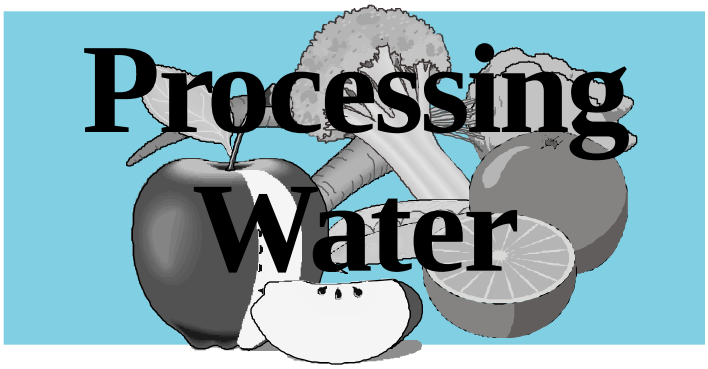


Karen L.B. Gast, Horticulturalist, Postharvest and Marketing; and Kim Holt

A great amount of water is used during the postharvest handling and marketing of fresh fruits and vegetables. Rinsing, cooling, washing, waxing and transporting are all phases that use water in one way or another. Because of this high degree of water-to-produce contact, it is important that the type of processing water used does not contaminate produce or serve as a source of cross-contamination.

Microbes found to cause foodborne illness associated with the use of contaminated processing water include: *Escherichia coli, Salmonella spp., Vibrio cholerae, Shigella spp., Cryptosporidium parvum, Giardia lamblia, Cyclospora cayetanensis, Toxiplasma gondii,* and the Norwalk and hepatitis A viruses. As an example, two Salmonella outbreaks linked to fresh tomato consumption occurred in 1990 and 1993. Tomatoes from both outbreaks were traced back to a single packing facility where a water-bath appeared to be the likely source of contamination.

Water can reduce contamination, but it can also increase it, especially if the water is reused. Reusing processing water may result in the build-up of microbial loads, including undesirable pathogens from the crop. So it is important to always use potable water and establish practices to ensure water quality is adequate for its intended use. Some general considerations include:

- Follow good manufacturing practices (GMPs) to minimize microbial contamination from processing water. Consider the packing facility as a processing plant.
- Water quality needs may vary. To determine how clean water should be, determine where in the process it is being used. For example, water for a final rinse before packaging needs to be very clean, compared with water in a dump tank where field soil from arriving produce quickly mixes with the water.
- Water quality should be consistent with EPA standards for drinking water. Water that meets microbial standards for drinking water is considered safe and sanitary.
- If water is reused for a series of processes, it should flow counter to the movement of produce. For example, water might be used first in a final rinse, then reused in an earlier operation, such as a dump tank. This ensures the cleanest water is used in the final rinse.
- Use good manufacturing practices for water that is used for food and food contact surfaces in processing facilities. These are found in Title 21 of the Code of Federal Regulations (CFR), sections 110.37(a) and 110.80(a)(1). Although 21 CFR 110.19 provides an exemption from the requirements in 21 CFR part 110 for establishments solely engaged in the harvest, storage, or distribution of raw agricultural commodities, U.S. operators using water for postharvest operations in the field or packing facility should consider those good manufacturing practices in part 110 that are applicable to their operations.

Consider practices that will ensure and maintain water quality.

- Periodically test water.
- Change water as necessary to maintain sanitary conditions.

- Develop standard operating procedures or sanitary operating plans (SOPs) that include water change schedules for all processes that use water.
- Clean and sanitize water contact surfaces as needed to ensure the safety of produce. Surfaces may include dump tanks, flumes, wash tanks and hydrocoolers.
- Install backflow devices to prevent contamination of clear water with potentially contaminated used water, such as between potable water fill lines and dump tank drain lines.
- Regularly inspect and maintain equipment used to maintain water quality. Examples include chlorine injectors, filtration systems and backflow devices.

Antimicrobial Chemicals

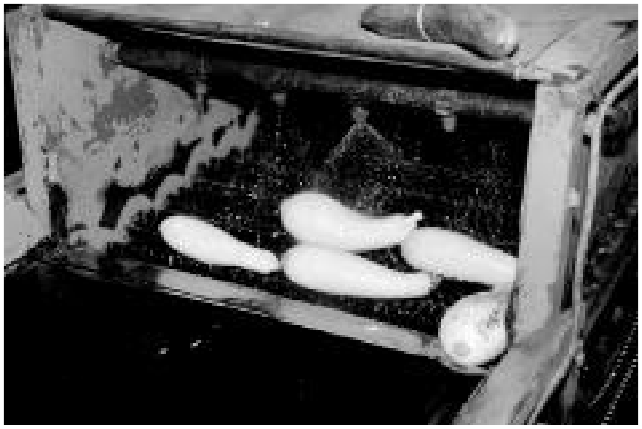
Preventing processing water from becoming contaminated is preferred to using antimicrobial chemicals, which may be added to contaminated water to correct a problem.

Antimicrobial chemicals are useful in reducing the build-up of microbes in processing water and may reduce the microbial load on the surface of the produce. An agent's effectiveness depends on its chemical and physical state, treatment conditions (such as water temperature, pH and contact time), resistance of pathogens and the nature of the fruit or vegetable surface.

Chlorine, for example, is commonly added to water at 50-200 parts per million (ppm) total chlorine, at a pH of 6-7.5, for a contact time of 1-2 minutes with fresh produce. Have chlorine-level test kits on hand to monitor and maintain prescribed levels.

Ozone has been used to sanitize wash and flume water in packing house operations, while ultraviolet radiation may also be used to disinfect processing water. Chlorine dioxide, trisodium phosphate and organic acids, such as lactic and acetic acid, are being studied for use as antimicrobial agents in produce water.

Operators need to consider options for water sanitation that are appropriate for their operations. Here are guidelines for using antimicrobial chemicals:



Only drinking quality water should be used in the cleaning process.

- Use only those chemicals approved by FDA and EPA.
- Use chemicals only according to their labels.
- Routinely monitor chemical levels and adjust to prescribed levels.
- Filter wash water to reduce the amount of organic material build-up. High levels can decrease effectiveness of chemicals.
- When using chemicals as prescribed, follow label directions for rinsing treated surfaces with clean water as needed.
- When using antimicrobial chemicals, know which chemical company to contact for technical assistance.

Wash Water

Washing fresh produce, also known as surface treatment, can reduce the overall potential for microbial contamination. Washing is an important step because most microbial contamination is on the surface of fruits and vegetables.

A number of postharvest processes–such as hydrocooling (opposite page), use of dump tanks and flume transport– involve a high degree of water-to-produce contact. So it is important to follow

good manufacturing practices to maximize the cleaning potential of these processes.

- **Use the appropriate wash method to fit the crop.** Brush washing is more effective than washing without brushes, but brushes need to be cleaned and sanitized often. Types of produce dictate what wash method is used: submersion, spray, or both. There is less contamination with spray washing compared to submersion washing. In submersion, wash water can become a source of contamination if not cleaned.
- **Maintain the efficacy of wash treatments.** Wash water, even with antimicrobial chemicals, reduces but doesn't eliminate pathogens on the surface of produce. A series of washes is more effective than a single wash.
- **Consider wash water temperature.** Wash water that is cool or cold is often used to remove field heat and lower the temperature of produce. But cold water can cause produce such as apples, celery and tomatoes to pull water into the plant, internalizing pathogens on the produce surface. Before immersing susceptible produce, use warm water for washing. Air cooling is another option. In the event it is not practical to expose produce to warmer temperatures, it is especially important for operators to follow good manufacturing practices to minimize pathogens in the water or on the surface of produce.
- **Consider alternative treatments for water-sensitive produce.** Dry cleaning (e.g. brushing, scraping, blowing air) is another method for cleaning produce that cannot tolerate water. Irradiation, the treatment of produce with ionizing radiation, is permitted for inhibition of ripening or sprouting and insect control. Treating produce with prescribed doses will also reduce pathogens, if present, depending on the sensitivity of the particular pathogen and the irradiation dose used.

Cooling Operations

Water, ice and forced air are methods for cooling produce. Of the three, forced air, using vacuum coolers or fans, is best because the fruit or vegetable has no contact with water or ice that can be a potential source of pathogenic contamination. Also,

The water quality of hydrocoolers should be monitored frequently.

reuse of water to cool continuous loads of produce is a potential problem because of cross-contamination. For example, new produce can be contaminated with water that was used on contaminated produce.

Operators need to follow good manufacturing practices to ensure that chilling does not introduce food safety hazards. Here are some guidelines:

- **Maintain temperatures that promote optimum produce quality.** High quality, intact produce is more resistant to microbial contamination.
- **Maintain air cooling equipment.** Make maintenance and inspection part of routine facility management. Remove potential sources of contamination from air intake areas.
- **Consider the use of antimicrobial chemicals in cooling water.** Antimicrobial chemicals in cooling water may reduce potential for contamination.

- **Keep ice and water clean and sanitary.** Periodically test for microbes in chilling water and water used to make ice. Contact ice suppliers for information about the source and quality of their ice. Change water in hydrocoolers as needed to maintain quality.
- **Manufacture, transport and store ice under sanitary conditions.**
- **Keep cooling equipment clean and sanitary**. Keep chilling equipment, such as hydrocoolers, and the containers that hold produce during chilling, clean and sanitary. Likewise, use good manufacturing practices to maintain a high level of sanitization throughout the plant.

Reference

Guide to Minimize Microbial Food Safety Hazard for Fresh Fruits and Vegetables, Food and Drug Administration. Available on the World Wide Web at: *http://vm.cfsan.fda.gov/~dms/prodguid.html.*

How to obtain FDA regulations

Title 21, Code of Federal Regulations: 21 CFR 100-169 and 21 CFR 170-199. Sections of Title 21 that are referenced in this publication can be viewed and printed from the Web at: *http://www.access.gpo.gov/nara/cfr/.*

You may purchase 21 CFR 100-169 or 21 CFR 170-199 from the U.S. Government Printing Office or by telephone at (202) 512-1800. FDA regulations may also be purchased at local branches of the U.S. Government Printing Office bookstores.

How to obtain EPA regulations

U.S. EPA. Ambient Water Quality Criteria for Bacteria, EPA Office of Water Regulations and Standards, EPA 832-B-92-005, January 1986.

Obtain by contacting the U.S. EPA / NCEPI, P.O. Box 42419, Cincinnati, OH 45242-2419. Telephone: 1-800-490-9198, FAX (513) 489-8695. You must give the EPA catalog number for the publication.

Electronic versions of additional EPA documents, such as criteria and supporting documents, are available at: *http://www.epa.gov.*

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