The selective electrochemical detection of dopamine in the presence of ascorbic acid and uric acid using electro-polymerised-β-cyclodextrin incorporated f-MWCNTs/polyaniline modified glassy carbon electrode

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ABSTRACT

The present work describes a differential pulse voltammetric determination of dopamine (DA) using a glassy carbon electrode (GCE) modified with poly-beta-cyclodextrin incorporated with oxidised (−OH) multi-walled carbon nanotubes (poly-β-CD(f-MWCNTs)) and anion-doped polyaniline (PANI) composite. The poly-β-CD(f-MWCNTs)/PANI composite modified electrode was prepared by electropolymerisation of β-CD(f-MWCNTs) on anion-doped polyaniline by scanning repetitively in the phosphate buffer solution (pH7) from −2.0 to 2.5V. The as-prepared poly-β-CD(f-MWCNTs)/PANI composite was characterized by scanning electron microscopy, transmission electron microscopy, electrochemical impedance spectroscopy and Fourier transform infrared spectroscopy. The composite presented excellent synergistic effect and shows an enhanced catalytic activity than electrodes modified with poly-β-CD and PANI. In comparison to the CV results of bare GC and modified GCE, the large electrochemical potential difference has achieved via the used of the poly-β-CD(f-MWCNTs)/PANI composite to distinguish the DA from AA and UA with peak-to-peak separations recorded at 244mV (AA-DA) and 135mV (DA-UA). Under optimum conditions, differential pulse voltammetric was used to determine the DA, and the voltammetric response of DA was linear over the concentration ranging from 2μmolL−1 to 24μmolL−1 with low detection limit (LOD) of 0.0164μmolL−1 (S/N=3) and high sensitivity of 26.79μAμM−1 cm−2. The poly-β-CD(f-MWCNTs)/PANI composite modified electrode exhibits high selectivity in the presence range of potentially interfering uric acid and ascorbic acid even in high concentration. As a proof of concept, the practicality of the sensors was examined in human urine samples, and shows acceptable practicality for the determination of DA.

1. Introduction

Dopamine (DA) is an important neurotransmitter from catecholamine family present in central nervous system, peripheral nervous system and hormonal. It coordinates and controls our cognition, emotion, movement, and hormone secretion. Hence, extensive concern have paid in the research community for correct determinations of DA due to it relation to various popular disease such as Parkinson’s, chronic fatigue syndrome (CFS) and other neurological disorders [1–4].

In fact, DA was found in human biological system with concentration vary from 10−7 to 10−3 mol L−1 [5] and often coexists with high concentration of ascorbic acid (AA) and uric acid (UA) in biological matrices [6]. The conventional electrodes like Au, Pt or glassy carbon electrodes are no longer the right candidate as the oxidation peaks of DA, AA and UA are too close and normally overlapped, causing accurate detection of DA become impractical [7]. To date, various modifiers have been used to enhance the selectivity and sensitivity of electrode for the determination of DA, such as nickel oxide nanoparticle conjugated with tyrosinase enzyme [8], nickel and copper oxide decorated graphene [9], carbon-based material incorporated with bimetalllic [10], poly(3,4-ethylenedioxythiophene) (PEDOT) conducting polymer [11] and single walled carbon nanotube [12] and so on. Admitting most of these systems devoted to the determination of dopamine, these modified materials had either drawback in term of sensitivity or the material synthesis was complicated and expensive. Therefore, it is highly motivated to develop a sensor which is not only sensitive and selective but facile, practicable and economical in biological, pharmacological and toxicological fields.