Validation study for the tree-fruit industry: effective strategies to sanitize harvest bins and picking bags

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Summary

Reduction of foodborne illnesses associated with produce can be better achieved by controlling potential food safety risk points during harvesting, processing, and distribution. Harvesting tools, bins and containers have been recognized as microbial reservoirs and contamination sources in several outbreaks and recalls. This project will validate cleaning and sanitation practices that are already approved and commercialized to minimize contamination risks during harvesting and handling, and encourage growers to implement these routines through data sharing and education.

Objectives

1. Evaluate the effectiveness of commercially available sanitizers (chlorine, chlorine dioxide, peracid, steam, and silver dihydrogen citrate) in reducing *Listeria monocytogenes*, *Salmonella* and Shiga-toxigenic *Escherichia coli* on experimentally inoculated coupons (wood, polycarbonate (plastic) and nylon) representative of food contact surfaces commonly used in the apple industry during harvesting.
2. Validate the selected sanitizers against surrogate microorganisms (*Enterococcus faecium, Listeria innocua*, and generic *Escherichia coli*) on bins and harvesting bags at commercial operations.

Methods

Wood, plastic, and nylon from used harvest bins and/or used picking bags will serve as surfaces for *Listeria, Salmonella*, and Shiga-toxigenic *E. coli* attachment and growth. Two bacteria forms will be investigated: sessile and biofilm. Surfaces will be subjected to the following treatments: i) chlorine (200 ppm for 1 or 2 min); ii) chlorine dioxide gas (200 ppm for 24 hr); iii) peracid (100 ppm for 1 or 2 min); iv) steam (2 atm for 1 or 2 min); v) silver dihydrogen citrate (ready-to-use solution for 1 or 2 min). After each treatment, coupons will be neutralized with Dey/Engley broth and vortexed for 30 sec. Serial dilutions will be made and spread-plated on selective media.

Results to Date

Multi-strain *Listeria* and *Salmonella* biofilms were grown in a CDC reactor at 20 ± 2 °C up to 96 hours. **Figure 1** shows the results obtained for the growth and attachment assay on the different surfaces. Overall, similar trends were observed for all biofilms. At 24 hr, wood and nylon showed similar count values. After 96 hr of incubation, nylon presented the highest number of attached cells. Polycarbonate (plastic) had significantly lower attachment counts at each time interval ($P < 0.05$) compared with wood and nylon. For nylon and wood the number of attached cells increased at each time interval. As incubation time increases, cell counts increased for all materials studied. Experiments have also been conducted with multi-strain pathogen cocktails to optimize attachment of sessile cells to materials.

Benefits to the Industry

This project will impact growers and packers of apples and other tree fruits, not only in Kansas, Missouri, Iowa and Washington, but also in other domestic production regions. The findings of our study will be easily transferable to other produce with similar harvesting and handling systems. Furthemore, we are not only validating sanitizer treatments against *Listeria monocytogenes* (the major threat for the apple industry), but also against other foodborne pathogens (e.g., *Salmonella* and *E. coli*) that are frequently associated with outbreaks and recalls of other produce and produce-related commodities, thus increasing the impact of the project results.

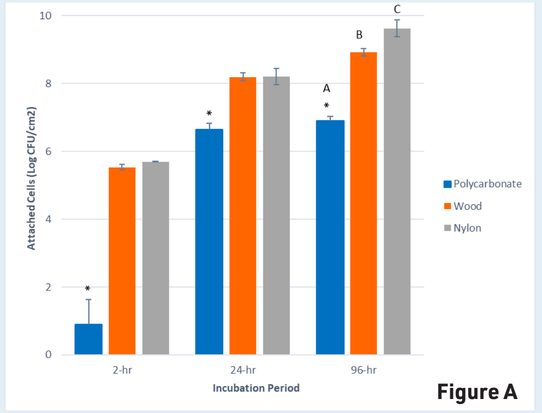

Figure A

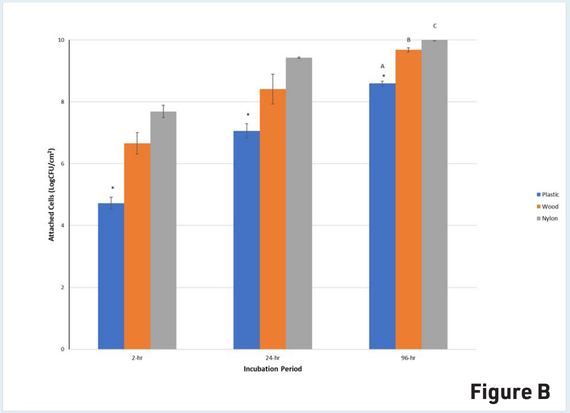

Figure B

Figure 1. Differences in attachment of: (**A**) *L. monocytogenes* and (**B**) Shiga-toxigenic *E. coli* cells to wood, nylon, and polycarbonate (plastic) after incubation for 2, 24 and 96 hr. Capital letters indicate a significant difference among incubation times for the same material.
(*) Denotes a significant difference among materials within the same incubation period.