RESEARCH IN PROCESS

Listeria monocytogenes growth potential, kinetics, and factors affecting its persistence on a broad range of fresh produce

SUMMARY

This project will examine *Listeria monocytogenes* (Lm) growth potential and kinetics on a broad range of whole and fresh-cut vegetables and fruits, under typical pre-market storage and/or retail display conditions, as well as under elevated abusive temperatures. The effects of the nutritional and physiochemical characteristics and microbial community of the produce on Lm growth and survival will be explored. Preliminary data collected to date, using several fresh-cut products (apple, lettuce, and mango), indicated gradual declines in Lm counts during storage at 4°C for up to 14 days.

OBJECTIVES

1. Determine *Listeria monocytogenes* (Lm) growth potential and kinetics on major classes of whole and fresh-cut produce under normal storage/retail display conditions.
2. Determine Lm growth potential and kinetics under temperature abuse conditions and develop an indexing system for quantifying temperature abuse.
3. Determine effects of produce nutritional and physiochemical characteristics on Lm growth potential and kinetics.
4. Evaluate the effects of the indigenous microbial community from produce on Lm growth.

METHODS

A large variety of whole and fresh-cut produce representing major fresh commodity categories (**Figure 1**) will be evaluated for supporting Lm growth at typical commercial storage and retail display conditions for up to twice the typical shelf life. Selected products will be inoculated with a cocktail of Lm strains and stored at conditions simulating pre-market storage and retail display conditions for a defined time length. The inoculated products will be periodically sampled over the storage time to determine Lm growth kinetics on individual products. Selected fresh-cut commodities that significantly promote or inhibit Lm growth will be further examined to determine correlations of Lm growth potential with the intrinsic properties of the produce, including nutrient contents (especially selected vitamins) and other physiochemical characteristics. Shifts in the microbiome on each product during storage and the potential effect on Lm survival will be examined by metagenomic analyses (**Figure 2**).

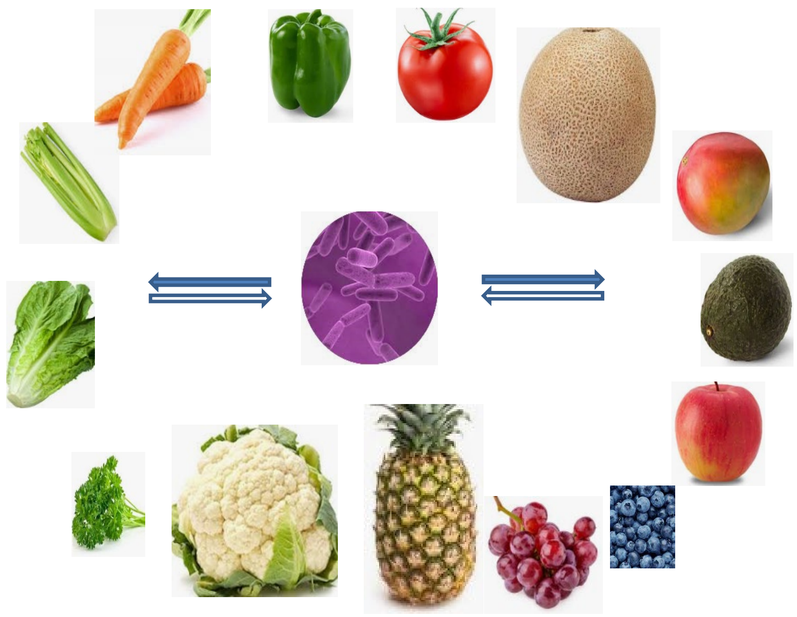


Fig. 1. A large variety of whole and cut fresh produce, including both vegetables and fruits, will be tested for the potential of supporting the growth of *L. monocytogenes* under normal storage/display conditions and under temperature abuse conditions.

RESULTS TO DATE

Preliminary data on Lm recovery was collected using several fresh-cut products, with fresh-cut cantaloupe (a product known for supporting Lm growth) and carrot (a product known for inhibiting Lm growth) as controls. While fresh-cut cantaloupe supported Lm growth at all temperatures tested, fresh-cut carrot completely inhibited Lm recovery from the cut surface (**Table 1**). This observation was consistent with previously published studies. Other fresh-cut products tested (apple, lettuce, and mango) did not support Lm proliferation during storage at 4°C for up to 14 days (**Table 2**). In contrast, the native microbiota on the fresh-cut products steadily increased during storage under the same conditions as for the inoculated Lm. This observation needs to be further confirmed with larger sample sets.

BENEFITS TO THE INDUSTRY

This project will provide food safety regulatory agencies, fresh produce trade associations, and fresh produce industry operators with valuable information on the potential and kinetics of Lm growth on a large variety of vegetables and fruits across the major fresh produce categories. This information will be very useful for developing updated science- and risk-based guidelines for best practices in fresh produce processing and distribution. A fresh produce temperature abuse indexing system based on quantification of Lm growth potential can aid industry in making accept vs. reject decisions for batches of fresh-cut products exposed to temperature abuse. Information on the effects of indigenous microbiota on Lm growth can potentially be used to develop effective and environmentally friendly intervention strategies for mitigating the risks of Lm contamination of fresh produce.

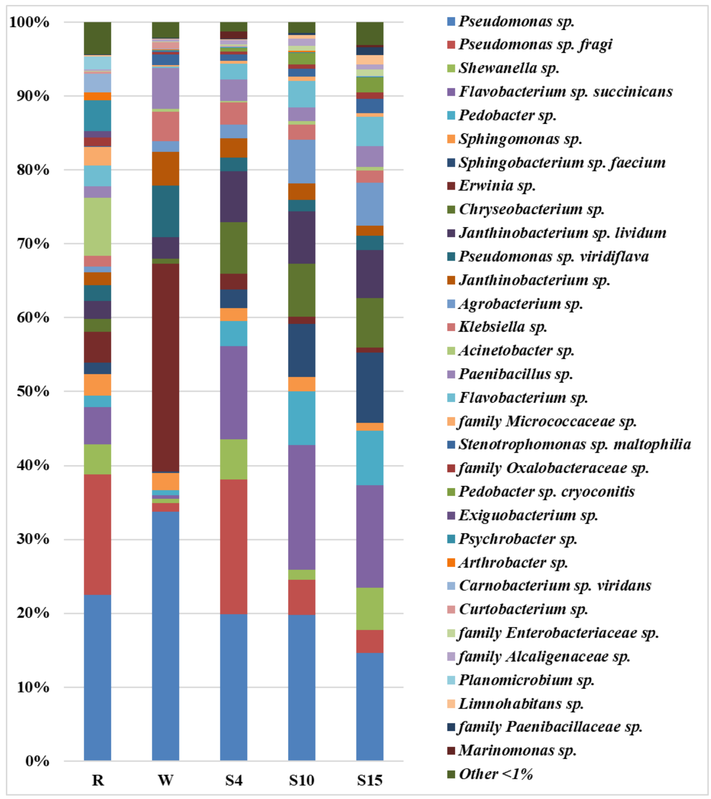


Fig. 2. Relative abundance of major bacterial taxa on baby spinach showing microbiome shifts before (R) and after (W) commercial washing in chlorinated water, and after storage (S) at 4, 10, and 15 ºC. Data was obtained in a previous study and presented here as an example of metagenomic analyses to be carried out for this project.

Table 1. Recovery of *L. monocytogenes* (log CFU/g) from the surface of fresh-cut cantaloupe and carrot after storage for 7 days at 4 and 12 ºC. Viable Lm was not recovered from carrot surface after inoculation.

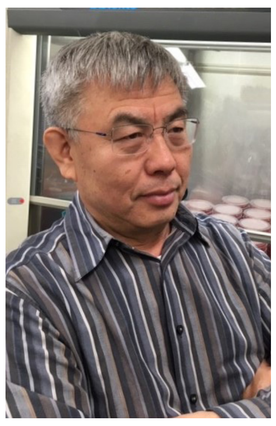
Storage		Cantaloupe	Carrot
Time (Day)	Temp (ºC)	(n=3)	(n=3)
0	--	4.15±0.04	< 1.3*
7	4	6.76±0.13	< 1.3
7	12	7.69±0.54	< 1.3

*Below LOD at 1.3 log CFU/g.

Table 2. Recovery of *L. monocytogenes* (log CFU/g) and native aerobic bacteria (APC) (log CFU/g) from selected fresh-cut produce following storage at 4 ºC for up to 14 days. Population of Lm slowly declined while APC population steadily increased during the storage.

Storage Time	Lm (Inoculated)			APC (No inoculation)		
(Day)	Apple	Lettuce	Mango	Apple	Lettuce	Mango
0	4.89±0.12	5.44±0.01	5.42±0.05	1.70±0.28	5.9±0.06	<1.22*
1	3.70±0.31	4.29±0.04	4.35±0.04	3.00±0.01	6.25±0.10	1.54±0.16
3	ND	ND	3.92±0.05	ND	ND	1.38±0.16
7	3.52±0.02	4.21±0.01	3.14±0.32	2.13±0.91	7.59±0.01	3.10±0.16
14	3.69±0.10	4.08±0.14	ND	4.76±0.32	6.77±0.13	ND

* Below LOD at 1.22 log CFU/g.
ND. Not determined.



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