Hello and welcome to Food Safety for Wash/Pack facilities, a training series brought to you by the CCE Cornell Vegetable Program. Implementing food safety practices in wash/pack facilities is critical for ensuring that foodborne pathogens are not introduced or spread as produce is sorted, graded, washed, and packed.

This is Caitlin Tucker, Program Assistant for the Cornell Vegetable Program. Throughout this series, I will walk you through principles of food safety, the ideal wash/pack facility layout, post-harvest water management, cleaning and sanitizing, and tips for cleaning larger washing equipment. Because food safety is a company-wide responsibility, we invite all farm employees to participate in this training.

Here are some highlights from Part 2: The Ideal Wash/Pack Facility

- Be intentional about facility design or modification
- Consider the 5 Principles of Hygienic Design, ergonomics, and layout
- Adequate lighting, clean-ability, organization, good drainage, and pest management are all important features of a wash/pack facility
- Rodents, birds, insects, and pets can introduce or spread contamination within a wash/pack facility

Let's begin!

Part 3: Post-Harvest Water Management

Objectives for Part 3:

- Highlight the ways that post-harvest water can contaminate crops
- Discuss the importance of monitoring pH, temperature, turbidity.
- Define sanitizers, and review sanitizer options
- Review common ways produce is washed

Why Focus on Post-Harvest Water

As a reminder, post-harvest water is any that is used for washing, cooling, ice-making, post-harvest fungicide or wax applications, or commodity movement.

The source and quality of water used for washing produce is critical for food safety. Workers, animals, equipment, and produce can all contaminate water. Water can easily spread pathogens and amplify even the smallest problem with contamination.

Here's one scenario in which a small contamination event could be amplified by post-harvest water. You go out to the field to harvest lettuce, you conduct a pre-harvest risk assessment, but because you're harvesting lettuce, which has numerous folds in which debris or contaminants can go unnoticed, you don't see bird feces in one of the heads of lettuce you've harvested. That head of lettuce goes into the wash water with the others that you've harvested. In the water, the feces can spread throughout and contaminate the whole batch of produce, particularly, if you do not use a sanitizer in the water to kill foodborne pathogens.

As I mentioned earlier, the source and quality of the water used for washing produce is critical for food safety.

Sources of Water Typically Found on the Farm

Number 1: Municipal

Municipal or city water is routinely treated and monitored for water quality. You should be able to get a copy of the water test results from the city. Municipal water is considered low risk, and is the safest source of water to use for produce washing.

Number 2: Well Water

Groundwater is generally less contaminated. This is because the soil, clay, rocks, and vegetation act as a natural filtration system. However, wells should still be regularly tested twice a season to drinking water standards. Ground water or well water is considered "medium risk"

Number 3: Surface Water

This includes rivers, ponds, canals, creeks, streams, or any other body of water that is exposed to the environment. Because of environmental exposure, surface water can easily become contaminated by feces or other pollutants. It is **very** hard to control the safety and quality of surface water. Which is why surface water is considered "high risk".

Produce Contamination through Infiltration

Another way produce can become contaminated in the wash water is through "infiltration". If the crop you are washing is very warm and the water you are washing it in is very cold, a vacuum like effect called infiltration can happen. The crop will suck up water, including any pathogens that are in the water. Infiltration can reduce the quality and shelf life of the crop AND once pathogens are inside they cannot be removed. Crops like tomatoes, peppers, cantaloupes, wilted greens, apples, and summer squash are more at risk. There is also more risk is if you completely submerge the vegetables or keep them in water for a longer period of time. Wounded or bruised fruit is also at greater risk because there are open wounds that foodborne germs can enter through.

Role of Sanitizers

To reduce the risk that produce becomes contaminated with foodborne pathogens in the wash water, sanitizers can be used. Here are some things you need to know about the role of sanitizers:

- Sanitizers do NOT clean contamination from produce
- They reduce contamination in the wash water
- They help to prevent pathogens from contaminating the rest of the produce
- It is very important that you follow label directions for concentration usage, duration of contact with produce, etc.

Because sanitizers kill living microorganisms like bacteria or fungi, they are considered pesticides. As such they should be registered with the EPA. You should also just that they are food grade.

Types of Sanitizers Available for Use in Wash Water

Chlorine Products

Chlorine Products are perhaps the most commonly used. This is because they are readily available – you can find them at any grocery store, hardware store, and they are relatively affordable. However, there are a few drawbacks to using chlorine products: They typically require mores steps to use effectively. This is because

temperature and pH great impact chlorine effectiveness. Furthermore they are also corrosive and highly reactive. They can cause harm to workers if not used properly, and they can damage equipment overtime.

Here are some tips for using a bleach, a chlorine product.

- As with any sanitizer, only use *food grade,* EPA registered bleach. Make sure employees wear proper personal protective equipment such as gloves, goggles, and aprons.
- Calculate the sanitizer amount based on known target concentration of FREE CHLORINE. Emphasis on "free" chlorine. This is because chlorine can get tied up with organic matter, or other dirt and debris. You may need to keep levels of chlorine high to account for loss.
- Regularly monitor pH and Free Chlorine. This can be done with monitoring strips. Chlorine efficacy is dependent on the pH of the water. Chlorine is most effective at a pH of 6.5-7.5. If your water is too basic, you can use food grade white vinegar of citric acid to lower the pH.

PAA and Hydrogen Peroxide

- PAA, which stands for (Peracetic or Peroxyacetic acid) and Hydogen Perxoide are another option. Many products like Sanidate, Oxidate, or Tsunami are mixtures of PAA and Hydrogen Peroxide. These types of products are highly effective at killing microbes and are chlorine-free.
- These products are typically more stable in water, and there is no issue with pH levels or water temperature.
- Because they are more stable, they generally require less monitoring.
- Calculations are needed for measuring out sanitizer. These calculations are based on the volume of water and concentration required for sanitizing. Be sure to monitor with the corresponding PAA test strips.
- You should still wear personal protective equipment such as gloves and safety glasses because these products are concentrated, they can still cause harm to workers. Use a ventilation cap to off-gas
- Spigots can be attached to the sanitizer container to allow workers to dispense the sanitizer more easily and safely.

Other Sanitizers

Ozone, is the unstable gas, O3. Ozone kills viruses and bacteria through a process called oxidation. It readily convert to oxygen leaving no residue on food contact surfaces, can lower cleaning time, and reduce water usage. Though it is more effective than chlorine at killing viruses and bacteria, it is typically much more expensive. Other drawbacks include: low doses may not effective kill some viruses, it is reactive and corrosive to some equipment surfaces, and in order for it to be effective, it must be present at a high concentration than is considered safe for humans.

Another option is UV sanitization. Germicidal UV light disrupts the DNA of bacteria, viruses, algae, and mold. It is a chemical free sanitizing option and has been used for years to disinfect and sanitize drinking water, wasterwater, air and food contact surfaces. Like other sanitizers, exposure to UV light can cause injury if you touch or look directly at the UV bulb while it is on.

Tips for Sanitizer Use

Whichever sanitizer you choose to use, it is important to understand the different factors that influence sanitizer efficacy.

Number 1: Following the Label

Always read and follow the label instructions. Pay particular attention to how the product is intended to be used – in other words in direct contact with produce vs. on a food contact surface. Identify the appropriate concentration that is required for the intended use. Sanitizer concentrations are typically measured in ppm, parts per million And finally, understand how different water variables, such as temperature, pH, and turbidity can impact sanitizers.

Number 2: Monitor Sanitizer Levels

Each sanitizer will have specific ways in which you should monitor the concentration in the water. Be sure you are using the right monitoring tool – you may be able to use an automated pH meter, monitoring strips, or other type of monitoring tool. Be sure you monitor the sanitizer level frequently throughout the use. Levels can change throughout the course of washing produce if water is drained or added, if the organic load builds up, or if the temperature changes. Check with the supplier if you have any questions about how to use the product, what the product can be used on, and so on. Lastly, be sure you are storing your sanitizer monitoring tools in an appropriate area. Tools and especially monitoring strips should be stored out of light and away from heat. Do not use monitoring strips past expiration, try to consistently read the strips under the same lighting, and store in the fridge, if possible.

Number 3: Monitor Water Temperature

Water temperature may affect the efficacy of the sanitizer, especially chlorine products. *Chlorine sanitizing solutions should be at a minimum temperature of 75°F!* Be aware though, that if water temperatures are TOO high, chlorine sanitizers can off gas and become a health hazard for workers. Water temperature should also be monitored because temperature differences between produce and water may cause infiltration. Thermometers are an easy way to monitor water and pulp temperatures, but be sure to stay away from glass and mercury thermometers.

Number 4: Monitor pH

Water pH can affect the efficacy of sanitizers, especially chlorine! As I mentioned before, chlorine is most effective at a pH of 6.5 – 7.5 . There are many ways to monitor pH – use can use pH test strips, handheld pH meters, or titration kits. All vary in accuracy and cost. As a reminder, adding chlorine and other sanitizers may change the pH of water, so you may need to measure the water pH before and after adding some sanitizers. Finally, make sure you adjust pH as needed based on the optimal pH range for effective use of your sanitizer.

Number 5: Monitor Turbidity

Turbidity is the measure of how cloudy water is. Turbidity can effect sanitizer effectiveness and pH readings. If water is especially turbid, you may need to add more sanitizer to maintain effectiveness, allow produce or food contact surfaces to be in contact with the sanitizer for a longer period of time. Turbidity can and should be monitored using a turbidity meter, a secchi disk, or another method. Secchi disks are circles that have alternating black and white quadrants. They can be placed under near a clear plastic or glass container. Take a sample of the post-harvest wash water and pour into the container. If you are unable to see the disk at the bottom, this should signal to you that the water should be changed and that your sanitizer may not longer be effectively killing pathogens in the water.

When Should Water be Changed?

In general, there is no set rule for when to change post-harvest water. It ultimately depends on many factors we've already discussed. Water that is used to was crops like leafy greens or cucumbers could perhaps be used longer compared to water that is used to wash root crops like beets or carrots that are coming in with more soil. The type of sanitizer you are using will factor it. The type of equipment you are using will factor in. Ultimately, it is up to each farm to develop an SOP for monitoring pH, temperature, and turbidity. This monitoring should ultimately help you determine when to change your water.

Disposal of Wash Water

And while we're on the topic of changing water, let's talk about how that water should be disposed. For starters, what are your local and state regulations? Waste water may be able to be discharged into grassy vegetative area away from surface water, ditches, and produce fields. It should never be discharged into septic systems or storm drains.

Do not discharge water if there is high concentrations of sanitizers (higher than label directions). If sediments build up in wash water, do not dump into landfills, streams, or other waterways.

Methods Commonly Used in Washing Produce

Number 1: Dunking

Dunking produce is a very simple and straightforward way for removing soil or other debris. This may involve dropping the produce into tubs, and agitating for at least 2 minutes for the water to "bathe" each piece of produce.

- You could choose to have multiple tubs to dunk produce in so that it can get progressively cleaner, and then drip dry as needed.
- This water should be changed as soil, debris, cloudiness increases.

Number 2: Bubblers

Bubblers are commonly used for greens. They usually consist of a tank or tub lined with perforated PVC pipes connected to a Jacuzzi Pump. This allows for a gentle agitation for a few minutes to loosen soil, insects, and cools the crop.

- Nets could then be used to scoop greens out of the water. Greens could then be allowed to drip dry or be placed into a greens spinner.
- Sanitizer can easily be added to the tank, but be mindful that the PVC piping will need to be regularly cleaned and sanitized as well.

Number 3: Triple Rinse

A triple rinse set-up is just as the name suggests – this method involves using three tanks rather than one.

- Tank 1 is set with sanitizer at proper level. This tank washes off much of the debris/soil etc.
- Tank 2 is set with sanitizer at proper level. This tank washes off what's left.
- Tank 3 is set with sanitizer of at least 5-10ppm. This tank rinses off produce but keeps a little sanitizer in water as an added precaution if some contamination makes it through Tanks 1 and 2.

Number 4: Greens Spinners

Spinners are increasingly being used to quickly and effectively dry greens. You have the option of purchasing a manual spinner, which can cost anywhere from $5-$275. They vary in capacity, anywhere from 1- 5lbs.

Electric Spinners are another option. As expected, they are much more expensive. Anywhere from $600- $3100, but are able to handle a 8-26 lb. capacity.

And finally, there's the ever popular DIY washing Machine Greens-Spinner. We see more and more farmers converting washing machines to greens spinners, so here are a few things to know if you choose to go this route:

New is best – you know its history. You can feel assured that the washing machine is clean. To be effective, modifications required. This will take some time and should be done in the off-season. Many farmers have done this and there are many resources available to help you modify one. I'd encourage you to check out University of Vermont's Chris Callahan's work on Washing Machine greens spinners. Consider using a basket insert. And finally, it is CRITICAL that this equipment can be disassembled for cleaning and sanitizing!! Washing machines were not built to be taken apart and cleaning and scrubbed and sanitized, but they absolutely must be if you intend to use them for produce washing.

Additional Work Horses in a Wash/Pack Facility

- Barrel Washers
- Brush Washers
- Or the AZS Produce Washer
- This equipment is much more complex to clean and sanitize and will require varying levels of disassembly. Like most aspects of food safety, every farm is going to have to make their decisions on which equipment or washing methods to invest in based on time, effectiveness, ease of cleaning and sanitizing, space available, infrastructure, and cost.

In Summary…

- Water quality is critical for preventing the introduction of pathogens of spread.
- Surface water should never be used to wash produce.
- Sanitizers can be used to kill pathogens in wash water and prevent contamination.
- It is **very** important that water temperature, pH, turbidity, and sanitizer levels be regularly monitored to ensure sanitizer effectiveness.
- All of the above variable can help to determine when to change water.
- There is no one right way to wash produce – consider water quality, type of produce being washed, how dirty produce is, sanitizers being used, etc.

Resources

Here are some resources to help get you started including instructions for measuring sanitizers, instructions for building wash tables, and shopping advice for washing machine greens spinners.

Cornell Vegetable Program –Food Safety

- How to Wash Produce Using a Peracetic Acid (PAA) Solution
- Material List and Cost Calculator for Building Wash Table and Aerator
- VIDEO –How to Use A Germicidal Bleach
- Cost calculator: Three Basin Produce Washing
- Sanitizer Dose Calculation Spreadsheet

- Building an Easy Clean Produce Wash Table
- Wash your Greens: A Low-Cost but Effective Washer/Spinner Design

Greens Spinners for Farm Use

Washing Machine Greens Spinners: Shopping Advice

Conclusion

Thank you for watching Part 3: Post-Harvest Water Management. If you have any questions or would like clarification or help identifying resources, do not hesitate to reach out. You can reach Extension Specialist Robert Hadad via email at rgh26@cornell.edu or by phone at 585-739-4065. You can reach Program Assistant, Caitlin Tucker, at cv275@cornell.edu or by phone at 573-544-4783.

If you would like to learn more about the Cornell Vegetable Program, visit cvp.cce.cornell.edu.

Up Next: Part 4 – Cleaning & Sanitizing