Colloids and Surfaces B: Biointerfaces 111 (2013) 270–276

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces B: Biointerfaces

journal homepage: www.elsevier.com/locate/colsurfb

Highly selective differential pulse voltammetric determination of phenazopyridine using $MgCr_2O_4$ nanoparticles decorated MWCNTs-modified glassy carbon electrode

Ali A. Ensafi[a,*], B. Arashpour[a], B. Rezaei[a], Ali R. Allafchian[b]

[a] Department of Chemistry, Isfahan University of Technology, Isfahan, 84156-83111, Iran
[b] Nanotechnology and Advanced Materials Institute, Isfahan University of Technology, Isfahan, 84156-83111, Iran

ARTICLE INFO

Article history:
Received 18 February 2013
Received in revised form 2 June 2013
Accepted 7 June 2013
Available online xxx

Keywords:
$MgCr_2O_4$ nanoparticles
Modified multiwall carbon nanotubes
Phenazopyridine
Voltammetry

ABSTRACT

A selective modified glassy carbon electrode based on multiwall carbon nanotubes decorated with $MgCr_2O_4$ nanoparticles was fabricated and used for the determination of phenazopyridine using differential pulse voltammetry. The electrochemical response of the modified electrode toward phenazopyridine was characterized by different electrochemical methods including differential pulse voltammetry (DPV), cyclic voltammetry (CV), and impedance spectroscopy. The prepared electrode showed an efficient synergic effect on the oxidation of phenazopyridine at pH 6.0. The oxidation peak current was proportional to the concentration of phenazopyridine from 0.05 to 7.5 μmol L^{-1}. The detection limit was 0.025 μmol L^{-1}. The applicability of the method was confirmed with satisfactory results obtained through the assay of phenazopyridine in human plasma, urine samples, and pharmaceuticals.

1. Introduction

Phenazopyridine is a type of azo dye and a very important organic compound for its optical and electrochemical properties as well as its medicinal relevance [1,2]. Other azo dyes, formerly used in textiles, printing, and plastic manufacturing, have been implicated as carcinogenic agents that can cause bladder cancer [3]. Evidence from animal models suggests that it is potentially carcinogenic [4], while phenazopyridine has never been shown to cause cancer in humans. Phenazopyridine is prescribed for its local analgesic effects on the urinary tract [5]. Moreover, it is sometimes used in conjunction with an antibiotic or other anti-infective medication at the inception of treatment to help provide immediate symptomatic relief [6–8]. Phenazopyridine frequently causes a distinct color change in the urine, typically to a dark orange to reddish color [9]. This effect is common and harmless, and indeed a key indicator of the presence of the drug in the body. Less frequently, it can cause a pigment change in the skin or eyes to a noticeable yellowish color. Other such side effects include fever, confusion, shortness of breath, skin rash, and swelling of the face, fingers, feet, or legs. Long-term use may cause yellowing of nails [10]. It is, therefore, necessary to develop a rapid and sensitive method with simple sample preparation and determination steps for phenazopyridine analysis in biological fluids.

Several analytical techniques are available for the assay of phenazopyridine in biological fluids. The methods commonly used for the determination of phenazopyridine include amperometry [11], gravimetry [12], polarography [13], voltammetry [14], UV spectrophotometry [15], and potentiometric sensor [16]. High performance liquid chromatography has been used with UV detection to determine phenazopyridine in a compound dosage form [17–19]. Some researchers have used liquid chromatography–mass spectroscopy (LC–MS) [20] and gas chromatography–mass spectrometry (GC–MS) [21,22] for the determination of this drug. The facile and intense voltammetric response due to the reduction of —N=N— into —NH—NH— and $—NH_2$ has provided a great deal of information about their optical, structural, electrochemical, and thermodynamic properties [1]. In recent years, substantial efforts have been devoted to the field of electrochemical methods based on modified electrodes, for their enhanced selectivity and sensitivity [23].

Carbon nanotubes are molecular-scale tubes with high electrical conductivity, high chemical stability, and very high tensile strength and modulus [24]. There has been much interest in diverse applications of carbon nanotubes such as in scanning probes [25,26], electron field emission sources [27], actuators [28], nanoelectronic devices [29], batteries [30], potential hydrogen storage material [31], and chemical sensors [32]. MNPs modified electrodes have also received serious consideration due to their high surface

* Corresponding author. Tel.: +98 311 3913269; fax: +98 311 3912350.
E-mail addresses: Ensafi@cc.iut.ac.ir, aaensafi@gmail.com (A.A. Ensafi).

0927-7765/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.colsurfb.2013.06.017