2017

Managing E. coli in Vegetable Wash Water

Vernon P. Grubinger
The University of Vermont, vgrubing@uvm.edu

Lynn Blevins
The University of Vermont, lynn.blevins@uvm.edu

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Vern Grubinger, University of Vermont Extension, vernon.grubinger@uvm.edu
Lynn Blevins, University of Vermont College of Medicine, lynn.blevins@uvm.edu

Introduction. Growers of fresh produce have been adopting on-farm food safety practices in response to market demands and new regulations. Food safety risks posed by fresh produce are small, but practical steps should be taken to address them. One of these steps is to minimize the level of potentially harmful bacteria in vegetable wash water. This reduces the risk of cross-contamination whereby one contaminated item leads to the spread of bacteria to other items washed in the same water. Doing so is especially important for crops that will be consumed raw, such as leafy greens.

Key practices in wash water management. First, only potable sources of water should be used. Second, the wash vessel, whether a tub, a tank or a sink, should be free of cracks and thoroughly cleaned prior to use. Third, anyone engaged in washing produce must wash their hands thoroughly prior to handling product. Finally, our on-farm research found that using multiple washes (rinses) helps reduce the population of E. coli bacteria in wash water, as does the addition of an approved sanitizer containing peracetic acid (PAA).

Using E. coli levels to assess wash water risk. There are many types of E. coli present in the environment, and most do not make people sick. However, the presence of generic E. coli indicates the presence of fecal material and thus the possibility that human pathogens such as E. coli 0157:H7, Salmonella, or Campylobacter could be present. Testing for generic E. coli is an accepted practice for assessing the food safety risk of water that comes in contact with crops.

There is currently no widely-accepted standard for E. coli levels in water once the vegetable washing process is underway. Ideally the level would be zero, but that may not be practical to achieve for all farms with every wash. Thus, a reasonable goal is keep E. coli levels as low as possible to prevent cross contamination between produce items. For reference, the maximum generic E. coli level set for recreational water use in Vermont is 235 CFU/100 milliliters. (Note that E. coli levels can be measured as CFU, colony forming units, or estimated as MPN, most probable number, per 100 ml of water. The results of the two methods are similar.)

On-farm research 2012-2014. University of Vermont Extension personnel cooperated with commercial leafy green growers across Vermont and in nearby states to study the effect of different numbers of washes (rinses) and/or two sanitizer treatments on generic E. coli levels in wash water. The goal was to identify the practices which were most effective at reducing the risk of cross contamination.

Throughout the study, generic E. coli levels in on-farm wash water were measured after each wash (up to three) of leafy greens. We also measured E. coli levels after adding an organically-approved sanitizer (SaniDate®) containing PAA to the water after the first or second wash, at the full labeled rate and/or at half that rate.

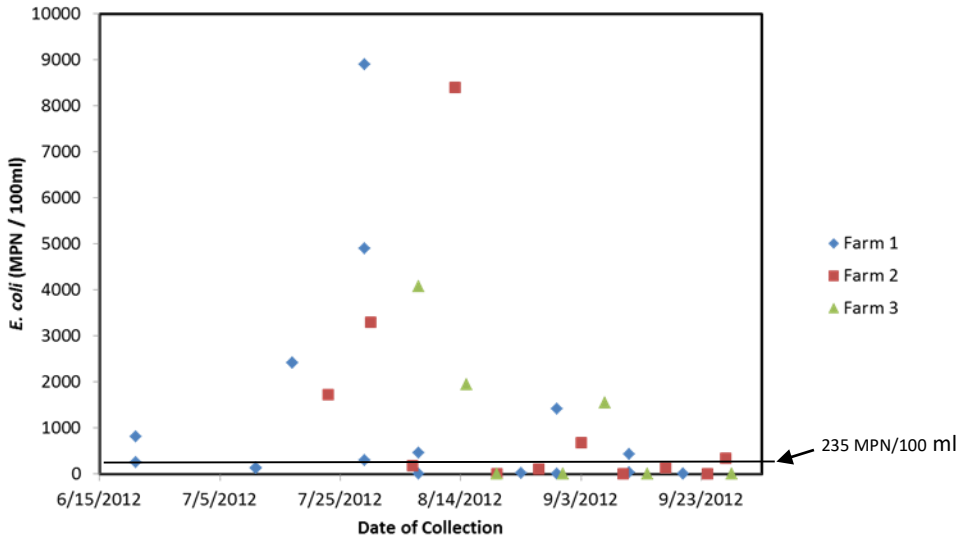
In 2012, with funding from the Vermont Agency of Agriculture, the research team collected bi-weekly water samples. Sampling took place from mid-June through mid-September on three commercial farms. In 2013, with funding from USDA Risk Management Education, the study team collected weekly samples, from mid-June through mid-October on four farms. Two of the farms had also participated in the 2012 sampling. In both years, all samples were taken from leafy greens washing systems. All farms had used composted manure to improve soil fertility, and all farms had an un-chlorinated but potable water supply for washing vegetables.

In 2014 growers were recruited to sample leafy greens wash water on their farms and submit samples for analysis using pre-paid mailers. Forty-three farms submitted a total of 80 paired water samples from a variety of leafy greens washing systems. The sample pairs represented a first wash and a 'final' wash that was the last in a series of multiple washes, a sanitized wash, or a combination. Twelve farms tested once (12 test pairs), 31 farms tested twice (62 test pairs) and 2 farms tested 3 times over the season (6 test pairs).

The Vermont Department of Health Laboratory performed the water analyses in all 3 years.

Results. In 2012 we found E. coli levels in the first wash on each farm varied greatly. High levels of E. coli were present in many of the samples, especially in mid- summer (Figure 1).

Figure 1. Level of generic E. coli in leafy greens in untreated wash water on three farms, after one wash in 2012. 235 MPN/100 ml represents the maximum E. coli level set by the State of Vermont for recreational water use.



Although E. coli was sometimes low or absent in the first wash water, in about half the samples the level of generic E. coli exceeded the recreational water standard of 235 MPN/100 ml. High E. coli levels were not predicted by appearance of the water. Whether water looked clean or dirty (turbid) did not appear to indicate how much E. coli it contained. On all three farms, the level of E. coli in water was greatly reduced by multiple washes and/or addition of sanitizer (Table 1.)

Table 1. Percent reduction of generic E. coli by number of washes and/or sanitizer treatment compared with a single wash on three farms in 2012.

	Double Wash n=18	**Triple Wash n=18**	**Full Rate Sanitizer in First Wash n=18**	**Half Rate Sanitizer in First Wash n=8**	**Half Rate Sanitizer in Second Wash n=10**
Minimum	73.9	94.9	96.9	79.9	96.3
Average (mean)	90.9	97.5	99.8	90.8	98.7
Maximum	98.8	100	100	99.8	99.9

In 2013, as in 2012, we found that either addition of sanitizer and/or triple washing proved effective in reducing E. coli levels in wash water. Double washing was not as effective as either of these treatments, but still reduced E. coli compared to an untreated single wash (Table 2.)

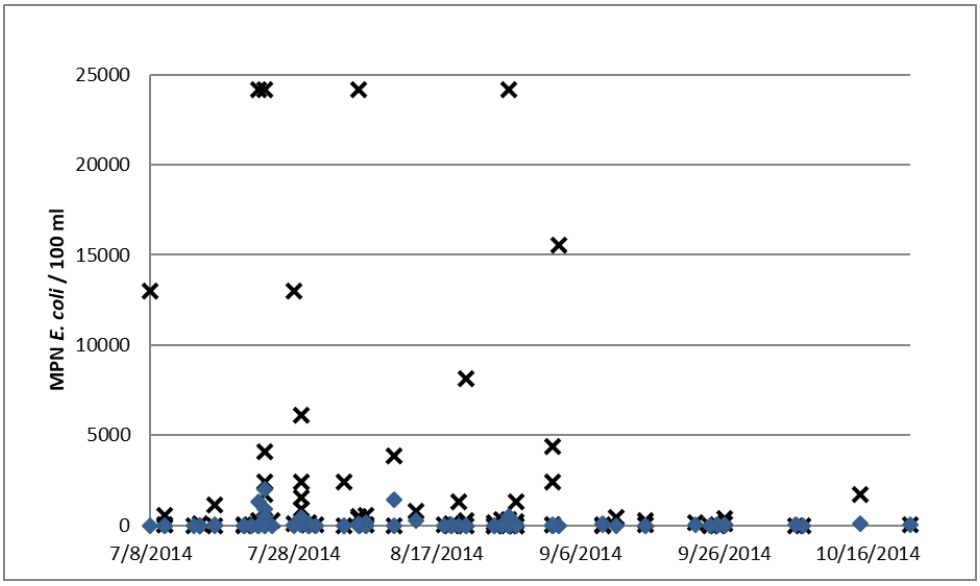
Table 2. Percent reduction of generic E. coli by number of washes and/or sanitizer treatment, compared with a single wash. Data combined from three farms in 2012 and four farms in 2013.

	Double Wash n=33	**Triple Wash n=33**	**Full Rate Sanitizer in First Wash n=53**	**Full Rate Sanitizer in Second Wash n=9**	**Half Rate Sanitizer in Second Wash n=21**
Minimum	56.6	89.6	55.3	98.1	94.6
Average (mean)	90.6	98.0	99.1	99.6	99.5
Maximum	100	100	100	100.0	100

In 2014 across all 43 farms with a variety of washing systems there was notable reduction in generic E. coli in wash water after multiple washing and/or use of sanitizer, compared to a single untreated wash (Figure 2.) There were some instances of very high levels of E. coli measured in the first wash on a few farms, over 20,000 MPN/100 ml. Conversations with growers from these farms about the high levels of E. coli in their wash water did not point to an obvious source for the contamination, such as wildlife observed on the farm or application of raw manure.

When farms with very high levels of E. coli in the first wash used a full rate of sanitizer, the levels were typically reduced to zero, but when a triple wash was used without sanitizer the E. coli levels were reduced, but not always to zero. This suggests that while triple washing can be effective at reducing E. coli in wash water with low incoming loads, it may not be sufficient for higher levels of incoming E. coli in wash water.

Figure 2. Incoming load of generic E. coli in first wash (X points) and the load of generic E. coli in the 'final' wash (diamond points) on 43 farms in 2014. Data combines all types of washing systems and treatments used.



Testing wash water for generic E. coli can help determine if a vegetable wash system is effectively reducing E. coli levels and thus the risk of cross contamination. Growers can obtain test kits from their state health departments or other accredited laboratories. In Vermont, the Department of Health offers an agricultural water test kit for $15. However, the water sample must arrive within 24 hours of collection so an overnight shipping cost may be incurred. Instructions provided by the lab should be followed to avoid contamination during handling.

In addition to testing the source of wash water at the beginning of each growing season, we recommend testing both the incoming load of E. coli in wash water (after the first, untreated wash) and the final load of E. coli in "used" wash water (after the last wash, and/or after addition of sanitizer). Testing is especially important in the summer months, when E. coli levels are most likely to be high. Testing multiple times each year, on a regular schedule, will provide a farm with information about the effectiveness of their wash system for avoiding cross contamination.

Good vegetable wash water management is one important part of an overall produce safety plan. For more information on brands, rates, and cost of wash water sanitizers, see this UMass fact sheet: https://ag.umass.edu/vegetable/fact-sheets/produce-wash-water-sanitizers-chlorine-paa