



**Expectations for Post-Harvest Water Used in Leafy Green and Herb
Field Operations**

Post-harvest use of water on leafy greens and herbs is, in some cases, an important step in removing organic matter (e.g., soil, plant, etc.) or microorganisms and/or in improving the quality or shelf-life of these products. Contamination of the leafy greens and herbs may occur however, if the water used to wash, cool, flume, rinse, etc., the product is not potable or if potability is not maintained.

Laboratory and field studies as well as outbreak investigations have all confirmed the potential for water to contaminate leafy greens and herbs. Pathogens that can cause human illness can be present in the water at the source or be introduced at any stage of the washing, rinsing, etc., process.

The following table “Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens” shows the outbreaks that have occurred over the last 20 years. These are documented outbreaks where people became sick from the consumption of leafy greens.

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Nov. 2021	<i>E. coli</i> O157	10	Leafy Greens	Multistate, U.S. https://www.cdc.gov/ecoli/2021/o157h7-12-21/index.html
Oct. 2021	<i>E. coli</i> O157	15	Spinach	Multistate, U.S. https://www.cdc.gov/ecoli/2021/o157h7-11-21/index.html
Oct. 2020	<i>E. coli</i> O157	40	Leafy Greens	Multistate, U.S. https://www.cdc.gov/ecoli/2020/o157h7-10-20b/index.html
Nov. 2019	<i>E. coli</i> O157	171	Romaine Lettuce (California)	Multistate, U.S. and Canada: https://www.cdc.gov/ecoli/2019/o157h7-11-19/index.html https://www.canada.ca/en/public-health/services/public-health-notices/2019/outbreak-united-states-e-coli-infections-romaine-lettuce.html
Oct. 2018	<i>E. coli</i> O157	91	Romaine Lettuce (California)	Multistate, U.S. and Canada: https://www.cdc.gov/ecoli/2018/o157h7-11-18/index.html https://www.canada.ca/en/public-health/services/public-health-notices/2018/outbreak-ecoli-infections-linked-romaine-lettuce.html

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Apr. 2018	<i>E. coli</i> O157	218, 5 dead	Romaine Lettuce (Arizona)	Multistate, U.S. and Canada: https://www.cdc.gov/ecoli/2018/o157h7-04-18/index.html https://www.canada.ca/en/public-health/services/public-health-notices/2018/public-health-notice-outbreak-e-coli-infections-linked-romaine-lettuce.html
Dec. 2017 - Jan. 2018	<i>E. coli</i> O157	67, 2 dead	Leafy greens/lettuce, unspecified	Multistate, U.S. and Canada: https://www.cdc.gov/ecoli/2017/o157h7-12-17/index.html https://www.canada.ca/en/public-health/services/public-health-notices/2017/public-health-notice-outbreak-e-coli-infections-linked-romaine-lettuce.html
Dec. 2015 - Jan. 2016	<i>Listeria monocytogenes</i>	19, 1 death	packaged salads	Multistate, U.S.: http://www.foodsafetynews.com/2016/08/cdc-adds-salad-to-listeria-questionnaire-in-wake-of-outbreak/#.WXdhDxTZqf4
Mar. 2015	<i>E. coli</i> O157:H7	12	leafy greens	Canada: http://www.foodsafetynews.com/2015/04/canadian-officials-investigating-e-coli-outbreak-possibly-linked-to-leafy-greens/#.WXdiNxTZqf4
Jul. 2014	<i>E. coli</i> O111	15	Salad/cabbage served at Applebee's and Yard House (Minnesota)	Minnesota, U.S.: http://outbreakdatabase.com/details/2014-outbreak-of-e.-coli-o157-fond-du-lac-tribe-minnesota
Oct. 2013	<i>E. coli</i> O157:H7	33	Pre-packaged salads and sandwich wraps (California)	Multistate, U.S.: http://www.cdc.gov/ecoli/2013/O157H7-11-13/index.html
Jul. 2013	<i>E. coli</i> O157:H7	94	Lettuce served at Federico's Mexican Restaurant	Arizona, U.S.: http://www.foodsafetynews.com/files/2013/11/Federicos-Final-Report.pdf

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Jul. 2013	<i>Cyclospora</i>	140 (Iowa); 87 (Nebraska)	Salad mix, cilantro	Multistate, U.S. (Iowa and Nebraska): http://www.cdc.gov/parasites/cyclosporiasis/outbreaks/investigation-2013.html
Dec. 2012 - Jan. 2013	<i>E. coli</i> O157:H7	31	Shredded lettuce from Freshpoint, Inc.	Canada: http://www.inspection.gc.ca/food/information-for-consumers/food-safety-investigations/freshpoint-inc/report/eng/1371564841187/1371565168146 ; http://www.phac-aspc.gc.ca/fs-sa/phn-asp/2013/ecoli-0113-eng.php ; http://www.huffingtonpost.com/2013/01/14/lettuce-recall-taco-bell-kfc-canada_n_2472085.html ; http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40s-1/dr-rm40s-1-ecoli-eng.php
Oct. 2012	<i>E. coli</i> O157:H7	33	Leafy greens salad mix (Massachusetts)	Multistate, U.S.: http://outbreakdatabase.com/details/2012-outbreak-of-e.-coli-o157-linked-to-wegmans-brand-organic-spinach-and-spring-mix
Apr. 2012	<i>E. coli</i> O157:H7	28	Romaine lettuce	California, U.S., and Canada: http://outbreakdatabase.com/details/2012-outbreak-of-e.-coli-o157h7-outbreak-linked-to-romaine-lettuce-canada-and-california
Dec. 2011	<i>Salmonella</i> Hartford	5	Lettuce; roast beef	New York, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Dec. 2011	Norovirus	9	Lettuce, unspecified	Oregon, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Oct. 2011	<i>E. coli</i> O157:H7	58	Romaine lettuce	Multistate, U.S.: http://www.cdc.gov/ecoli/2011/ecoliO157/romainelettuce/032312/ ; Slayton, R. B., Turabelidze, G. G., Bennett, S. D., Schwensohn, C. A., Yaffee, A. Q., Khan, F. F., & ... Gieraltowski, L. B. (2013). Outbreak of shiga toxin-producing <i>Escherichia coli</i> (STEC) O157:H7 associated with romaine lettuce consumption, 2011. <i>PLoS ONE</i> 8(2): e55300. doi:10.1371/journal.pone.0055300. Available from http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0055300
Oct. 2011	<i>E. coli</i> O157:H7	26	Lettuce	Multistate, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Aug. 2011	N/A	8	Lettuce; onions; tomatoes	New Jersey, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jul. 2011	<i>Cyclospora cayetanensis</i>	99	Lettuce based salads	Georgia, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jun. 2011	Norovirus	23	Garden salad	Connecticut, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Apr. 2011	<i>Salmonella</i> Typhimurum	36	Multiple salads	Illinois, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Feb. 2011	Norovirus	24	Garden salad	Pennsylvania, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jan. 2011	Norovirus	93	Lettuce; salad, unspecified	Maryland, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jul.-Oct. 2010	<i>Salmonella</i> Java	136	Salad vegetable	U.K.: Gobin M, Launder N, Lane C, Kafatos G, Adak B. National outbreak of <i>Salmonella</i> Java phage type 3b variant 9 infection using parallel case-control and case-case study designs, United Kingdom, July to October 2010. <i>Euro Surveill.</i> 2011;16(47):pii=20023. Available from http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20023

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
May 2010	<i>E. coli</i> O145	33 (26 lab-confirmed)	Romaine Lettuce grown in Arizona	Multistate, U.S.: http://www.cdc.gov/ecoli/2010/ecoli_o145/index.html
Apr. 2010	<i>Salmonella</i> Hvittingfoss	102	Lettuce, tomatoes, and olives served at Subway restaurants	Illinois, U.S.: http://outbreakdatabase.com/details/2010-outbreak-of-salmonella-hvittingfoss-infections-linked-to-subway-sandwiches-illinois
Jan. 2010	<i>E. coli</i>	260	Lettuce grown in France	Denmark: Ethelberg S, Lisby M, Böttiger B, Schultz AC, Villif A, Jensen T, Olsen KE, Scheutz F, Kjelsø C, Müller L. Outbreaks of gastroenteritis linked to lettuce, Denmark, January 2010. Euro Surveill. 2010;15(6):pii=19484. Available from http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19484
Dec. 2009	Norovirus	16	Lettuce	Wisconsin, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Aug. 2009	<i>Salmonella</i> Typhimurium	27	Lettuce	Colorado, U.S.: http://outbreakdatabase.com/details/colorado-picnic-iceberg-lettuce-2009 ; http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Aug. 2009	<i>Salmonella</i> spp	124	Romaine lettuce; Recalls issued by Tanimura & Antle, Inc. (lettuce), Muranaka Farm, Inc. (parsley), and Frontera Produce (cilantro)	Multistate, U.S., Puerto Rico, Canada: http://www.foodsafetynews.com/2009/09/a-mid-summer-salmonella-outbreak/#.Um6p3SRQ1fQ ; http://www.foodsafetynews.com/2010/06/publishers-platform-4/#.UqiCCY1Q2gh ; http://www.oregonlive.com/news/index.ssf/2009/08/company_recalls_lettuce_over_s.html
Jul. 2009	<i>Salmonella</i> Typhimurium	145	Shredded lettuce from Taylor Farms	Multistate, U.S., Canada: http://outbreakdatabase.com/details/taylor-farms-shredded-lettuce-2009 ; http://www.cdc.gov/foodborneoutbreaks/Default.aspx

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
May. 2009	Norovirus	10	Lettuce, onion, and tomato in chicken salad	Idaho, U.S.: http://outbreakdatabase.com/details/idaho-restaurant-chicken-salad-lettuce-onion-tomato-2009
Nov. 2008	<i>E. coli</i> O157:H7	130	Romaine lettuce	Ontario, Canada: http://www.thestar.com/life/health_wellness/2008/11/12/lettuce_prime_suspect_in_e_coli_outbreak.html
Oct. 2008	<i>E. coli</i> O157:H7	2	Chopped shredded iceberg lettuce (Michigan)	Ontario, Canada: http://www.marketwired.com/press-release/canadian-food-inspection-agency-cfia-outbreak-e-coli-o157-h7-united-states-related-cases-906741.htm
Oct. 2008	<i>E. coli</i> O157:H7	43 (Johnathan's Family Restaurant), 21 (Little Red Rooster Restaurant), 12 (M.T. Bellies Restaurant)	Lettuce	Ontario, Canada: http://outbreakdatabase.com/details/2008-outbreak-of-e.-coli-o157h7-linked-to-romaine-lettuce-canada ; http://outbreakdatabase.com/details/2008-outbreak-of-e.-coli-o157h7-at-little-red-rooster-restaurant-ontario ; http://outbreakdatabase.com/details/2008-outbreak-of-e.-coli-o157h7-at-m.-t.-bellies-restaurant-canada
Oct. 2008	Norovirus	64	Tomato relish, lettuce-based salad	Illinois, U.S.: http://outbreakdatabase.com/details/illinois-restaurant-or-office-setting-or-private-home-tomato-relish-or-lettuce-based-salads-2008
Aug.-Sep. 2008	<i>E. coli</i> O157:H7	74	Lettuce from Aunt Mid's Produce Company (California)	Michigan and Illinois, U.S., Canada: http://outbreakdatabase.com/details/aunt-mids-produce-company-lettuce-2008

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Aug.-Oct. 2008	<i>E. coli</i> O157:H7	13	Spinach (Oregon)	Multistate, U.S.: http://outbreakdatabase.com/details/multistate-unknown-location-spinach-2008 ; http://www.foodsafetynews.com/2010/06/publishers-platform-4/#.Um64rCRQ1fQ
May. 2008	<i>E. coli</i> O157:H7	10	Pre-packaged lettuce	Washington, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
May. 2008	<i>E. coli</i> O157:H7	6	Pre-packaged salad	Tennessee, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
May 2008	<i>E. coli</i> O157:H7	9	Lettuce (California, U.S.)	Washington, U.S.: http://www.about-ecoli.com/ecoli_outbreaks/view/california-romaine-lettuce-e-coli-outbreak/#.Uqidy11Q2gg
Apr. 2008	<i>Salmonella</i> Branderup	12	Green salad, tomato	Iowa, U.S.: http://outbreakdatabase.com/details/2008-outbreak-of-salmonella-braenderup-at-a-restaurant-iowa
Jul. 2007	<i>Shigella sonnei</i>	72	Salad	California, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jul. 2007	<i>E. coli</i> O157:H7	26	Lettuce	Alabama, U.S.: http://outbreakdatabase.com/details/2007-outbreak-of-e.-coli-o157h7-at-little-rosies-mexican-taqueria-alabama
Feb. 2007	Norovirus	8	Lettuce	Tennessee, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jan. 2007	Norovirus	9	Salad	Idaho, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens

Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Nov. 2006	<i>E. coli</i> O157:H7	78	Lettuce	Multistate, U.S.: http://outbreakdatabase.com/details/taco-bell-restaurants-lettuce-2006
Oct. 2006	<i>E. coli</i> O157:H7	205	Pre-packaged baby spinach from Dole Food Company (California)	Multistate, U.S.: Grant J, Wendelboe AM, Wendel A, Jepson B, Torres P, Smelser C. Spinach-associated Escherichia coli O157:H7, Utah and New Mexico, 2006. Emerg Infect Dis [serial on the Internet]. 2008, October;14(10): 1633–1636. Available from https://wwwnc.cdc.gov/eid/article/14/10/07-1341_article ; Jay MT, Cooley M, Carychao D, Wiscomb GW, Sweitzer RA, Crawford-Miksza L, et al. Escherichia coli O157:H7 in feral swine near spinach fields and cattle, central California coast. Emerg Infect Dis. 2007 December; 13(12): 1908–1911. Available from http://www.cdc.gov/EID/content/13/12/1908.htm
Sep. 2006	Norovirus	9	Salad	Virginia, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Sep. 2005	<i>E. coli</i> O157:H7	34	Pre-packaged bagged lettuce from Dole Food Company	Multistate (Minnesota, Washington, Oregon), U.S.: http://outbreakdatabase.com/details/dole-food-company-triple-washed-ready-to-eat-lettuce-2005 ; http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jun. 2006	<i>Salmonella</i> Typhimurium	18	Lettuce, tomatoes	Maryland, U.S.: http://outbreakdatabase.com/details/maryland-restaurant-or-private-home-lettuce-or-tomato-2006
Oct. 2005	<i>E. coli</i> O157:H7	12	grapes, green; lettuce, prepackaged	Multistate, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Nov. 2004	<i>E. coli</i> O157:H7	6	Lettuce, unspecified	New Jersey, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Jul. 2004	<i>Salmonella</i> Newport	97	Iceberg lettuce	Multistate, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Nov. 2003	<i>E. coli</i> O157:H7	19	Spinach, unspecified	California, U.S.: Klonsky, Karen. <i>E. coli</i> in spinach, foodborne illnesses, and expectations about food safety. <i>Agricultural and Resource Economic Update</i> , University of California, 10(2), Nov/Dec 2006. Available from http://giannini.ucop.edu/media/are-update/files/articles/v10n2_1.pdf
Oct. 2003	<i>E. coli</i> O157:H7	16	Spinach, unspecified	California, U.S.: http://outbreakdatabase.com/details/sequoias-portola-nursing-homesodexo-spinach-2003
Sep. 2003	<i>E. coli</i> O157:H7	51	Lettuce-based salads, unspecified	California, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Nov. 2002	<i>E. coli</i> O157:H7	60	Romaine lettuce	Multistate, U.S.: http://www.cdc.gov/ecoli/2011/ecoliO157/romainelettuce/120711/index.html
Jul. 2002	<i>E. coli</i> O157:H7	32	Romaine lettuce from Spokane Produce (Washington)	Washington, U.S.: http://www.cidrap.umn.edu/news-perspective/2002/08/lettuce-blamed-e-coli-o157h7-outbreak-affecting-dozens-washington-state
Jul. 2002	<i>E. coli</i> O157:H7	55	Caesar salad	Washington, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Nov. 2001	<i>E. coli</i> O157:H7	20	Lettuce-based salads, unspecified	Texas, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Oct. 2000	<i>E. coli</i> O157:H7	6	Salad	Indiana, U.S.: http://outbreakdatabase.com/details/indiana-restaurant-salad-2000
May 2000	<i>Campylobacter jejuni</i>	13	Salad	Connecticut, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
May 2000	Norovirus	3	Salad	Ohio, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Feb. 2000	Norovirus	7	Salad	Ohio, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Oct. 1999	<i>E. coli</i> O157:H7	45	Lettuce, salad	Pennsylvania and Oregon, U.S.: http://www.outbreakdatabase.com/details/multistate-retirement-facility-and-private-home-romaine-lettuce-1999
Oct. 1999	<i>E. coli</i> O157:H7	47	Salad	Ohio, U.S.: http://outbreakdatabase.com/details/ohio-restaurant-salad-1999
Oct. 1999	Norovirus	16	Salad	West Virginia, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Sep. 1999	<i>E. coli</i> O157:H11	6	Lettuce	Washington, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Sep. 1999	Norovirus	115	Lettuce	Washington, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Sep. 1999	<i>E. coli</i> O111:H8	58	Salad	Texas, U.S.: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4915a2.htm
Aug. 1999	Norovirus	25	Salad	Minnesota, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
May 1999	Norovirus	28	Salad	Florida, U.S.: http://www.cdc.gov/foodborneoutbreaks/Default.aspx
Feb. 1999	<i>E. coli</i> O157:H7	72	Lettuce	Nebraska, U.S.: http://outbreakdatabase.com/details/1999-outbreak-of-e.-coli-o157h7-linked-to-iceberg-lettuce-at-golden-coral-steak-house-iceberg-lettuce-nebraska

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens

Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
May 1998	<i>E. coli</i> O157:H7	2	Salad	California, U.S.: Centers for Disease Control and Prevention. Surveillance for outbreaks of Escherichia coli O157:H7 infection: summary of 1998 data. Atlanta, GA: Centers for Disease Control and Prevention, Division of Bacterial and Mycotic Diseases, Foodborne and Diarrheal Diseases Branch; 1999. p. 1-3.. Available from http://outbreakdatabase.com/details/restaurant-salad-1998
May 1996	<i>E. coli</i> O157:H7	61	Lettuce	Multistate (Connecticut, Illinois, New York), U.S.: http://outbreakdatabase.com/details/fancy-cutt-farms-mesclun-lettuce-1996 ; Hilborn ED, Mermin JH, Mshar PA, et al. A Multistate Outbreak of Escherichia coli O157:H7 Infections Associated With Consumption of Mesclun Lettuce. Arch Intern Med. 1999;159(15):1758-1764. doi:10.1001/archinte.159.15.1758. Available from http://www.ncbi.nlm.nih.gov/pubmed/10448779
Oct. 1995	<i>E. coli</i> O153:H46	11	Lettuce	Ohio, U.S.: https://www.foodsafetynews.com/2018/04/almost-6-dozen-outbreaks-traced-to-leafy-greens-since-1995/
Sep. 1995	<i>E. coli</i> O153:H47	30	Lettuce	Maine, U.S.: http://outbreakdatabase.com/details/cross-contamination-of-iceberg-lettuce-1995
Sep. 1995	<i>E. coli</i> O157:H7	21	Lettuce	Idaho, U.S.: http://outbreakdatabase.com/details/1995-outbreak-of-e.-coli-o157h7-linked-to-romaine-lettuce-idaho

Foodborne Illness Outbreaks Associated with Lettuce and Leafy Greens				
Date	Causative Agent	Illnesses Reported	Source	Country of Outbreak
Jul. 1995	<i>E. coli</i> O153:H48	74	Lettuce	Montana, U.S.: Ackers, M. L., Mahon, B. E., Leahy, E., Goode, B., Damrow, T., Hayes, P. S. & Slutsker, L. (1998). An outbreak of Escherichia coli O157: H7 infections associated with leaf lettuce consumption. Journal of Infectious Diseases, 177(6), 1588-1593. Available from http://www.ncbi.nlm.nih.gov/pubmed/9607837 ; http://outbreakdatabase.com/details/leaf-lettuce-1995

How do Leafy greens and herbs become contaminated?

The use of dump or dip tanks where leafy greens and herbs enter the water can carry microorganisms that cause human disease. These pathogens can survive and multiply in the wash water if the water is not treated appropriately. As leafy greens and herbs are washed, they may disperse organic matter (e.g., soil, plant matter, etc.) into the water. Microorganisms, which are ubiquitous in soil and associated with fruits and vegetables, can adhere to and grow on particles of organic matter. These sometimes microscopic particles of organic matter can be deposited within the wash water, be shielded from water treatments and may potentially contaminate “clean” incoming leafy greens and herbs. The very nature of washing adds to the total organic load of a wash water, as particles are removed and remain in the washing basin or tank. For this reason, it is essential to treat wash water appropriately and monitor its effectiveness.

Water Treatment

Chlorine is the most common treatment used for produce wash water. However, even with the use of chlorine, it can be challenging to maintain the potable quality of wash water throughout the day.

Chlorine has two roles in wash water. The main role is to prevent pathogens from surviving in water and contaminating incoming produce. The secondary role of chlorine is to reduce the microbial load on the leafy greens and herbs themselves. Science shows that chlorine may reduce but does not eliminate bacteria from the surface of produce. There is no definitive kill step. Complete elimination of pathogens on produce using chlorinated water is unlikely as there are several conditions that can affect the efficacy of washing/rinsing. These include:

1. Amount of time between contamination and washing/rinsing. Bacteria will adhere better to leafy greens and herbs over time, making them more difficult to wash off.
2. Attachment at inaccessible sites – Leafy greens and herbs have a high edible surface area to mass ratio of which there are many indentations, folds, grooves, etc., where bacteria can attach better. These can then survive the washing/rinsing better because they are somewhat protected.
3. Biofilms – Studies have shown that biofilms can form on the surface of some leafy greens and herbs, making them very difficult to wash/rinse off.
4. Washing/rinsing conditions – water temperature, type of system (spray, dump, brushes, etc.), contact time. All of these add variations that can affect the overall success of the washing/rinsing system.

Other control measures

Since many of these factors cannot be controlled, washing/rinsing should not be relied upon to completely eliminate pathogens from leafy greens and herbs. Things such as good employee hygiene, controlling manure use, proper cleaning of equipment, etc., all help to ensure that the risks are also mitigated.

CanadaGAP requirements

Based on the above information the CanadaGAP program requires that water used on leafy greens or herbs not present a risk and that potable water is used or potability is maintained.

The definition within the CanadaGAP glossary for potable water is the following:

Potable water: Water that meets the parameters under the Canadian Water Quality Guidelines for Drinking Water Quality (biological parameters are 0 Total Coliforms and 0 *E. coli*).

In Section 15.1 Water (for fluming and cleaning) of the Fruit and Vegetable Manual it states:

Water for Hydro-cooling, Cooling, Fluming and Washing Product (including cooling with slush/ice slurry) [FOR ALL COMMODITIES EXCEPT FOR SMALL FRUIT* and PROCESSING POTATOES (If not applicable, proceed to the next sub-section: For Cranberries and Haskaps Only)]

FOR Leafy Vegetables and Cruciferae (EXCEPT FOR Broccoli, Cauliflower, Cabbage and Brussels sprouts)

- ! Water is **kept potable** at all times
- ! Water is changed daily (at a minimum) or more frequently to reduce the load of organic matter, and only **potable water** is used to fill or replenish flumes, hydro-coolers, dump tanks, buckets, drums or pits

Final Rinse Water FOR ALL COMMODITIES (EXCEPT FOR PROCESSING POTATOES, CUCUMBERS AND PEPPERS SENT FOR PICKLING, AND SMALL FRUIT*, EXCLUDING CRANBERRIES AND HASKAP) (If not applicable, proceed to the next sub-section: Water for Wetting Packaging Accessories and Other Items)

FOR Leafy Vegetables and Cruciferae (EXCEPT FOR Broccoli, Cauliflower, Cabbage and Brussels sprouts)

- If water has been used to hydro-cool, cool, flume, or wash product (even though it was kept potable), the person responsible provides a **final potable water rinse**

FOR ALL COMMODITIES (EXCEPT FOR PROCESSING POTATOES, CUCUMBERS AND PEPPERS SENT FOR PICKLING, AND SMALL FRUIT*, EXCLUDING CRANBERRIES AND HASKAP)

- ! If the person responsible is using water for a final rinse, water is potable
- ! ● At least twice annually (after your operation's start date) – If providing a final rinse, the person responsible tests the water for Total Coliforms and *E. coli* using an accredited lab that uses appropriate sampling and testing methods to perform analyses in accordance with the applicable requirements of *ISO/IEC 17025*, to ensure that the water (even if it is from a municipal source) is potable (File under Tab: Test Results) *Refer to Appendix G: Water Testing*
 - ! Once prior to use
 - ! At least once more during the season to ensure water potability is being maintained
- The person responsible ensures the water sample is taken directly from the rinse equipment (unless a hose is used to rinse product; then the sample may be taken from the water source) when testing for potability

Note: *If there are multiple packing lines or rinsing equipment EACH one (e.g., set of nozzles on each packing line not individual nozzles, hose, etc.) must be tested twice. Contamination can occur in the equipment itself and this needs to be assessed.*

How can I meet the CanadaGAP requirements?

Achieving potability and/or maintaining potability within water can be tricky BUT it can be done. It may take several attempts and some innovation to ensure maximum effectiveness. The CanadaGAP appendices have guidance on treating water with chlorine as well as some other treatment methods.

Refer to Appendix B: Chlorination of Water for Fluming and Cleaning Fresh Fruits and Vegetables and Cleaning Equipment – An Example

****Read the appendix carefully – it contains the information you need in order to successfully achieve/maintain potability.

Do I need help from an expert?

Experts/consultants may be required to help with implementation. New ways, equipment or technologies may need to be sought. It's a process, often involving trial-and-error to achieve an effective treatment. But it can be done and it will help to ensure that the very real risk from contaminated water to the product is achieved.

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