

Food Safety on the Farm: Good Agricultural Practices and Good Handling Practices—Water¹

Keith R. Schneider, Renée Goodrich-Schneider, and Douglas L. Archer²

As part of the Food Safety on the Farm series, a collection that reviews the generally recognized principles of GAPs as they relate to produce, primarily at the farm level and with particular focus on fresh Florida crops and practices, this publication focuses on GAPs and GHPs relating specifically to water use. The publications in this series can be found online at the EDIS website at http://edis.ifas.ufl.edu/topic_series_food_safety_on_the_farm.

Introduction

Good agricultural practices (GAPs) and good handling practices (GHPs) encompass the general procedures growers, packers and processors of fresh fruits and vegetables should follow to ensure the safety of their product. GAPs usually deal with pre-harvest practices (i.e., in the field), while GHPs cover post-harvest practices, including packing and shipping. This fact sheet covers GAPs and GHPs relating to water use. Seven other Florida Cooperative Extension factsheets will focus on other specific aspects of the GAPs program and how they relate to Florida crops and practices.

Water is one of the most critical components of food safety on the farm and in post-harvest handling and processing. Water has the potential to transmit both chemical and biological hazards to fresh produce. It is used in every phase of operation: irrigation, transplant establishment, the application of pesticides and fertilizers, frost protection,

product rinsing and washing, direct processing, facility cleaning, cooling operations, and personal hygiene for workers. The application of contaminated water at any of these points can introduce pathogens that could potentially reach the consumer.

Microbial Hazards

Water can be a carrier of many pathogenic strains of microorganisms, including but not limited to *E. coli* O157:H7, *Salmonella*, *Shigella*, *Cryptosporidium*, *Cyclospora*, and hepatitis A. Even small amounts of contamination with some of these organisms can result in foodborne illness. It is often difficult to identify with certainty the source of microbial contamination for fresh produce. In recent outbreaks associated with tomatoes, the problem was traced back to a single packing facility where a dump tank appeared to be the likely source of contamination (CDC 2007). Growers and packers must take a proactive role in minimizing these microbial hazards whenever they can (FDA 1998).

How to Control Potential Hazards

The quality of fresh produce is affected by many factors associated with water. The quality of the water used, the ways in which it is used, and the type of the crop being grown all influence and affect the potential for contamination. Water quality is extremely important when it comes into direct

1. This document is FSHN06-02, one of a series of the Food Science and Human Nutrition Department, UF/IFAS Extension. Original publication date November 2006. Revised April 2010. Reviewed June 2016. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Keith R. Schneider, associate professor; Renée M. Goodrich-Schneider, associate professor; and Douglas L. Archer, professor; Food Science and Human Nutrition Department, UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

contact with the edible portion of produce. There may need to be better quality controls in these cases than in cases where water makes minimal contact with the edible portion of produce (FDA 1998).

Other factors that influence the potential for a pathogen to get onto or into fresh produce include the condition and type of crop, the length of time between pathogen contact and harvest, and post-harvest handling practices. Produce with large surface areas (lettuce, spinach, etc.) and those with rough surfaces (e.g., cantaloupe) may be at greater risk, especially if pathogen contact occurs close to harvest and/or during post-harvest handling (FDA 1998).

The following areas have been identified by the US Food and Drug Administration (FDA, 1998) as important when assessing water quality. By controlling these areas, a grower/packer/processor may be able to minimize microbial food-safety hazards related to water usage in specific operations.

Agricultural Water

Agricultural water quality varies. For example, water that is clean one day may become contaminated the next, perhaps by wastewater discharge or polluted runoff from upstream livestock operations. Surface water contamination may also affect groundwater (i.e., surface water could infiltrate an old well with a cracked casing) (FDA 1998).

To help ensure high-quality water, make sure wells are properly constructed and protected, and/or treat water prior to use to reduce microbial loads. Remember, not all interventions are equally effective. Review your operations to gain a clear understanding of which changes will have the greatest impact (FDA 1998).

General Considerations

There are many sources of agricultural water. Flowing surface water can come from rivers, streams, irrigation ditches, and open canals. Water can also come from impoundments, such as ponds, reservoirs, lakes, and wells. Lastly, water may be obtained from a municipal supply. Generally speaking, groundwater is less likely to be contaminated than surface water, but under certain conditions, shallow, improperly constructed, or older wells may become contaminated from surface water (FDA 1998). In order to prevent contamination:

- Maintain wells in good working condition.
- Review existing practices and conditions to identify potential sources of contamination.

- Be aware of current and historical uses of land.
- Make sure that feedlots, animal pastures, and dairy operations in the region use and maintain fences or other barriers to minimize animal access to shared water sources.
- Find out if manure is applied to land by many farms in the region.
- Find out how local rainfall patterns and topography affect the likelihood that contaminated runoff from these operations will reach surface waters.
- Make sure that controls are in place to minimize contamination of agricultural waters from other farm or animal operations.
- Consider practices that will protect water quality.
- Consider irrigation water quality and use.

Microbial Testing of Agricultural Water

Microbial testing gives growers only a “snapshot” of water quality. For example, a single test performed last month would have limited predictive value for this month if a rainfall event happened to wash cattle runoff into your tomato field. Growers who are concerned about water quality should first focus their attention on GAPs to maintain and protect the quality of their water sources (FDA 1998).

However, periodic testing still can be a useful tool. Growers can test their water supply for microbial contamination on a periodic basis, using standard indicators of fecal contamination, such as *E. coli*. Make sure these tests are performed by a qualified commercial, state, or local government laboratory (FDA 1998).

Still, even if your results do not show bacterial safety concerns, this does not necessarily mean that there is an absence of protozoa and/or viruses. Water quality, especially surface water quality, can vary with time, and most tests will not tell you if specific pathogens are present in low numbers. Growers should consult local water quality experts, such as specialists from state or local environmental protection or public health agencies, UF/IFAS Extension offices and research centers, or land-grant universities, for advice that is appropriate for their individual operations (FDA 1998).

Processing Water

Fruits and vegetables are highly susceptible to contamination during post-harvest handling due to the high degree of water-to-produce contact. Water can be useful in reducing

potential contamination, but it may also serve as a source of contamination or cross-contamination. If processing water is reused, microbial contamination can build up and result in the contamination of a large batch of produce. Practices should be instituted to ensure that water quality is adequate both at the start and at the end of all post-harvest processes (FDA 1998). The following practices are recommended:

- In series of processes where water is being reused, water flow should be counter to the movement of produce through the different operations so that the most processed produce is always exposed to the cleanest water.
- Ensure that water is maintained in a condition suitable for its intended application, through regular treatment with disinfectant chemicals, the levels of which are closely monitored.
- Ensure routine water-quality testing of ice intended for use on/with fresh produce.

General Considerations

Follow good manufacturing practices (GMPs) to minimize microbial contamination from processing water. GMPs for water used for food and food contact surfaces in processing facilities are in Title 21 of the Code of Federal Regulations (CFR), sections 110.37(a) and 110.80(a)(1). These GMPs are in place for all manufacturers, packers, and processors of food products, and can be found online at http://www.access.gpo.gov/nara/cfr/waisidx_09/21cfr110_09.html (FDA 2009).

Consider practices that will ensure and maintain water quality (FDA 1998).

- Perform periodic water sampling and microbial testing.
- Change water as necessary to maintain sanitary conditions. Develop SOPs (standard operating procedures or sanitary operating plans), including water change schedules, for all processes that use water.
- Clean and sanitize water contact surfaces (such as dump tanks, flumes, wash tanks, and hydrocoolers) as often as necessary to ensure the safety of produce.
- Install backflow devices and legal air gaps as needed (such as between potable water fill lines and dump tank drain lines) to prevent the contamination of clean water by potentially contaminated water.
- Routinely inspect and maintain equipment designed to assist in maintaining water quality, such as chlorine injectors, filtration systems, and backflow devices, in order to ensure efficient operation.

- Minimize the accumulation of organic material in wash water. In some cases, the filtration of recirculating water or the use of a net to remove plant material and other debris from tanks may further prevent the accumulation of organic material.

Antimicrobial Chemicals

Another point to remember is that the best offense may be a good defense. Preventing a pathogen from getting onto your product in the first place is preferable to trying to remove one. Antimicrobial chemicals used in processing water can be useful in reducing microbial build-up and may reduce the potential for contamination (FDA 1998).

The effectiveness of an antimicrobial agent depends on many factors too numerous to mention here. If you want more information, refer to *Chlorine Use in Produce Packing Lines* (<http://edis.ifas.ufl.edu/CH160>), a fact sheet by Ritenour et al. (Ritenour et al. 2002). There are many different chemicals and methods you can use: sodium hypochlorite (food-grade bleach), ozone, ultraviolet radiation, chlorine dioxide, trisodium phosphate, and organic acids (such as lactic and acetic acids). Operators should consider which options are most appropriate for their individual operations. Contact chemical companies that sell antimicrobial chemicals for additional technical assistance (FDA 1998). When using antimicrobial chemicals, the following recommendations are in order:

- Follow each manufacturer's directions for proper mixing of antimicrobial chemicals, and do not exceed manufacturers' suggested allowable levels for antimicrobial chemicals in wash water.
- After contact between produce and processing water that contains antimicrobial chemicals, be sure to apply a clean water rinse of appropriate quality, to remove treatment residues, in compliance with the manufacturer's directions.

Wash Water

Produce may be washed at several junctures, including in the field, in a cooling facility, or in the processing facility itself. No washing process can remove all pathogens, but every additional cleansing step helps. Since a lot of microbial contamination is on the surface of fruits and vegetables, proper washing can be an important part of your process (FDA 1998).

Another reason for extra care at this step is that if pathogens are not removed or controlled here, they can contaminate other produce and equipment, creating a bigger problem. A number of post-harvest processes (such as hydrocooling, use of dump tanks, and flume transport) use a lot of water, meaning that there is a high risk of cross-contamination. Packers should follow good manufacturing practices to maximize the potential for these processes to assist in cleaning produce (FDA 1998).

- Use appropriate wash methods; vigorously washing produce will have greater efficacy in pathogen removal. For easily bruised produce, other options are available, including submersion, spray, or both.
- Use a series of washes if appropriate to the operation in question. An initial wash may be useful in the removal of the bulk of field soil, followed by one or more washes containing an antimicrobial chemical.
- Maintain the efficacy of wash treatments.
- Consider the wash water's temperature for certain produce. In general, wash water should not be at a cooler temperature than the produce being washed, in order to prevent the internalization of pathogens that may be present in the wash water.
- Consider alternative treatments for water-sensitive produce.

Cooling Operations

Cooling is a step that is often overlooked when trying to reduce microbial contamination. Different methods can be employed, including the uses of water, ice, and forced air. The best method depends on the fruit or vegetable being processed. In most cases, air cooling—particularly vacuum cooling or the use of fans—runs the lowest risk of contaminating your product. If you use water and/or ice, remember that the operator is a potential source of contamination. If you reuse your water in produce cooling, remember that microbial contamination can build up (FDA 1998). Good practices may include the following:

- Cool the product quickly and maintain temperatures that promote optimum produce quality.
- Maintain air-cooling equipment and cooling areas.
- Consider the use of antimicrobial chemicals in cooling water.
- Keep water and ice clean and sanitary.
- Manufacture, transport, and store ice under sanitary conditions.

- Equipment should be clean and sanitary.
- Prevent condensate and/or defrost water of evaporator-type cooling systems (e.g., vacuum cooling, cold storage) from dripping onto produce or any surfaces with which produce may come into contact.
- Store similar commodities together (according to level of processing) to avoid cross-contamination.
- Locate temperature-monitoring devices in the warmest area of the refrigerator unit and calibrate them on a regular basis.

References

Centers for Disease Control and Prevention (CDC). 2007. Multistate Outbreaks of *Salmonella* Infections Associated with Raw Tomatoes Eaten in Restaurants—United States, 2005–2006. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5635a3.htm> (June 2016).

Ritenour, M.A., S.A. Sargent, and J.A. Bartz. 2002. *Chlorine Use In Produce Packing Lines*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. HS-761. <http://edis.ifas.ufl.edu/CH160> (June 2016).

United States Food and Drug Administration. 1998. Guide to minimize microbial food safety hazards for fresh fruits and vegetables. FDA/CFSAN website. <http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/ProduceandPlantProducts/ucm064574.htm> (February 2010).

United States Food and Drug Administration. 2009. Current good manufacturing practice in manufacturing, packing, or holding human food. Title 21 Code of Federal Regulations, Pt. 110.37(a) and Pt. 110.80(a)(1). http://www.access.gpo.gov/nara/cfr/waisidx_09/21cfr110_09.html (June 2016).

United States Food and Drug Administration. 2008. Guide to minimize microbial food safety hazards of fresh-cut fruits and vegetables. FDA/CFSAN website. <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/ProducePlantProducts/ucm064458.htm> (April 2013).