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REVIEW PAPER

Decolorization and Biodegradation of textile dyes: A Review

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ABSTRACT

The goal of this review is to provide a description of the basic properties of azo dyes as well as the various treatment techniques for removing them from water. Traditional azo dye-contaminated wastewater treatment solutions are restricted to physical and chemical procedures with significant energy and economic costs. Biological decolorization is both cost-effective and environmentally caring, making it a viable alternative to artificial processes. Many species (bacteria, fungus, and algae) have demonstrated efficient dye adsorption and degradation due to the presence of numerous essential dye degrading enzymes. Microbial mechanisms have been discovered to be effective in mineralizing manmade dyes.
Keywords: - *Bioremediation, Effluent, Pollution, Microbial Cells, Fungi.*

INTRODUCTION

Today's life faces the introduction of endless measures of pollutants in nature among fast industrialization and urbanization. Water is crucial to planet Earth's survival and proximity to life. Large amount of wastewater is discharged by the textile industry which released into the water bodies and is a major environmental concern [1]. The most typical problem was that the textile dyeing industry produces significant volumes of high-grade colored liquid waste. Over a million tons of synthetic dyes are produced worldwide for the leather industry, textile industry, pharmaceutical industry, foodstuffs industry, cosmetics industry, plastics and paper industry [2].Colorants linked to metals such as copper, cobalt and in particular chromium are difficult to break down and constitute a substantial source of pollution because of their enhanced organic presence. It generates harmful and permanent impacts of ecotoxicology, biological build-up, floral and aquatic fauna biomagnification and biological cycle modification [3,4]. Untreated wastewater is less biodegradable and of damaging quality. It is one among the enormous sources of phenol noticeable amines [5]. This potent metal-dye combination has carcinogenic and mutagenic characteristics for anyone exposed to dyes pollutants. This can lead to skin cancer (due to photosensitivity), photodynamic damage, allergic contact dermatitis, renal, reproductive, liver, cerebral malfunction, breathing irritation and asthma [6]. The textile and dyestuff industries are the two main suppliers of toxic dyes. In the industrial world, dyes must be chosen based on

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their washability and photostability. It should also be resistant to microbial deterioration, making removal from water using traditional wastewater treatment methods a difficult operation. Since then, over 1,00,000 dyes have been produced, with a total yearly production of about 7 X 10^5 metric tonnes.10-15% of unused teeth generally penetrate directly into aquatic bodies. Color is the first and immediate indicator when water is contaminated by harmful dyes. The water intake is directly contaminated by highly colored wastewater. Dyes are usually synthetic in origins. They are very stable and seldom present for biodegradation because of their complex aromatic molecular structures. Synthetic dyes are geared to the chemical structures of the chromophorous group as triphenylmethane dyes, azo dyes, nitrous dyes, anthraquinone and xanthanes. Due to their complicated structure, the synthetic dyes are very resistant to degradation and are quite hazardous for crops, aquatic system and human beings. Physicochemical procedures have traditionally been employed to treat azo dye-contaminated effluents, but their high economic and energy costs, as well as the environmental problems connected with their usage, have driven technical advancement in recent years toward the employment of microorganisms. Because of their longevity, flexibility, enzyme activities and chemical structures, these biological alternatives are effective. Furthermore, hybrid technologies have been created, which combine different technologies into one, taking the best of each and going beyond the boundaries of existing conventional therapies [7,8]. According to recent research, molecular approaches such as metagenomics and metaproteomic are being employed to investigate the molecular breakdown process of azo dyes. These technologies may be used for screening and identifying critical genes, proteins, and enzymes that will be required for gaining a thorough understanding of the intrinsic biodegradation process of dyes. [9,10,11].The capacity of microbes to decolorize dyes has recently gotten a lot of interest. Dyedecolorization by microorganisms is a low-cost method of removing dyes from the environment. Bioremediation nowadays is based on the pollutant-degrading abilities of naturally existing microbial consortia, with bacteria playing a key role. Microbial consortia are commonly utilized for environmental remediation without studying the constituent microbial populations, and the complexity of the microbial consortium allows them to act on a range of contaminants.

OVERVIEWS ON TEXTILE DYES

Dyes are chemicals with the capacity to attach to a substrate and provide color. They can be chemical or biological in origin. Their chemical structure, colour, application and particle charge in solution may all be used to classify them. They are categorized as azo dyes, nitro dyes, naphthalein dyes, triphenyl methane dyes, indigoid dyes, and anthraquinone dyes based on their chemical structure [12,13]. They are categorized as acid dyes, basic dyes, direct dyes, ingrain dyes, dispersion dyes, mild dyes, vat dyes, and reactive dyes based on their use. A class of azo dyes, as well as their degradation products, encourage the migration of hazardous ground and surface waters polluted by textile effluents, which can contaminate other water sources. Dyes causes an undesirable color of water, obstructs light diffusion and reduces dissolved oxygen in river ecosystems posing a danger to aquatic life. As a result, processing textile dye effluents before dumping them into water streams is critical. When compared to other types of dyes, azo dyes are synthetic chemicals that are frequently employed due to their vivid color, simplicity of handling, usage, and economic feasibility in synthesis. Monoazo, diazo, triazo, polyazo, and azoic dyes can be distinguished by the number of azo linkages (–N=N–) present in a molecule of the dye [14].

PHYSICO CHEMICAL METHODS FOR DEGRADATION OF TEXTILE DYES

Advanced processes of oxidation, adsorption, ozonation and membrane filtration include the most widely used physiochemistry [15,16,17]. The following methods were most frequently used: photocatalytic decay, coagulation, flocculation, and photo-electrocatalytic oxidation etc. Unfortunately, while these procedures were successful in removing colors from wastewater, they have a number of disadvantages, including complicated infrastructures, high costs, ineffective color removal, formation of secondary pollutants, or significant volumes of contaminated sludge and harmful by-products [18,19].

MICROBIAL DEGRADATION OF TEXTILE DYES

Microorganisms are extremely important in the decolorization and detoxification of textile dyes. Currently, a lot of approaches for the control of textile dye effluents have been developed, with ecofriendly biological treatment approaches demonstrating the greatest outcomes at the lowest cost as compared to Physiochemical approaches. Many microorganisms including bacterial, fungal, and algal species may adsorb and breakdown color's. When contrast to the fungal system, bacteria decolorize and mineralize pigments more quickly. A large variety of color's has been identified for decoloration and detoxification by several bacterial animals such as Bacillus, *Pseudomonas, Enterobacter* and *Halobacteretcsss*. Several investigations have been conducted to create efficient remediation strategies using a combination of aerobic and anaerobic microbial treatments. *P. luteola, P. mirabilis,* and *K. rosea* demonstrated promising dye degradation results in anoxic circumstances, as did numerous other bacterial species under aerobic circumstances.

BACTERIA

Bacillus spp., Alcaligenes spp., and *Acinetobacter spp*. are some important bacteria that have been discovered to be helpful in the bioremediation of halogenated fragrance mixtures and textile effluent. For the development and amount of dye decolorization, each bacterial culture has distinct cultural and nutritional needs. Differently optimal cultural (pH, temperature, anoxic / aerobic settings, dye concentrations, dosages of inoculum, and nutritional (carbon-nitrogen) conditions, diverse bacterial species which are able to decolorize different color's, were utilized for dye treatment.In addition, they use several resistance mechanisms, which include removal of metal ions through extra-cellular obstacles such as the capsule, cell wall and plasma membrane. Metal ions are extruded by efflux or diffusion pumps. Ions are intracellularly sequestrated through metal ions [20]. In the interaction between bacteria and metal, biofilm development is critical for bacterial survival in the presence of high metal concentrations, and efflux systems allow bacteria to interact with various amino acids as a strategy of environmental adaptation. In recent times, *Serratialiquefaciens* has been proposed as a possible bacterium for azo dye degradation (Azure -B), which has been demonstrated to be successful in lowering phytotoxicity, genotoxicity and dye cytotoxicity [21]. Strains of the *Acinetobacter* and *Klebsiella* species exhibited good results for the colouration and decoloration of mono and di-azo dyes frequently used in textiles [22].

FUNGI

Fungi's capacity to adjust its metabolism for the use of diverse carbon and nitrogen sources makes it a feasible alternative for dye degradation. Because of its oxidative and non-specific ligninolytic enzymes, many fungi can decolorate and reduce pollutants. *Trametesversicolor* degrades the red dye 27 via peroxidases [23], *Aspergillusniger* and *Aspergillusterreus* by degrading, absorbing and reduced the toxicity of the red azo dye MX-5 [24].White red is the most investigated among many fungi and is a good technique for removing dye. In fact, these fungi are utilized in the processing of/degradation of lignin in dead plant biomass, lignin peroxidase (LiP), manganese peroxidase (MnP) (Lac).Fungal biomass is regarded an excellent bio sorbent to textile dyes since the use of basic fermentation procedures and inexpensive growth medium 76 is economically cultivable in considerable quantities. The major arguments for utilizing macro-fungi are: (1) dry weight in big quantities; (2) Chemical stability in most alkaline and acidic environments; and (3) good mechanical strength, easily and inexpensively accessible everywhere. In addition, macrofungi's fruiting bodies have a strong texture when dried and other physical features can be used to make bio-resource products as well.

YEASTS

In compared to bacteria and filamentous fungus, yeasts exhibit certain sophisticated characteristics. As a result, it is emerging as a possible alternative to established therapeutic approaches that involve bacteria and fungus [25]. *Candida boidinii* MM 4035 was the first methylotrophic yeast with dye decolorizing capacity to be identified. Manganese-dependent peroxidase activity was identified during the decoloration technique [26].

CONCLUSION

Mineralization and degradation of color'scontinuing to be a problem for wastewater treatment and the textile industry. Findings from numerous literatures indicate that microorganisms have a high capacity for color removal from dye wastewaters. Dye removal methods have changed over time. This has been a path paved by physical and chemical processes that has led to the adoption of ecologically friendly and lucrative biological solutions for the industry. Plants, algae, and other microbial biomasses have been employed as an alternative for dye removal in these biological solutions. Given that bacteria are adaptable in nature, have the capacity to digest pollutants, and have a high tolerance to hazardous color's, they provide various benefits for microbial remediation of textile industry wastewater. However, the true potential of the microbial strains and their enzyme may be investigated in appropriate bioreactors for future application in textile wastewater treatment.

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