PÔSTER - RESUMO - DISPOSITIVOS ELETRÔNICOS, ELETROQUÍMICOS, SUPERCAPACITORES E BATERIAS

ELECTROCHEMICAL CHARACTERIZATION OF PHENACETIN IN SYNTHETIC URINE MEDIUM USING A GRAPHITE ELECTRODE FOR FORENSIC APPLICATIONS

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Phenacetin (N-(4-ethoxyphenyl)acetamide) is an organic white crystalline substance, odorless and practically insoluble in water, which was historically used in human and veterinary medicine for its analgesic and antipyretic properties. Despite being banned in many countries due to its nephrotoxic and carcinogenic effects, phenacetin has re-emerged as an adulterant in illicit drug preparations, often mixed with cocaine and other substances to increase volume or mimic pharmacological effects. Its structural similarity to paracetamol, with an ethoxy group replacing the hydroxyl group, makes it chemically stable and electrochemically active, enabling detection via electroanalytical methods. This study aims to characterize the electrochemical behavior of phenacetin in a synthetic urine/acetonitrile (ACN) medium using a low-cost graphite electrode as an electrochemical sensor. Phenacetin solutions were prepared at different concentrations (0.25, 1.25, 2.5, 3.75, and 5.0 mg/mL) from a stock solution

obtained by mixing 9.0 mL of synthetic urine, 6.0 mL of ACN. Synthetic urine was prepared containing urea (18.0 mmol/L), NH4Cl (18.0 mmol/L), KH2PO4 (15.0 mmol/L), CaCl2 (10.0 mmol/L), KCl (20.0 mmol/L), and NaCl (49.0 mmol/L) in deionized water. Electrochemical measurements were performed using a μ-Autolab Type III potentiostat controlled by NOVA software, with a conventional three-electrode cell: graphite working electrode, platinum wire auxiliary electrode, and Ag/AgCl (KCl 3.0 mol/L) reference electrode. Three voltammetric techniques were employed: Cyclic Voltammetry (CV) at a scan rate of 50 mV/s, Square Wave Voltammetry (SWV), and Differential Pulse Voltammetry (DPV). The CV analysis revealed a well-defined oxidation peak for all concentrations, confirming the electroactivity of phenacetin on the graphite surface. The anodic peak potential varied with concentration, ranging from approximately +1.22 V for 0.25 mg.mL to +1.4–1.5 V for 5.0 mg/mL. A direct proportionality between anodic peak current and phenacetin concentration was observed, allowing the construction of a calibration curve based on the main oxidation peak. The linear regression analysis yielded a coefficient of determination (R^2) of 0.9152, indicating good linearity and sensitivity within the investigated concentration range. This proportional relationship suggests that the electrochemical oxidation of phenacetin is diffusion-controlled and suitable for quantitative applications. Comparative analysis between techniques showed that CV provided higher sensitivity compared to SWV and DPV under the same conditions. This enhanced sensitivity may be attributed to the slower kinetics of phenacetin oxidation, which is better characterized by the continuous potential sweep in CV. Pulsed techniques (SWV and DPV), while generally more sensitive for reversible systems, may not offer sufficient temporal resolution or optimal parameters for detecting this specific oxidation process. The oxidation mechanism is likely associated with the ethoxybenzene moiety, which undergoes electron transfer at the graphite surface in the acidic medium provided by synthetic urine/ACN. The presence of ACN improves phenacetin solubility and maintains electrochemical stability. These preliminary results confirm the feasibility of detecting phenacetin electrochemically in a complex simulated matrix (synthetic urine/ACN) using a simple, unmodified graphite electrode. The proposed method offers advantages such as low cost, rapid analysis, minimal sample preparation, and potential for on-site forensic screening. Future studies will focus on: (i) validation of the method in real seized samples, (ii) investigation of common interferents (caffeine, lidocaine, procaine, etc.), (iii) optimization of SWV and DPV parameters to improve sensitivity, (iv) determination of analytical figures of merit (LOD, LOQ,

repeatability, reproducibility), and (v) comparison with standard reference methods (HPLC, GC-MS) for accuracy assessment. The development of portable electrochemical sensors for phenacetin detection represents a valuable tool for forensic laboratories, enabling rapid identification of adulterants in illicit drug formulations and contributing to public health and safety.

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Palavras-chave: phenacetin; cyclic voltammetry; electrochemical sensor; graphite electrode; synthetic urine; forensic analysis.