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Phytoremediation of Textile Wastewater Laden with 1,4-Dioxane Using Eichhornia crassipes: A Sustainable Development Approach

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Abstract : The release of textile wastewater loaded with 1,4 dioxane into aquatic ecosystems has been associated with various human health risks and adverse environmental impacts. In parallel, phytoremediation has been recently employed to treat highly polluted wastewater because various plant species tend to produce certain enzymes as a defense mechanism against a toxic environment. To our best knowledge, this study is the first to investigate the ability of phytoremediation using Eichhornia crassipes for the removal of various pollutants, including 1,4 dioxane, from textile wastewater. A phytoremediation system composed of Eichhornia crassipes was acclimatized for 10 d, and then operated in four lab-scale hydroponic systems, viz., negative control, positive control, and two different 1,4 dioxane concentration (400 and 500 mg/L). After 11 d of operation, the phytoremediation system achieved removal efficiencies of 67.5±3.4%, 89.4±4.4%, 83.6±3.8% for 1,4 dioxane (at initial concentration 400 mg/L), chemical oxygen demand (COD) (at initial concentration 679 mg/L), and cumulative heavy metals, respectively. The removal of these pollutants was mainly supported by the phyto-sorption and phytodegradation mechanisms. The economic feasibility of this phytoremediation system was validated by estimating the capital and operating costs, requiring 4.6 USD for the treatment of 1 m3 textile wastewater. The study concluded that the phytoremediation process could be used as a practical and economical approach to treat textile wastewater laden with various organic and inorganic pollutants. Due to the observed pollution reduction and human health protection, the study objectives would fulfill the targets of SDG 3 “Good Health and Well-being” and SDG 6 “Clean Water and Sanitation”. Further studies are required to (i) investigate the ability of plant species to withstand higher concentrations of 1,4 dioxane for an extended operation time and (ii) understand the biochemical pathways for the degradation of 1,4 dioxane via the action of plant enzymes and the associated microbial community.

Keywords : 1,4 dioxane concentrations, hydrophytes, Eichhornia crassipes, phytoremediation effectiveness, SDGs, textile industrial effluent
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