

# Fruit and Vegetable Washing in Food Retail Environments

Anna Starobin<sup>1\*</sup> and Sally Foong-Cunningham<sup>2</sup>

<sup>1</sup>Ecolab Inc., 8300 Capital Drive, Greensboro, NC 27409, USA

<sup>2</sup>Ecolab Inc., 370 Wabasha St. North, St. Paul, MN 55102, USA

## SUMMARY

Consumption of fruits and vegetables is encouraged as part of a healthy diet by The Dietary Guidelines for Americans for 2010. If the benefits of fruits and vegetables are to be enjoyed, they need to be handled properly at all steps along the supply chain, from farm to fork. Approximately 131 produce-related outbreaks occurred between 1996 and 2010. These outbreaks resulted in 14,132 illnesses, 1,360 hospitalizations and 27 deaths, and were associated with approximately 20 fresh produce commodities. Food retail plays a big role in providing safe produce to consumers. This paper gives an overview of the procedures used by retail establishments and explains the reasons for some of the practices recommended in industry guidelines.

## OVERVIEW

Fruits and vegetable are known to be a good source of many important nutrients, including potassium, vitamin C, folate, fiber, and numerous phytochemicals (3). Vegetables and fruits with high levels of fiber may reduce the risk of obesity and type 2 diabetes; those rich in potassium may lower blood pressure and lower the risk for kidney stone development (13). Aside from being recommended for weight management, fruit and vegetable consumption is recommended for bone development and chronic disease risk management (2, 14).

Worldwide concern and knowledge about foodborne illness have been steadily increasing over the past several decades. Historically, the problem of microbiological contamination of fruits and vegetables was not considered significant, since it was originally believed that the low pH of fruits and vegetables would control the contamination (15). In addition, few outbreaks were associated with fruits and vegetables because of the lack of adequate pathogen identification technology. Today, it is increasingly recognized that raw fruits and vegetables are vulnerable to contamination, since final consumption occurs without a cooking step. In view of the complexity of the vegetable washing procedure, this paper summarizes recommendations provided by various guidelines and research papers for proper handling of fruit and vegetables in food service establishments.

Based on the Centers for Disease Control and Prevention's (CDC) evaluation of estimated foodborne illnesses, hospitalizations, and deaths due to food commodities in the United States between 1998 and 2008, it is estimated that 46% of illnesses and 23% of deaths were produce related (4). Twenty-two percent of illnesses were associated with leafy vegetables, which were the main items associated with illnesses within the produce category, which resulted in 14% of hospitalizations and caused 6% of deaths (4).

A variety of microorganisms have been linked to foodborne outbreaks connected to the consumption of raw fruits and vegetables. These organisms, which can contaminate fruits and vegetables, come from multiple sources outside of the food service establishment, including water, wild animals, soil, harvest containers, harvest crews and handlers, inadequate hygiene of buildings and equipment, transportation and storage. The complexity of contamination sources, both upstream and downstream, from the receiving door of the restaurant, retail deli or other food service facility is shown in *Fig. 1* (5).

Microbial contamination can be caused by bacteria, viruses, parasites, molds and yeasts. According to the Food and Drug Administration (FDA) database between 1996 and 2010, bacterial agents (86.5%), parasites (11.6%) and viruses (1.9%) were associated with the majority of fresh produce-related outbreaks and illnesses (12) (*Fig. 2*).

Pathogens involved in these outbreaks include *Escherichia coli* O157:H7, *Salmonella* species, *Listeria monocytogenes*, *Cyclospora*, *Shigella sonnei*, Hepatitis A and norovirus (4, 12). Sprouts, leafy greens, tomatoes, melons (e.g., cantaloupes and honeydew melons), berries, herbs and green onions accounted for 88.5% of the total produce-associated outbreaks (12).

In addition to food safety risks that are introduced upstream in the supply chain, improper handling of fruits and vegetables in the food service establishment can lead to microbiological cross-contamination and/or growth of pathogens that are already on the produce. Effective hand washing coupled with thorough cleaning and sanitation, as well as suitable storage and proper handling procedures of fruits and vegetables, can reduce this risk. Most microbial

\* Author for correspondence:

Phone: +1 336.931.2185

Fax: +1 336.668.9763

E-mail: anna.starobin@ecolab.com

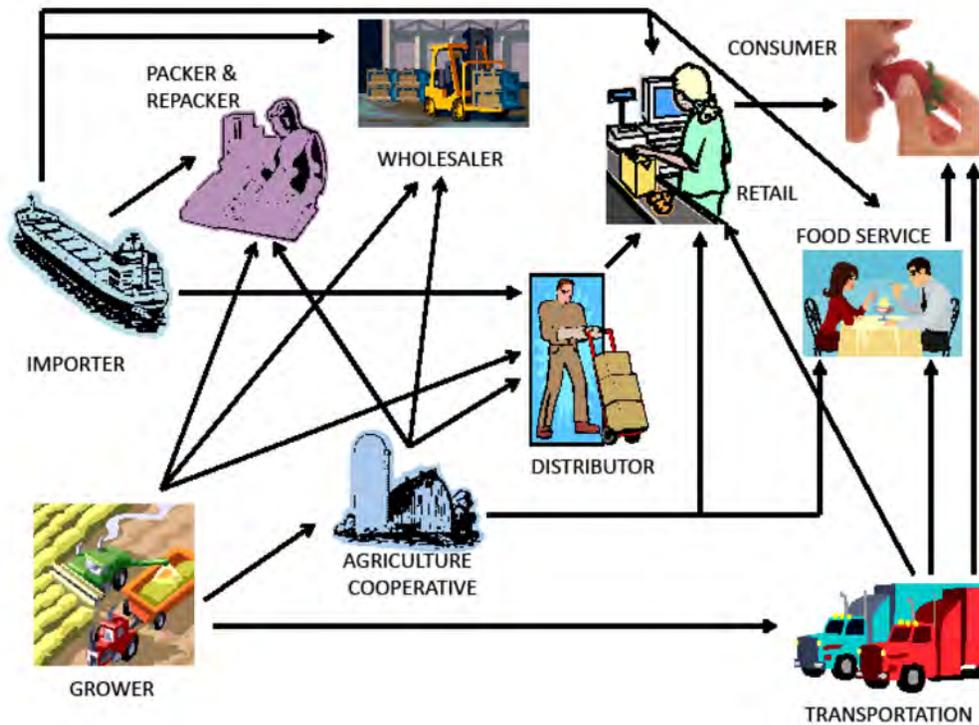


Figure 1. Fresh fruit and vegetable supply chain illustrating the complexity of contamination sources (5)

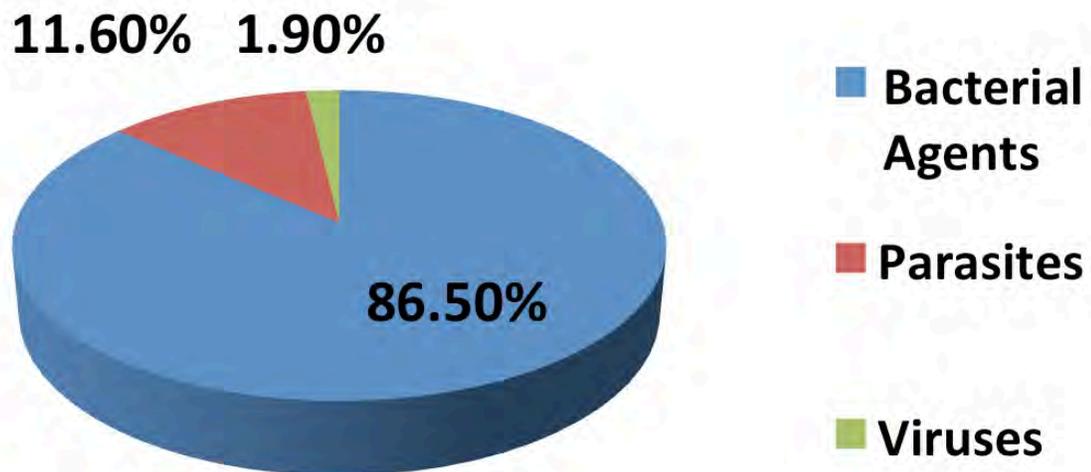
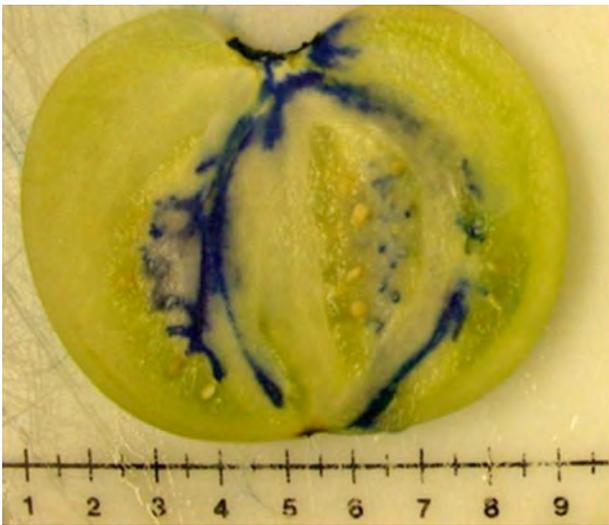


Figure 2. Fresh produce-related outbreaks and illnesses microbial contamination (12)

contamination is on the surface of the produce; therefore, washing produce can reduce the overall potential for microbial food safety hazards. If pathogens are not removed or inactivated, contamination can spread to additional produce while the food is being processed (9).

Fresh produce, especially of the leafy green type, is often soaked in ice water to preserve quality. When the microbiological water quality is not maintained, this practice has the potential to lead to food safety problems. The water in which produce is soaked, along with pathogens that may be present in the water, could be drawn into the interior of the produce through stem scars, cracks, cuts or bruises of fruits and vegetables, as a result of a temperature-generated pressure differential (7, 10). *Figure 3* shows an example of this phenomenon.



*Figure 3. Potential internalization of microorganisms inside a tomato, as illustrated with a dye solution that entered through the stem and blossom-end scar (1)*

*Courtesy: Institute for Food and Agricultural Sciences—University of Florida.*

Maintaining a sanitary condition of the water and a temperature difference between produce and water can reduce the risk of microorganism infiltration (8). Antimicrobials can minimize the potential for cross-contamination from processing water to the product, especially in situations when having a temperature differential between the wash water and the produce is not practical. Using spray-type wash treatments instead of submerging produce could be considered as well (9).

## RECOMMENDATIONS FOR PROPER HANDLING OF FRESH PRODUCE BY FOOD SERVICE OPERATORS

1. Purchase produce from a safe and reliable source of supply. Evaluate the growing and processing conditions, including the produce washing procedure, and employee hygiene practices.

2. Store raw cut melons, fresh sprouts, cut leafy greens and cut tomatoes at temperatures at or below 41°F (5°C) (11).
3. Wash hands thoroughly with soap and running potable water before and after handling produce.
  - Employees can be carriers of pathogenic microorganisms located on the skin, hair and hands or in the respiratory tract or digestive system. When employees come into contact with food, the potential exists for transmitting foodborne illness by contaminating the food, contact surfaces, water sources or other employees (8).
4. Wash, rinse and sanitize all sinks, utensils, cutting boards, slicers and other food contact surfaces before and after use with fresh produce.
  - Microorganisms may be transmitted from an unclean sink or utensil to produce.
  - Protect sources of water from contamination. Use potable water for washing. Comply with applicable local requirements for water that comes into contact with fresh-cut produce or food-contact surfaces.
  - Wash produce under running potable water or immerse whole produce along with using an antimicrobial in the wash water prior to preparing it in ready-to-eat form (9, 11).
  - Antimicrobial chemicals used with quality water can minimize the possibility of processing water becoming contaminated with microorganisms that could ultimately cross contaminate the product (9, 16). All chemical substances that disinfect or sanitize wash water and contact food must be used in accordance with FDA and EPA regulations and according to the manufacturer's labels (9). Rinsing produce with potable water may be required, unless otherwise indicated on the product label.
5. Maintain the wash water temperature at 10°F (6°C) warmer than the temperature of the pulp of the produce being washed.
  - Colder water can cause pathogens from the produce surface to be pulled into the plant material because of the osmotic pressure difference. If this occurs, washing is unlikely to reduce pathogen numbers. The recommended temperature differential may be achieved either by heating the water or by air cooling the produce before immersion (10).
  - As an alternative to using water alone for submerging produce, the use of antimicrobial chemicals in the wash water or in a spray could be considered (9).
6. Validation of the product's antimicrobial properties should be done using scientifically valid and standard test methods. When an actual use process is evaluated, validation goals should be clearly articulated. For example, consider whether the method is intended to improve produce shelf life or reduce/prevent

cross-contamination of pathogens via wash water. Other factors to consider include the types and levels of microorganisms, the procedure used for inoculation, number of test replicates, and test conditions, such as produce and sanitizer temperatures. If an antimicrobial is used for washing produce, follow EPA-registered label instructions or the manufacturer's directions for use. Rinse the washed produce with potable water if this step is recommended by manufacturer or required by FDA.

7. Scrubbing produce is recommended only when a clean brush is used on produce with a peel or a tough rind, such as on citrus fruits or cantaloupe, that will not be bruised or penetrated by the brush bristles (10).

8. Leafy green salads in sealed bags labeled "washed" or "ready-to-eat" that are packaged in a facility inspected by a regulatory authority and operated under cGMPs do not need additional washing at the time of use unless this is specifically directed on the label. Safety is not enhanced by additional washing of ready-to-eat green salads. The risk of cross-contamination from food handlers and food contact surfaces during washing may outweigh any food safety benefit that further washing may provide (6).

#### AUTHOR INFORMATION

Phone: +1 336.931.2185

Fax: +1 336.668.9763

E-mail: [anna.starobin@ecolab.com](mailto:anna.starobin@ecolab.com)

#### REFERENCES

1. Bartz, J. A., S. A. Sargent, and M. Mahovic. 2012. Guide to identifying and controlling postharvest tomato diseases in Florida. Available at: <http://edis.ifas.ufl.edu/pdffiles/HS/HS13100.pdf>. Accessed 18 August 2016.
2. Bica, L. A., and E. M. Jamelske. 2012. USDA fresh fruit and vegetable program creates positive change in children's consumption and other behaviors related to eating fruit and vegetables. *J. Child Nutr. Mgmt.* <http://eric.ed.gov/?id=EJ1000222>. Accessed 18 August 2016.
3. Centers for Disease Control and Prevention. 2011. Strategies to prevent obesity and other chronic diseases: The CDC Guide to strategies to increase the consumption of fruits and vegetables. Atlanta: U.S. Department of Health and Human Services. Available at: [http://www.cdc.gov/obesity/downloads/FandV\\_2011\\_WEB\\_TAG508.pdf](http://www.cdc.gov/obesity/downloads/FandV_2011_WEB_TAG508.pdf). Accessed 25 August 2016.
4. Centers for Disease Control and Prevention. 2013. Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998–2008 *Emerg. Infect. Dis.* Available at: <http://www.cdc.gov/foodborneburden/attribution-1998-2008.html>. Accessed 25 August 2016.
5. International Fruit and Vegetable Alliance (IFAVA). 2013. 4.3 Identifying structure and stakeholders. Available at: <http://ifava.org/ifava-toolkit-online/step-by-step-guide-to-starting-your-national-program/identifying-structure-and-stakeholders>. Accessed 25 August 2016.
6. Palumbo, M. S., J. R. Gorny, D. E. Gombas, L. R. Beuchat, C. M. Bruhn, B. Cassens, P. Delaquis, J. M. Farber, L. J. Harris, K. Ito, M. T. Osterholm, M. Smith, and K. M. J. Swanson. 2007. Recommendations for handling fresh-cut leafy green salads by consumers and retail foodservice operators. *Food Prot. Trends* 27:892–898.
7. Parish, M. E., L. R. Beuchat, T. V. Suslow, L. J. Harris, E. H. Garrett, J. N. Farber, and F. F. Busta. 2003. Methods to reduce/eliminate pathogens from fresh and fresh-cut produce. *Compr. Rev. Food Sci F.* 2:161–173.
8. U.S. Food and Drug Administration. 2008. Guidance for industry: Guide to minimize microbial food safety hazards of fresh-cut fruits and vegetables. V. Personnel. Available at: <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/ProducePlantProducts/ucm064458.htm#ch5>. Accessed 25 August 2016.
9. U.S. Food and Drug Administration. 2008. Guidance for industry: Guide to minimize microbial food safety hazards of fresh-cut fruits and vegetables. VIII. Production and process controls. Available at: <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/ProducePlantProducts/ucm064458.htm#ch8>. Accessed 25 August 2016.
10. U.S. Food and Drug Administration. 2013. FDA Food Code 2013: Annex 3 – Public health reasons/administrative guidelines – Chapter 3, Food. 3-302.15. Available at: <http://www.fda.gov/downloads/Food/GuidanceRegulation/RetailFoodProtection/Food-Code/UCM374510.pdf>. Accessed 17 September 2016.
11. U.S. Food and Drug Administration. 2013. FDA Food Code 2013: Chapter 3 – Food. 3-302.15 Washing fruits and vegetables. Available at: <http://www.fda.gov/downloads/Food/GuidanceRegulation/RetailFoodProtection/FoodCode/UCM374510.pdf>. Accessed 17 September 2016.
12. U.S. Food and Drug Administration. 2013. Standards for the growing, harvesting, packing, and holding of produce for human consumption. Available at: <http://www.regulations.gov#!documentDetail;D=FDA-2011-N-0921-0001>. Accessed 25 August 2016.
13. United States Department of Agriculture (USDA). Why is it important to eat vegetables? Available at: <https://www.choosemyplate.gov/vegetables-nutrients-health>. Accessed 25 August 2016.
14. Vatanparast, H., A. Baxter-Jones, R. A. Faulkner, D. A. Bailey, and S. J. Whiting. 2005. Positive effects of vegetable and fruit consumption and calcium intake on bone mineral accrual in boys during growth from childhood to adolescence: the University of Saskatchewan Pediatric Bone Mineral Accrual Study. *Am. J. Clin. Nutr.* 82:700–706.
15. World Health Organization, Food Safety Unit. 1998. WHO/FSF/FOS/98.2 Surface decontamination of fruits and vegetables eaten raw: a review. Available at: [http://apps.who.int/iris/bitstream/10665/64435/1/WHO\\_FSF\\_FOS\\_98.2.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/64435/1/WHO_FSF_FOS_98.2.pdf?ua=1). Accessed 25 August 2016.
16. Zhang, G., L. Ma, V. H. Phalen, and M. P. Doyle. 2009. Efficacy of antimicrobial agents in lettuce leaf processing water for control of *Escherichia coli* O157:H7. *J. Food Prot.* 72:1392–1397.