TREATMENT OF TEXTILE DYE EFFLUENT USING AQUATIC MACROPHYTE AS PHYTOREMEDIATION PROCESS

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Abstract: Phytoremediation technique used for removing heavy metals and other pollutants from dye effluent using aquatic macrophytes which are free floating plants having long roots floating beneath the water surface. Aquatic macrophyte used in this study is water hyacinth (*Eichhornia crassipes*). Dye wastewater contains pollutants in terms of Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Color and heavy metals. This lab-scale study is carried out to determine the phytoremediation potential of water hyacinth to remediate dye wastewater by reducing concentration of heavy metals and other physicochemical parameters. The experiment was carried with the help of 25% diluted dye wastewater. It has been found that, water hyacinth performs well in 25% wastewater after dilution. The overall reduction in parameters after 7 day cycle of 25% dilution was about 70%.

Keywords: Phytoremediation, Macrophytes, Eichhornia crassipes, Dye wastewater

1. INTRODUCTION

Phytoremediation basically refers to the use of plants and associated soil microbes to reduce the concentrations or toxic effects of contaminants in the environments (Greipsson, 2011). It is a novel, cost-effective, efficient, environment- and eco-friendly, in situ applicable, and solar-driven remediation strategy. Techniques of phytoremediation include phytoextraction (or phytoaccumulation), phytofiltration, phytostabilization, phytovolatilization, and phytodegradation (Alkorta *et al.*, 2004).

1.1 Phytoextraction

Phytoextraction (also known as phytoaccumulation, phytoabsorption or phytosequestration), is the uptake of contaminants from soil or water by plant roots and their translocation to and accumulation in aboveground biomass i.e., shoots. (Sekara et al., 2005; Yoon et al., 2006; Rafati et al., 2011)

1.2 Phytofiltration

Phytofiltration is the removal of pollutants from contaminated surface waters or waste waters by plants (Mukhopadhyay and Maiti, 2010). In phytofiltration, the contaminants are absorbed or adsorbed and thus their movement to underground waters is minimized. This technique is used to reduce the mobility and bioavailability of pollutants in the environment, thus preventing their migration to groundwater or their entry into the food chain (Erakhrumen, 2007).

Plants can immobilize heavy metals in soils through sorption by roots, precipitation, complexation or metal valence reduction in rhizosphere (Barcelo and Poschenrieder, 2003; Ghosh and Singh, 2005; Yoon et al., 2006; Wuana and Okieimen, 2011).

1.3 Phytovolatilization

Phytovolatilization is the uptake of pollutants from soil by plants, their conversion to volatile form and subsequent release into the atmosphere

1.4 Phytodegradation

Phytodegradation is the degradation of organic pollutants by plants with the help of enzymes such as dehalogenase and oxygenase; Plants can accumulate organic xenobiotics from polluted environments and detoxify them through their metabolic activities

1.5 Rhizodegradation

Rhizodegradation refers to the breakdown of organic pollutants in the soil by microorganisms in the rhizosphere (Mukhopadhyay and Maiti, 2010).

The main reason for the enhanced degradation of pollutants in the rhizosphere is likely the increase in the numbers and metabolic activities of the microbes.

1.6 Phytodesalination

Phytodesalination refers to the use of halophytic plants for removal of salts from salt-affected soils in order to enable them for supporting normal plant growth (Manousaki and Kalogerakis, 2011; Sakai et al., 2012).

Textile dye wastewater contains substantial pollution loads which increase the Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Suspended solids (TSS), Total Dissolved Solids (TDS) and heavy metals. This wastewater has serious negative impact not only on under-ground and surface water and land area in close proximity to the source of discharge but also on the aquatic ecological system.

Water hyacinth originated in the American tropics and spread to all tropical climate countries. Its enormous biomass production rate, its high tolerance to pollution, and its heavy metal and nutrient absorption capacities (Chanakya et al., 1993; Singhal and Rai, 2003; Ingole and Bhole, 2003; qualify it for use in wastewater treatment ponds. So present study was undertaken to evaluate the phytoremediation potential of water hyacinth (*Eichhornia crassipes)* plants against textile industry dye wastewater.

2. MATERIALS AND METHODS

2.1 COLLECTION OF PLANTS:

The water hyacinth of uniform sizes used in research was collected from Chandola Lake, Ahmedabad, Gujarat.

2.2 EXPERIMENTAL SETUP:

Twenty litres plastic troughs were taken for the experiment. Primary and secondary treated textile dye wastewater was collected textile industry. Before transferring plants into troughs, an initial analysis of main physico-chemical and biological parameters were done. The test plants were transferred to plastic troughs containing textile dye. The duplicate set of 25% dye wastewater + 75% tap water was taken for test. A 7- day cycle was conducted and samples were analysed after 3-day, 5-day and lastly 7-day.

2.3 ANALYSIS:

All the analysis of the parameters like chemical oxygen demand (COD), pH and colour was executed in the laboratory using standard methods. Analysis of heavy metals like iron, copper, nickel and zinc was done by Colorimetric method.

3. RESULTS AND DISCUSSION

Phytoremediation is a new area of treatment technology that takes advantage of fact that certain species of plants flourish by accumulating waste materials present in the water. The results indicate that, the test plant (*Eichhornia crassipes*) reduced all the physic-chemical and biological parameters to a significant level as shown in table no. 1 and table no.2.

In all parameters it has been found *Eichhornia crassipes* performs well in 25% dye waste water. This indicates dilution enhances the performance of test plants in dye waste water. After 7-day cycle growth of the plants reduced a bit but the survival of plants was good as shown in fig. no.1.

Fig. No.1: Conditions of plants after 7-day cycle

4. CONCLUSION

In this present work, a preliminary study was made to find the potential of *Eichhornia crassipes* in treating dye waste water. It has been found that, water hyacinth performs well in 25% wastewater after dilution. The overall reduction in parameters after 7 day cycle of 25% dilution is depicted below;

- Primary wastewater treatment after 7-Day cycle is:
  - ✓ COD reduction was 73.91%
  - ✓ Colour reduction was 38.34%
  - ✓ Fe reduction was 71.4%
  - ✓ Cu reduction was 42.85%
  - ✓ Ni reduction was almost 100%
  - ✓ Zn reduction was 90.90%

- Secondary wastewater treatment after 7-Day cycle is:
  - ✓ COD reduction was 82.6%
  - ✓ Colour reduction was 32.91%
  - ✓ Fe reduction was 78.57%
  - ✓ Cu reduction was 58.33%
  - ✓ Ni reduction was almost 100%
  - ✓ Zn reduction was 80%

The water hyacinth was found to be efficient in reducing the concentrations of heavy metals, colour and COD. At this time of water, energy and environmental purity crisis, water hyacinth can be a very effective tool in polishing the wastewater after primary and secondary treatments or can be used as an integrated process.

Table no.1: Physico-chemical parameters of 25% dye wastewater

	pH	**COD**	**COLOR**
INITIAL READING	P: 8.1 S: 8.4	P: 215.6 mg/L S: 68.6 mg/L	P: 51.1 Cu S: 43.7 Cu
AFTER DILUTION	P: 8.1 S: 8.4	P: 73.6 mg/L S: 55.2 mg/L	P: 19.3 Cu S: 16.1 Cu
3 DAY CYCLE	P: 7.9 S: 8.3	P:48 mg/L S:28.8 mg/L	P: 16.9 Cu S: 14.5 Cu
5 DAY CYCLE	P: 7.8 S: 8.1	P:29.4 mg/L S:26.13 mg/L	P: 14.3 Cu S: 13.1 Cu
7 DAY CYCLE	P: 7.5 S: 7.9	P: 19.2 mg/L S: 9.6 mg/L	P: 11.9 Cu S: 10.8 Cu

Note: P= Primary treated dye wastewater, S= Secondary treated dye wastewater

Table no.2: Heavy metals analysis of 25% dye wastewater

HEAVY METALS	**Fe**	**Cu**	**Ni**	**Zn**
INITIAL READING	P: 3.8 ppm S: 3.0 ppm	P: 1.6 ppm S: 1.3 ppm	P: 1.4 ppm S: 1.0 ppm	P: 2.5 ppm S: 2.2 ppm
AFTER DILUTION	P: 3.5 ppm S: 2.8 ppm	P: 1.4 ppm S: 1.2 ppm	P: 1.0 ppm S: 1.0 ppm	P: 2.2 ppm S: 2.0 ppm
3 DAY CYCLE	P: 2.2 ppm S: 1.9 ppm	P: 1.2 ppm S: 1.14 ppm	P: 0.8 ppm S: 0.5 ppm	P: 0.6 ppm S: 0.82 ppm
5 DAY CYCLE	P: 1.5 ppm S: 1.3 ppm	P: 1.0 ppm S: 0.8 ppm	P: BDL S: BDL	P: 0.5 ppm S: 0.6 ppm
7 DAY CYCLE	P: 1.0 ppm S: 0.6 ppm	P: 0.8 ppm S: 0.5 ppm	P: BDL S: BDL	P: 0.2 ppm S: 0.4 ppm

Note: P= Primary treated dye wastewater, S= Secondary treated dye wastewater, BDL= Below detectable limit

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