

PhD PROPOSAL FOR THE DOCTORAL SCHOOL « Végétal, Animal, Aliment, Mer, Environnement »

GENERAL INFORMATION

Thesis title: Sustainable biorefinery of plant fibres
Acronym of the project: UPWEARS 1
Discipline de recherche 1 : Chemistry of natural products
Discipline de recherche 2 : Biopolymers and biosourced materials
Three keywords: Plant fibers, textiles, green chemistry
Registration establishment: Université de Nantes
Research unit: Unité d'accueil : UR BIA Biopolymères, Interactions, Assemblages
Name of the thesis director HDR (Accreditation to supervise research) required: : Marc Lahaye Email address of the thesis director: Marc.lahaye@inrae.fr
Name of the thesis co-director (if applicable): HDR (Accreditation to supervise research) required: Richard Sibout Email address of the thesis co-director (if applicable): Richard.sibout@inrae.fr
Name of the thesis co-supervisor 1 (if applicable): Sofiane Guessasma Email address of the thesis co-supervisor 1 (if applicable): Sofiane.guessasma@inrae.fr
Contact(s) (mailing address and E-mail): INRAE Unité BIA- Biopolymères Interactions Assemblages Équipe Paroi Végétale et Polymères Pariétaux (PVPP) Impasse Y. Cauchois / Site de la Géraudière BP71627 44316 NANTES cedex 03 France
<input checked="" type="checkbox"/> Interview

SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context: (10 lines)

The clothing industry is a major contributor to environmental pollution due to issues like dyes, microplastics, poor recycling, and the transportation impacts. In response to this, the European project [UPWEARS](#), which involves 15 international partners, aims to produce prototypes of recyclable smart clothing with limited environmental impact.

One of the primary goals of UPWEARS is to develop sustainable European textile fibre production, processing and recycling methods. This objective involves reevaluating the selection of hemp and flax plants for fibre production and their processing into textiles in collaboration with industrial partners ([Linificio](#), [Pafil to name a few](#)).

Traditional processing of plant fibre typically involves degumming (the removal of non-fibre components) and bleaching using alkaline oxidative reagents. However, this process is energy-intensive, environmentally harmful, and requires high water consumption. To address these issues, the aim of the PhD project is to develop eco-friendly alternatives using Deep Eutectic Solvents (DES) as green solvent.

Assumptions and questions (8 lines)

Deep eutectic solvents can be used to degum natural fibers and create textiles by changing their texture and color.

The main steps of the thesis and scientific procedure (10-12 lines)

The main objectives are:

- Developing an efficient DES functionalization of fibres to serve as templates for further derivatization specifically designed for smart garment applications;
- Gaining a deeper understanding of the chemical mechanisms involved in DES-assisted degumming and bleaching process;
- Addressing the extraction of valuable components, such as lignin, to be recovered from recycled DES;
- Implementing DES-based process at the pilot scale in an industrial environment with optimised technical and economic criteria;
- Tackling the economic, societal, and environmental benefits of utilizing DES compared to classical processes;
- Participating in the consortium meetings, dissemination activities, and communications towards partners, scientific community, and stakeholders.

Methodological and technical approaches considered (4-6 lines)

Biochemistry (NADES)

Analytical chemistry (HPLC, GCMS, HPAEC, MS, NMR)

Microscopy (visible, fluorescence, Raman)

Scientific and technical skills required by the candidate

We are looking for a highly motivated PhD candidate to work in an international environment with partners in Italy, Portugal, Sweden, Belgium, United Kingdom, and New Zealand.

The candidate would preferably have a strong background in chemical engineering and/or material science, with an additional expertise in plant science being advantageous.

In addition, knowledge of natural fibres and instrumental techniques including spectroscopy and microscopy dedicated to chemical, thermal, mechanical and elemental analysis, as well as large instruments will be much appreciated.

THESIS SUPERVISION

Unit name: BIOPOLYMERES, INTERACTIONS, ASSEMBLAGES (BIA)	Team name: Paroi Végétale et Polymères Pariétaux (PVPP)
Unit director name: Bernard Cathala	Team director name: Estelle Bonnin et Anne-Laure Chateigner-Boutin
Mailing address of the unit director: bernard.cathala@inrae.fr	Mailing address of the team director: anne-laure.chateigner-boutin@inrae.fr 02 40 67 50 59

Thesis director

Surname, first name: Lahaye Marc

Position: Research director

Obtained date of the HDR (Accreditation to supervise research):

Employer: INRAE

Doctoral school affiliation: ED-VAAME

Rate of thesis supervision in the present project (%): 40

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 100

Number of current thesis supervisions/co-supervisions: 2

Thesis co-director

Surname, first name: Sibout Richard

Position: research director

Obtained date of the HDR (Accreditation to supervise research): 2015

Employer: INRAE

Doctoral school affiliation: ED-VAAME

Rate of thesis supervision in the present project (%): 30

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 100

Number of current thesis supervisions/co-supervisions: 2

Thesis co-supervisor 1 (if applicable)

Surname, first name: Guessasma Sofiane

Position: research director

Accreditation to supervise research yes no If yes, date diploma received:

Employer: INRAE

Doctoral school affiliation: ED-VAAME

Rate of thesis supervision in the present project (%): 30

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 90

Number of current thesis supervisions/co-supervisions: 3

Professional status of previous PhD students supervised by both director and co-supervisors (from 5 years)

Please provide the following information for each PhD students supervised

Surname, first name:

Date of PhD beginning and PhD defence:

Thesis supervision:

Professional status and location:

Contract profile (post-doc, fixed-term, permanent):

List of publications from the thesis work:

Five main recent publications of the supervisors on thesis subject:

Chen, Mingrui, Luo, Dian, Yang, Yicheng, Lahaye, Marc, Tang, Tingting, Lan, Weijie, Lee, KangJu and Liu, Yaowen.(2024) Exploring the impact of co-extracted cell wall polysaccharides on the stability of blueberry anthocyanins in deep eutectic solvent. Chemical Engineering Journal. 153065. DOI: 10.1016/j.cej.2024.153065

Lahaye, M., Thoulouze, L., Calatraba, M., Gauclain, T., Falourd, X., Le-Quere, J. M., Foucat, L. and Bauduin, R. (2023) A multimodal and multiscale investigation of factors affecting the juice yield of cider apples. *Food Chemistry*. 420. 135649. DOI: 10.1016/j.foodchem.2023.135649

Falourd, X., Lahaye, M. and Rondeau-Mouro, C. (2022) Assessment of cellulose interactions with water by ssNMR: (1)H->(13)C transfer kinetics revisited. *Carbohydrate Polymers*. 298. 120104. DOI: 10.1016/j.carbpol.2022.120104

Chen, Mingrui and Lahaye, Marc. (2021) Natural deep eutectic solvents pretreatment as an aid for pectin extraction from apple pomace. *Food Hydrocolloids*. 115. 106601. DOI: <https://doi.org/10.1016/j.foodhyd.2021.106601>

Chen, Mingrui, Falourd, Xavier and Lahaye, Marc. (2021) Sequential natural deep eutectic solvent pretreatments of apple pomace: A novel way to promote water extraction of pectin and to tailor its main structural domains. *Carbohydrate Polymers*. 266.118113. DOI: <https://doi.org/10.1016/j.carbpol.2021.118113>

THESIS FUNDING

Origin(s) of the thesis funding: European project
Gross monthly salary: 2200€
Thesis funding state: acquired
Funding beginning date/duration of the thesis funding: 01/10/2024

Date: 20 June 2024

Name, signature of unit director: B. Cathala



Name, signature of team director: CHATEIGNER-BOUTIN Anne-Laure



Name, signature of thesis project director:

