Simultaneous Azo Dye Removal and Bioelectricity Generation by an Up-Flow Constructed Wetland-Microbial Fuel Cell With Biochar Substrate

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Health and environmental problems result from both the release of dyes into ecosystems and greenhouse gas emissions from energy generation via fossil fuel combustion. To create a cost-effective, sustainable alternative, the abilities of planted up-flow constructed wetland-microbial fuel cells to generate bioelectricity and decolorize azo dye were evaluated over 18 days. Reactors amended with pomegranate biochar were supplied with distilled water (control), methyl orange (200 mg/L), or synthetic wastewater. The first goal was energy production, which increased in all groups. The synthetic wastewater-no biochar reactor produced 713% greater energy (.0666 J) than the distilled water-no biochar reactor (.00819 J), possibly due to electrolytes in wastewater elevating electrical conductivity. Biochar increased cell potential by enhancing bacterial growth and electrocatalysis for the cathodic reduction of oxygen. In the synthetic wastewater reactor, this was likely offset by biochar adsorbing cations, reducing conductivity and, thus, energy production. The second goal was water remediation, which was assessed by Bacopa monnieri viability, dye adsorption, and dissolved oxygen levels. Respective increases of 57.17% and 270.36% in plant height and number of leaves of the methyl orange-biochar reactor suggest that biochar reduced acidity by releasing free bases. Dye removal increased with biochar concentration. Significant adsorption ($p<.05$) between the 35% (72.98%) and 10% (39.14%) biochar compared to the no biochar group resulted from electrostatic, functional group, and pi-pi interactions and hydrogen bonding. Bioreactors demonstrated efficacy to sustain native species for wetland conservation and repurpose agricultural wastes for bioelectricity production and dye remediation.

Awards Won:

Fourth Award of $500