INTERNSHIP PROPOSAL AT INSA TOULOUSE

TRANSFORMATION OF WASTEWATER INTO A RESOURCE: Analysis of the gelling properties of biopolymers by coupling spectroscopic measurements and rheological tests.

CONTEXT

With a view to transitioning to a more circular economy anchored in the bioeconomy, waste and wastewater are no longer considered solely as discharges, but also as resources. The wastewater treatment plant is thus tending to become a water resource recovery facility (WRRFs). Among the innovative processes developed recently, the aerobic granulation process is receiving particular attention. It is based on the use of dense microbial granules rather than simple flocs, which significantly improves settling performance, thus making it possible to reduce the size and energy consumption of the facilities.

These granules have a particularly interesting characteristic: they contain a high proportion of biopolymers, produced by certain bacteria, with gelling and super-water absorbents properties. Such materials offer varied perspectives, ranging from agriculture (protection against desiccation) to materials engineering (additives for concrete or cement, fire retardants). Regarding gelling properties, the challenge is to be able to produce, in a controlled manner, biopolymers with these targeted properties. This involves orienting the process towards target chemical signatures that govern gelling by acting on the operating parameters and microbial selection. **It therefore appears essential to better understand the relationship between the gelling properties of these biopolymers and their (bio)chemical composition (chemical groups), in order to identify the desired characteristics of biopolymers that will then guide their production conditions.**

It is in this context that INSA Toulouse, via its Toulouse Biotechnology Institute and more specifically the SYMBIOSE team, is offering a Master 2 level internship.

OBJECTIVES OF THE INTERNSHIP

The objective of the internship is therefore to characterize biopolymers produced by aerobic granulation processes, by linking their gelling properties and their chemical fingerprint. The approach will thus combine spectroscopic analysis (FTIR) to obtain chemical fingerprints and functional gelation tests, with the aim of identifying the key chemical groups involved in the crosslinking and gel formation mechanisms, but also those whose presence can, conversely, reduce gelling capacities.
The study will therefore seek to establish correlations between the (bio)chemical composition of these biopolymers (chemical fingerprint obtained by Fourier transform infrared spectroscopy – FTIR/ATR) and their functional properties (rheological and gelation tests).

Initially, specific **methodological work** will be carried out to evaluate the sensitivity, limit of quantification and reproducibility of FTIR spectroscopy applied to highly heterogeneous and low concentration biopolymer samples. In particular, metered addition experiments will validate the robustness of the method and better quantify the spectroscopic signals of interest.

In a second phase, **FTIR analyses and gelation tests will be performed on samples from industrial granular sludge reactors and a laboratory reactor**; a comparison of the raw sludge and the biopolymers obtained after extraction will be performed. The data obtained will then be subjected to chemometric processing (PCA, PLS, etc.) to explore and model correlations between chemical fingerprints and gelation properties.
These results will ultimately help to better steer production conditions toward biopolymers with high gelation potential.

Internship steps:

- Bibliography: (i) extracellular biopolymers and their gelling properties, (ii) s-EPS extraction methods, (iii) FTIR spectroscopic characterization method and statistical analyses of pretreatment and normalization, (iv) standard addition method applied to spectroscopic analyses, (v) gelation method developed in the laboratory, (vi) chemometrics.

- Development of the experimental design and analysis of the sensitivity, reproducibility, and robustness of FTIR spectroscopy applied to biopolymer samples from pellets,
- Spectroscopic analyses to determine the chemical fingerprint of biopolymers from different bioreactors (industrial and laboratory), before and after extraction,
- Rheological and gelation tests to evaluate their functional properties,
- Linking of chemical and functional data to identify correlations,
- Interpretation of results and dissemination in the form of reports and presentations.

WHO ARE YOU

- Engineer (or equivalent) in process or bioprocess engineering, bac +5 level.
- Interest in analytical techniques for characterizing biopolymers
- Strong taste for experimental work and data analysis
- Rigor and precision in analytical work and data analysis.
- Interest and aptitude for teamwork.
- Ease of writing (in French or in English).
- Motivation for environmental issues.

CONDITIONS

Fundings : traineeship grant (around 650 €/mois)
Period : February to Jully 2025
Location : TBI, INSA, 135 Avenue de Rangueil, 31077 Toulouse Cedex 04
www.toulouse-biotechnology-institute.com
https://www.toulouse-biotechnology-institute.fr/poles/equipe-symbiose/

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REFERENCE

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