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Exploring the potential of microbial fuel cells to convert organic waste into sustainable energy: A climate change mitigation strategy

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Abstract

In light of recent advancements in climate science, the use of microbial fuel cells (MFCs) offers a promising solution to waste treatment, utilization, and clean energy production. This study evaluated the bioelectricity potential of various biological wastes (palm oil processing waste, kitchen waste, cow dung) and their combinations using MFC technology. The study revealed that the proximate components of the fresh biological wastes varied, with CD having the highest moisture content and varying levels of ash, carbohydrates, proteins, and fats. The pH and total titratable acidity (TTA) values were inversely related to each other, and the mineral constituents of the wastes showed high concentrations of potassium, sodium, and calcium. Electricity generation was quantified, and the choice of biological waste for further study was based on the waste that generated the highest electricity potential. The microbial community in the MFCs was dominated by members of the phyla Proteobacteria, Firmicutes, and fungi at different periods of isolation. *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus penneri*, *Lactobacillus animate*, *Saccharomyces cerevisiae*, and *Aspergillus flavus* were associated with the generation of electricity, but only *Alcaligenes faecalis* and *Lactobacillus fermentum* were not retained until the end of the study. The kitchen waste exhibited the best electricity generation potential compared to other substrates, with a maximum current, voltage, and power density of 0.65mA, 0.59V, and 279.52 mW/m2, respectively. The use of mediators, including ferricyanide, EDTA, methylene blue, KMnO4, and neutral red, increased the amount of energy generated. The order of energy generation using different mediators was presented as ferricyanide> EDTA > methylene blue > KMnO4 > neutral red, with ferricyanide showing the greatest potential (power density and percentage energy contribution of 924.79mW/m2 and 993.39% respectively). Their inhibitory effects on cell growth were observed, with methylene blue being the least inhibitory and KMnO4 the most. Overall, the physicochemical components of the biological wastes presented them as viable substrates for the sustainment of electrogens and the development of MFCs, with kitchen waste being the most promising substrate. This research provides a baseline for the use of domestic waste for the generation of energy, waste control, and management. The use of MFCs holds great potential for the sustainable production of clean energy and waste treatment in the future.

Keywords

Microbial_fuel_cells, Biological_wastes, Electricity_generation Kitchen_waste, Mediators, Sustainable_energy