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DTO modified glassy carbon electrode at non-aqueous media: investigation of electrochemical behaviors of Que on the electrode surface

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Electrochemical and spectroelectrochemical measurements leading to the determination of kinetic parameters for antioxidants (e.g., redox potential, number of electrons transferred, electrode reaction rate constant, *etc.*), are very relevant, not only for evaluating the antioxidative abilities of flavonoids [1], but also for understanding their reaction mechanisms. The half-wave potential (E1/2) is a useful parameter for supplying information on the scavenging activity of the flavonoids. This has been rationalized on the basis that both electrochemical oxidation and hydrogen-donating free radical scavenging involve the breaking of the same phenolic bond between oxygen and hydrogen, producing the phenoxy radical and hydrogen, in an electron and proton transfer reaction. Thus a flavonoid which has a low value of $E_{1/2}$ is a good scavenger [2, 3]. Quercetin (Que) is one of the most abundant plant-derived polyphenols and is widely consumed with a human diet [4]. Most flavonoid molecules have the same structure as Que, except that they have a specific sugar molecule in place of one of Que hydroxyl groups on the C ring, which dramatically changes the activity of the molecule.

Electrochemical oxidation of Que, as an important biological molecule, has been studied in non-aqueous media using cyclic voltammetry, electrochemical impedance spectroscopy and scanning electron microscopy. To investigate the electrochemical properties of Que, an important flavonoid derivative, on a different surface, a new glassy carbon electrode has been developed using dithiooxamide (DTO) as modifier in non-aqueous media. The surface modification of glassy carbon electrode (GCE) has been performed within the 0.0 mV and +800 mV potential range with 20 cycles using 1 mM DTO solution in acetonitrile. However, the modification of Que to both bare glassy carbon and DTO modified glassy carbon electrode surface was carried out in a wide +300 mV and +2800 mV potential range with 10 cycles. Following the modification process, cyclic voltammetry has been used for the surface characterization in aqueous and non-aqueous media whereas electrochemical impedance spectroscopy has been used in aqueous media. Scanning electron microscopy has also been used to support the surface analysis. The obtained data from the characterization and modification studies of DTO modified and Que grafted glassy carbon electrode showed that the developed electrode can be used for the quantitative determination of Que and antioxidant capacity determination as a chemical sensor electrode. In this study, the electrochemical mechanism of oxidation of Que was investigated, for a wide range of non-aqueous solution conditions onto the DTO modified GCE surface, using CV, EIS and SEM techniques. Information on the mechanism of Que oxidation obtained from results at studies may play a crucial role in understanding its antioxidant activity. This study precedes studies initiated to find out the ability of Que determination in natural samples. The DTO/GCE electrode was used for the first time in non-aqueous media. This modified electrode was found to be very sensitive to Que molecules and could be used for the determination of Que in the future studies. The next step in our study is to use this modified GCE sensor electrode for the quantitative determination of Que using voltammetric techniques, and with this in mind, different plants are going to be collected and then varying antioxidant derivatives are going to be extracted from these plants. From the extract Que is going to be quantified by different voltammetric, spectroscopic and microscopic techniques (cyclic voltammetry, differential pulse voltammetry, square wave voltammetry, X-ray photoelectron spectroscopy, raman spectroscopy, ellipsometry, scanning electron microscopy, *etc.*) in these natural samples.

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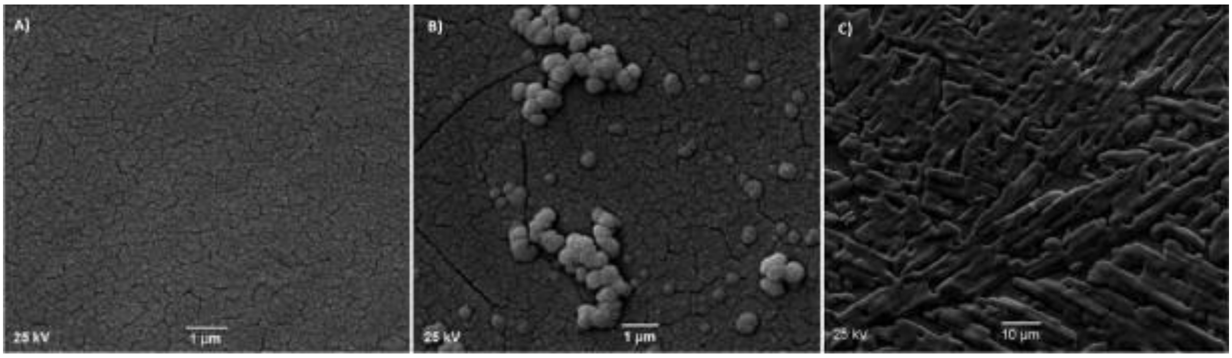

Figure 1. SEM images of (A) bare GCE, (B) DTO/GCE and (C) DTO/GCE-Que