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ARTICLES

Determination of Captopril in Pharmaceutical Forms by Stripping Voltammetry

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Abstract—A voltammetric procedure is developed for determining captopril in pharmaceuticals. It is based on the preliminary electrochemical accumulation of the captopril oxidation product on a platinum electrode in a 0.1 M HNO_3 solution at 1.2 V versus a saturated silver–silver chloride electrode. The reduction current of the oxidation product is a linear function of captopril concentration in the range from 1.2×10^{-6} to 3.2×10^{-4} M. The determination limit is 9.2×10^{-7} M. The relative standard deviation is between 1 and 4%.

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Captopril, 1-(3-mercapto-2-methyl-1-oxopropyl)-L-proline, is a synthetic dipeptide, an active inhibitor of the angiotensin-converting enzyme (ACE) used in clinical practice to treat for hypertension and heart failure and in a combined therapy of myocardial infarction [1].

Additionally, captopril is the only inhibitor of ACE bearing a thiol group; therefore, it can take up free radicals in living systems and exhibit antioxidant properties [2–4].

Chromatography [5–8], spectroscopy [3, 9, 10], chemiluminescence [11], and capillary electrophoresis [12, 13] are used for determining captopril in different matrices.

The flow-injection determination of captopril with spectrophotometric, fluorimetric, and chemiluminescence detection was reported in [14, 15]. The automated technique for the flow-injection determination of captopril in pharmaceutical preparations is of interest [16]. It is based on the indirect biamperometric detection of captopril using an indicator Fe(III)/Fe(II) redox system. The calibration graph is linear in the analytical range of captopril concentrations from 0.03 to 3.6 μg/mL (in the determination of 0.76 μg/mL captopril, the RSD was 1%).

It is known that captopril is oxidized at different electrodes [17, 18].

A procedure was developed for determining captopril by square-wave cathodic adsorption stripping voltammetry at a stationary mercury electrode. Captopril was preconcentrated on the mercury surface as a poorly soluble salt, which was then reduced in the cathodic potential range. The reduction current depended on the concentration of captopril. The calibration graph was linear in the range of captopril concentrations from 0.5 to 180 μg/L, depending on the accumulation time. The detection limit for captopril was found to be 0.5 μg/L ($S/N = 3$) at a preconcentration time of 300 s. The procedure was applied to the determination of captopril in two pharmaceutical forms (recovery factor was 97.9–98.8%) [19]. However, the necessity of removing dissolved oxygen significantly extended the time and cost of analysis.

The goal of this work was to develop a voltammetric procedure for determining captopril in pharmaceuticals using preliminary electrochemical preconcentration.

EXPERIMENTAL

Voltammetric determinations were carried out using an Ekotest-VA voltammetric analyzer. A 20.0-mL portion of a supporting electrolyte and an aliquot of a

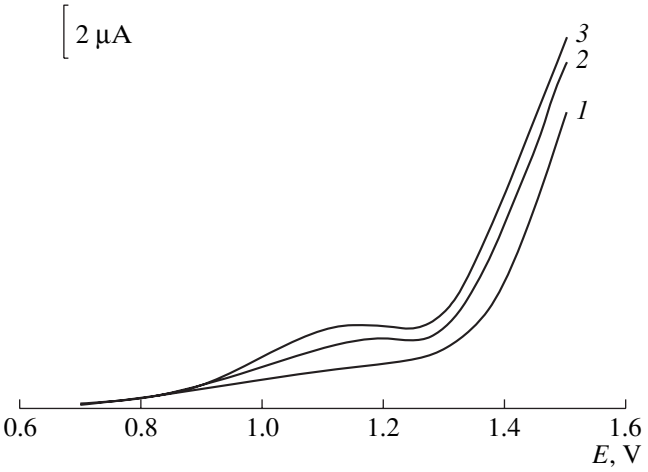


Fig. 1. Voltammograms of the oxidation of (*1*) 0, (*2*) 2.2×10^{-3}, and (*3*) 4.2×10^{-3} M captopril in a 0.1 M HNO_3 solution at a platinum electrode at a potential sweep rate of 50 mV/s.

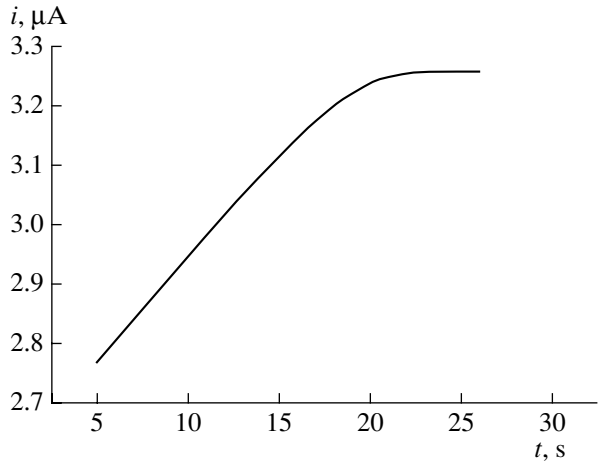


Fig. 2. Reduction current of captopril as a function of the time of the electrochemical accumulation of 5.7×10^{-5} M captopril at 1.2 V.

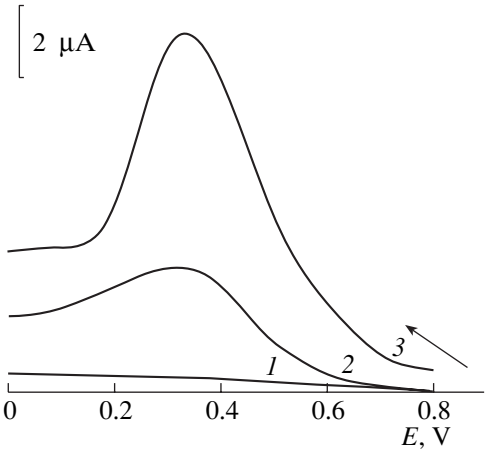


Fig. 3. Voltammograms of the reduction of (*1*) 0, (*2*) 5.7×10^{-5}, and (*3*) 2.2×10^{-4} M captopril in a 0.1 M HNO_3 solution at a platinum electrode at a potential sweep rate of 50 mV/s after a 20-s electrochemical accumulation at 1.2 V.

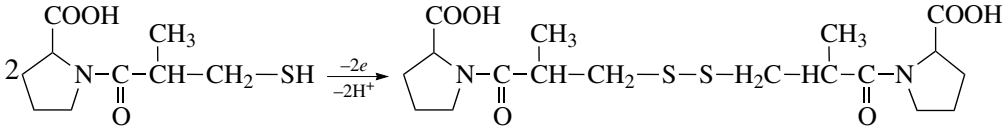
test solution were placed in a 50.0-mL three-electrode cell containing a stationary platinum working microelectrode, an auxiliary electrode, and a saturated silver–silver chloride reference electrode. Voltammograms were recorded at a linear potential sweep at a rate of 50 mV/s. Because determination was carried out in the anodic range of potentials, oxygen was not removed from the solution.

RESULTS AND DISCUSSION

Captopril was oxidized at a platinum electrode in a 0.1 M HNO_3 solution to form a plateau of limiting current in the potential range 1.15–1.25 V.

Because the analytical signal appeared only at high concentrations of captopril (Fig. 1), the product of captopril oxidation was previously electrochemically accumulated at 1.2 V.

It is known [20] that thiol-containing compounds are oxidized to form disulfide.



The adsorption of captopril on a platinum electrode surface is described by the Langmuir equation (Fig. 2). The working time of accumulation was 20 s.

A sharp peak was observed at 0.35 V in the cathodic voltammograms of the adsorbed product. The current of this peak linearly increased with an increase in the captopril concentration (Fig. 3).

The reduction current was a linear function of captopril concentration in the range from 1.2×10^{-6} to 3.2×10^{-4} M. The determination limit found from the 3σ test was 9.2×10^{-7} M. The results of determining captopril in model solutions were verified by the added–found method (Table 1).

Table 1. Voltammetric determination of captopril in model solutions ($n = 5$, $P = 0.95$)

Added, μg	Found, μg	RSD, %
10	9.9 ± 0.2	1
100	98 ± 2	2
250	246 ± 5	2
500	484 ± 23	4
1500	1495 ± 33	2

Table 2. Determination of captopril in pharmaceutical forms ($n = 5$, $P = 0.95$)

Sample	Content, mg	Found, mg	RSD, %
Tablets of captopril	25.0	24.7 ± 0.3	1
Tablets of capoten	25.0	24.8 ± 0.2	1

Our data allowed us to develop a procedure for the voltammetric determination of captopril in pharmaceuticals.

Procedure for determining captopril in pharmaceuticals. A tablet of the preparation was triturated, an accurately weighed sample of about 0.1 g was dissolved in 25.0 mL of distilled water, and a 0.5-mL portion of the solution was transferred to the cell. Electroaccumulation was carried out at 1.2 V for 20 s, and cathodic voltammograms were recorded at a linear sweep of potential from 0.8 to 0 V at a rate of 50 mV/s.

The results are presented in Table 2.

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