

Proposed List of MELiSSA PhD Topics

Topic Title: Understanding and characterization of exopolysaccharide (EPS) production in high intensity photobioreactors (PBR)

Keywords: Photobioreactor, Spirulina, MELiSSA loop

Abstract

MELiSSA stands for “Micro-Ecological Life Support System Alternative”. MELiSSA is the European project for circular life support systems and is characterized by a biological and chemical/physical approach based on first principles modelling and implementation of a suitable deterministic engineering approach. Within the MELiSSA loop, the production of oxygen from carbon dioxide and the production of edible biomass is performed by photosynthetic compartments, including a microbial photobioreactor inoculated with *Limnospira indica* microalgae (a.k.a. *Arthrospira platensis*).

Limnospira indica has been chosen for its light energy conversion efficiency, its high pH environment that reduces contamination, and its high nutritional value. Yet, the requirements of a Mars Transit mission impose much higher kinetic volumetric productivity than the current state-of-the-art (e.g. DicoFlux or Priam photobioreactors), while maintaining high constraints on energy, mass, and volume budget of photobioreactors under the ALISSE criteria notation. With such constraints, the intensification of kinetic performance for a scalable production of oxygen and biomass calls for the use of higher light intensities and intensified cultures. However, activities on *Limnospira* culture intensification have shown an increase in the EPS proportion due to the light intensification. An important EPS percentage in the culture modifies the viscosity of the medium and spectral physical properties of the cells. It also increases the formation of biofilm with a risk of clogging especially in thin or internally lightened cultures, or in the instrumentation and harvesting hardware.

The proposed PhD shall study the EPS presence in *Limnospira indica* cultures in terms of growth-relevant metabolic pathways, k_La (volumetric gas-liquid transfer coefficient, limitations), radiative characteristics of the cell suspension and boundary conditions under varying environmental conditions. Attention will be given to understanding the influence of the growth conditions but also of the intensified photobioreactor design parameters to enable the control of EPS production. Focus should be placed on the *Limnospira indica* PCC 8005 strain, used in the ArtEMISS and BIORAT-1 payload developments.

Impact on MELiSSA Project:

Improvement of the efficiency and design of intensified photobioreactors to reach the requirements of future space missions.

Potential MELiSSA Partners:

Universitat Autònoma de Barcelona (E), SCK-CEN: Belgian Nuclear Research Center (B).
Université Clermont Auvergne (F) and Algosolis (F) support would be recommended.
Possible Wrocław University of Science and Technology (PO)

References:

Fahrion, J., Mastroleo, F., Dussap, C.-G., Leys, N. (2021), “Use of Photobioreactors in Regenerative Life Support Systems for Human Space Exploration”, Front. Microbiol., Sec. Microtechnology,

Lasseur, C., Brunet, J., de Wever, H., Dixon, M., Dussap, G., Godia, F., Leys, N., Mergeay, M., Van Der Straeten, D. (2010), "MELiSSA: the European Project of closed life support system", *Gravitational and Space Biology*, 23: 3-12

Decamp, A., Michelo, O., Rabbat, C., Laroche, C., Grizeau, D., Pruvost, J., Gonçalves, O. (2021), "A New, Quick, and Simple Protocol to Evaluate Polysaccharide Composition", *Mar. Drugs*, 19, 101

MELiSSA foundation website: [Melissa Foundation](#)

ALISSE criteria presentation. Version 1, issue 0, 18th November 2009.

ESA Technical Note 137.4 Appendix. Applicable document for using Oscar Methodology System Engineering applied to the MELiSSA data management system: requirements

Candidate's background requirements:

Candidates preferably possess a degree in biology, chemistry, biotechnology or bioengineering. They must be familiar with metabolic pathways analysis, process engineering and simulation tools. It would be an advantage, if the candidates also have some lab experience.