PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU6.09

Curriculum: 6. Health and Ecosystems

Use of microalgae for the sustainable treatment of dairy wastewater and as a renewable source of compounds for plant biostimulation and protection

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Host University/Institute: University of L'Aquila

Research Keywords:	Microalgae-based wastewater treatment
	Biostimulants and biopesticides from microalgae
	Plant immunity
Reference ERCs:	LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology
	LS9_11 Biomass production and utilisation, biofuels
	LS9_9 Plant pathology and pest resistance
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Microalgae have received increasing interest as part of wastewater treatment, based on their ability in mixotrophic cultivation to utilize organic and inorganic carbon, as well as inorganic nitrogen and phosphorous, reducing the concentration of these substances in the water. Moreover, the use of microalgae can improve the purification performance of bacterial systems (microalgae-bacteria aggregates) by providing additional oxygen from photosynthesis, thus reducing the total energy costs of oxygen supply.

Microalgae are also a renewable source for biomass and for biologically active metabolites with potential application in the pharmaceutical and agrifood industries. Preliminary evidences show that plant treatment with microalgae extracts can stimulate both their productivity and immunity, conferring a broad spectrum resistance.

The aim of the research project is to use microalgae grown in dairy wastewater to obtain a biostimulating product for agricultural sector, able to replace chemical fertilizers and pesticides.

Currently, agricultural production is dependent on the massive use of fertilizers and pesticides with damage to the environment and human health. However, sustainable control

of plant diseases is possible by exploiting the innate immunity of plants, that can counteract the infection of the plant by microorganisms.

The multidisciplinary approach, in a natural synergy between environmental sciences, plant physiology and biotechnology, includes:

1) optimization of microalgae growth in small to medium scale dairy wastewater under non-axenic conditions,

2) microbiological and chemical analysis on both the algal biomass and the dairy wastewater,

3) preparation and characterization of various formulations of algal extract using eco-sustainable extraction techniques,

4) treatment of Arabidopsis thaliana and Solanum lycopersicum with the different formulations of algal extract and evaluation of:

A) productivity and nutritional quality of treated plants

B) pest and disease control (infection test with different plant pathogens, both fungal and bacterial),

5) treatment of human umbilical vein cells (HUVEC) in culture with the various formulations of algal extract, to estimate any toxic effects for humans that may derive from their use in the agrifood sector,

6) evaluation of the economic convenience deriving from the use of algal extracts in use of current pesticides through a ""technical-economic"" evaluation,

7) evaluation of the potential risks deriving from the use of algal extracts in agriculture through a life cycle assessment (LCA).

The use of microalgae for wastewater biodepuration, reducing the need for expensive treatments before their discharge, represents an important goal with social and economic consequences.

The cultivation of microalgae provides valuable biomass for different industrial sectors, as a source of innovative biological compounds such as pharmaceuticals, biofertilizers / biostimulants for agriculture, cosmetics and fine chemicals.

The development of efficient microalgae treatments is necessary to profitably and sustainably exploit the potential of these biomasses, recovering and separating high value-added components and minimizing waste generation.

Furthermore, the research will also concern the protection of plants from diseases, an important field of scientific and applied research. The impact that climate change has on the biodiversity of plants and microorganisms, and consequently on agricultural crops, is a

current issue of growing scientific interest for the protection of species of agronomic importance.

Research team and environment

The Laboratory of plant physiology and biotechnology of UNIVAQ has a long and recognized experience in the field of plant biotechnology and biochemistry, and in particular in the study of oligosaccharins derived by the plant cell wall that act as elicitors of plant defense responses. The research team is composed by the PI prof. Mattei and 3 researchers. Using biochemistry and molecular biology techniques, the group contributed to identifying oligosaccharin oxidases involved in the defense against plant pathogens. In recent years, the laboratory has devoted its attention to the growth of microalgae for wastewater treatment and for the production of bio-fuels. This research activity has been recognized at national and international level, as evidenced by publications on high impact scientific journals, patents and national and international research projects coordinated by the same operating unit. The research unit has active partnerships with industrial and university colleges and research organizations at national level. Collaborations already established with agrifood and biotechnology companies have allowed the research unit to develop industrial research and development activities. Equipment available at MESVA includes molecular and biochemical biology laboratories equipped with all basic equipment, growth chambers for microalgae and plants, filamentous fungi, yeasts and bacteria. Specific instruments for biochemical and molecular biology analysis available are: HPLC; FPLC; cell counter; Multi-Cultivator, a photobioreactor for small-scale screening experiments of phototrophic organisms as algae, cyanobacteria and plant cells; Real Time PCR.

Suggested skills for this research topic

The candidate will need skills in plant/microalgae growth, physiology and molecular biology, extraction and analysis of bioactive compounds, plant defense responses towards biotic and abiotic stresses.