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Application of Bioluminescence for Appraisal of Fungal Bioremoval and Detoxification of a Textile Dye

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TEXTILE DYES are among the recalcitrant organic compounds in industrial wastes. The effect of these residues on the ecosystem depends on the way they are handled. In developing countries residues of coloring materials are usually discharged without treatment into the terrestrial and/or aquatic ecosystem. Bioremediation technologies appear to be promising to treat these residues prior to its disposal. Among these technologies, use of fungal biomass proved to be effective in removing dye residues. In this study, experiments were curried out to gain the highest production of fungal biomass to use in the bioremoval studies.

The results indicate that *Aspergillus niger* strain 20 was among the best biomass accumulators based on biomass yield and specific growth rate. In this study the ability of this strain to remove direct violet textile dye in concentrations ranging between 100 to 1000 mg/l was assessed. The removal capacity was analyzed using decolorization of dye solution and the toxicity of the degradation products.

The results show that the fungus biomass was able to remove 70 % of dye color in two hours from a range of concentration up to 800 ppm. The color removal decreased in higher concentration (above 800 mg/l), however, it was still relatively high. In the higher concentration of dye the removal has increased with time reaching close to 73% after 72 hr of incubation.

The bioreporter *Acinetobacter* DF4/PUTK2 carrying luciferase genes luxCDABE was employed to determine the amount of dye toxicity. The strongest bioluminescence inhibitory effect of the dye was recorded with the highest three dye concentrations. However, the rest of tested concentrations showed decrease in bioluminescence inhibition values, indicating a reduction of dye toxicity level. Chemical analyses indicate that fungal treatments reduced the COD (chemical oxygen demand) value of the dye solutions. This is

evidence that the fungal treatment was successful in dye bioremediation. The luminescence biosensor was proved to be fast technique for tracing dye removal and toxicity.

Keywords: Bioremediation, Textile dye, Fungi, Toxicity, Luminescence biosensor

Despite technological advances in the textile and dyeing industry, they also caused new and significant environmental concerns, as dye residues represent a major threat to the environment. Not all dyes currently used could be degraded and/or removed by physical and chemical processes, and there is a possibility that the degradation products become more toxic than the dye itself. These pollutants not only add color to water but they also may cause extensive toxicity to the aquatic and other forms of life. Nearly 10–15% of the total dyes from various textile and other industries are discharged in wastewater causing extensive pollution (Robinson *et al.*, 2001 and Keharia & Madamvar, 2003). Therefore, the treatment of industrial effluents containing dyes (aromatic compounds) becomes necessary prior to their final discharge. However, most of the conventional methods for the effective removal of phenols, aromatic amines and dyes are outdated due to their certain inherent limitations (Robinson *et al.*, 2001, Abadulla *et al.*, 2000, Sumathi & Manju, 2000, Knapp *et al.*, 1997 and Kapdan *et al.*, 2000) reported the ability of fungal strains to decolorize two dyes; Orange II and Everzol Turquoise Blue G. What are the current methods for renovation of industrial waste water from textile dye companies are still limited particularly in developing countries due to the lack of appropriate cost effective techniques.

Several toxicity and mutagenicity bioassays have been described and different methods using microorganisms have been used to assess the acute toxicity of industrial wastewaters. Among these bioassays are Ames test (Ames *et al.*, 1973) tests based on algae growth (Wei *et al.*, 2006) and bioluminescence tests (Marinella and Damia, 2003). The last test is based on the inhibition of the bioluminescence of luminescent bacteria *Vibrio fischeri* or *Photobacterium phoshoreum* as a factor of toxin removal (Bitton, 1983).

The present work aims at assessing the use of fungi as a bioremediation for certain textile dye residues using bioluminescence biosensor technique.

Material and Methods

Dye

One of the most commonly used textile dye namely direct violet RN (direct violet 31) was used. The dye was obtained from Ixmadye Dyestuffs and Chemicals Co. Removal of dye by the fungal culture was monitored using spectrophotometer LBK (model 4054). The λ_{max} value of the RN (direct violet 31) dye was 542 nm and the reduction in the absorbance value at this wavelength