

# Challenges in Assessing Albanian Wine Quality through Their Total Antioxidant Content

---

**Kledi Xhaxhiu**<sup>1,2</sup>

Nensi Isak<sup>1,2</sup>, Xhensiana Ndreka<sup>1,2</sup>, Avni Berisha<sup>2,3</sup>, Magdalena Cara<sup>2,4</sup>, Besnik Baraj<sup>1,5</sup>

<sup>1</sup>University of Tirana, Faculty of Natural Sciences, Department of Chemistry Blv. Zogu I, 25/1, 1001 Tirana, Albania

<sup>2</sup>Research Center of Nanotechnology, Academy of Sciences of Albania, Murat Toptani Avenue, 1000 Tirana, Albania

<sup>3</sup>University of Prishtina, Faculty of Natural and Mathematics Sciences, Department of Chemistry, Mother Theresa Str. 10000, Prishtina, Kosovo

<sup>4</sup>Agricultural University of Tirana, Faculty of Agriculture and Environment, Department of Plant Protection, Paisi Vodica 1025, Tirana, Albania

<sup>5</sup>Research Unit "Water Assets", Academy of Sciences of Albania, Murat Toptani Avenue, 1000 Tirana, Albania

[kledi.xhaxhiu@fshn.edu.al](mailto:kledi.xhaxhiu@fshn.edu.al)

---

## Abstract

The complex composition of wine makes catechin determination via direct voltammetry challenging. In this study, we present an ex-situ voltammetric method using bare and modified carbon paste electrodes (CPE) to accurately determine catechin levels in wines. This method involves two steps: (a) extraction/adsorption onto the carbon paste, and (b) differential pulse voltammetry (DPV) measurement. Nanomaterial modifications of the CPE significantly improved selectivity in catechin extraction and quantification, offering a reliable approach for classifying and certifying Albanian and imported wines based on antioxidant content.

We successfully demonstrated this method using various CPE modifiers, including zeolite type X, Prrenjasi clay, single-walled (SWCNT), and multi-walled carbon nanotubes (MWCNT). The MWCNT-modified electrode exhibited the highest sensitivity, with a limit of detection (LOD) of 197 nM and a limit of quantification (LOQ) of 596 nM. Catechin concentrations in Albanian wine samples ranged from 665 to 2235 mg/L, with red wines showing higher levels than white wines.

A comparison using the Prussian blue spectrophotometric method confirmed these findings, showing consistent trends in increasing antioxidant content across both methods. The study highlights how environmental factors, such as soil composition, sunlight, and climate, influence catechin synthesis, with wines from warmer regions of Albania showing higher antioxidant levels. This method offers a valuable tool for ensuring the quality and classification of wines based on their catechin content.