A new biomimetic sensor for detecting carnitine, a potential biomarker in ovarian cancer

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Introduction

Carnitine (CRT) displays an important role in cellular metabolism and energy production. It has actions that include the metabolites associated with glycolysis and β-oxidation of fatty acids. The change of its levels in biological fluids has been associated to the presence of ovarian cancer, making CRT a potential biomarker of the disease. Sensitive CRT determination (in low levels) becomes therefore important, for which a low cost and sensitive device would be appreciated. A biomimetic polymer is proposed herein for this purpose, produced by bulk electropolymerization around a hydrophobic paper substrate that was made conductive by casting a graphite-based ink.

Materials and methods

The electrode substrate was prepared by modifying cellulose paper, first with solid wax and after with carbon ink. The hydrophobicity of the paper was tested by contact angle and the ink properties evaluated by Thermogravimetry, Raman Spectroscopy and FTIR.

Two different biomimetic materials were electropolymerized over the carbon conductive support: 3,4-ethylenedioxythiophene (EDOT) and dodecilbenzenesulfonic acid sodium salt (NaDBS). The polymeric film depositions were obtained by chronoamperometry at 0.9 V vs Ag/AgCl during 240 s. The obtained sensors were characterized by Electrochemical Impedance Spectroscopy (EIS), in 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES) buffer at pH 7.0.

Results

The EDOT and NaDBS-based biomimetic sensors were calibrated by EIS using CRT standard solutions. The results showed linear responses over a wide concentration range, with average slopes of 303 and 450 Ω×L/mol, and detection limits of $1x10^{-9}$ and $1x10^{-8}$ mol/L, respectively. Both sensors exhibited good selectivity for CRT in diluted urine samples. Their application to the analysis of spiked urine samples revealed relative errors < 16% and the possibility of reusing the sensor after each calibration. In addition, the conductive ink proved good thermal stability and reusability. Overall, the biomimetic sensors described herein seem a successful approach for the determination of CRT in urine.

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