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ORIGINAL ARTICLE

Validated electroanalytical determination of flavoxate hydrochloride and tolterodine tartrate drugs in bulk, dosage forms and urine using modified carbon paste electrodes

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KEYWORDS

Flavoxate HCl;
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Carbon paste electrode;
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Polyethylene glycol

Abstract Simple, precise, inexpensive and sensitive voltammetric methods have been developed for the determination of flavoxate HCl (FLXHC) and tolterodine tartrate (TOLT) in the bulk, pharmaceutical dosage forms and human urine using ferrocene modified carbon paste electrode (FMCPE) for FLXHC and polyethylene glycol modified carbon paste electrode (PEGMCPE) for TOLT. The electrochemical behavior of FLXHC and TOLT showed irreversible diffusion-controlled oxidation processes in Britton-Robinson (BR) buffer over the entire pH range from 2 to 6 for FLXHC and from 2 to 9 for TOLT. The peak current was evaluated as a function of some variables such as pH, scan rate and number of cycles of ferrocenium solution and PEG concentration. The linear ranges were 7.8×10^{-6}–1.2×10^{-4} mol L^{-1} and 7.6×10^{-7}–2.2×10^{-4} mol L^{-1} for FLXHC and TOLT, respectively. The limits of detection and quantification were 5.9×10^{-7} and 2×10^{-6} for FLXHC and 8.6×10^{-8} mol L^{-1} and 2.9×10^{-7} mol L^{-1} for TOLT. The percentage recoveries were found in the following ranges: 99.2–101.1% and 99.7–101.1% for FLXHC and TOLT, respectively.

1. Introduction

Flavoxate HCl (FLXHC) is described as a smooth muscle relaxant but it also has antimuscarinic effects. It is a tertiary amine and is used for the symptomatic relief of pain, urinary frequency and incontinence associated with inflammatory disorders of the urinary tract (Sweetman, 2009).

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Tolterodine tartrate (TOLT) is a muscarinic receptor antagonist indicated for the treatment of overactive bladder with symptoms of urge urinary incontinence, urgency and frequency. TOLT was the first drug to be developed specifically for the treatment of overactive bladder (Malhotra et al., 2007).

Literature survey reveals that chromatographic methods for FLXHC (El-Gindy et al., 2008; Attimarad, 2010; Attimarad et al., 2012; El-Shaheny et al., 2014; Yunoos et al., 2014; Rathod et al., 2015; Attia et al., 2016b) and TOLT (Krishna et al., 2009; Rao et al., 2010; Ramathilagam et al., 2012; Shetty and Shah, 2011a; Mhamunkar et al., 2012; Yanamandra et al., 2012; Kumar et al., 2013; Parveen et al., 2014; Attia et al., 2016b), spectrophotometric methods for FLXHC (Attimarad, 2011, 2012) and TOLT (Shetty and Shah, 2011b; Vanilatha et al., 2011; Fraihat and Khatib, 2013), potentiometric methods for the determination of FLXHC (Rizk and Abdel-Haleem, 2010; Ismail, 2016) and TOLT (Sakr and El Nashar, 2012), spectrofluorimetric method for TOLT (Nassar et al., 2013) and electrochemical voltammetric methods for the determination of FLXHC at mercury electrode (Ghoneim et al., 2007) and TOLT at glassy carbon electrode (Kul, 2014) and boron doped diamond electrode (Macikova et al., 2013) were reported for the determination of these drugs in bulk, dosage forms and biological fluids.

Electrochemical methods are sensitive, accurate and low-cost techniques used for determination and monitoring electro-active species in industrial, environmental analysis, biological and pharmaceutical analysis (Beitollahi et al., 2008a,b, 2012; Beitollahi and Sheikhshoaie, 2011a,b,c; Molaakbari et al., 2014; Beitollahi and Mostafavi, 2014; El-Ries et al., 2008; Rizk et al., 2015; Elshal et al., 2013; Elshal and Attia, 2013; Attia and Saber, 2011; Attia, 2010; Attia et al., 2011, 2014, 2015, 2016a; Tasdemir, 2016; Raj et al., 2016; Filik et al., 2016).

There is a need to determine drugs at high sensitivity than the reported methods; therefore, the aim of work was the development of rapid, economical, simple, precise and sensitive voltammetric method for the determination of FLXHC and TOLT at modified carbon paste electrodes in bulk, dosage forms and urine using cyclic voltammetry (CV) and differential pulse voltammetry (DPV) techniques showing very low detection limits.

2. Experimental

2.1. Apparatus

All voltammetric measurements were performed using AEW2 electrochemistry workstation with ECprog3 electrochemistry software, manufactured by Sycopel Scientific Limited (Tyne & Wear, UK). Glass cell with the three electrodes was connected to the electrochemical workstation through a C-3-stand. A platinum wire was employed as auxiliary electrode. All the cell potentials were measured with respect to Ag/AgCl (3 mol L^{-1} NaCl) reference electrode. All electrodes and the C3 stand were obtained from BASi (Indiana, USA). Solutions were degassed using pure nitrogen prior and throughout the

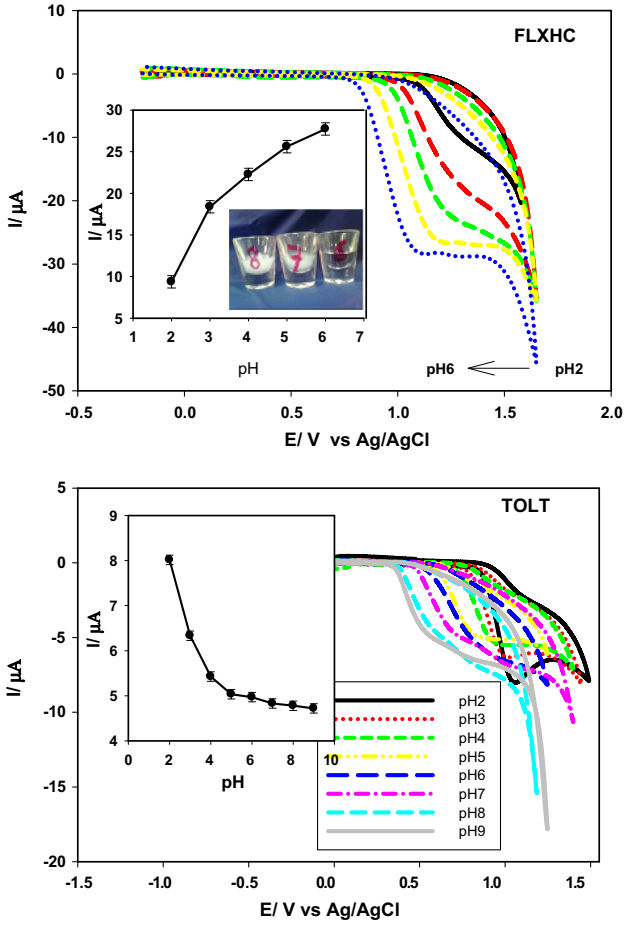

Figure 1 Cyclic voltammograms of the effect of solution pH on the oxidation of FLXHC and TOLT (1×10^{-3} mol L^{-1}) at CPE using BR buffers at scan rate of 100 mV s^{-1}. The inset: plot of anodic peak currents as a function of pH for FLXHC and TOLT at CPE.

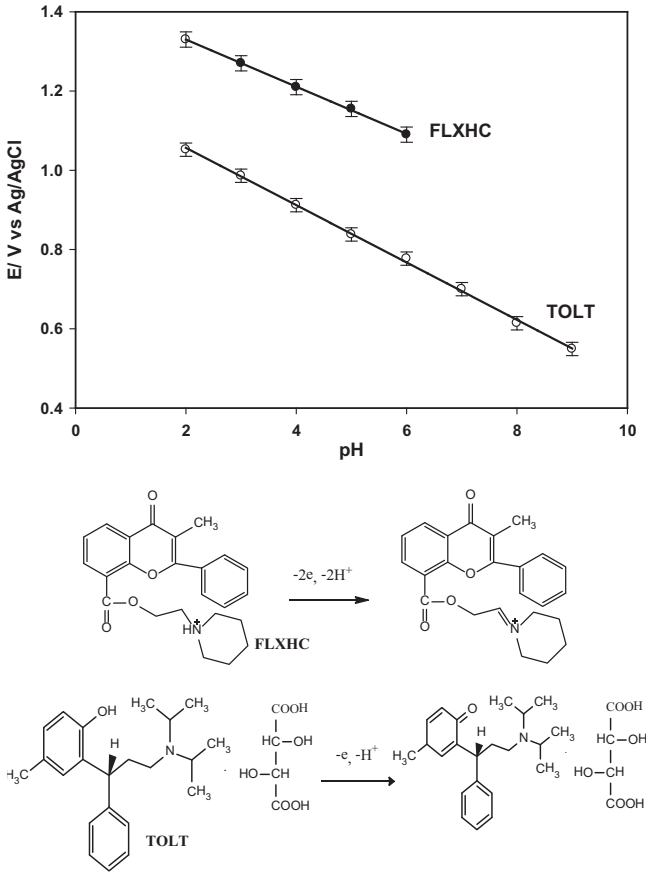

Figure 2 Plot of peak potentials as a function of pH for FLXHC and TOLT at CPE. The oxidation mechanism of FLXHC and TOLT.