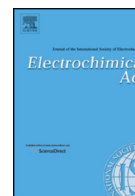


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Electrooxidation of morin on glassy carbon electrode modified by carboxylated single-walled carbon nanotubes and surfactants



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ABSTRACT

Voltammetric characteristics of morin on glassy carbon electrode (GCE) modified by carboxylated single-walled carbon nanotubes (SWNT-COOH) and surfactants in phosphate buffer have been found. Cationic cetylpyridium bromide (CPB), nonionic Triton X100 and anionic sodium dodecylsulfate surfactants under different concentrations have been tested as modifier of SWNT-COOH/GCE. The form of CVs and oxidation potentials are not changed significantly in the presence of all type surfactants on the electrode surface that confirms negligible influence of surfactant on electron transfer rate. Morin oxidation currents are increased on surfactant-modified electrodes. The best characteristics are observed on CPB (1 μM)/SWNT-COOH/GCE when 1.8-fold increase of oxidation currents has been observed in comparison with SWNT-COOH/GCE. Mechanism of morin oxidation on CPB/SWNT-COOH/GCE is suggested on the basis of relationship between oxidation potential and pH of supporting electrolyte. Electrooxidation is adsorption-controlled irreversible two-step process with participation of one electron and one proton on each step. The linear dynamic ranges of morin determination under conditions of differential pulse voltammetry are 0.1–100 and 100–750 μM with the limits of detection and quantification 28.9 and 96.0 nM of morin, respectively. The developed approach applied for morin quantification in mulberry leaves using preliminary extraction with ethanol.

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1. Introduction

Morin (3,2',4',5,7-pentahydroxyflavone) is one of the natural flavonoids that is presented in plants, fruits, flowers and plant derived materials [1,2]. It belongs to flavonol subclass and consists of two aromatic rings (A and B in Scheme 1) which are linked by an oxygen-containing heterocycle (ring C).

Morin possesses various biological and biochemical effects including anti-inflammatory, antineoplastic, cardioprotective activities [3–5] and chemopreventive effect against oral carcinogenesis *in vitro* and *in vivo* [6]. Moreover, it shows antioxidant properties that realized via different mechanisms: scavenging of reactive oxygen species, inhibition of the enzymes participating in reactive oxygen species production, chelation of low valent metal ions such as Fe^{2+} or Cu^{2+} and regeneration of membrane bound antioxidants such as α -tocopherol [7–10].

Antioxidant properties of morin are caused by ability to electron transfer that allows to use electrochemical methods for their investigation. Electrochemical measurements leading to the determination of physicochemical parameters for antioxidants (e.g. redox potential, number of electrons transferred, electrode reaction rate constant, etc), are relevant also for understanding their reaction mechanisms. On the other hand, the electroanalytical techniques have advantages over other analytical methods, such as rapid response, higher sensitivity and low detection limits, as well as the possibility to improve the selectivity by using suitable electrode conditions.

Therefore, a number of electrochemical methods using bare glassy carbon (GCE) [11,12], platinum [13,14] and hanging mercury dropping [15] electrodes as well as various modified electrodes based on graphene oxide/silver nanoparticles [16], poly(tetrafluoroethylene)-deoxyribonucleate acid film modified GCE [17], polyvinylpyrrolidone-doped carbon paste electrode [18], multi-walled carbon nanotubes-paraffin oil paste electrode [19] and nujol-graphite or diphenylether-graphite paste electrodes [20] have been developed for morin determination. Application of chemically modified electrodes increases the sensitivity and selectivity of quantification. Different types

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