

**Proposition d’un sujet de thèse en cotutelle**

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**Domaines d’expertise :**

Microbiologie, Biologie, Sciences alimentaires, Qualité des produits alimentaires d’origine végétale et animale

**Publications importantes en relation avec le sujet proposé :**

Abi Khalil R., Yvon S., Couderc C., Belahcen L., Jard G., Sicard D., Bigey F., El Rammouz R. Abi Nakhoul P., Eutamène H., Tormo H. &Ayoub M.-J. 2022. Microbial communities and main features of Labneh Ambaris, a traditional Lebanese fermented goat's milk product. Submitted. *Journal of Dairy Science*

Ayoub M-J, Bechara p., Habchi M, Hosry R., Akl M., Haj Hassan S. & Abi Nakhoul P. 2022. Raw goat’s milk fermented Ambarees from Lebanon: insights into the chemical changes and microbial dynamics occurring during an artisanal production, with an accent on yeasts. Submitted. *Journal of Dairy Research*

Ayoub M-J, Legras J-L, Abi Nakhoul P., Nguyen H.V., Saliba R. & Gaillardin C. 2021. Lebanon’s native oenological Saccharomyces cerevisiae flora: assessment of different aspects of genetic diversity and evaluation of winemaking potential. *Journal of Fungi*. 7(8):678. https://doi.org/10.3390/jof7080678

Mrad, R., El Rammouz, R., Maroun, R. G., & Louka, N., 2015. Effect of intensification of vaporization by decompression to the vacuum as a pretreatment for roasting Australian chickpea: Multiple optimization by response surface methodology of chemical, textural and color parameters. *Journal of Food Quality*, 38 : 139- 152. P6.

Mrad, R., El Rammouz, R., Maroun, R. G., & Louka, N., 2014. Study of IVDV as a texturizing pre-treatment for roasting maize and its effect on quality parameters. *Current Science International*, 3(3) : 222- 231.

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**Domaines d’expertise :**

L’équipe de recherche « Adaptation, diversité et écologie des levures domestiquées » dans lequel s’intègrerai la doctorante travaille sur la diversité et l’adaptation des levures domestiquées dans les produits fermentés avec comme deux grand modèle d’étude le vin et le pain. Son activité de recherche fait appel à plusieurs disciplines : génétique moléculaire, génomique, métagenomique, écologie des communautés et génétique des populations. Le site web de l’équipe <https://www6.montpellier.inrae.fr/spo/Equipes/ADEL>, présente les thématiques plus précisément.

**Publications importantes en relation avec le sujet proposé :**

* 2021

Alfonzo A, Sicard D, Di Miceli G, Guezenec S, Settanni L. 2021. Ecology of yeasts associated with kernels of several durum wheat genotypes and their role in co-culture with Saccharomyces cerevisiae during dough leavening. *Food Microbiology*, **94**: 103666.

Boudaoud S, Sicard D, Suc L, Conéjéro G, Segond D, Aouf C. 2021.Ferulic acid content variation from wheat to bread. *Food Science & Nutrition*,. https://onlinelibrary.wiley.com/doi/abs/10.1002/fsn3.2171 (Accessed March 29, 2021).

Boudaoud S, Aouf C, Devillers H, Sicard D, Segond D. 2021. Sourdough yeast-bacteria interactions can change ferulic acid metabolism during fermentation. *Food Microbiology*, **98**: 103790.

* 2020

Bigey F, Segond D, Friedrich A, Guezenec S, Bourgais A, Huyghe L, Agier N, Nidelet T, Sicard D. 2020. Evidence for Two Main Domestication Trajectories in Saccharomyces cerevisiae Linked to Distinct Bread-Making Processes. *Current Biology*, S0960982220316912.

Carbonetto B, Nidelet T, Guezenec S, Perez M, Segond D, Sicard D. 2020. Interactions between Kazachstania humilis Yeast Species and Lactic Acid Bacteria in Sourdough. *Microorganisms*, **8**: 240.

von Gastrow L, Madec M-N, Chuat V, Lubac S, Morinière C, Lé S, Santoni S, Sicard D, Valence F. 2020. Microbial Diversity Associated with Gwell, a Traditional French Mesophilic Fermented Milk Inoculated with a Natural Starter. *Microorganisms*, **8**: 982.

Roussel P, Onno B, Michel E, Sicard D. 2020. *La panification au levain naturel*. éditions Quae https://library.oapen.org/handle/20.500.12657/39944 (Accessed January 11, 2021).

* 2019

Urien C, Legrand J, Montalent P, Casaregola S, Sicard D. 2019. Fungal Species Diversity in French Bread Sourdoughs Made of Organic Wheat Flour. *Front. Microbiol.*, **10**. https://www.frontiersin.org/articles/10.3389/fmicb.2019.00201/full (Accessed June 16, 2020).

* 2018

Carbonetto B, Ramsayer J, Nidelet T, Legrand J, Sicard D. 2018. Bakery yeasts, a new model for studies in ecology and evolution. *Yeast*, **35**: 591–603.

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**Description du sujet de thèse proposé : Discipline :**

Microbiologie - Technologie alimentaire et biologie moléculaire

**Titre et Résumé :**

**Development of novel protein-rich and sensory appealing bakery products using adapted autochthonous starters and legumes flours**

**Résumé**

L’augmentation de l’insécurité alimentaire au Liban couplée à une forte industrialisation de l’alimentation, a conduit à une baisse de la qualité nutritionnelle des aliments. Cette tendance touche particulièrement le domaine boulanger qui a pris plus de place dans les ménages libanais par raréfaction des ressources protéiques. Faire face à cela impose d’envisager autrement l’alimentation et de promouvoir à nouveau des systèmes alimentaires durables. L’une des solutions serait de recourir à des ressources trouvées dans des produits locaux naturels dans le but d’assurer une offre boulangère plus grande, plus diversifiée et plus saine. Dans ce contexte, ce projet vise à produire des produits boulangers nouveaux ayant des propriétés organoleptiques et nutritionnelles intéressantes. Pour cela il faudra sélectionner des levains autochtones afin de les utiliser comme levains à des préparations boulangères nouvelles. L’exploitation des propriétés technologiques de ces levains autochtones associée à l’introduction de nouveaux ingrédients boulangers, les protéines et les farines de légumineuses, permettra de développer des produits innovants, naturels (exempts d’additifs alimentaires) et dotés de caractéristiques organoleptiques nouvelles et de propriétés nutritionnelles supérieures à celles des produits actuellement présents sur le marché libanais, notamment en termes de teneur en protéines, minéraux et vitamines. Ce projet contribuera à une autosuffisance alimentaire locale par la préservation et la maitrise des productions traditionnelles aléatoires, la diversification de l’offre des produits boulangers locaux, l’augmentation de leur accessibilité et l’assurance de leur qualité, notamment par l’augmentation de leur valeur nutritionnelle. L’utilisation de farines de légumineuses à grande échelle augmentera la demande pour ces plantes et contribuera à la relance de leurs cultures et à l’augmentation des surfaces plantées au Liban ce qui sera bénéfique pour les secteurs agricole et industriel et contribuera à répondre à la crise alimentaire que traverse actuellement le Liban et le monde.

**Sujet :**

**Description du sujet (contexte scientifique, description du problème, Objectifs, …..) :**

Lebanon is currently going through one of the most serious crises in its contemporary history due to several factors, one of them being its great dependence on imports. The bakery sector, which represents one of the pillars of Lebanese food, is not immune to this crisis, aggravated in this particular case by the explosion of the Beirut port and the destruction of the national silos. In this project we aim at producing novel baked foods endowed with richer organoleptic features than their usual industrial counterparts and rich in leguminous proteins to increase the sources of meat-alternative proteins in the human diet. Legumes are part of the classical diet of numerous Mediterranean countries, including Lebanon, and they are culturally well accepted by consumers. These plants adapted to the climate of many Mediterranean countries, and more particularly Lebanon, are easy to produce by environmental friendly means and have numerous nutritional and health benefits. To reach our goal, we herein propose a comprehensive approach that exploits legumes in numerous ways. To manufacture the novel foods, we will turn to the use of legumes flours and we will propose new adapted autochthonous starters isolate from legumes for their use in sourdough fermentations. Our objectives are to: (i) Introduce legumes as new food ingredients for bakery products and determine their properties, functionalities, nutritional benefits and effects of their use. (ii) Encourage the use of legumes flours in an enrichment approach, by introducing them in various formulations of bakery products and testing the effects of their use. (iii) Exploit autochthonous microorganisms isolated from traditional Lebanese foods based on legumes fermentations and sourdoughs. (iv) Propose new starters for the baking industry adapted to legumes flours (v) Develop new products, enriched with legumes proteins, having many health benefits including improved bioavailability of nutrients, more proteins, minerals and vitamins, lower glycemic indexes, reduced antinutritional factors and longer shelf-life than their counterparts as well as new appealing organoleptic features and a reduced cost in comparison to animal-protein based foods. (vi) Evaluate social acceptance of the baked goods by utilizing sensorial analysis approaches and consumers’ acceptance studies. (vii) Promote consumption of the newly developed products and the use of the new proteins, flours, starters to encourage new sustainable consumption behaviors and increase acceptance in the general and professional population. Our project thus introduces sustainable baked foods rich in alternative and cheap sources of proteins of plant origin. The development of these novel foods is inspired by traditional Mediterranean foods and will mimic the fermentations they are based upon while securing them against unpredictable evolutions. The novel baked products, formulated and evaluated as to minimize resistance and increase consumers’ acceptance, will be characterized by better nutritional, organoleptic and techno-functional properties and will benefit consumers by offering improved bio-preservation, answering nutritional needs and enhancing food security and acceptability. They will also benefit various actors of the bakery field including bakers, whether artisanal or industrialized, as well as individual households. Aside from its international scope, the work will be of major importance to Lebanon since this pioneering project will contribute to ensuring food security and independence through diversification of the offer of baked goods found on the Lebanese market.

**Approche méthodologique :**

To select starters from the major microbial species present in legumes sourdoughs we will use identification and intraspecific typing to detect the major strains that should be the most adapted to be used in baked foods production. We will use for this purpose classical microbial and molecular biology methods (PCR, RFLP, sequencing, etc…). Assessment of fermentation properties and other properties of the relevant strains will come next and will be done using high throughput techniques like fermentation robot. Various biochemical and technological traits of interest, including reduction of antinutritional factors, fermentation capacities and enzymatic activities will be determined. Based on these results, the most relevant and interesting strains will be selected to develop mixed starters of LAB bacteria and yeasts to be used in the formulations of various bakery products. In parallel, a second part will address proteins purification from several legumes. To optimize the purification procedure, different methods will be tested and their efficacy assessed. Various properties of the purified proteins will be determined. The third part will be devoted to the formulation of novel baked products using legumes proteins, flours, and starters. We will collaborate on this issue with industrialized and artisanal bakeries. The rheological, chemical and physical characteristics of the dough and products as influenced by the use of these new ingredients will be evaluated in order to better understand the effects of using the selected starters, proteins and new flours. The rheological, chemical, physical and aromatic characteristics of the develop prototypes will be evaluated in order to better understand the effects of the use of selected starters and protein rich flours. Sensory profiling of the products will also be determined to propose the most adequate food prototypes. The sensory features of the products will be determined by resorting to sensorial analysis approaches and consumers’ acceptance studies. Promotion of the novel products will be made through campaigns, blogs, fairs, tasting sessions and offering starters and new formulations/mixes to producers.

**Résultats attendus :**

The ultimate goal of our project is to introduce new products, rich in low-cost nutritious legumes proteins and possessing new and appealing organoleptic and nutritional features to the variety of bakery products, including staple ones like bread, available to consumers. At the end of this thesis project we expect to: (i) Uncover the effects of using legumes flours and proteins as new food ingredients for bakery products, determine their properties, functionalities, nutritional benefits and potential uses. (ii) Identify and conserve autochthonous microorganisms isolated from traditional foods and based on natural fermentations and sourdoughs (iii) Propose new starters for the baking industry adapted to legumes flours addition after uncovering the nutritional and organoleptic effects of their use (iv) Develop new products, enriched with chickpea proteins, having many health benefits including improved bioavailability of nutrients, more proteins, fibers, minerals and vitamins, lower glycemic indexes, reduced antinutritional factors and longer shelf-life than their counterparts as well as new appealing organoleptic features and a reduced cost in comparison to animal-protein based foods. (v) Engage bakers in the formulation and production processes of the new foods. (vi) Introduce these products to the Lebanese society and ensure their social acceptance in the general and professional population as well as in specific consumers’ niches (e.g. vegans) (vii) Promote and encourage new sustainable consumption behaviors

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**Mots clés :**

Produits boulangers, pain, farine, légumineuses, formulation, fermentation, microbiologie, physico-chimie, aromes, analyse sensorielle

**Possibilité de financement (Justificatif éventuel) :**

Les travaux inscrits dans le cadre de cette thèse bénéficieront du soutien d’un projet de recherche scientifique octroyé par l’université libanaise à Dr Pierre Abi Nakhoul, enseignant chercheur à la faculté d’agronomie ainsi que l’appui d’un industriel – Crown Flour Mills, pour réaliser les travaux relatifs à la partie formulation, panification et analyse physico-chimique sur la farine et le pain ainsi que l’analyse sensorielle des produits boulangers issus de ce travail

**Profil Scientifique du candidat :**

Etudiant diplômé de la faculté d’agronomie avec un titre d’ingénieur Agronome - option sciences et technologies alimentaires et ayant travaillé lors de son projet de fin d’études sur la microbiologie, la biologie moléculaire, des analyses chimiques et sensorielles. Il doit avoir donné complète satisfaction concernant son travail au laboratoire, son implication et sa motivation pour effectuer sur ce genre de travail. Une expérience préalable dans la synthèse et la relation d’articles est fortement souhaitée

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