

Control of *Salmonella* and *Listeria monocytogenes* on peaches through spray-bar brush bed sanitizer intervention



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Summary

Recent foodborne illness outbreaks due to *Salmonella* and *Listeria monocytogenes* and linked to peach and stone fruit consumption posed serious health risks to consumers and caused huge economic loss for the industry. These outbreaks highlight the potential for foodborne pathogens to survive and persist on stone fruits during production, processing, and handling. This is particularly concerning for fresh stone fruits like peaches, which do not undergo a kill step before consumption. While sanitizing agents are commonly added to peach spray wash water, there is limited knowledge about the practical efficacy of current antimicrobial interventions for reducing pathogens on fruits. The main objective of this study is to assess and validate critical operating parameters for commercially used sanitizers against *Salmonella* and *L. monocytogenes* on peaches.

Objectives

1. Validate the efficacies of selected sanitizers against *Salmonella* and *L. monocytogenes* on peaches.
2. Verify the selected sanitizer interventions in representative commercial peach packing lines in California.

Methods

The selected variety of peaches will be inoculated with a 3-strain cocktail of either *Salmonella* or *L. monocytogenes*. After 24 hours, the inoculated peaches will undergo treatment with commonly used brush bed sanitizers, including chlorine, chlorine dioxide, and peroxyacetic acid, at the industry-standard concentration ranges and contact time. The fidelity of *E. faecium* NRRL B-2354 as a surrogate for *L. monocytogenes* and *Salmonella* on peaches during brush bed spray wash will be verified through bench-scale experiments and a pilot brush bed spray system. It will then be used as a nonpathogenic surrogate for in-plant validation of spray-bar sanitizer intervention on peaches in three enrolled peach packing operations in California to verify the lab-based effectiveness of selected sanitizers in controlling *L. monocytogenes* and *Salmonella*.

Results to Date

Results revealed that chlorine at 50, 100, and 150 ppm free chlorine (FC) led to dose-dependent reductions of *L. monocytogenes* and *Salmonella* on peaches after 30 s, achieving reductions of ~0.9, 1.5–1.6, and 1.7–1.8 log CFU/peach, respectively (**Figure 1A**). Exposure to 2.5 ppm and 5.0 ppm chlorine dioxide for 30 s led to reductions of ~0.7 and ~1.1 log CFU/peach, respectively (**Figure 2A**). Extending the contact time to 2 min slightly but significantly increased the efficacy of both sanitizers (**Figures 1B and 2B**). During the 30-s exposures in tap water, substantial bacterial cross-contamination occurred between inoculated and uninoculated fruit, and process water, with *Salmonella* exhibiting higher transfer than *L. monocytogenes*. Chlorine application mitigated cross-contamination of both pathogens but did not prevent it under the tested conditions (**Table 1**).

Benefits to the Industry

This study will provide the industry with science-based recommendation on the best process parameters and standard operating procedures. The outcomes will also establish a framework for validated process controls and verification of standard operating procedures that can be implemented by the stone fruit industry to ensure compliance with FSMA Preventive Controls requirements.

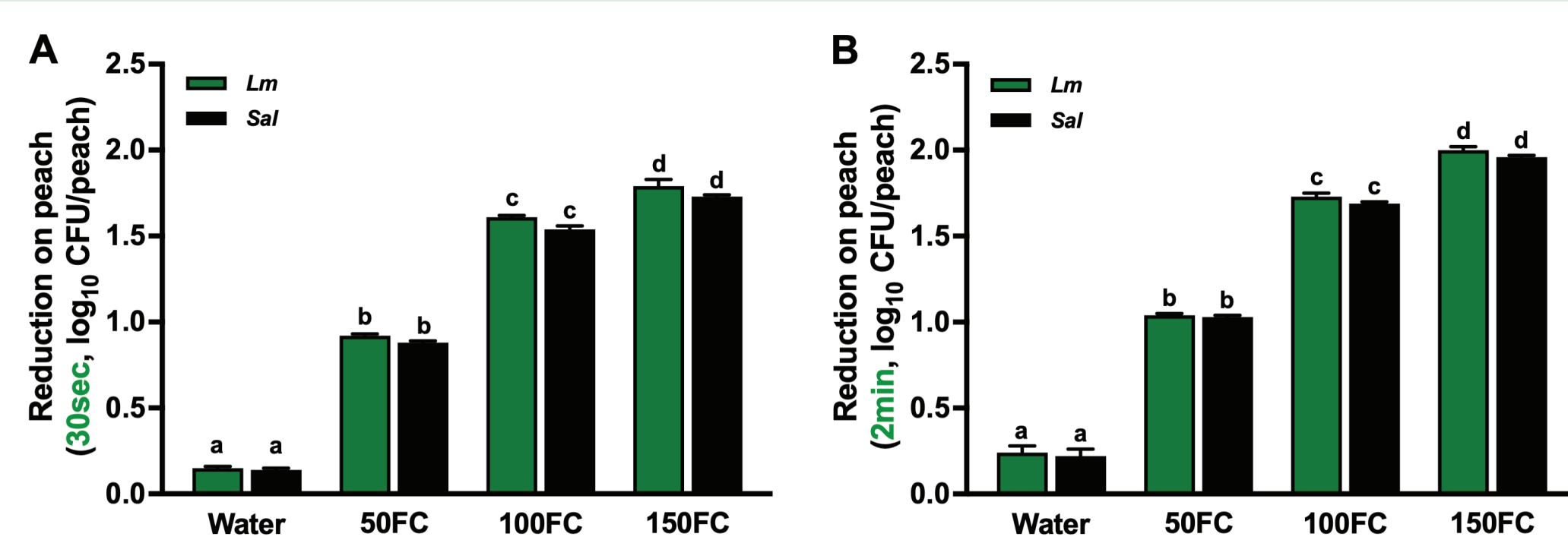


Figure 1. Effectiveness of chlorine against *Listeria monocytogenes* and *Salmonella* on peaches. A. 30 s contact time; B. 2-min contact time. Water: Peaches washed with tap water. 50 FC - 150 FC: Peaches washed with chlorine solution at 50 ppm to 150 ppm free chlorine. Mean \pm SEM, n = 30. ^{a-d} Means among bars without common letters differ significantly ($P < 0.05$).

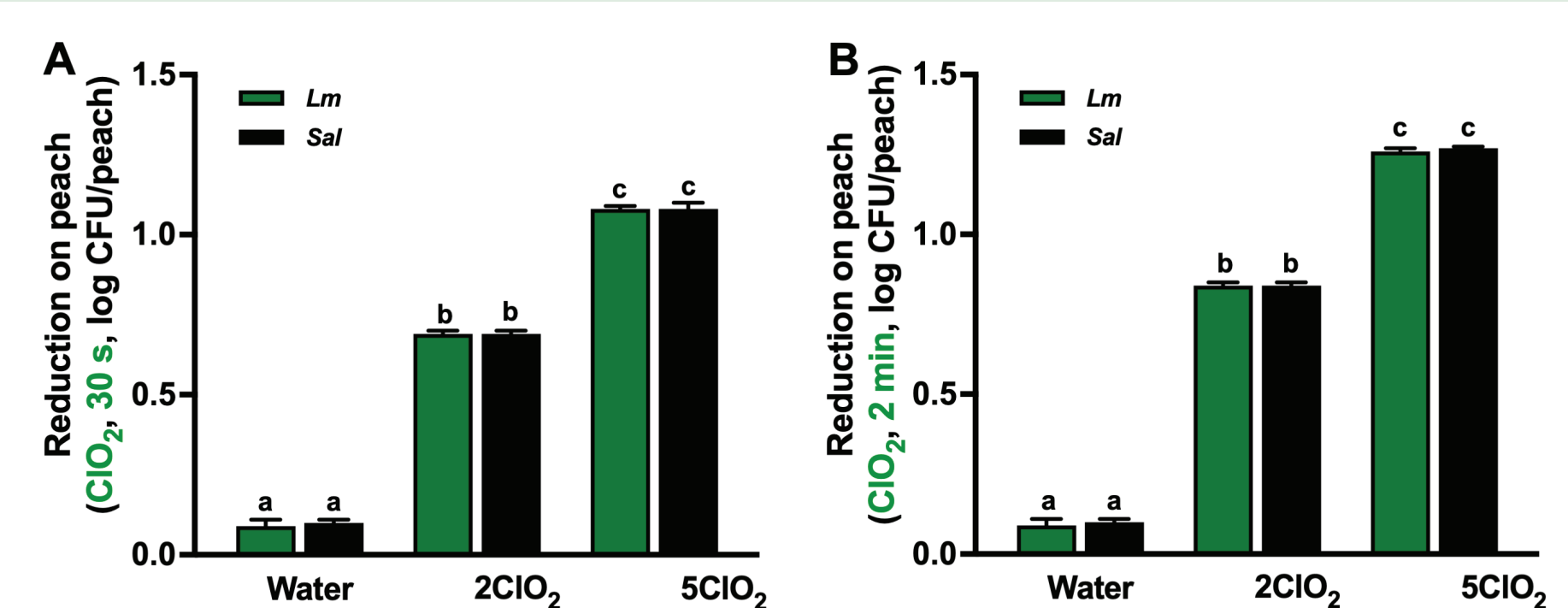


Figure 2. Efficacy of chlorine dioxide against *Listeria monocytogenes* and *Salmonella* on peaches. A. 30 s contact time; B. 2-min contact time. Water: Fruit washed with tap water. 2ClO₂: Fruit washed with 2.5 ppm chlorine dioxide. 5ClO₂: Fruit washed with 5.0 ppm chlorine dioxide. Mean \pm SEM, n = 30. ^{a-c} Means among bars without common letters differ significantly ($P < 0.05$).

Table 1. Effectiveness of chlorine intervention in preventing cross-contamination.

Strains	Treatment	Inoculated	Uninoculated	Wash solution	
		Reduction (log CFU/peach)	Recovery (log CFU/peach)	Plating (log CFU/ml)	MF (log CFU/100 ml)
<i>L. mono</i>	Tap water	0.12 \pm 0.03 ^a	2.87 \pm 0.01 ^a	1.73 \pm 0.04 ^a	/
	50 ppm FC	0.94 \pm 0.02 ^b	2.65 \pm 0.06 ^b	0.73 \pm 0.09 ^b	/
	100 ppm FC	1.68 \pm 0.01 ^d	2.52 \pm 0.01 ^c	< LOD	1.17 \pm 0.04 ^a
	150 ppm FC	1.83 \pm 0.02 ^e	2.14 \pm 0.11 ^d	< LOD	0.98 \pm 0.09 ^a
<i>Salmonella</i>	Tap water	0.15 \pm 0.02 ^a	3.01 \pm 0.06 ^a	2.41 \pm 0.02 ^a	/
	50 ppm FC	0.99 \pm 0.02 ^b	2.72 \pm 0.04 ^b	< LOD	0.57 \pm 0.17 ^a
	100 ppm FC	1.67 \pm 0.01 ^d	2.67 \pm 0.06 ^{bc}	< LOD	0.18 \pm 0.11 ^b
	150 ppm FC	1.86 \pm 0.01 ^f	2.56 \pm 0.08 ^{bc}	< LOD	0.00 \pm 0.00 ^b

MF: membrane filtration. FC: free chlorine. Means \pm SEM, n = 9 for inoculated fruit, n = 36 for uninoculated fruit, and n = 6 for water samples. ^{a-f} Means within a column of the selected strain with different letters differ significantly ($P < 0.05$).