

реальных образцов (лекарственных средств и безалкогольных напитков). Полученные результаты сопоставлены с данными независимых методов. Высокая чувствительность и селективностью, а также простота и доступность разработанных подходов позволяет применять их для контроля качества лекарственных средств и пищевых продуктов.

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ELECTROOXIDATION OF HYDROXYCINNAMIC ACIDS ON THE POLY(PHENOL RED)-MODIFIED ELECTRODE AND ITS ANALYTICAL APPLICATION

Hydroxycinnamic acids are secondary plant metabolites widely distributed in foodstuff [1]. Among them, caffeic, ferulic, and *p*-coumaric acids (Fig. 1) are the most abundant. Therefore, sensitive and selective methods for the quantification of hydroxycinnamic acids are required.

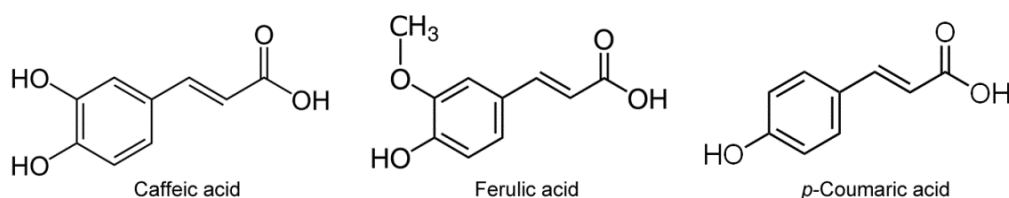


Fig. 1. Structure of hydroxycinnamic acids.

The presence of phenolic moiety in the structure of hydroxycinnamic acids makes them electroactive and allows use voltammetry for their quantification. Chemically modified electrodes are widely used for individual and simultaneous determination [2-4]. Polymer modified electrodes are almost out of consideration in this case. The current work is focused on the investigation of hydroxycinnamic acids electrooxidation on the novel modified electrode based on the poly(phenol red) and development of voltammetric method of their quantification.

Glassy carbon electrode modified with polyaminobenzene sulfonic acid functionalized single-walled carbon nanotubes and electrodeposited poly(phenol red) has been developed. Modification provides significant increase of the electrode effective surface area and electron transfer rate as confirmed by cyclic voltammetry and electrochemical impedance spectroscopy. Electrooxidation of caffeic, ferulic, and *p*-coumaric acids has been studied in Britton-Robinson buffer.

Variation of the supporting electrolyte pH has shown that oxidation potentials of these acids are shifted to the less positive values indicating protons participation in the electrode reaction. Caffeic acid electrooxidation is quasi-reversible, while it is irreversible for ferulic and *p*-coumaric acids. The highest oxidation currents of hydroxycinnamic acids have been observed at pH 2.0, which has been used in further investigations.

The potential scan rate has been varied in the range of 5-150 mV s⁻¹. Oxidation currents of caffeic, ferulic, and *p*-coumaric acids are increased with the growth of the scan rate. The linear dependence of oxidation current vs. square root of the scan rate has been obtained. The slopes of the plots $\ln I$ vs. $\ln \nu$ of 0.36, 0.43 and 0.56 for caffeic, ferulic, and *p*-coumaric acids, respectively, indicate diffusion-controlled process.

The electrooxidation parameters (anodic transfer coefficient (α_a), the number of electrons (n), diffusion coefficient (D), and heterogeneous electron transfer rate constant (k^0)) have been calculated (Table 1).

Table 1 – Electrooxidation parameters of caffeic, ferulic, and *p*-coumaric acids on the poly(phenol red)-modified electrode

Parameter	Caffeic acid	Ferulic acid	<i>p</i> -Coumaric acid
α_a	0.62	0.46	0.40
n	1.97	1.9	1.9
D , cm ² s ⁻¹	$(3.9 \pm 0.1) \times 10^{-5}$	$(2.1 \pm 0.3) \times 10^{-5}$	$(4.6 \pm 0.2) \times 10^{-5}$
k^0 , cm s ⁻¹	2.48×10^{-3}	1.53×10^{-3}	2.12×10^{-3}

Poly(phenol red)-modified electrode gives response to the caffeic, ferulic, and *p*-coumaric acids in their simultaneous presence. Three well-resolved oxidation peaks at 0.48, 0.70, and 0.90 V have been observed for caffeic, ferulic, and *p*-coumaric acids, respectively, under conditions of differential pulse voltammetry in Britton-Robinson buffer pH 2.0. The peak potential separation of 0.22 and 0.20 V has been achieved allowing simultaneous determination of the hydroxycinnamic acids (Fig. 2).

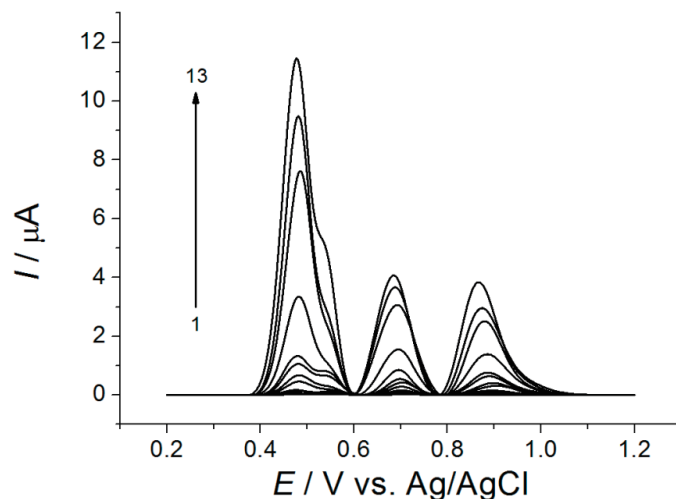


Fig. 2. Baseline-corrected differential pulse voltammograms of equimolar mixtures of hydroxycinnamic acids (0.10–100 μM) on the poly(phenol red)-modified electrode in Britton-Robinson buffer pH 2.0.

The linear dynamic ranges of 0.10–2.5 μM for all acids and 2.5–100 μM for caffeic acid (2.5–50 μM for ferulic and *p*-coumaric acids) have been obtained. The detection limits at $S/N = 3$ equal 47.6, 22.4, and 38.0 nM for the caffeic, ferulic, and *p*-coumaric acids, respectively.

Electrooxidation of caffeic, ferulic, and *p*-coumaric acids has been studied and their simultaneous voltammetric determination has been achieved for the first time using poly(phenol red)-modified electrode.

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РАЗРАБОТКА МЕТОДИКИ ПРОВЕРКИ ПРИГОДНОСТИ ПОРОХА ДЛЯ ПАТРОНОВ

Показатели глубины проникновения в преграду патронов при использовании могут быть различны ввиду их неправильного хранения и несоответствия срока годности, что неблагоприятно сказывается при использовании оружия, как в военной, так и в гражданской сферах. В связи с этим, целью работы является разработка методики проверки пригодности пороха для патронов, которая обеспечит надёжность результатов и простоту её использования.

Данная методика предусматривает отказ от экспериментальных исследований при проведении проверки пригодности пороха в самих патронах. Поэтому необходимо заменить такие исследования прогнозирующим элементом, в роли которого будет выступать экспериментально доказанный график зависимости глубины проникновения пули в преграду от срока и условий хранения пороха, а также выведенный закон изменения траектории движения пули при прохождении через преграду [1].

Согласно II закону Ньютона в инерциальной системе отсчёта ускорение тела прямо пропорционально равнодействующей сил, приложенных к телу и обратно пропорционально массе. Поскольку внутри пластины в каждый момент времени на пулю действует сила сопротивления, которая направлена против движения пули, а по вели-