Graphene-based electrochemical biosensor for the determination of phenolic compounds

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Graphene is an extraordinary nanomaterial given its chemical and electrochemical properties. The use of graphene as a transducer, both as graphene oxide (GO) or electrochemically reduced graphene oxide (ERGO) forms, may provide enhanced electroactivity for biosensors. Furthermore, it is possible to take advantage of its chemical structure, i.e. it is possible to use remaining carboxylic acid groups after the electrochemical reduction as anchoring points to create covalent bonds with biomolecules. These features make possible the building of improved biosensors.

In this study, it is postulated an enzymatic biosensor from a graphene platform using its chemical properties. Biosensor uses covalent bonds formed with the EDC reaction (N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride), where EDC activate the linkage among graphene carboxylic groups and enzyme amine groups. The used enzyme is laccase, which acts as a catalyst in the oxidation of phenolic compounds.

Phenols are high priority pollutant compounds, present in biological degradation process and also in industrial wastes. Presence of high concentrations of phenols in food can indicate lack of freshness. Moreover, the extreme toxicities of some of these phenolic compounds make their determination of major concern in environmental analysis.

There are various ways to quantify phenolic compounds. This communication describes an electrochemical biosensor method, which can be an alternative in front of spectrophotometric reactions or heavy instruments as HPLC or HPLC-MS. Biosensor-based methods provide some advantages such as easy and fast operation, low maintenance costs and high sensitivity.

Thus, the goal of this study is to develop biosensors for determination of phenols using laccase enzyme on electrode platforms of ERGO (Enzyme-ERGO-GEC). As it can be observed in the Figure 1, where catechol calibration curves using different platforms (Enzyme-ERGO-GEC, ERGO-GEC and GEC) are compared, it is possible to see that graphene enhances sensitivity in front of a bare electrode and also that the signal is improved with the use of the enzyme.

Figures

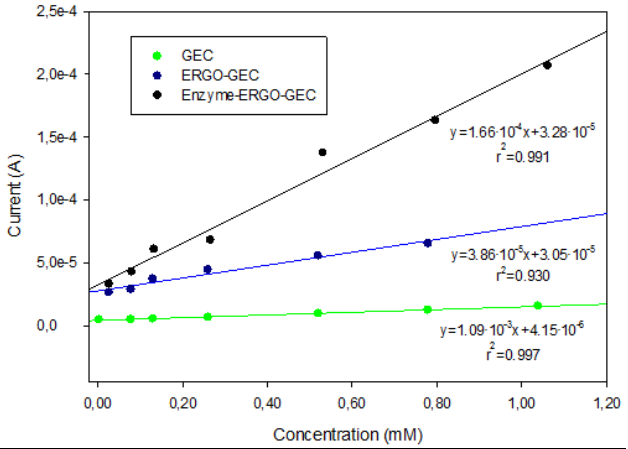

Figure 1: Calibration curve for catechol (reduction peak) in PBS 0.5M at pH=7.4 and 10mV·s^{-1} scan rate.

References

[1] A. Gutés, F. Céspedes, et al., Biosensors & Bioelectronics, 20 (2005) 1668

[2] A. Gutés, A. B. Ibañez, et al., Anal. Bioanal. Chem., 382 (2005) 471