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BIODEGRADATION OF TEXTILE DYES USING BACTERIA ISOLATED FROM THE TEXTILE EFFLUENT

SANGEETHA.K[1] AND AJITHA.S[2]

[1]Assistant Professor of Biotechnology

V.V. Vanniaperumal College for Women, Virudhunagar

Tamil Nadu, India.

ABSTRACT

Rapid industrialization and tremendous increase of human population increases the conventional solid and liquid waste and it create problems to environment and mankind. One of the most important problems is the textile dye pollution to land and water system. High concentrations of textile dyes in water bodies stop the re-oxygenation capacity of the receiving water and cutoff sunlight, thereby upsetting biological activity in aquatic life and also the photosynthesis process of aquatic floral population. The textile organic dyes must be separated and eliminated from water but especially from industrial wastewaters by effective biological treatment. Microorganisms, include bacteria, fungi and algae, can degrade or absorb a wide range of dyes. The biological mode of treatment of dye bath effluents offers distinct advantages over the conventional modes of treatment. In this present study, *Pseudomonas* sp. isolated from textile effluent sourced from Aruppukottai, Virudhunagar district was evaluated for their efficiency to decolorize the dyes Dispersal navy blue, direct jade green, sulphur black and red dye by complete decolourization and confluent growth of bacterial isolate. It was found that isolated *Pseudomonas* sp. can decolorize dispersal navy blue (92.46%), red dye (74%), direct jade green (72.72%), sulphur black (58.05%) at 200 ppm of initial concentration.

Key words: Dye, Biodegradation, Textile effluent

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1. INTRODUCTION

Industrialization is vital to a nation's economy because it serves as a vehicle for the development. However, there are associated problems resulting from the introduction of industrial waste products into the environment. Many of these products are problematic because of persistence (low biodegradability) and/or toxicity. One of the most important problems is the textile dye pollution to land and water. Water pollution control is at present one of the major thrust areas of scientific research. Color removal in particular has recently become an area of major scientific interest.

Synthetic dyes are coloring agents mainly used in textile industries which generate a huge amount of wastewater in the process of dyeing. Different dyes used in textile industry usually have complex aromatic molecular structures which make them more stable and more difficult to be biodegraded. Dyes are released into the environment through industrial effluent from three major sources such as textile, dyestuff manufacturing and paper industries.

Dye concentrations in watercourses higher of 1 mg/L caused by the direct discharges of textile effluents, treated or not, can give rise to public compliant. (Zaharia et al., 2009). High potential health risk is caused by adsorption of azo dyes and their breakdown products (toxic amines) through the gastrointestinal tract, skin, lungs, and also formation of hemoglobin adducts and disturbance of blood formation. LD50 values reported for aromatic azo dyes range between 100 and 2000 mg/kg body weight (Börnick & Schmidt, 2006).

The textile organic dyes must be separated and eliminated from industrial wastewaters by effective and viable treatments. Although several physical-chemical methods have been used to eliminate the colored effluents in wastewater, they are generally expensive, produce large amounts of sludge. (Anjaneyulu et al., 2005; Babu et al., 2007; Robinson et al., 2001; Zaharia et al., 2011)

The biological mode of treatment of dye bath effluents offers distinct advantages over the conventional modes of treatment. This method is more economical and leads to less accumulation of relatively harmless sludge. Research data indicates that certain dyes are susceptible to anoxic/anaerobic decolorization, and also that an anaerobic step followed by an aerobic step may represent a significant advancement in biological decolorization treatment in future (Ong et al., 2005). The main advantage of biological treatment in comparison with

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certain physico-chemical treatments is that over 70% of organic matter expressed by CODCr may be converted to biosolids (Anjaneyulu et al., 2005)

The objective of this study is to isolate the organism capable of degrading dyes from textile effluent and to optimize some environmental factors for decolorization.

2. MATERIALS AND METHODS

2.1 Sample collection

Textile industry effluent was collected from an industry in Aruppukottai, of Virudunagar district, Southern Tamil Nadu, which is well known for handloom production with flourishing dyeing units. The water sample was collected from the dye contaminated sites in clean and sterile container. The sample was kept in icebox and then brought to the laboratory

2.2 Dye

Textile dyes used in this experiment are dispersal navy blue, direct jade green, sulphur black and red. They were collected from the dyeing industry.

2.3 Culture Media

Minimal broth was used for isolation of bacteria from the textile effluent. Nutrient broth with 200 ppm of respective dyes was used for decolorization test.

2.4 Isolation and Identification of Dye-Decolorizing Bacteria from Textile Effluent

Textile effluent was inoculated into the flask containing sterile minimal broth and incubated at 37^{o}C for 24 hours. Culture from minimal broth was spread into the plate containing sterile minimal agar and incubated at 37^{o}C for 24 hours. For isolating bacteria capable of decolorizing dye, colonies from minimal plate were inoculated into plate containing sterile nutrient agar with respective dyes. The colonies that have clear zone around them are isolated and used for further analysis. The isolated bacteria were subjected for biochemical analysis for identification.

2.5 Estimation of Decolorization

Decolorization of the individual dyes was determined at their respective maximum absorption wavelength in the culture supernatants using a colorimeter. A sample from culture broth was withdrawn at regular intervals of 1st, 3rd, 5th, 7th day and about 3 ml was centrifuged at 10000 rpm for 15 minutes. The optical densities (OD) were measured (Ajay Kumar Pandey et al.,)

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2.6 Optimization of Environmental factors for efficient Decolorization

2.6.1 Effect of pH

Effect of pH (5, 7, 9) on decolorization of all four dyes at 200 ppm initial concentration of dye was tested. Nutrient broth of pH 5 and 9 was prepared by adding Con.HCl and NaOH respectively. Then it was autoclaved. 200 ppm of respective dyes was added to sterile broth. Each flask was inoculated with starter culture and incubated at 37^{o}C for 7 days. After the incubation period, the culture was withdrawn from each flask and centrifuged separately at 10000 rpm for 15 minutes and optical density was measured.

2.6.2 Effect of Temperature

Effect of temperature (25^{o}C, 37^{o}C, 50^{o}C) on decolorization of all four dyes at 200 ppm initial concentration of dye was tested. Decolorization medium was prepared and inoculated with starter culture and incubated at various temperatures (25^{o}C, 37^{o}C, 50^{o}C) for 7 days. After the incubation period, the culture was withdrawn from each flask and centrifuged separately at 10000 rpm for 15 minutes and optical density was measured.

2.6.3 Effect of Carbon source

Effect of different carbon sources (glucose, sucrose, starch) on decolorization of all four dyes at 200 ppm initial concentration of dye was tested. Nutrient broth with different carbon sources (glucose, sucrose, starch) was prepared and autoclaved. 200 ppm of respective dyes was added to the sterile broth. The flasks were inoculated with starter culture and incubated at 37^{o}C for 7 days. After the incubation period, the culture was withdrawn from each flask and centrifuged separately at 10000 rpm for 15 minutes and optical density was measured.

3. RESULTS AND DISCUSSION

3.1 Isolation and Identification of Dye-Decolorizing Bacteria from Textile Effluent

The bacteria capable of dye decolorizing were identified by the formation of clear zone around the colony. Then the isolated colonies were taken separately for further morphological, biochemical analysis to identify the organism. The isolated organism was identified as *Pseudomonas* sp.

3.2 Estimation of Decolorization

Four dyes- dispersal navy blue, direct jade green, sulphur black and red were selected and the decolorization pattern was measured

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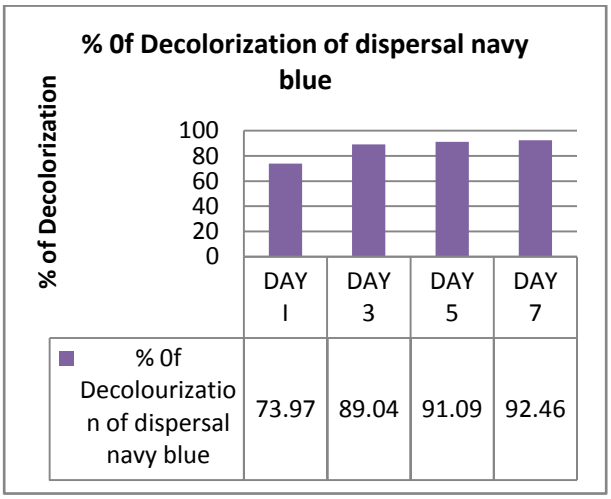
by inoculating isolated *Pseudomonas* sp. The extent of decolorization was expressed as percentage (%) of decolorization and estimated by the formula

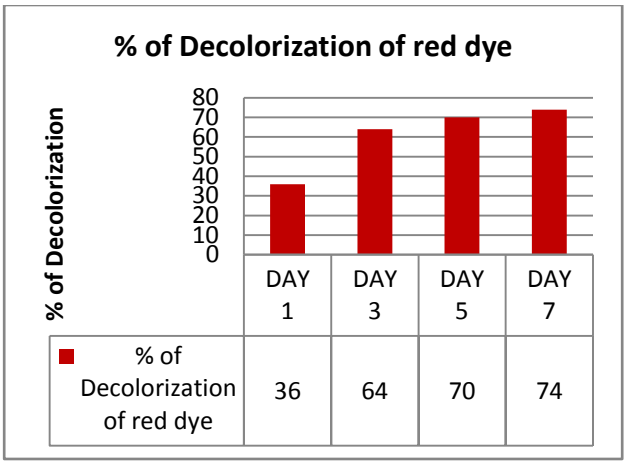
% of decolourization = A_i-A_t/A_i ×100, where initial absorbance of dye solution and absorbance at cultivation time denoted by A_i and A_t respectively.

The percentage of decolorization of dyes during different days of incubation was illustrated in the following Graphs 1, 2,3, 4 and fig 1. From the results it was noted that the percentage of decolorization reaches maximum after 7 days of incubation. There is no significant increase in the percentage after 8 days.

Khadijah et al., (2009) isolated 1540 bacterial isolates and screened for their ability to degrade selected azo dyes. Overall the consortia were able to degrade 70 - 100% color within 72 hours compared to 60 – 97% color removed by individual isolates. In the present study it was observed that isolated *Pseudomonas* sp., can decolorize 92.46% of the dye Dispersal navy blue after 7 days of incubation.



Graph 1: Decolorization of dispersal navy blue by *Pseudomonas* sp.



Graph 2: Decolorization of red dye by *Pseudomonas* sp.

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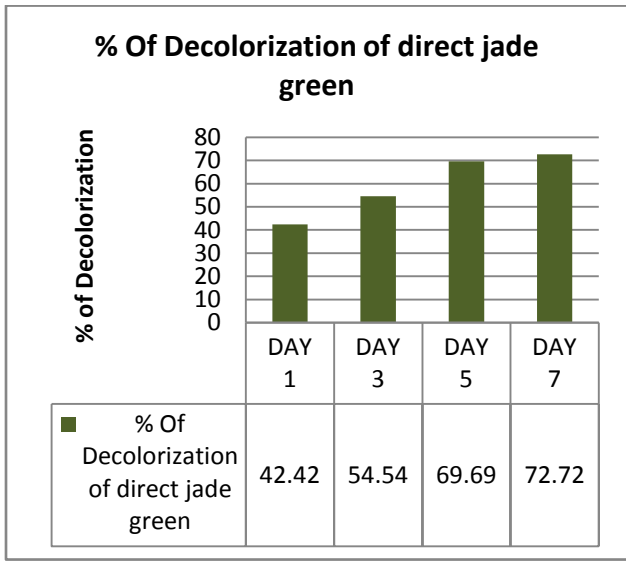
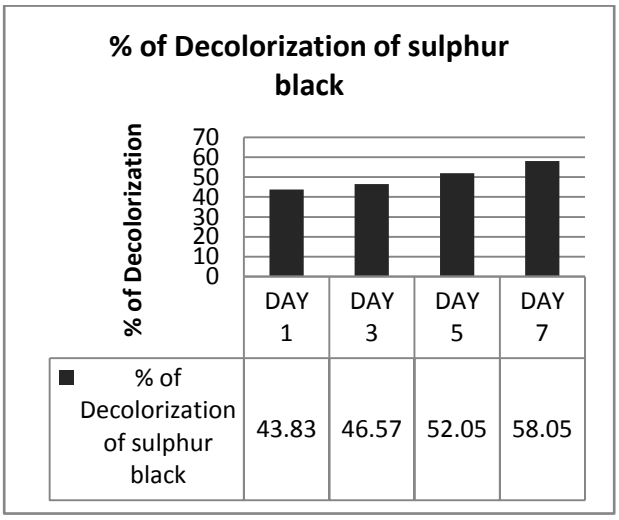


Graph 3: Decolorization of direct jade green by *Pseudomonas* sp.

Fig 1: Decolorization of Dispersal Navy Blue by isolated *Pseudomonas* sp.



Graph 4: Decolorization of sulphur black by *Pseudomonas* sp.

3.3 Optimization of Environmental factors for Efficient Decolorization

3.3.1. Effect of pH

The optical densities (OD) were measured. The percentage of decolorization of all four dyes at different pH was illustrated in the following Graph 5.

Simphiwe P. Buthelezi, Ademola O. Olaniran and Balakrishna Pillay(2012) studied bioflocculant-producing bacteria and isolate it from activated sludge of a wastewater treatment plant. Bioflocculants from these indigenous bacteria were very effective for decolorizing the different dyes tested in this study, with a removal rate of up to 97.04%. The decolorization efficiency was largely influenced by the type of dye, pH, temperature, and flocculant

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concentration. A pH of 7 was found to be optimum for the removal of both whale and mediblue dyes, while the optimum pH for fawn and mixed dye removal was found to be between 9 and 10. Optimum temperature for whale and mediblue dye removal was 35 °C, and that for fawn and mixed dye varied between 40–45 °C and 35–40 °C, respectively.

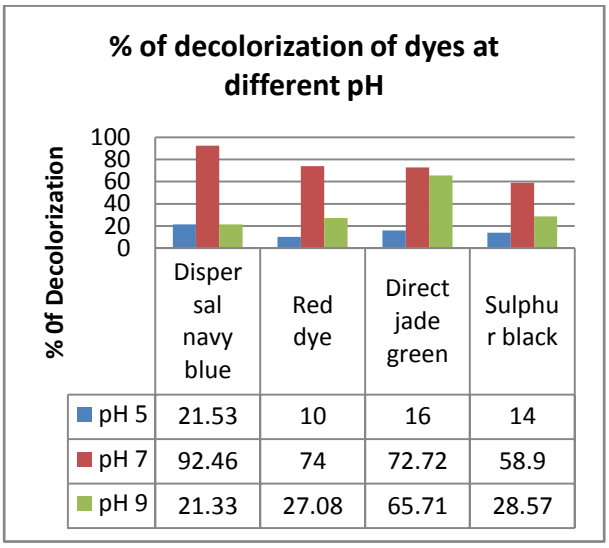
In the present study the optimum pH for the decolorization was found to be pH 7.

3.3.2 Effect of Temperature

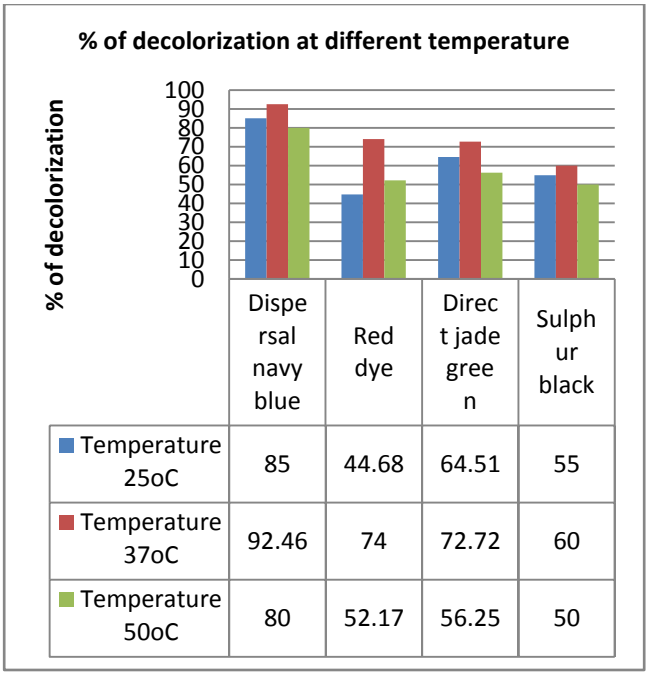
The percentage of decolorization of all four dyes at different temperature was illustrated in the following Graph 6. From the results, the optimum temperature for decolorization was found to be 37^{o}C.

3.3.3. Effect of Carbon source

The percentage of decolorization of all four dyes at different carbon source was illustrated in the following Graph 7. From the results the optimum carbon source for decolorization was found to be glucose for dyes- dispersal navy blue, direct jade green and red. The optimum carbon source for sulphur black was found to be starch.



Graph 5: Decolorization of dyes at different pH by isolated *Pseudomonas* sp.



Graph 6: Decolorization of dyes at different temperature by isolated *Pseudomonas* sp.

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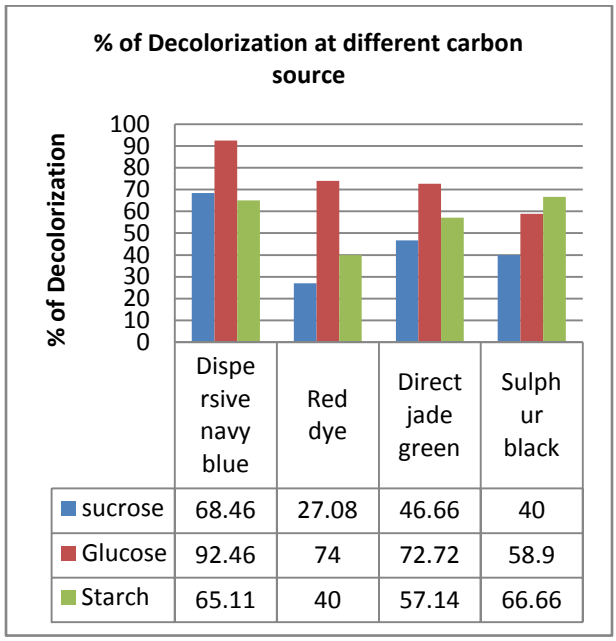

Graph 7: Decolorization of dyes at different carbon source by isolated *Pseudomonas* sp.

CONCLUSION

The results obtained show that the isolated *Pseudomonas* Sp. in liquid media is able to decolourize all of the selected dyes, but to differing extents. The bioremoval efficiency for 4 dyes differed significantly depending on the period of incubation, pH, temperature and carbon source. It was found that isolated *Pseudomonas* sp. can decolorize dispersal navy blue (92.46%), red dye (74%), direct jade green (72.72%), sulphur black (58.05%) at 200 ppm of initial concentration. The optimum pH for the decolorization was found to be 7. The optimal temperature was found to be 37^{o}C. The optimum carbon source for decolorization was found to be glucose for four dyes- dispersal navy blue, direct jade green, red and yellow dye. The optimum carbon source for sulphur black was found to be starch.

From the above results, it was concluded that the isolated *Pseudomonas* sp. can efficiently remove various types of dyes. Future work will concentrate on using the enzymes in the development of a textile effluent treatment system.

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