H₂O-Go: Practical Recommendations to Meet Postharvest Agricultural Water Requirements

Produce Safety Educators’ Call #66
May 9, 2023
Instructions

• All participants are muted.
• There will be time for questions and discussion at the end of the meeting.
• Feel free to use the chat box to ask questions as well!
• This session will be recorded and the presentation will be shared via the listserv and on our website after the call.
• The views and opinions expressed in this presentation are those of the speakers and do not necessarily reflect legal advice, views or positions of the PSA and its members, nor any entities they represent.
• PSA and NECAFS launched a survey to understand the costs and barriers of beginning or expanding food safety practices on farms and in packinghouses
• Allows for the development of relevant educational materials
• Survey is set to close on June 1\textsuperscript{st}
• Survey is available in English and Spanish
  – English-language survey: https://qualtrics.uvm.edu/jfe/form/SV_agW9o6VWOUCivCC
Welcome Dr. Yulie Meneses

• Newest PSA Spanish-Language Extension Associate

• Located in Miami, FL
  – Super to have national distribution of our SLEAs

• Background in water reuse/sustainability in the food industry

• Jumping into the PSA
  – Reviewing Spanish translation of PSR Preamble
  – Becoming a PSA Trainer
Harvest/Postharvest Water Educators’ Call Series

• This webinar concludes the Harvest/Postharvest Water series of PSA Educators’ Calls... for now
• We are prioritizing the release of educational materials – stay tuned!
• Please continue to reach out to PSA with Subpart E questions
Thank you to all of you for joining us!

Keep the comments/suggestions coming so we can keep the focus of these webinars on thing you value.
The PSA Website

English: producesafetyalliance.cornell.edu
Spanish: es.producesafetyalliance.cornell.edu
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H2O-Go Part 2: Practical Recommendations to Meet Postharvest Ag Water Requirements

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Professor & Food Safety Extension Specialist, University of Florida
A Note

• We have highlighted certain products as examples
• Their use does not constitute endorsement, but merely examples for teaching purposes

A big thank you

To Dr. Keith Schneider for sharing content that was used in this presentation.
What are we going to do today?

• Food safety considerations for postharvest water (e.g., washing, hydrocooling, top icing, fungicide drenches)

• Discussions with your growers surrounding postharvest water
  1. Do I need to wash?
  2. Single pass vs recirculated or batch systems
  3. Treat, effectively and appropriately, to reduce cross-contamination
Many Uses for Postharvest Water

Removing dirt and debris
- Longer shelf life, control of spoilage microorganisms
- Better adhesion of waxes
- Aesthetics

Cleaning & sanitation
- Food safety
- Reduction in spoilage microorganisms

Cooling
- Longer shelf life

Commodity movement
- Less damage and bruising

Handwashing
- Food safety

Handwashing
- Less damage and bruising

Removing dirt and debris
- Longer shelf life, control of spoilage microorganisms
- Better adhesion of waxes
- Aesthetics
FSMA PSR Harvest/Postharvest Water

• Requirements:
  • Any postharvest water must not have any detectable generic *E. coli* per 100 mL
  • You must establish a water change schedule for recirculated water
    • You must visually monitor water for buildup of organic material
  • If sanitizers are used to maintain water quality, must be approved and labeled for use
Subpart E Compliance Dates

FDA proposes compliance dates for harvest and postharvest agricultural water requirements.

<table>
<thead>
<tr>
<th>Business Size</th>
<th>Water Related Enforcement Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>All other businesses (&gt;$500K)</td>
<td>January 26, 2023</td>
</tr>
<tr>
<td>Small businesses (=&gt;$250K-500K)</td>
<td>January 26, 2024</td>
</tr>
<tr>
<td>Very small businesses (=&gt;$25K-250K)</td>
<td>January 26, 2025</td>
</tr>
</tbody>
</table>
Seems simple, so what’s the big deal?

- Water facilitates microbial transfer from contaminated produce to non-contaminated produce
  - Foodborne pathogens will go unnoticed
  - Decay organisms (molds, yeast, bacteria) will decrease shelf-life and will also be spread
    - A lot of times this resonates much better with growers, so sell the double benefit of managing postharvest washing appropriately

- Washing does not alleviate preharvest contamination risk
  - Adding a sanitizer, along with management of critical parameters to wash water, reduces risk from potential cross-contamination
Postharvest water is **NOT** used for…

- Postharvest water is not a kill step
- It will not un-adulterate contaminated product
- It is not to be used in lieu of GAPs
To wash or not to wash, that is the question...
Do growers have to wash produce?

- The FSMA Produce Safety Rule does not require growers or packers to wash produce
  - FSMA PSR requires water-change schedules, visually monitoring water quality, managing water temperature appropriate to commodity, and maintaining safe and adequate sanitary water quality

- Washing, even with a sanitizer, does not disinfect produce but may benefit aesthetics and shelf life
Why some growers will wash

• Buyer or other industry requirements

• Washing produce is purely for aesthetics or quality
  • Remove soil, clean surface
  • Rapidly cool produce to maintain quality

• If you must wash, how can we minimize food safety risks?
Risk Profiling Harvest/Postharvest Systems

- If you want to move the needle… let’s talk management
Minimizing or Managing Risk

- Consider field-packing
- Consider dry-packing
- Consider cooling without dunking (*water quality)
- Consider single pass systems (*water quality)
  - Add low dose sanitizer to prevent biofilm build-up

- If recirculated or batch systems are needed…
  - Consider a sanitizer (Science tells you “Must Use a Sanitizer”)
  - Consider water change schedule to reduce organic matter
  - Develop a plan to prevent organic matter build-up (e.g., culling, sorting, debris removal, clean bins if submerging, pre-wash commodities, filtration systems)
Why and how to use sanitizers?

- To prevent postharvest cross-contamination
- May provide protection against infiltration of pathogens (by reducing the pathogens)
- Cross-contamination is when bacteria, viruses, or protozoa are transferred from one surface to another
When washing an antimicrobial’s job is to stop cross-contamination.
When washing an antimicrobial’s job is to stop cross-contamination
Postharvest Washing

- If not properly controlled, a single mistake can impact everything processed

<table>
<thead>
<tr>
<th></th>
<th>Salmonella transfer onto tomatoes from one contamination event</th>
<th>Salmonella remaining in wash water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Only</td>
<td>218,776 per g of tomato</td>
<td>4,365,158 per ml of water</td>
</tr>
<tr>
<td>150 ppm Free Chlorine</td>
<td>&lt;10 per g (none detected)</td>
<td>&lt;1 in 10 ml (none detected)</td>
</tr>
</tbody>
</table>

Dunn et al., 2019
### Batch, Recirculated, and Single-pass

<table>
<thead>
<tr>
<th>Method</th>
<th>Volume Type</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch</td>
<td>Small volumes</td>
<td>Tub with water</td>
</tr>
<tr>
<td>Recirculated</td>
<td>Larger volumes</td>
<td>Flume</td>
</tr>
<tr>
<td>Single-pass</td>
<td>One time through the system</td>
<td>Spray bars</td>
</tr>
</tbody>
</table>
So what is best sanitizer out there?

• How the sanitizer is going to be used matters a lot
• What crop is being packed?
• How is the water being applied?
• Will the water be recirculated?
• How long is the water used before it is replaced?
• Think about these factors as we discuss a few of the commonly used sanitizers are used during postharvest activities
Factors Affecting Sanitizer Efficacy

- Water pH
  - Important for some sanitizers
- Water Turbidity
- Water Temperature
- Sanitizer concentration
  - Label is law (think about your water system ~ different concentrations for spray bar v batch system)
- Contact time
  - Remember you aren’t sanitizing the produce (sanitizing the water)
A Brief Word on Turbidity

- Turbidity can be used as a measure of water quality.
- The higher the turbidity, the lower the potential quality, or to state in a different way the higher the demand for sanitizer.
- Other tests can be used (e.g., chemical oxygen demand or COD), but turbidity is quick and easy.
- As quality drops or demand increases, the amount of sanitizer needed to maintain water quality also increases.
A Brief Word on Temperature and Infiltration

- Water temperature can affect the efficacy of a sanitizer
- Cooler water can slow chemical reactions, but hot water can cause chemicals to break down faster
- Important: Temperature differential can lead to infiltration of surface contaminants
  - Hot produce immersed in cold water, organisms on the surface can be drawn into the produce, this is called infiltration
  - A study by Zhou et al. 2014 examined time, immersion depth and temperature on infiltration (e.g., minimizing contact time between fruit & water, minimizing depth of fruit in water (monolayer) all reduced infiltration)
Chemical Sanitizer Regulations

• Approval as Sanitizer
  • Environmental Protection Agency
    • EPA label showing approval for washing fruits and vegetables
  • Look for appropriate concentration and minimum contact time, is a rinse needed?

• The label is your hard-to-understand friend (and also legally required)

https://www.grunge.com/59169/equations-mysterious-properties/
SaniDate 15.0
Label Hunt


What is the EPA registration number?
What page can you find the instructions for treatment of water?

Page 2
SaniDate 15.0 Label Hunt

- What ppm PAA is your target?
- What’s the dosing per 25 gallons?
- What is the contact time?
- Does water need to be at a certain pH?
- Do you need to rinse?

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TREATMENT OF RAW, POST HARVEST FRUITS AND VEGETABLES AND PROCESSING WATERS

FOR REDUCTION AND CONTROL OF PATHOGENIC BACTERIA IN RAW, POST-HARVEST FRUIT AND VEGETABLE PROCESS AND WASH WATERS (REGULATED BY US EPA)

Use SaniDate 15.0 to reduce (in 90 seconds) 99.9% of pathogenic bacteria Escherichia coli O157:H7, Salmonella enterica, and Listeria monocytogenes in processing waters used for washing fruits, and vegetables.

1. Add SaniDate 15.0 batch-wise or continuously to processing water without fruits, or vegetables present at a dilution of 0.8–1.9 fl. oz. per 25 gallons of water. This provides approximately 40–100 ppm of peroxycetic acid and 27–64 ppm of hydrogen peroxide.
2. Allow the solution to circulate at least 90 seconds before adding raw fruits, or vegetables.
3. Adjust dose as needed to maintain a minimum product concentration of 40 ppm of peroxycetic acid.
4. Allow for a minimum contact time of 90 seconds.
5. Prepare fresh process water daily. Do not reuse water that is badly fouled.
Commonly used Sanitizers for Postharvest Washing

**Hypochlorite (Chlorine)**
- Sodium (liquid)
- Calcium (powder or tablet)

**Peracetic Acid**
- Liquid ranging from 5-15%
Free vs. Total Chlorine

- Since free chlorine gives us the antimicrobial power, that is what we always monitor
  - Sometimes referred to as available chlorine

- However, free chlorine must be in the correct form
  - Influenced by pH of the water
Hypochlorites

• Hypochlorites and Cl₂ form hypochlorous acid (HOCl) when introduced into water
• Hypochlorous acid is the chemical agent that is responsible for killing the pathogens

\[
\text{NaOCl} \quad \text{Ca(OCl)}_2 \quad \text{Cl}_2 \quad (\text{H}_2\text{O}) \quad \text{HOCl}
\]
How pH affects efficacy of hypochlorite

- At high pH, hypochlorous acid (HOCl) converts to hypochlorite ion (OCl⁻)
  - Hypochlorite ion is relatively ineffective against pathogens
  - Both HOCl and OCl⁻ are measured as ‘free’ chlorine
Why it’s important

- Hypochlorite ion is relatively ineffective against pathogens
- But both are measured as ‘free’ chlorine

\[
\text{NaOCl} + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{NaOH} \\
\text{HOCl} \rightarrow \text{H}^+ + \text{OCl}^- \]

Here’s the missing part of the equation:
Why this is important

• Sodium hydroxide (NaOH) is a base

• This means the more NaOCl you add, the base will be produced and the higher the pH will go and the less effective the chemistry becomes

• This why you **HAVE TO** use an acidifying agent (citric acid, phosphoric acid) to counteract the formation of NaOH

• Sweet spot is pH 6-7

\[
\text{NaOCl} + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{NaOH}
\]
Chemical Sanitizers - Factors Affecting Activity

- pH
- Organic Matter
- Others
  - Water Hardness
    - Mg, Ca
  - Time/temperature
  - Concentration
  - Biofilms
Hypochlorites (HOCl)

**Advantages**
- Broad spectrum
- Hard water tolerant
- Low-temperature activity
- Relatively inexpensive
- No residual activity or film formation

**Disadvantages**
- Toxicity at low pH: Chlorine gas
- Extremely low pH or high temperature
- Corrosive/Irritant
- Unstable
- Environmental concerns
- Disinfection by-products (DBPs)
Practical Applications

• Monitoring
• Test strips
• Free Chlorine
• pH
Summary – Take Home

- Washing produce isn’t mandatory
  - Dry packing
  - Field packing

- Consider reducing time produce is in contact with the water
  - Spray tables/bars
  - Avoid dunking/submerging

- Science supports using sanitizers in all systems of harvest/postharvest water
  - Single pass systems ~ reduce biofilms
  - Batch/recirculated systems ~ reduce cross-contamination
Information overload?

- Postharvest Water Decision Tree – Cornell GAPs
  
  [https://cals.cornell.edu/national-good-agricultural-practices-program/resources/educational-materials/decision-trees/postharvest-water](https://cals.cornell.edu/national-good-agricultural-practices-program/resources/educational-materials/decision-trees/postharvest-water)

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**Postharvest water includes any water that contacts fresh produce or food contact surfaces during or after harvest.**

This includes water used for rinsing, washing, cooling, evening, or moving fruits and vegetables. Postharvest water use may be a necessary part of fruit and vegetable production, but it is also a potential source of contamination. Understanding the risks associated with postharvest water use, and how to minimize them, are important for produce safety. The key things you need to do to ensure the safety of postharvest water are to:

1. **Start with clean water.** Water must be free of detectable generic E. coli or a 100 ml water sample (5).
2. **Treat with sanitizer,** or in some other way maintain water quality during use (1).
3. **Change bulk/hand tank water when dirty** (3).
4. **Monitor water temperature** at appropriate temperatures to avoid inactivation (2).
5. **Clean and sanitize tanks/tote regularly** (9), making sure to reduce or eliminate pooled water (5).
6. **Document postharvest activities** when required (4, 7) or as best practice.

**Start with clean water**

Only use water that has been tested and confirmed to meet the standard of no detectable generic E. coli in a 100 ml water sample as producer wash water (5). Water quality testing can be done by the form or by the municipality or other water supplier, but the water must be tested to know its initial quality (5). Contaminated water can contaminate produce, so starting with clean water is essential. Do not use untreated surface water for postharvest use (9). If you use surface water, you must treat the water and regularly monitor to ensure the treatment is effective. If sanitizer is used as the treatment, it must be used according to instructions on the label (9).
Information overload?

• Produce Safety Alliance sanitizer tool
  • Labeled Sanitizers for Produce - Excel Tool in Sanitation heading
  • https://producesafetyalliance.cornell.edu/resources/general-resource-listing/
  • Look up product labels, see sizes available, see what products are labeled for specific uses
  • Tutorial: https://www.youtube.com/watch?v=wNNJOeITtxU
For information check out these videos on YouTube.

There are three videos (basic chemistry, pH effects, and why more isn’t better)

They can be found at:

- [https://www.youtube.com/channel/UCY2J9s4m0fKwSianlO4ELRg/videos](https://www.youtube.com/channel/UCY2J9s4m0fKwSianlO4ELRg/videos) (CONTACT)
- [https://www.youtube.com/channel/UCj0D5pizX4--ds4gORTw2ug](https://www.youtube.com/channel/UCj0D5pizX4--ds4gORTw2ug) (KRS_UF)
More Resources

Food Safety Considerations for Postharvest Washing of Produce and Sanitation of Packing Areas

Using Sanitizers on Organic Fruit and Vegetable Farms- Merging National Organic Program Standards with Good Agricultural Practices
https://extension.tennessee.edu/publications/Documents/SP798-C.pdf
Thank you!
Questions?

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