BIO REMOVAL OF AZO DYES FROM TEXTILE EFFLUENTS : A REVIEW

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ABSTRACT: This Research Paper Explore the Review on Application of Bio Waste Materials on Adsorptive Removal of Azo dyes from Textile Effluents. Textile, paper, food, cosmetics, and pharmaceutical sectors all utilize synthetic dyes, with the textile industry being the major consumer. azo dyes are the most often used synthetic dyes in the textile industry, out of all the dyes available. Textile dyeing and finishing operations produce a lot of dye-containing wastewater, which is one of the major contributors of water pollution across the world. Several physico-chemical techniques have been used to treat textile wastewater, but these technologies have a number of drawbacks, including high costs, limited efficiency, and secondary contamination issues. Biological techniques, which include bacteria, fungus, yeast, algae, and plants, as well as their enzymes, have gained popularity as a cost-effective and environmentally acceptable alternative to physico-chemical processes. Biosorption or biodegradation are two ways that biological activities might decolorize azo dyes. Dye degradation may also be aided by a number of reductive and oxidative enzymes. This paper examines how biological processes decolorize and degrade azo dyes, demonstrating that microbial and plant cells are highly efficient biological weapons against poisonous azo dyes.

Keyword: Azo dye, Microorganism, Bio waste Materials ,Biosorption , Textiles Effluents

1 INTRODUCTION

Dyes are the most common chemical substances used in industrial coloring. Dyes are organic compounds that have their own colour. Dyes are divided into two categories:(i) chromospheres groups in their chemical structures, such as azo dyes, anthraquinone dyes, and phthalocyanine dyes, and (ii) their application technique, such as dispersion dyes for polyester and reactive dyes for cotton . The primary categories of dyes include azo (monoazo, diazo, triazo, and polyazo), anthraquinone, triarylmethane, and phthalocynine. Because of its chemical structure, which is defined by one or more azo bonds (-N=N-), azo dyes absorb light in the visible range . Every year 2.8 * 10^5 tons of textile dyes are pumped in to water environment throughout the world .Azo dyes are the most prevalent of all textile dyes (about 3000 distinct types) because to their ease of biosynthesis, chemical stability, and colour diversity when compared to natural dyes . A total of 80% of azo dyes are utilized in the textile industry's dyeing process. Textile, leather, food, paper, cosmetics, and pharmaceutical sectors all utilize them. It is believed that 10-15% of the colors used in textiles are toxic.

The textile dyeing and finishing industry has created a major pollution problem since it is one of the most chemically intensive industries on the globe and the biggest polluter of clean water (after agriculture). Over 3600 different textile dyes are presently produced by the industry. Textile production processes such as dyeing and printing require around 8000 chemicals. Many of these chemicals are hazardous and can affect human health either directly or indirectly. Water is used extensively in textile manufacture, dyeing, and printing. An average-sized textile mill that produces roughly 8000 kg of fabric per day uses about 1.6 million gallons of water per day. This is used in dyeing at a rate of 16 percent and printing at a rate of 8%. Specific water usage for dying ranges from 30 to 50 liters per kilo gram of material, depending on the type of dye employed. Yarn dyeing uses around 60 liters' of water every kilo gram of yarn. The dyeing process accounts for 15% to 20% of the overall waste water flow. Colored and printed fabric and yarn must also be cleaned to achieve washing fastness and bright backgrounds. This is accomplished through the use of cleaning chemicals such as caustic soda-based soaps, enzymes, and so on. This removes any surplus colour and paste from the substrate. Cleaning printing equipment with water is also necessary to remove loose colour paste from printing blankets, printing screens, and dyeing vessels .It takes around 500 gallons of water to cover one sofa with enough fabric. Textile dyeing and finishing procedures account for 17 to 20% of industrial water pollution, according to the World Bank. Only 72 harmful compounds have been found in water as a result of textile dyeing, 30 of which are irreversible. For the garment and textile industries, this is a horrifying environmental concern.

Millions of liters of this effluent, which is rich of colour and organic compounds from dyeing and finishing salts, is discharged as dangerous toxic waste by mills. Sulphur, naphthol, vat dyes, nitrates, acetic acid, soaps, chromium compounds, heavy metals such as copper, arsenic, lead, cadmium, mercury, nickel, and cobalt, as well as some auxiliary chemicals, make the effluent very hazardous. The hue of the effluent is generally rather high. To eliminate colour and, if feasible, remaining contaminants, a complementary treatment step is required. The textile sector has been declared the world's worst polluter of the environment. Every stage of the textile production and finishing process need a considerable number of chemicals and water. Water is required to transport chemicals into the cloth as well as to wash it at the start and conclusion of each stage. It becomes clogged with chemical additives and is subsequently discharged as effluent, polluting the environment.

The dyeing procedure leaves the textile fibers unbound and is released into the environment. The release of dye-containing effluent from various industrial practices into water bodies and surrounding industrial areas is a major source of concern, which has a number of negative effects on life, including decreased aquatic photosynthesis, dissolved oxygen exhaustion, and toxic effects on flora, fauna, and humans. The presence of dyes in textile effluent imparts a disagreeable look, and their breakdown products (colorless amines) are poisonous, carcinogenic, and mutagenic .

2 REVIEW OF LITERATURE

A review of the literature indicates that a significant amount of research has been done on surface water contamination caused by industrial pollutants. The ground water has not been spared from the effects of industrial effluents; thus, more time is needed to examine the extent of pollutant migration and contamination in ground water.

Shah etal (2018) evaluated various Azo Dye Removal Technologies. The introduction of significant volumes of effluent wastewater containing industrial textile colouring chemicals into the rest of the environment would worsen water quality by causing pollution, eutrophication, and disturbance of aquatic life, posing a major health risk. Furthermore, the majority of dyes and their metabolic intermediates are carcinogenic and mutagenic. Synthetic dyes are pollutants created by the biosphere, and they are incompatible with the conventional technique of mineralization of organic effluent. The azo dyes are the most significant and widely used commercial dyes, accounting for about 75% of all textile dye products. The employment of physicochemical techniques to clean effluent from the dying process has drawbacks, such as the excessive use of chemicals and the apparent issues with sludge disposal. Bioremediation for dye removal is gaining popularity since it is clearly economical, ecologically benign, and generates far less sludge.[1]

Singh etal (2017) studied Bio Removal Methods for Textiles effluents . Textile, paper, food, cosmetics, and pharmaceutical sectors all utilise synthetic dyes, with the textile industry being the major consumer. azo dyes are the most often used synthetic dyes in the textile industry, out of all the dyes available. Textile dyeing and finishing operations produce a lot of dye-containing wastewater, which is one of the major contributors of water pollution across the world. Several physico-chemical techniques have been used to treat textile wastewater, but these technologies have a number of drawbacks, including high costs, limited efficiency, and secondary contamination issues. Biological techniques, which include bacteria, fungus, yeast, algae, and plants, as well as their enzymes, have gained popularity as a cost-effective and environmentally acceptable alternative to physico-chemical processes. Biosorption or biodegradation are two ways that biological activities might decolorize azo dyes. Dye degradation may also be aided by a number of reductive and oxidative enzymes. This paper examines how biological processes decolorize and degrade azo dyes, demonstrating that microbial and plant cells are highly efficient biological weapons against poisonous azo dyes.[2]

Dye removal from industrial wastewater is a major environmental problem, according to Seow et al.(2016). Biological degradation, ion exchange, chemical precipitation, reverse osmosis, coagulation,

flocculation, and other physical and chemical treatment techniques for dye removal have all been investigated thus far. However, many treatment methods have drawbacks, such as high costs and the production of hazardous sludge. Adsorption, which is the most cost-effective and efficient way for removing colours, has become the most used approach. The application of adsorption in the removal of dyes from aqueous solution will be discussed in this review. The method' adsorption parameters, such as solution pH, starting dye concentration, adsorbent dose, and temperature, have also been described. The results of the literature study were used to make conclusions about the influence of those adsorption variables on dye adsorption.[3]

Shekoohiyan et al. (2016) investigated the adsorption of reactive azo dyes on activated carbon produced by NH_4Cl. The ability of NH_4Cl-induced activated carbon (NAC) to adsorb RR198, an azo reactive model dye, from an aqueous solution was investigated. The effects of pH (3 to 10) on adsorption effectiveness, adsorbent dosage (0.1 to 1.2 g/L), dye concentration, and contact duration were studied. N. Chaudhary et al. (2015) investigated the use of low-cost adsorbents to remove Rhodamine-B from aqueous solution. They converted a coconut shell and waste Fly ash into activated carbon in this study and then tested the waste's adsorption ability for removing textile azo colours from an aqueous solution.[4,5]

Physicochemical study of textile dye effluent and screening of textile dye degradation microbial species were investigated by Islam et al.(2015) . They claimed that dye degradation and decolorization processes, which include a variety of physical and chemical methods, have inherent drawbacks such as cost, economic unfeasibility (requires more energy and chemicals), inability to remove some recalcitrant dyes, and the production of large amounts of sludge, which, if not properly treated, can lead to secondary pollution. As a result, biological degradation is regarded as a viable approach for the elimination of hazardous azo dyes due to its eco-friendliness and low cost.[6]

Mehta et al. (2014) investigated low-cost adsorbents for adsorptive dye removal from industrial dye effluents. They stated that human activities such as industrial, agricultural, and residential activities have had an impact on the environment, resulting in serious issues such as global warming and the creation of wastewater carrying high levels of pollutants. Furthermore, society's fast modernisation has resulted in the production of vast quantities of low value commodities with no practical application. Such materials are commonly regarded as garbage, and disposing of them is a challenge. The use of all of these materials as low-cost adsorbents for wastewater treatment may provide them some utility. A brief overview of low- cost alternative adsorbents has been provided with the goal of employing these waste/low-cost materials in wastewater treatment.[7]

Mohamed et al.(2014) investigated the use of several types of coagulants to remove reactive dye from textile industry effluent. The efficacy of coagulation-flocculation in removing commercially used reactive dye from textile effluent was investigated in a research. Aluminium sulphate (alum), polyaluminium chloride (PAC), and magnesium chloride were investigated as coagulants ($MgCl_2$). As a coagulant aid, Koaret PA 3230 polyelectrolyte was utilised.[8]

The removal of textile azo dyes from aqueous solutions using a low-cost adsorbent activated carbon-fly ash combination was investigated by Chaudhary, K. et al., (2014) Adsorption of azo dyes from aqueous solution and textile dye waste is successful using a 1:1 combination of activated carbon fly ash.[9]

Panic et al. (2013) investigated the azo dye adsorption on polymer substrates. The use of polymeric adsorbents for azo dye removal from solution has been examined. Adsorption methods are frequently employed to remove some types of contaminants from water, particularly those that are difficult to degrade. The researchers looked at removing azo dyes as pollutants from wastewaters from the textile, paper, printing, leather, pharmaceutical, and other sectors. The kind and extent of contamination will be assessed using standard methods of water and wastewater analysis . Surface and ground water samples will be collected on a regular basis from the proposed location and analysed to determine the nature and quality. Chemical analysis will be performed on samples of wastewater emitted by various companies. Color, odour, temperature, pH, electrical conductivity, total suspended solids, total dissolved solids, total solids, chemical oxygen demand, total hardness, alkalinity, dissolved oxygen, biological oxygen demand, chlorides, sulphates, phosphates, nitrate, lead, chromium, zinc, pesticides, and other organic pollutants will all be determined using modern analytic techniques. Adsorbents for the removal of dyes will be made from low-cost bio-waste materials that may be employed directly or after little physical or chemical modification.[10]

2.1 DETRIMENTAL EFFECT OF AZO DYES

Azo dyes, which are found in textile wastewater, are a significant concern owing to their toxicity. Azo dyes with a nitro group have been shown to be mutagenic in nature (Chung and Cerniglia, 1992), and when broken down, hazardous chemicals such 1, 4-phenylenediamine and o-tolidine are produced (Rosenkranz and Kolpman, 1990). In addition, sulfonated azo dyes were shown to have a lower or no mutagenic impact than unsulfonated azo dyes (Jung et al., 1992). 3-methoxy-4-aminoazobenzene, a rare aromatic amine, has been discovered to be a potenthepatocarcinogen in rats and an apotent mutagen in bacteria . Acid Violet 7, a commercial textile azo dye, has the capacity to cause lipid per oxidation, chromosomal abnormalities, and acetyl cholinesterase inhibition. Because of its metabolites 4- aminoacetanilide and 5-acetamido-2-amino1-hydroxy-3,6-naphtalenedisulfonic acid, the toxicity of Acid Violet 7 dye rises during biodegradation by Pseudomonas putida. Similarly, Methyl Red is a mutagenic dye, and its microbial breakdown product, N, N-dimethylphenylenediamine (DMPD), is a poisonous and mutagenicaromatic amine that stays unaltered in the culture. In human hepatoma cells, Tsuboy et al.(2007) discovered that the azo dye Disperse Blue 291 is genotoxic, mutagenic, and cytotoxic, as well as causing micronuclei and DNA fragmentation. Sunset Yellow, Carmoisine, Quinoline Yellow, Allura Red, Tartrazine, and Ponceau 4 are rare azo compounds that have been shown to damage children when used as food and drink additives (Parliament, Council, The, & Union, 2008). Dyes that cause bladder cancer in humans, as well as splenic sarcomas, hepatocarcinomas, and nuclear abnormalities in experimental animals, are discussed. In albino rats, the azo dye Metanil Yellow was found to be hepatotoxic. Metanil Yellow and Orange II metabolism has also been investigated in rats and guinea pigs as model systems. Because of azo dyes' negative impacts on human health and the environment, there is an urgent need to prohibit their use in the environment. However, in practice, this is not possible. As a result, adopting treatment technologies that decrease or eliminate colours from wastewaters is a solution to this problem. The dimensions of biological techniques used for bio decolorization and biodegradation of azo dyes from various sources are compiled in this study.[11,12,13]

2.2 AZO DYES DECOLORIZATION AND DEGRADATION VIA BIOLOGICAL METHODS

Adsorption on microbial biomass (biosorption) or biodegradation of the dyes by live cells are two techniques for decolorization and degradation of azo dyes. Biological treatment of textile azo dyes has been proven to be the best approach since it can degrade virtually all dye materials while also overcoming many of the physico-chemical methods' drawbacks. Numerous research focusing on the employment of microorganisms to breakdown dyes show that biodegradation is an environmentally acceptable and cost- effective way to manage dye-containing wastewater (Vitorand Corso, 2008; Pajot et al., 2011).

Through anaerobic, aerobic, and sequential anaerobic-aerobic treatment procedures, microorganisms (bacteria, fungus, algae, and yeast), plants, and their enzymes may successfully remove the colour of a wide spectrum of azo dyes.[14,15]

2.3 BIOSORPTION

Biosorption is the process of microbial mass absorbing or accumulating substances .Biosorption has been effectively utilised to remove hazardous pigments from bacteria, yeast, filamentous fungus, and algal biomass . The cell wall components, such as heteropolysaccharides and lipids, which contain various functional groups such as amino, hydroxyl, carboxyl, phosphate, and other charged groups, create significant attraction interactions between the azo dye and the cell wall . Won et al. (2005) discovered Corynebacterium glutamicum as a latent azodye Reactive Red 4 biosorbent. Mnif et al. (2015) identified Bacillus weihenstephanensis RI12, a bacterial strain that biosorbs Congo Red using the SPB1 biosurfactant. Fungi have been utilised as a latent sorbent for decolorization of azo dyes from industrial effluents, similar to bacteria-mediated biosorption, and have received a lot of interest. Several factors influence effective biosorption, including pH, temperature, ionic strength, contact duration, adsorbent, dye concentration, dye structure, and the kind of microbe employed. In addition to the use of bacterial and fungal biomass in the biosorption of azo dyes, algae are also useful biosorbents since they may be found in both freehand and salt water . According to Donmez and Aksu(2002), algae's biosorption capability is due to their large surface area and strong binding affinity. The physical mechanisms that underlie algal biosorption include electrostatic attraction and complexation in the cell wall of algae. Dead algal cells outperformed live cells as biosorbents because they require no nutrients, can be kept and utilised for long periods of time, and can be regenerated using organic solvents or surfactants . The primary benefits of the biosorption process are its high selectivity, efficiency, economics, and ability to function at low concentrations . It has also been shown to be an effective approach over currently existing physico-chemical techniques such as ion exchange . Early saturation is a significant drawback of biosorption, as is the lack of biological control over the distinctive biosorbent.[16,17,18]

2.4 DECOLORIZATION AND DEGRADATION BY ENZYMES

Many studies have been published on the use of physico-chemical techniques to remove colour from dye- containing effluents These procedures include adsorption, chemical treatment, coagulation, and ion pair extractions, among others, but they are associated with issues such as high costs and the production of huge volumes of sludge, which requires safe disposal. Over traditional physico-chemical treatments, the enzymatic method offers an alternate strategy for decolorization/degradation of azo dyes from wastewater since it produces less sludge and is also more cost effective. Several enzymes are involved in the removal of azo dyes, and they have shown to be an efficient molecular weapon in the decolorization of azo dyes (Singh et al., 2015). Reductive and Oxidative enzymes are the two major groups of enzymes that conduct azo dye decolorization.[19]

2.5 ENZYMES THAT CATALYSE REDUCTIVE REACTIONS

Azoreductases are catalytic proteins encoded by bacteria algae, and other microorganisms and yeast Several bacterial species have been discovered as having the ability to degrade azo dyes in anaerobic (low oxygen) environment (Oturkar et al., 2011). The azo link is first broken by the bacterial azoreductase enzyme during the dye decolorization process, resulting in the formation of the Under lowered circumstances, poisonous colourless aromatic amines are formed . Azoreductases For azo dye decolorization, fully rely on reducing equivalents (e.g., NADPH, NADH, and FADH) . Because most azo dyes include sulfonate groups and have a high molecular weight, they cannot pass through bacterial membranes. This demonstrates that dye lowering action is independent of the dye's intracellular absorption Enzymes have been classified as FMN-dependent reductase, FMN-independent reductases NADHDCIP reductases are thought to be marker enzymes for bacterial and fungal mixed function oxidase systems, and they help with xenobiotic chemical detoxification [20]

2.6 APPLICATION OF MICROORGANISMS IN AZO DYE DECOLORIZATION AND DEGRADATION

The role of several types of bacteria in the decolorization of azo dyes has been studied extensively. These bacteria may be found in a variety of biological settings, including soil, water, human and animal excrement, and even contaminated food. Because bacteria are easy to cultivate and proliferate quickly, they are ideal for decolorization and full mineralization of azo dyes. A bacterial system's decolorization process might be anaerobic, aerobic, or a combination of both The bacterial decolorization and degradation of these dyes has been considered since it can result in a better yield. Degree of biodegradation and mineralization, may be used with a broad variety of azo dyes, is inexpensive, environmentally benign, and produces less sludge .Under anaerobic conditions, bacteria-mediated decolorization and degradation of azodyes involves azoreductase-assisted breakdown of the azo bond(- N=N-), resulting in the formation of colourless hazardous aromatic amines, which are then removed aerobically or an aerobically

It is reported that azo dyes are generally resistant to bacteria mediated degradation under aerobic conditions because oxygen rich environment usually hampers breakdown of the azobond. However ,some aerobic bacterial strains are reported to have ability to reduce the azo bond by oxygen insensitive or aerobic azo reductases proving that decolorization and degradation demands oxygen rich environments Extremophiles, an interesting bacterial community that are used in bioremediation of dye containing effluents, where normal bacterial strains could not sustain due to the high temperature and high NaCl concentration Staphylococcus, Exiguobacterium and Aeromonas hydrophila are the halo tolerant Bacillus strains reported for decolorization of azo dyes in the presence of high concentration of NaCl. Similarly, Geobacillusstearothermophilus Bacillus badius responsible for decolorization of several azo dyes, including Amaranth up to extreme temperature 85 degree Celsius .Several pure bacterial cultures are reported for removal ofazo dyes

2.7 ALGAE (PHYCOREMEDIATION)

In the bioremediation of textile effluent, both living and nonviable algae have been utilised Several study groups have determined that microalgae can help solve global environmental issues such as greenhouse gas emissions and wastewater treatment Algae use three inherent processes to decolorize azo dyes: usage of chromophore for algal biomass synthesis via assimilation, generation of CO_2 & H_2O during colour to non-color molecule conversion, and chromophore adsorption by algal biomass. However, while azo dyes have a harmful effect on aquatic life, they do not appreciably inhibit algal growth and algae have been found to thrive in industrial effluents (Dubeyet al., 2011). Algal decolorization can be caused by enzymatic degradation, adsorption, or both. Blue green algae, green algae, and diatoms are the most researched algae involved in the decolorization and degradation of azo dyes. Several species of Chlorella have been discovered to be effective decolorizers of azo dyes, generating their corresponding aromatic amines, which are then metabolized into simpler organic molecules such as CO_2 and H_2O. Algal- mediated degradation of azo dyes, like that of bacteria, relies on an induced version of the enzyme azoreductase to break down the azo link, resulting in the formation of aromatic amines suggested that the enzymes azoreductase, laccase, and polyphenol oxidase, all obtained from Oscillatoria curviceps, play a role in the breakdown of the dye Acid Black. In contrast to bacteria and fungus, which require the addition of carbon and other nutrients to remove colours, algae do not Patil et al. (2015) found that two green algae species, Chara and Scenedesmus obliquus, effectively destroyed the fabric dye Congo Red and Crystal Violet via the oxidative enzymes peroxidase and laccase. Immobilized microalgae such as Chara vulgaris immobilized on alginate may scavenge a larger proportion of colour from textile dyes than suspended algae.[21,22]

2.8 FILAMENTOUS FUNGI (MYCOREMEDIATION)

There have been several investigations on the ability of fungi to oxidize phenolic, nonphenolic, soluble, and no soluble colours Dye mycoremediation is a cost-effective alternative to current treatment procedures. The lignolytic fungi of the class basidiomycetes are the most commonly employed in dye decolorization and degradation. A metabolic product of a broad range of intra and extracellular enzymes is devoted to the fungal potential of bioremediation of various complex organic contaminants Fungi are involved in a wide range of complicated conversion processes, including the hydroxylation of complex polyaromatic hydrocarbons, dye effluents, organic waste, and steroid chemicals It was discovered that the breakdown of aromatic compounds by fungi is a secondary metabolic process that occurs when resources (C, N, and S) become scarce, and these aromatic compounds are subsequently utilized as a source of energy and nutrients for the cultures' growth Due to its nonspecific enzyme activity rot fungi produce lignin peroxidase (LiP), manganese peroxidase (MnP), and laccase, which play a major role in the degradation of many aromatic compounds and avoid the production of toxic aromatic amines that occur during azodyereduction. After 3 days of treatment, Enayatizamir et al. (2011) found that P.chrysosporium degraded Azo Black Reactive 5 dye by up to 92 percent. After 10 days of treatment, P. chrysosporium URM6181 and Curvularia lunata URM6179 strains decolorize wastewater containing textile indigo dye by up to 95 percent Recently, Gajera et al. (2015) identified six fungus species, the most effective decolorizer of five textile azo dyes being Hypocreakoningii (Red HE7B, Reactive Violet 5, Red BlackB, Light Navy Blue HEG, Dark Navy Blue H2GP). Although P. chrysosporium is the most well-known white rot fungus for dye decolorization and degradation, other fungal species have also contributed to azo dye bioremediation .It is now well accepted that dyes are removed via fungus assisted adsorption or enzymatic processes. Many factors influence filamentous fungi's growth, enzyme production, and subsequent dye degradation, including culture conditions, nutrient conditions, particularly nitrogen limitation, carbon source, time, pH, agitation, temperature, oxygen supply, additives, and salts Although several fungal species are successful in the decolorization and degradation of azodyes, they face numerous challenges in the removal of dyes from textile wastewaters, including large volume production, biomass management, and the nature of synthetic dyes Despite these decolorization-related issues, fungal-mediated decolorization is a viable replacement or supplement for current treatment methods.[23,24,25]

2.9 YEAST

Adsorption enzymatic degradation, or a mix of both are the processes used by yeast for dye decolorization, similar to microalgae. In recent years, there has been a lot of research on dye removal by different yeast species since it has a number of benefits over bacteria and filamentous fungus. They not only grow quickly like bacteria, but they can also survive in harsh environmental conditions, such as low pH. After 7 days of treatment, yeast strain Candida zeylanoides destroyed many simple azo dyes in liquid aerated batch cultures, with colour loss ranging from 44 to 90 percent The decolorization of numerous azo dyes by certain ascomycetes yeast species, including Candida tropicalis, Debaryomyces polymorphus and Issatchenkiaoccidentalis, was shown to be followed by enzyme-mediated biodegradation Lucas et al. (2006) utilised Candidaoleophila to decolorize Reactive Black 5, a common textilediazo dye. Candida albicans absorb the most DirectViolet 51 dye at pH 2.5 while Candida tropicalis has a comparable role at pH 4.0 for Violet 3 decolorization Yang et al. (2003) discovered that two yeasts (D. polymorphus and C. tropicalis) and a filamentous fungus (Umbelopsis isabellina) were able to totally decolorize 100 mg of Reactive Black 5 in 16-48 hours. The decolorization of two azo dyes, Malachite Green and Methyl Red, was previously investigated using the S. cerevisiae MTCC463 strain Waghmode et al. (2011b) found that employing G. geotrichum MTCC 1360, the decolorization, COD, and TOC removal of a combination of Golden Yellow HER, Remazol Red, RubineGFL, Scarlet RR, Methyl Red, Brilliant Blue, and Brown 3REL is greater under aerobic than anoxic or anaerobic conditions.[26,27,28]

3 CONCLUSIONS

Azo dyes make up the vast majority of all dyes manufactured and used in the textile industry. They are xenobiotic compounds having an aromatic functionality and one or more azo (-N=N-) groups that are electron-deficient. Textile manufacturing is the major source of dye-containing effluent. Because of its aesthetic appeal, toxicity, mutagenicity, and carcinogenicity, the discharge of dye-containing wastewater into the environment is a major source of concern. As a result, textile industry effluents are a major environmental problem, and dye treatment from effluent is required prior to disposal. Biological methods, which include bacteria, fungus, yeast, algae, and plants, transcend the limits of physico-chemical procedures and offer an alternative to conventional azo dye removal technologies. These techniques are low-cost, eco-friendly, and adaptable to a wide range of dye structures. This review stresses biological systems' potential for decolorization and degradation of azo dyes, as well as their potential processes. Bacteria are the most often used microorganisms for removing colours from textile effluents because they are easy to culture, have evolved to live in harsh environments, and decolorize azo dyes more quickly than other bacteria. The adaptability and activity of chosen microorganisms determine the efficacy of microbial methods for bio removal of azo dyes. Treatment systems with diverse microbial populations or consortiums are more successful in mineralizing azo dyes because the microbial community's metabolic activities are coordinated. The function of oxidative and reductive enzymes, as well as their potential processes, are discussed in this review to better understand the molecular foundation of azo dye decolorization and degradation. Furthermore, the future answer to the problem of coloured wastewater in textile dyeing businesses is the development of new nanotechnologies. Nanotechnology, in combination with traditional biological processes, will be essential in improving environmental protection.

Declaration of Competing Interest: The authors declare that they have no any conflict of interest.

REFERENCES

[1]. Shah, M.P.: *Austin J. Biotech.& Bioeng*., 5(1) (2018)1090-1096.

[2] Singh, P.K. & Singh, R. L.:*Int. J. Appl. Sci. Biotechnol* , 5(2)(2017) 108-126. [3] Seow, T.W. & Lim, C.K.: *Int. J. Appl. Eng. Res.*,11(4) (2016) 2675-26-79.

[4] Shekoohiyan, S., Moussavi, G., Mojab, S. & Alahabadi, A.: *J. Enviro. Health. Eng. Manage.* ,3(1), (2016), 1-7.

[5]. Choudhary, N., Ram, S., Sharma, A., Sharma, S.&Chowdhary, V.:*Int. J. Chem. Sci.;*13(4), (2015)20- 26.

[6]. Islam, MD.I., Mehedy, MD.E., Chowdhury, S., Sen, P., Shormi, H.J. & Biswas, M.: *J. Enviro. Sci.*, 9(3), (2015), 51-55.

[7]. Mehta, M.J. & Chorawala, K.K.*: Int. J. Eng. Res. Appli.*,4(12), (2014), 40-44.

[8]. Mohamed, R.M.S.R., Nanyan, N.Mt., Rahman, N.F.A., Kutty, N.M.A. & Kassim, A.H.M.: *Asian J. Appl. Sci.*,2(5), (2014), 650-657.

[9]. Chaudhary, K.D., Sharma, S., Jain, S. & Chowdhary, V.: *Int. J. Chem*. 3(2)(2014)2-18.

[10]. Panic, V.V., Seslija, S.I., Nesic, A.R. & Velickovic, S.S.: *J.Hem. Ind.*67(6), (2013), 881-900. [11]. Chung KT and Cerniglia CE (1992) Mutagenicity of azo dyes: structure activity relationships.

Mutat. Res. 277: 201-220.

[12]. Rosenkranz HS and Kolpman G (1990) The structural basis of the mutagenicity of chemicals in *Salmonellatyphimurium*: the national toxicology program data base. *Mutat. Res.* 228: 51-80

[13]. Tsuboy MS, Angeli JPF, Mantovani MS, and Ribeiro LR (2007) Genotoxic,mutagenic and cytotoxic effects of the commercialdye C.I Disperse Blue 291 in the human hepatic cellline HepG2. *Toxicol. in Vitro* 21: 1650-1655.

[14]. Vitor V and Corso CR (2008) Decolorization of textile dye by isolated *Candida albicans* from industrial effluents. *J.Ind. Microbiol. Biotechnol.* 35: 1353-1357

[15]. Pajot HF, Delgado O, de Figueroa LIC and Farina JI (2011) Unravelling the decolorizing ability of yeast isolates from dye polluted and virgin environment: An ecological and taxonomical overview. *Antonie Van Leeuwenhoek* 99:443-456.

[16]. Won SW Choi SB and Yun YS (2005) Interaction betweenprotonated waste biomass of *Corynebacteriumglutamicum* and anionic dye Reactive Red 4. *Col. Surf. A*262: 175-280.

[17] Mnif I, Fendri R and Ghribi D (2015) Biosorption of Congo Redfrom aqueous solution by *Bacillus weihenstephanensis*RI12; effect of SPB1 bio surfactant addition on bio decolorization potency. *Water Sci. Technol.* 72-99.

[18]. Donmez G and Asku Z (2002) Removal of chromium (VI) from saline wastewater by *Dunaliella*

species. *ProcessBiochem.* 38: 751-762.

[19]. Singh RL, Singh PK and Singh RP (2015) Enzymatic decolorization and degradation of azo dyes- a review. *Int.Biodeter. Biodegr.* 104: 21-31.

[20]. Oturkar CC, Nemade HN, Mulik PM, Patole MS, Hawaldar RRand Gawai KR (2011) Mechanistic investigation of decolorization and degradation of Reactive Red 120 by *Bacillus lentus* BI377. *Bioresour. Technol.* 102: 758-764.

[21]. Dubey SK., Dubey J, Mehra S, Tiwari P and Bishwas AJ(2011) Potential use of cyanobacterial species in bioremediation of industrial effluents. *Afr. J.Biotechnol.* 10: 1125-1132.

[22]. Patil KJ, Mahajan RT, Lautre HK and Hadda TB (2015)Bioprecipitation and biodegradation of fabric dyes by using *Chara* sp. and *Scenedesmus obliquus*. *J. Chem.Pharm. Res.* 7: 783-791.

[23]. Christian V, Shrivastava R, Shukla D, Modi HA and Vyas BRM(2005) Degradation of xenobiotic compounds by lignin degrading white rot fungi: enzymology and mechanism involved. *Ind. J. Exp. Biol.*
43: 301-312.

[24]. Enayatizamir N, Tabandeh F, Rodriguez-Couto S, Yakhchali B,Alikhani HA and Mohammadi L (2011) Biodegradation pathway and detoxification of the di azo dye ReactiveBlack 5 by *Phanerochaete chrysosporium*. *Bioresour.Technol.* 102: 10359-10362.

[25]. Gajera HP, Bambharolia RP, Hirpara DG, Patel SV and GolakiyaBA (2015) Molecular identification and characterization of novel *Hypocrea koningii* associated with azo dyes decolorization and biodegradation of textile dye effluents. *Process Saf. Environ. Prot.* 98: 406-416.

[26]. Lucas MS, Amaral C, Sampaio A, Peres JA and Dias AA (2006)Biodegradation of diazo dye Reactive Black 5 by a wild isolate of *Candida oleophila*. *Enzyme Microb. Tech.* 39:51-55.

[27]. Yang Q, Yang M, Pritsch K, Yediler A, Hagn A, Schloter M andKettrup A (2003) Decolorization of synthetic dyes and production of manganese-dependent peroxidise by new fungal isolates. *Biotechnol. Lett.* 25: 709-713.

[28]. Waghmode TR, Kurade MB and Govindwar SP (2011b) Time dependent degradation of mixture of structurally different azo and non azo dyes by using *Galactomyces geotrichum* MTCC 1360. *Int. Biodeter. Biodegr.* 65: 479-486.