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Textile Dye Removal from Wastewater Effluents by Using Potential Microbes

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Abstract: ***Water pollution has become a major crisis in the Modern world. It has created a great impact on the Environment. The wastewaters that are produced by the Industries are very toxic in nature and cause many ill effects to Human beings and Environment. Toxic Effluents are produced from Industries such as Dyeing, Tannery, Steel, Paper Mills, etc. It contains Heavy Metals, Dyes, Toxic Compounds and many more pollutants. The Conventional methods prove to be very expensive and also not effective. The remedy for this problem is that a methodology should be adopted such that it is Effective in removing the toxic Pollutants and also Cost Efficient. Bioremediation proves to be the best method to achieve this target. Bioremediation is the process of using Potential microbes to degrade and remove Toxic pollutants from wastewater. This proves to be highly efficient and effective comparing other methods. This project is about the Experimental analysis of Dye water Effluent taken from a Common effluent treatment plant. The Physico-Chemical parameters was analysed, studied and compared. Also, the Dye analysis was performed by spectrophotometer for evaluating the dye removal percentage.***

Keywords: Bioremediation, wastewater, microbes, pollution, Toxic

1. Introduction

Colour is the most visible pollutant that can be easily recognized in wastewater and it should be treated properly before discharging into water bodies or on land. The presence of colour in wastewater either in industrial or domestics needs is considered as the most undesirable. Besides, the occurrence of various colouring agents like dyes, inorganic pigments, tannins and lignin which usually impart colour (Muhammad Ridhwan *et al.*, 2011) become among the main contributor for these environmental matter with dyes wastes are predominant. Dyes are widely used in many industries such as textile dyeing, food, cosmetics, paper printing, leather and plastics, with textiles industry is the major consumer. The number of synthetic dyes presently utilizes in textile industry is about 10000, representing an annual consumption of around 7x105 tones worldwide (Karthikeyan *et al.*, 2010).Small-scale industries in India contribute 3900 million litres waste water per day. Industrial Wastewater is generally very toxic in nature due to the presence of Dyes, Heavy metals, Toxic Compounds, etc. This has resulted in water pollution to a greater extent. It has led to serious health issues to human and threat to the Aquatic systems. The removal of Dyes has always been a challenging task. Although commercial methods are available it proves to be quite expensive. So, the adoption of Bioremediation is carried over to degrade and successfully remove these harmful pollutants from wastewater. The use of potential Bacteria have proved to be very effective and efficient in removing the Dyes. This is the approach that is to be carried out in this project. In this study, some important parameters that should be considered in the removal of Dyes from the Dye effluent is going to be investigated.

Bioremediation constitutes the use of natural biota and their processes for pollution reduction; it is a cost effective process and the end products are non-hazardous (Ahmedna *et al.*, 2004). Bioremediation is an integrated management of polluted ecosystem where different microorganisms are employed which catalyze the natural processes in the polluted or in the contaminated aquatic or terrestrial ecosystem (Iskandar and Adriano 1997).Textile is one of the largest industries and results in water pollution contributed by untreated effluent discharge, which contains high concentrations of consumed metal based dyes, phenol, aromatic amines etc. The discharge of textile effluent alters the Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon(TOC), suspended solids, salinity, colour, a wide range of pH (5–12) and the recalcitrance of organic compounds, such as azo dyes and gives the rivers intense colouration (Savin and Butnaru 2008).The application of microorganisms for dye wastewater removal offer considerable advantages such as the process is relatively low cost, environmental friendly, produce less secondary sludge and the end products of complete mineralization are not toxic (Forgacs *et al.*, 2004). Numerous research works has been conducted and proven the potential of microorganisms such as *Cunninghamella elegans*, *Aspergillus niger*, *Bacillus cereus*, *Chlorella* sp. and also *Citrobacter* sp. on dye wastewater removal. The adaptability and the activity of each microorganism are the most significant factors that influence the effectiveness of microbial decolorization (Kuo *et al.*, 2003).

The use of synthetic chemical dyes in various industrial processes, including paper and pulp manufacturing, plastics, dyeing of cloth, leather treatment and printing has increased considerably over the last few years, resulting in the release of dye-containing industrial effluents into the soil and aquatic ecosystems (Aksu 2005). Since most of these dyes are toxic in nature, their presence in industrial effluents is of major environmental concern because they are usually very recalcitrant to microbial degradation (Pagga and Brown 1986). In some cases, the dye solution can also undergo anaerobic degradation to form potentially carcinogenic compounds that can end up in the food chain (Banat *et al.*, 1996). Moreover, highly coloured wastewaters can block the penetration of sunlight and oxygen, essential for the survival of various aquatic forms (Crini 2006). Textile industries utilize substantial volumes of water and chemicals for wet-processing of textiles. These chemicals, ranging from inorganic compounds and elements to polymers and organic products are used for desiring, scouring, bleaching, dyeing, printing, and finishing (Dos Santos *et al.*, 2007). There are more than 8,000 chemical products associated with the dyeing process listed in the Colour Index, including several structural varieties of dyes, such as acidic, reactive, basic, disperse, azo, diazo, anthraquinone- based and metal-complex dyes (Banat *et al.*, 1996).

The removal of colour from wastewaters is often more important than the removal of the soluble colourless organic substances, which usually contribute to the major fraction of the biochemical oxygen demand (BOD). Methods for the removal of BOD from most effluents are fairly well established; dyes, however, are more difficult to treat because their synthetic origin are mainly complex aromatic molecular structures, often synthesized to resist fading on exposure to sweat, soap, water, light or oxidizing agents (Aksu 2005 and Khan et al 2007). This renders them more stable and less amenable to biodegradation (Fewson 1988 and Seshadri *et al.*, 1994). Many approaches, including physical and chemical processes, have been used in the treatment of industrial wastewater containing dye but such methods are often very costly and not environmentally safe (Nigam *et al.*, 1996 and Rauf *et al.*, 2007). Methods utilizing powdered activated carbon and activated bentonites have been commonly used (Pala *et al.*, 2002 and Yavuz *et al.*, 2002). However, the large amount of sludge generated and the low efficiency of treatment with respect to some dyes have limited their use (Pearce *et al.*, 2003). Colour removal using ozone is also usually effective and fairly rapid, but not all the methods employed give satisfactory results especially for some dispersed dyes (Aksu 2005).

2. Materials and Methods

2.1 Preparation of Nutrient Agar

A Nutrient Agar proves to be the food source for the bacteria that is to be produced. Nutrient broth contains the following: 5.0 g/l Beef extract, 5.0 g/l pepton, 3.0 g/l Sodium Chloride, which is to be transferred to 1 litre of Distilled water. At this point, the prepared Nutrient broth is checked for its pH value, Since Bacteria can survive only at neutral pH. Then, the prepared 1 litre of Nutrient broth will be transferred into Ten 250 ml Conical Flasks equally. Now, 1.5 g of Agar powder should be introduced to each of the ten Conical Flasks containing Nutrient Broth and autoclaved for sterilization.

2.2 Microorganism and Cultivation method

The bacterial strains that are used in this study were isolated from the soil and waste water samples. Bacterial Production is done through the process of serial dilution; the Microbial Load was reduced to the maximum, for Isolation of Pure culture. After the Serial Dilution, the reduced microbial load containing sample will be transferred into a Petridish containing Nutrient Agar and was kept inside the Bacteriological Incubator under supervision for 48 hours. After growing the bacteria, the pure culture is obtained by streaking the grown bacteria into a fresh petridish containing the Nutrient agar. Streaking of this pure culture is performed in aseptic condition that is inside the laminar air flow chamber in front of the spirit lamp. The streaked plates contain the pure culture which can be used for treating the Waste water effluent. The pure culture thus produced can be preserved in Slants in a refrigerator such that the culture can be used for future investigations. The slants should be tightly sealed by cotton plugs to prevent contaminations.

2.3 Treatment by potential Microbes with Aeration

The raw dye water effluent was treated by the grown potential microbes with the support of aeration process. The aeration process involved helps in supplying oxygen for the microbes to multiply and degrade the toxic substance such as heavy metals, dyes, etc. observations were made at regular intervals and change in colour was observed in 24 hours and 48 hours respectively.

2.4 Measurement of dye concentration

The dye concentrations were measured with a spectrophotometer UV-vis (Uviline 9400, SECOMAM) at intervals during the decolourization process. The concentration dye was detected by spectrophotometer by reading the culture supernatant at specific maximum absorbance wavelength, λmax after centrifugation (10, 000 rpm, 4°C for 20 mins). The efficiency of colour removal was determined by the following equation: Colour removal (%) = Ci - Cf / Ci × 100%, where Ci and Cf were initial and final concentrations, respectively.

2.5 Decolourization of Textile dye effluent by *Streptococcus* sp.

The ability of bacterial decolourization of reactive dye water effluent was investigated to compare their biodegradability. The required pH was adjusted to 7 while dye concentrations were measured using spectrophotometer UV-vis at different wavelengths corresponding to the maximum absorbance of each dye. The dye solution at desired concentration, pH and temperature taken in 250 ml conical flasks was contacted. The flasks were sterilized before incubated and kept under agitation in a rotating orbital shaker at 150 rpm and 37°C for desired time. Samples were withdrawn and analyzed for colour removal. All the experiments were conducted triplicate and the values of data are presented.

3. Results and Discussion

For the dye removal a particular bacterial slant was selected, keeping in view that it is the most potential bacterial slant. It was observed that *Streptococcus* sp. were able to degrade the dye Concentration present in the Effluent. A maximum of 87.03% of dye was successfully removed from the Dye effluent. The table represents the Dye removal percentage of *Streptococcus* sp at different Absorbance level and a graph has been plotted.

Table 3.1: Dye Removal Percentage

S.No	Absorbance	Raw Effluent	Treated Effluent	Percentage
1.	450	0.979	0.127	87.03
2.	465	0.832	0.127	84.74
3.	480	0.744	0.140	81.18
4.	495	0.630	0.131	79.21
5.	510	0.499	0.148	70.34
6.	525	0.412	0.095	76.94
7.	540	0.345	0.111	67.83
8.	555	0.267	0.150	43.82
9.	570	0.199	0.140	29.65
10.	585	0.142	0.139	2.11
11.	615	0.244	0.127	47.95
12.	630	0.153	0.125	18.30
13.	645	0.257	0.155	39.69

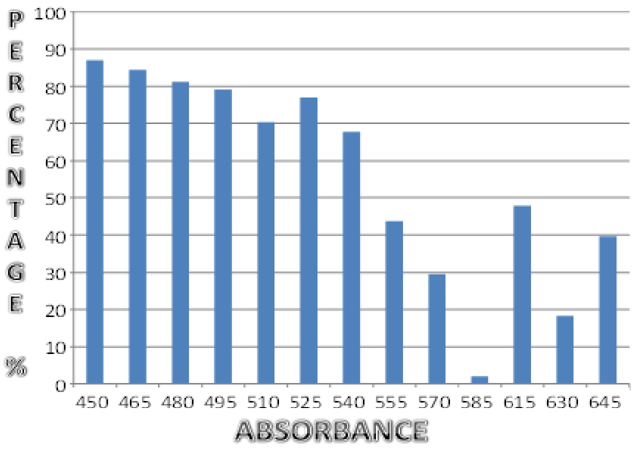

Figure 3.1: Graph representing the Removal Percentage of Dye

4. Conclusion

Since, the Dye water sample taken for the study seems to be with high toxicity. The dye Effluent was treated with the potential microbes in a circular glass bowl by supplying oxygen to the bacteria. Then, the treated dye water was analyzed for its Physico-Chemical parameters after treatment, in order to compare the parameters and its reduction. The analyses of Metal ions will be carried out by Atomic Absorption Spectroscopy and the analyses of Dyes will be carried out by Spectrophotometer. By taking the determined optimum conditions into consideration, the capacity of microorganism to remove metals and Dyes from industrial waste water was researched with the same method. The isolation and characterization of bacteria was also carried over. Finally, the most potential microbe was be identified and compared with its potential ability to remove the Heavy metals and Dyes from Wastewater.

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