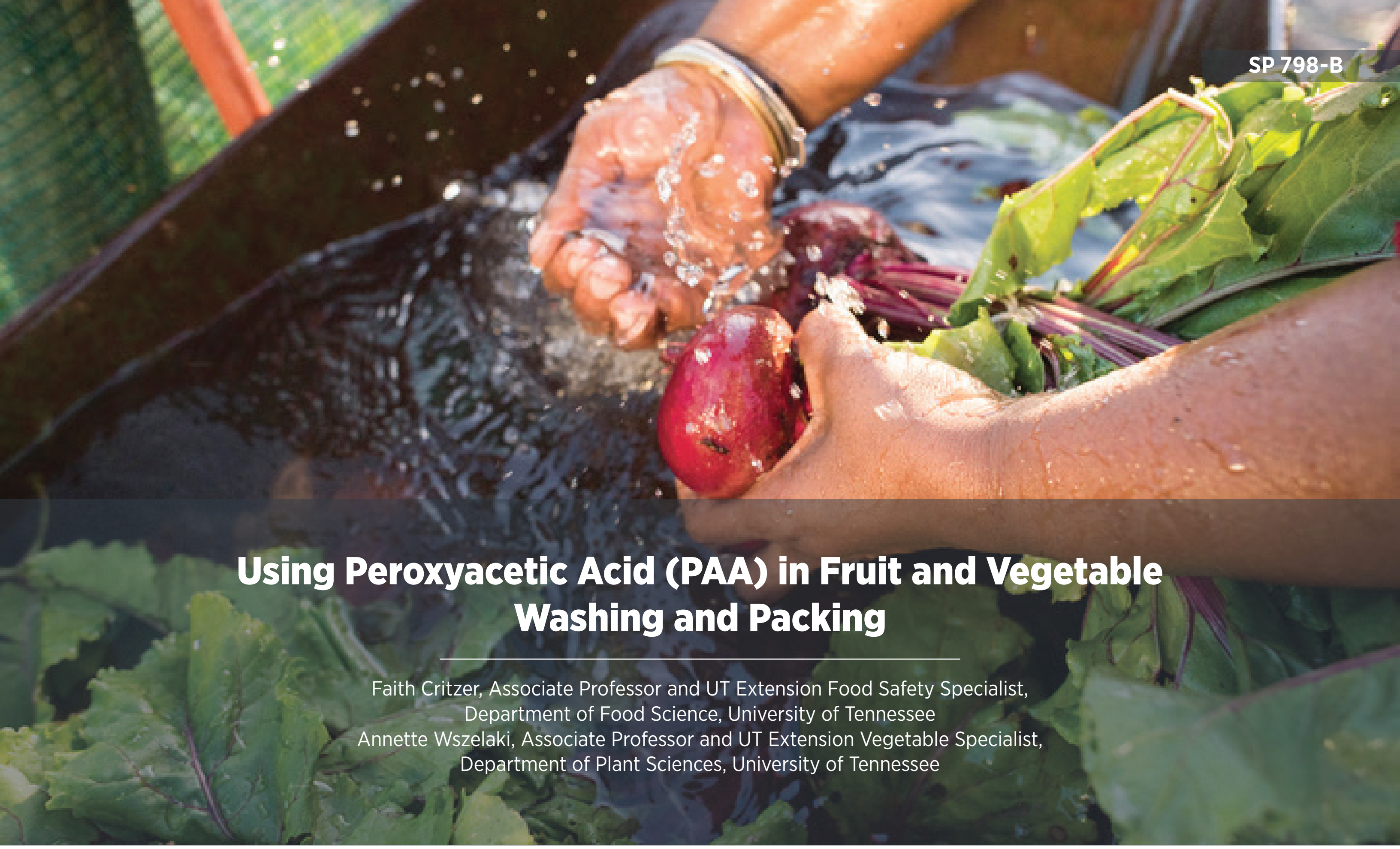

SP 798-B

Using Peroxyacetic Acid (PAA) in Fruit and Vegetable Washing and Packing

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Introduction

Peroxyacetic acid, which is also known as peracetic acid or PAA, is a commonly used sanitizer in the produce industry. PAA goes by many trade names, such as Sanidate 5.0, VigorOx 15 F&V, BioSide HS-15%, and Tsunami 100, all of which are a mixture of PAA, water, hydrogen peroxide and acetic acid (Figure 1). Once dissolved in water, the breakdown products of PAA are carbon dioxide, oxygen and water.

$$\underbrace{H_2O_2}_{\text{Hydrogen Peroxide}} + \underbrace{CH_3CO_2H}_{\text{Acetic Acid}} \leftrightarrow \underbrace{CH_3CO_3H}_{\text{Peracetic Acid}} + \underbrace{H_2O}_{\text{Water}}$$

Figure 1. Chemical composition of peroxyacetic acid sanitizers.

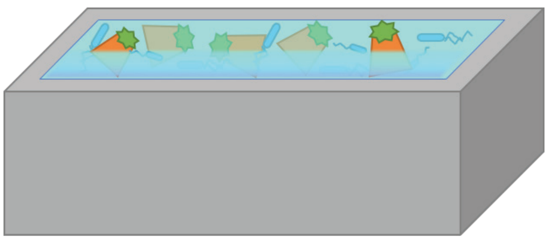
PAA has gained approval by the FDA and is being used increasingly in the fruit and vegetable industry for postharvest fruit and vegetable washing (21 CFR 173.315), as well as cleaning and sanitizing packinghouse equipment, utensils, bins and other postharvest contact points (21 CFR 178.1010). PAA is also approved as a synthetic substance that is allowed in certified organic production (7 CFR Sec. 205.601). It should also be noted that as a strong oxidizing compound, PAA can cause corrosion of metal it contacts. As always, personal protective equipment should be worn when handling concentrated forms of PAA.

Washing produce

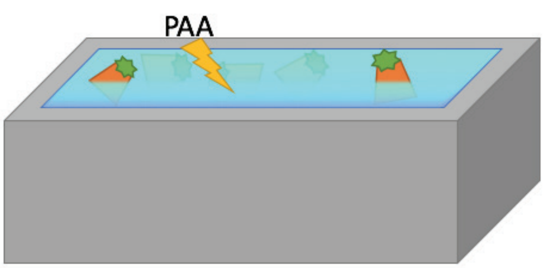
Markets require many types of produce to be washed prior to sale in order to remove dirt and other debris. Produce can be contaminated with foodborne pathogens (harmful microorganisms that can make people ill) before it enters the packinghouse, and these pathogens cannot be seen with the naked eye. This makes the washing step one of the most important steps in packing because, if not controlled, it can be a source of cross-contamination (when foodborne pathogens fall off contaminated produce into the water where they can contaminate more produce). Sanitizers, such as PAA, should be used during the washing step to eliminate cross-contamination because, if pathogens are on the surface of produce, some can be dispersed into washing water and contaminate any fruits or vegetables that are washed after that contaminated produce. These sanitizers are designed to inactivate/kill any bacteria that are introduced into the water, drastically reducing the possibility of cross-contamination (Figure 2).

NOTE: Washing will not remove or inactivate foodborne pathogens or chemical contaminants on the produce itself, so Good Agricultural Practices (GAPs) always must be followed.

Produce contaminated with foodborne pathogens will not look any different than uncontaminated produce. It is expected that occasionally, pathogen-contaminated produce will enter the packinghouse.



During washing, some foodborne pathogens will fall off the contaminated produce and into the wash water where they can cross-contaminate other produce they contact.



Using a sanitizer works very well at inactivating bacteria when they fall into wash water, though it will not inactivate the bacteria that remain attached to the produce.

Figure 2. An overview of entry of foodborne pathogens into washing systems and the role of sanitizers in wash water to limit cross-contamination.

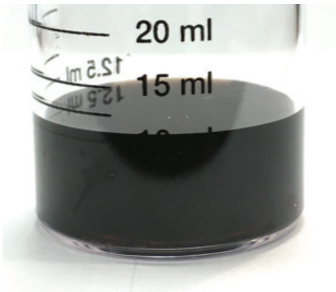
Critical parameters for postharvest water

The label must be followed when applying any sanitizers. The label must specify:

- The EPA registration number and FDA clearance (21 CFR Part 173.315 or Generally Recognized as Safe status) for use on food contact surfaces.
- That it is labeled for the intended use: Direct contact for postharvest washing of produce.
- The minimum and maximum concentration.
- The recommended contact time.
- Any other label requirements, such as a mandatory potable water rinse.

Most PAA sanitizers will require you to maintain between 24-85 ppm peracetic acid in postharvest processing water. While PAA has a very strong oxidizing capacity, which is what makes it a very effective sanitizer, it also breaks down rapidly. Growers must be diligent about monitoring the levels of PAA in their postharvest washing operations. Based on size, crops grown, and throughput of produce in the operation, growers may choose to measure the concentration of PAA anywhere from every 15 minutes to hourly. Growers with larger throughputs will find a continuous monitoring and automated injection system advantageous. Monitoring of many sanitizers can rely upon oxidation-reduction potential (ORP) meters. However, data from UC Davis indicates that ORP is not accurate when measuring concentrations of PAA or hydrogen peroxide in postharvest systems (Suslow, 2004). There are specific sensors designed to accurately measure concentrations of PAA if a highly automated system is desired.

Using test strips or titration gives growers a way to monitor their washing systems at frequent intervals. Monitoring systems for PAA will also interact with hydrogen peroxide, although at a slower rate. For these reasons it is imperative to adhere strictly to the time limits for reading test strips or titrations in order to achieve as accurate a reading as possible. Titration kits rely on the ability of PAA to oxidize iodide to iodine, which then reacts with starch, resulting in a dark purple to black color. It then is titrated with sodium thiosulfate to reach a colorless endpoint (Figure 3). The number of drops needed to create this color change can determine approximate concentration of PAA in the solution. Records should be kept whenever readings are taken to demonstrate proper sanitizer strength in the produce wash water.



Starting PAA solution, typically dark purple/black that has had reagents added and is ready to be titrated with sodium thiosulfate.

End-point of the PAA titration, a colorless solution. The number of drops of titrant added indicates the concentration of PAA.

Figure 3. Starting and end-point colors in the peroxyacetic acid titration method.

Recordkeeping

Keeping records to demonstrate proper management of packinghouse water is key. These records should indicate the sanitizer concentration at start-up and at regular intervals dictated by the postharvest water monitoring standard operating procedure (SOP). Corrective actions should also be developed if sanitizer concentrations dip below established minimum concentrations. These typically include adding sanitizer to increase the level to the appropriate concentration and more frequent monitoring to ensure the concentration of sanitizer remains stable. Other pertinent records, such as change schedules for batch or recirculated water based upon turbidity, should also be considered.

Sanitizing packinghouses

The packing environment, if not properly cleaned, can serve as an area that contaminates produce as it is packed. PAA can also be used for sanitizing food contact surfaces, utensils, packing bins and other areas in the packinghouse, such as floors, walls and drains. It is critical to maintain a routinely clean packing environment since microorganisms can easily grow on equipment and other surfaces in the packinghouse.

There are three critical steps to sanitizing in the packinghouse:

1. Clean: Remove dirt and other organic matter with a food grade detergent.
2. Rinse: Rinse with potable water.
3. Sanitize: Apply sanitizer.

When sanitizing utensils, equipment or other areas in the packinghouse it is imperative to remove any soil load prior to application of the sanitizer. Any residual organic matter will interact with the sanitizer and make it unavailable to inactivate bacteria. Detergents work very well for removing soil and are highly recommended when cleaning surfaces rather than simply applying water. Detergents for use in packinghouses should be surfactant based, which are similar to the household detergents used to clean dishes.

It is important to develop a system to determine when sanitation events should occur. It is recommended that you establish a master sanitation schedule that dictates when areas of the packinghouse are cleaned. As an example, areas such as coolers may receive only weekly or biweekly cleaning rather than the daily cleaning that takes place in the primary packing area. In addition to the master sanitation schedule, it is also important to establish Sanitation Standard Operating Procedures, or SSOPs, that very clearly describe how a surface is to be cleaned and sanitized so that any employee can adequately carry out the task.

Critical parameters

The critical parameters described on the previous page for washing are the same for application of PAA as a sanitizer. On the label, you will want to find:

- The EPA registration number and FDA clearance (21 CFR Part 173.315 or Generally Recognized as Safe status) for use on food contact surfaces.
- That it is labeled intended use: Food contact surfaces (porous and nonporous) and nonfood contact surfaces (walls, drains, ceilings and floors).
- The minimum and maximum concentration.
- The recommended contact time.

Sanitizers should be left to air dry on all equipment and surfaces sanitized in the packinghouse. Regular monitoring of PAA should also occur as described above to assure the appropriate concentration is being applied.

NOTE: Nonfood contact surfaces (e.g., floors, walls) typically can have higher concentrations of sanitizer applied than food contact surfaces.

In addition to properly cleaning and sanitizing, it is recommended that visual inspections be made after cleaning and before a sanitizer is applied to make sure all equipment is clean. Some growers also like to incorporate tools such as adenosine triphosphate (ATP) meters to make sure a surface is clean before the sanitizer is applied. ATP is found in all living matter and ATP testing methods rely upon this fact to determine when there is an above normal amount of soil or plant material left on a surface.

ATP readings are taken by swabbing a surface with a cotton swab. When finished swabbing you place the swab into a plastic sheath and release a solution carrying the enzyme luciferase, which is the same enzyme that causes fireflies to light up. Luciferase interacts with any ATP present on the swab and causes fluorescence. The swab can then be placed into an ATP meter and the relative fluorescence units read. This tool provides a very accurate way to determine if a surface has been adequately cleaned prior to applying a sanitizer. If the reading comes back above a predetermined threshold, a re-cleaning should occur followed by a repeated ATP test. These verification checks are becoming increasingly important for produce growers to demonstrate that they have a strong sanitation program in their packing facility.

Recordkeeping

Keeping records to demonstrate that packinghouse sanitation is conducted on a regular basis as delineated in the master sanitation schedule is recommended. These records should indicate when cleaning and sanitizing took place, the location, SOP followed, concentration of any sanitizer used, and who was responsible for the procedure. Additional records should be kept describing other verification activities such as visual inspections or ATP readings after a sanitation event and any corrective actions that were needed (e.g., re-clean and sanitize surfaces).

Conclusion

PAA is increasingly being used in produce operations for both packinghouse sanitation as well as fruit and vegetable washing. Always consider the pros and cons when considering adoption of a new sanitizer for your operation.

Suslow, T. 2004. Oxidation-Reduction Potential (ORP) for Water Disinfection Monitoring, Control, and Documentation. University of California Extension Publication 8149. Available at http://anrcatalog.ucanr.edu/pdf/8149.pdf. Accessed November 3, 2016.

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