Electrochemical and piezoelectric study of a multifunctional protein: Galectin-1

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Introduction

Galectins are a family of eukaryotic carbohydrate binding proteins (lectins) that have been identified in phylogenetically distinct species ranging from nematodes to mammals. It recognizes β-galactoside glycoconjugates. Galectins are multifunctional proteins involved in many cellular processes and act both intracellularly and extracellularly within most tissues[1]. These processes can be cell differentiation, tissue development, pre-mRNA splicing, immunoregulation and progression of tumors.[2] From the galectin family, galectin-1 (gal-1) and galectin-3 (gal-3) have been most intensively studied in human cancers.[1] Several classes of biomolecules, such as proteins, have been widely studied for their use in biosensors. The term “biosensor” refers to analytical devices that are based on biological components and are capable of sensing biologically-relevant analytes with either electrical or optical readout.[3] Especially gold has been widely used in techniques that involve recognition of molecules or ions, catalysis, and electron transfer phenomena that require stable and highly reproducible surfaces.[4] Due to importance of this biomolecule, electrochemical and piezoelectric studies were performed to investigate its redox and affinity properties, in order to propose their use in the construction of a biosensor.

Results and Discussion

Cyclic Voltammetry were performed in a potentiostat BAS CV-27 model. We used an electrochemical cell with a volume of about 5 mL. The working electrodes used were gold disk with geometric area of 0,0314 cm^2 and ITO (Indium Thin Oxide); reference electrode was Ag / AgCl (saturated KCl) and auxiliary electrode was platinum wire.

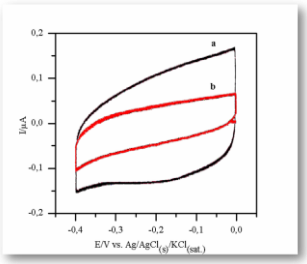

Figure1. : Cyclic voltammograms for a gold electrode in a PBS solution, pH 7,4 at 50 mV s^{-1} (**a**) clean electrode (**b**) modified electrode with gal-1.

To carry out the measures in the Electrochemical Quartz Crystal Microbalance (EQCM), Stanford 200 model, it was used gold working electrodes with 25 mm diameter, deposited on quartz crystals with AT cut (5 MHz).

Figure 1 shows cyclic voltammograms for a gold electrode in PBS solution. Comparing the curve (a) and (b), it was observed that the electrode surface was actually modified by Au-S bond, which is quite stable. It was found that does not occur Faradaic process in the potential range studied. However there was a significant reduction of the capacitive current after modification with gal-1, indicating, as expected, a layer of low dielectric constant.

In order to investigate the behavior of the sulfur present in the free cysteine residues of the protein structure, the gold electrode modified with gal-1 was subjected to a potential variation between +0,0 V and -1,0 V to promote the reduction of Au-S bond formed on its surface. Simultaneously to cyclic voltammetry, measurements of frequency variation were performed by EQCM. The results were quite consistent because the first cathodic scan showed a peak of sulfur reduction in -0,6 V which does not appear in the second scan. An increase of quartz crystal vibration frequency, caused by the electrode mass loss was observed, proving the protein desorption to the surface of the gold electrode.

Conclusions

The results showed that gal-1 has chemisorption to the surface of the gold working electrode. This specific interaction was confirmed with reduction of the Au-S bond and the test with the ITO electrode. This result has a great importance to study the role of sulfur in the interaction between galectin and galactose or other sugars.

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