Development, evaluation, validation and implementation of FTIR-based technology for rapid microbial identification of pathogens associated with cow mastitis

Duration: 2020-2022

Highlights

- Rapid and cost-effective methods of identifying microbial pathogens can have a tremendous impact on milk quality and reduce losses due to quality defects associated with bovine mastitis.
- Current methods require the use of well-trained technicians, reagents, expensive instrumentation (e.g., MALDI TOF MS) and/or expensive genotyping (whole genome sequence or PCR) methods.
- We have developed a single-step technology [based on Fourier transform infrared (FTIR) spectroscopy] for the identification of microorganisms that is reagent-free and provides results in 1-2 minutes subsequent to initial microbial culture.
- This technology can be implemented on portable instruments suitable for on-farm use.
- For proof-of-concept, we are developing FTIR spectral databases for use in the identification of isolates from the Mastitis Pathogens Culture Collection maintained by the Réseau mammite/Mastitis Network at the Faculté de médecine vétérinaire de l'Université de Montréal. We have carried out an evaluation study of the method to demonstrate the successful discrimination (>99%) between Gram-positive and Gram-negative mastitis pathogens and between coagulase-negative staphylococci (CoNS) and S. aureus, and we have also achieved successful discrimination (>99%) between multiple species within the CoNS group.
- The next steps include integration of the methodology with commercially available on-farm culture kits and validation of the database for identification of bacteria isolated from the milk of Quebec dairy cows exhibiting subclinical mastitis.

Objectives

Our general objective is to develop cost-effective methodology for rapid species identification of bacteria, yeasts, and molds that can be implemented in the agri-food sector for on-site use by addressing the following questions:

- Can we develop a one-step method for microbial identification down to the species level?
- Can such a technology be used to discriminate between microorganisms implicated in cow mastitis and milk quality?
- Can the proposed technology provide comparable accuracy to current technologies?
- Can on-farm implementation be successfully achieved?

Results and potential benefits

Economic:
A one-step microbial identification technology capable of providing timely identification of contagious and environmental mastitis pathogens isolated from milk cultures will result in Improved mastitis prevention and control on dairy farms, leading to:

- Increased overall profitability of dairy farms
- Improved milk quality; reduction in product losses due to quality defects
- Increased productivity of the dairy sector

Environmental - For information only:

- Reduction of routine antibiotic use in dairy cows for prevention and control of mastitis (blanket dry-cow therapy)

Social - For information only:

- Improvement of animal health and welfare on Quebec dairy farms

Innovative aspects

- Simpler technology currently under development in our laboratory to identify species of bacteria, yeasts and molds.
- Focus for the first time on the identification of bacterial species isolated by bovine milk culture and associated with clinical mastitis or with subclinical mastitis resulting in unacceptable milk quality.
- Farmers and milk processors can benefit from increased low-cost surveillance of their animals and dairy-based products.

Professionals trained

- Ms. **Xin Di Zhu,** doctoral student (in progress), aims to develop expertise in addressing food safety issues, particularly in relation to microbial hazards, and is involved in collaborative projects in this area of research with labs at Health Canada and the Canadian Food Inspection Agency. In the present project, Ms. Zhu's roles are:
  - Developed FTIR spectral databases encompassing over 300 isolates obtained from the Mastitis Pathogens Culture Collection
  - Developed FTIR-based classification models for microbial discrimination and identification based on differences between the infrared spectra of the microorganisms
  - Tested the performance of the newly developed FTIR-based microbial identification methods against existing methods
- Ms. **Lisa Lam** and Ms. **Tamao Tsutsumi** (doctoral students)
  Both students are completing their doctoral theses concerning various applications of FTIR spectroscopy in clinical microbiology; they trained and assisted Ms. Zhu in all the aspects of her work listed above.

For further information

The results of this ongoing research project will be included in the doctoral thesis of Ms. Zhu and will be published in a peer-reviewed scientific journal such as Journal of Dairy Science. She will have the opportunity to present these findings to research participants at the Faculté de Médecine Vétérinaire de l'Université de Montréal and conferences will be given at different moment for example at the Novalait Forum Techno.

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