Factors affecting persistence of *Listeria monocytogenes* need to be identified for evaluation and prioritization of interventions

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Project funding dates

January 1, 2020 – December 31, 2020

Acknowledgements

We would like to thank our industry collaborators, Thomas Krueger, Matts Wells, and Diane Wetherington. Thanks also to Kate Ghezzi-Kopel, Cornell University Mann Library, for help in the development of the review protocols.

Summary

Persistence of *Listeria* in produce packing and fresh-cut facilities continues to be a concern that must be addressed through implementation of "seek and destroy" programs. While industry has improved their ability to detect *Listeria* persistence ("seek"), identification and implementation of strategies to eliminate or manage persistence ("destroy") remain a challenge. There is a need to have improved resources to (i) rapidly identify risk factors responsible for *Listeria* persistence and factors that contribute to dispersal of resident strains; and (ii) identify appropriate science-based interventions that prevent, eliminate, or manage relevant root causes. The produce industry has a need for data and procedures to validate *Listeria* persistence interventions, which will allow produce facilities to justify a given control strategy to regulatory agencies, customers, and auditors.

Benefits to the Industry

Near-term benefits will include the ability of the produce industry to immediately use interventions identified as effective, including use of our findings to justify interventions to regulators or third parties. The produce industry will also be able to immediately use the factors review and the final prioritization list to help them in the selection of appropriate and effective interventions to use in their facilities. The distinct, quantifiable and measurable outcome for this project will be the development of a published set of guidelines, vetted by a focus group of experts, on factors contributing to *Listeria* persistence and the prioritization of validated interventions to address these factors, specifically in produce facilities.

Objectives

1. Conduct a systematic review of published and unpublished data and literature to identify modifiable factors that may contribute to resident *Listeria* in produce packing and fresh-cut facilities and relevant interventions, assess the validity of these findings based on the strength of evidence, and prioritize interventions for assessment in Objs. 2 and 3 using expert elicitation.
2. Use controlled experiments and observational studies to validate selected interventions identified in Obj. 1 in produce packing and fresh-cut facilities with resident *Listeria*.
3. Validate selected interventions that are challenging to validate experimentally (e.g., extensive facility modifications) using our previously developed agent-based model.

Methods

We are working on a rapid review to identify a list of factors and relevant interventions, such that all studies must meet the inclusion criteria listed in **Table 1**. We will then work with each of our operations to select factors and relevant interventions for testing using a root cause analysis framework. Next, we will implement interventions and assess them with either a controlled experiment or an observational study. Then we will apply an agent-based model to evaluate different interventions using data obtained in objectives 1 and 2. Finally, we will conduct a focus group to review the outputs from the computer simulations tested by the model and develop final guidelines on how to address a *Listeria* persistence problem.

Results to Date

The protocol for the rapid literature review has been established and posted on https://osf.io/2m3cj/. The database search, de-duplication, abstract screening, and conflict resolution have been completed. The full text literature review is currently in progress (**Figure 1**). A pilot study to test the root cause analysis procedure for identifying and implementing intervention strategies to control persistent *Listeria* has been performed in a local packinghouse (**Figure 2**). Additionally, packinghouses to be used for the current study have been identified.

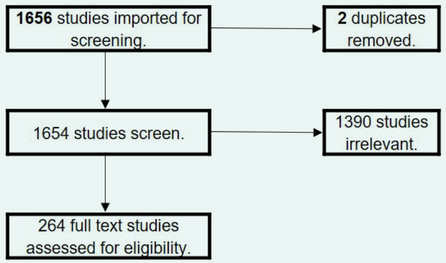

Figure 1. Results from the study screening process for the rapid literature review.

Figure 2. Samples were collected at a participating operation as a pilot to test the root cause analysis strategy that will be used in the current study for identifying and implementing interventions to control persistent *Listeria*.

Inclusion criteria:
Take place in a food operation (including produce fresh-cut facilities or packinghouses) with description of environment/plant (including dairy, meat, retail meat, delicatessens, fish, produce packinghouses and fresh-cut produce)
Include sampling of specified/described surfaces and microbiological testing of samples
Report samples evaluated for Listeria
Specifically refer to persistence, permanent, residence, recurrence, dispersal, or other relevant terms in our proposed study
Be original research or a review of original research
Have matching subtypes for at least 3 sampling events over at least 2 months
Use a substantive subtyping method (i.e., ALFP, MLVA, MLVST, PFGE, RAPD and REA, Ribotyping, and WGS)
Be in English

Table 1. Physico-chemical parameters (pH, oxidation-reduction potential [ORP], chemical oxygen demand [COD], and electrical conductivity [EC]) of process wash water (PWW) generated in the lab and obtained from commercial processing line from washing shredded lettuce.