

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

### GENERAL INFORMATION

<b>Thesis title: Impact of the variability of minor components of grain endosperm on wheat technological quality</b>
<b>Acronym:</b> EVAGRAIN
<b>Disciplinary field 1:</b> Food sciences <b>Disciplinary field 2:</b> Agronomy
<b>Three keywords:</b> Pentosans, Lipids, Bread
<b>Research unit :</b> UR 1268 BIA
<b>Name of the thesis director HDR required:</b> Luc SAULNIER <b>Email address of the thesis director:</b> luc.saulnier@inrae.fr <b>Name of the thesis co-director (if applicable):</b> HDR required: Guy DELLA VALLE <b>Email address of the thesis co-director (if applicable):</b> guy.della-valle@inrae.fr <b>Name of the thesis co-supervisor 1 (if applicable):</b> Sophie Le Gall <b>Email address of the thesis co-supervisor 1 (if applicable):</b> sophie.le-gall@inrae.fr <b>Name of the thesis co-supervisor 2 (if applicable):</b> <b>Email address of the thesis co-supervisor 2 (if applicable):</b>
<b>Thesis grant (funding origin and amount):</b> 50% ANR (acquired - contract ANR-20-CE21-0008-05) <b>co-funding 50% PdL region (submitted)</b>
<b>Contact(s) (mailing address and E-mail):</b> INRAE UR 1268 BIA, 3 impasse Yvette Cauchois, CS 71627, 44 316, Nantes Cedex, France - Email: luc.saulnier@inrae.fr
<b>Recruitment process:</b> Recruitment process depends on thesis funding. To select the corresponding recruitment process, please visit the EGAAL website <a href="#">here</a> . This information is needed for proposal publication. <input type="checkbox"/> <b>Doctoral school contest</b> <input checked="" type="checkbox"/> <b>Interview</b> <input type="checkbox"/> <b>Other (indicate) :</b>

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## SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

### **Socio-economic and scientific context : (10 lines)**

Wheat is the most important renewable resource for human food and animal feed. The evaluation of wheat quality is complex, especially as agriculture (1) faces challenges linked to climate changes and (2), has to meet consumer expectations for more nutritious and healthier food. This context imposes significant constraints on wheat production and grain transformation, which requires a closer adaptation of the raw material to the food transformation processes. Part of the answer lies in a better use of wheat cultivars, which implies a better characterization of their use value.

Currently, the criteria that determine this use value are mostly empirical and focused on bakery use. In addition, the perception of « quality » has long been driven by the concept of having enough proteins capable of forming a suitable gluten network in dough, in order to ensure the greatest volume of bread. The ANR EvaGrain project aims to develop a new evaluation system of wheat quality and as part of it, to introduce new relevant biochemical criteria by integrating non-protein components such as lipids and pentosans.

### **Assumptions and questions (8 lines)**

Most studies on grain quality have focused on proteins and starch, although minor compounds of grain (lipids, cell wall polysaccharides/pentosans) play an important role in milling properties, transformation into baked foods and nutritional properties. These effects are due to their interactive properties, such as their ability to absorb large amounts of water for pentosans or to interact with starch polymers and proteins for lipids. The content and structure of these compounds although partly genetically determined, are influenced by climate changes and also vary according to their localization in the grain. The study will determine lipids and pentosans, in grain and flour of various cultivars grown in different environments, and seek for relations with dough processing properties. In particular, the PhD project will focus on the interaction of pentosans with water and its kinetics.

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

The PhD project will investigate the variability of lipids and pentosans in a set of wheat cultivars selected to cover a broad range of technological performances, in order to feed a decision support system. It encompasses 3 main steps:

1- Lipids and pentosans will be quantified by state of the art methods developed at BIA, for a collection of 150 wheat samples and over two years. New analytical approaches using enzymatic fingerprinting will be set-up and implemented to determine the main structural features of pentosans in order to select most representative samples.

2 - For selected samples, the water content and mobility will be determined by NMR in grain, flour and dough and related to pentosans structural features, in order to establish the impact of their variability on the behaviour of the dough.

3 - Data statistical analysis will be carried out to identify most significant relationships of the pentosans (and lipids) structure and properties with wheat quality criteria for breadmaking.

Finally, within the framework of the EvaGrain project, these relationships will feed into a decision support system that will be used by stakeholders in the cereal sector.

### **Methodological and technical approaches considered (4-6 lines)**

- Analytical biochemistry for the measurement of lipids and carbohydrate, including GLC, GLC/MS, HPLC methods.
- Size exclusion chromatography and light scattering for Mw determination, viscosity of macromolecular solution
- NMR relaxometry to study water mobility

- Rheological methods: penetrometry, thermomechanical analysis, extension and adhesion tests (dough)
- Data analysis: multivariate analysis (PCA, PLS, HCA...)

### Scientific and technical skills required by the candidate

The PhD project takes place within the framework of a collaborative research project funded by the ANR and including 10 academic and industrial partners. The PhD work will include regular presentations to the project steering committee. Numerous exchanges of data and information will take place with the partners involved in the evaluation of wheat quality/bread performance as well as with another PhD involved in knowledge integration and computer development of the decision support system.

We are looking for candidates with a master's degree or equivalent in the fields of food science, biochemistry/analytical chemistry with an interest in data processing/analysis.

Good communication skills are requested

Good level of French is required or will have to be acquired during PhD

Knowledge of cereal/wheat products is desirable

## THESIS SUPERVISION<sup>1</sup>

<b>Unit name:</b> INRAE UR 1268 BIA	<b>Team name:</b> PVPP and BIBS
<b>Unit director name:</b> Marc ANTON	<b>Team director name:</b> Anne-Laure Chateigner-Boutin
<b>Mailing address of the unit director:</b> marc.anton@inrae.fr	<b>Mailing address of the team director:</b> anne-laure.chateigner-boutin@inrae.fr
<b>Thesis director</b> 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	

<sup>1</sup> 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.

**Thesis co-director**

Surname, first name: DELLA VALLE Guy

Position: IRHC

Obtained date of the HDR (Habilitation thesis to supervise research): 1993

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) (%): 40

Number of current thesis supervisions/co-supervisions: 1

**Thesis co-supervisor 1 (if applicable)**

Surname, first name: LE GALL Sophie

Position: Research Engineer, Head of BIBS platform

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) (%):

Number of current thesis supervisions/co-supervisions:

**Thesis co-supervisor 2 (if applicable)**

Surname, first name:

Position:

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

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:

**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)**

*Doctorant 1*

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

*Doctorant 2*

Nom, prénom : ASSAD-BUSTILLOS MéliSSa

Date de début et de fin de thèse : Mai 2016-Juin 2019

Direction de thèse : Guy DELLA VALLE

Emploi actuel, lieu : Post-doctorat ETH Zurich (CH)

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

Liste des publications issues de ce travail de thèse :

M. Assad-Bustillos, C. Tournier, C. Septier, G. Della Valle, G. Feron. Relationships of oral comfort perception and bolus properties in the elderly with salivary flow rate and oral health status for two soft cereal foods. *Food Research International*, 2019, 118, 13–21,  
<https://doi.org/10.1016/j.foodres.2017.11.05>

M. Assad-Bustillos, C. Tournier, G. Feron, S. Guessasma, AL Reguerre, G. Della Valle. Fragmentation of two soft cereal products chewed by elderly with different oral health status. *Food Hydrocolloids* 2019, 91, 153-165, doi.org/10.1016/j.foodhyd.2019.01.009

M. Assad-Bustillos, J. Palier, H. Rabesona, Y. Choiset, G. Della Valle, G. Feron. The role of the bolus structure degree on protein bioaccessibility during *in vitro* digestion of a pea protein fortified sponge-cake chewed by elderly. *J. Texture Studies*, 51, 134-143, 2019. DOI:10.1111/jtxs.12486

Assad-Bustillos M., Jonchère, C., Garnier, C., Réguerre, A.L., Della Valle, G. Rheological and microstructural characterization of batters and sponge cakes fortified with pea proteins, *Food Hydrocolloids*, 101, 105553, 2020, <https://doi.org/10.1016/j.foodhyd.2019.105553>

**Five main recent publications of the supervisors on thesis subject:**

Marion, D., Saulnier, L., 2020. Minor components and wheat quality: Perspectives on climate changes. *J. Cereal Sci.* 94, 103001. doi:10.1016/j.jcs.2020.103001

Barron, C., Bar-L'Helgouac'h, C., Champ, M., Saulnier, L., 2020. Arabinoxylan content and grain tissue distribution are good predictors of the dietary fibre content and their nutritional properties in wheat products. *Food Chem.* 328, 127111. doi:10.1016/j.foodchem.2020.127111

Saulnier, L., 2019. CHAPTER 4. Types and Functionality of Polysaccharides in Cereal Grains, in: Beta, T., Camire, M.E. (Eds.), *Food Chemistry, Function and Analysis No. 6 Cereal Grain-Based Functional Foods: Carbohydrate and Phytochemical Components*. The Royal Society of Chemistry, pp. 54–84. doi:10.1039/9781788012799-00054

Fanuel, M., Ropartz, D., Guillon, F., Saulnier, L., Rogniaux, H., 2018. Distribution of cell wall hemicelluloses in the wheat grain endosperm: a 3D perspective. *Planta* 248, 1505–1513. doi:10.1007/s00425-018-2980-0

Arufe, S., Chiron, H., Doré, J., Savary-Auzeloux, I., Saulnier, L., Della Valle, G., 2017. Processing & rheological properties of wheat flour dough and bread containing high levels of soluble dietary fibres blends. *Food Res. Int.* 97, 123–132. doi:10.1016/j.foodres.2017.03.040

**THESIS FUNDING**

**Origin(s) of the thesis funding: 50% ANR – 50 % PdL region**

**Gross monthly salary: 1874 €**

**Thesis funding state : Partly acquired (co-funding)**

**Funding beginning date/Funding ending date: October 2021- 36 months**

**Date: March 29<sup>th</sup> 2021**

**Name, signature of unit director: Marc Anton**

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

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



**Name, signature of thesis project director:** Luc Saulnier

