

PhD PROPOSAL FOR THE DOCTORAL SCHOOL « Ecologie, Géosciences, Agronomie, ALimentation »

GENERAL INFORMATION

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| Thesis title: Cell Wall impact on storage protein availability and digestibility of sorghum grains. |
| Acronym: So-WallDigest |
| Disciplinary field 1: Food sciences |
| Disciplinary field 2: Agronomy |
| Three keywords: Sorghum, grain, digestibility |
| Research unit : Biopolymères Interactions Assemblages (BIA), INRAE of Nantes |
| Name of the thesis director HDR required: Saulnier Luc |
| Email address of the thesis director: luc.saulnier@inrae.fr |
| Name of the thesis co-director (if applicable): HDR (Habilitation thesis to supervise research) required: |
| Email address of the thesis co-director (if applicable): |
| Name of the thesis co-supervisor 1 (if applicable): Francin-Allami Mathilde |
| Email address of the thesis co-supervisor 1 (if applicable): mathilde.francin-allami@inrae.fr |
| Name of the thesis co-supervisor 2 (if applicable): Mameri Hamza |
| Email address of the thesis co-supervisor 2 (if applicable): hamza.mameri@inrae.fr |
| Thesis grant (funding origin and amount): 50/50 INRAE (obtained)/Région Pays de la Loire (in progress) |
| Contact(s) (mailing address and E-mail): INRAE Site de la Géraudière, CS 71627, F-44 316 Nantes Cedex 3 |
| Recruitment process: Recruitment process depends on thesis funding. To select the corresponding recruitment process, please visit the EGAAL website here . This information is needed for proposal publication. <input type="checkbox"/> Doctoral school contest <input checked="" type="checkbox"/> Interview <input type="checkbox"/> Other (indicate) : |

All sections must be filled. Once filled, please save the proposal form in pdf format using the following naming: Supervisor Name_Unit_Subject Acronym_EN.pdf

ED EGAAL

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SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context : (10 lines)

In occident, a qualitative and quantitative intake of protein is now ensured by the consumption of products derived from the animal products (meat, milk, eggs, fish). At the world scale, the transition to plant protein resources is imperative for the future given the demographic outlook and the environmental cost of animal husbandry. Sorghum is the 5th most cultivated cereal in the world. Sorghum is an ecological plant: thanks to its good photosynthetic yield even in dry conditions and to its dense and deep root system, sorghum is able to extract and use more water and soil nutrients efficiency. In addition, sorghum plant is able to efficiently remove fertilizers from the soil, so it is easy to dispense with fertilizer. It is also few exposed to diseases and pests therefore requires less phytosanitary treatments. Thanks to these agri-environmental benefits, sorghum could become an essential way for global food security.

Assumptions and questions (8 lines)

The digestibility of the storage proteins (mainly kafirins) by gastrointestinal proteases is significantly lower in sorghum grain than for other cereals. Some data indicate that cell walls could play an important role in the availability and digestibility of these proteins. Our working hypothesis is that endosperm cell walls constitute a physical barrier in sorghum grains that limit the digestibility of protein bodies by gastrointestinal proteases.

The research question proposed to the candidate is to verify this hypothesis by exploring the impact of cell walls on the protein digestibility of sorghum grains.

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

1. Impact of cell walls on the storage protein digestibility: effect of the wall integrity
2. Characterization of the interactions between storage proteins and cell walls.
3. Cell wall setting up during grain development
 - Cell wall evolving-relationship with the storage proteins.
 - Identification of the genes involved in the cell wall setting up.
4. Cell wall deconstruction during germination process
 - Activity of cell wall degrading enzymes
 - Characterization of the cell wall during germination
 - Differential expression of genes involved in cell wall breakdown at a tissue scale.

Methodological and technical approaches considered (4-6 lines)

In vitro digestion of storage proteins

- Biochemistry and physico-chemistry of proteins and polysaccharides (assays, enzymology, LC-MS chromatography)
- Fluorescence microscopy, transmission electron, immunostaining
- Transcriptomics (RNAseq, data interpretation)

Scientific and technical skills required by the candidate
 Skills required in protein and polysaccharide biochemistry. Experience in the "omics" data analysis under R, as well as in microscopy would be an additional advantage for a good progress of the thesis.
 This work involving multidisciplinary and communication with several scientists, the student will have to demonstrate a sense of synthesis in order to be able to relate all the data acquired during the three years of the thesis.
 Good writing and communication skills in French and English.

THESIS SUPERVISION¹

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|---|--|
| Unit name: Biopolymères Interactions Assemblages (BIA) | Team name: Parois Végétales et Polymères Pariétaux (PVPP) |
| Unit director name: Marc Anton | Team director name: Estelle Bonnin et Anne-Laure Chateigner-Boutin |
| Mailing address of the unit director: marc.anton@inrae.fr | Mailing address of the team director: estelle.bonnin@inrae.fr et anne-laure.chateigner-boutin@inrae.fr |
| Thesis director Surname, first name: Saulnier Luc Position: Research Director Obtained date of the HDR (Habilitation thesis to supervise research): 1997 Employer: INRAE Doctoral school affiliation: EGAAL Rate of thesis supervision in the present project (%): 40% Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 70% Number of current thesis supervisions/co-supervisions: 2 | |
| Thesis co-director | |

¹ In EGAAL Doctoral School, if only one scientist in thesis supervision = 100% of supervision rate; if 2 people involved in thesis supervision = from 50% to 70% of supervision rate for the director; if 3 people involved in thesis supervision = 40% / 30% / 30% of supervision rate distribution among supervisors.

Surname, first name:

Position:

Obtained date of the HDR (Habilitation thesis 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: Francin-Allami Mathilde

Position: Researcher

Habilitation thesis to supervise research yes no If yes, date diploma received:

Employer: INRAE

Doctoral school affiliation: EGAAL

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

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 0%

Number of current thesis supervisions/co-supervisions: 0

Thesis co-supervisor 2 (if applicable)

Surname, first name: Hamza Mameri

Position: Researcher

Habilitation thesis to supervise research yes no If yes, date diploma received:

Employer: INRAE

Doctoral school affiliation: GAIA

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

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 50%

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

Doctorant 1

Surname, first name: Cherkaoui Mehdi

Date of PhD beginning and PhD defence: oct 2016 to déc 2019

Thesis supervision: Guillon Fabienne and Mathilde Francin-Allami

Professional status and location: engineer at BIBS platform, INRAE Nantes

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

List of publications from the thesis work:

Cherkaoui, M., Lollier, V., Geairon, A., Boudier, A., Larré, C., Rogniaux, H., Jamet, E., Guillon, F. and **Francin-Allami, M.** Cell Wall Proteome of Wheat Grain Endosperm and Outer Layers at Two Key Stages of Early Development. *Int. J. Mol. Sci.* 2020;21: 239. doi:10.3390/ijms21051740.

Cherkaoui M, Geairon A, Lollier V, Clemente HS, Larré C, Rogniaux H, Jamet E, Guillon F, **Francin-Allami M.** Cell Wall Proteome Investigation of Bread Wheat (*Triticum Aestivum*) Developing Grain in Endosperm and Outer Layers. *Proteomics.* 2018 Dec;18(23):e1800286. doi: 10.1002/pmic.201800286

Doctorant 2

Surname, first name: Nadia YACOUBI

Date of PhD beginning and PhD defence: 1 décembre 2012 - 29 septembre 2016

Thesis supervision: L.SAULNIER en cotutelle U. GENT F. Van Immerseel

Professional status and location: Research Manager Poultry Nutrition - EVONIK, Germany

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

List of publications from the thesis work:

Yacoubi, N., **Saulnier, L.**, Bonnin, E., Devillard, E., Eeckhaut, V., Rhayat, L., Ducatelle, R., Van Immerseel, F., 2018. Short-chain arabinoxylans prepared from enzymatically treated wheat grain exert prebiotic effects during the broiler starter period. *Poult. Sci.* 97, 412–424. doi:10.3382/ps/pex297

Yacoubi, N., Van Immerseel, F., Ducatelle, R., Rhayat, L., Bonnin, E., **Saulnier, L.**, 2016. Water-soluble fractions obtained by enzymatic treatment of wheat grains promote short chain fatty acids production by broiler cecal microbiota. *Anim. Feed Sci. Technol.* 218, 110–119. doi:http://dx.doi.org/10.1016/j.anifeedsci.2016.05.016

Five main recent publications of the supervisors on thesis subject:

Francin-Allami M, Alvarado C, Daniel S, Geairon A, Saulnier L, Guillon F. Spatial and temporal distribution of cell wall polysaccharides during grain development of *Brachypodium distachyon*. *Plant Sci.* 2019;280:367-382.

Saulnier L. Types and Functionality of Polysaccharides in Cereal Grains. *Cereal Grain-based Functional Foods: Carbohydrate and Phytochemical Components.* 2019;6:54-84.

Cherkaoui, M., Lollier, V., Geairon, A., Boudier, A., Larré, C., Rogniaux, H., Jamet, E., Guillon, F. and **Francin-Allami, M.** Cell Wall Proteome of Wheat Grain Endosperm and Outer Layers at Two Key Stages of Early Development. *Int. J. Mol. Sci.* 2020;21: 239. doi:10.3390/ijms21051740

Hennet L, Berger A, Trabanco N, Ricciuti E, Dufayard JF, Bocs S, Bastianelli D, Bonnal L, Roques S, Rossini L, Luquet D, **Terrier N** and Pot D. Transcriptional Regulation of Sorghum Stem Composition: Key Players Identified Through Co-expression Gene Network and Comparative Genomics Analyses. *Frontiers in plant science*, 2020;11: 224. https://doi.org/10.3389/fpls.2020.00224

Mameri H, Brossard C, Gaudin JV et al. Structural Basis of IgE Binding to alpha- and gamma-Gliadins: Contribution of Disulfide Bonds and Repetitive and Nonrepetitive Domains. *J. Agri Food Chem.* 2015;63: 6546-6554 .

THESIS FUNDING

Origin(s) of the thesis funding: 50% INRAE (TRANSFORM department) ; 50% région Pays de la Loire

Gross monthly salary: 1874 euros


Thesis funding state : Partly acquired (co-funding)

Funding beginning date/Funding ending date: september 2021-august 2024.

Date: 15th march 2021

Name, signature of unit director:

Institut National de la Recherche Agronomique
Biopolymères, Interactions, Assemblages (BIA)
rue de la Géraudière - BP 71627
44316 Nantes Cedex 3 - France



Name, signature of team director:



Name, signature of thesis project director:

