### **Citrus Packing Facility Sanitation**



CCQC Food Safety Workshop August 6, 2019



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











#### The cost of recalls

## On average, food recalls cost companies about <u>\$10 million in lost revenue\*</u>

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



### **Topics in Presentation or to Raise in Q&A**

- 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** 



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Maintenance

### **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 **Control Panels Bolt Connections Condensation**, Buttons, Sandwich joints **Unmaintained gaskets Surface Finishes Hollow Areas Cushioning pads/diverters** Tubing **Poor welds Floors Drains Exposed aggregate flooring Air Blowers Cooling Evaporator Coils Corrosion (rusting, pitting)** 







#### 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



![](_page_10_Picture_2.jpeg)

### Facility Engineers and OEMs Adopt Sanitary Design into Core Company Values

![](_page_11_Picture_1.jpeg)

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

- Drip
- Drain
- Drawn
- Diffuse
- Disperse

![](_page_11_Picture_8.jpeg)

### **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.

![](_page_12_Picture_6.jpeg)

http://www.streamlight.com

![](_page_12_Picture_8.jpeg)

![](_page_12_Picture_9.jpeg)

### **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 Equipment10. 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**

![](_page_13_Picture_22.jpeg)

Acknowledgements to Rudi Groppe rudi@heinzen.com

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![](_page_14_Figure_0.jpeg)

As practical in older facilities, create traffic separation and segregation for equipment, worker, and product flow

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![](_page_14_Picture_3.jpeg)

#### **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*

![](_page_15_Picture_5.jpeg)

![](_page_15_Picture_6.jpeg)

# 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

![](_page_16_Picture_2.jpeg)

![](_page_16_Picture_3.jpeg)

#### BASELINE "Swabathons" REVEAL KEY HARBORAGE SITES AND TRAFFIC TRANSFER

![](_page_17_Figure_1.jpeg)

#### **Spatial Mapping Results**

	1	<u> </u>			1		
OUSE)			95	.0%			5 <mark>.0%</mark>
YING			68.6%			31	.4%
ROOM		63	8.9%			36.1	1%
ROOM			71.9%			2	28.1%
AREA			1	00.0%			
ROOM	86.7%					13.3%	
OUSE	73.0%				27.0%		
OUSE	61.1%				38.9%		
AREA		ř.	1	00.0%			
ROOM		li li	1	00.0%			
ROOM	Ĺ	ř.	81.5%				18.5%
SHER		48.4%				51.6%	
IPING		42.9%				57.1%	
YING	19.0%			8	.0%	/	
0	% ■ Negative	20%	40% Positive	e	60%	80%	100%

ZONE 1 (PACKING HO WASHING/FUNGICIDE/DRYING/WAXING/DR UV ROOM/SORTING R SHIPPING R CULL STAGING A **RECEIVING/COOLING F** PACKING H **OUTSIDE PACKING H** FORK LIFT/FUELING/CLEANING DEGREENING/RIPENING R COLD R BIN WA BIN DUM **BIN DR** 

![](_page_18_Picture_3.jpeg)

#### Listeria monocytogenes core genome allelic profiles of ESJV2 by Location and Year

![](_page_19_Figure_1.jpeg)

#### Example of L. mono core genome allelic profiles from non-citrus facilities

![](_page_20_Figure_1.jpeg)

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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

<b>Operational location FCS</b>	Samples tested	Samples molecular positive		Samples culture positive*	
Final Packout FCS	221	11	5.0%	6	2.7%
Size Sorting grader	10	2	20.0%	2	20.0%
Sorting room chute	4	0	0.0%	0	0.0%
Washing/fungicide/drying/waxing	34	1	2.9%	0	0.0%
Total	269	14	5.2%	8	3.0%

Listeria spp. confirmed ; no L. monocytogenes

![](_page_21_Picture_3.jpeg)

### **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

![](_page_22_Picture_7.jpeg)

#### Attention to Cleaning and Sanitation Verification has Improved but Remains Challenging

![](_page_23_Picture_1.jpeg)

![](_page_23_Picture_2.jpeg)

![](_page_23_Picture_3.jpeg)

### **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

![](_page_24_Picture_11.jpeg)

#### **Critical Elements of C&S Programs**

![](_page_25_Figure_1.jpeg)

Graphic concept acknowledgement to Justin Kerr

![](_page_25_Picture_3.jpeg)

#### **Repeatable Sanitation Program Essentials**

![](_page_26_Figure_1.jpeg)

![](_page_26_Picture_2.jpeg)

Graphic credit Justin Kerr

![](_page_26_Picture_4.jpeg)

### **Clean first...then sanitize**

![](_page_27_Picture_1.jpeg)

**DOSE TIME TEMPERATURE MECHANICAL FORCE** 

![](_page_27_Picture_3.jpeg)

![](_page_27_Picture_4.jpeg)

### **Simplified SSOP Building Blocks**

How much physical time will be allotted to cleaning+ inspecting + sanitizing? How will water be used, is there adequate volume and pressure at the correct time of use?

Can the employee complete the task safely & consistently ?

What Detergents and concentrations?

Who completes inspection?

What inspection tools & Sanitizer?

Graphic credit Justin Kerr

Factor IN

SOLUTIONS

pma

### 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)

![](_page_29_Picture_9.jpeg)

### Cleaning and Sanitization: Key Elements Hard Surface Sanitizers

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

![](_page_30_Picture_8.jpeg)

### **'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

![](_page_31_Picture_4.jpeg)

#### Recommended Use Levels for Quats

Walls & Ceilings for Mold	2,000 5,000 ppm*
Equipment Sanitizing	200 ppm
Floors & Drains	800 pµ.n
Floor Mats	1,800 ppm
Foot Baths	2,400 ppm
No Rinse	< 200 ppm

#### **Common Cleaning and Sanitizing Schedules**

#### **Surfaces and Cleaning Substances**

TYPE OF SURFACE	RECOMMENDED CLEANING SUBSTANCE	FREQUENCY OF USE
Stainless steel	Alkaline, not abrasive Acid, not abrasive	Daily Weekly
Metals (copper, aluminum, galvanized surfaces)	Moderately alkaline substances with corrosion inhibitors	Daily
Wood	Detergents with surfactants	Daily
Rubber	Alkaline Substances	Daily
Glass	Moderately alkaline substances	Daily
Concrete Floors	Alkaline	Daily

![](_page_32_Picture_3.jpeg)

![](_page_32_Picture_4.jpeg)

### **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

![](_page_33_Picture_8.jpeg)

### **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

![](_page_34_Picture_11.jpeg)

#### **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 manage on a time frequency.

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

https://www.sterilex.com/product-details/ultrastep/

![](_page_35_Picture_5.jpeg)

![](_page_35_Picture_6.jpeg)

#### **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

![](_page_36_Picture_9.jpeg)

#### *Listeria monocytogenes* Recovery After Sanitizer Treatment of Surfaces with *in-vitro* Established Biofilms

![](_page_37_Figure_1.jpeg)

#### On-Site Verification of Sanitation Program Efficacy at Persistent *L. monocytogenes* Facility Sites

ON-SITE TREATMENT	PRE-CEANING	POST-CLEANING	POST-SANITIZER
In-House PAA (230 ppm)	POSITIVE	POSITIVE	POSITIVE
In-House Chlorine (100 ppm)	POSITIVE	POSITIVE	POSITIVE
High Dose PAA (325 ppm)	POSITIVE	POSITIVE	NEGATIVE
1% Rely On Potassium peroxymonosulfate Sulfamic acid	POSITIVE	POSITIVE	NEGATIVE
Decon 7 (proprietary novel quats and surfactants)	POSITIVE	POSITIVE	NEGATIVE

![](_page_38_Picture_2.jpeg)

#### 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

![](_page_39_Picture_8.jpeg)

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

![](_page_40_Picture_10.jpeg)

### 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

![](_page_41_Picture_8.jpeg)

### 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

![](_page_42_Picture_11.jpeg)

<u>Total lapsed time</u> 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

![](_page_43_Picture_6.jpeg)

### **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

![](_page_44_Picture_6.jpeg)

#### **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

![](_page_45_Picture_9.jpeg)

### 90-day Cleaning and Sanitation Packing Facility Improvement "Heat" Map

![](_page_46_Figure_1.jpeg)

#### 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</li>

» re-clean & sanitize

- Unacceptable > 1,000
  - » Corrective Action system analysis
  - » Re-training

All assessed as visually 'clean'

![](_page_47_Picture_10.jpeg)

#### **Collect the Data – Use the Data**

	Week 1		Week 2		
Location	ATP Swab	TPC CEU/owoh	ATP Swab	TPC CEU/owoh	
	(KLU)	CFU/SWaD	(KLU)	CFU/SWaD	
Conveyor	32	< 1	68	44	
Brush Bed	54	1840	45	4680	
Polishing Brushes	1154	< 1	555	67	
Intralox	29	< 1	55	< 1	
	<b>J</b> Monitoring	Verificat	ion		

![](_page_48_Picture_2.jpeg)

### 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

![](_page_49_Picture_7.jpeg)

#### 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 2<sup>nd</sup> 3<sup>rd</sup> round molecular confirmation
  - Biochemical determinative tests including speciation
- Day 16 Notification to firm; preliminary key findings
  - Listeria spp. and L. monocytogenes including FCS

![](_page_50_Picture_11.jpeg)

![](_page_50_Picture_12.jpeg)

# 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° 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

![](_page_51_Picture_2.jpeg)

Vist mop and r usir-brooms- dry

### Full Breakdown and Deep Cleaning/Steaming

![](_page_52_Picture_1.jpeg)

![](_page_52_Picture_2.jpeg)

![](_page_52_Picture_3.jpeg)

#### Effective Cleaning is 99% of effective sanitation. The remaining 1% is the job of sanitizers

![](_page_53_Picture_1.jpeg)

Acknowledgement to Elis Owens Ph.D. BIRKO Corporation

![](_page_53_Picture_3.jpeg)

#### Acknowledgements to the Suslow Lab Staff

![](_page_54_Picture_1.jpeg)

Janneth Pinzon Associate Specialist

![](_page_54_Picture_3.jpeg)

Adrian Sbodio Staff Research Assistant II

![](_page_54_Picture_5.jpeg)

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

![](_page_55_Picture_0.jpeg)

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