Microbial Water Quality and Fresh Market Vegetables

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(541)737-6825
My Agenda

• Foodborne illness in the US
• FSMA and how it might impact you
• Produce Safety Rule - "covered" produce and "agricultural water"
• Microbial quality of agricultural water
• Produce safety research at OSU – past, current, and upcoming
• How you can help us
• How we can help you
Foodborne illness in the US

- 48 million cases of foodborne illness in the US annually
- 128,000 hospitalizations
- 3,000 deaths

- Changing populations with increased susceptibility
  - 30% of US population is especially “at risk”

- Foodborne illnesses are not always simple stomachaches.
Example of Fresh Produce Contamination, 2011

Multistate Outbreak of *E. coli* O157:H7 Infections Linked to Romaine Lettuce

At a Glance:
• Case Count: 58
• States: 9
• Deaths: 0
• Hospitalizations: 33
• Recall: Yes

Illnesses traced to salad bar at a single grocery store chain. Further investigation identified a single farm as the source. Source on farm not identified.
Example within the Pacific Northwest, 2016

Multistate Outbreak of Listeriosis Linked to Frozen Vegetables

At a Glance:

- Case Count: 9
- States: 4
- Deaths: 3
- Hospitalizations: 9
- Recall: Yes

11 SKUs initially recalled.
Further investigation led to ~400 SKUs recalled
All product processed from May 2014-June 2016
Why FSMA and how it is designed to help?

- Globalization
  - 15% of US food supply is imported
- New Foods and Production Processes
  - More foods in marketplace
  - New hazards
  - Processes with unknown efficacy
- Broad prevention mandate with accountability
- Responsibility for food safety goals from farm-to-table
- Partnerships and responsibility across the food system
Food Safety Modernization Act (FSMA)

• **7 Major Rules**
  • Accredited third-party certification
  • Foreign supplier verification programs (FSVP) for importers of food for humans and animals
  • Mitigation strategies to protect food against intentional adulteration
  • Sanitary transportation of human and animal food
  • Preventive controls for food for animals
  • Preventive controls for human food
  • Standards for produce safety**
Farm-to-Table Prevention and Control

Major focus of these rules is on microbial food safety; however, chemical and physical hazards are also important.
The rule provides an exemption for produce that receives commercial processing that **adequately reduces** the presence of microorganisms of public health significance, under certain conditions.
<table>
<thead>
<tr>
<th>Business Size</th>
<th>Compliance Dates for Sprouts</th>
<th>Compliance Dates For Most Produce</th>
<th>Water Related Compliance Dates¹</th>
<th>Compliance Date for Qualified Exemption Labeling Requirement ²</th>
<th>Compliance Date for Retention of Records Supporting a Qualified Exemption</th>
</tr>
</thead>
<tbody>
<tr>
<td>All other businesses (&gt;500K)</td>
<td>1/26/17</td>
<td>1/26/18</td>
<td>1/26/22</td>
<td>1/1/2020</td>
<td>1/26/16</td>
</tr>
<tr>
<td>Small businesses (&gt;250K-500K)³</td>
<td>1/26/18</td>
<td>1/28/19</td>
<td>1/26/23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very small businesses (&gt;25K-250K)⁴</td>
<td>1/28/19</td>
<td>1/27/20</td>
<td>1/26/24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ According to the Proposed Rule issued 9/13/17, Compliance dates for Subpart E, Agricultural Water, allow an additional four years.
² A farm eligible for a qualified exemption must notify consumers as to the complete business address of the farm where the food is grown, harvested, packed, and held. A farm is a small business if, on a rolling basis, the average annual monetary value of produce sold during the previous 3-year period is no more than $500,000.
³ A farm is a very small business if, on a rolling basis, the average annual monetary value of produce sold during the previous 3-year period is no more than $250,000.

*Training Requirements*

Before the compliance date, every covered farm that does not qualify for an exemption must have a supervisor (such as a farm owner/operator) complete a standardized food safety training program. You can find out more about food safety training from the Produce Safety Alliance. [https://producesafetyalliance.cornell.edu/training](https://producesafetyalliance.cornell.edu/training)

Revised 10/09/17
The Produce Safety Rule:
Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption

• Key Requirements:
  • Agricultural Water – FDA is considering modifications to simplify rule
  • Biological Soil Amendments
  • Domesticated and Wild Animals
  • Worker Training and Health and Hygiene
  • Equipment, Tools, and Buildings

• Applies to produce that is consumed raw OR that is not processed with a validated kill step.
Do you grow, harvest, pack, or hold “covered” produce?

Examples of “covered” produce = consumed raw:

- Onions
- Sweet Cherries
- Blueberries
- Blackberries
- Plums

- Walnuts
- Marionberries
- Cabbage
- Broccoli
- Kale

Not Covered Produce (not subject to the rule) = rarely consumed raw – List is Exhaustive

Asparagus, Beans (black, great Northern, kidney, lima, nay, pinto), garden beets (roots & tops),
cashews, sour cherries, chickpeas, cocoa beans, coffee beans, collards, sweet corn, cranberries,
dates, dill (seeds & weed), eggplants, figs, ginger, hazelnuts, horseradish, lentils, okra, peanuts,
pecans, peppermint, potatoes, pumpkins, winter squash, sweet potatoes, water chestnuts

Rule does not apply to:

- Food grains
Are you excluded or exempted from the rule?

• Exclusions:
  • Personal or on-farm consumption
  • Farms with <25,000 average annual value of produce sales (3 years)

• Qualified Exemptions (modified requirements):
  • Farm must have <$500,000 in average annual food sales (3 years)
  • AND
  • Sales to qualified end users must be >50% of sales
    • Qualified end users:
      • Consumer
      • Restaurant or retail food establishment in same state or Indian reservation as farm or <275 miles away
  • Label produce with name and address of farm and some documentation.
  • Exemption withdrawn if outbreak or investigation occurs.
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Revised 10/09/17
Do you apply any water to your “covered” produce?

**Agricultural water**: water intended to, or likely to, contact the harvestable portion of the crop or food-contact surfaces.
Is this Agricultural Water?

Lettuce

Overhead irrigation, Pond water

SUPPLEMENTAL MATERIAL
Is this Agricultural Water?

Citrus

Drip irrigation, Surface water

SUPPLEMENTAL MATERIAL
Is this Agricultural Water?

Apples

Pesticide application,
Well water

SUPPLEMENTAL MATERIAL
Is this Agricultural Water?

Potatoes

Overhead Irrigation, Surface water

SUPPLEMENTAL MATERIAL
Is this Agricultural Water?

Carrots

Drip irrigation, surface water

SUPPLEMENTAL MATERIAL

PSA Curriculum
Microbiological water quality requirements for “covered” produce

<table>
<thead>
<tr>
<th>Pre-Harvest Activities</th>
<th>Harvest Activities</th>
<th>Post-Harvest Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>Direct contact</td>
<td>Direct contact</td>
</tr>
<tr>
<td>Overhead cooling, etc.</td>
<td>Food-contact surface contact</td>
<td>Food-contact surface contact</td>
</tr>
<tr>
<td>Sprout Irrigation</td>
<td>Ice contacting food-contact surfaces</td>
<td>Ice contacting food-contact surfaces</td>
</tr>
<tr>
<td>Treated Agricultural Tea</td>
<td>Hand washing</td>
<td>Hand washing</td>
</tr>
</tbody>
</table>

Low levels of generic *E. coli* allowed 112.44(c)

No detectable generic *E. coli*/100 ml water 112.44(a)
Overview of Microbial Water Quality Standards (112.44 and 112.45)

Water source:

- Public Water System (Safe Drinking Water Act)
- Untreated ground water
  - Establish quality: n = 4 over 1 year
    - Annual Verification (n = 1)
  - No detectable E. coli in 100 ml
  - GM: <126 E. coli in 100 ml
- Untreated surface water (or held in this capacity)
  - Baseline Survey → Water Quality Profile (WQP)
    - (n = 20 over 2 years)
    - Annual Verification (n = 5)
  - GM: <126/100 ml
  - STV <410/100 ml
- Treated water
  - No detectable E. coli in 100 ml
  - GM: <126/100 ml
  - STV <410/100 ml
- Public water supply

Allowable Use of Water:

- Pre- and Post-Harvest
- Pre-Harvest Only
- Not suitable for use on covered produce
  - Mitigation Required

No testing required (documentation)

GM: >126/100 ml
STV >410/100 ml

No detectable E. coli in 100 ml*

* or held in this capacity
Surface Water Testing Decision Tree

**Covered Produce AND Direct Application**

- Water Quality Profile
  - Meets Standards?
    - Yes: Maintain Normal Operations
    - No: Apply Mitigation Strategy
  - Monitor Water Quality
Apply Mitigation Strategy:
Goal: Provide same level of public health protection as using irrigation water that met the standard

<table>
<thead>
<tr>
<th>Time Interval Between Irrigation and Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 0.5 log reduction per day (up to 4 days)</td>
</tr>
<tr>
<td>• Alternative data – research needed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time Interval Between Irrigation and End of Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Supporting data – research needed</td>
</tr>
<tr>
<td>• Recordkeeping</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treat Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Supporting data – research needed</td>
</tr>
<tr>
<td>• Recordkeeping</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discontinue Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Inspect</td>
</tr>
<tr>
<td>• Make changes</td>
</tr>
<tr>
<td>• Retest</td>
</tr>
</tbody>
</table>
Moving forward with agricultural water

FDA is reconsidering the water testing requirements section of the Produce Safety Rule

- Water compliance dates have been delayed
- No timeline on when there will be more information/guidance

Surveys and research to identify highest risk for prioritizing investments in mitigation strategies
Assist stakeholders with compliance
Produce Safety Research

We need your help!

Previous, current, and upcoming research and training opportunities
Microbial Die-Off in Onions Produced with Contaminated Irrigation Water: Greenhouse and Field Studies

Day 19
April 10

Day 27
April 18

Day 54
May 15

Day 75
June 5

Day 117
July 17

Day 129
July 30

Work conducted in collaboration with Drs. Clint Shock and Stuart Reitz at Malheur County Experiment Station

Previous Research

Greenhouse research funded by the Western Center for Food Safety and the Center for Produce Safety.
Field research was funded by the Oregon Specialty Crop Block Grant Program.
Research Question

Do finishing practices used by the onion industry mitigate any potential risk associated with poor water quality?

• Treasure Valley is a major producer of dry bulb onions.
• Dry bulb onions are the only “covered” produce grown in Treasure Valley, but it is the highest value crop.
• No confidence that they could meet water quality standards of produce rule.
• Conventional practices provide a long period between last irrigation and harvest (4 weeks).

• Approach: Conduct a field trial with irrigation water contaminated with various levels of generic *E. coli* on the last irrigation and evaluate onion bulbs for contamination throughout finishing.
### Field Layout

<table>
<thead>
<tr>
<th>Block</th>
<th>Tier</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td>Tier 1</td>
<td>10,000 CFU/100 ml</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Block 1</td>
<td>Tier 2</td>
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<tr>
<td>Block 2</td>
<td>Tier 3</td>
<td>1000 CFU/100 ml</td>
<td>0</td>
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<td>Block 3</td>
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<tr>
<td>Block 4</td>
<td>Tier 5</td>
<td>1000 CFU/100 ml</td>
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<tr>
<td>Block 5</td>
<td>Tier 6</td>
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<tr>
<td>Block 6</td>
<td>Tier 7</td>
<td>100,000 CFU/100 ml</td>
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<tr>
<td>Block 7</td>
<td>Tier 8</td>
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</tr>
<tr>
<td>Block 8</td>
<td>Tier 9</td>
<td>1000 CFU/100 ml</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Block 9</td>
<td>Tier 10</td>
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</tr>
</tbody>
</table>

**Dimensions:**
- **7 m**
- **28 cm**

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28 cm

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7 m
Mobile Command Centers
Contaminated Irrigation Monitoring – Day 0

Targeted contamination levels:

- 1 log CFU/ml
- 2 log CFU/ml
- 3 log CFU/ml

- 1000 CFU/100 ml
- 10,000 CFU/100 ml
- 100,000 CFU/100 ml

IDEXX ColiSure
Why field trials are great and terrible at the same time...
## Onion Contamination Rates During Finishing

### Targeted Irrigation Water Contamination Level

<table>
<thead>
<tr>
<th>Targeted Irrigation Water Contamination Level</th>
<th>Total Generic E. coli Applied during irrigation (log CFU/tape)</th>
<th>Onion samples positive for generic E. coli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninoculated</td>
<td>0</td>
<td>0/150</td>
</tr>
<tr>
<td>1000 CFU/100 ml</td>
<td>700,000</td>
<td>0/150</td>
</tr>
<tr>
<td>10,000 CFU/100 ml</td>
<td>8,900,000</td>
<td>9/150</td>
</tr>
<tr>
<td>100,000 CFU/100 ml</td>
<td>63,000,000</td>
<td>20/150</td>
</tr>
</tbody>
</table>

### Onion samples positive for generic E. coli

<table>
<thead>
<tr>
<th>Days post-irrigation</th>
<th>0/150</th>
<th>0/150</th>
<th>9/150</th>
<th>20/150</th>
</tr>
</thead>
</table>

### Onion analysis

- Onion samples positive for generic E. coli are analyzed under different contamination levels and days post-irrigation.
- The data shows the increase in contamination levels with higher inoculation levels and longer post-irrigation periods.
Research Conclusions

Do finishing practices used by the onion industry mitigate any potential risk associated with poor water quality?

Yes, conventional curing practices (extended irrigation to harvest intervals) mitigate contamination from very poor quality irrigation water (>100,000/100 ml).

Caveats: Drip irrigation, soil type, weather conditions.

For more information – see research publications:

Microbiological quality of agricultural water on Oregon’s vegetable/berry farms
Joy Waite-Cusic and Lauren Gwin

Sources and control of *Listeria* in Pacific Northwest Produce
Jovana Kovacevic, Dave Stone, and Joy Waite-Cusic
Microbiological quality of agricultural water on Oregon’s vegetable/berry farms

• Characterize water sources and water use in Oregon’s produce industry

• Perform a high level analysis of the microbiological quality of water used by Oregon’s specialty crop farms using available water testing data

• Characterize the microbiological quality of agricultural water of multiple farms utilizing the same surface water source - potential for sharing water testing data

• Provide Oregon’s specialty crop industries with training to assist with compliance of the agricultural water quality standards, including testing and mitigation strategies

We need you!
Sources and control of *Listeria* in Pacific Northwest Produce

- Investigate the prevalence, contamination points, and characteristics of *Listeria* spp. in produce growing, handling and processing environments
- Perform targeted sampling in produce handling and processing environments to identify high risk areas and harborage sites for *Listeria monocytogenes*
- Provide Oregon’s specialty crop industries with training and education on new guidelines, sources of *Listeria* contamination, dissemination and controls, environmental monitoring for *Listeria* spp., and hands-on training for environmental sample collection
  - Survey to capture current status and costs of environmental monitoring programs

*We need you!*
Additional Product Safety Rule Training

Compliance Training – Produce Safety Alliance
- Oregon Department of Agriculture
- Oregon State University
- Others

Add-on Curriculum – commodity- or topic-specific
- Western Regional Center to Enhance Food Safety (OSU)
- Oregon State University – USDA FSOP Grant
  - Small and very small growers
  - Bilingual
- Oregon State University – SCBGP Grants
  - Agricultural water testing and calculations
  - Environmental monitoring

On-Farm Readiness Review
- Oregon Department of Agriculture/Oregon State University
Acknowledgments

Linda Harris and Anne-laure Moyne – UC-Davis
Monty Saunders – MCES
Selena Callahan - OSU

Amber Barnard
John Jorgenson
Thank you for your time.
I am happy to answer questions.

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