

Evaluation of sanitation protocols for non-conventional food-contact surface materials used in produce packinghouses

Summary

There is a lack of guidance on cleaning and sanitizing (C&S) practices for non-conventional (hard-to-clean, porous) food-contact surfaces (FCS) in produce packinghouses. This project evaluates C&S practices for non-conventional FCS, and the associated risks of product contamination influenced by the FCS characteristics in these environments. Onsite visits and semi-structured interviews with packinghouse operators (n=15) and produce safety educators (n=22) followed by thematic analysis of the transcripts identified key C&S challenges and nonconventional FCS of concern. Challenges include resource limitations, knowledge gaps, outdated equipment, language barriers, and reluctance to invest in change. Experimental work includes assessment of pathogen persistence and C&S protocol efficacy on non-conventional FCS (n=4) under varied conditions (pre-growth stress, wet vs dry inoculum, FCS cleanliness, and environmental conditions).

Objectives

1. Utilize a mixed methods approach to confirm types of porous food-contact surfaces in produce packing areas.
2. Evaluate the effectiveness of cleaning and sanitizing of porous food-contact surfaces in produce packing areas.

Methods

Thematic analysis of packinghouse site visits and produce safety educator interviews were completed to identify key challenges. Microbial growth curves based on pre-growth conditions were established for 4–5 serotypes each of *Listeria monocytogenes*, *Salmonella*, and Shiga toxin-producing *Escherichia coli* (STEC) using a microplate reader. Microbial persistence on stainless steel (control) over time at 21°C was evaluated. For the wet inoculum method, bacteria were cultured under at 21°C in tryptic soy broth, and bacterial cocktails were inoculated at 4 log CFU/coupon. A virus cocktail was inoculated at 5 log PFU/coupon. For the dry inoculum (**Figure 1**), 17.5 mL of the bacteria wet inoculum was mixed with sterile sand (100 g) for 2 min, spread onto Petri dishes, and dried at 40°C for 24 h. Persistence was determined using standard, culture-based detection methods.

Results to Date

- Thematic analysis of transcripts identified key C&S challenges including resource limitations, knowledge gaps, outdated equipment, language barriers, and reluctance to invest in change.
- Regarding persistence on stainless steel at 21°C, at 4 h post-inoculation (wet method), bacterial counts increased by 1.88, 1.70, and 2.02 log CFU/coupon for *Salmonella*, *L. monocytogenes*, and STEC, respectively. By 7 days, bacteria were reduced by >3 log CFU/coupon compared to initial levels (**Table 1**). For dry inoculation, bacteria were transferred to stainless steel surfaces and remained detectable over 7 days (**Table 2**).
- Aichi virus (AiV) persisted longer than Tulane virus (TuV) at 21°C for wet inoculation on stainless steel. Tulane virus was detectable up to 24 h and decreased by >3 log PFU/coupon. Conversely, AiV remained infectious for at least 7 days with an approximate 2-log reduction (**Figure 2**).

Benefits to the Industry

This research aims to examine practices that will help the produce industry standardize packinghouse or packing area procedures to reduce risks of contamination. Additional knowledge gaps include a lack of information on the environmental cleaning practices on diversified, limited season farming operations with small packing areas. A majority of small to medium-size farms are diversified meaning they produce multiple raw agricultural commodities. The findings will support ongoing efforts to educate the produce industry on good agricultural practices (GAPs) that reduce the risks of spreading microbial contamination on-farm. Extension educators and specialists will be able to integrate the findings into practical information during FSMA Produce Safety Grower Trainings, USDA GAPs Training workshops, and other food safety educational sessions and publications.

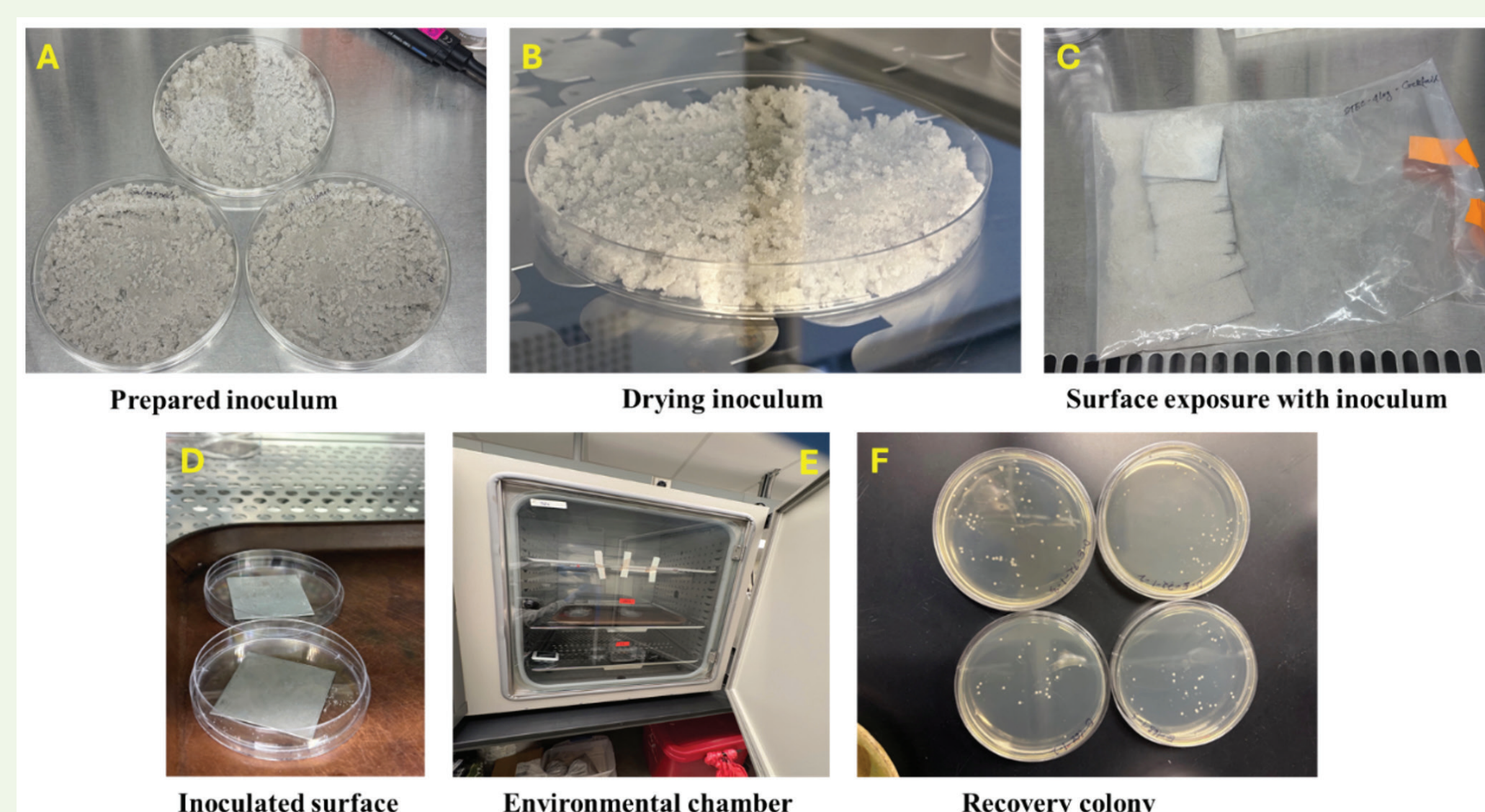


Figure 1: Dry inoculum method for bacteria

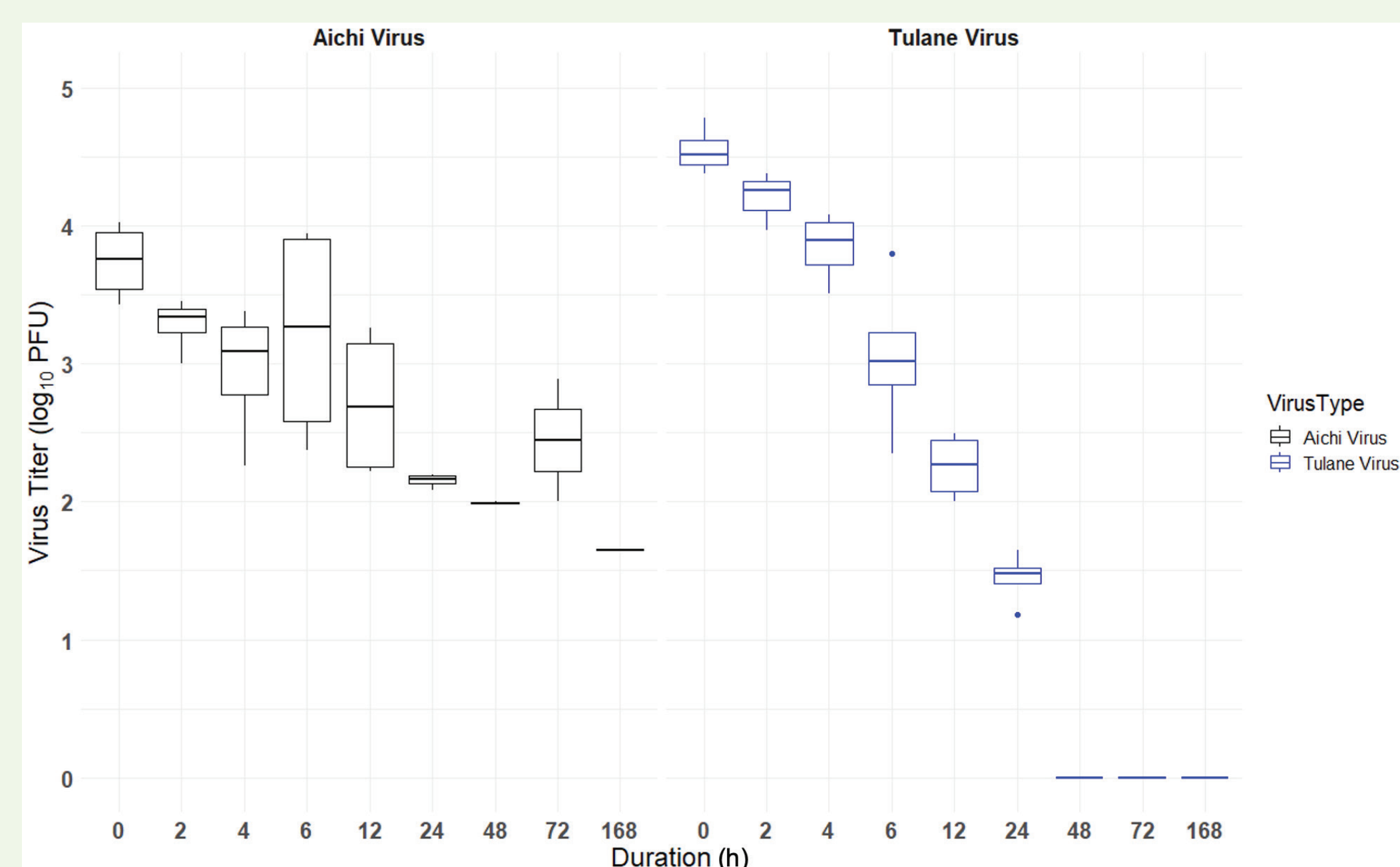


Figure 2: Virus persistence over time on stainless steel surface at 21°C using the wet inoculum method

Time (h)	Log CFU/coupon (±standard deviation)		
	<i>Salmonella</i>	<i>L. monocytogenes</i>	STEC
2	5.38±0.12	5.98±0.015	5.81±0.14
4	5.88±0.06	5.70±0.05	6.02±0.07
12	4.34±0.02	4.15±0.19	3.66±0.38
24	4.20±0.08	4.22±0.04	4.22±0.22
48	3.86±0.003	3.92±0.05	3.95±0.03
72	3.01±0.18	3.07±0.13	3.00±0.07
168	2.73±0.11	2.67±0.11	2.59±0.06

Table 1: Bacterial persistence over time on stainless steel surface at 21°C using the wet inoculum method

Time (h)	Log CFU/ coupon (±standard deviation)		
	<i>Salmonella</i>	<i>L. monocytogenes</i>	STEC
2	3.97±0.33	3.60±0.24	4.24±0.24
4	3.80±0.20	4.13±0.17	3.36±0.35
12	4.04±0.05	4.44±0.08	3.71±0.18
24	3.57±0.11	4.35±0.16	3.50±0.08
48	3.74±0.05	3.81±0.02	3.62±0.08
72	3.79±0.01	3.93±0.05	3.58±0.11
168	3.79±0.12	3.50±0.04	3.70±0.01

Table 2: Bacterial persistence over time on stainless steel surface at 21°C using the dry inoculum method



Contact

Kristen E. Gibson, PhD
University of Arkansas System Division of Agriculture
keg005@uark.edu

Authors

Hanyi Shi, Md. Ashrafudoulla, Francis Torko,
and Kristen E. Gibson

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