Improved Stability and Availability of Free Chlorine for Processing Organic, Ready-to-Eat Produce

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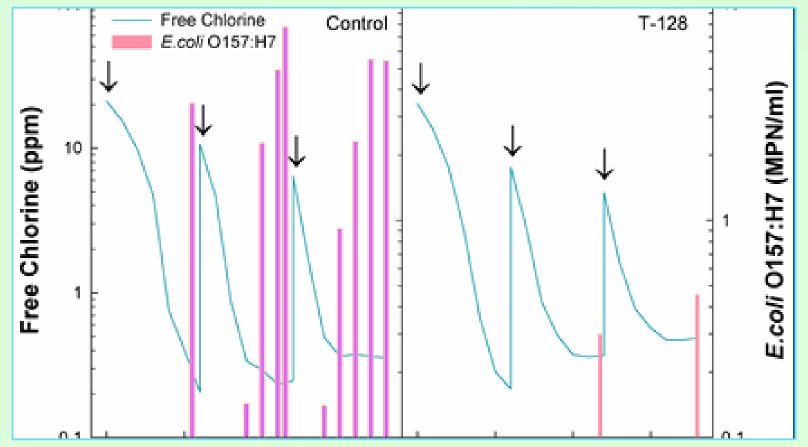
Abstract

Outbreaks of microbial food-borne illnesses have been associated with ready-to-eat produce items. Organic farming and processing practices potentially present greater risks than conventional practices. Microbial testing is a research tool for guiding ongoing constant improvement in mitigation efforts, but lacks the sensitivity for lot by lot release decisions while giving the illusion of activity. Processes that better control cross-contamination and improve lethality are needed. USDA-ARS, (Agricultural Research Service) scientists have reported that the addition of the SW (T-128) formulation of SmartWash Solutions to a chlorinated wash system significantly improves the stability and availability of free chlorine in the presence of soils and high levels of organic material, greatly increases the antimicrobial properties of a chlorinated wash system, mitigates the risk of cross-contamination and reduces contaminants at lower levels of free chlorine when compared to a traditional pH controlled chlorine solution. In pilot plant studies, using a full two-stage commercial line, the SWO formulation, also from SmartWash Solutions, was shown to have similar impacts on wash system efficacy when tested with generic E. coli on leafy greens using procedures based on the USDA-ARS protocol. The SWO formulation is OMRI listed, is compatible with organic processing requirements and is currently in use in numerous processing plants. The mechanism of action behind the patent pending SW and SWO formulations has not been elucidated but is consistent with a sequestration model that slows the reaction of chlorine with organic material while still maintaining antimicrobial efficacy.

Background

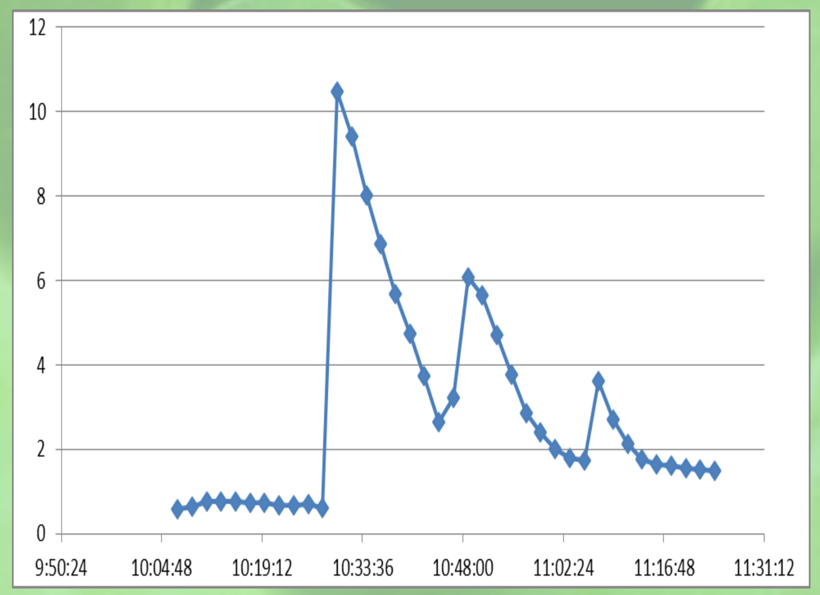
- Ready-to-eat produce lacks a strong kill step.
- Safety is dependent on the total system including GAP, GMP and other sound practices. This is especially important with more natural soil amendments.
- The incoming level of inoculum must be controlled.
- Until a wash system achieves a validated 4-5 log reduction, a wash system will not be good enough.
- The best wash system is the system most tolerant of deficiencies in the other aspects of the path from field to fork.
- This led the USDA to focus on stressing the wash system for comparisons.



The effect of T-128 (Original SmartWash formula) on recovery of E. coli O157:H7 in the process wash water after continuously washing un-inoculated lettuce with inoculated baby spinach in chlorinated water and replenishing sodium hypochlorite (arrows) From Yaguang Luo et al, “Improving produce safety by stabilizing chlorine in washing solutions with high organic loads”, CPS 2009 RFP FINAL PROJECT REPORT

Method and Approach

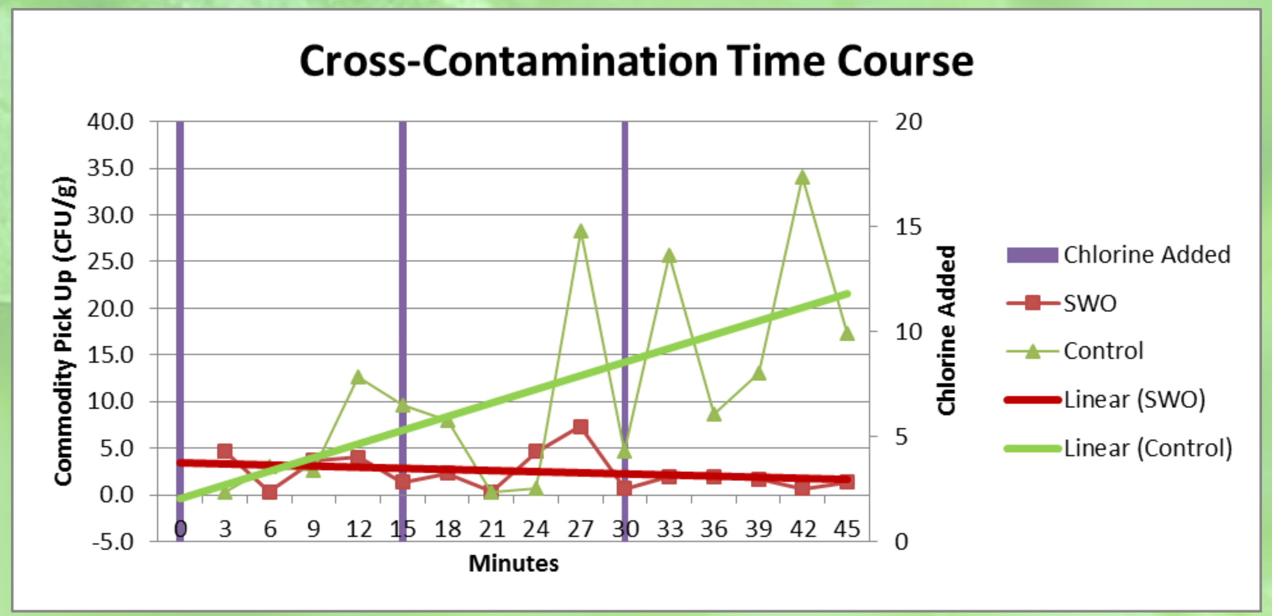
- A chlorine depletion protocol analogous to the USDA studies was used as illustrated to the right. Both water and cross-contaminated product were examined to demonstrate a system compatible with the NOP.
- The declining heights of the peaks reflect the consumption of chlorine by the organic load from the chopped romaine lettuce.
- Baby spinach was inoculated with generic E. coli at about 50,000 CFU/g which were allowed to establish themselves for about 48 hrs. under refrigeration.
- Romaine lettuce was chopped and fed into the two-stage commercial wash system at one tote every 5 minutes (about 7 pounds per min.) to capture cross-contamination and provide organic load.
- The inoculated spinach was dribbled into this stream of romaine lettuce at 60 grams per min.



- These feed rates were held constant through three 15 minute depletion cycles to create three periods of increasing stress on the wash system for each treatment.
- Three acidulants were metered in to control pH. Acidulant 1, citric acid, controlled pH between 6 and 6.5, while acidulants 2 and 3, SW and SW^O respectively, were metered to control pH to 3-3.5 in the Primary and pH 6 to 6.5 in the Secondary. Citric acid was not used at pH 3.5 to avoid outgassing without the stabilizing effects of the SmartWash chemistry.
- Samples were periodically taken from the exit of the Primary (1°, highest organic load) and the Secondary (2°, lower organic load)

Results and Discussion

- SW^O reduced cross-contamination of chopped Romaine lettuce by spinach inoculated with generic E. coli in this depletion study. (p ~ 0.007) as illustrated in the figure to the right.
- The cross-contamination with SW^O shows no trend with time (p~0.33) while cross contamination with citric acid increases ~1.5 cfu/g per three minutes (p~0.015) indicating that the cross-contamination is significantly more pronounced as organic load increases in the wash water from the product.
- If one were to super impose the cross-contamination (right) results over the chlorine time results (above) one would see a breakpoint where cross-contamination begins to increase at about 2 ppm. This is only an observation at this point and should be evaluated more directly for a validated process.



- The table to the right illustrates the generally low recovery of organisms from the wash water, irrespective of the adjuvant.
- The only recovered E. coli, the inoculum in these studies, was recovered from the primary tank for the citric acid control. No E. coli was recovered from either SmartWash SW or SmartWash SW^O.
- The background flora in the citric acid control was greater than either the SW or SW^O as measured by coliforms and HPC. These bacteria presumably were derived from the product used in the study and indicate lower antimicrobial activity for the citric acid system. Direct lethality data not reported here supports this observation.

Location	Coliforms MPN/100 ml			E. coli MPN/100 ml			HPC CFU/ 1 ml		
	< 1	< 5	>5	< 1	< 5	>5	< 1	< 5	>5
Citric 1°	5	2	5	10	1	1	2	4	6
Citric 2°	4	5	3	12	0	0	8	3	1
SW 1°	8	1	3	12	0	0	5	4	3
SW 2°	12	0	0	12	0	0	7	4	1
SW^O 1°	10	1	1	12	0	0	8	4	0
SW^O 2°	10	1	1	12	0	0	10	1	1

These studies were done under stressed conditions. The inoculation levels were very high compared to those expected in a processing facility. The chlorine was purposefully depleted to observe failures. Such conditions should never occur in a plant. Conditions that mitigate the cross-contamination observed in these studies should provide a margin of safety when used as guidance for commercial practice in the absence of better data. Direct measurement of the observed 2 ppm breakpoint under various inoculum stresses would be desirable.

The data strongly supports that SW^O is an effective adjuvant. However, extrapolating to all situations is a great leap. For instance, these studies used a relatively concentrated level of E. coli on the spinach. One must question whether the cross-contamination potential would be the same with twice as much spinach at half the load or whether it would be closer to twice as much because the controlling factor is the surface area bearing the inoculum. Spinach is the most difficult leafy green to sanitize but ranking as a carrier for contaminating other greens is unknown. However, SW^O is in widespread commercial use without problems. This reduces the concerns associated with these questions.

Conclusions

A wash system with SmartWash SW^O, an NOP compliant wash adjuvant, is:

- more effective at controlling cross-contamination than a system using citric acid as an acidulant.
- more likely to control cross-contamination as organic load builds in the wash system than a system using citric acid as an acidulant.
- observed to mitigate cross-contamination to about 2 ppm chlorine.
- able to better control background flora in wash water than a wash system using citric acid.

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