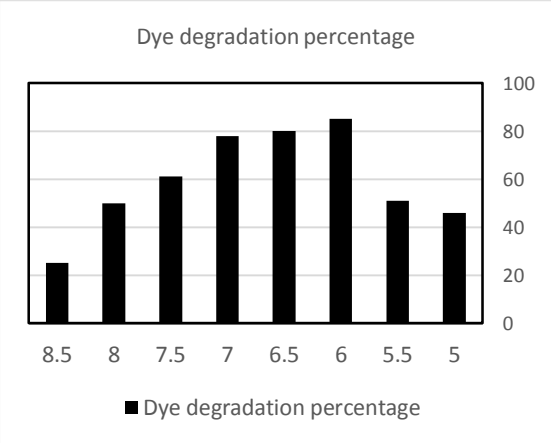

Fig. 1. pH effect on Azo dye degradation with *Ganoderma applanatum* growth (dry weight) at 100 ppm.

Table 2. pH effect on Azo dye degradation with *Ganoderma applanatum* growth (dry weight) at 100 ppm.

pH	Dye degradation percentage
5.0	46
5.5	51
6.0	85
6.5	80
7.0	78
7.5	61
8.0	50
8.5	25

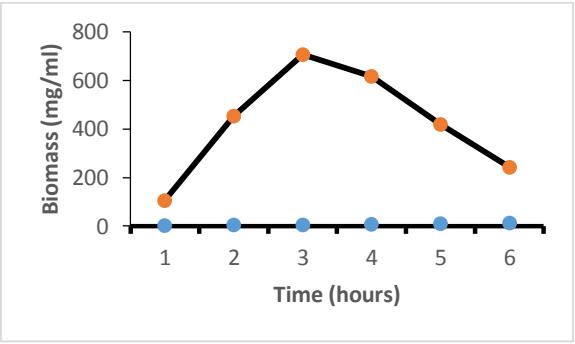

Fig. 2. Determination of *Ganoderma applanatum* growth (dry weight) during dye degradation at 100 ppm.

Discussion

Nowadays, wastewater represents an extra source of water available for many purposes, for example, in irrigation. Use of wastewater in agricultural irrigation is becoming a common and ever increasing practice. Biodegradation of dyes in textile waste waters are found to be a very effective method of effluent treatment. *G. applanatum* degradation efficiency was reached up to 86 % through using of this basidiomycetous organism.

Selvam and his collaboratories (Selvam *et al.* 2012) have studied The decolourization of Congo red, Rhodamine 6G and Malachite green at 50µM concentration by *Ganoderma* sp. were observed as 77%,

65.3%, and 75.2%, respectively on the fifth day. *Ganoderma applanatum* produced the highest percentage of dyes degradation after 6 days (Table1). Similarly, It has found within 5 days (Cripps *et al.* 1990). Also, *Bjerkendra aedusta* and *Trametes versicolor* removed 95% of HRB38 dye within 4 days (Selvam *et al.* 2003). However, *Fomes lividus* was able to decolourize 30.8% of orange G within 9 days, whereas Congo red was removed up to 74% within 8 hours and amido black 10B up to 98.9% in 6 hours (Tychanowicz *et al.* 2004). Several industrial dyes were decolourized biocatalytically by extracellular enzymes. pH 6.0 was proved the best for Azo- dyes degradation by *G. applanatum* that produced the highest percentage of dyes degradation. The efficiency of dyes decolorization depends on the structure and complexity of azo dyes, which might be changed through charging at different pH values.

Conclusion

In the present study, *Ganoderma applanatum* were used for decolourization of Congo red, Rhodamine 6G and Malachite green, and also for dye industry effluent. *G. applanatum* was resulting in the almost complete removal of color at the end of the sixth day of the incubation period. It was concluded that the efficiency of dyes decolorization depends on the structure and complexity of azo dyes. These results showed that the complex and large structure of these compounds is more sensitive to enzymatic decolourization. The use of White rot fungi may be conceivably used in textile dye degradation, indeed, suggesting a potential application field for the removal of dyes from industrial effluents.

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