# Rapid and low-cost determination of flavonoids and hormones using nanomodified-CPE in combination with ESV

**Kledi Xhaxhiu**[1,2]
Nensi Isak[1,2], Muhamed Farruku[1,2], Avni Berisha[2,3], Edlira Baraj[4], Magdalena Cara[2,5], Besnik Baraj[1,6]

[1]*University of Tirana, Faculty of Natural Sciences, Department of Chemistry Blv. Zogu I, 25/1, 1001 Tirana, Albania*
[2]*Regional Centre of Nanotechnology, Academy of Sciences of Albania, Murat Toptani Avenue, 1000 Tirana, Albania*
[3]*University of Prishtina, Faculty of Natural and Mathematics Sciences, Department of Chemistry , Mother Theresa Str. 10000, Prishtina, Kosovo*
[4]*Polytechnic University of Tirana, Faculty of Mathematical Engineering and Physical Engineering, Department of Chemistry, Sulejman Delvina str. 1019, Tirana, Albania*
[5]*Agricultural University of Tirana, Faculty of Agriculture and Environment, Department of Plant Protection, Paisi Vodica 1025, Tirana, Albania*
[6]*Research Unit "Water Assets", Academy of Sciences of Albania, Murat Toptani Avenue, 1000 Tirana, Albania*

kledi.xhaxhiu@fshn.edu.al

This study presents a rapid, low-cost, and sensitive method for determining bioactive compounds: flavonoids (catechin, CAT) and hormones (estradiol), using extractive stripping voltammetry (ESV) with nanomodified carbon paste electrodes (CPEs). The technique combines partial extraction of the target analyte onto the electrode surface with differential pulsed voltammetry (DPV), enabling interference-resistant detection in complex matrices [1-3]. For catechin determination in plant-derived beverages (PDBs), the method demonstrated excellent selectivity, overcoming interferences that hinder direct voltammetry [1,3]. Using multi-walled carbon nanotubes (MWCNTs) as modifiers enhanced sensitivity (LOD: 197 nM, LOQ: 596 nM), outperforming other nanomaterials (zeolite X, clay, SWCNTs). The method exhibited high accuracy (98–104% recovery) with a low detection limit ($1.2 \times 10^{-8}$ M) on bare CPE. Application to Albanian wines revealed catechin concentrations of 665–2235 mg/L, with red wines containing higher levels than white wines. For estradiol, optimization of modulation amplitude (0.05 V yielding better LOD/LOQ than 0.07 V) and modifier selection was critical. While some modifiers (amorphous carbon, cyclodextrin, 5% MWCNTs) reduced performance, ionic liquid-based pasting liquids significantly enhanced signal response (optimal adsorption: 10 min), and functionalized MWCNTs provided the highest sensitivity (15 min adsorption). The method effectively minimized interference from common biological compounds (ascorbic acid, uric acid, dopamine), except for riboflavin.

This study establishes ESV with nanomodified-CPEs as a cost-effective, rapid, and reliable approach for quantifying structurally diverse analytes in complex samples, offering advantages over conventional voltammetry in terms of selectivity, sensitivity, and affordability.

**References**

[1] K. Xhaxhiu, A. M. Ashrafi, M. Dvořák, A. Mukherjee, R. Guráň, O. Zítka, L. Richtera, Total flavonoid content in plant derived beverages determined by extractive stripping voltammetry, Results in Chemistry, Vol. 5, 2023, 100967, https://doi.org/10.1016/j.rechem.2023.100967
[2] X. Ndreka, N. Isak, K. Xhaxhiu, J. Kudr, O. Zitka, M. Farruku, B. Baraj, Electroanalysis 2024, 36, e202400084. https://doi.org/10.1002/elan.202400084
[3] Rapid and Sensitive Electrochemical Determination of Flavonoids in Albanian Wines Using Zeolite X and Prrenjasi Clay As Carbon Paste Modifiers: Original Scientific Paper. *J. Electrochem. Sci. Eng.* 2025, 2682. https://doi.org/10.5599/jese.2682