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The Effect of Nutrients in Anodic Chamber to the Performance of Microbial Fuel Cell (MFC)

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ABSTRACT

This paper describes a device known as a Single-chamber Microbial Fuel Cell (SMFC) that was used to generate bioelectricity from plant waste containing lignocellulosic components, such as bamboo leaves, rice husk and coconut waste, with various anodic chamber substrate compositions. The maximum power density among all assembled SMFCs was determined to be 231.18 μW/m^2, generated by coconut waste. This model's bioelectricity production was enhanced by adding organic compost to the anodic chamber, which acts as a catalyst in the system. The maximum power density of 788.58 μW/m^2 was attained using a high proportion of coconut waste (CW) and organic compost. These results show that the higher percentage of lignin in CW improved the bioelectricity of SMFC.

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INTRODUCTION

In 2050, the global population is projected to increase by 2 billion, from 7.7 billion to 9.7 billion (United Nations, 2019). Population growth will increase the energy demand, leading to the depletion of energy resources

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such as fossil fuels. Fossil fuels, made up of decomposing plants and animals buried by layers of rocks from over a million years ago, are a non-renewable energy resource consisting of coal, oil and natural gas (Energy.Gov, 2017; National Geographic Society, 2019). Eventually, these non-renewable energy sources will be depleted due to the continued use of fossil fuels to generate electricity. In addition to being non-renewable, fossil fuels contribute to global warming by emitting large amounts of CO_2 into the atmosphere due to the carbon emission's ability to retain heat (Denchak, 2022). It was estimated that over 8 million people worldwide die every year due to inhaling polluted air from burning fossil fuels containing particles such as greenhouse gases (Kottasová & Dewan, 2021). That is why finding a renewable energy source to produce electricity for all consumers is essential. Numerous renewable energy sources have been developed, including discovering Microbial Fuel Cell (MFC) to meet the ever-increasing energy demand. MFC is an environmentally friendly device with minimal carbon emissions. MFC can generate electricity from organic residues, such as food or water waste, as it converts biodegradable substances into simpler substances to generate bioelectricity (Koch et al., 2016; Ucar et al., 2017).

According to a study done in 2020, MFC, however, cannot support bioelectricity for a large population due to its low power density (Khoo et al., 2020), and a few factors influence the operation of MFC. The type of substrate and its concentration in the anodic chamber were identified as the factors that influenced the voltage production of MFC (Aghababaie et al., 2015; Kumar et al., 2017). In addition, solid organic waste has gained significant interest as MFC substrates due to its high organic matter content, a crucial component for these systems (Kumar et al., 2022). Previous research found that solid fruit waste generates more electricity than solid food waste (Moqsud, 2021). This finding suggests that plant waste has the potential to function as an MFC substrate for bioelectricity production.

Due to the higher concentration of lignocellulosic, which functions as bacteria's food source, plant wastes have the potential to be utilised as MFC substrates. Certain microorganisms, when fed lignocellulosic materials, can convert the complex polysaccharides (cellulose and hemicellulose) present in lignocellulosic materials into simpler carbohydrates that can be used for energy production (Chandra & Madakka, 2019). To the best of our knowledge, researchers are still investigating the optimal composition of plant waste for producing MFCs with a higher voltage. Therefore, this research employed lignocellulosic materials with various compositions as a substrate for a single-chamber MFC (SMFC).

METHODOLOGY

Construction of a Single-chamber Microbial Fuel Cell (SMFC) Without Adding Organic Compost

This study used a single-chamber MFC to generate electrical energy from electrons derived by bacteria in the anodic chamber.