Pending Title -

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As we all know, many fruits and vegetables grow outdoors on, or in, the soil. Most people know this fact and will not expect that a carrot is as clean as a loaf of bread. Some soil or debris on fresh produce is usually acceptable, especially when selling in the direct-to-consumer markets. Regardless, it is not a surprise that consumers' expectations have evolved over time to buying produce that is clean and flawless. Also, there are extra benefits to having "clean" produce to bring to your markets. This factsheet aims to help you with how to wash your produce for the benefit of you and your consumers.

What does it mean to "wash" your produce?

To "wash" your produce means you use water to clean the soil and debris off the produce. It does not mean using soaps or detergents on the produce. "Washing" produce can be done in many ways including dunking the produce (like in a sink), spraying off the produce (like on a table with a screen for a top), using a vegetable wash table with conveyor belt and spraying water, using a dunk tank, etc. Some farms will choose to use sanitizers in the wash water to prevent cross-contamination to other produce, we will discuss best practices below. Some produce tolerates having the soil and debris removed and will hold up well in storage and look great. But you need to think carefully about which of your products needs to be washed and which don't. If you wash produce that is fragile (like a strawberry) it will not have a very long shelf-life AND you run the risk of introducing contaminants unnecessarily to it with the water.

What type of produce can be washed?

Produce that can be washed includes any fruits and vegetables with skin tough enough to withstand being wet (sprayed or dunked) without starting to break down. This includes (but is not limited to): apples, winter squash, peppers, melons, carrots, beets, lettuce, kale, cauliflower, broccoli, cabbage, onions, zucchini, cucumbers, swiss chard, rutabaga, turnips, eggplant, and potatoes.

Not all produce should be washed. Produce that isn't usually washed includes (but is not limited to): sweet corn, blueberries, strawberries, raspberries, tomatillos, tomatoes, green beans, cherries, and peas.

Why should produce growers wash their produce?

1. To remove soils and other contaminants that are on the produce after harvest. Chances are your market's demand is for produce free of garden soils and other debris. Usually, you want to make the produce look pristine for the markets you attend. We all know attractive displays sell better!
2. To reduce the number of harmful microbes that make people sick. Produce can grow close to the ground so it may be contaminated by:
    a. raw manure,
    b. non-finished compost,
    c. feces from domestic or wild animals,
    d. contaminated irrigation water
    e. cross-contamination during the harvest process by dirty hands, dirty knives, or dirty bins.

Produce that is free of soils and debris can have a longer shelf-life.

Types of wash systems:

1. **Single-pass wash system**: for this system, the water is sprayed on the produce to wash the garden soil and other debris off the produce. The water used in this system completely drains and is not recirculated or reused in any way. There is a low-risk of cross-contamination with this water since it is only used as clean water, then drained, so no sanitizer is needed in this system. Examples of a single pass wash system include spraying root vegetables on a mesh-topped table; a single-pass vegetable wash table with water drains and no recirculating water.

2. **Recirculating wash system**: for this system, water is sprayed on produce and collected, then pumped back up to wash more produce. There is a higher risk of cross-contamination here because you're reusing the water. So the best practice is to use a sanitizer in this system's recirculating wash water. An example of this system is a rinse conveyor system.

3. **Immersion wash system**: for this system, you have a tank or flume or sink of water. The vegetables or fruit (commonly apples in Maine) are dumped into the tank, the tank can have some agitation and a conveyor for the apples to move up and out of the tank once they have been in the tank for a set amount of time. There is a higher risk of cross-contamination here because you're reusing the water. So the best practice is to use a sanitizer in this system's wash water.

4. **Triple wash system**: for this system, the produce (often greens) gets dunked three times. There are typically three sinks filled with potable water. The greens get submerged in sink 1 for a set amount of time, typically a few minutes (often agitated by

hand) and then they are moved to sink 2 to soak for a set amount of time, then they are moved to sink 3 to soak for a set amount of time. The idea is each time they are moved they will shed more dirt and contaminants. Best practice (but not required) is to have a sanitizer in the water of sink 3 to prevent cross-contamination since all the leaves are submerged in the same water and there is bound to still be some contaminants left in the water, even after 3 dunkings. Then, for greens, you can use a salad spinner to get rid of the excess water which will help dry the surfaces of the greens quicker which helps stop the spread of contaminants.

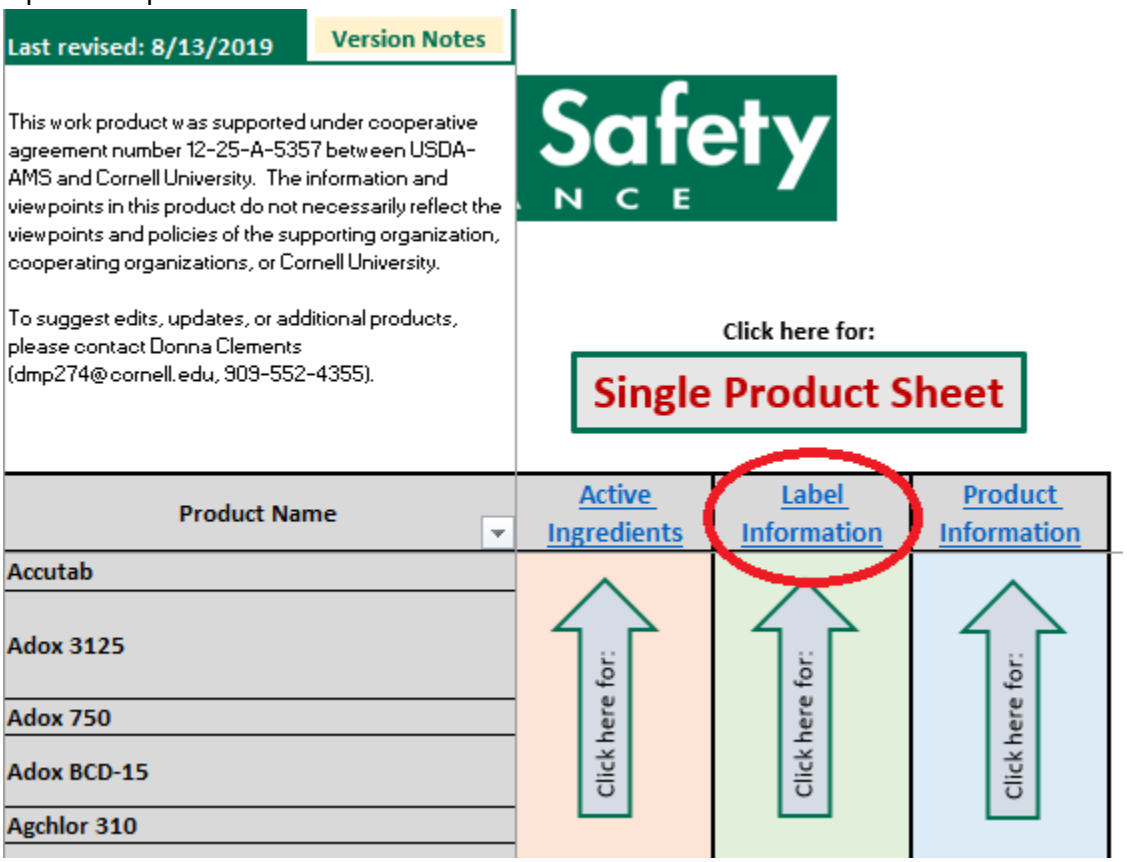
After washing the produce, the best practice is to clean the tank/sink/table/bin you used. This can be as frequent as you think is necessary (after every batch of produce, or after each day of harvest, etc.) The FSMA Produce Safety Rule states that any food contact surfaces must be visibly clean before use. When a surface becomes visibly contaminated (e.g., with feces or blood from an injured worker) it must be cleaned AND sanitized. If it becomes visibly dirty (with soils or debris) it must be cleaned. You don't have to clean and sanitize after every use...you be the judge. Cleaning means using a detergent and the appropriate brush to scrub the surface to remove soils and possible slime buildups (biofilms). Spray with sanitizer when done the cleaning step when appropriate. **REMEMBER - a food contact surface must be cleaned before it can be sanitized. After applying the sanitizer, allow that enough contact time with the bins/sinks/tables before stacking/nesting them. ALWAYS follow the label instructions**

Choosing a sanitizer and how to use it correctly:

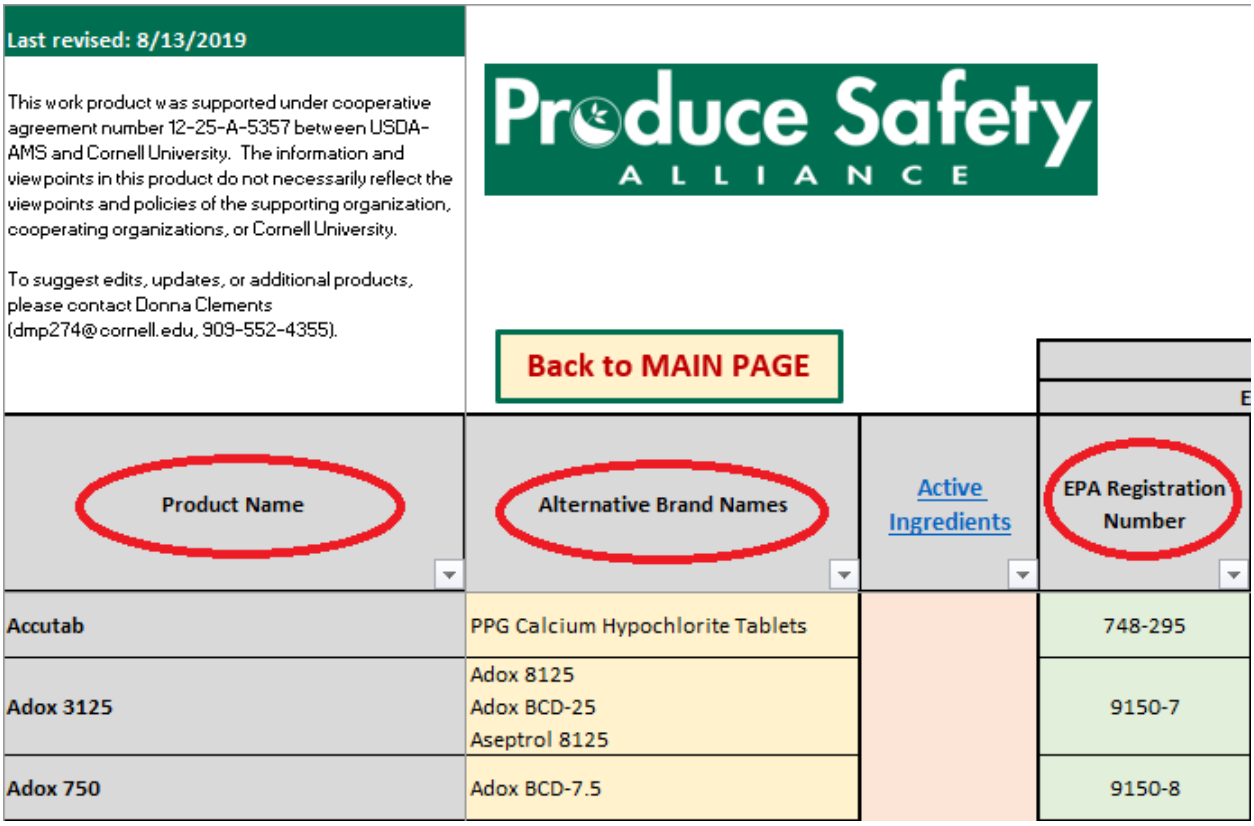
Sanitizers are regulated by the Environmental Protection Agency (EPA). Only use an EPA approved sanitizer formulation for your intended use (e.g., food contact surfaces, vegetable wash, irrigation water). Make sure it has an EPA number on the label. The label is the LAW so follow the directions carefully, only using it for what the label describes. Does the label say "use for washing fresh produce" or "use for sanitizing non-porous food contact surfaces"? Is that what you intend to use it for? If the label does not reasonably describe your intended use, it is probably the wrong type of sanitizer. Please see this document from the Produce Safety Alliance (PSA) for a comprehensive assistance in choosing a sanitizer that is appropriate for your operation. As a quick guide to choose a sanitizer, follow these steps:

1. Download the PSA sanitizer Excel tool.

2. Open the spreadsheet and click on “Label Information”



3. In the new tab that will open, either search for the “Product Name”, the “Alternative Brand Names”, or the EPA number (in case you already have a product at hand and would like to check if it is approved).



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To suggest edits, updates, or additional products, please contact Donna Clements (dmp274@cornell.edu, 909-552-4355).

Produce Safety ALLIANCE

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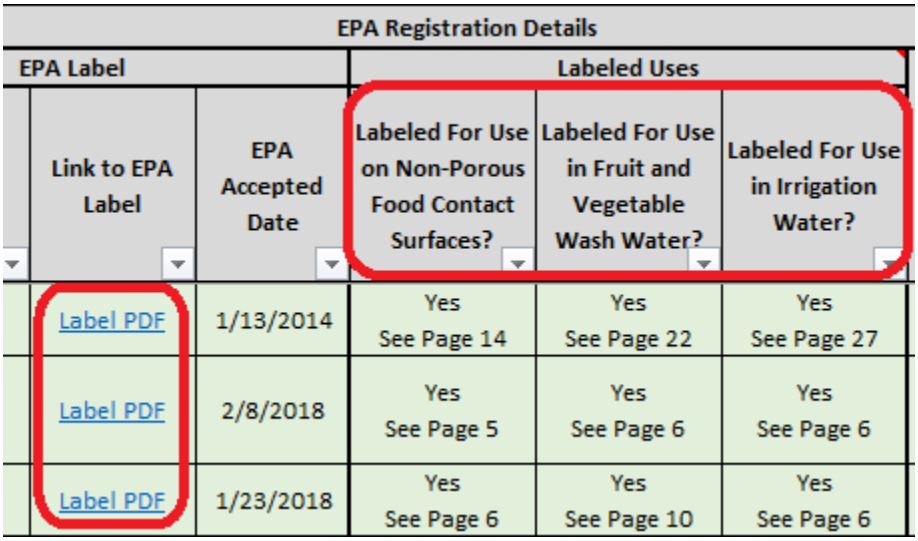
Product Name	Alternative Brand Names	Active Ingredients	EPA Registration Number
Accutab	PPG Calcium Hypochlorite Tablets		748-295
Adox 3125	Adox 8125 Adox BCD-25 Aseptrol 8125		9150-7
Adox 750	Adox BCD-7.5		9150-8

4. This same tab will provide you with links for the full EPA Label as well as tell you the approved uses under “Labeled Uses”.



EPA Registration Details					
EPA Label			Labeled Uses		
	Link to EPA Label	EPA Accepted Date	Labeled For Use on Non-Porous Food Contact Surfaces?	Labeled For Use in Fruit and Vegetable Wash Water?	Labeled For Use in Irrigation Water?
	Label PDF	1/13/2014	Yes See Page 14	Yes See Page 22	Yes See Page 27
	Label PDF	2/8/2018	Yes See Page 5	Yes See Page 6	Yes See Page 6
	Label PDF	1/23/2018	Yes See Page 6	Yes See Page 10	Yes See Page 6

5. After you choose a sanitizer for your intended use (or check that a sanitizer you already have is approved for your intended use), you must use the EPA number to check on the NPIRS website to determine if it has a label for use in Maine.

Common types of sanitizers

When choosing a chemical sanitizer for your operation, consider the safety for workers and the environment, stability, water quality, pH, and corrosiveness. Use sanitizers that are approved for use on food contact surfaces, based on the label information, that matches the surfaces that you have on your farm. The manufacturer is a good resource when determining whether a specific sanitizer is safe for your operation. Don't be afraid to contact them!

1. Chlorine - Hypochlorous acid - Sodium hypochlorite - Germicidal Bleach
    a. Bleach is pH sensitive: at low pH levels there is a potential for toxic gas to form and at a high pH it isn't effective against harmful microbes.
    b. Chlorine will bind to any organic matter in the water. Organic matter will make the water turbid. So, if the turbidity (cloudiness) of the water is too high (too cloudy), the chlorine will become less effective.
    c. Chlorine is corrosive to your equipment and can irritate your skin.
    d. To achieve 25ppm concentration using Clorox Germicidal Bleach for produce wash water use ¾ cup of 6% sodium hypochlorite to 75 gallons of water with a submersion time of 2 minutes (Callahan, 2020).

2. PAA - Peroxyacetic Acid with or without hydrogen peroxide - Sanidate 5.0 (EPA #70299-19) or Oxidate (EPA #70299-12) are the most common examples, but you should work with your chemical supplier to find which product would be the best for your use.
    a. This type of product is usually more expensive than bleach.
    b. PAA is less sensitive to pH or turbidity.
    c. PAA is non-corrosive to equipment and won't irritate the skin at the low concentrations required for PAA in produce wash water.
    d. Some of these products are approved for organics.
    e. The by-products after action are non-toxic.
    f. To achieve 27-96ppm of PAA concentration using Sanidate for produce wash water, use 59.1-209.5 fl oz per 1000 gallons of water (Callahan, 2020).

What to Monitor as You Use Sanitizers in Your Wash Water

1. Concentration of the Sanitizer: Know what concentration you need for the intended use of the sanitizer. You need to know *how to* and *how often* to monitor the concentration.
    a. TEST STRIPS: If you use test strips to monitor the concentration of sanitizer, make sure they are the ones that measure concentrations appropriate for the sanitizer you choose and for how you're using it. For example, there are test strips for bleach to be used in pools and those can't be used for bleach as a food contact surface sanitizer because the test strips don't have readings low enough. But you also want to make sure you have a test strip that will have

concentrations larger than the highest concentration allowed for your use so you can see if your sanitizer is too concentrated, such as this titration kit.

b. Oxidation Reduction Meter (ORM): You can also get an ORM to use to monitor the concentration of the sanitizer in your wash water.

You should be testing your wash water at regular intervals as you are using the sanitizer. Use your best judgment and establish the maximum amount of time needed that applies to your operation before changing the sanitizer.

2. Turbidity and pH: You should also be monitoring your wash water for turbidity and pH. Turbidity is a measure of how cloudy your water is getting from the soil and other organic matter that accumulates after dunking produce. High turbidity is an indication that excess organic matter may be causing the sanitizer to not be effective and at this point is counterproductive to getting your produce clean. It's best practice to change out your wash water on a regular, as-needed basis depending on how cloudy your water is getting. The pH can change in your water as it gets more turbid. To monitor pH, you can get test strips or a pH meter.

3. Water temperature: Water temperature is important to monitor as you are washing your produce. The temperature of the water should be cool, but not too cold. If it's too cold the sanitizer will become less effective. If it's too warm it may encourage the growth of some pathogens and diseases. The temperature can range from 55 degrees F to 120 degrees F. Make sure you check the label of the sanitizer to take note of the effective temperature range. NOTE: If you wash tomatoes, melons, peppers or apples, the water temperature should not be more than 10 degrees F cooler than the interior of the produce. If the water is colder, the water and any pathogens in the water can be sucked inside the fruit or vegetable and no amount of sanitizing will kill the interior pathogens.

You should be testing your wash water for sanitizer concentration, water pH, turbidity and temperature at regular intervals as you are using the sanitizer. It's best practice to document these readings when you are using a sanitizer on your farm and it's required documentation if your farm is covered under the FSMA Produce Safety Rule.

Overall, the goal is getting your produce free of soil and debris and looking nice for your markets without increasing the risk of cross-contamination or being the source of any food borne illnesses. Washing produce with just water and/or adding sanitizer to your wash water, while not mandatory, will increase shelf-life and will help reduce the risk of cross-contamination and therefore will reduce the risk of spreading foodborne illnesses.

Resources:

UMASS Extension: Produce Wash Water Sanitizers: Chlorine and PAA
https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/pssanitizerlawtonkinchlasept15.pdf

UNH Extension: Farm Food Safety— Cleaning and Sanitizing Food Contact Surfaces

https://extension.unh.edu/resource/farm-food-safety%E2%80%94-cleaning-and-sanitizing-food-contact-surfaces

Produce Safety Alliance: Cleaning vs. Sanitizing
https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/Cleaning-vs-Sanitizing.pdf

Produce Safety Alliance: Introduction to Selecting an EPA-Labeled Sanitizer
https://producesafetyalliance.cornell.edu/sites/producesafetyalliance.cornell.edu/files/shared/documents/Sanitizer-Factsheet.pdf

University of Minnesota Extension: Cleaning and Sanitizing Food Contact Surfaces
https://drive.google.com/file/d/1zjUOnP39n_C_gxhZTxBK-DW3qdeQqgP4/view

Penn State Extension: Reasons for Washing Fresh Produce
https://www.youtube.com/watch?v=Ee5xq_B79xs

Callahan, C. 2020. UVM Extension Ag Engineering: A Guide to Cleaning, Sanitizing, and Disinfecting for Produce Farms. https://blog.uvm.edu/cwcallah/2020/03/30/clean-sanitize-disinfect/

LaMotte, 7191-02 Peracetic Acid Test Kit: https://megadepot.com/product/lamotte-7191-02-peracetic-acid-test-kit?format=v&p=ms&source=ads&gclid=CjwKCAjw5vz2BRAtEiwAbcVIL_KPpX7ONQ8RMIpUroKJcIvnNX4fh70ct-RKPmwvHzYcR5HV9M9X0hoClVsQAvD_BwE

Milwaukee, pH58 pH/ORP/Temperature Waterproof Meter:

https://megadepot.com/product/milwaukee-instruments-ph58-pocket-size-ph-orp-temperature-meter-with-replaceable-electrode

National Pesticide Information Retrieval System website:
http://npirspublic.ceris.purdue.edu/state/Default.aspx