BIODEGRADATION OF TEXTILE AZO DYES BY BACTERIAL STRAIN ISOLATED FROM DYE-WASTE EFFLUENT

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ABSTRACT

A variety of synthetic dyestuffs released by the textile industry pose a threat to environment safety. Azo dyes account for majority of all dyestuffs because they are extensively used in the textile, papers, food, leather, cosmetics and pharmaceutical industries. Existing effluent treatment procedures are unable to remove recalcitrant textile azo dyes completely from effluent because of their color fastness, stability and resistance to degradation. Bacterial decolorization and degradation of azo dyes under certain environmental conditions has gained momentum as method of treatment, as these are inexpensive, eco-friendly and can be applied to wide range of such dyes. Dye degradation is process in which the large dye molecules are broken down chemically into smaller molecules. The resulting products are water, carbon dioxide, and mineral by products. With consideration of above principle, present study isolated azo textile dye degrading 7 bacterial strains from textile industrial effluent/dyestuff(Solapur), using serial dilution techniques and biochemical analysis. Dye degradation study carried by incubation of strain in minimal broth with dye (0.1mg/lit) was done. After respective time interval in UV-Spectroscopic analysis considerable reduction in dye absorption is recorded.

Keywords : Dye waste effluent, Azo dye Biodegradation, Decolorization, UV-Spectroscopic analysis, Biochemical tests.

INTRODUCTION

Rapidity of industrialization and urbanization around the world has led to the recognition and understanding of relationship between environmental pollution and public health(1). The pollutions triggered by the human activities have became the top most challenge for modern civilization. Dyes are synthetic, aromatic, water-soluble and dispersible organic colorants with anannual production of over 7×10^5metric tons worldwide(1). Synthetic dyes are extensively used in textile dyeing,paper printing, colour photography, pharmaceuticals, cosmetics and various industries [1]. Azo dyes are one of the versatile class of synthetic dyes with the greatest variety of colors been used extensively for textile, leather dyeing, and paper painting and printing[6], color photography as additives in petroleum products because of their ease and cost effectiveness in synthesis, firmness, high stability to light, temperature, detergent and microbial attack and variety in color as compared to natural dyes (Couto 2009).Microorganisms that have the ability to decolorize dyes have been reported by many researchers.

Many microorganisms are capable of decolorizing the azo dyes, which includesbacteria and fungi. Structural characteristics of azo dyes are substituted aromatic rings which are considered as xenobiotic compounds and their degradation intermediates are mutagenic and carcinogenic[4]in nature. Rapid industrialization has given rise to various unwanted elements that accumulated in the biosphere up to toxic levels to damage the natural environment. Dyes are natural or synthetic colored organic compounds having the property ofimparting their color to the other substances, such as textile fibers. The dyestuff, textile, paper and leather industries, the major users of dyes, produce effluents that are usually very resistant to the biological treatment and hence, their industrial waste is a major problem to the environment(5,6).

Biodegradation refers to the breakdown of complex molecules to most small and simple ones. The original complex molecules are often environmentallyobjectionable. The biodegradation is a biological process by which environmentalpollutants are eliminated or converted into less toxic (or even useful) substances.Natural biodegradation is often chiefly catalyzed by indigenous microbial or plantpopulations in soil or aquatic ecosystems.Biodegradation has at least three definitions-(i) a minor change in an organic molecule leaving the main structure still intact,(ii) fragmentation of a complex organic molecule in such a way that the fragmentscould be reassembled to yield the original structure, and (iii) complete mineralization.Mineralization is the transformation of organic molecules to mineral forms(6).

The studies of biodegradation of dyes and its derivate products are ofenvironmental interest because of its recalcitrant nature, carcinogenicity,mutagenicity and toxic effects. A dye may be defined as an organic compound containing both chromophoreand auxochrome groups linked to benzene ring. Chromophore is responsible forimparting color to the compound and auxochrome imparts the property ofelectrolytic dissociation. The chromogen-chromophore structure is often notenough to impart solubility and cause adherence of dye to fiber. Theauxochrome or bonding affinity groups are amine, hydroxyl, carboxyl, andsulfonic radicals, or their derivatives. Azo dyes are characterized by presence of nitrogen-nitrogen (N=N) bond in itschemical structure. In last few years, several microorganisms have been reported to decolorize and transform to completely mineralized azo dyes. The bacterial degradation of azo dye is initiated by a reductive cleavage of azo bond, which result in the formation of amines. The aromatic amines that are formed in the course of these reactionsmay be degraded aerobically (Stolz A., 2001)(2).

MATERIALS AND METHODOLOGY:

2.1. Sample Collection –

The dye effluents were collected from MIDC industrial area situated at Akkalkot road, Solapur, Maharashtra, India. The effluent was collected in plastic cans. Before collecting sample, the cans were rinsed by distilled water.

2.2. Physico-Chemical Analysis –

The collected effluent samples has been analysed to determine its physico - chemical parameters. The various parameters viz., Temperature, pH, Color, Odour, Total dissolved solid (TDS), Total suspended solid (TSS), Total solids(TS), Chemical oxygen demand(COD), Biological oxygen demand(BOD), Total hardness, Iron were analysed in the laboratory by following standard protocols.

2.3. Isolation of micro-organisms from dye-waste effluent –

The isolation of dye degrading bacterial strain carried by serial dilution and then were cultured on Minimal medium with composition of K_2HPO_4, KH_2PO_4, $C_6H_5O_4Na_3.2H_2O$, $MgSO_4.7H_2O$, $(NH_4).SO_4$as per required concentrations supplemented with azo dye as carbon source. The plates were incubated at 37^0C for 24hrs. Colonies of different morphology were isolated and utilized for decolourization study.

2.4. Screening of micro-organisms based on decolourization activity –

Selected bacterial isolates were tested for their ability to degrade the textile azo dyes. The isolated bacterial strains were screened out by incubating them in 250ml Erlenmeyer flask containing 100ml of Minimal medium with 100ug/ml of azo dye. The pH was adjusted to 7.2. The flask were kept on mechanical shaker and incubated at 37^0 C for 7 days. Sample were drawn after at every 24 hours interval for spectroscopic analysis. For spectroscopic analysis centrifuged sample was taken.

2.5. Assay of decolourisation –

Decolourisation ativity was expressed in terms of percentage decolourisation and was determined by monitoring the decrease in absorbance at absorption maxima of dye using UV- visible spectrophotometer. The observation was recorded at 24 hrs, 48 hrs, 72 hrs, 96 hrs, 120 hrs, 144 hrs and 168 hrs respectively.

2.6. Identification of selected isolates –

The two selected dye degrading bacterial strains were named as DB 1, DB 2 based on their dye degrading ability, and were identified using morphological and biochemical properties for the standard protocol.

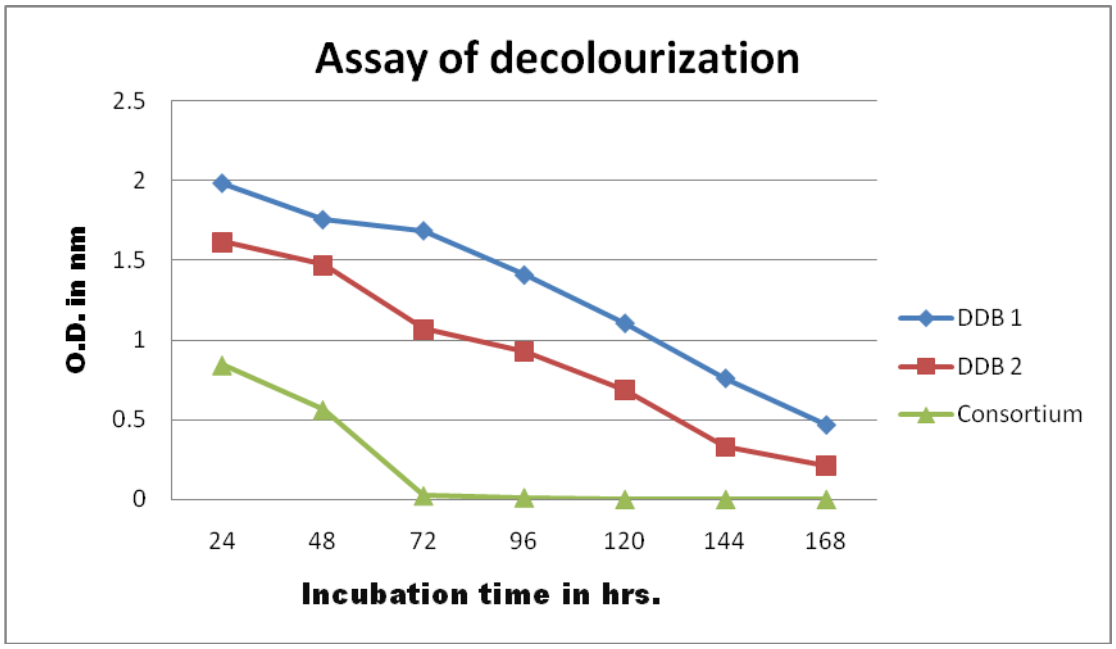
RESULTS AND DISCUSSION:

3.1. Identification and characterization of bacteria isolated from textile dye effluent –

The degradation of dye effluents used several physical, chemical and biological methods. The physico-chemical methods are economic limited[(9)]. The present study was focused on biodegradation of textile dye by using bacterial isolated from textile dye effluents. Therefore, seven different bacterial isolates were obtained from taken samples. Among them, the two bacteria are more effective against effluent samples. Two different dye degrading bacteria of DB 1, DB 2, identified as *Sphingomonas paucimobilis, Aeromonas salmonicida* respectively.

3.2. Assay of azo dye decolourisation –

As per methodology we recorded the absorbance of dye inoculated medium with two identified strain separately and third flask containing consortium. We found gradual decrease in absorbance of all test samples, against dye containing minimal media as blank. According to observation complete decolourisation was found at seventh day i.e. 168 hrs by individual strains. Consortium gave complete decolourisation of test sample at fourth days i.e. 96 hours.



3.2. Physico-chemical characterization of textile dye effluent samples –

Textile dye industrial effluents are one of major sources of environmental toxicity. It not only affects the quality of drinking water but also has damaging impact on the soil microflora and aquatic ecosystems. Soil is the most sympathetic habitat for a wide range of microorganisms that includes bacteria, fungi, algae, viruses and protozoa. Industries keeps on releasing effluents which is cause problems for the survival of the soil micro flora[2]. The dye effluents were collected from dying industries in MIDC, Solapur, Maharashtra, India. These industries discharge the pink coloured effluents with dyes and toxic compounds into the open environment. It was found that the dyeing industries are among those which result to water and soil pollution [8]. Therefore, the collected sample have been analyzed to determine their physico – chemical characteristics of the dye effluents and recommended level of National Environment Quality Standards were shown in Table 1.

Table 1: Physico-chemical characterization of textile dye effluent sample

Sr. No.	Parameters	Sample	Standards
1	Temperature(^{o}C)	30	40
2	pH	4.5	5.5 to 9.0
3	Colour	Blackish orange	Colourless
4	Odour	Unpleasant	Odourless
5	DO(mg/l)	268	4-15
6	BOD(mg/l)	76	100
7	COD(mg/l)	169	250
8	TDS(mg/l)	8000	2100
9	TSS(mg/l)	1500	100
10	TS(mg/l)	6500	20-500
11	Alkalinity(mg/l)	7300	20
12	Hardness(mg/l)	60	75 – 85
13	Calcium(mg/l)	10.64	75
14	Magnesium(mg/l)	49.36	50
15	Oil and Grease	10000	10

CONCLUSION –

Above study confirmed the decolorization of Azo dye by the isolated *Sphingomonas paucimobilis, Aeromonas salmonicida, spp.* and their consortium under in vitro conditions. Thus the study has confirmed the potential of *Sphingomonas paucimobilis, Aeromonas salmonicida spp* in the decolorization of the dye indicating their possible application for treatment of textile effluents. As per above result and discussion decolourisation potential of consortium is most effective and prominent than single strain application. Therefore application of bacteria for dye decolourisation is more effective and environmental friendly. Above investigation is more helpful for residential area, land and water resources present surrounding to dye polluted area.

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