Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 14 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

Supervisor information	
Family name	MARCHAL
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Web reference	Cliquez ou appuyez ici pour entrer du texte.
Lab name	GEPEA, Process Engineering for Environment and Food Laboratory
Lab web site	http://gepea.fr/_language_en.html http://algosolis.com/en/
Polytech name	Polytech Nantes
University name	Nantes University
Country	France

PhD information	
Title	Biorefining of microalgae : Characteirzation of ground biomass, a strategy to develop relevant fractionation processes of valuable biomolecules
Main topics regards to CSC	II-13 chimie verte, II-9 ingénierie alimentaire, VI-3

list (3 topics at maximum)	ingénierie du développement durable
Required skills in science and engineering	Chemical engineering, chemical analysis, biomolecules characterization. Good/proficient in spoken and written English is necessary, Good working knowledge in French would also be an advantage

Subject description (two pages maximum)

Biorefinery of renewable resources like microalgae offer great opportunities to substitute biomolecules (lipids, proteins, antioxidants) to traditional raw material in various industry sectors such as food/nutrition and feed, cosmetics, pharmacy, energy or green chemistry. Such strategies need innovative choices of soft and energy-efficient processes to guarantee the integrity of fragile molecules and develop eco-friendly production. For large-scale production (food, energy or green chemistry), wet processing of biomass that avoids expensive drying steps has been proposed. Biomass wet treatment includes a cell disruption step to release the valuable biochemical compounds in the aqueous phase, followed by the downstream processing step (extraction, concentration and purification).

In this work we will focus on the recovery of hydrophobic lipids and hydrophilic proteins from ground microalgae. The objective is to develop an analytical procedure to characterize the suspension after cell disruption: in which phase are the target compounds (cell fragments, aqueous phase)? Are they independent or in simple or multicomponents aggregates? What are the key parameters that describe the target molecules organization (size of aggregates, density, zeta potential, etc)? These parameters could then be relied to the cell disruption conditions but it could also help determining the adequate fractionation processes (filtration, solvent extraction etc).

The recovery of the valuable compounds during the fractionation steps is strongly affected by the former operations (culture, harvesting, storage, cell disruption procedure).

The choice of the microalgae strain, the culture conditions will influence the nature and quantity of molecules to be recovered. For example, the culture in an open pool or a closed photobioreactor, the use of synthetic culture medium or recirculated wastewater will induce different risks of contamination with other microorganisms, which may modify the availability of the target compounds (degradation,

reorganization etc.). The culture in sea water will induce a high salts concentration which will strongly impact the organization of biomolecules released during the cell disruption, like proteins.
The harvesting may impact the composition of the cells depending on the segregation technology. The flotation or the centrifugation are based on the density, the filtration on the cells size.
The storage of the concentrated biomass before and after cell disruption may have a strong impact on the composition (contamination, enzymatic degradation, oxidation, denaturation, reorganization).
The cell disruption is a crucial step for the recovery of the valuable compounds. The release of the target compounds in the aqueous phase, their integrity and their organization adapted to their recovery will be strongly modified, depending on the cell disruption rate but also on the energy delivered during the disruption, or the physic-chemical conditions (temperature, pH, salt concentration, etc.).
The clarification, fractionation and purification steps thus depend on the control of these former steps.
In literature, a lot of studies can be found on the culture of microalgae and their harvesting. But very few works deal with the impact of the downstream processing on the recovery and integrity of the target compounds.
Preliminary tests were performed in the GEPEA laboratory to evaluate the impact of the cell disruption step on the recovery of lipids and proteins. It was shown that the cell disruption rate influences the release of polar lipids, which may modify the organization of neutral lipids. Depending on the presence of antioxidant, some proteins may aggregate or not.
A deeper analyze of the impact of the pretreatment steps of the microalgae biomass (culture, harvesting, cell disruption) on the fractionation steps is strongly necessary to develop the biorefinery of such renewable resources, with efficient innovative choices of soft and energy-efficient processes to guarantee the integrity of fragile molecules and develop eco-friendly production.
The GEPEA laboratory in Saint Nazaire (France), with the AlgoSolis facility, allows the production of biomass and the study of all the downstream processing steps (harvesting, cell disruption, fractionation). The apparatus are available at the lab and the pilot scale. Several analytical methods are also developed in the lab to characterize the biomolecules. Strong collaborations have been developed with INRA BIA laboratory (Nantes, France) for complementary analysis. The PhD student will thus benefit of an ideal stimulating working environment that will allow the acquisition of important results for the international community working on the microalgae valorization.

The supervisors will be Dr Luc MARCHAL (Nantes University, HDR, luc.marchal@univ-nantes.fr) and Dr Estelle COUALLIER (CNRS, estelle.couallier@univ-nantes.fr).