POLYPYRROLE-MODIFIED SACCHAROMYCES CEREVISIAE USED IN MICROBIAL FUEL CELL

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Microbial fuel cells (MFCs) have the potential to be utilized for water purification, energy generation, and as biosensors. However, their practical applicability is severely restricted due to their low current density. This study introduces an enhanced version of Bakersýeast (S. cerevisiae) that incorporates MFC (Microbial Fuel Cell) modified with polypyrrole (pPy) in the presence of 9,10-phenanthrenequinone (PQ).

PQ functions as a redox mediator, facilitating the flow of electrons across the yeast membrane. This leads to an increased permeability of the membrane to electrical charge, while having a minor inhibitory effect on yeast growth [1]. To enhance MFC performance, yeast cells were genetically altered to incorporate a conductive polymer pPy, which was generated by leveraging the metabolic activities of the yeast cells themselves. pPy facilitates electrical charge transfer from the microbe to the electrode while also ensuring the yeast cell remains unharmed [2].

Three graphite electrodes coated with PQ, in their unmodified state, were tested. The electrodes were coated with yeast, and another set of electrodes were coated with yeast modified with pPy. Each set of electrodes was tested in PBS solution and a glucose/potassium hexacyanoferrate solution after 20 minutes of incubation. The electrodes were assessed using cyclic voltammetry. The unmodified electrode showed an oxidative peak of 165 mA in the glucose/potassium hexacyanoferrate solution. The yeast-covered electrode exhibited a significantly higher oxidative peak of 304 mA, which is 1.84 times greater than that of the unmodified electrode. The modified-yeast-covered electrode had the highest oxidative peak of 369 mA, which is 2.24 times greater than that of the unmodified electrode.

Based on the findings, it can be inferred that the current measured by graphite electrode is enhanced by 2.24 times when it is coated with PQ and pPy modified yeast. This results in greater potassium hexacyanoferrate oxidative peak currents compared to using PQ to cover the electrode. Therefore, the pPy modified yeast has a great potential to be used in microbial fuel cell for enhanced charge transfer.

[1] J. Rožėnė et al. Electrochimica Acta 373 p. 159-168 (2021)
[2] A. Kisieliute et al. Chem. Eng. 356 p. 1014–1021 (2019)