Improving Sustainability Through Biotechnologies: Electrochemical Analysis of Rhizobium tropici Biopolymer for Fuel Cell Applications

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Current environmental challenges necessitate expanding research on biopolymers as supplements in energy technologies to further the transition to a sustainable future. The bacterium Rhizobium tropici produces Extracellular Polymeric Substance (RT-EPS), which benefits soil health as a natural buffer. This study utilized electrochemical analysis to understand the mechanism of its advantageous properties for application in Proton-Exchange Membrane (PEM) fuel cells. Cyclic voltammetry using a three-electrode setup swept from -0.8 to 0.8 volts at 10 mV/sec was run using solutions of 150 mg of dialyzed biopolymer in 15 mL of deionized water at neutral, acidic, and basic pH. The maximum capacitance was 1691 mF/cm2 in basic pH, exemplifying double layer formation in solution that demonstrates the charged groups on the biopolymer structure that enable its pH tolerance. The biopolymer was then applied to a Perfluorosulfonic Acid (PFSA) membrane to utilize its natural capacitance to enhance PEM fuel cell efficiency. Fuel cells are essential to power grid stabilization as they can translate intermittent renewable sources of energy to match demand through hydrogen fuel. Assessed using 0.1 mg/cm2 platinum catalyst carbon electrodes, the biopolymer membrane improved PEM fuel cell efficiency through greater power outputs, higher current density values, and longer voltage discharging without necessitating additional platinum catalyst, which has significant environmental effects. Max power output reached 129 mW/cm2, 51% higher than the control, and current density values were extended by 80% with the biopolymer applied. This exemplifies the advantageous electrochemical properties of this sustainable biopolymer that can be utilized to improve clean energy advancements.

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