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Use of biogenic silver nanoparticles on the cathode to improve bioelectricity production in microbial fuel cells

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To date, research on microbial fuel cells (MFCs) has. focused on the production of cost-effective, high-performance electrodes and catalysts. The present study focuses on the synthesis of silver nanoparticles (AgNPs) by *Pseudomonas* sp. and evaluates their role as an oxygen reduction reaction (ORR) catalyst in an MFC. Biogenic AgNPs were synthesized from *Pseudomonas aeruginosa* via facile hydrothermal synthesis. The physiochemical characterization of the biogenic AgNPs was conducted via scanning electron microscopy (SEM), X-ray diffraction (XRD), and UV-visible spectrum analysis. SEM micrographs showed a spherical cluster of AgNPs of 20–100 nm in size. The oxygen reduction reaction (ORR) ability of the biogenic AgNPs was studied using cyclic voltammetry (CV). The oxygen reduction peaks were observed at 0.43 V, 0.42 V, 0.410 V, and 0.39 V. Different concentrations of biogenic AgNPs (0.25–1.0 mg/cm^2) were used as ORR catalysts at the cathode in the MFC. A steady increase in the power production was observed with increasing concentrations of biogenic AgNPs. Biogenic AgNPs loaded with 1.0 mg/cm^2 exhibited the highest power density (PD_{max}) of 4.70 W/m^3, which was approximately 26.30% higher than the PD_{max} of the sample loaded with 0.25 mg/cm^2. The highest COD removal and Coulombic efficiency (CE) were also observed in biogenic AgNPs loaded with 1.0 mg/cm^2 (83.8% and 11.7%, respectively). However, the opposite trend was observed in the internal resistance of the MFC. The lowest internal resistance was observed in a 1.0 mg/cm^2 loading (87 Ω), which is attributed to the high oxygen reduction kinetics at the surface of the cathode by the biogenic AgNPs. The results of this study conclude that biogenic AgNPs are a cost-effective, high-performance ORR catalyst in MFCs.

KEYWORDS

oxygen reduction reaction, cathode modifier, biogenic, nanoparticles, microbial fuel cell