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Studies on the Degradation of Textile Dye by *Pseudomonas Aeruginosa*

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Abstract

Use of textile dyes is becoming extensively easy in the textile industry because of their wide variety and varied applications. A large quantity of commercially available dyes is known to be used in the textile industries today and 10 % of nearly a million tons of dyes that are produced are released in environment as dyestuff waste. These dyes when disposed into the environment causes pollution and serious irreversible damage to the ecosystem as they significantly affect the photosynthetic activity of aquatic plants and are also toxic to aquatic organisms which eventually get into the food chain. In the present study the bacteria were isolated from samples collected from various textile industry effluent samples and were assayed for its dye degradation ability. The bacterial isolates which were capable of complete degradation of the dye were identified by morphological and biochemical characterization. The activity of these bacteria on different dyes for maximum degradation was tested using different physical parameters like different pH, temp and Dye concentration. The test organism Pseudomonas aeruginosa showed maximum dye degradation on the 8th day of incubation at 40 mg/l of dye concentration. The test organism showed maximum degradation at 40 ^{0}C, and a optimal pH of 6.0 to 8.0. In the present investigation Pseudomonas aeruginosa was found to be capable of maximum degradation of all the dye samples. The present study reveals the practical application potential of using bacterial species in the bioremediation of dye effluents that can be used to reduce pollution caused by textile industries.

Keywords: Pseudomonas aeruginosa, bioremediation, pollution control, textile dyes, effluent degradation.

Introduction

Dyes used in textile industry have a synthetic origin and complex aromatic molecular structures which make them stable and difficult to be biodegraded. 80% of the commercial dyes used all over the world in textile industries are Azo dyes[1]. Azo dyes, contain one or more azo bond (-N=N-) as its chemical structure and account for its major contribution in all textile dyes used[2]. Due to their complex structure the Azo dyes are poorly biodegradable and represent a potential class of organic pollutant which is very important[3]. Estimations state that 10-15% of the total dye is lost during synthesis and the dyeing Processes[4]. Due to its high reactivity it is difficult to process the dye and of the total usage, nearly 10% of dyes are released into the environment as toxic wastes[5].

Microorganisms play a very important role in the biodegradation and mineralization of these dyes which is of great significance[6-7]. The ability of the microorganism to degrade larger toxic chemical compounds called xenobiotics comes under the field of Environmental biotechnology. Several microbial strains having the potential to decolorize a large variety of dyes belonging to different groups have been isolated and studied by many researchers and scientists[8]. Studies on the various environmental factors determine the degradation of azo dyes present in effluent samples of textile industries are in process and are found to be a complicated process due to the intricate structure of the dyes[9-11]. Use of individual isolates have been found successfully explain the degradation of dyes. But these applications are not practical in the treatment system due to the complexity and heterogeneity of the dye compounds present in effluent samples. Biodegradation of dyes have been studied as a method degradation and mineralization over the past decades[12]. Such degradation processes are environmentally friendly and cost effective and are also competitive alternative to chemical decomposition process[13]. Most azo dyes unfortunately are recalcitrant to aerobic degradation by bacterial isolates[14].

Reports state that enzyme extracts of the cell and also membrane- encapsulated cells can efficiently degrade azo dyes more efficiently than use of bacterial cells directly[15-17]. Flavin reductases are enzymes which are located in the cytoplasm of the cells which act on the integration and reduction of the dyes[18], which implies that anaerobic reduction of azo dyes is an intracellular process. Uses of multiple bacterial cultures are found to have similar removal or degrading rates for azo dyes and other analogue compounds with simpler structures.

Material and Methods

Sample collection: Soil and effluent samples for the isolation of the bacterial samples for dye degradation in the present study were collected from various points of discharge from dyeing units and areas where idols are permanently painted in Kolkata, West Bengal, India.

Isolation and Identification of Dye degrading Bacteria: For isolation of individual cultures, the soil and effluent samples were first serially diluted using sterile water blanks and 100 micro liters of the diluted sample was spread plated on Nutrient Agar media. Individual colonies thus obtained after incubation as pure cultures were maintained on nutrient agar. The textile dye samples were mixed with minimal salts basal medium in the ratio of 1:100ml v/v. The dye mixed medium was inoculated with the isolated bacterial culture and the media incubated at room temperature on an incubator shaker at a speed of 200rpm, the experiment was carried out in triplicates. After every two days absorbance was measured at 590nm using a UV-Vis spectrophotometer to determine the extent of dye degradation. The bacterial isolates which were capable of complete degradation of the dye were identified based on the morphological and biochemical characterization as per Bergye's manual of Determinative Bacteriology.

Optimization: Degradation of different textile dye samples were optimized using the test organism under different physical parameters using the basal media constant. The Dye concentrations used for optimization of degradation in the present study was between 10mg/l to 80mg/l. The optimization of pH was between 4-8. The temperature for optimization was 28ºC, 37ºC, 40ºC. The extent of degradation of the dye samples under different optimization conditions were determined by measuring the absorbance at 590nm using UV-Vis spectrophotometer.

Results and Discussion

Various morphological and biochemical characterization and selective medias were used and tests conducted on the potential isolates which were found to degrade the dyes maximally for the identification of the same. Based on all the tests and growth on selective media the isolated microorganism was identified as *Pseudomonas aeruginosa*. The optimization conditions for degradation of the dyes gave the following results. With increase in the dye concentration, the degradation extent decreased. Dye degradation was inhibited to a great extent with the increase in the concentration of the dyes used which can be due to the toxic activity of the dye on the test organism. Maximum dye degradation was observed 40 mg/l of the dye concentration (figure-1). The concentration of the dye in which the isolate showed maximum degradation was further used for optimization studies.

Addition of 1% glucose as a source of carbon increased the degradation of the dye (figure-2). Ammonium nitrate as a source of nitrogen increased the rate of degradation compared to the other sources (figure-3). The efficiency of dye degradation depended on the pH as a major factor which could be due to the fact that the optimum pH for the growth of isolated bacteria was neutral or slightly acidic. The best results of de-colorization were achieved at pH 6.0 at an incubation time of 8 days (figure-4). The test isolate showed maximum degradation at a temperature 40 ^{0}C which was found to be optimum (figure-5).

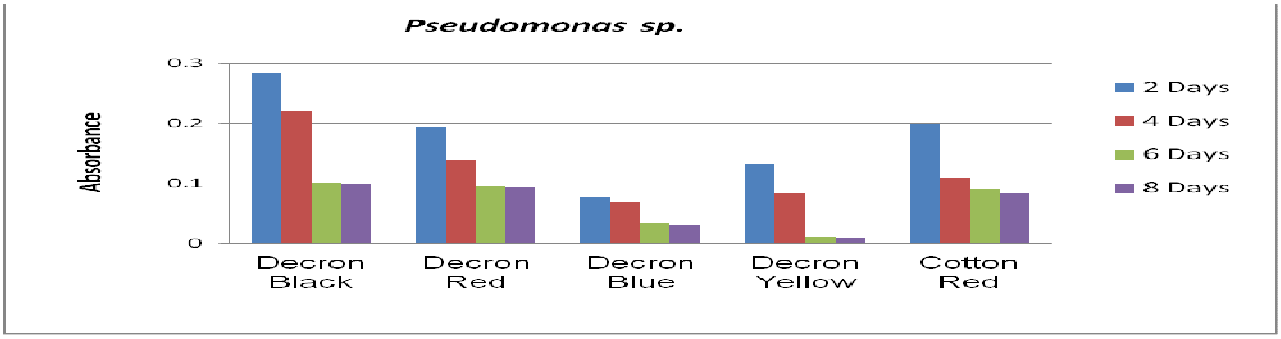

Figure-1
Dye (40 mg/l) degradation by *Pesudomonas aeruginosa.*

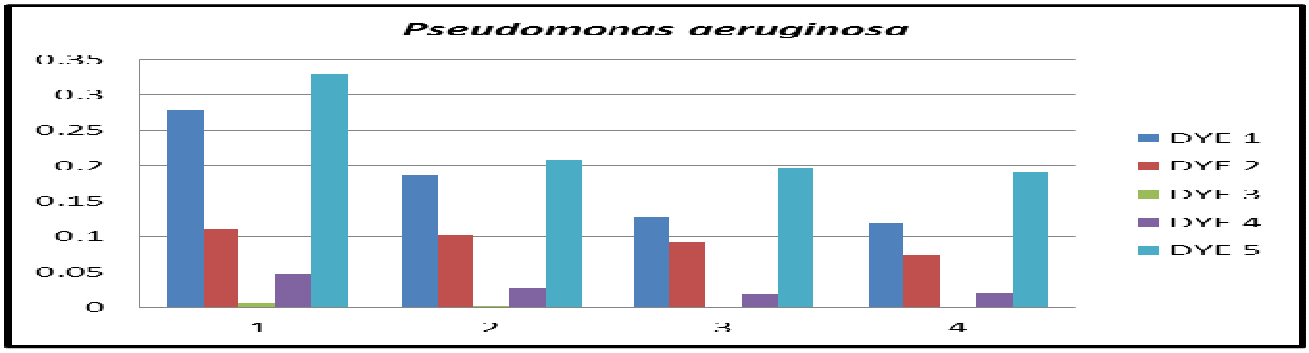

Figure-2
Carbon- (GLUCOSE) 1%

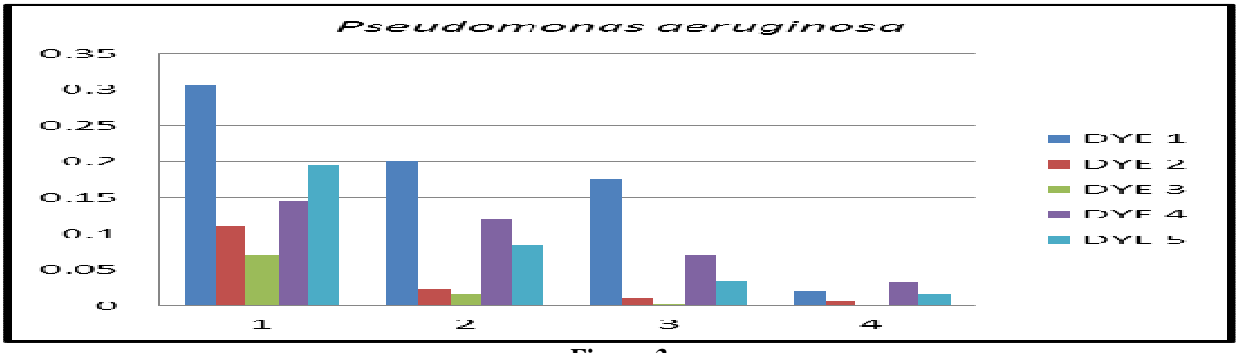

Figure-3
Nitrogen- Ammonium Nitrate

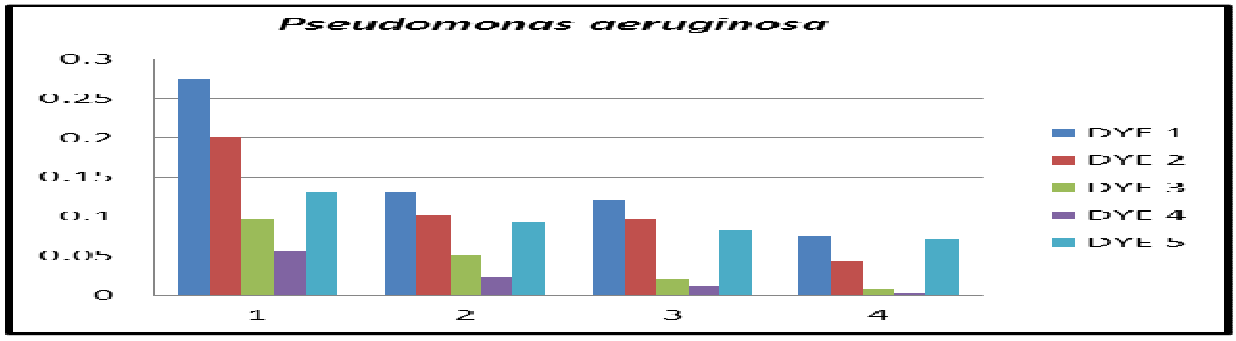

Figure-4
pH 4

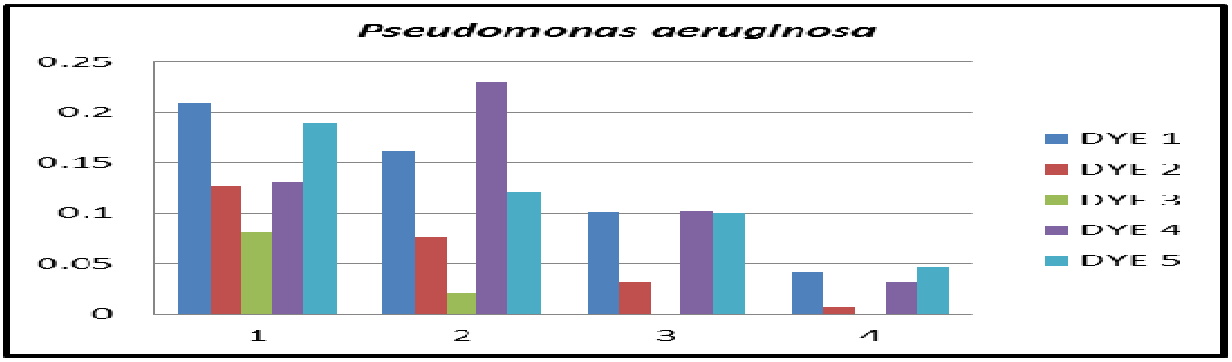

Figure-5
40ºC

Conclusion

Manmade activities are disturbing the environment which is caused by the disposal of non degradable organic and inorganic wastes into the natural ecosystem. Synthetic dyes are used in many manufacturing processes which include tanning industries, textile industries, leather industries, etc. Many industries of these industries do not have adequate technology or facility to dispose their effluents which are released into the environment without any treatment or by use of partial physical or chemical treatments. Due to which there is an enormous load of toxic non degradable substance in the aquatic ecosystem and the water pollution is a serious problem today. The solution to solve this problem is biodegradation, ie use of biological agents such as microorganisms which can be used effectively to treat the dye residues remaining in the effluents as well as reduce the other harmful effects of effluents to the natural environment. The present investigation clearly indicates the effects of bio degradation using microorganisms which can be applied in treating the textile industries effluent which can be released into the water bodies without affecting the ecosystem.

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