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Biological Decolorization of Synthetic Dyes: A Review

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ABSTRACT

Both synthetic and natural dyes are widely used in various industries particularly in Textile Industries. Many harmful and hazardous effects of synthetic dyes have been reported, but these are using very commonly worldwide. One of the most important problems of synthetic dyes is its decolorization. Scientists have been trying to remove the colour with the help of certain chemicals, fungi, bacteria, algae, and many other techniques, but Biological Decolorization of Synthetic Dyes is very common and most effective method. In the present paper review has been done about various process used in Biological Decolorization of Synthetic Dyes.

Keywords: Synthetic Dyes, Biological Decolorization, Algae etc.

I. INTRODUCTION

Adding color to textile products like fibers, fabrics etc. is known as Dyeing. A special solution containing dyes and particular chemical material has been used for dyeing. After dyeing, dye molecules have uncut Chemical bond with fiber molecules. The temperature and time controlling are two key factors in dyeing. There are mainly two classes of dye, natural and man-made i.e. synthetic dye. To decorate clothing, or fabrics for other uses dyeing has been done by humans with the help of natural dyes for many years but in the last 150 years, humans have produced synthetic dyes for more range of colors, and to render the dyes more stable to resist washing and general use. Particular types of dyes have been used for particular fiber as well as for particular stages of the textile production process. Basic dyes have been used for Acrylic fibers, acid dyes for Nylon and protein fibers. Vat dyes and modern synthetic reactive and direct dyes have been used for Cotton. Many harmful and hazardous effects of synthetic dyes have been reported, but these are using very commonly worldwide. One of the most important problems of synthetic dyes is its decolorization. Scientists have been trying to remove the colour with the help of certain chemicals, fungi, bacteria, algae, and many other techniques, but Biological Decolorization of Synthetic Dyes is very common and most effective method. In the present paper review has been done about various process used in Biological Decolorization of Synthetic Dyes.

Megha et al. have been worked on Decolorization of different dyes by an indigenous strain of fungus from Eucalyptus tree. Their study has been proved that from number of different synthetic dyes (RBBR, Malachite Green, and Congo red) Mucor hiemalis decolorize RBBR dye most efficiently. Ideal conditions for decolorization of 50 ppm RBBR dye has been achieved at 30°C, 5.0 pH and shaking speed of 130 rpm for both free and immobilized biomass although complete decolorization has been achieved in more than one week. The investigations have been proved the higher decolarization capacity of immobilized biomass then free fungal biomass. (1)

Ravikumar et al. have been done batch experiment for the decolorization of direct red dye using A. niger and A. flavus under static and shaking conditions. They have been found that at 50 mg/L 97% and 87% decolorization has been achieved with Aspergillus

niger in 48 hrs at static and shaking condition but in case of A. flavus percentage of decolorization has been found to be 78% and 83% in 48 hrs in static and shaking condition respectively.(2)

Naik et al. have been used biological method to explore the usability of the microorganisms i.e. bacteria, P. aeruginosa for the removal of dyes from aqueous solutions using two commercial synthetic dyes i.e. Reactive orange 16 and Reactive black 5. It involves the use of In their investigations effects of various parameters such as pH, temperature and initial dye concentration have been investigated and the effectiveness of this method to remove the dye solution has been determined by measuring the percentage of colour removal. The results have been showed that the bacteria are able to decolorize these two reactive dyes and the optimum pH, temperature. As per their study it has been suggested that Pseudomonas aeruginosa is a tremendous potential strain for decolorization of reactive textile dye effluent, and it can be used as a practical alternative in the treatment of textile wastewater to achieve effluents that congregate the CPCB emissions standards.(3)

For decolorization of industrial synthetic dye a regenerable bacterial surface displaying system have been developed by Lin LI et al., they also have been evaluated its effects on independent and continuous operations. A bacterial laccase (WlacD) has been engineered onto the cell surface of the solvent tolerant bacterium P. putida to form a whole cell biocatalyst. This study has been demonstrated, for the first time, the methodology by which the engineered P. putida with surface-immobilized laccase has been successfully used as regenerable biocatalyst for biodegrading synthetic dyes, thereby opening new perspectives in the use of biocatalysts in industrial dye biotreatment.(4)

Rehman et al. have been investigated on the fungi, Aspergillus niger and Nigrospora sp. for decolorization of Synozol red HF-6BN. Decolorization study has been showed that Aspergillus niger and Nigrospora sp. have been able to decolorize near about 90% Synozol red 6BN in 24 days. A fungal-based protein with relative molecular mass of 70 kDa has been partially purified and examined for enzymatic characteristics. The highest activity have been exhibited at temperature ranging from 40-50°C and at pH=6.0. In the presence of metal cations the enzyme activity has been enhanced. It has been suggested that A. niger and N. sp. have effective potential in color removal from textile wastewater-containing azo dyes. (5)

Mirzadeh et al. have been given an idea to prepare immobilized laccase on porous silica beads followed by evaluation of both free and immobilized laccases for decolorization of few synthetic dyes. Presences of HBT as laccase mediator on decolorization pattern, effects of laccase concentration, pH and temperature alteration have also been investigated. The kinetic parameters, Km and Vmax of the free and immobilized laccases have also been calculated for each synthetic dye. The immobilized laccase of P. variabile on porous beads as an efficient biocatalyst for decolorization of synthetic dyes have been introduced. (6)

Chulalaksananukul et al. have been worked on decolorization seven different synthetic dyes. Using a laccase enzyme extract, enriched from the fungal liquid culture supernatant, the anthraquinone derivative dyes have been decolorized in more than two hours at less than 55°C by 55 and 70%, respectively. The four azo compounds viz. Amaranth, Cibacron Brilliant Red 3B-A, Direct Blue 71 and Reactive Black 5, and the indigo molecule (Indigo Carmine), has been showed a higher resistance to decolorization i.e. less than 10% in more than 5 hours, although of them Amaranth, Reactive Black 5 and Indigo Carmine have been efficiently decolorized by T.

versicolor in agar plate assays. The study has been showed that using laccase alone has effective potiential in decolorization process. (7)

Ghosh et al. have been applied a carbon sorbent derived from an agriculture waste, mustard straw to study the removal of irgalite dye from aqueous solution. In their research the comparison of adsorption and simultaneous adsorption have been done using and biodegradation of irgalite dye have been done using P.putida with activated carbon prepared from mustard straw, which showed removal of more then 80 % higher SAB, with respect to adsorption (70%). For biodegradation of irgalite by P. putida at shake flask level Haldane's growth model has been fitted the best. (8)

Naik et al. have been worked on Reactive dyes i.e. one of the most used dyes in textile industries for dyeing of cellulosic fiber. Decolorization of a very important synthetic dye i.e. Reactive Red 152 has been investigated in their study. From textile effluent, a potential dye degrading organism, Pseudomonas sp. has been isolated. To get maximum dye decolorization few optimum conditions such as pH, temperature, various carbon source and nitrogen source have been investigated. Under optimized condition almost decolorization of dye has been observed. It has been suggested that the dye can be used as sole source carbon and energy source for cell growth. Phytotoxicity on wheat has been tested and treated samples have been found to be non-toxic. The results have been suggested that isolated organism Pseudomonas sp. is suitable bacterium for the bioremediation of textile waste water. (9)

Biological method have been used to explore the usability of the microorganisms i.e. bacteria, Lactobacillus delbruckii for the removal of dyes from aqueous solutions by Hamid et al. It involves the use of two commercial synthetic dyes i.e. Reactive orange 16(RO 16) and Reactive black 5(RB 5). Few parameters like pH, temperature and initial dye concentration have been studied and the effectiveness of this method to remove the dye solution has been determined by measuring the percentage of colour removal. The results have been showed that the Lactobacillus delbruckii has tremendous potential strain for decolorization of reactive textile dye effluent, and it can be used as a practical alternative in the treatment of textile wastewater to achieve effluents that congregate the Malaysian emissions standards. (10)

Briganti et al. have been worked on the effects of various parameters of real dyeing bath formulations, like equalizing and fixing additives on the decolorization catalyzed by Funalia trogii enzymatic extracts, to understand their influence on the recalcitrance to biodegradation of this type of wastewater. The decolorization of selected dyes and dye mixtures after tissue dyeing has been performed in the presence and absence of auxiliary compounds. The use of extracts containing laccase only or laccase plus cellobiose dehydrogenase has been done for enzymatic declorization up to different extents. The comparison of extracellular extracts have been obtained from spent straws from the commercial growth of Pleurotus sp. mushrooms with those from F. trogii reveals similar decolorization extents thus allowing to further decrease the costs of bioremediation. (11)

Santana et al. have been studied on the degradation of synthetic dye mixtures, using photoelectro-catalytic properties of particulate films of TiO2 supported on titanium substrate and excited by UV–Vis radiation. Spectrophotometric methods have been used for the measurement of decolorization of the Dyes. Data analysis has also been shown that, under the conditions of this study, the Cl^- present in the electrode/solution interface can be oxidized to generate the ClO_3^- species. These species turned out to be powerful oxidizing agents, which together with the

hydroxyl radical, work in the efficiency of the photo-catalytic process. (12)

Karnchanatat et al. have been worked to obtain new laccase and enzyme source with remarkable dye removal potential. More then 25 isolates of white rot fungi have been studied for extracellular laccase-production using 2,2-azinobis (3-ethylbenzothiazoline-6-sulfonate) (ABTS) assay as indicator. Out of these, the highest laccase activity has been exhibited by Polyporus pseudobetulinus strain WR77 and its suitable enzyme production medium contains; 1% (w/v) rice chaff, less than one gram per litre diammonium tartrate, and 0.01 g/L peptone as the carbon; inorganic and organic nitrogen sources; respectively. New enzyme and source with satisfactory dye removal potential have been successfully achieved. (13)

Investigations have been done by P. Sotiropoulos et al. on an integrated electro chemical decolorization, degradation treatment procedure of indigo carmine dye, which comprises electro-coagulation, electro-oxidation and advanced electro-chemical oxidation using the electro-Fenton process. The electro-coagulation process has been performed by sacrificial iron electrodes, the indirect electro-oxidation process by dimensionally stable Ti/Pt and graphite electrodes in NaCl electrolyte solution, and the electro-Fenton process by iron electrodes and added amounts of H2O2. All electrochemical experiments have been conducted in the same electrochemical cell with the same apparent electrode surface and inter-electrode distance. The three different electrochemical processes have been discussed; their efficiencies have been compared and evaluated. It has been proved in the study that this method is safe and efficient process for removal of indigo carmine dye from aqueous solutions and dye house effluents. (14)

Comparative study has been done by Oryasin et al. on Biological decolorization of two textile dyestuff (Benazol black ZN and Cibacron black W-NN); using 22 microfungi strains isolated from polluted industrial soil areas. Benazol black ZN has been maximum decolorized by Haematonectria haematococca (HH1) and Cibacron black W-NN by A. niger in optimum conditions. (15)

Polyphenol oxidase enzyme from quince leaves in immobilized on calcium alginate beads have been used by Usluoglu et al., in investigations on water pollution, for the effective decolrization of textile industrial effluent. (16)

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