Citrus Packing Facility Sanitation

CCQC Food Safety Workshop
August 6, 2019

Trevor Suslow
VP Produce Safety
tsuslow@pma.com
+1 530-304-1257 mobile
Still located in Davis, CA

Emeritus Extension Research Faculty
tvsuslow@ucdavis.edu
Listeria monocytogenes is recognized as an environmental pathogen of concern in both RAC and value-added produce.
The cost of recalls

On average, food recalls cost companies about $10 million in lost revenue*

• Also brand and associated reputation loss
• Category avoidance by consumers

* USDA ERS, 2018
• Understanding risks to facility environmental compliance
• Prevention as the key implementation for risk reduction
• Hygienic and sanitary design challenges
• Defending a clean break strategy to limit recalls
• C&S verification for environmental monitoring
• How to respond to a swab-a-thon
The consequences of frequent Listeria intrusion can be minimized with persistence and repeatable procedures.

Set in-process sanitation goals to minimize Listeria early surface attachments or spread during production.

1. Keep water pooling and tracking-spread under control.
2. Use dry/granular sanitizers on areas of low water use and around drains.
3. Use dry and/or wet sanitizer to control higher water use areas.
4. Do not allow gross product accumulation on equipment or floors.
5. Designate flow charts for waste removal and frequencies.
6. Control water pooling in all entries and temporary bin handling areas.
Simple Keys to a *Listeria* control Program

3-Stage Approach to Address Preventative & Corrective Actions

**Sanitation / Environmental Practices**
- Intensive Environmental swabbing
- Footwear / clothing
- Traffic patterns
- Sanitation
- Maintenance

**Facility / Equipment Design**
- Facility layout
- Floors
- Design for Sanitation

**Personnel Training**
- GMPs and FSMA
- Maintenance
- Sanitation
- Performance-based food safety goals
Key Challenges In Sanitary Design or Function

- Awareness, Attitudes, and Resources
- Legacy facilities
- Heritage Equipment
- Fabrication and Surfaces
- Patch-work and work-arounds
- Carryover equipment
- Limited or no linear flow
- Overcrowding, lack of expansion planning
Details, even with heroic effort to improve too often elude us… even items on our checklist

- I see it, but I don’t react
- I see it, but I don’t know who to tell
- It’s right there but I don’t see it
- I saw that and told XXX, but never fixed
- I saw that but they said it was fine

Clearly, this rind residue has been here for a while
Common Areas of Environmental Harborage

- Laminations
- Bolt Connections
- Sandwich joints
- Surface Finishes
- Cushioning pads/diverters
- Poor welds
- Exposed aggregate flooring
- Corrosion (rusting, pitting)
- Control Panels
- Condensation, Buttons,
  Unmaintained gaskets
- Hollow Areas
- Tubing
- Floors Drains
- Air Blowers
- Cooling Evaporator Coils
Each Bin Represents a Seasonally Variable and Largely Unknown Risk of Adding Pathogens to Water and the Facility
Learn how to recognize your Listeria risk
Facility Engineers and OEMs Adopt Sanitary Design into Core Company Values

Facility and Equipment Design Elements Should Protect Product Contact Surfaces from Indirect Transfer

- Drip
- Drain
- Drawn
- Diffuse
- Disperse
Visual Inspection Basics

1. The foundation to your environmental monitoring program.

2. Inspection needs to be completed by someone other than the sanitation supervisor(s).

3. At least 500 lumen flashlight, best if its rechargeable and kept at the inspection persons desk to always be ready.

4. IF it looks dirty, product or organic matter or if it has calcium or mineral build up then “work arounds ” wont work

5. Identify the soil type, consult the chemical company and review SSOP to prevent that accumulation.

http://www.streamlight.com
Guiding Principles of Ideal Sanitary Design

Facility Design Guiding Principles
1. Defined Hygienic Zoning
2. Controlled Flows
3. Controlled Floor Systems
4. Controlled Room Temperatures
5. Controlled Room Pressures
6. Sanitarily Designed Facility Exterior
7. Sanitarily Designed Doors, Walls & Ceilings
8. Sanitation & Maintenance Access
9. Sanitarily Designed Support Equipment
10. GMP-based Facility Design

Equipment Design Guiding Principles
1. Microbiological Clean
2. Made of Compatible Materials
3. Accessible
4. No Liquid Collection
5. Hollow Areas Hermetically Sealed
6. No Niches
7. Sanitary Operational Performance
8. Hygienic Design of Maintenance Enclosures
9. Hygienic Compatibility
10. Validated SSOPs

Acknowledgements to Rudi Groppe
rudi@heinzen.com
As practical in older facilities, create traffic separation and segregation for equipment, worker, and product flow
Baseline CA Citrus Industry Swab Recap
Overall *Listeria* testing outcome in packing operations; Total Swabs 1,475

- Overall average 10 facilities; 2016-2018
  - Zone 2 and 3 only
  - 31% Molecular Positive ---- 30% Culture Positives

- Range of positives per date –
  - 3 to 93% molecular positive
  - 3 to 87% culture positive *Listeria* sp.
  - 3 to 28% culture positive *L. monocytogenes*
Across facilities, Listeria is frequently found around bin dumps and all bin handling areas.

To date, sub-typing and pattern analysis suggests traffic patterns reflect the spread of transient Listeria and may lead to established isolates.
BASELINE “Swabathons” REVEAL KEY HARBORAGE SITES AND TRAFFIC TRANSFER

Listeria spp.

Listeria monocytogenes

Both together
**Spatial Mapping Results**

<table>
<thead>
<tr>
<th>Location</th>
<th>Negative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1 (Packing House)</td>
<td>95.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Washing/Fungicide/Drying/Waxing/Drying</td>
<td>68.6%</td>
<td>31.4%</td>
</tr>
<tr>
<td>UV Room/Sorting Room</td>
<td>63.9%</td>
<td>36.1%</td>
</tr>
<tr>
<td>Shipping Room</td>
<td>71.9%</td>
<td>28.1%</td>
</tr>
<tr>
<td>Cull Staging Area</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Receiving/Cooling Room</td>
<td>86.7%</td>
<td>13.3%</td>
</tr>
<tr>
<td>Packing House</td>
<td>73.0%</td>
<td>27.0%</td>
</tr>
<tr>
<td>Outside Packing House</td>
<td>61.1%</td>
<td>38.9%</td>
</tr>
<tr>
<td>Fork Lift/Fueling/Cleaning Area</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Degreening/Ripening Room</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cold Room</td>
<td>81.5%</td>
<td>18.5%</td>
</tr>
<tr>
<td>Bin Washer</td>
<td>48.4%</td>
<td>51.6%</td>
</tr>
<tr>
<td>Bin Dumping</td>
<td>42.9%</td>
<td>57.1%</td>
</tr>
<tr>
<td>Bin Drying</td>
<td>19.0%</td>
<td>81.0%</td>
</tr>
</tbody>
</table>
Listeria monocytogenes core genome allelic profiles of ESJV2 by Location and Year

There does not seem to be a persistent/predominant strain in this particular facility.
Example of L. mono core genome allelic profiles from non-citrus facilities

Isolates from different facilities belong to same cgMLST clusters. Some of the cgMLST complexes include strains from several years (persistence) and from different geographically separate facilities.

Graphic view with Phyloviz2
## Outcome at One Enrolled Citrus Packing Operation
### 2018 Food Contact Surface Swabs

<table>
<thead>
<tr>
<th>Operational location FCS</th>
<th>Samples tested</th>
<th>Samples molecular positive</th>
<th>Samples culture positive*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Packout FCS</td>
<td>221</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Size Sorting grader</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sorting room chute</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Washing/fungicide/drying/waxing</td>
<td>34</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>269</strong></td>
<td><strong>14</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

Listeria spp. confirmed; no L. monocytogenes
Key Outcomes

- High prevalence of Listeria may be expected on NFCS throughout RAC facilities until significant changes are made.

- Seasonality appears to play a role in prevalence and location at a facility.

- Sub-typing is needed to guide traffic and source tracking.

- Current cleaning and sanitation regimes, in general, are inadequate.

- Frequent or predominant negative test results should be questioned.

- Zone 1 (FCS) remain vulnerable.
Attention to Cleaning and Sanitation Verification has Improved but Remains Challenging
Key Efficacy Challenges of Sanitation

- Inadequate commitment from Ownership and Management
- Fundamentally uncleanable facility and equipment
- Inconsistent coordination across departments
  - Scheduling, Sanitation, Maintenance, QA/QC, etc.
- Inadequate resources to achieve expected/required outcomes
  - Inadequate time to clean and sanitize!
  - Inadequate investment in a dedicated, well-trained, supervised, and rewarded sanitation crew
  - Inadequate potable water – distribution, pressure, quality, temperature
  - Improperly designed/fabricated sanitation equipment/tools
  - Wrong or misapplied chemistries
Critical Elements of C&S Programs

- Time
- Temperature
- Clean
- Action
- Chemistry

Graphic concept acknowledgement to Justin Kerr
Repeatable Sanitation Program Essentials

1. Verifiable SSOP’s that are repeatable & understood by trained employees

2. Manageable frequencies assigned for daily & periodic sanitation.

3. Continuous training and sharing of performance data with sanitation employees.

4. Water volume & pressure are adequate; detergents applied in timely fashion.

5. Detergents selected to support the removal of organic and inorganic soils.

6. Brushes and Sanitation utensils that support equipment and environment.

7. Routine and thorough inspection of all surfaces. Document all results.

8. Sanitizers and process treatments that aide in maintaining the sanitary conditions desired.

Graphic credit Justin Kerr
Clean first...then sanitize

Manual Cleaning

Clean out of Place COP

Clean in Place CIP

DOSE  TIME  TEMPERATURE  MECHANICAL FORCE
### Simplified SSOP Building Blocks

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much physical time will be allotted to cleaning + inspecting + sanitizing?</td>
</tr>
<tr>
<td>How will water be used, is there adequate volume and pressure at the correct time of use?</td>
</tr>
<tr>
<td>Can the employee complete the task safely &amp; consistently?</td>
</tr>
<tr>
<td>What Detergents and concentrations?</td>
</tr>
<tr>
<td>Who completes inspection?</td>
</tr>
<tr>
<td>What inspection tools &amp; Sanitizer?</td>
</tr>
</tbody>
</table>

Graphic credit Justin Kerr
Cleaning and Sanitization Key Elements:

Cleaning Agents

- Acid Cleaners
- Alkaline Cleaners
- Non-Caustic Cleaners
- Chlorinated Caustic Cleaners
- Neutral Cleaners
- Solvent-Based Cleaners
- Displacement cleaners
- Combination Cleaners (Blend On-Site)
Cleaning and Sanitization: Key Elements

Hard Surface Sanitizers

- Chlorine / Sodium Hypochlorite
- Quaternary Ammonium Compounds ("Quats")
- Iodophors
- Peroxyacetic Acid ("PAA")
  - PAA now approved at up to 500ppm post rinse
- Acidified Sodium Chlorite (ASC)/Chlorine Dioxide
- Hot Water/Steam
‘Quat’ Verification Options

Quick-strips are generally formulated for 2-chain quats
- typically more durable on surfaces
- Test strips cover wide range… may be hard to interpret

Recommended Use Levels for Quats

<table>
<thead>
<tr>
<th>Surface</th>
<th>Quat Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls &amp; Ceilings for Mold</td>
<td>2,000-5,000 ppm*</td>
</tr>
<tr>
<td>Equipment Sanitizing</td>
<td>200 ppm</td>
</tr>
<tr>
<td>Floors &amp; Drains</td>
<td>800 ppm</td>
</tr>
<tr>
<td>Floor Mats</td>
<td>1,800 ppm</td>
</tr>
<tr>
<td>Foot Baths</td>
<td>2,400 ppm</td>
</tr>
<tr>
<td>No Rinse</td>
<td>&lt; 200 ppm</td>
</tr>
</tbody>
</table>
# Common Cleaning and Sanitizing Schedules

## Surfaces and Cleaning Substances

<table>
<thead>
<tr>
<th>TYPE OF SURFACE</th>
<th>RECOMMENDED CLEANING SUBSTANCE</th>
<th>FREQUENCY OF USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel</td>
<td>Alkaline, not abrasive</td>
<td>Daily, Weekly</td>
</tr>
<tr>
<td></td>
<td>Acid, not abrasive</td>
<td></td>
</tr>
<tr>
<td>Metals (copper, aluminum, galvanized</td>
<td>Moderately alkaline substances with corrosion inhibitors</td>
<td>Daily</td>
</tr>
<tr>
<td>surfaces)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>Detergents with surfactants</td>
<td>Daily</td>
</tr>
<tr>
<td>Rubber</td>
<td>Alkaline Substances</td>
<td>Daily</td>
</tr>
<tr>
<td>Glass</td>
<td>Moderately alkaline substances</td>
<td>Daily</td>
</tr>
<tr>
<td>Concrete Floors</td>
<td>Alkaline</td>
<td>Daily</td>
</tr>
</tbody>
</table>
General Cleaning & Sanitizing Procedure

**Step 1** – Remove all exposed products
**Step 2** – Dry clean/sweep area
**Step 3** – Wet area to be cleaned
**Step 4** – Clean and scrub area
**Step 5** – Rinse
**Step 6** – Sanitize
**Step 7** – Air dry/Store properly
Drains - Daily Clean-up

1. Move equipment or food contact surfaces that could get contaminated or use a splash guard
2. Remove drain cover
3. Rinse with low pressure hose
4. Apply foam or detergent solution
5. Scrub with designated brush (1/4 inch smaller than drain opening)
6. Rinse with low pressure hose
7. Flood with sanitizer
8. Insert bactericidal ring if used
9. Replace drain cover
10. Clean drain brush and store in sanitizer
Managing Floors and Drains

1. Use of water diversion tools like PIG Original Spill Blocker Dikes, to move water flow to desired areas and prevent accumulation in others.

2. Use of dry floor treatments or sanitizers like Sterilex Ultra Step, Con Quat or QFT powder to control employee traffic, as well as pallet jacks and fork trucks. Floor spreaders can lay down a defined amount and be managed on a time frequency.

https://www.newpig.com/pig-original-spillblocker-dike/p/PLR204

Potential Impacts of Cleaners and Sanitizers

• Aluminum, Brass & Soft Metals or Galvanized
  - Avoid Sodium & Potassium hydroxides
  - Avoid sodium hypochlorite bleach

• Acid will strip the galvanized coating from sheet metal
• Acids will etch concrete floors
• Solvents may damage plastics
• Peroxide bleaches vs. Chlorine Bleaches
• Waste water sodium/salt issues
Listeria monocytogenes Recovery After Sanitizer Treatment of Surfaces with *in-vitro* Established Biofilms

![Graph showing log CFU/sample for various surfaces and treatments](image)

- **Bin**: 
  - Before: Black
  - Control: Grey
  - Steroklor (100 PPM): Yellow
  - Steroklor (1000 PPM): Light Green
  - ChicoWash (2.65): Green
  - ChicoWash (3.11): Dark Green
  - Decon 7: Blue
- **Conveyor**: 
  - Before: Black
  - Control: Grey
  - Steroklor (100 PPM): Yellow
  - Steroklor (1000 PPM): Light Green
  - ChicoWash (2.65): Green
  - ChicoWash (3.11): Dark Green
  - Decon 7: Blue
- **Green Tarp**: 
  - Before: Black
  - Control: Grey
  - Steroklor (100 PPM): Yellow
  - Steroklor (1000 PPM): Light Green
  - ChicoWash (2.65): Green
  - ChicoWash (3.11): Dark Green
  - Decon 7: Blue
- **Curtain**: 
  - Before: Black
  - Control: Grey
  - Steroklor (100 PPM): Yellow
  - Steroklor (1000 PPM): Light Green
  - ChicoWash (2.65): Green
  - ChicoWash (3.11): Dark Green
  - Decon 7: Blue
- **Black Tarp**: 
  - Before: Black
  - Control: Grey
  - Steroklor (100 PPM): Yellow
  - Steroklor (1000 PPM): Light Green
  - ChicoWash (2.65): Green
  - ChicoWash (3.11): Dark Green
  - Decon 7: Blue
- **White crate**: 
  - Before: Black
  - Control: Grey
  - Steroklor (100 PPM): Yellow
  - Steroklor (1000 PPM): Light Green
  - ChicoWash (2.65): Green
  - ChicoWash (3.11): Dark Green
  - Decon 7: Blue
### On-Site Verification of Sanitation Program Efficacy at Persistent *L. monocytogenes* Facility Sites

<table>
<thead>
<tr>
<th>ON-SITE TREATMENT</th>
<th>PRE-CLEANING</th>
<th>POST-CLEANING</th>
<th>POST-SANITIZER</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-House PAA (230 ppm)</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>In-House Chlorine (100 ppm)</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>High Dose PAA (325 ppm)</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>1% Rely On</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>NEGATIVE</td>
</tr>
<tr>
<td>Potassium peroxymonosulfate Sulfamic acid</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>NEGATIVE</td>
</tr>
<tr>
<td>Decon 7 (proprietary novel quats and surfactants)</td>
<td>POSITIVE</td>
<td>POSITIVE</td>
<td>NEGATIVE</td>
</tr>
</tbody>
</table>
Early Learnings from WSU:UCD Multiple Swabathons at Bidart Bros. Apple Facility

UCD pre-screen all duplicate swab-enrichments using Transcription Mediated Amplification (ROKA Atlas™ LisLm)

WSU used three common Listeria/Lm culture media
  • Purified all suspect colonies from all media

Presumptive colonies sent to UCD for genetic marker screening
Only approx. 5% of all purified colonies were confirmed as Listeria or L. monocytogenes

Many effective Lis/Lm media in other food and environmental recovery may be problematic in produce
  • Better selective and differential media are available currently
Interspecies competition may limit growth rate and final threshold population of *L. monocytogenes* which impacts detection + recovery

- *L. monocytogenes* strains were paired with three non-*monocytogenes* Listeria
  - *L. innocua* & *L. seelegeri* most common among tree-fruit packing facilities

- Individual isolate and ratio to *L. monocytogenes* affected outcome

- Enrichment broth used affected degree of impact

**KEY LEARNING**

- If you are just testing for Listeria spp. this is not a limiting factor
- Modern pre-enrichment and rapid tests have a better conversion ratio
  - DNA/RNA ‘molecular positive’ ≅ Culture confirmed
- If you react to molecular positives it is even less a practical concern
Understanding Typical Industry Time to Result (TTR)

- Day 1 – Collect swabs
- Day 1 – Receive at service lab
- Day 1 – Pre-enrichment culture initiated
- Day 2 – Primary molecular screen and result
  - Action on positives planned and initiated
  - Day 2 or 3 – Investigative culture-confirmation option

Add 1 day TTR if samples shipped O.N.
Subtract half-day if protocol uses target capture method
Case Example: When (not) to sample, based on TTR

- Sample 1
  - S1- Processing in lab
  - Ship to receiver
- Sample 2
  - S2- Processing in lab
  - Ship to receiver

Results Sample 1 – Positive FCS; culture confirmed
Results Sample 2 – Positive FCS; culture confirmed
Notifications to receiver
Actions taken Seek to Destroy

Total lapsed time
Results – 28 days
Notifications - > 45 days
Outcome – rolling recall
Clean-break not defensible
10 Principles of Sanitary Design

i. Cleanable to a microbiological standard

ii. Made of materials compatible with sanitizers

iii. Accessible for inspection, maintenance, cleaning and sanitation

iv. No product or liquid accumulation

v. Hollow areas (ex. rollers) should be hermetically sealed
10 Principles of Sanitary Design

vi. No points of entrapment or niches
vii. Sanitary operational performance
viii. Hygienic design of maintenance enclosures
ix. Hygienic compatibility with other plant systems
x. Validated cleaning and sanitizing protocols
Evaluating the Effectiveness of a Sanitation Program

- Microbiological testing
- Adenosine triphosphate (ATP) testing
- Rapid bacteria-specific swabs
- Use of sanitation records – Trending
- Recognizing site-specific deviations
- Recognizing equipment: practice-specific risks
- Training, training, training
- Recognition and reward
90-day Cleaning and Sanitation
Packing Facility Improvement “Heat” Map

No one factor to sustained performance
- Training
- Re-training to the data
- Replaced ‘uncleanables’
- Eliminated practices
- Altered chemistries

Six-day TPC swab cycle

100’s
1,000’s
10,000’s
Industry “Best Practice” Standards

What is considered an acceptable ATP-count for clean food contact surfaces?

- Really clean - < 50 RLU
- Reasonably Clean - < 300
- Corrective Action – > 300 < 1,000
  » re-clean & sanitize
- Unacceptable - > 1,000
  » Corrective Action – system analysis
  » Re-training

All assessed as visually ‘clean’
## Collect the Data – Use the Data

<table>
<thead>
<tr>
<th>Location</th>
<th>ATP Swab (RLU)</th>
<th>TPC CFU/swab</th>
<th>ATP Swab (RLU)</th>
<th>TPC CFU/swab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyor</td>
<td>32</td>
<td>&lt; 1</td>
<td>68</td>
<td>44</td>
</tr>
<tr>
<td>Brush Bed</td>
<td>54</td>
<td>1840</td>
<td>45</td>
<td>4680</td>
</tr>
<tr>
<td>Polishing Brushes</td>
<td>1154</td>
<td>&lt; 1</td>
<td>555</td>
<td>67</td>
</tr>
<tr>
<td>Intralox</td>
<td>29</td>
<td>&lt; 1</td>
<td>55</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

Monitoring Verification
Establishing a Credible “Clean-break”

- Cleaning and Sanitation SOPs and SSOPs
- Documented evidence of training
- Documented verification of cleaning and sanitation
- Verification of calibrations and dose
- Verification of performance standards
  - Time, contact, micro, EMP
Understanding Public Health Inspection Timeline: Real Case Example

- Day 1 - Inspection and Swabs Collected
- Day 2 - Received at lab services unit
- Day 3 – Pre-enrichment cultures initiated
- Day 7 - Primary Screen and first presumptive positives
- Day 7 to 9 – Media plating and purification of isolates
- Day 10 – Molecular confirmation of isolates
- Day 13 to 15 – 2nd -3rd round molecular confirmation
  - Biochemical determinative tests including speciation
- Day 16 - Notification to firm; preliminary key findings
  - *Listeria* spp. and *L. monocytogenes* including FCS
Example of positive sites from a recent post-inspection swabathon driven recall

Bin conveyor chain – Bin contact
Trash eliminator conveyor belt – fruit contact surface
Transition zone trash eliminator to $1^\circ$ sorter-rollers
Conveyor belt size distribution line
Sorting line V-belts
Interior harvest bin
Pre-cooler and ripening room fork-lift surfaces
Packing area footing – dry surface at swabbing
Line steamer control panel
Dust mop and Push-brooms– dry at time of swabbing
Full Breakdown and Deep Cleaning/Steaming
Effective Cleaning is 99% of effective sanitation. The remaining 1% is the job of sanitizers.
Acknowledgements to the Suslow Lab Staff

Janneth Pinzon
Associate Specialist

Adrian Sbodio
Staff Research Assistant II

Mariya Skots
Junior Specialist

Accomplishments and knowledge shared are attributed to research funding from the Center for Produce Safety, CA Citrus Research Board, CA Citrus Quality Council, Unrestricted Gift-funds and in-kind support, and facilitation from individual CA citrus packers and shippers and members of the pathogen testing developers and service providers.
PMA Science & Technology Team
Trevor Suslow
	tsuslow@pma.com
530.304.1257 mobile
Operating from Davis, CA