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Invasive Aquatic Plant based Biochar for the Treatment of Industrial Wastewater: An Innovative Green Approach

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Abstract

Industrial wastewater pollution has exerted serious environmental threats in recent past. In the quest of exploring green technology for water treatment, biochar (BC) is deemed to be in the limelight. Current advancement in BC technology facilitates a new strategy to manage invasive plants through the production BC. Hence, the present study was designed to evaluate the potential utilization of BC which was made by invasive aquatic plant; *Pistia* sp., *Salvinia* sp., and *Eichhornia* sp. to treat industrial wastewater. Both activated and non-activated BC (125-250 µm particle size) were used as the adsorbent material of the developed filter. A mass of 50 g of BC was placed between fine and coarse sand in each filter. The treatment efficiency of the BC filters was analysed filtering wastewater collected from a rubber processing factory. Both raw and treated water samples were analysed for, pH, Total Suspended Solids (TSS), Biological Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Kjeldahl Nitrogen (TKN), Ammoniacal-Nitrogen (NH_3-N), Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Phosphates (TP), Nitrate (NO_3-N), turbidity and heavy metals (Zinc, Chromium). The control setup was constructed only with sand and gravel layers. Chemical and physical characterization of BC was analysed using Fourier Transform-Infrared Spectroscopy (FT-IR) and Scanning Electron Microscopy (SEM). Brine shrimp lethality assay was carried for toxicological evaluation. Functional groups that involve for the adsorption mechanism (O-H stretching-3,550-3,200 cm^{-1}, C=C aromatic stretching-1400-1660 cm^{-1}, Phenol-O-H bending-1,300-1,400 cm^{-1}) were recorded in all BC samples. Observed SEM images indicated differences between the surface morphology of each BC sample. *Pistia* sp. based activated BC gave the best removal efficiency for the tested chemical parameters compared to the other activated and non-activated BC. *Pistia* sp. based activated BC showed 100% removal of TP and NO_3-N, following greater reduction of Turbidity (99.70%), TSS (88.67%), NH_3-N (86.17%), TKN (79.20%), COD (75.00%), and BOD_5 (71.68%). TDS (46.05%), EC (33.22%), and pH (21.22%) reduction was found to be below 50%. Removal of Chromium and Zinc were recorded as 60.80% and 78.75%. The toxicity assay showed 100% mortality in raw wastewater and control setup whereas 70-85% in non-activated BC incorporated filters. No mortalities were recorded in activated BC incorporated filters. This study concludes that the BC produced from *Pistia* sp. is a promising adsorbent for the treatment of wastewater. Hence, outcomes of the study propose a green approach for the effective usage of invasive aquatic plants for sustainable wastewater treatment.

Keywords: Biochar, *Pistia* sp., Invasive aquatic plant, Wastewater