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Biodegradation on the Removal of Dyes from Textile Effluent

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Abstract: *Due to the emission of coloured and toxic effluents into water bodies, the textile industry is one of the most polluting sectors. One of the primary contaminants in textile effluent is dye.Alternative approaches, like biodegradation, are being investigated since standard treatment procedures fall short of totally removing colours from textile wastewater. An approach that has shown promise for dye removal is biodegradation. Biodegradation is an economical, environmentally responsible, and long-lasting technique for dye removal from textile effluent. The scope of the study is to remove the dye from textile effluent. The review focuses mostly on bacteria (Pseudomonas aeruginosa, a common bacterium found in soil and water) to eliminate two synthetic commercial colours. According to the findings, P. aeruginosa could effectively remove the maximum number of colours from wastewater after five days of aerobic growth. The presence of carbon and nitrogen sources significantly improved the degradation efficiency. According to the study, P. aeruginosa may be employed in the bioremediation of textile wastewater contaminated with synthetic colours. To optimize the procedure for use in large-scale applications, more research is required. Textile wastewater should be carefully treated before being discharged into water bodies or the environment on land since colours are the most noticeable pollutant and are immediately recognisable in textile wastewater. Numerous microorganisms, including bacteria, fungi, yeast, and algae, are employed to remove dyes. In this review, the primary focus is on bacteria that remove colour from textile effluent. The review focuses on the removal of two synthetic dyes, RO16 and RB5. Because of the enormous water pollution caused by textile effluent, human health is at risk and the environment is harmed.*

Keywords: Biodegradation, Decolourization, Textile dyes, Pseudomonas aeruginosa

I. INTRODUCTION

Synthetic dyes are frequently employed in a variety of industries, including those that produce textiles, leather, paper, and plastics, and when they are released into water bodies untreated, they constitute a serious threat to aquatic life. Complex organic substances are naturally broken down into simpler forms by a process called biodegradation, which involves the activity of microbes like bacteria. This strategy is becoming more and more popular for dealing with environmental contamination brought on by synthetic colours in wastewater. A sustainable method for dye degradation is microbial degradation, which uses microbes to convert the colours into non-toxic chemicals. In this way, biodegradation is a promising method for removing dye that can assist to lessen the negative effects of synthetic dyes on the environment.

The study implies the removal of dyes by various methods. The common methods used for dye removal are by chemical or biological processes such as advanced oxidation process, Membrane filtration techniques, photocatalytic degradation, Nanofiltration, Ultrafiltration, Physio-chemical (Coagulation &Flocculation)(Wang, H. et.al). The literature reviewed shows that biological method is used to explore the usability of the microorganisms i.e., Bacteria, Pseudomonas aeruginosa (Maqbool, Z.), the removal of dyes from aqueous solutions(Karthikeyan, K. et.al).It involves the use of two commercial synthetic dyes i.e., Reactive orange 16 (RO16) and Reactive Black (RB 5) dyes (Forgacs, E. et.al). Since dyes are toxic and hazardous to the environment it should be removed effectively with less cost and maintenance (Moosvi, S. et.al). In this review the effects of different parameters such as pH, Temperature and initial dye concentration were studied and effectiveness was determined by measuring the percentage of colour removal. The results showed that decolourizing of these two reactive dyes is possible. Therefore, Pseudomonas aeruginosa is used as an alternative practice in decolourization.

1.1 PROBLEM STATEMENT

A promising process that uses microorganisms to totally mineralize dyes into non-toxic end products is called biodegradation. However, a number of variables, including pH, temperature, the amount of initial pollutant present, and the kind of microorganisms that are involved in the degradation process, affect how effective the process is. Reactive dyes are low exhaustion properties due to the hydrolysis of reactive dyes with water. Occurrence of colouring agents cause a great impact in the environment. Since dyes are most probably used, we have to remove colour from dye so that there won't be any hazards to the environment. Treating dye wastewater are most problematic due to their chemical stability, high COD, toxic. Many methods are costly for removing dye. So cost effective method is discussed in this review.

II. LITERATURE REVIEW

Anna Christina R. Ngoet.al (2022)discusses the effects of azo dyes and their by products on human health and the environment, as well as the biological methods that can be used to remove these dyes from the environment. Particular attention is paid to the use of various microorganisms, enzymes that are involved in the degradation of azo dyes, and recent developments that could be used to treat azo dyes. Research on the intersection of these advancements and the subject of bioremediation, particularly in the area of dye degradation, is still interesting to study. In the end, these microbes may open the door to the safe conversion of xenobiotics like azo dyes.

Ejder korucu, Mehtap et.al(2015)states that because of high levels of total dissolved solids (TDS), the prevalence of poisonous heavy metals, and the non-biodegradable nature of the dyestuffs present in the effluents, the textile industry produces wastewater that is extremely polluted, and treating it is a very serious problem. Conventional treatment methods can remove dyes through a variety of processes, such as biological and chemical oxidation, coagulation, and adsorption, but none of these can be employed successfully on their own. The treatment of industrial effluent containing dye has been done in a variety of ways, including physically, chemically, and/or biologically, however these techniques are frequently very expensive and unsafe for the environment. Additionally, their use has been constrained by the quantity of sludge produced and the ineffectiveness of some dye's treatments.

Esther Forgacs (2004) et.al reviewed that there are more contemporary techniques for removing synthetic colours from water and wastewater. The many techniques of removal, including adsorption on different sorbents, chemical decomposition by oxidation, photodegradation, and microbiological decolouration, employing activated sludge, pure cultures, and microbe consortiums are explained. The benefits and drawbacks of the various techniques are explored, and their effectiveness is contrasted.

Hui Wang (2008)et.al states from a textile mill, a bacterial strain known as CK3 was recovered.Numerous reactive textile dyes, including azo and anthraquinone dyes, were successfully decoloured by the bacterial strain CK3.CK3 could endure up to 1000 mg/l of dye and thrived at a high concentration of dye (200 mg/l), which caused a 95% decolorization extent in 36 hours. Citrobacter sp. CK3 appeared to have decolorizing action through biodegradation rather than inert surface adsorption, according to UV-vis studies and colourless bacterial cells.This bacterial strain has the potential to be exploited in the biological treatment of dyeing mill effluents due to its high decolorization extent and ease of conditions.

Karthikeyan, K. et.al (2010)clearly defines this work shows promising microbial strain Aspergillus niger HM11 can be employed to decolorize textile dyeing wastewater containing related pigments. The objective of current work is to examine the impact of different bioprocess factors on the decolorization of an azo dye, Congo red, by a fungus strain called Aspergillus niger HM11.

Maqbool Zahid (2011) investigated to identify and characterise metal-tolerant bacterial strains that are capable of treating textile wastewater and dye decolorization.To test this, 220 metal-tolerant bacteria isolated from textile wastewaters from various textile businesses in Faisalabad were given four different reactive dyesreactive red 120 (RR120), reactive black 5 (RB5), reactive orange 16 (RO16), and reactive yellow 2 (RY2) and asked to decolorize them. The ability of four bacterial strains, namely ZM17, ZM130, ZM160, and ZM183, to decolorize the dyes RR120,

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RB5, RO16, and RY2 when exposed to a mixture of the heavy metals Cr, Cd, Zn, and Pb led to their selection for further study.

M.T. Moreira et.al(2000)objective was to compare the ability of seven exceptional strains with strong ligninolytic activity to remove dye colour. The effects of manganese and oxalic acid concentration will be compared in further tests to try and correlate dye decolorization and ligninolytic activity.All seven-fungus produced manganese peroxidase (MnP), but only Phlebia radiata showed laccase activity. There was no lignin peroxidase (LiP) activity found.

Myrna Solis et.al(2012) illustrates biological, chemical, and physical oxidation, coagulation, and adsorption are just a few of the processes that can be employed to remove colours using standard treatment technologies. However, none of these procedures work well when applied separately. Industrial wastewater containing dye has been treated using a variety of techniques, including physical, chemical, and/or biological processes, however these procedures are frequently very expensive and not environmentally safe. Additionally, their use has been constrained by the enormous amount of sludge produced and the poor treatment effectiveness for particular colours.

R.G. Saratale et.al(2010)review primarily focuses on the various decolorization techniques and explores the impact of various physicochemical conditions on the effectiveness of different bacteria at removing dye. Investigations have been made into the enzymatic processes responsible for the bacterial breakdown of azo dyes, the identification of metabolites using a variety of analytical techniques, and the toxicity of these substances.It emphasises the use of these methods for the treatment of wastewaters containing azo dyes and offers an outline of bacterial decolorization/degradation of azo dyes.

Safia Moosvi et.al (2006) analysisthe consortium of the bacterial cultures P. polymyxa, M. luteus, and Micrococcus sp. which shows good decolorization capacity, no reports of these bacterial species for dye decolorization have been made yet.Agitated cultures demonstrated poor decolorization despite having high development. Given that it demonstrated effective decolorizing capacity for nine out of ten dyes tested, the mixed culture appears to have potential utility in the treatment of waste water containing dyes.

Shertate R.S et.al(2013) discovered that cell-free extract may decolorize the dye by up to 80.13 percent in just 24 hours. A study on the decolorization of the dye in the presence of 1% glucose, 1% yeast extract, and 1% starch indicated that the percentages of decolorization were up to 92.77%, 94.00%, and 92.05%, respectively. These findings support the hypothesis that the isolate might successfully decolorize the dye.

Shweta Agrawal et.al (2019)article provides an overview of dye biodegradation research studies conducted in reactors, as well as general trends and their economic viability for the total removal of azo dyes from effluents.It can be said that complete mineralization of these dyes and significant BOD and COD removal can be accomplished in the anaerobic phase of continuous anaerobic/aerobic systems supplied with substrate combinations with a high BOD, COD, and low dye concentrations. In the following aerobic phase, the remaining BOD from the auxiliary substrates may mineralize.

Veni Pande et.al (2019)demonstrates that dyes come in a variety of structural forms, including direct, anthraxquinone, acidic, basic, azo, disperse-based, and metal complex dyes, among others and further study was made based on this and dyestuff diminishes transparency and prevents sunlight from getting to the necessary depth, it is present in water bodies.

III. MATERIALS AND METHODS:

3.1 CHEMICALS

Stock solutions 100PPM of dyes were prepared in distilled water and was diluted as required to the working concentrations. A stock solution is a concentrated form of a substance or chemical that is usually diluted or used as a model for creating solutions with lower concentrations. A stock solution is a concentrated form of the dye compound that is used to gauge the effectiveness of the biodegradation process when discussing the biodegradation of colours using bacteria.

3.2 MICRO-ORGANISM AND CULTIVATION METHOD:

Bacteria, Pseudomonas aeruginosa were used majorly, since it has the ability of degrading azo dyes. Stock cultures were stored @ 20°C in 20% glycerol. The used medium is nutrient broth. A stock solution of the dye was prepared in deionized water and used. Nutrient agar plates, which include nitrogen, carbon, amino acids, vitamins, and minerals, can be used to cultivate Pseudomonas aeruginosa. After 24-48 hours of 37°C incubation, colonies with a little bluish-green colour and a rough appearance will start to develop on the plates.

3.3 MEASUREMENTS OF DYE CONCENTRATION:

When determining the amount of a dye in a solution, spectrophotometers are frequently utilised. To detect how much light is being absorbed by the dye at a particular wavelength, a spectrophotometer is used. In the following step, a calibration curve is used to correlate the absorbance with the dye concentration. Measured with a UV-VIS spectrophotometer. Concentration dye was detected at a specific maximum absorbance wavelength. Efficiency of colour removal was determined.

3.4 DECOLOURIZATION OF AZO DYES PSEUDOMONAS AERUGINOSA:

It is well recognized that Pseudomonas aeruginosa may decolorize azo dyes, which are synthetic colours frequently used in the food, cosmetics, and textile sectors. The azo link (N=N) in the dye molecule is reduced during the decolorization process, creating aromatic amines as a result. To evaluate the effects of environmental factors, pH, Temperature and initial dye concentrations on bacterial decolourization were investigated. pH is measured and adjusted by NaOH or HCL for required one. Erlenmeyer flasks were sterilized before incubation and kept under agitation in a rotating orbital shaker for desired time. Samples were withdrawn at regular time intervals and it is analysed. Effect of initial dye concentration and the inoculum volume on the rate of decolourization was evaluated.

IV. CONCLUSION

In summary, biodegradation is a beneficial method for removing colours from textile wastewater. Microorganisms are used in biodegradation to break down the complex chemical structures of colours, completely removing them from the effluent. Biodegradation is an environmentally friendly process that doesn't create garbage or harmful by products. This approach is more affordable than other traditional approaches since it may be used to treat huge volumes of textile wastewater. Additionally, because it can increase the effectiveness of treatment overall, biodegradation is a supplementary strategy to other treatment options. Therefore, biodegradation is a long-term method for getting colours out of textile waste that can help preserve the environment and advance sustainable development.

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