

Self-Sustaining Bioelectrochemical Cell from Fungal Degradation of Lignin-Rich Agrowaste

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Abstract

The present work describes a self-sustaining bioelectrochemical system that adopts simple cell configurations and operates in uncontrolled ambient surroundings. The microbial fuel cell (MFC) was comprised of white-rot fungus of Phanaerochaete chrysosporium fed with oil palm empty fruit bunch (EFB) as the substrate. This fungal strain degrades lignin by producing ligninolytic enzymes such as laccase, which demonstrates a specific affinity for oxygen as its electron acceptor. By simply pairing zinc and the air electrode in a membraneless, single-chamber, 250-mL enclosure, electricity could be harvested. The microbial zinc/air cell is capable of sustaining a 1 mA discharge current continuously for 44 days (i.e., discharge capacity of 1056 mAh). The role of the metabolic activities of P. chrysosporium on EFB towards the MFC's performance is supported by linear sweep voltammetry measurement and scanning electron microscopy observations. The ability of the MFC to sustain its discharge for a prolonged duration despite the fungal microbes not being attached to the air electrode is attributed to the formation of a network of filamentous hyphae under the submerged culture. Further, gradual lignin decomposition by fungal inocula ensures a continuous supply of laccase enzyme and radical oxidants to the MFC. These factors promote a self-sustaining MFC devoid of any control features.

Keywords

Author Keywords: microbial zinc; air cell; Phanaerochaete chrysosporium; white-rot fungus; membraneless MFC; lignin-rich agrowaste
KeyWords Plus: MICROBIAL FUEL-CELL; WHITE-ROT FUNGUS; PHANEROCHAETE-CHRYSPORIUM; ELECTRICITY-GENERATION; BIOFUEL CELLS; WASTE; ENZYMES; POWER; FUNDAMENTALS; BIOCATHODE

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