**PhD PROPOSAL FOR THE DOCTORAL SCHOOL**

**« Végétal, Animal, Aliment, Mer, Environnement »**

# **GENERAL INFORMATION**

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| **Thesis title:** Development of Innovative Control Methods to control emerging hazards associated with protein alternatives |
| **Acronym of the project:** DECIMALE |
| **Disciplinary field 1:** microbiology  **Disciplinary field 2:** food safety |
| **Three keywords**: food pathogens, genomes, controls |
| **Registration establishment:** Oniris VetAgroBio |
| **Research unit:** UMR 1014 INRAE Oniris SECALIM |
| **Name of the thesis director HDR (Accreditation to supervise research) required:** Emmanuel JAFFRÈS  **Email address of the thesis director: emmanuel.jaffres@oniris-nantes.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):** Boris MISERY  **Email address of the thesis co-supervisor 1 (if applicable): boris.misery@oniris-nantes.fr**  **Name of the thesis co-supervisor 2 (if applicable):** Géraldine BOUÉ  **Email address of the thesis co-supervisor 2 (if applicable): geraldine.boue@inrae.fr** |
| **Contact(s) (mailing address and E-mail):**  SECALIM Oniris VetAgroBio G5, Route de Gachet 44307 Nantes |
| **Doctoral school contest**  **Interview**  **Other (specify):** |

# **SCIENTIFIC DESCRIPTION OF THE PhD PROJECT**

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| **Socio-economic and scientific context: (10 lines)**  Future demographic and environmental challenges are encouraging populations to explore new alternatives. Plant products and the use of insects are now recognized as potential alternatives to animal products. However, the measures already implemented to control the microbiological quality of conventional foodstuffs have not been developed for plant and insect-based protein substitutes.  The transposition of classic analytical methods is not suitable for controlling these emerging hazards. Indeed, for the insect matrix, limits have been highlighted for detecting pathogens and spoilage bacteria due to the richness and variability of their microbiota and these matrices can give rise to new hazards not detected by the current targeted methods implemented (Brulé et al 2024). Plant alternatives can increase significantly the exposure to already known hazards through their high consumption level but also through the implementation of new processing processes. |
| **Assumptions and questions (8 lines)**  The thesis project aims to characterize the bacterial diversity of these food alternatives, insects and plant products, and to evaluate the effectiveness of microbiological control methods and to develop them with a view to their future regulation and quality controls relevant to implement. Innovative methods such as metagenomics and quantitative PCR will be used in addition to the classical cultural methods for microbiology.  The ultimate objective is to assist public authorities in controlling the safety and quality of protein alternatives, particularly insect Novel Foods, as well as the booming plant-based alternatives. The results of this project will provide valuable scientific support for the development of agri-food industries, while meeting the growing needs of consumers looking for new safe and sustainable protein sources. |
| **The main steps of the thesis and scientific procedure (10-12 lines)**  **The PhD thesis project will take place in 5 consecutive phases:**   1. Identify and prioritize emerging biological hazards associated with the use of 2 protein alternatives (plant and insect): literature review, hazard analysis and risk ranking ***- 5 months***   Deliverables:   * Literature review *(Article 1)* * Risk ranking for foods-hazards pairs *(Article 1)* * Foods selection: Insect and Plant and the relevant hazard models  1. Characterization of the microbial ecosystems of the 2 selected food models (insect and plant) by using the culture-dependent and independent (metagenomic approach) methods ***– 9 months***   Deliverables:   * Strains isolation and collection from the food models using the culture media * Characterization of the selected microbial ecosystems *(Article 2)*  1. Characterization of the isolated strains from food matrices (Whole-Genome Sequencing, WGS) whose choice will be refined according to the results of steps (1 and 2) ***- 12 months***   Delivrables:   * + The genomes analysis will allow to identify markers related to the bacterial virulence, the food transformation process resistance and food spoilage *(Article 2)*  1. Develop a strategy and methods to detect targeted hazards ***- 6 months***   Delivrables:   * + Strategy for detecting emerging hazards by developing a decision tree including cultural and non-cultural methods *(Article 3)*   + Assessment of the developed detection methods effectiveness by challenge test on matrices *(Article 3)*  1. Writing deliverables (articles) and finalizing the PhD thesis manuscript ***- 4 months***   Delivrables:   * + PhD thesis manuscript   + PhD thesis defense |
| **Methodological and technical approaches considered (4-6 lines)**  Classical microbiology, metagenomics, handling in P2 laboratory ; hazards analysis and prioritization, bioinformatics analyzes |
| **Scientific and technical skills required by the candidate**  Microbiology; basic notions in statistics; knowledge in molecular biology and bioinformatics would be a plus |

# **THESIS SUPERVISION**

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| **Unit name:** UMR 1014 INRAE-Oniris SECALIM | **Team name:** |
| **Unit director name:** Marie-France Pilet | **Team director name:** |
| **Mailing address of the unit director:**  [marie-france.pilet@inrae.fr](mailto:marie-france.pilet@inrae.fr) | **Mailing address of the team director:** |
| **Thesis director**  Surname, first name: Emmanuel JAFFRÈS  Position: Associate professor  Obtained date of the HDR (Accreditation to supervise research): 18th of october 2023  Employer: French ministry for agriculture  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) (%): 0  Number of current thesis supervisions/co-supervisions: 0 | |
| **Thesis co-supervisor 1 (if applicable)**  Surname, first name: Boris MISERY  Position: Associate professor  Accreditation to supervise research  yes  no If yes, date diploma received:  Employer: French ministry for agriculture  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) (%): 0  Number of current thesis supervisions/co-supervisions: 0 | |
| **Thesis co-supervisor 2 (if applicable)**  Surname, first name: Géraldine BOUÉ  Position: Associate professor  Accreditation to supervise research  yes  no If yes, date diploma received:  Employer: French ministry for agriculture  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) (%): 55%  Number of current thesis supervisions/co-supervisions: 2 | |
| **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: GAILLAC Antoine  Date of PhD beginning and PhD defence: december 2020 – february 2024  Thesis supervision: Emmanuel JAFFRÈS (co-direction : Hervé PREVOST)  Professional status and location: looking for work  Contract profile (post-doc, fixed-term, permanent):  List of publications from the thesis work:  Gaillac A., Gourin C., Dubreil L., Briandet R., Prévost H. and **E. Jaffrès**. Biofilm formation of the food spoiler Brochothrix thermosphacta on different industrial surface materials using a biofilm reactor. Food Microbiology. Volume 120, June 2024. DOI: https://doi.org/10.1016/j.fm.2023.104457  Gaillac A., Briandet R., Delahaye E., Deschamps J., Vigneau E., Philippe Courcoux., **Jaffrès E** and H. Prévost (2022). Exploring the diversity of biofilm formation by the food spoiler Brochothrix thermosphacta. Microorganisms. 2022 Dec 15;10(12):2474. doi: 10.3390/microorganisms10122474  Surname, first name: MAILLET Aurélien  Date of PhD beginning and PhD defence: february 2017 – february 2021  Thesis supervision: Hervé PREVOST (co-supervisor: Emmanuel JAFFRÈS)  Professional status and location: Molecular & Genomics Capability Lead, MARS Global Services Laboratories  Contract profile (post-doc, fixed-term, permanent): permanent  List of publications from the thesis work:  Maillet A., Bouju-Albert A, Roblin S., Vaissié P., Leuillet S, Dousset X., **Jaffrès E**., Combrisson J. and H Prévost (2021). Impact of DNA extraction and sampling methods on bacterial communities monitored by 16S rDNA metabarcoding in cold-smoked salmon and processing plant surfaces. *Food Microbiology*. 95:103705. DOI: 10.1016/j.fm.2020.103705  Maillet A., Denojean P., Bouju-Albert A., Scaon E., Leuillet S., Dousset X., **Jaffrès E**., Combrisson J. and H Prévost (2021). Characterization of Bacterial Communities of Cold-Smoked Salmon during Storage. *Foods*. 10(2):362. DOI: 10.3390/foods10020362  Surname, first name: ILLIKOUD Nassima  Date of PhD beginning and PhD defence: november 2014 – july 2018  Thesis supervision: Monique ZAGOREC (co-supervisor: Emmanuel JAFFRÈS)  Professional status and location: Associate professor by contract, Université de Rennes 1  Contract profile (post-doc, fixed-term, permanent): fixed-term  List of publications from the thesis work:  Illikoud N, Rossero A, Chauvet R, Courcoux P, Pilet MF, Charrier T, **Jaffrès E**, Zagorec M. (2019) Genotypic and phenotypic characterization of the food spoilage bacterium *Brochothrix thermosphacta*. Food Microbiol. 2019 Aug ; 81: 22-31. doi: 10.1016/j.fm.2018.01.015.  Illikoud N, Gohier R, Werner D, Barrachina C, Roche D, **Jaffrès E**, Zagorec M. (2019) Transcriptome and Volatilome Analysis During Growth of *Brochothrix thermosphacta* in Food: Role of Food Substrate and Strain Specificity for the Expression of Spoilage Functions. Front Microbiol. 2019 Nov 8 ; 10:2527. doi: 10.3389/fmicb.2019.02527  Illikoud N, Klopp C, Roulet A, Bouchez O, Marsaud N, **Jaffrès E**, Zagorec M. (2018) One complete and three draft genome sequences of four *Brochothrix thermosphacta* strains, CD 337, TAP 175, BSAS1 3 and EBP 3070. Stand Genomic Sci. 2018 Oct 10; 13:22. doi: 10.1186/s40793-018-0333-z  Illikoud N, **Jaffrès E**, Zagorec M. (2018) *Brochothrix thermosphacta*. Elsevier’s Reference Module in Life Sciences - Encyclopedia of Microbiology (Fourth Edition). <https://doi.org/10.1016/B978-0-12-809633-8.12106-5>  Nom, prénom : FELICIANO Rodney  Date de début et de fin de thèse : Octobre 2019 – Janvier 2023  Direction de thèse : Jeanne-Marie Membré (co-encadrement Géraldine Boué)  Emploi actuel, lieu : Post-doc SECALIM  Contrat (post-doc, CDD, CDI) : Post-doc  Liste des publications issues de ce travail de thèse :  Feliciano, R. J., G. Boué, F. Mohssin, M. M. Hussaini and J.-M. Membré 2023. Raw milk quality in large-scale farms under hot weather conditions: Learnings from one-year quality control data. Journal of Food Composition and Analysis 117: 105127. <https://doi.org/10.1016/j.jfca.2023.105127>.  Feliciano, R. J., P. Guzmán-Luna, G. Boué, M. Mauricio-Iglesias, A. Hospido and J.-M. Membré 2022. Strategies to mitigate food safety risk while minimizing environmental impacts in the era of climate change. Trends in Food Science & Technology 126: 180-191. <https://doi.org/10.1016/j.tifs.2022.02.027>  Feliciano, R., G. Boué, F. Mohssin, M. M. Hussaini and J.-M. Membré 2021. Probabilistic modelling of Escherichia coli concentration in raw milk under hot weather conditions. Food Research International 149: 110679. <https://doi.org/10.1016/j.foodres.2021.110679>.  Feliciano, R. J., G. Boué and J.-M. Membré 2020. Overview of the potential impacts of climate change on the microbial safety of the dairy industry. Foods 9(12). https://doi.org/10.3390/foods9121794.  Nom, prénom : NGET Sovannmony  Date de début et de fin de thèse : Octobre 2020 – Septembre 2023  Direction de thèse : Lionel Boillereaux (co-encadrement Géraldine Boué)  Emploi actuel, lieu : Enseignant-chercheur à Institute of Technology of Cambodia  Contrat (post-doc, CDD, CDI) : CDD  Liste des publications issues de ce travail de thèse :  Nget S, Mith H, Boué G, Curet S, Boillereaux L. The Development of a Digital Twin to Improve the Quality and Safety Issues of Cambodian Pâté: The Application of 915 MHz Microwave Cooking. Foods. 2023 Mar 11;12(6):1187. doi: 10.3390/foods12061187. PMID: 36981120; PMCID: PMC10048061.  Nom, prénom : VERVERIS Ermolaos  Date de début et de fin de thèse : Janvier 2020 – Septembre 2024  Direction de thèse : Androniki Naska (co-encadrement Géraldine Boué)  Emploi actuel, lieu : Scientific officer at Nutrition and Food Innovation Unite (EFSA)  Contrat (post-doc, CDD, CDI) : CDI  Liste des publications issues de ce travail de thèse :  Ververis, E., Niforou, A., Poulsen, M., Pires, S. M., Federighi, M., Samoli, E., ... & Boué, G. (2024). Substituting red meat with insects in burgers: estimating the public health impact using risk-benefit assessment. *Food and Chemical Toxicology*, 114764.  Boué, G., Ververis, E., Niforou, A., Federighi, M., Pires, S. M., Poulsen, M., ... & Naska, A. (2022). Risk–Benefit assessment of foods: Development of a methodological framework for the harmonized selection of nutritional, microbiological, and toxicological components. *Frontiers in Nutrition*, 9, 951369.  Ververis, E., Boue, G., Poulsen, M., Pires, S. M., Niforou, A., Thomsen, S. T., ... & Naska, A. (2022). A systematic review of the nutrient composition, microbiological and toxicological profile of Acheta domesticus (house cricket). *Journal of Food Composition and Analysis*, *114*, 104859.  Kooh, P., Ververis, E., Tesson, V., Boué, G., & Federighi, M. (2019). Entomophagy and public health: a review of microbiological hazards. *Health*, *11*(10), 1272-1290. | |
| **Five main recent publications of the supervisors on thesis subject:**   * Brulé L., Misery B., Baudouin G., Yan X., Guidou C., Trespeuch C., Foltyn C., Anthoine V., Moriceau N., Federighi M. and Boué G. (2024). Evaluation of the Microbial Quality of *Hermetia illucens* Larvae for Animal Feed and Human Consumption: Study of different type of Rearing Substrates. Foods. Accepted * Maillet, A., Denojean, P., Bouju-Albert, A., Scaon, E., Leuillet, S., Dousset, X., Jaffrès E., Combrisson, J. and Prévost, H. (2021). Characterization of bacterial communities of cold-smoked salmon during storage. Foods, 10(2), 362. * Bouju-Albert A., Saltaji S., Dousset X., Prévost H. and E. Jaffrès (2021). Quantification of viable Brochothrix thermosphacta in cold-smoked salmon using PMA/PMAxx-qPCR. Frontiers in Microbiology. 2021 Jul 14;12:654178. DOI: 10.3389/fmicb.2021.654178. * Kooh, P., Jury, V., Laurent, S., Audiat-Perrin, F., Sanaa, M., Tesson, V., Federighi, M. and Boué, G. (2020). Control of biological hazards in insect processing: Application of HACCP method for yellow mealworm (*Tenebrio molitor*) powders. Foods, 9(11), 1528. | |

# **THESIS FUNDING**

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| **Origin(s) of the thesis funding:** 50/50Oniris / Région Pays de La Loire (CPER) |
| **Gross monthly salary:** 2100 euros |
| **Thesis funding state:** Partly acquired (co-funding) |
| **Funding beginning date/duration of the thesis funding:** 01/12/2024 - 3 years |

**Date:** 19/07/2024

**Name, signature of unit director:**

Marie-France Pilet

**Name, signature of team director:**

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



**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](mailto:ed-vaame@doctorat-paysdelaloire.fr)