Journal of Pharmaceutical Analysis 2012;2(3):193–199

Contents lists available at ScienceDirect

Journal of Pharmaceutical Analysis

www.elsevier.com/locate/jpa
www.sciencedirect.com

ORIGINAL ARTICLE

Adsorptive stripping voltammetric methods for determination of aripiprazole

Derya Aşangil[a], İbrahim Hüdai Taşdemir[b,*], Esma Kılıç[a]

[a]*Ankara University, Faculty of Science, Department of Chemistry, 06100 Ankara, Turkey*
[b]*Amasya University, Faculty of Arts and Science, Department of Chemistry, 05100 Amasya, Turkey*

Received 16 November 2011; accepted 10 January 2012
Available online 8 February 2012

KEYWORDS

Adsorptive stripping voltammetry;
Aripiprazole;
Electrochemical behavior;
Human serum and urine;
Pharmaceuticals

Abstract Anodic behavior of aripiprazole (ARP) was studied using electrochemical methods. Charge transfer, diffusion and surface coverage coefficients of adsorbed molecules and the number of electrons transferred in electrode mechanisms were calculated for quasi-reversible and adsorption-controlled electrochemical oxidation of ARP at 1.15 V versus Ag/AgCl at pH 4.0 in Britton–Robinson buffer (BR) on glassy carbon electrode. Voltammetric methods for direct determination of ARP in pharmaceutical dosage forms and biological samples were developed. Linearity range is found as from 11.4 μM (5.11 mg/L) to 157 μM (70.41 mg/L) without stripping mode and it is found as from 0.221 μM (0.10 mg/L) to 13.6 μM (6.10 mg/L) with stripping mode. Limit of detection (LOD) was found to be 0.11 μM (0.05 mg/L) in stripping voltammetry. Methods were successfully applied to assay the drug in tablets, human serum and human urine with good recoveries between 95.0% and 104.6% with relative standard deviation less than 10%.

1. Introduction

Aripiprazole (ARP), chemically known as 7-{4-[4-(2,3-dichlorophenyl)piperazin-1-yl]butoxy}-3,4-dihydroquinolin-2(1H)-one (Fig. 1), is an atypical antipsychotic and antidepressant used in the treatment of schizophrenia, bipolar disorder and clinical depression. ARP represents a well-tolerated and effective addition to the antipsychotic armamentarium; it acts as a potent partial agonist at dopamine D_2 receptors and serotonin 5-HT1A receptors. ARP is rapidly absorbed after oral administration and the bioavailability of the drug is approximately 87% [1–3].

Only a few analytical techniques including HPLC with UV detection [4], LC–MS/MS [5,6], HPLC with tandem mass spectrometry [7], UPLC with tandem mass spectrometry [8], HPLC–MS [9], column switching HPLC [10] and capillary electrophoresis [11] have been devised for the determination of ARP in pharmaceutical samples or biological fluids. These methods are sufficiently sensitive but are also tedious and require highly sophisticated instrumentation for routine analysis. Although ARP is an electroactive molecule on different

*Corresponding author. Tel.: +90 358 2421613/4684; fax: +90 358 2421616.
E-mail address: ihudai@hacettepe.edu.tr (İ.H. Taşdemir).

Peer review under responsibility of Xi'an Jiaotong University.
doi:10.1016/j.jpha.2012.01.009

Production and hosting by Elsevier

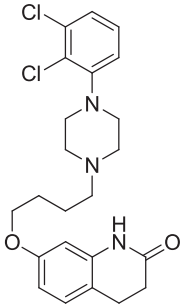

Figure 1 Chemical structure of ARP.

electrodes, there is no study dealing with electrochemical behavior of ARP based on its oxidation or reduction up to date.

Voltammetric techniques, such as cyclic voltammetry (CV), differential pulse voltammetry (DPV) and square-wave voltammetry (SWV), have been proved to be very sensitive for the determination of organic molecules including drugs and related molecules in pharmaceutical dosage forms and biological fluids [12,13]. These methods are faster, easier to be operated and more economic than spectroscopic and chromatographic methods. The sensitivity could be increased drastically when the stripping voltammetry is applied. Adsorptive stripping voltammetry (AdSV) has been shown to be an efficient technique for assay of trace amount of a wide range of species which have interfacial adsorptive character onto the working electrode surface [14].

One aim of the present study was the investigation of electrochemical oxidation behaviors of ARP using voltammetric methods. Development of new validated direct and stripping voltammetric determination methods for the assay of ARP in different samples including pharmaceutical preparations, human serum and human urine was another objective of present study.

2. Materials and methods

2.1. Apparatus

All voltammetric measurements such as CV, SWV, DPV, bulk electrolysis (BE), differential pulse anodic adsorptive stripping voltammetry (DPAAdSV) and square-wave anodic adsorptive stripping voltammetry (SWAAdSV) were carried out using a CH-instrument electrochemical analyzer (CHI 760). A three electrode cell system incorporating the glassy carbon electrode (GCE) (BAS MF-2012) as working electrode, platinum wire as an auxiliary electrode (BAS MW-1034) and a Ag/AgCl reference electrode stored in 3.0 M KCl solution (MF-2052 RE-5B) was used in all experiments.

A three electrode combination system for bulk electrolysis consisting of reticulated vitreous carbon (BAS MF 2077) as working electrode, coiled platinum wire as an auxiliary electrode (23 cm) (BAS MW-1033) and a Ag/AgCl (in 3.0 M KCl) reference electrode (BAS MF-2052 RE-5B) was used.

All pH measurements were made with Thermo Orion Model 720A pH ion meter having an Orion combined glass pH electrode (912600).

Double-distilled deionized water was supplied from Human Power I^+, ultra pure water system (Produced by ELGA as PURELAB Option-S). All data were obtained at ambient temperature.

2.2. Reagents and solutions

Standard sample of ARP (99.0%, from Bristol Myers Squibb) was used to prepare the stock solution of ARP. This solution was prepared by dissolution of precisely weighed amounts of ARP in methanol in order to have the ARP concentration of 5.0×10^{-3} M (2.24 g/L). Calibration solutions were prepared by diluting the stock solution with Britton–Robinson buffer (BR) and pH value of these solutions was adjusted using 0.2 M NaOH or 0.2 M HCl solutions.

Abilify tablets (from Bristol Myers Squibb) each containing 5 mg ARP were used as pharmaceutical preparation.

All chemicals used in preparation of BR solution, such as phosphoric acid (Riedel), boric acid (Riedel), acetic acid (Merck), and the chemicals to adjust the pH of supporting electrolyte were of analytical reagent grade. Double-distilled deionized water was used in preparations of all the solutions.

All ARP solutions were protected from light and were used within the same day to avoid decomposition.

2.3. Preparation and analysis of samples

To prepare the solutions of tablets, the drug content of ten tablets was weighed initially, finely powdered and mixed in order to get homogeneous powder. The average mass per tablet was determined. A powder sample equivalent to one tablet was weighed and transferred into a 50.0 mL calibrated flask and then 25–30 mL of methanol was added. The contents of the flask were sonicated for 30 min to achieve complete dissolution of ARP. Following the solution step, the content of flask was completed to mark with methanol and centrifuged for 30 min at 1500 rpm after sufficient shaking. 10.0 mL of sample from the clear supernatant liquor was withdrawn and quantitatively diluted to 100.0 mL with BR buffer and pH was adjusted to desired value. This solution was kept at +4.0 °C in dark. Sufficient volumes from this solution were transferred into a calibrated volumetric flask of 10.0 mL, pH was controlled and volume was completed to mark with BR buffer, then content of flask was transferred to electrochemical cell and voltammetric measurements were performed.

Similarly, spiked human serum and urine samples were analyzed. Serum and urine samples obtained from healthy individuals were stored frozen until assay. After gentle thawing, 1.0 mL aliquot volume of serum (or urine) was added to electrochemical cell containing 9.0 mL of BR buffer and then sufficient volumes from stock tablet solution were transferred, after deaeration with argon, measurements were performed to determine ARP content of cell using direct calibration methods.

2.4. Voltammetric procedure

In all voltammetric studies (CV, DPV, SWV, DPAAdSV, SWAAdSV) 10.0 mL of ARP solution in BR was placed into the electrochemical cell for each time. Electrode connections were adjusted and then cell content was deoxygenated with purified argon (99.99% purity) for 15 min before the first running and 30 s between all individual successful runnings. After 2 s equilibration time voltammograms were recorded by applying a positive-going scan.