



METABIOLAC industrial research chair in metabolic activity and the functionality of bioprotective lactic cultures

Duration: 2016-2021

Highlights

- Market trends limit resorting to traditional microbiological barriers (e.g., chemical additives) to ensure food quality and safety.
- The discovery of new generations of natural and safer antimicrobials represent one of the most promising approaches.
- As part of this project, unique lactic acid bacterial strains with antibacterial and antifungal properties against pathogenic strains or spoilage strains in fermented dairy products were isolated and characterized.
- Technological processes were developed for the production and long-term stabilization of bioprotective cultures and functional ingredients.
- The effectiveness of the various ingredients developed was validated in different dairy matrices, notably cheddar (activity against *Clostridium tyrobutyricum*) and yogurt (antifungal activity).
- The effectiveness of bactoformin, nisin and reuterin against the clinical isolates responsible for bovine mastitis was demonstrated *in vitro*. In addition, the bacterial load of dairy cows' teat skin was reduced following the implementation of teat baths based on a combination of these three antimicrobial compounds.

Objectives

Our specific objectives in dairy sector are:

- To conduct *in vitro* and *in vivo* evaluations of the potential of new, natural antimicrobial-based products produced by lactic acid bacteria as an alternative to antibiotics in the prevention and treatment of sub-clinical and clinical mastitis in dairy cows;
- To develop an environmentally friendly approach based on the use of bioprotective lactic acid bacterial cultures or their metabolites for the positive modulation of microbial ecosystems in milk and dairy products and for controlling undesirable flora in these products. The impact of such an approach on the quality and safety of these products will be evaluated.

Results and potential benefits

Protective cultures and metabolites demonstrating unique antibacterial and antifungal activity: Several bioprotective lactic acid bacterial strains were identified and selected for their antibacterial or antifungal activity against pathogenic flora and spoilage flora in fermented dairy products. Some of these strains demonstrated an ability to inhibit the growth of moulds frequently isolated in cheese (*Penicillium chrysogenum*) or a spoilage strain in dairy products such as *Clostridium tyrobutyricum*, which is responsible for the butyric swelling of cheese. Six strains of *Lactobacillus reuteri* that produce reuterin, a broad-spectrum aldehyde that can inhibit the growth of moulds in yogourt, were isolated. The purified reuterin obtained demonstrated strong fungicidal activity as well as antibacterial activity against pathogenic strains resistant to some antibiotics. This antimicrobial, as well as bactoformin and nisin, prevented the growth of bacteria isolated from bovine mastitis cases. The use of teat baths based on a combination of the three antimicrobial compounds reduced the bacterial load of dairy cows' teat skin, suggesting their potential use for the prevention of mammary infections in dairy cattle. In parallel, a fermentation and spray-drying process for the production of natural bioingredients, concentration and long-term stabilization of culture environments containing selected protective strains and their metabolites was developed.

Galenic food-grade forms for the protection and controlled release of bacterial cultures or their metabolites: Capsules for protecting protective cultures and metabolites with antibacterial and antifungal activity and gradually releasing them in food were developed and characterized. Their effectiveness as bioconserving agents was demonstrated in Cheddar cheese, grated Mozzarella cheese and stirred yogurt type models.

In the mid-term, this work will help improve the safety of dairy products through the use of natural products and will help reduce losses related with their downgrading. This new generation of safe, natural products might also be useful for stemming the apparition of mastitis in cows.



Innovative aspects

- Approach focusing on the use of new synergic consortiums based on bioprotective lactic acid bacteria and/or natural antimicrobial compounds in order to reduce the use of chemical additives and salt for food preservation (biofood sector) and antibiotics for the prevention of bovine mastitis (veterinary sector).
- Updating of innovative, industry-transferable processes for the small- and large-scale production, stabilization and protection of the various consortiums of antimicrobial compounds developed.

Professionals trained

Training of skilled workers in the field of milk and dairy product quality and safety.

Laurent Dallaire (entrepreneur, Innodal), **Hélène Pilote Fortin** (food specialist) and **Samantha Bennet** (research assistant) completed their Master's project in the context of the Chair, while **Sabrina Naimi** (postdoctoral fellow, Institut Cochin) and **Hebatoallah Hassan** (assistant instructor) completed their PhD studies. Additionally, three PhD students (**Liya Zhang**, **Samira Soltani** and **Isabelle Iachella**) are currently pursuing their research projects.

For further information

- Presentation of the results at Novalait's Forum Techno and annual meeting, as well as Agropur's annual scientific meeting and the Acfas's 88th annual conference
- Presentation of posters at national and international conferences
- Publishing of scientific articles in *Food Control*, *Frontiers in Chemistry*, *Frontiers in Microbiology and Probiotics and Antimicrobial Proteins*, *Industrial Biotechnology*, *ACS Infectious Disease*, *International Journal of Food Microbiology*, *Scientific Reports*, *Archives of Microbiology*, *FEMS Microbiology Reviews*, and *Environmental Microbiology*.
- Patenting
- Development of a spin-off (Innodal) by a chair student for the large-scale production of bioprotective cultures
- Signing of an agreement with a company to conduct research on the bioprotective activities of the *Carnobacterium divergens* M35 strain (approved by Health Canada as a new food additive) in fermented dairy products
- Tests for scaling up four bioprotective cultures were completed by a ferment company

Financial contributions

The research chair is funded under the program of the National Sciences and Engineering Research Council of Canada (NSERC) Industrial Research Chair in collaboration with the Quebec consortium for industrial bioprocess research and innovation (CRIBIQ).

Industrial partners are:

- Biena
- Cascades
- La Coop Fédérée
- Fumoir Grizzly
- Novalait
- Olymel
- Sani-Marc Group

Total budget: \$1,916,685

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