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Electrochemical quantitative determination of sertraline in pharmaceutical formulation using a gold electrode in bicarbonate solution

Elektrohemijsko kvantitativno određivanje sertralina u farmaceutskim proizvodima na elektrod iod zlata u bikarbonatnom elektrolitu

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Abstract

The electrochemical characterization of sertraline standard at gold electrode was at first performed by cyclic voltammetry measurements (CV) in pH 8.4 bicarbonate buffer. Then Au electrode was evaluated for the quantitative determination of sertraline using square wave voltammetry (SWV). Namely, (2-hydroxypropyl)-β-cyclodextrin (HPβCD) sertraline inclusion complexe was employed to enhance the electrode sensitivity of the drug determination. Using the proposed SWV technique, the anodic current peak of sertraline oxidation was linear within a concentration range of 0.1–0.5 μM with a limit of detection (LOD) of 2.0 × 10^{-8} M and a limit of quantification (LOQ) of 6.7 × 10^{-8} M. In the case of inclusion complex of the sertraline with HPβCD, a good linearity range of 0.1–0.9 μM was obtained with a LOD of 2.6 × 10^{-8} M and a LOQ of 8.8 × 10^{-8} μM. Comparing the regression equations, it can be concluded that the sensitivity in the presence of inclusion complex can be up to 5 times higher. The applicability of the developed method was confirmed by the analysis of this drug in pharmaceutical formulation.

Keywords: *sertraline; gold electrode; bicarbonate electrolyte; square wave voltammetry; inclusion complex (HPβCD)*

Izvod

Elektrohemijska karakterizacija standarda sertralina je urađena cikličnom voltametrijom(CV) u pH 8.4 bicarbonatnom puferu. Elektroda od zlata je zatim testirana za kvantitativno određivanje sertralina koristeći voltametriju sa pravougaonim impulsima (SWV). Inkluzioni kompleks (2-hydroxypropyl)-β-cyclodextrin (HPβCD) sertralina je testiran u cilju poboljšanja osetljivosti electrode za kvantitativno određivanje leka.

SWV tehnikom je pokazano da je anodni strujni vrh oksidacije sertralina linearan u opsegu koncentracija 0.1–0.5 μM uz granicu detekcije (LOD) od 2.0 × 10^{-8} M i granicu kvantifikacije (LOQ) od 6.7 × 10^{-8} M. Inkluzioni kompleks sertralina sa HPβCD je ispoljio linearnost u opsegu koncentracija od 0.1–0.9 μM uz LOD of 2.6 × 10^{-8} M i LOQ od 8.8 × 10^{-8} μM. Analizom eksperimentalnih podataka može se zaključiti da je osetljivost electrode od zlata za određivanje sertraline porasla više od pet puta kada je lek vezan u inkluzioni kompleks. Primenljivost razvijene metode je potvrđena uspešnim određivanjem leka u farmaceutskim oblicima.

Ključne reči: *sertralin; elektroda od zlata; bicarbonatni electrolit; voltametrija sa pravougaonim impulsima; incluzioni compleks (HPβCD)*

Introduction

Sertraline hydrochloride in pharmaceutical formulation, sold under the brand name (Sidata, Zoloft, Lustral), is an antidepressant in the class of selective serotonin-reuptake inhibitors (Fig. 1). Serotonin is a neurotransmitter and is considered a happiness hormone. Numerous serotoninreuptake inhibitors are efective and used in the treatment of depression, including sertraline. Sertraline is primarily used to treat clinical depression in adult patients, as well as obsession, panic disorder, and social phobia in adults and children. It is used orally and therapeutic doses of sertraline are 5–200 mg day−1 for four weeks, thus providing 80–90% inhibition of the serotonin transporter in the striatum [1–3]. There is an increasing demand for rapid tests for the determination of trace concentrations of sertraline. In this context, diferent electrochemical methods showed a particular potential for practical applications in biomedical analyses. Among diverse cyclodextrins, βCD has shown a signifcant ability in drug-sensing applications [4-6]. The aim of this work is to develop an electrochemical method using a gold electrode for quantitative determination of sertraline as standard and in pharmaceutical formulations. The method is based on the electrochemical oxidation of sertraline as the standard and its inclusion complexes (HPβCD) in a pH 8.4 bicarbonate bufer using SWV. The biologically relevant range of sertraline concentrations was examined.

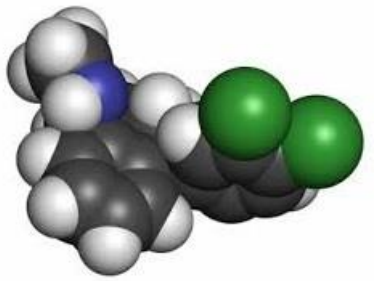

Figure 1. *The structure of sertraline hydrochloride*

Results and discussion

Figure 2 presents CVs for the oxidation of sertraline and its inclusion complexes with HPβCD as well as the voltammogram of the Au electrode in the blank solution for the sake of comparison. The electrochemical behavior of Au was described by taking into account adsorption processes such as chemisorption of OH^- which occurred in the potential region of – 0.1 to + 0.3 V vs. SCE followed by the oxide formation at more positive potentials [7]. The onset potential for the oxidation of sertraline and its inclusion complex with HPβCD was correlated with formation of AuOH species. Also in the region of the AuOH layer, formation higher reaction currents were obtained with inclusion complexes of sertraline indicating the improvement of sertraline electrooxidation ability in the presence of HPβCD. The similar improvement of the oxidation abilities we reported for inclusion complexes of nifedipine and amlodipine also at Au electrode [8] as well as for arylazo pyridone dyes [9]. It seems that the formation of the inclusion complex of the sertraline with HPβCD leads to an easier deprotonation during electrochemical oxidation. At more positive potentials (E > 450 mV) anodic currents for the sertraline and its inclusion complex with HPβCD oxidation decrease in regards to the Au electrode in blank solution. It shows their inhibiting effect on the Au oxide formation obviously attributed to the presence of sertraline and diminished during complexation with HPβCD. The peak of oxide reduction also decreases in comparison to the oxide reduction of the Au electrode in a blank solution.

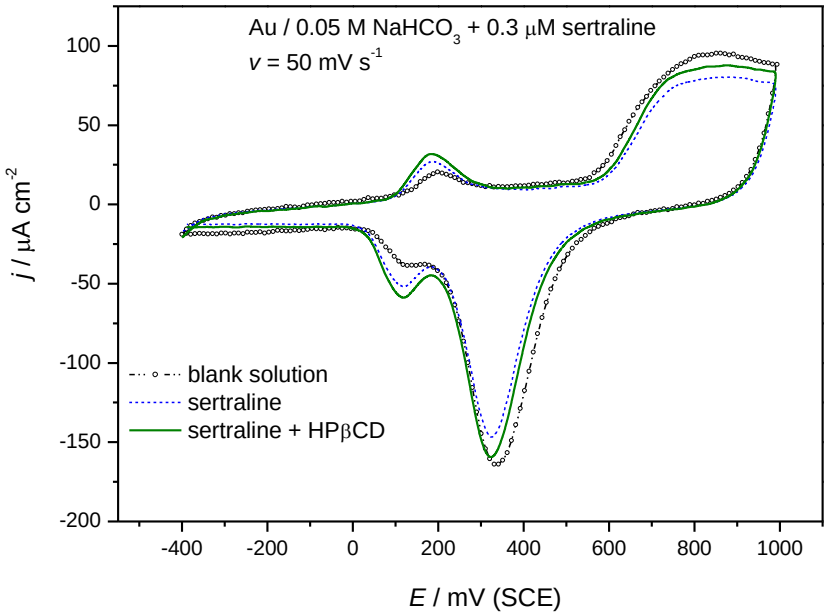

Figure 2. *CVs of Au electrode with 0.3 μM sertraline (dash line), inclusion complex of sertraline (full line) and in blank solution (dot line) in 0.05 M $NaHCO_3$. Scan rate 50 mV s^{-1}*

For quantitative determination of sertraline the SWV technique was employed. Fig. 3a showed SWV curves of sertraline presented with one peak at ~ 100 mV. For sertraline concentrations higher than 0.5 μM reaction currents decline due to the surface saturation with reaction species. The inclusion complex of sertraline with HPβCD depicts higher reaction currents in SWV measurements (Fig. 3b), as it was presented in the potentiodynamic measurements. As was observed by CV, the improvement of the oxidation ability regarding inclusion complexes we reported and for SWV determination of amlodipine [8] and arylazo pyridone dyes [9]. Also the peak potential was shifted towards more positive potentials for ~ 50 mV in the presence of the inclusion complex while the range of investigated concentrations was wider.

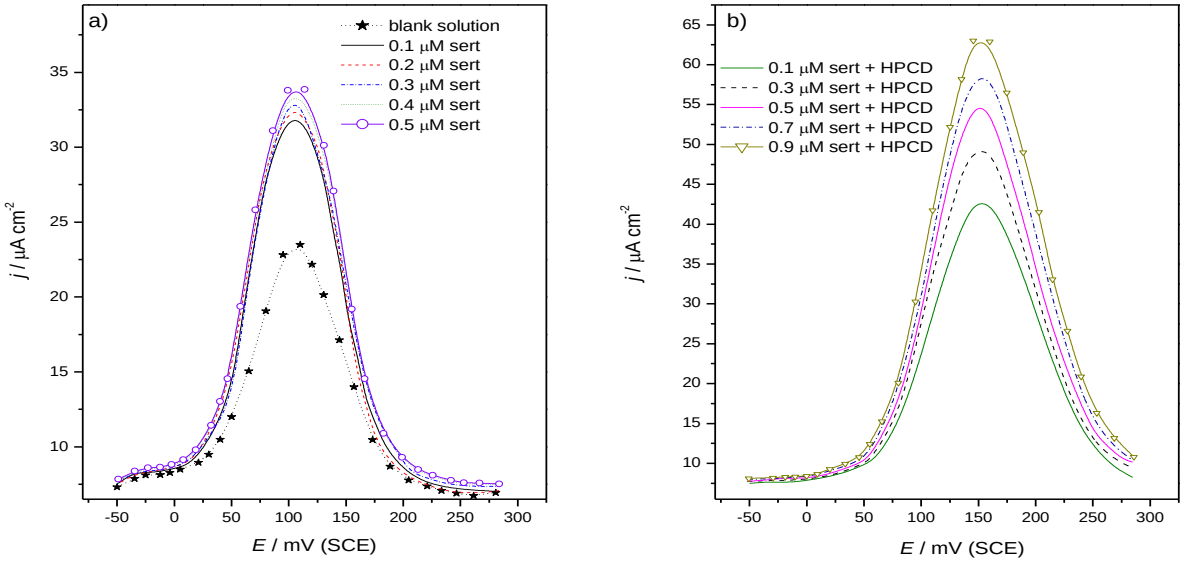

Figure 3. *Sertraline (a) and its inclusion complex with HPβCD (b) determined by SWV at Au (the concentrations added in electrolyte are presented in legend). Step size 5 mV, pulse size 25 mV and scan rate 10 mV s^{-1}, accumulation time 30 s, at the potential (– 50 mV)*

In Fig 4 it is presented the determination of the sertraline standard and its unknown concentrationsin Sidata tablets and when bonded in inclusion complex with HPβCD. All SWV determined sertraline concentrations were confirmed by HPLC–UV indicating that there is statistically no significant difference between the electrochemical and the HPLC method. [10].

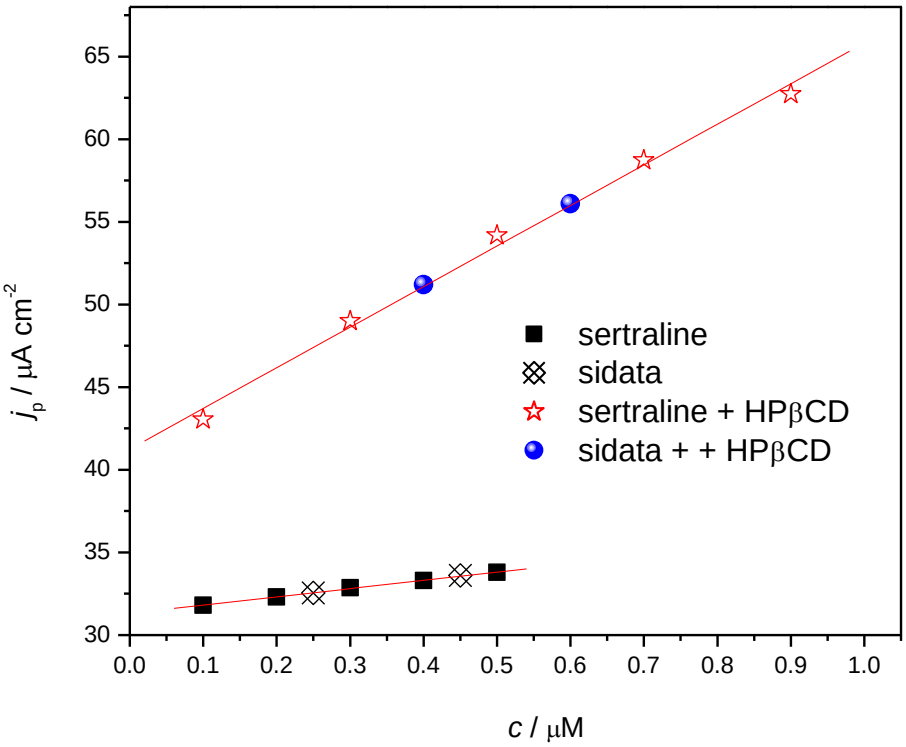

Figure 4. *Dependence of j_p from c (data collected from Fig. 2a) for the sertraline standard and its unknown concentrations in Sidata tablets (a); and (data collected from Fig. 2b), for the inclusion complex of the sertraline standard with HPβCD*

Conclusion

The obtained results showed that the gold electrode in bicarbonate electrolyte exhibited a signifcan sensitivity and electrocatalytic response to the inclusion complexes of cyclodextrin with sertraline as standard and in Sidata tablets. Using and developing the SWV method and comparing it to the previously published results on different electrode surfaces concerning electrochemical behavior of sertraline, it can be concluded that the extension of the linear concentration range was accomplished. Based on the constructed calibration curve, the values of unknown sertraline concentration in the Sidata tablet were determined opening perspectives for serious analytical applications.

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