PhD DISSERTATION PROJECTS

**Lactic acid bacteria fermentation to improve the techno-functional and nutritional value of products and by-products in the agri-food chain**

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The purpose of this PhD research project is to investigate the potential use of lactic acid bacteria (LAB) fermentation to valorise the tecno-functional characteristics of product and by product of food industries. The first part of the research will be focused on the study of different LAB metabolism with the aim to find out the most performing strains to be used in the fermentation process. In the last part of the project the fermentation will be used as part of the production process to obtain a product that will be reinsert in the food chain.

Fermentazione lattica come strategia per migliorare le caratteristiche tecniche, funzionali e nutrizionali di prodotti e sottoprodotti della filiera agroalimentare

L’obbiettivo di questo progetto di dottorato è di investigare il potenziale uso della fermentazione da parte di batteri lattici (LAB) per valorizzare le caratteristiche tecnologiche, funzionali e nutrizionali dei prodotti e sottoprodotti della filiera agroindustriale, con l’obbiettivo finale di ottenere prodotti tradizionali migliorati e/o prodotti innovativi. La prima parte della ricerca sarà focalizzata sullo studio del metabolismo dei LAB, al fine di trovare i ceppi più performanti. Successivamente, la fermentazione sarà usata come parte integrante del processo per ottenere prodotti che saranno reinseriti nella filiera agroalimentare.

# **1. State-of-the-Art**

There is a lot of evidence showing how the overuse of our natural resources is taking us to a point of no return where the environment can no longer sustain society as we know (Aschemann-Witzel and Stangherlin, 2021).

By 2050, there will be at least 10 billion people in the world, and the demand of food sources is projected to significantly increase and, alongside this, food waste (FW) is becoming one of the most severe environmental, social, and economic problems in developed and developing countries. That’s why moving to more sustainable protein sources together with the optimization of the current resources and the reduction and re-use of food waste throughout the agri-food chain, has become of primary importance.

However, using this kind of matrices is a real challenge, because their chemical composition, the presence of antinutritional compounds, the unavailability of important components such as vitamins and often the poor techno-functional and organoleptic properties, make these kinds of products difficult to use.

Research is fast moving forward to find innovative and sustainable technologies to reuse and integrate new protein sources and food waste in the food chain.

In this optic, lactic acid fermentation could represent a valid tool to improve the techno-functional properties, making these matrices more attractive (Adebo et al., 2022; Papagianni, 2012).

It is known that LAB are able to produce high-valuable molecules and, thanks to their metabolism, could modify the structural characteristics of the matrices through proteolysis and the production of viscous compounds such as exopolysaccharides (EPS) (Wang et al., 2021). In particular, in this PhD project, the phenotypic characteristic of different LAB species belonging to UPCC (University of Parma Culture Collection) will be studied and the most promising strains will be selected and used for the fermentation process.

In particular, the fermentation characteristics, the ability to produce exopolysaccharides and thus the possibility to modulate the viscosity of fermented products, together with the ability to produce aroma and other interesting compounds will be taken into consideration.

Different vegetal-based products will be tested, from plant food waste, plant by-products, plant protein extract, cereals and legumes flours, etc.

The final aim of this PhD project will be to improve the characteristics of existing products by adding the fermented matrices as a functional ingredient or developing new fermented food and/or beverages from FW and underutilize matrices, that will be reinsert in the food chain.

**2. PhD Thesis Objectives and Milestones**

Within the overall objective mentioned above this PhD thesis project can be subdivided into the following activities according to the Gantt diagram given in Table 1:

A1) **Literature review**

A2) **Screening of LAB,** grow performances and metabolites production

A3) **LAB fermentations,** use of underuse traditional or alternative sources from different vegetable matrix

A4) **Developing new enriched products** or renovate traditional foods

A5) **Writing and Editing** of the PhD thesis, scientific papers and oral and/or poster communications.

***Table 2***Gantt diagram for this PhD thesis project.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activity / Months | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** |
| A1) | **Literature review** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A2) | **LAB screening** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A3) | **LAB fermentations** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A4) | **Developing new enriched products** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A5) | **Thesis and Paper Preparation** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# **3. Selected References**

Adebo, J.A., Njobeh, P.B., Gbashi, S., Oyedeji, A.B., Ogundele, O.M., Oyeyinka, S.A., Adebo, O.A., (2022) *Fermentation of Cereals and Legumes: Impact on Nutritional Constituents and Nutrient Bioavailability*. Fermentation 8, 63. https://doi.org/10.3390/fermentation8020063

Aschemann-Witzel, J., Stangherlin, I.D.C., (2021) *Upcycled by-product use in agri-food systems from a consumer perspective: A review of what we know, and what is missing*. Technol. Forecast. Soc. Change 168, 120749. https://doi.org/10.1016/j.techfore.2021.120749

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