Toulouse Biotechnology Institute
Bio & Chemical Engineering

PhD POSITION – InZymes

Toulouse Biotechnology Institute, France & Wageningen University & Research, the Netherlands

Exploring xylophagous-insect microbiomes by chemical, metagenomic and metaproteomic approaches for the discovery of new lignin-active enzymes

Keywords: lignin, lignocellulose, microbial consortia, xylophagous insects, omics, enzyme discovery, analytical chemistry

CONTEXT

Second-generation lignocellulosic biorefineries can replace fossil resources for the production of fuels, chemicals and materials, but their sustainability depends on the full valorisation of biomass, including lignin. Lignin represent about 10-35% of lignocellulose; it is highly recalcitrant and is still mostly burned, though its conversion into chemicals and materials could yield at least ten times more value. In nature, the gut microbiomes of xylophagous insects (such as termites, beetles, carpenter moths and ants) have evolved under strong selective pressure the ability to deconstruct lignocellulose. Enriching these microbiomes in controlled bioreactors concentrates the metabolic diversity needed for lignin transformation, making them an untapped reservoir of microorganisms and naturally tailored enzymes – a "natural model of enzyme assemblage" for the design of new biocatalysts.

OBJECTIVES

-Elucidate the lignin-degrading activity of xylophagous-insect microbiomes implemented in controlled bioreactors, combining in-depth chemical characterisation and multi-omics approaches;

-Determine the structural modifications of lignin induced by the enriched consortia and identify their key ligninolytic members;

- Capture, express and characterise novel lignin-modifying enzymes from the most active consortia.

WORK PROGRAMME

•Enrichment and activity: implementation of ten xylophagous-insect microbiomes in bioreactors under industrially relevant conditions; lignin characterisation before and after microbial activity by quantitative ^{13}C-IS pyrolysis-GC-MS, 2D HSQC NMR, and measurement of lignocellulolytic enzymatic activities on lignin model compounds.
•Multi-omics: shotgun metagenomics and metaproteomics of the most promising consortia to identify ligninolytic members and candidate genes.
•Enzyme discovery: synthesis, cloning and heterologous expression of selected lignin-modifying genes, and characterisation of their activity on relevant lignin-related molecules.

SUPERVISION AND ENVIRONMENT

The PhD will be supervised by Dr Guillermina Hernández-Raquet (Research Director, INRAE-TBI), whose group has recognised expertise in microbial engineering and bioprocessing, analytical methods and meta-omics (16S and shotgun sequencing, genome reconstruction, qPCR). Co-supervision will be provided by Dr Mirjam Kabel and Dr Gijs van Erven (Wageningen University & Research; WUR), whose group has recognised expertise in lignin analytical chemistry (2D HSQC NMR, pyrolysis-GC-MS, LC-MS/MS). The candidate will be hosted at WUR to perform chemical characterisation. The project also involves collaborations with the GeT-PlaGe INRAE genomics platform and metaproteomics experts.

CANDIDATE PROFILE

MSc (or equivalent engineering degree) in microbiology, biotechnology, biochemistry, bioprocess engineering or a related field. Experience in microbial cultivation, molecular biology (cloning, heterologous expression), analytical chemistry and bioinformatics (Linux, R) will be appreciated. We seek a motivated, rigorous candidate with good communication skills in English, and taste for interdisciplinary teamwork.
Mobility Rule: Applicants must not have resided or conducted their primary activity (work, studies, etc.) in France for more than 12 months in the last 36 months. Periods of stay as a tourist, refugee, or time spent in national service, are not considered as residency.

HOW TO APPLY

Send a CV, a motivation letter, and the contact details of two referees to Dr Guillermina Hernandez-Raquet (TBI)
e-mail : hernandg@insa-toulouse.fr
Start date: **September 2027**. Application deadline: **10 November 2026**.

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