

Project description

Descrizione del progetto

Introduction

The metabolic versatility, functional diversity, ease of culturing of algae has made them extremely interesting organisms for biotechnological applications.

The possibility to use them as a source of fuel has been and is being explored. Although the cost of fuel from algae is still too high, the reduction of fossil fuel reservoirs and the increasing cost of crude oil will make algal biofuels more and more convenient. With respect to other sources of biofuels, the fact that algae are highly productive in terms of biomass and oils and that their production is not in competition with crop cultures make these organisms preferable to most other.

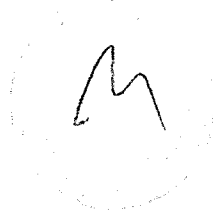
Algae are also excellent sources of biomass at low price that can be used as such for animal feed and as dietary supplement for human consumption.

The large metabolic diversity of algae also makes them an excellent source of a variety of compounds of biological significance, from antioxidants, which are produced in an amazing variety and large quantity, to dye, vitamins and other compounds of pharmaceutical relevance.

Previous experience and team work

Many of the proponents (e.g. Prof. M. Giordano, Prof. F. Polonara, Dr. A. Norici, R. Zanolli) have been jointly involved in projects on biotechnological utilization of algae funded by Cariverona Foundation and MIPAF. In recent years, the possibility of using the fatty acid complement of algae for the production of plastics has also been successfully explored (Bioenerchem PON project, in which the algal physiology lab and the energetics lab of UNIVPM were involved).

Engineers, economists and biologists from UNIVPM are now involved in exploratory research into the possibility of using microalgae for the phytodepuration of wastewater from olive oil production (and other sources), which may become a very profitable activity, given the increasing cost of disposing of wastewaters from productive activities. The biomass will be used for the production of high added value products. The economical feasibility and the commercial outcome of such activities are being evaluated by economists at the Department of Agricultural, Food and Environmental Sciences (D3A). A European project (Eranetmed) has just been submitted by the proponents on these topics.



The difficulties of all the above reside in the possibility of accessing tailored strains that respond to the specific requirement of a given application in a more effective way.

In this project, we propose to establish a platform for metabolomic analyses of microalgae, which, in combination with the existing instrumentation, will allow the selection of "ad hoc" strains for various applications. We shall also constitute a strain bank, which may be made available to external parties and become a source of commercial revenues. This will also act as the base for all major projects developed on algal biotechnology by the UNIVPM and international partners and will therefore constitute a major asset for the application to European (or other) funds.

Link to Horizon2020:

The project refers to three major themes in H2020: Sustainable Food Security (SFS), Blue Growth (BG) and Bio-Based Industries (BBI).

Among the recently launched calls, our research is relevant for:

- BG-01-2016: Large-scale algae biomass integrated biorefineries
- BBI-2016-R09: Exploiting algae and other aquatic biomass for production of molecules for pharma, nutraceuticals, food additives and cosmetic applications
- BBI-2016-D08: New sources of proteins for animal feed from co-products to address the EU protein gap
- BBI-2016-F01: Valorisation of by-products or waste-streams from the food processing industry into high added-value products for market applications
- BBI-2016-R01: Valorisation of the organic content of wastewater as feedstock, contributing to the renewable circular economy

Furthermore, in "SFS-15-2014: Proteins of the future", many projects dealt with macro- and micro-algae.

The Facility:

The facility will be a center of excellence, with personnel from UNIVPM and young scientists trained in the top institutions in the field. It will be equipped with state-of-the-art biomolecular and biochemical equipment for the characterization and manipulation of algal strain (mostly already available at UNIVPM or in the partner laboratories). The existing instrumentation will be implemented with a metabolomic platform specifically designed to work with algae, which will be made available to users of UNIVPM research groups. We also expect that the array of instruments in the ALGALAB will increase over the years thanks to the resources that it will attract and to the contribution of the foreign partners.

Metabolomic requires a substantial computational ability and state-of-the-art statistical methods. For this reason, our team includes engineers and mathematicians, who will make it possible to contribute expertise that is rarely available in an algal biotech facility.

The lab will also include a library of the strains that may be patented and made available commercially to external clients.

A portion of the investment will be for experienced postdoctoral fellows, whose task will be of setting up the metabolomic platform and train young UNIVPM scientists.

We shall also build on the proponent's experience in FTIR spectroscopy in whole algal cells to develop innovative methods for the monitoring of cultures and for the rapid analyses of biomass. No instrumentation will be required for this in this project, but the personnel that will be hired will invest part of their time for this task.

This facility will also be flanked by a UNIVPM spin-off, Greentech, for the commercial aspects.

Internationalization:



The following institutions have expressed interest in participating to this Initiative:

1. Universidade Federal de Rio de Janeiro, Brazil
2. EMPRAPA, Empresa Brasileira de Pesquisa Agropecuária, Ministério da Agricultura, Pecuária e Abastecimento, Brazil
3. Algal Biomass Energy Research and Development Center, Tsukuba University, Japan
4. University of Maryland, USA
5. Center Algatech, Institute of Microbiology, Czech Academy of Science, Czech Republic
6. Carnegie Institution of Washington USA
7. Kwansai Gakuin University, Japan
8. Stanford University, USA
9. University of Konstanz, Germany
10. Université Pierre et Marie Curie, Laboratory of Computational and Quantitative Biology, France

All these partners have indicated a very strong interest in contributing and have highlighted the need for such a collaborative enterprise, which finally generates the required critical mass of expertise and instrumentation (in situ and in the associated labs) to properly investigate the genomic diversity of algae and produce applicable outcomes.

We have also identified an advisory board, constituted by the following renowned scientists:

1. Prof. Peter Kroth, Konstanz, Germany
2. Prof. Arthur Grossman, Carnegie and Stanford, USA
3. Prof. John Raven, Dundee University, UK
4. Prof. John Beardall, Monash University, Australia
5. Prof. Charles Delwiche, University of Maryland, USA
6. Prof. Yoshihiro Shiraiwa, Tsukuba University, Japan
7. Prof. Ofelia Araujo, UFRJ, Brazil

All foreign partners have expressed the will to allow free access to their research facilities; access to top notch instrumentation around the world will contain the investment for the establishment of the lab and will dramatically increase its research capability.

The partner institutions will also provide training (free of charge) in state-of-the-art methodologies for the young scientists that will populate the lab.

It is our intention to offer facilitated access to the laboratory to researchers of the Ionian-Adriatic Macroregion to help strengthen collaborative research and knowledge dissemination in the area. This acquires special interest due to the recent constitution of the European Union Strategy for the Adriatic-Ionian region (EUSAIR) and of the Association of the University of the Adriatic-Ionian Macroregion (UNIADRION), whose permanent secretariat has its base in UNIVPM (the present general secretary is the proponent of this project).

Interdisciplinarity Project

Interdisciplinarietà del progetto

The project will incorporate A) Phycological expertise located at DISVA (Giordano and Norici), where M. Giordano's group has over thirty years of experiences in algal biology and specifically on CO₂ responses, C allocation, nutrient metabolisms, biochemistry of algae. The background of the algal biology team is perfectly fit to the experimental approaches proposed here, both with respect to algal cultivation, physiological characterization of strains, algal biochemistry and metabolomic. B) Engineering/energetics expertise at DIISE (Polonara, Di Nicola, Corvaro), which will provide the necessary understanding of the energetic problems associated with algae culture and with the exploitation of biomass. The engineers will also be in charge for the development of the computational means for the evaluation of the large dataset generated by -omic approaches. C) Economic and consumer research expertise, provided by the D3A group (Zanoli), which will be essential for the management of the lab and for the exploitation of the results for commercial application. D) Mathematical and Statistical expertise, also available at DIISE (Montecchiarri, Marietti, Papalini, Petrini), which will allow a rapid evaluation and



statistical assessment of the results obtained. The collaboration among these research groups will be maximal and all members of the team, especially the younger ones, will have the opportunity to closely interact with all groups and foreign partners to expand their knowledge and their ability to approach multidisciplinary research. Research students will also be involved in the activity of ALGALAB and provided top-notch training.

Objectives

Obiettivi

This project aims at setting up an excellence, international core facility, where expertise from the best institutions in the world concur to the selection of natural strains and the engineering of new strains to be utilized for the various productive aims.

A metabolomic platform devoted to algal biotechnology will produce data of enormous relevance for the utilization of alga biomass. Such facility does not exist in Europe, where metabolomic is mostly used in animal and vascular plants model, with very limited access for other experimental models. to the best of our knowledge. This severely hampers research efforts in the field.

The results our platform will produce will make it possible to develop strains with the appropriate metabolic response to attain biomass of the desire type for each application. This will be used for the research effort of UNIVPM research groups and will be also made available as a service to external groups, this way ensuring a means of subsistence to the lab.

We shall use the ensemble of techniques available at UNIVPM and in the partner international laboratories to generate strains that will be used for research and commercial application. We shall also be able to generate tailored strains on request.

Expected Impact

Risultati attesi

The facility will become a center of attraction for researcher around the world and a center of coordination for algal biotechnology research worldwide. The cooperation of so many internationally renowned institutions will make this center rapidly acquire international recognition which will drastically increase the scientific reputation of UNIVPM, with all the positive consequence that this will bring in terms of attractiveness of our university to students and researchers around the world.

This facility will interact with other centers of excellence in UNIVPM, such as the Marche Structural Biology lab, which may receive sequences of commercial interest from ALGALAB for overproduction of proteins and their crystallization. Such combination is rare in the world and would constitute an added value for both facilities and the university.

New equipment to be shared

Condivisione delle attrezzature da acquisire

Most of the investment requested will go into the purchase of a LC/GC-MS system for metabolic analyses. LC/GC-MS is usually at the center of metabolic platforms due to its high throughput, good coverage of metabolites, great sensitivity and dynamic range, while ensuring accurate, reliable quantitation of even low-level or difficult-to-analyze samples. The acquisition of such instrumentation will allow us to investigate the fine biochemical composition of algae in the quest for abundant compounds, but also for little represented constituents of great commercial added value. We shall also buy a tensiometer for the analyses of chemico-physical properties of cells and growth media, with a resolution of 0.01 mN/m, which would allow us to investigate very relevant aspects for the utilization of algal biomass In order to explore consumer cognition and emotions we shall acquire eyetracking systems, EEG, GSR to complement the equipment already available at the consumer research and neuromarketing lab All these instruments will be made available to UNIVPM groups with research interests coherent with those of ALGALAB.

Keywords

Parole chiave

algae, metabolomic, biofuels, nutraceutical, feed, food