Bio-based carbon dots for monitoring and removal of emergent aquatic contaminants

Area of Knowledge: LIFE SCIENCES

Group of disciplines: Plant, Animal & Environmental Biology, Physiology, Ecology & Conservation

Research project

Carbon dots are new nanomaterials with unique properties allowing a wide range of high-tech applications in different areas such as engineering, medicine and environment. This project aims to investigate three distinct varieties of algae found in Ria de Aveiro as a source of biomass for the synthesis of photoluminescent bio-carbon dots (BCDs), thereby improving the algae sector's valorisation and contributing to the EU blue bioeconomy. Moreover, the chemical and optical versatility of BCDs will be explored with a dual purpose in environmental remediation: i) as a nanosensor for realtime detection and tracking of metals and emergent contaminants such as biocides and pharmaceuticals and ii) as highly efficient nano-agents capable of passivating and remediating the potential toxic effects to aquatic life. The effectiveness of BCDs in reducing the toxicity of contaminants will be evaluated using ecotoxicity tests with three organisms, namely a dipetra, *Chironomus riparius*, a cladocera, *Daphnia magna* and the zebrafish *Danio rerio*, as representative of different functions in the food chain. This project will be developed in the "Environmental Changes, Hazards & Conservation" (ECHC) Research Group of the CESAM - Centre for Environmental and Marine Studies (University of Aveiro, Portugal) under the supervision of Dr. Inês Domingues. This theme focuses on the sources of anthropogenic contamination of freshwaters and aims at developing technological, innovative and efficient mitigation methodologies, being thus aligned with the scientific objectives of CESAM and ECHC. The nano compounds will be developed in the Centre for Mechanical Technology and Automation (TEMA) from the University of Aveiro under the supervision of Dr. Gil Gonçalves.

This theme contributes to UN Sustainable Development Goals 6 (Clean water and sanitation) and 15 (Life on land) by contributing to the improvement of freshwater quality for human consumption and at the ecosystem level.

Job position description

The main goal of this project is the development of novel BCDs by exploring algae biomass from Ria de Aveiro, with potential application as photoluminescent nanosensors for the detection and screening of tracers' levels of metals and emerging pollutants on aquatic ecosystems and respective remediation. The following specific questions will be addressed: i) What are the physicochemical properties of BCDs produced by the different types of algae?; ii) Are the BCDs toxic for the tested species?, iii) Are the algae-derived BCDs effective in the tracing and removal of selected contaminants?, iv) Can the BCDs deliver the same performance when embedded in a hydrogel matrix, allowing for easy recovery and reuse in contaminated water? To achieve this main objective and answer the questions asked above, the candidate is expected to address several specific objectives: a) Preparation of BCDs using algae biomass with natural occurrence in Ria de Aveiro ecosystem, namely *Gracilaria vermiculophylla* (red algae), *Ulva lactuca* (green algae) and *Fucus vesiculosus* (brown algae).

b) Structural and optical characterization of the BCDs obtained through the different types of algae and processing methodologies. The different pigmentation of the algae biomass will be able to afford BCDs with different optical performances. c) Integration of BCDs on a biobased hydrogel matrix for easy recovery and reuse. d) Validation of BCDs luminescent nanosensors and optimisation of the detection limits, monitorisation and remediation of aquatic contaminants. e) Assessment of the toxicity reduction of the selected contaminants by the action of BCDs (either directly as integrated in the hydrogel) using endpoints at several levels of biological organisation since the biochemical (e.g. oxidative stress indicators, neurological damage indicators) to the individual (e.g. development, growth, behaviour, reproduction, etc) using three model organisms: *C. riparius*, D. magna and *D. rerio* (embyo/larval stages).

Supervisor team

Dr. Inês Domingues (inesd@ua.pt)

Research Group description

Website with the description of CESAM´s RG "Environmental Changes, Hazards & Conservation" objectives: https://www.cesamla.pt/sobre/grupos-de-investigacao/echc/

Additional information

Website of CESAM: www.cesam-la.pt

Website of the University of Aveiro, Portugal: https://www.ua.pt/en/