جامعة عبد المالك السعدي
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Université Abdelmalek Essaadi

N° d'ordre/Année :

Pole for Doctoral Studies
Center for Doctoral Studies Sciences, Technologies, and Medical Sciences

ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE

M. ACHACHE Mohamed

Will present his research work with the aim of earning a Doctorate

Doctoral program: Biology, Chemistry and Geology
Discipline: Chemistry
Specialty: Physical Chemistry -Applied Electrochemistry for Sensors

On 06/12/2025 at 10H30 at the Thesis Defense Hall of The Faculty of Sciences of Tetouan, UAE
Under the Theme

Development of innovative electrochemical sensors based on green, bio-sourced and synthetic materials for the detection of compounds of pharmaceutical, biomedical, environmental and food interest

Front of the jury composed of:

First Name & Last Name	Establishment	Designation
Pr. RIFFI TEMSAMANI Mohammed Khalid	FS of Tetouan, UAE	President
Pr. AMINE Aziz	FST of Mohammedia, UH2C	Reviewer
Pr. El AMRANI Mohamed Amin	FS of Tetouan, UAE	Reviewer
Pr. LABJAR Najoua	ENSAM of Rabat, UM5	Reviewer
Pr. CHAOUKET Faiza	FS of Tetouan, UAE	Examiner
Pr. RAISSOUNI Ihssane	FS of Tetouan, UAE	Examiner
Pr. BOUCHTA Dounia	FS of Tetouan, UAE	Co-supervisor
Pr. CHOUKAIRI Mohamed	FS of Tetouan, UAE	Supervisor

Research Laboratory: *Laboratory of Materials Engineering and Sustainable Energy (LMESE), Faculty of Science, Abdelmalek Essaadi University, B.P. 2121, Tetouan 93002, Morocco, UAE/U05FS*

Abstract

The increasing exposure to pharmaceutical, biological, and phenolic compounds presents in medicines, food, and the environment represents a major risk to human health and ecosystems. These substances are implicated in serious diseases such as neurological disorders, cancers, and hormonal imbalances. Therefore, monitoring in the pharmaceutical, biomedical, environmental, and food sectors is essential to rapidly detect these contaminants, ensure product quality, and protect consumers from their toxicological effects.

In this context, our work focused on the development of innovative electrochemical analytical tools that are specific, efficient, and accessible in laboratory settings for the early detection of eight target molecules:

- Paracetamol, for pharmaceutical quality control and therapeutic monitoring.
- Dopamine and its main metabolite, homovanillic acid, for improved diagnosis, monitoring, and understanding of neurological and endocrine disorders.
- Catechol, hydroquinone, and bisphenol A, as priority environmental pollutants.
- Gallic acid and caffeic acid, major phenolic compounds with antioxidant properties monitored in food and beverages.
- To achieve this, eight electrochemical sensors were developed:
- Carbon paste and sonogel electrodes modified respectively with montmorillonite and monocalcium phosphate for the detection of paracetamol.
- Sensors modified with shrimp shell powder, and the amino acid L-leucine, for the simultaneous detection of dopamine/paracetamol and of homovanillic acid, through modification of the carbon paste and sonogel matrices, respectively.
- Two sensors based on nickel nanoparticles and montmorillonite for the simultaneous detection of catechol, hydroquinone, and bisphenol A.
- Finally, two carbon paste electrodes modified with rare-earth-based nanocomposites (lanthanum and neodymium) for the quantification of gallic acid and caffeic acid.

These sensors were characterized using electrochemical and physicochemical methods to confirm surface modifications and were tested in real sample matrices (tablets, urine, synthetic cerebrospinal fluid, water, fruit juice, coffee) without prior treatment, except for simple dilution. The results demonstrated excellent sensitivity, selectivity, and stability, outperforming existing devices.

Additionally, a theoretical study on paracetamol was conducted using DFT calculations and Monte Carlo simulations, confirming the experimental electrochemical results.

This research paves the way for efficient, cost-effective, and sustainable analytical solutions, contributing to enhanced pharmaceutical, clinical, environmental, and food safety monitoring, and ultimately improving public health and product quality.

Keywords: Artificial cerebrospinal fluid; Bisphenol A; Carbon paste electrode; Cafeic acid; Catechol; Dopamine; Electrochemical detection; Environmental pollutants; Food analysis; Gallic acid; Human urine; Hydroquinone; Lanthanum nanocomposite; Leucine; Low-cost; Monocalcium phosphate; Montmorillonite; Neodymium nanocomposite; Neodymium nanocomposite; Paracetamol; Pharmaceutical tablets; Shrimp shell waste; Sonogel-Carbon electrode; Water samples.