18th National and 3rd International Conference of Iranian Biophysical chemistry

هجدهمین همایش ملی و سومین همایش بین المللی بیوشیمی فیزیک ایران

25-26 Des, 2024, University of Hormozgan

۶-۵ دی ماه ۱۴۰۳، دانشگاه هرمزگان

Development of an Electrochemical Tyrosinase Biosensor Using Sulfonic Acid-Modified Magnetic Nanoparticles for Dopamine and Phenolic Compound Detection

Seyyede Fatemeh Aboutorabi[1], Hassan Faridnouri[1]*, Sadegh Rostamnia[2], Seyyed Ahmad Nabavi Amri[3]

[1.] Department of Biology, Damghan University, Damghan, Iran
[2.] Department of Chemistry, Iran University of Science and Technology (IUST), Tehran, Iran
[3.] Department of Chemistry, Damghan University, Damghan, Iran
faridnouri@du.ac.ir

Abstract

An electrochemical biosensor based on tyrosinase (Tyr) was developed for the detection of dopamine and phenolic compounds across medical, environmental, and industrial applications. The biosensor utilized sulfonic acid (SO_3H)-modified magnetic nanoparticles (MNPs) prepared via a hydrothermal synthesis method followed by in-situ surface functionalization. The MNPs enhanced the electrical conductivity and enzyme adsorption on the electrode surface, significantly improving sensor performance. A magnetic carbon paste electrode was fabricated with an optimal graphite-to-paraffin weight ratio. Subsequently, MNP suspension was deposited on the electrode surface, followed by the addition of 15 µL of 4 mg/mL Tyr solution. The biosensor was allowed to stabilize for 24 hours before undergoing electrochemical characterization. Cyclic voltammetry (CV) revealed an apparent electron transfer rate constant (k_s) of 0.008 s^{-1} and a formal potential ($E^{\circ\prime}$) of 0.21 V. Differential pulse voltammetry (DPV) demonstrated the biosensor's performance for catecholamine detection. For cafeic acid, the limit of detection (LOD) was 45.4 µM within a linear range of 1–74 µM, with a sensitivity of 1.68 $\mu A \cdot \mu M^{-1} \cdot cm^{-2}$ and a Michaelis-Menten constant (K_m) of 30 µM. For catechol, the LOD was 68 µM in a linear range of 1–107 µM, with a sensitivity of 1.8 $\mu A \cdot \mu M^{-1} \cdot cm^{-2}$ and K_m of 55.3 µM. For L-DOPA, the LOD was 50.6 µM in a linear range of 1–137 µM, with a sensitivity of 0.9 $\mu A \cdot \mu M^{-1} \cdot cm^{-2}$ and K_m of 68.92 µM. The results suggest that incorporating cross-linking agents such as glutaraldehyde to covalently stabilize the enzyme on the nanoparticles could further enhance the biosensor's kinetic and electrochemical properties, offering improved reliability and sensitivity.

Key words

Magnetic nanoparticles, sulfonic acid modification, polyphenols, L-DOPA, and carbon paste electrode