PÔSTER - RESUMO - SENSORES E BIOSSENSORES

BIOSENSOR FOR DETECTING AZOSPIRILLUM BRASILENSE GENOME MONITORED BY ELECTROCHEMICAL TECHNIQUES AND FORCE-DISTANCE CURVES

Felipe Zahrebelnei (felipe.zahrebelnei@ifpr.edu.br)

Rafael Mazer Etto (mazeretto@hotmail.com)

Carolina Weigert Galvão (carolinawgalvao@hotmail.com)

Andreia Gerniski Macedo (agmacedo@utfpr.edu.br)

Jarem Raul Garcia (jarem.garcia@gmail.com)

Christiana Andrade Pessoa (christianapessoa@hotmail.com)

Karen Wohnrath (karen.woh@gmail.com)

The United Nations has identified zero hunger and sustainable agriculture as key priorities within its Sustainable Development Goals. In this context, plant growth-promoting bacteria (PGPB) play an essential role by enhancing agricultural productivity without expanding cultivated areas or increasing agrochemical inputs, thereby supporting sustainable food production. Monitoring PGPB populations is crucial for understanding their dynamics in the field. Electrochemical biosensors represent an attractive strategy for this purpose, offering rapid, low-cost detection compatible with portable devices [1].The use of nanomaterials, particularly carbon-based materials such as graphene oxide (GO) and gold nanoparticles (AuNPs), can significantly enhance biosensor performance. AuNPs stabilized with silsesquioxane (SSQ) polymers enable the formation of stable and conductive nanocomposites [2]. Therefore, this study aimed to develop an electrochemical DNA biosensor based on a screen-printed carbon electrode (SPCE) modified with a nanocomposite composed of GO and AuNPs stabilized in a novel SSQ derivative. Initially, the AuNPs–SSQ nanocomposite was synthesized [3] and subsequently combined with a GO suspension. The resulting material was used to modify the SPCE surface, and its electrochemical behavior was evaluated by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) in the presence of the K3[Fe(CN)6]/K4[Fe(CN)6] redox probe. The modified electrode exhibited enhanced electrochemical performance compared to the bare SPCE, with increased anodic (Ipa) and cathodic (Ipc) peak currents and a decreased charge transfer resistance (Rct), indicating improved electron transfer properties. For biosensing assays, an oligonucleotide probe with a specific nitrogenous base sequence (AZOprobe) was immobilized onto the modified electrode for hybridization with the genome of Azospirillum brasilense (AZOgenome). The hybridization process was monitored by CV, EIS, and Force–Distance Curve measurements. After AZOprobe immobilization, decreases in Ipa and Ipc and an increase in Rct were observed, attributed to electrostatic repulsion between the negatively charged redox probe and the DNA layer. These effects became more pronounced after incubation with AZOgenome, confirming successful hybridization. Force–Distance analyses further supported these findings: in air, the AZOprobe-modified surface exhibited strong adhesion forces due to exposed nitrogenous bases, whereas hybridization with AZOgenome significantly reduced these interactions. Similar behavior was observed in liquid-phase, enabling in situ monitoring. An analytical calibration curve was constructed using EIS measurements at different AZOgenome concentrations. Plotting Rct variation against log[AZOgenome] yielded a linear correlation, demonstrating the biosensor’s quantitative detection capability. Overall, the nanocomposite exhibited electrocatalytic properties that enhanced electrode performance. The developed biosensor successfully detected and quantified AZOgenome hybridization through electrochemical techniques and Force–Distance analysis, highlighting its potential application in monitoring beneficial agricultural bacteria. The authors acknowledge GDEM–UEPG and INEO for financial support (FAPESP 2025/27044-5; CNPq 408449/2024-1).

[1] ZAHREBELNEI, F. et al. Talanta, v. 286, p. 127484, 2025.

[2] ZAHREBELNEI, F. et al. Chemosensors, v. 12, no. 12, p. 259, 2024.

[3] LIMA, D. et al. Colloids and Surfaces B: Biointerfaces, v. 213, p. 112355, 2022.

Palavras-chave: electrochemical biosensor; plant growth-promoting bacteria; sustainable agriculture; silsesquioxane polymers; gold nanoparticles; graphene oxide.