Nature Environment and Pollution Technology © Technoscience Publications	Vol. 6	No.3	pp. 417-420	2007

PHYTOREMEDIATION OF AQUEOUS SOLUTION CONTAINING DIRECT BLACK E DYE WITH *HYDRILLA VERTICILLATA*

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ABSTRACT

Phytoremediation refers to a set of technologies that use different plants as a containment technique. This technology is receiving attention lately. As the results from field trials, it indicates that it is a cost saving technique compared to conventional treatment. The present investigation has helped to understand about the phytoremediation capacity of *Hydrilla verticillata* to remove colour from the aqueous dye solution. The colour has been completely removed from 10 and 20 ppm aqueous Direct Black E solution after 96 hrs, and from 50 ppm solution after 5 days. Thus, the study helps us to understand the possibility of bioremediation of dyeing industry effluent using *Hydrilla verticillata*. The recycling and reuse of Direct dye containing dyeing industry effluents would be possible in the days to come.

INTRODUCTION

Water is a vitally important substance. It is such a medium, which gave birth to the first primitive life, and without it no life could exist. Throughout the history, the quality and quantity of water available to man have been the vital factor in ascertaining his well-being.

The rapid industrialization has resulted in many developments in the every field of science. But this trend has ultimately resulted in a condition, namely pollution. One of the most rapidly growing industries is textile industry (Abrahart 1997).

Dyes or dyestuffs are coloured substances capable of imparting their colour, fast to light. The first synthetic dyestuff was prepared in 1856 by W. H. Perkins called Perkins violet dye, commonly known as mauve. This discovery stimulated the study and research on the synthetic dyes and the progress was very rapid (Inbaraj 2001).

Textile industry in India is one of the oldest and greatest organized sectors. There are many textile mills concentrated in Ahmedabad, Bombay, Coimbatore, Kanpur and Delhi. It is estimated that the future growth of textile industry in India will be mostly in rural areas. These industries are considered as one of the largest consumers of freshwater. Washing is essential during mercerizing, scouring, bleaching, dyeing and printing. These processes discharge high quantity of wastewaters (Kavitha et al. 2003).

Characteristics of Dyeing Industry Effluent

The quantity and quality of effluents largely depend on the dye used and method of dye application. Generally, dyeing effluents are intensely coloured, contain excess suspended solids, dissolved solids and exert a high BOD. They are usually hot and have an alkaline pH. They contain residual dyes, mordants, auxiliary chemicals, acids, alkalis, nitrites, chromium salts, sodium chloride and surfactants etc.

Apart from the dyeing effluents, those from sulfide and vat dyeing are the strongest. The spent sulfide liquors are dark coloured with a high pH and sulfide content. The permanganate value (4hrs) is also high. Care should be exercised while treating these liquors as acid may liberate hydrogen sulfide gas. Sulphides may be removed by treatment with chlorine or hypochlorites. Spent vat dyes are strongly alkaline and have fairly high permanganate value. An important point to be remembered is that under the conditions of dyeing (acidic/alkaline pH, T and P) internal reactions may take place and certain toxic compounds may be produced which may not be originally present. Reactive dyes are highly preferred due to their colour fastness and wash fastness (Manivasakam 1995).

Phytoremediation of Dyeing Industry Effluent

When various industrial effluents are considered, the dyeing industrial effluents have been reported to be very complicated and, hence, various stages were reported for their efficient treatment. The major pollutants such as colour, BOD and COD were found to be removed using certain chemical agents such as chlorine, sodium hypochlorite etc.

Phytoremediation has other obvious appealing attributes. It is an *in situ* cleanup strategy, which means that contaminants can be treated in place thereby eliminating or lessening the costs and liabilities associated with cleanup methods that involve excavation and transportation for off-site disposal. Perhaps more importantly, phytoremediation strategies can be used on site which are polluted with heavy metals as well as organic chemicals.

The residual dyes are reported to impart high degree of colour to the receiving waters making them unfit for other uses and also aesthetically unpleasing (Manivasakam 1995). Hence, it is essential to find a suitable alternative, such as aquatic plants, which could be used to treat the contaminated water. Phytoremediation is also a less expensive and low cost natural treatment.

MATERIALS AND METHODS

Sampling of dyeing industry effluent: Dyeing industry effluent was collected from a dyeing industry located at Tirupur, Tamilnadu, India.

Estimation of dye concentration: The wavelength of maximum absorbance (λ max) and the dye concentration were determined using Systronics UV-Vis spectrophotometer Model No. 118. The wavelength of maximum absorbance (λ max-648 nm) was used as the monitoring wavelength.

Preparation of stock dye solution: Accurately 1000 mg of Black E dye was weighed and dissolved in 1000 mL of water to get 1000 ppm dye solution.

Preparation of working solution: Appropriate amount of stock solutions were diluted and made up to 1000mL to get 10, 20, 30, 40 and 50 ppm of dye solutions.

Batch Experiments

The stock culture of the plant was maintained in the laboratory pond at ambient temperature. About 1 m^3 containers with 5 litre of dye solution were prepared and the weighed plants were introduced. Sample solutions were withdrawn daily and the colour reduction was recorded.

RESULTS AND DISCUSSION

The batch experiments have clearly shown (Table 1) (Fig.1) that the colour imparted by 10 ppm Direct Black E solution has lost its colour completely after 72 hrs, and the 20 ppm solution after 96 hrs. In 30 ppm aqueous dye solution, maximum 99% colour removal has been found after 96 hrs. At the same time, for the remaining two dye concentrations (40 and 50 ppm), the colour reduction has reached to about 98%.

Ambika & Sumalatha (2005) have suggested that *Hydrilla verticillata* is capable of defluoridating fluoride-contaminated ground water. This aquatic plant has not shown any signs of toxicity even at 20 mg/L concentration of fluoride. It was capable of growing and functioning normally. So this plant can be effectively used to phytoremediate fluoride contaminated ground water. Aquatic plants generally exhibit good tolerance levels to metals and other mineral ions. These plants are known to tolerate high levels of metal ions by forming metal-protein complexes. Tolerance to one metal causes the aquatic plants to evolve tolerance to other metal ions(Shirke & Chandra 1991, PTI 1997) too.

Thus, the colour removal obtained using *Hydrilla verticillata* is comparatively higher and offers good potential for the treatment of textile wastewaters. During the period, the biomass has been increased, which shows that the plant is tolerant to the toxic condition and is capable of performing the treatment of water. After treatment, the plant material could be subjected to composting.

Table 1: Percentage of colour reduction from Direct dye using *Hydrilla verticillata.*

Concentration ppm	Percentage of colour reduction (%)			
	24 hrs	48 hrs	72 hrs	96 hrs
10	90.0	92.5	100	100
20	86.3	90.6	99.4	100
30	77.0	88.5	97.9	99.1
40	70.7	85.7	97.3	98.5
50	62.3	80.3	95.0	98.0

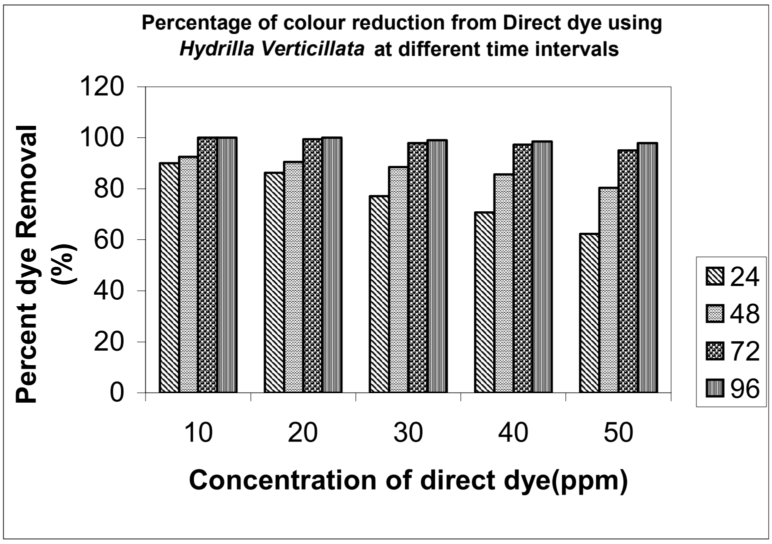

Fig.1: Percentage of colour reduction from Direct dye using ***Hydrilla Verticillata*** at different time intervals.

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