Department of Horticulture

Fresh Produce Food Safety Team

Virginia Cooperative Extension
Virginia Tech • Virginia State University
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Post-harvest Water and Use of Sanitizers

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Recap of Packinghouse Food Safety Concerns **(video)**

Outline

- Important Terms to Know
- Cleaning VS. Sanitizing
- Postharvest Water – minimize risks
- Sanitizer 101
- Sanitizer Calculations
- Monitoring
- Demos

Important Terms to Know

- **Clean:** Food or food contact surfaces are washed and are visually free of dust, dirt, food residues, and other debris
- **Sanitize:** Treat clean food-contact surfaces with heat or chemicals to reduce the number of pathogenic microorganisms
- **Disinfectant:** A chemical agent that is applied to inanimate objects; it reduces the microbial load to an acceptable level for public health
- **Sterilize:** the complete elimination of pathogenic microorganisms, including the spores of foodborne pathogens

Cleaning vs. Sanitizing

What's the difference

Cleaning

- Cleaning is the process of removing food and other soils
- Cleaning agents:
  - Detergents
  - Solvent cleaners
  - Acid cleaners
  - Abrasive cleaners

Sanitizing

- Sanitizing is the process of reducing the number of microorganisms that are on a properly cleaned surface to a safe level
- Sanitizing agents only work on properly cleaned and rinsed surfaces
- Hot Water
  - Must maintain appropriate water temperature
- Chemical
  - Several different types (discussed later)

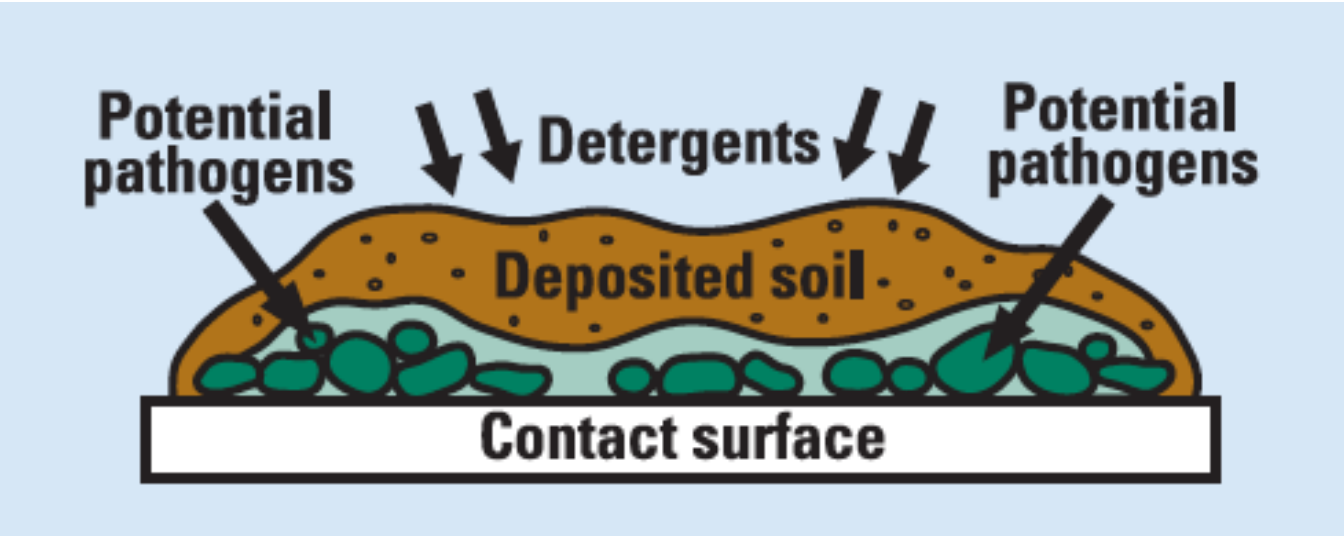
Multi-step process

- Pre-cleaning – Scrape and rinse to remove loose food.
- Wash - Use detergent solutions to remove stuck-on food
- Rinse to remove food and detergent
- Sanitize to kill attached surviving bacteria and viruses
- Air Dry

How the process works

① Washing helps loosen soils and other organic matter from the surface

② Detergent and scrubbing also helps break the adhesion of microorganisms to the surface

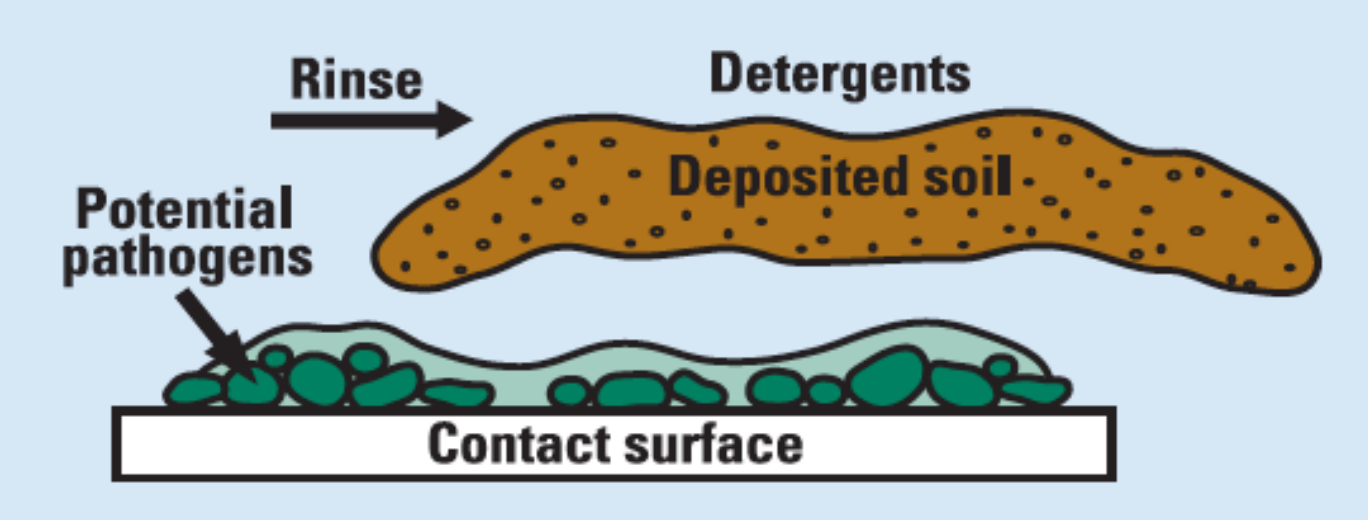


Iowa State University Extension, June 2011

How the process works

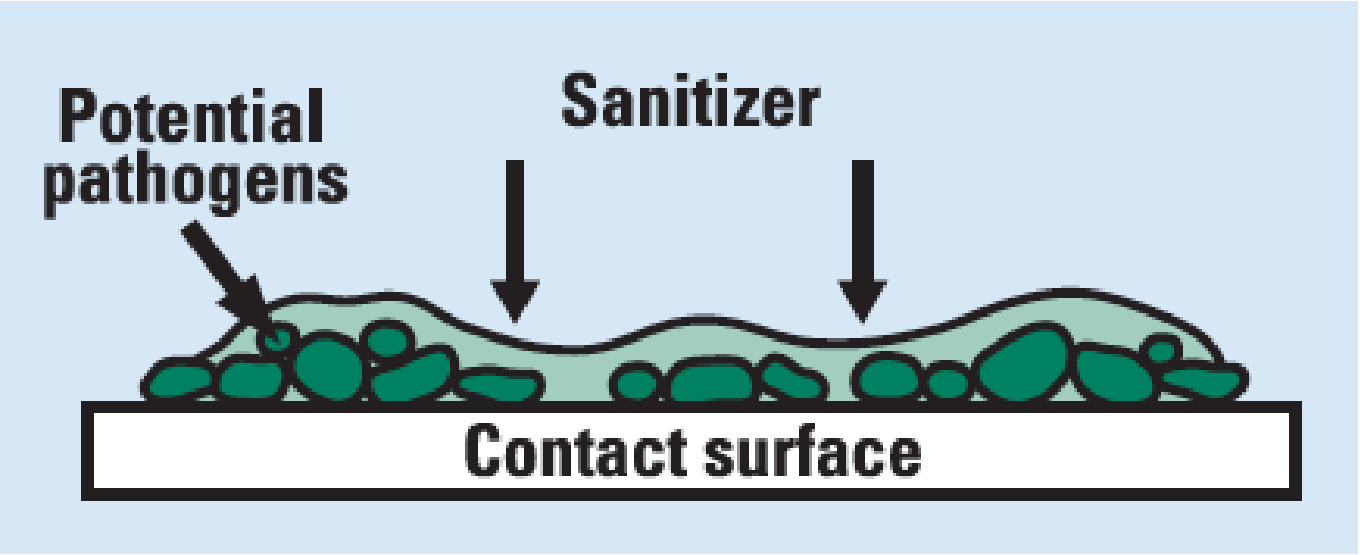
③ Rinsing removes loosened soil and detergent from the surface

- This step is important because organic material and detergent can bind up sanitizer making it less effective



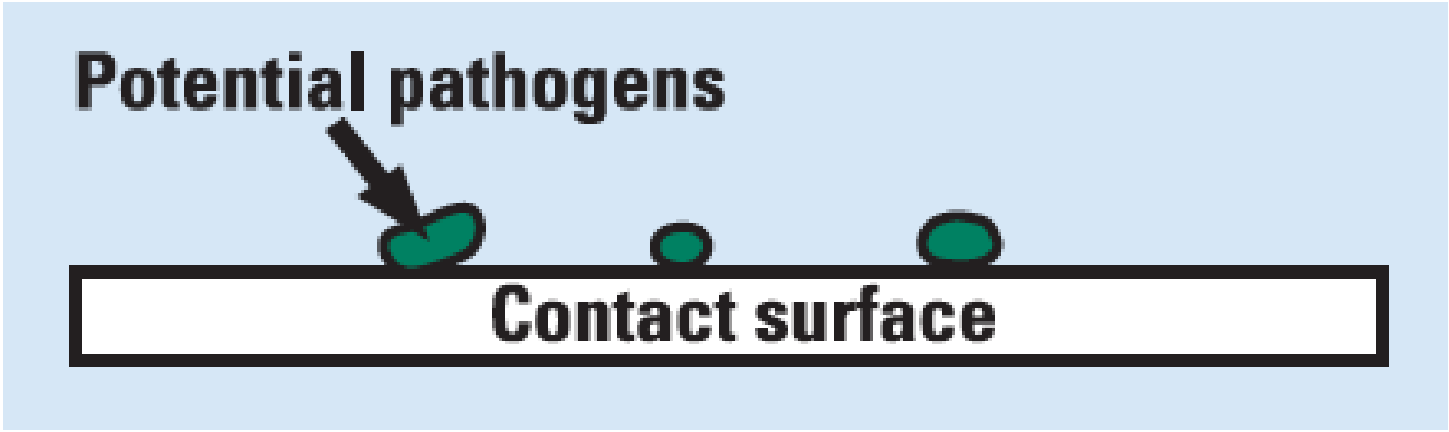
How the process works

④ Applying the sanitizer to clean surfaces actually provides a 'kill' step for reducing the number of microorganisms



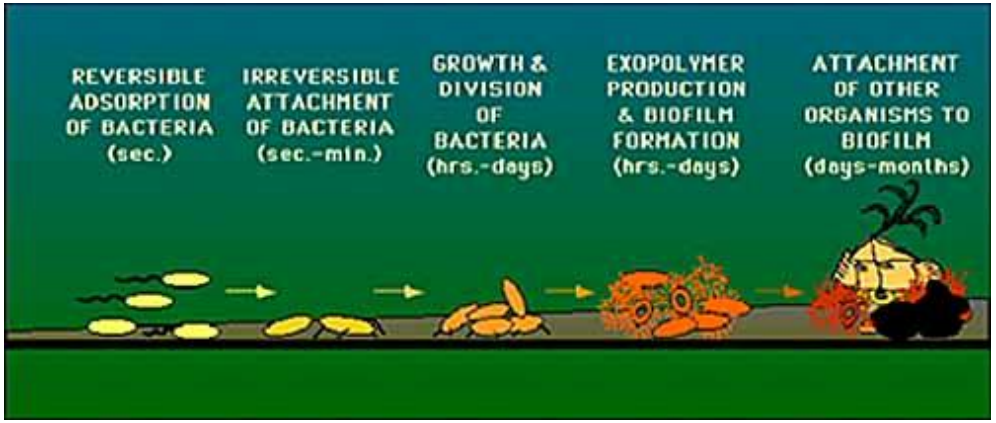
How the process works

⑤ The surface is not completely free of microorganisms, but the number is greatly reduced (levels below that of public health significance)



Bio-Films

- A thin, not visible, layer of food and bacteria that has built up on a surface
- Biofilms can form over a long period of time as a result of poor cleaning procedures
- They prevent cleaners and sanitizers from effectively reaching all surfaces



Postharvest Water

Critical for Food Safety and Quality

Postharvest Water
How to minimize risks…

- Use potable water
- Change water as necessary to maintain sanitary conditions
- Clean and sanitize water contact surfaces
- Install backflow devices and legal air gaps
- **Use sanitizers**
- **Keep water no more than 10°F cooler than produce; or limit the submersion time**

Sanitizers

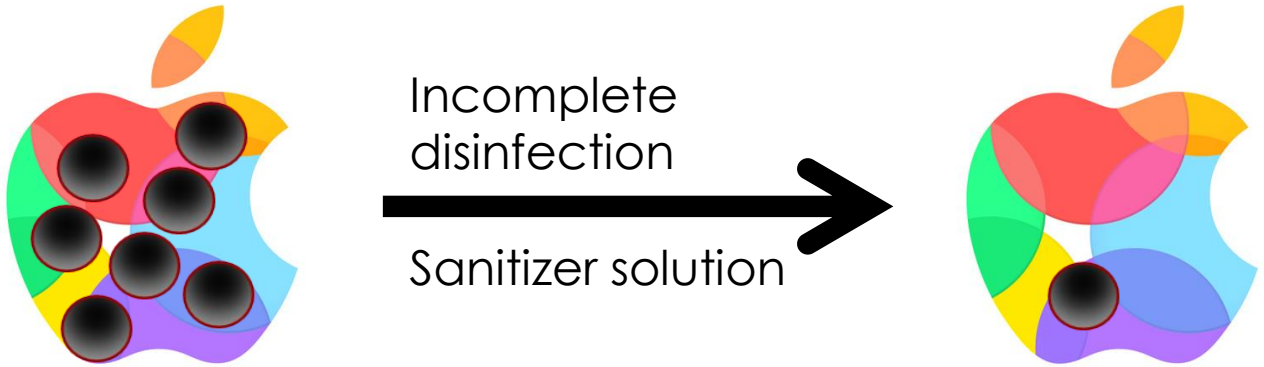
- Sanitizers are regulated by the Environmental Protection Agency (EPA) the same way as pesticides
- Only certain formulations and concentrations are approved and registered for use on fruits and vegetables
- The label is the law
- Be extremely careful (mixing sanitizers can be unsafe)

ULTRA CLOROX® BRAND REGULAR BLEACH (EPA Reg. No. 5813-50)
[REGISTERED AS Clorox® Regular-Bleach]
FOR FRUIT & VEGETABLE WASHING
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Thoroughly clean all fruits and vegetables in a wash tank. Prepare a sanitizing solution o 25 ppm available chlorine. After draining the tank submerge fruit or vegetables for 2 minutes in a second wash tank containing the recirculating sanitizing solution. Spray rinse vegetables with the sanitizing solution prior to packaging. Rinse fruit with potable water only prior to packaging.

Why add a sanitizer?

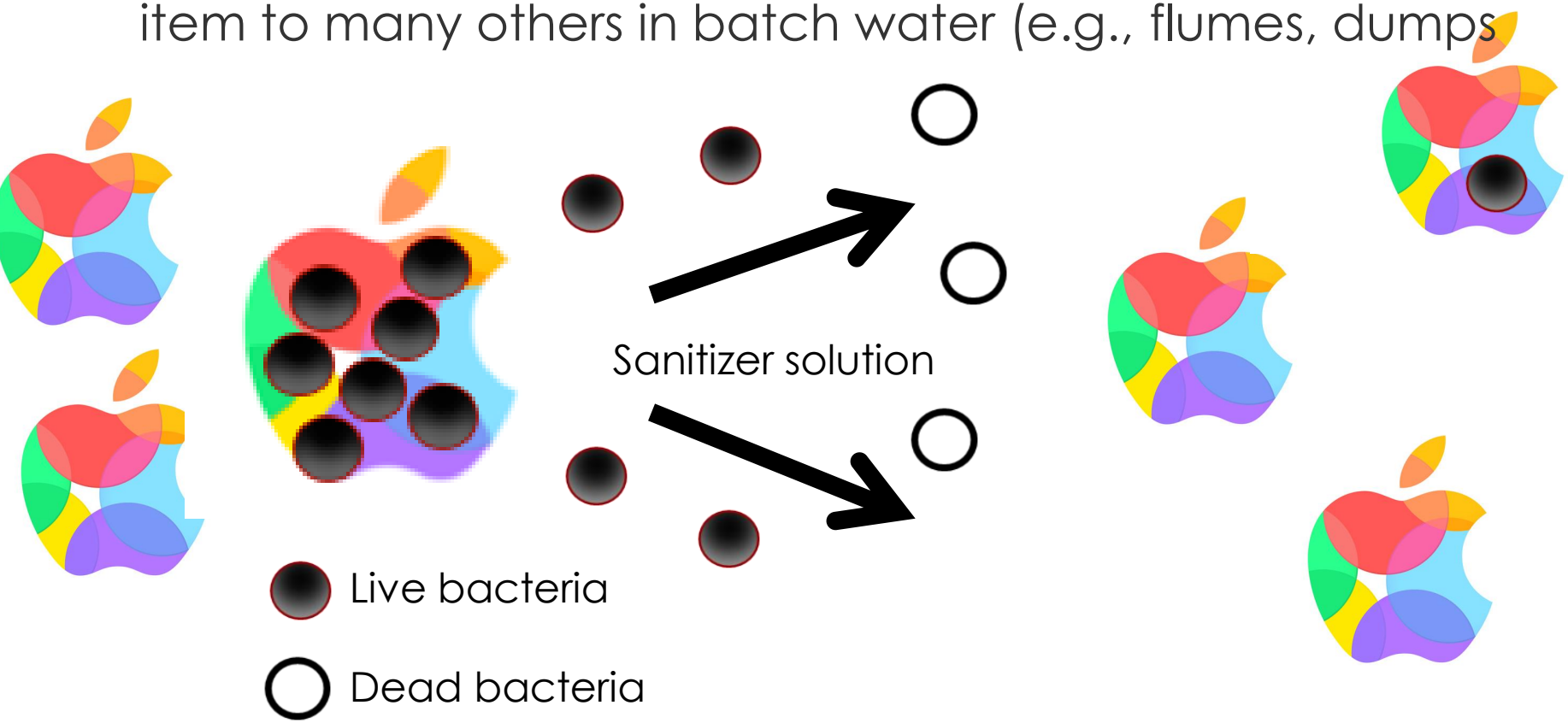
- Sanitizer cannot be relied on to completely remove spoilage and pathogenic microbes from produce



- Not sanitizing produce; sanitizing water
- Use Good Agricultural Practices (GAPs) to prevent contamination before it occurs

Reduce Likelihood of Cross Contamination

- Prevents movement of bacteria from one contaminated item to many others in batch water (e.g., flumes, dumps



Example of Dump Tank – Sanitizer/Postharvest water **(video)**

Infiltration

- Water temperature is also a concern because of infiltration
- Infiltration occurs when the produce is warmer than the water
- Higher risks associated with:
  - Submersion > Floating > Spray
  - Susceptible commodities (tomatoes, cantaloupes, apples)
  - Wounded or bruised fruit

Infiltration

Bacteria can enter the stem scar with improper handling or wash water management

Fruit pulp must be < 10°F warmer than water temperature to prevent infiltration

Sanitizer 101

Chlorine, PAA, and others

Types of Sanitizing Agents

- Halogens
- Ionic compounds
- “Active” oxygen
- “Newer” Technologies
- “Hurdle” Technology

Examples of Halogens and Halogen Compounds

- **Chlorine (will cover in-depth)**
- Chlorine dioxide
- Bromine
- Iodine

Examples of Ionic Compounds

- Trisodium phosphate (TSP)
- Quaternary ammonium compounds (Quats)
- Organic acids

Examples of "Active" Oxygen

- Hydrogen peroxide
- **Peroxyacetic acid (PAA) - will cover in-depth**
- Ozone

“Newer” Technologies

- Irradiation
- Pulsed light
- Edible coatings

Hurdle Technologies

- Hurdle technology uses a combination of treatments such as controlling pH, humidity, and temperature with preservatives to create multiple obstacles to microbial growth
- Lots of research on-going in this area

Common Sanitizers used in the Fresh Produce Industry

- Chlorine compounds
  - Hypochlorite(s) (bleach)
- Hydrogen peroxide/ peroxyacetic acid
- CHECK out the Chlorine and PAA *QUICK GUIDE*

Chlorine Efficacy

Germicidal properties affected by:

1. Concentration of added chlorine
2. pH of chlorinated water
3. Organic and inorganic matter
4. Temperature of water

Effect of pH on Chlorine Efficacy

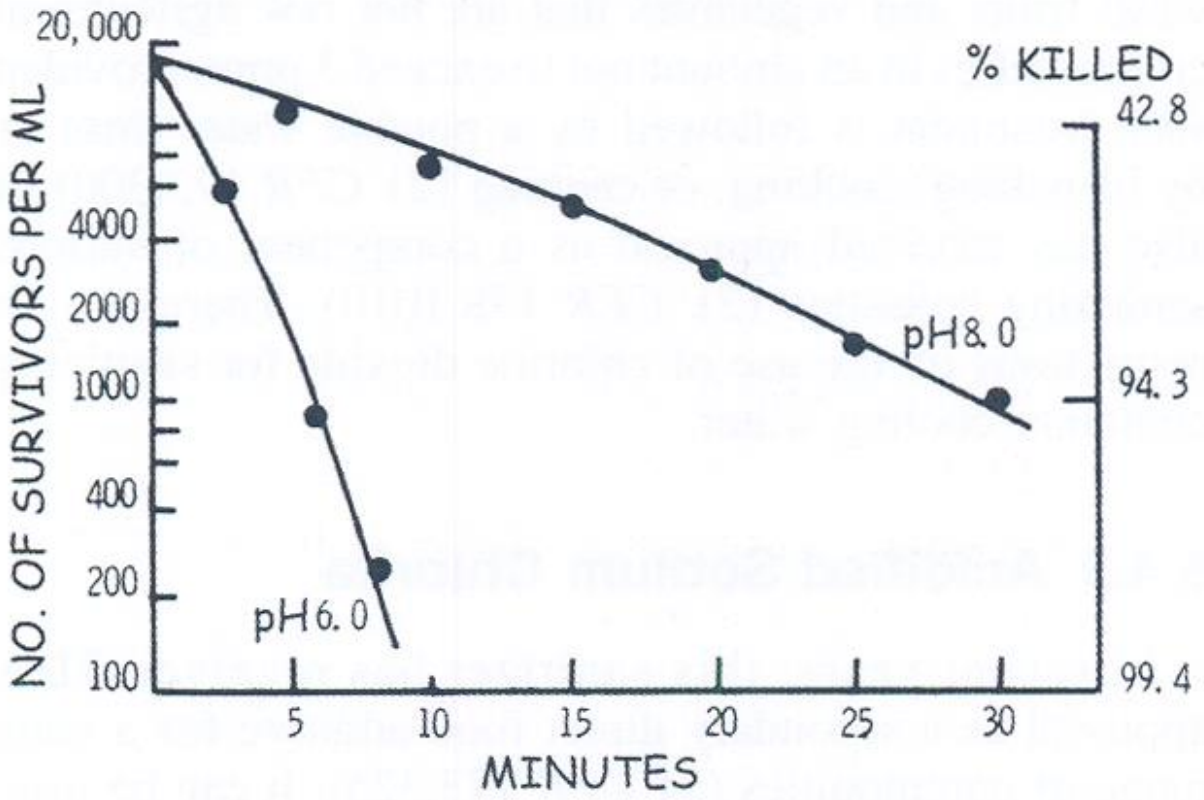


Figure 5-2—Laboratory experiments have shown that bacterial spores are killed more slowly when the pH of the water is above pH 7.0.

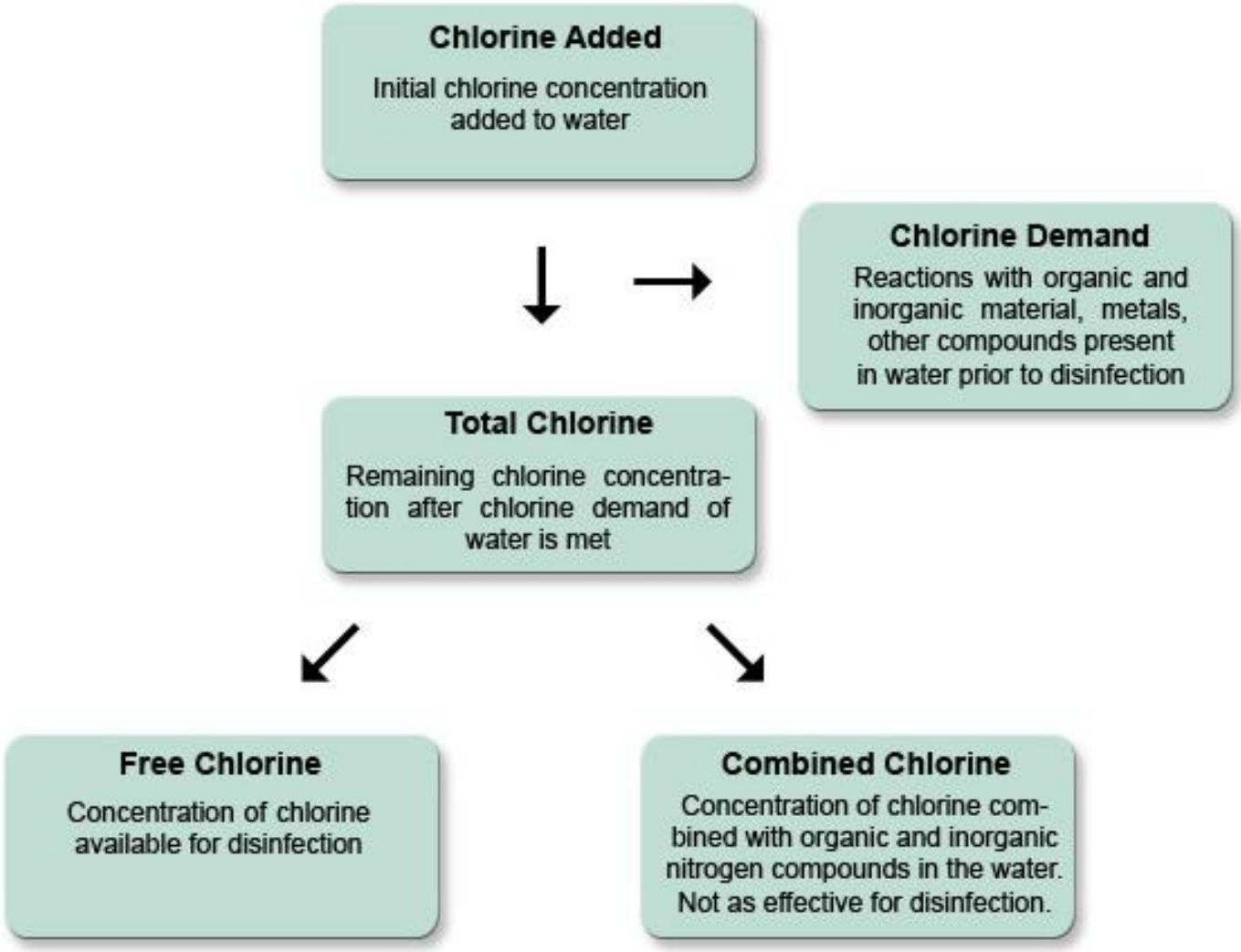
Target pH range: 6.5 to 7.5

Effect of Temperature on Chlorine Efficacy

Table 5-2—Solubility of chlorine gas in water at various temperatures.

Temperature		Chlorine Dissolved
°F	°C	ppm
50	10	9800
68	20	7600
86	30	5600
122	50	3900
140	60	3200
176	80	2200
194	90	1200
212	100	00

Summary of Chlorination Concepts



Peroxyacetic Acid

- Examples: SaniDate and Tsunami
- Peroxyacetic Acid
  - FDA: 80 ppm limit for produce contact
  - Strong oxidant and disinfectant
  - Broad range of efficacy
- Use in accordance with label instructions
- Test strips are available & monitoring devices

www.biosafesystems.com

What type of PAA is right for your operation -

Table 1: Post-Harvest Product Recommendation(s)

State of Produce *(Marketed/Consumed)*	Treatment Method	StorOx 2.0	SaniDate 5.0	SaniDate 12.0	SaniDateFD
Fresh Market/Raw	Low Volume Wash Spray Bar or Fogging	X			
Fresh Market/Raw	High Volume Wash Spray Bar		X		
Fresh Market/Raw	Dump, Drench, Flotation Tanks, Flumes, or Hydrocoolers		X	X	
Processed *(Chunks, Cut, Diced, Frozen, or Juices)*	Wash Spray Bars, Dump Tanks, Flumes, Hydrocoolers, or Fogging				X

What concentration (ppm) is right for your commodity -

Fresh Market / Raw Vegetables *(StorOx 2.0, SaniDate 5.0, SaniDate 12.0, and SaniDateFD)* [A, B, C]

VEGETABLES	PAA Concentration by Treatment Method (PPM)		
	Dump, Drench, Flotation Tanks, Flumes, or Hydrocoolers	Wash Spray Bar	Fog
Artichoke	40–60	60–80	80–200
Asparagus	40–60	60–80	80–200
Broccoli	40–60	60–80	80–200
Brussel Sprouts	40–60	60–80	80–200
Cabbage	40–60	60–80	80–200
Cauliflower	40–60	60–80	80–200
Carrots	24–40	60–80	60–80
Celery	24–40	40–60	40–60
Sweet Corn	24–40	60–80	60–80
Cucumbers	40–50	60–80	60–80
Garlic	40–50	50–60	50–60
Garden Herbs	40–60	60–80	80–200
Lettuce *(All Types)*	40–60	60–80	70–80
Leafy Greens	40–60	70–80	80–200
Melons *(All Types)*	40–60	60–80	80–200
Mushrooms	24–30	30–40	30–40
Onions *(Green)*	40–60	60–80	80–200
Peas	40–60	60–80	80–200

Sanitizer Calculations

Let's Do Some Math…

Important Note

- Always use an EPA registered sanitizer
- Sanitizers are treated like pesticides
- Example:
  - Bleach is typically 5.25 to 12.5% sodium hypochlorite (NaOCl)
  - Look for EPA registration number, such as Ultra Clorox Regular Bleach: 5813-50
- Lastly, remember many factors affect sanitizer effectiveness (including pH, organic matter, etc…)

Sample Calculations

- Formula:

$$\frac{\text{Desired concentration (ppm)}}{\text{Bleach concentration (ppm)}} \times \text{Tank Volume} = \text{Bleach volume to add}$$

- Example: How much 6% bleach should be added to a tank to make up 500 gallons of 200 ppm hypochlorite?
(ppm = % X 10,000)

$$\frac{200 \text{ (ppm)}}{60{,}000 \text{ (ppm)}} \times 500 \text{ gallons} = 1.7 \text{ gallons}$$

- Mix 1.7 gallons of bleach with 498.3 gallons of potable water

Another Example

Volume of bleach to add (in mL) = $\frac{\text{(volume of final solution)(desired ppm of NaOCl)}}{\text{(bleach ppm)}}$

Assume bleach is 5.25% NaOCl and you want a 150 ppm NaOCl in final solution

1 gallon

Solve for X

$X = \frac{(3785.41\ \text{mL})(150\ \text{ppm})}{(52500\ \text{ppm})} = 10.82\ \text{mL}$ or about 2 tsp/gallon

*assumes no demand

How much chlorine?

- 2-7 ppm of FREE chlorine and a pH of 6.0-7.5 in wash water at all times is sufficient to kill bacteria in water
- Add 50-150 ppm of TOTAL chlorine to wash water to start. This will help ensure the FREE, active chlorine will not be used up too quickly
- Initial level will depend on what type of produce you are washing, the amount of organic matter that collects in the wash water, and how often you change the wash water
- Monitor FREE chlorine over time to determine when to add more chlorine or change wash water (~test chlorine demand)

Chlorine Demand Made Easy by Dr. Suslow (UC Davis)

Simple Steps to Estimating Chlorine Demand for Small-Scale Wash Water Batches

1. **Make up a typical wash volume with no bleach**
2. **Add typical harvested product and agitate**
3. **Add small amounts of bleach and mix for 15 sec**
   - **pH is not important to measure for this purpose**
4. **Measure Free Chlorine with test strip**
5. **Repeat until target Free Cl level hits 5 ppm**
   - **Repeat Free Cl measurement in 2 min with no added bleach**
   - **If still 5 ppm you're done; if not 5 ppm repeat Step 3-5**
6. **Repeat with 'dirty' product**
   - **Muddy conditions, if likely**
   - **Impact of turbidity**

Monitoring

Is a corrective action necessary?

Things to include when monitoring sanitizers

- Sanitizer effectiveness can be affected by:
  - Water pH
  - Organic Load
    - Initial and accumulated amount
  - Type of produce and flow rate through the water system
  - Active concentration
    - Example: total vs. free chlorine; PAA

Model Wash Water Log

- Example log for chlorine
- Keep it simple
- Other things to add to log
  - Commodity
  - Source / lot code
  - Special handling
  - Link / tie in to other logs

Date and Time	Temp (F)	Measured pH	Corrective Action (amount added- ml)		Measured Free Chlorine	Corrective Action (amount added)	Initial
			Acid to Lower pH	Base to Raise pH			
9/13/12 08:33	59	6-7			50		Lsuslow
Re-measure New Time							
9/13/12 09:10	56	7-8	10		50-100		Lsuslow
Re-measure New Time - 09:20		6			50-100		Lsuslow
Re-measure New Time							
Re-measure New Time							
Re-measure New Time							
Re-measure New Time							
Re-measure New Time							
Re-measure New Time							

Acceptable – No Corrective Action Needed

- pH – 6-7
- Free Chlorine – 25-50 ppm

Model Wash Water Log

By Dr. Suslow, UC Davis

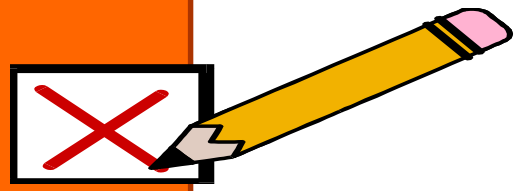
Corrective Action(s)

- Procedure to be followed when deviation occurs
- Cannot fix/correct, if you don't monitor

Example Corrections:

- Observation: Sanitizer concentration from dispenser varies day to day.
  Correction: Repair or replace chemical proportioning equipment and train cleaning crew in its proper use.

- Observation: Juncture of two tables tops trap food debris
  Correction: Separate tables to allow access for cleaning.



- Observation: Chlorine reading is out of acceptable range
  Correction: Add more chlorine or change water (too dirty)