Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 03, March -2018

BIODEGRADATION OF TOXIC DYES AND TEXTILE DYE EFFLUENT –A REVIEW

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Abstract:-*Environmental pollution due to urbanization and rapid growth of industries has a detrimental effect on human health and ecology. Textile dyes constitute a major source of waste water pollution. Dye is an integral part which is used to impart color to materials having the Chromophore and the Auxochrome group. The waste generated during the process and operation of the dyes, contains the inorganic and organic contaminant leading hazardous ecosystem and biodiversity. The physico-chemical treatment may only decolorize the waste but it increases its toxicity but by adopting biological living systems there is abadetement in its toxicity.. The decolorization of the dye takes place either by adsorption on the microbial biomass or and enzymatic degradation. Bioremediation takes place by anaerobic and/or aerobic process. In the present review the decolorization and degradation of dyes by fungi have been reviewed. The factors affecting decolorization and biodegradation of dye compounds such as pH, temperature, dye concentration, effects of carbon dioxide and nitrogen, agitation, effect of dye structure, electron donor ,immobilization of enzymes and use of Bioreactors involved in microbial decolorization of dyes have been also high lightened in the review.*

Key words*: Bioremediation, Xenobiotics, Fungi as robust organisms, LMEs, Immobilization of enzymes, Bioreactors, Biodegradation, Mineralization*

Introduction

Colored industrial effluents have become a vital source of water pollution and because water is the most important natural source; its treatment is a responsibility. Usually colored wastewater is treated by physical and chemical processes but by this tactics, only colored is removed and it causes increase in its toxicity. The synthetic dyes are frequently used in several recent technologies and industrial sectors (Acemioglu and al., 2010; Bhole and al., 2004). Due to the persistent nature and recalcitrant dyes, the large quantities of discharge cause the contamination of water and pollution in the environment (Crini, 2006). The effects of dyes on human health can range from gastrointestinal irritation to the cancer, mutagenic effects, and skin irritation and even to fertility (Santhi and al., 2009). Usually colored wastewater is treated by physico-chemical processes (Ho and McKay, 1998). But these treatments have limitations like the formation of toxic by-products and intensive energy requirements (Padmesh and al., 2005; Aksu, 2005) and are ineffective in removing dyes, are expensive and not adaptable to a wide range of colored water (Banat and al., 1996; Fu and al., 2001). Color removal, especially from textile effluents, has gargantuan challenge over the last decades, and up to now there is no single and cost-effectively attractive treatment that can effectively decolorize as well as treat the dyes effluents. Dyes and pigments are widely used, mostly in the textile, paper, plastics, leathers, food and cosmetics industry to color products. Textile industry consumes large volume of water and produce large amount of wastewater during all phases of textile production and finishing. The release of colored effluents represents a serious green pollution and a human health concern particularly in developing countries. A number of biotechnological approaches have been suggested by recent research as of potential interest towards combating this pollution source in an eco-efficient manner, including the use of bacteria or fungi, often in combination with physicochemical processes . Further antimicrobial activities of the first stage textile dye effluent were also carried out (Pandya et. al, 2011) . A wide variety of microorganisms are capable of decolorization of a wide range of dyes some of them are as bacteria *Escherichia coli* NO3, *Pseudomonas luteola*, *Aeromonas hydrophila*; *Aspergillus niger*, *Phanerochaete chrysosporium*, *Aspergillus terricola*, *P. chrysosporium*; *Saccharomyces cerevisiae*, *Candida tropicalis*, *C. lipolytica; algae: Spirogyra species Chlorella vulgaris C. sorokiniana, Lemna minuscula, Scenedesmus obliquus, C. pyrenoidosa and Closterium lunula*.

Biotreatment depicts a cheaper and environmentally friendlier alternative for colour removal in textile effluents. The ecofriendly microbial decolorization and detoxification is a alternative to the physical and chemical methods. The kinetics of decolorization and the environmental factors affecting the decolorization rates is relatively scarce. The decolorization can be realized biologically by three different processes: biosorption, biodegradation and bioaccumulation. The biosorption is considered the most advantageous than others for the treatment of colored waters (Kaushik and Malik, 2009) and is identified as the preferred technique for decolorization by giving the best results (Jain and al., 2003; Ho and McKay, 2003).

The degradation of dyes by several different bacteria such as *Aeromonas hydrophila* and *Pseudomonas putida* has reached a high percentage of decolorization in several studies (Ren and al., 2006; Chen and al., 2003; Chen and al., 2007). The role of fungi in the treatment of colored waters has been greatly studied (Azmi and al., 1998; Brar and al., 2006). By using inexpensive media culture, several fungal species dead or alive were used for water decolorization by biosorption (Fu et Viraraghavan, 2002; Mittal et Gupta, 1996; Kaushik et Malik, 2009). Recently, studies move away from the use of bacterial biomass because its isolation is difficult and requires an abundant amount of nutrients while the amount of bacterial biomass obtained is low. In comparison with the bacterial biomass, the separation of dye effluent is easier for fungal biomass (Kaushik and Malik, 2009). Compared with living biomass, dead biomass eliminates the problems of toxicity and nutritional requirements. In this case, dead organisms are not affected by toxic waste (Brady and al., 1994) their use is effective when the conditions are not always favorable for growth and maintenance of the microbial population (Crini and al., 2006). Their operation is easy and simple. It is therefore an effective biosorbent. Mou and al. (1991) compared the living and autoclaved cells and found that those autoclaved are more effective in fading waters. Fu and Viraraghavan (2001) showed that the capacity of dead biomass *Aspergillus niger* to remove a dye (either basic or acidic) is better than living. Tatarko and Bumpus (1998) used the two cultures of the fungus *P. Chrysosporium* living and dead (autoclaved) to treat water. They found that the autoclaved cells have a higher percentage of biosorption (90%) than living cells (70%).

We also studied the ability of diodegradation of Azo dyes by 51 different fungal isolates. 3 fungal isolates that showed maximum degradation were *Aspergillus spp, Mucor spp* and *Rhizopus spp* and optimized the conditions for better degradation with all 3 fungi. Decolorization and degradation had reached upto 91% at end of 4^{th} day after optimizing the conditions. The degradation also incresead upto 89% with pH 3, at ambient temperature 38° C giving aerobic conditions and upto almost 98% using raw lignocellulosic substrates, glycerol and ethanol.
Further their degradation mechanism was studied and magic behind this degradation was all due to LMEs i.e. Lignin modifying enzymes. All the 3 fungal isolates had LMEs but maximum LMEs were produced by Rhizopus spp and so it was further screened for enzyme production and optimization. Also sequencing of Rhizopus spp was done for its identification and it was found to be *Rhizopus oryzae. (Jadeja, 2012).*

Synthetic textile dye under static and shaking conditions with respect to various parameters.. They are considered as recalcitrant compound for degradation. The rate of enzyme utilization and dye decolorization also increased linearly with increasing initial biomass concentration. A kinetic model describing the rate of enzyme utilization and substrate inhibition as function of the initial substrate and flow rate was developed. The kinetic constants were determined using the experimental data. The discharge of highly coloured effluents containing dyes can be damaging to the receiving marine water bodies and can result in serious environmental pollution problems.

Owing to the inherent short comings of conventional biological effluent dye treatment processes, we have proposed diverse intriguing approaches that await practical implementation. This study demonstrates the feasibility of fungi coupled with various reactor systems. Stirred tank reactor system was found very effective for efficient treatment of textile waste water containing azo dyes by my strain *Rhizopus oryzae* immobilized on Scotch Brite which is a very rare approach. Overall color, BOD and COD were removed by 94.53, 89.50 and 99.24% respectively (JadeJa, 2012). Aerobic Fluidized bed Reactor acclimatized with the fungal biomass consortium of *Pleurotus ostreatus* MTCC No: 1804, *Pleurotus sajor-caju* MTCC No: 141, *Tremetus versicolour* MTCC No: 138 and *Tremetus hirsute* MTCC No: 136 were found to be more efficient in treating the textile dyeing effluent containing Drimarene Red X 6BN, Drimarene Blue X 3LR CDG and Drimarene Yellow X4RN by achieving 95.2% of color removal and 89.4% COD removal (K.Balaji and S.Poongothai 2012).Using up-flow column reactor(UFCR) immobilized with Aspergillus niger SA1 decolorization of 94.26% of 10 mgl-1 of Dimarene blue K2RL dye was obtained, however it reduced to 58.51% at 300mgl-1 of dye. Recycling is an important parameter in any industry in terms of time and economy and we have found almost same results with recycling also that shows the efficacy of fungi (Jadeja, 2012).

Water pollution through industrial discharges, which is mainly in the form of effluent or wastewater, is one of the biggest problems. These effluents have strong concentrations of chemical oxygen demand (COD), phenol and its derivatives and often contain metals, inorganic nutrients, organic compounds, proteins, cyanides, chlorinated lignin and dyes. Bioremediation of toxic industrial effluents by microorganisms serves as an effective method to substitute the conventional recovery and removal processes. Fungal biomasses have huge capability of treating effluents discharged from various industries.

CONCLUSION

Fungal decolorization of dye effluent is receiving much consideration due to cost effective and less regeneration by microorganisms such as bacteria, fungi, yeast, algae, and plants. Recent fundamental research works have revealed the existence of wide variety of microorganisms capable of decolorizing wide range of dyes. The use of microorganisms for the removal of synthetic dyes from industrial effluents offers considerable advantages this process was relatively inexpensive, running costs were low and the end products were completely mineralized with no toxicity. Degradation of dye is a complex process works to detoxify, decolorize, degrade and mineralize the dyes are done in lab scale only. Hence the need of effective complete conversion of textile effluent into useful liquid waste by using microbes is required. White rot fungi are ubiquitous in nature and their adaptability to extreme conditions makes them good biode-graders. Their enzyme producing activity makes them effective decolorizes; they remove toxic metals by biosorbtion ultimately rendering the effluents more ecofriendly taking a first step towards Green Revolution.

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