Applied research for improved Post-Harvest Produce Washing

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The most recent estimates indicate that there are over 81 million instances of food borne illnesses in the USA annually, with an estimated cost of $152 billion dollars per year (1). Furthermore, the Center for Disease Control (CDC) has estimated that between 1998 and 2008, at least 46% of foodborne illnesses were due to produce (2). Water is one of the attributing sources of contamination on-farm and needs to be managed to reduce food safety risks. The upcoming Produce Rule mandated through the Food Safety Modernization Act of 2011 will include regulations pertaining to agricultural water. However, while proposed food regulations will require increased food safety practices, there is little guidance in complying with these upcoming regulations. UMass Food Science Extension has been working to identify best practices for postharvest produce washing.

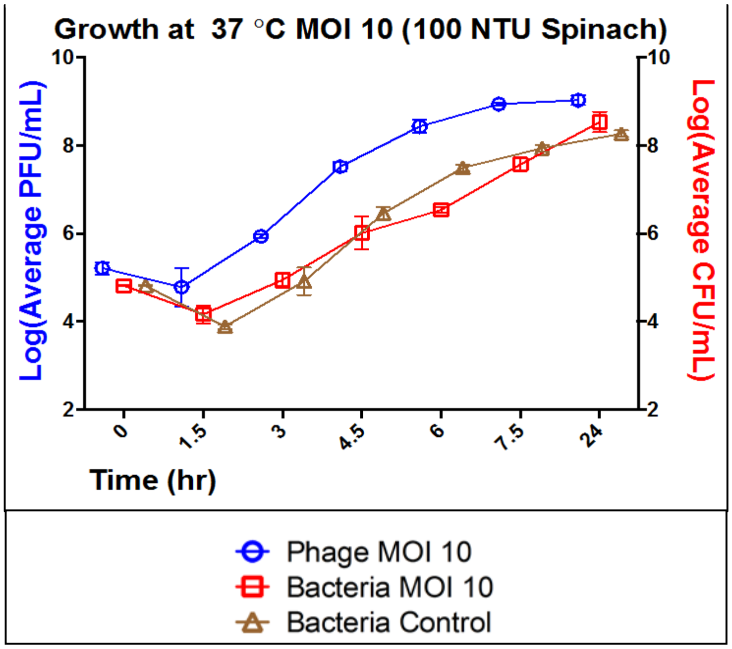
Quality Control: The use of sanitizer in produce water has been demonstrated to be effective in reducing water contamination. Research using bench top sampling of model wash water with the presence of *E.coli 0157:H7* with as little as 1.2ppm of chlorine has shown to be effective in reducing microbial loads. We have also conducted evaluations on commercially available quality controls to assess scale approprioate monitoring tools to ensure proper sanitizer concentrations. In one study we evaluated and compared two commercially available portable Oxidative Reduction Potential (ORP in millivolts) meters and a three types of free chlorine test strips as an on farm quality control tool to monitor process wash water sanitation. The quality controls were evaluated using different types of synthetic process wash water (soil, vegetation, and vegetation / soil and challenge water) at varied turbidity concentrations that were inoculated with *E.coli O157:H7.* Results indicate that different types of wash water solutions can influence the free residual chlorine levels. Data suggests ORP range 650-800 RmV and free chlorine test strips used under low turbid wash conditions can be used as a qualitative tool to monitor the free residual chlorine levels for small farm postharvest sanitation management as a best practice for food safety (Table 1).

Commercially Available Options: In addition to chlorine based sanitizers, peroxyacetic acid based systems are regulatory compliant and have been shown to be effective. UMass has prepared a fact sheet that outlines some of the current commercially available chlorine and peroxyacetic acid sanitizers, how they compare against others in the market place and where to source them. To learn more you can go to: https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/pssanitizerlawtonkinchlasept15.pdf

New Approaches: There is a variety of research activities presently being conducted at UMass to identify new best practices for produce safety. Examples include:

- <u>Alternative Sanitizers:</u>
  - *Bacteriophage*:
    Bacteriophages are viruses that target infection within bacteria. They have been a used as a natural approach to reduce surface contamination food surfaces in meat production. We recently investigated the use of bacteriophage as a natural alternative sanitizer for produce wash water. Initial analysis indicated that bacteriophage may provide at least a 2 log reduction in *Salmonella* in broth models. However, when experiments were conducted using model wash water with and without the presence of organic load bacteriophage were not an effective sanitizer for salmonella using spinach wash water models at 20°C and 37° C or in broth solutions at 20°C.

Figure 1: Bacteriophage are not effective in reducing Salmonella in model wash water solutions.



  - *Organic Acids:* Carvacrol and lauric arginate are examples of organic acids that has been shown to have antimicrobial activity. The food science research group at UMass has developed nano-emulsified organic acids that are highly effective antimicrobials against a range of different microorganisms. Recently research utilized colloidal essential oils containing carvacrol as an antimicrobial treatment for seeds used to grow sprouts. Additional research is being further investigated for use in other produce types.

- <u>Detection:</u> Proposed FSMA Produce Rule will likely include agricultural water sampling on-farm yet most farms do not have the resources to conduct microbial analysis. UMass is researching and developing low cost, easy-to-use and capable of being conducted in low resource settings, such as on-farm. Proof of concept has been able to detect as low as 4 logs. While this technology has not yet been optimized the current progress is promising and relevant to the produce industry.

Table 1: The presence of chlorine will reduce E.coli 0157:H7 by 7 logs.

Wash Solutions	**Sanitizer treatments: NaClO (ppm)**		**Residual Free Cl (Avg HACH)**	Target: 650-800 mV		***E. coli O157:H7* ***
				ORP# 1	**ORP# 2**	
Clean H2O	Water, 0NTU	0 ppm	0 ppm	444.9 ±	455 ± 38	–
	Water, 0 NTU	50 ppm	50 ppm	679.5 ±	705 ± 47	+
Soil + H2O	Soil @ 50 NTU	0 ppm	0 ppm	520.9 ±	490 ± 43	–
	Soil @ 25 NTU	50 ppm	25 ppm	687.0 ±	699 ± 21	+
	Soil @ 50 NTU	50 ppm	50 ppm	708.2 ±	718 ± 20	+
Cucumber + H2O	Cucumber, 50 NTU	0 ppm	0 ppm	344.2 ±	315 ± 26	–
	Cucumber, 25 NTU	50 ppm	11 ppm	822.8 ±	824 ± 21	+
	Cucumber, 50 NTU	50 ppm	1.2 ppm	573.9 ±	556 ± 18	+
Cucumber + Soil	Cucumber/Soil, 50 NTU	0 ppm	0 ppm	375.0 ± 21.6	362 ± 48	–
	Cucumber/Soil, 25 NTU	50 ppm	13 ppm	764.9 ± 13.7	781 ± 18	+
	Cucumber/Soil, 50 NTU	50 ppm	10 ppm	833.1 ± 37.0	816 ± 15	+
Organic Challenge H2O	Challenge water, 0ppm Cl	0 ppm	0 ppm	220.1 ± 17.2	223 ± 24	–
	Challenge water, 50ppm Cl	50 ppm	0 ppm	209.9 ± 25.6	224 ± 31	–
	Challenge water, 200ppm Cl	200 ppm	0 ppm	211.8 ± 1.2	210 ± 1	–

* Indicates survival of ***E. coli O157:H7*** in a sample wash water solution.
(+) Reported > 7 log reduction (CFU/ml), (-) Held a microbial load > 7 (log CFU/ml)

1. Hoffmann, s., Maculloch, B. and Batz, M. Economic Burden of Major Foodborne Illnesses Acquired in the United States, EIB-140. Economic Research Service/USDA, Bulletin Number 140, May 2015. http://www.ers.usda.gov/media/1837791/eib140.pdf

2. Painter JA, Hoekstra RM, Ayers T, Tauxe RV, Braden CR, Angulo FJ, Griffin PM. Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998-2008. Emerg Infect Dis. 2013 Mar;19(3):407-15. doi: 10.3201/eid1903.111866.