Desalination 260 (2010) 137–146

Contents lists available at ScienceDirect

Desalination

journal homepage: www.elsevier.com/locate/desal

Biodegradation and decolorization of triphenylmethane dyes by *Staphylococcus epidermidis*

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ARTICLE INFO

Article history:
Received 31 July 2009
Received in revised form 21 April 2010
Accepted 24 April 2010

Keywords:
Decolorization
Staphylococcus epidermidis
Triphenylmethane dyes

ABSTRACT

Staphylococcus epidermidis isolated from textile wastewater were tested for their decolorization capacity. Biodegradation of Crystal violet, Phenol red, Malachite green, Methyl green and Fuchsin (750 ppm) were investigated within (12 h, 10 h, 14 h, 12 h and 10 h) under shaking condition in Mineral Salt Medium (MSM) solution at a pH of 7.5 and a temperature of 25 °C. Our results showed that *Staphylococcus epidermidis* had a high decolorization capacity. Using a 2.6×10^6 CFU/ml inoculum size. We noted also that decolorization of dyes solutions (750 ppm) was achieved after the addition of 0.10% (w/v) yeast extract and 7 mM of glucose in MSM. Chemical Oxygen Demand (COD) removal, FTIR and UV–Visible analysis confirmed biodegradation of dyes. The phytotoxicity and microbial toxicity studies of extracted metabolites suggested their least toxic nature.
Our results suggest the potential use of *Staphylococcus epidermidis* in triphenylmethane dyes decolorization. Phytotoxicity studies revealed that biodegradation of dyes by a microbial culture, resulted in its detoxification. Thus treated effluent can be used for ferti-irrigation.

1. Introduction

Large numbers of chemically different dyes are used for various industrial applications and a significant proportion appears in wastewater and is spilled into the environment. Improper chemical disposal of dyes leads to the reduction in sunlight penetration that causes a decrease in photosynthetic activity. The physical and chemical treatments available have limited use and are having high operational cost [1]. Synthetic dyes used are recalcitrant to remove by conventional wastewater treatments such as adsorption, photo-oxidation, flocculation, photodegradation and chemical degradation [2]. The biological degradation has less sludge producing properties. Currently an extensive research is focusing to find a cheap optimal microbial biomass, which is as cheap as possible for the removal of contaminating dyes from polluted water [2]. Color is usually the first contaminant to be recognised in wastewater and a very small amount of dye in water (10–20 mgl/1) is highly visible and affects water transparency and gas solubility [3]. The effluents from dye manufacturing and consuming industries are highly colored coupled with high chemical and biochemical oxygen demands (COD and BOD) [4]. Triphenylmethane dyes are aromatic xenobiotic compounds used extensively in many industrial processes, dye-stuff manufacturing industries, as a biological stain, textile paper printing [5]. Studies of the biodegradation of triphenylmethane dyes have focused on the decolorization of dyes via reaction reduction. Triphenylmethane dye-decolorizing by several microorganisms has been reported elsewhere [6]. Some of the triphenylmethane dyes are used as dermatological agents, and have been shown to be effective in controlling fungal growth under varying conditions [7]. Biological decolorization of triphenylmethane dyes is widely reported. Yatome et al. [8] reported the degradation of triphenylmethane dye (Basic violet 3) by *Pseudomonas pseudomallei* 13NA. Kwasniewska [9] demonstrated that oxidative red yeasts *Rhodotorulae* sp. and *Rhodotorulae rubra* had a high biodegradation potential against Crystal violet dye. In addition, Bumpus and Brock [10] showed that triphenylmethane dyes undergo extensive biodegradation in ligninolytic cultures of *Phanerochaete chrysosporium* [8]. Pararosaniline, Crystal violet and victoria blue were shown to be degraded by the growing cells of *Bacillus subtillis* IFO 13719. Yatome et al. [11] reported the microbial degradation of Crystal violet by *Nocardia corallina*. The ability of *Cyathus bulleri* to decolorize Crystal violet, Malachite green and bromophenol blue was also reported [12]. It has been reported that Crystal violet was decolorized by *Coriolus ersicolor*, *Funalia trogii*, *Laetiporus sulphureus* and *P. chrysosporium* [13].

In this study, a new potent bacterium isolated from textile wastewater *Staphylococcus epidermidis*, was tested for its ability to decolorize triphenylmethane dyes (Crystal violet, Phenol red, Malachite green, Methyl green and Fuchsin). In addition the phytotoxicity and microbial toxicity of the end product were assessed.

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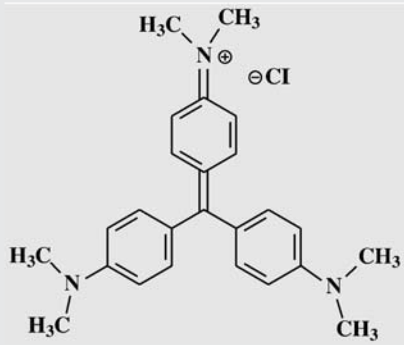
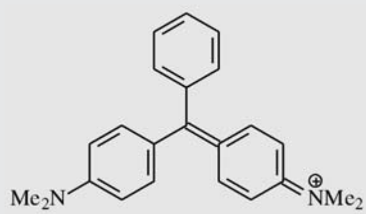
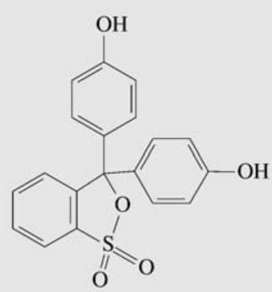
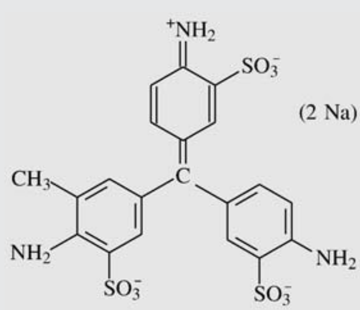
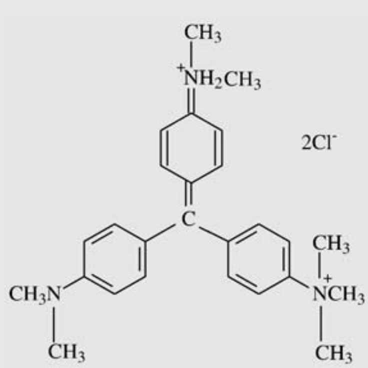
0011-9164/$ – see front matter
doi:10.1016/j.desal.2010.04.052

Table 1
Chemical structure of dyes used in this study.

Dyes	Structural	λ_{max} (nm)	Chemical class
Crystal violet		592	Triphenylmethane
Malachite green		618	Triphenylmethane
Phenol red		431	Triphenylmethane
Fuchsin		530	Triphenylmethane
Methyl green		632	Triphenylmethane