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

GENERAL INFORMATION

Thesis title: Histological and compositional determinants of hemp stem quality
Acronym of the project: QUALICHANVRE
Disciplinary field 1: plant biology **Disciplinary field 2: biochemistry, molecular biology and imaging**
Three keywords: Hemp, plant fibres, pectins
Registration establishment: Nantes University
Research unit: UR BIA
Name of the thesis director HDR (Accreditation to supervise research) required: Chateigner-Boutin, Anne-Laure **Email address of the thesis director:** anne-laure.chateigner-boutin@inrae.fr **Name of the thesis co-director (if applicable): HDR (Accreditation to supervise research) required:** **Email address of the thesis co-director (if applicable):** **Name of the thesis co-supervisor 1 (if applicable): Mathis, Fabienne** **Email address of the thesis co-supervisor 1 (if applicable):** f.mathis@hemp-it-adn.com **Name of the thesis co-supervisor 2 (if applicable): Francin-Allami, Mathilde** **Email address of the thesis co-supervisor 2 (if applicable):** mathilde.francin-allami@inrae.fr
Contact(s) (mailing address and E-mail): unité BIOPOLYMERES, INTERACTIONS, ASSEMBLAGES **INRAE U1268 – 3 Impasse Yvette Cauchois, La Géraudière** **44316 NANTES CEDEX 3**
☐ **Doctoral school contest** ☒ **Interview** ☐ **Other (specify):**

SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context: (10 lines)

Hemp, which has been cultivated for thousands of years, is currently in increasing demand as part of the transition to more plant-based textiles and materials. Hemp has many advantages (low water requirement, resistant, soil improvement), and produces high-quality fibres. The project addresses the need for breeding varieties that produce very high quality fibres with good yields.

The aim of the thesis project is to identify the parameters that determine hemp stem fibre quality.

Hemp fibres are phloem bundles. They are formed during the stem development and play a role in transporting the elaborated sap. They are grouped into bundles of fibres that adhere to each other.

When mature, the stems are cut and then retted on the ground, a natural process that facilitates the extraction of the fibres.

Assumptions and questions (8 lines)

We hypothesise that pectins are decisive compounds for the quality of hemp fibre, in particular for its aptitude for retting. These polysaccharides are present in the middle lamella and are involved in tissue cohesion. During retting, enzymes degrade the middle lamella and facilitate fibre isolation. We propose to adress the following questions:

-Are there hemp lines with contrasting pectin content/distribution?

-Do these lines differ in their retting ability?

-Which genes are differentially expressed in hemp stems with contrasting pectin content/distribution? Can these genes be markers of retting ability?

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

- 1: Bibliographical search, assimilation of scientific and technical skills

- 2: Screening of hemp lines using imaging and biochemical approaches to assess line diversity and identify contrasted lines. In particular, pectic polysaccharides will be targeted.

- 3: Imaging approaches will be used to identify stem constituents that are important for the end-use quality of hemp fibre during its development. The distribution of pectins involved in tissue cohesion and retting ability will be established by immunohistochemistry using specific antibodies.

- 4: Comparative analysis of lines with contrasted pectin content and aptitude for retting. A comparative transcriptome analysis of the fibre zone of developing stems will be carried out between 2 to 4 contrasted lines (in terms of pectin content) to highlight the genes differentially expressed in these contrasted genotypes. These lines will also be compared in terms of retting ability. The genes identified will be assessed for their usefulness as markers of aptitude for retting.

- 5: Valorisation of the results (articles, conferences) and writing of the thesis

Methodological and technical approaches considered (4-6 lines)

Conducting and managing a collaborative research project

Monitoring plant cultures and collecting samples

Analysis of stem characteristics, composition and distribution of cell wall compounds using biochemical and imaging methods

Comparative analysis of transcriptomes

Statistical analysis of data

Scientific and technical skills required by the candidate

The thesis project is part of a collaboration between HEMP-IT-ADN, an entreprise specialised in hemp breeding, and the INRAE-BIA unit in Nantes. The thesis work will include regular exchanges and presentations to both partners.

We are looking for candidates with a Master 2 or equivalent degree in plant sciences, with skills in biochemistry and/or imaging and an interest in data processing/analysis.

Good oral and written communication skills are required, as well as proficiency in English and French

THESIS SUPERVISION

Unit name: unité BIOPOLYMERES, INTERACTIONS, ASSEMBLAGES (BIA)	**Team name:** Paroi Végétale et Polymères Pariétaux (PVPP)
Unit director name: Bernard Cathala	**Team director name:** Anne-Laure Chateigner-Boutin et Estelle Bonnin
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: Chateigner-Boutin, Anne-Laure

Position: Researcher INRAE & PVPP Team director

Obtained date of the HDR (Accreditation to supervise research): : 01/09/2017

Employer: INRAE

Doctoral school affiliation: VAAME

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

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

Number of current thesis supervisions/co-supervisions: 2

Thesis co-director

Surname, first name:

Position:

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

Employer:

Doctoral school affiliation:

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

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

Number of current thesis supervisions/co-supervisions:

Thesis co-supervisor 1 (if applicable)

Surname, first name: Mathis, Fabienne

Position: : Responsable R&D

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

Employer: Hemp-it ADN

Doctoral school affiliation:

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

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 30

Number of current thesis supervisions/co-supervisions: 1

Thesis co-supervisor 2 (if applicable)

Surname, first name: Francin-Allami, Mathilde

Position: researcher

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

Employer: INRAE

Doctoral school affiliation: VAAME

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

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 30

Number of current thesis supervisions/co-supervisions: 1

Private partner (if CIFRE funding, private funding…)

Surname, first name:

Position:

Employer:

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

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

Number of current thesis supervisions/co-supervisions:

International partner (if Cotutelle thesis)

Surname, first name:

Position:

Employer:

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

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

Number of current thesis supervisions/co-supervisions:

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: Le, Thang Duong Quoc

Date of PhD beginning and PhD defence: october 2017-décember 2020

Thesis supervision: Anne-Laure Chateigner-Boutin

Professional status and location: Research Engeneer, CENTURI Multi-engineering platform, Marseille

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

List of publications from the thesis work:

1- Legland, D., **Le, T. D. Q**., Alvarado, C., Girousse, C., & Chateigner-Boutin, A. L. (2023). New Growth-Related Features of Wheat Grain Pericarp Revealed by Synchrotron-Based X-ray Micro-Tomography and 3D Reconstruction. Plants (Basel, Switzerland), 12(5), 1038. https://doi.org/10.3390/plants12051038

2- David Legland, Camille Alvarado, Eric Badel, Fabienne Guillon, Andrew King, **Thang Duong Quoc Le**, Camille Rivard, Louis Paré, Anne-Laure Chateigner-Boutin, Christine Girousse. (2022) Synchrotron Based X-ray Microtomography Reveals Cellular Morphological Features of Developing Wheat Grain. Applied science. Special issue "Applications of X-ray Phase Contrast Imaging". 12(7), 3454; https://doi.org/10.3390/app12073454

3--**Le, T. D. Q**., Alvarado, C., Girousse, C., Legland, D., & Chateigner-Boutin, A. L. (2019). Use of X-ray micro computed tomography imaging to analyze the morphology of wheat grain through its development. Plant methods, 15, 84. https://doi.org/10.1186/s13007-019-0468-y

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Surname, first name: Cherkaoui, Mehdi

Date of PhD beginning and PhD defence:: october 2016-december 2019

Thesis supervision: Guillon Fabienne

Professional status and location: Research Engeneer, INRAE

Contrat (post-doc, CDD, CDI) : fixed-term

List of publications from the thesis work:

- Cherkaoui M, Lollier V, Geairon A, Bouder A, Larré C, Rogniaux H, Jamet E, Guillon F and Francin-Allami M (2020). Cell Wall Proteome of Wheat Grain Endosperm and Outer Layers at Two Key Stages of Early Development. *Int. J. Mol. Sci., 21*, 239. Int J Mol Sci. 3;21:1740. *https://doi.org/10.1016/j.plantsci.2018.12.018*
- Cherkaoui M, Geairon A, Lollier V, Clemente HS, Larré C, Rogniaux H, Jamet E, Guillon F, Francin-Allami M (2018). Cell Wall Proteome Investigation of Bread Wheat (*Triticum Aestivum*) Developing Grain in Endosperm and Outer Layers. Proteomics. 18(23):e1800286. https://*doi*.org/*10.1002/pmic.201800286*

Five main recent publications of the supervisors on thesis subject:

1- Costes C, Navarro Sanz S, Calatayud C, Soriano A, Mameri H, Terrier N, **Francin-Allami M**. (2024). Transcriptomic analysis of developing sorghum grains to detect genes related to cell wall biosynthesis and remodelling. BMC Genom Data.,7;25(1):14. https://doi.org/10.1186/s12863-024-01198-x

2- **Anne-Laure Chateigner-Boutin**, Camille Alvarado, Marie-Françoise Devaux, Sylvie Durand, Loïc Foucat, Audrey Geairon, Florent Grélard, Frédéric Jamme, Hélène Rogniaux, Luc Saulnier, Fabienne Guillon (2021-05). The endosperm cavity of wheat grains contains a highly hydrated gel of arabinoxylan. Plant Science, 306, 110845, https://dx.doi.org/10.1016/j.plantsci.2021.110845

3-Yves Verhertbruggen, Axelle Bouder, Jacqueline Vigouroux, Camille Alvarado, Audrey Geairon, Fabienne Guillon, Mark Wilkinson, Fabian Stritt, Markus Pauly, Mi Yeon Lee, Jenny Mortimer, Henrik Scheller, Rowan A.C. Mitchell, Cătălin Voiniciuc, Luc Saulnier, **Anne-Laure Chateigner-Boutin** (2021). The TaCslA12 gene expressed in the wheat grain endosperm synthesizes wheat-like mannan when expressed in yeast and Arabidopsis. Plant Science, 302, 110693, https://dx.doi.org/10.1016/j.plantsci.2020.110693

4-Vásquez-Ocmín PG, Marti G, Bonhomme M, **Mathis F,** Fournier S, Bertani S, Maciuk A. (2021) Cannabinoids vs. whole metabolome: Relevance of cannabinomics in analyzing Cannabis varieties. Anal Chim Acta. 1;1184:339020. doi: 10.1016/j.aca.2021.339020.

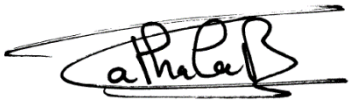
5- **Francin-Allami M**, Alvarado C, Daniel S, Geairon A, Saulnier L, Guillon F (2019). Spatial and temporal distribution of cell wall polysaccharides during grain development of *Brachypodium distachyon*. Plant Sci.;280:367-382. *https://doi.org/10.1016/j.plantsci.2018.12.018*

THESIS FUNDING

Origin(s) of the thesis funding: Région Pays de la Loire 50%. Private company partner 50% (Hemp-it ADN) acquired on condition that the Region Pays de la Loire accepts co-financing.
Gross monthly salary: 2100 euros
Thesis funding state: Partly acquired (co-funding)
Funding beginning date/duration of the thesis funding: 15/10/2024, duration 3 years

Date: 06/06/2024

Name, signature of unit director: Cathala Bernard



Name, signature of team director: Chateigner-Boutin Anne-Laure

Name, signature of thesis project director: Chateigner-Boutin Anne-Laure

All sections must be filled in. Once completed, please save the proposal form in PDF format using the following naming: Supervisor Name_Unit_Subject Acronym_EN.pdf
Please also send a Word version to make it easier to change the layout if necessary.

Documents to be send to: ed-vaame@doctorat-paysdelaloire.fr