Key Learnings from CPS Wash Water Symposium

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On January 22, 2013, the Center for Produce Safety (CPS) conducted a seminar on postharvest water disinfection. This event had its roots in the June 2012 CPS Research Symposium and a series of research reports from funded scientists describing the variables that must be controlled to insure proper wash water quality in produce operations. In light of recent produce related disease outbreaks where improper wash water management may have been a contributing factor and stakeholder inquiries regarding the efficacy of disinfectants and proper monitoring protocols, CPS conducted the seminar to highlight relevant research data, provide a forum for discussion on key issues and stimulate produce industry thinking on effective management methods. The discussion sessions were far-ranging and thought provoking and a number of key learnings and industry needs were identified. The following are my take-ways from the meeting shared here to assist you in developing your own food safety programs:

1. **It's not just wash water**. The concept of water disinfection is much more than just a question of treating wash water. In postharvest operations, water is frequently used in the produce industry to convey raw products from harvest containers onto sorting lines, cool product via direct contact with chilled water or make ice used to cool products in addition to washing whole or cut produce.

2. **The use of a disinfectant does not "sterilize" the product; they prevent cross contamination**. Disinfectants are used in water that contacts produce to prevent cross contamination and not necessarily to kill microorganisms that might be present on the surface of the fruit or vegetable. If water is not properly treated with active disinfectant, after a period of time the water could become a source of contamination for any fruits or vegetables that are conveyed, cooled or washed in it. Therefore the primary reason for treating water with disinfectants is to keep the water clean of microbial build up. In most systems the level of microbial reduction on the surface of fruits or vegetables is generally thought to be 1-2 logs.

3. **It is important to know how your disinfectants work and how to measure their presence**. An operator needs to understand the chemistry of the disinfectant you chose to use in your systems. For example, if chlorine is used as a disinfectant, the commercial chemical sodium hypochlorite disassociates in water to hypochlorous acid (HOCl) and hypochlorite (OCl^-) ion. Together these are called "free" chlorine, but the hypochlorous acid is really the "active" moiety with hypochlorite ion being 80% less effective as a disinfectant. It is also important to understand the impact of pH on the activity of a disinfectant. If pH is decreased, the proportion of active hypochlorous acid is increased thereby increasing the "active" chlorine in your system. Indeed, at a pH of 6.5, 95% of the total chlorine is active hypochlorous acid whereas at pH 8.0, only 20% of the total chlorine is active hypochlorous acid. Chlorine will also interact with organic compounds in the water to form chloramines which are reflected in measures or "total" chlorine but are, themselves, ineffective disinfectants. So while it is important to understand the chemistry of your disinfection system, it is also important to recognize appropriate verification measures to insure you are correctly determining the concentration of disinfectant available in the water.

4. **Know the difference between critical control points and operational limits**. As an industry, we are familiar with the concept of Hazard Analysis Critical Control Point and many of our operations have well developed HACCP programs in place. With HACCP, it is important to identify Critical Control Points (CCPs) and define critical operational limits that are measurable and controllable. It is equally important to develop operational set points so that the process is not permitted to drop below the critical limit. For example, if a critical limit for a disinfectant in a wash system is determined to be 10 ppm of, then the operational limit should be set at >12 ppm to insure that action can be taken prior to the critical limit being reached. In this way, the process stays within the limits established and the product is never subject to conditions outside those limits.

5. **Know the terminology and how to properly employ it in developing your own food safety programs**. Validation and verification are not interchangeable terms though we often see confusion when these terms are used. Validation is an experimental activity that demonstrates the controls put in place achieve the goals an operation establishes for their systems under conditions reasonably likely to occur during processing, cooling or conveyance. Validation data can be developed via the scientific literature, lab-scale experimentation and in-plant testing. Verification refers to ongoing activities to measure that the validated process is operating according to the parameters established via experimentation and testing. With the release of the proposed Preventive Controls rules by FDA in January 2013, these terms are moving to the forefront of our industry conversations. FDA is proposing that an operation validate and retain the data from the validation studies to show that any preventive controls put in place actually are effective in preventing cross contamination. FDA further proposes that operators verify that the process is conducted within the validated protocols and set points.

6. **The efficacy of disinfectants must be determined in the context of a multivariate system**. We often see the "killing" potential of various disinfectants and sanitizers described as if pathogens exist as single cells dispersed in fresh water. The reality is that water used to cool, convey or wash produce is rarely crystal clear and water composition can change based on regional differences, sources, commodities being treated and the equipment being used. It is therefore important to examine the effectiveness of water disinfection treatments with full knowledge of the variables that can impact efficacy. These might include: pH, temperature, salinity, dissolved organic materials, crop debris, soil, product demand, turbidity, agitation, contact time, product to water ratios, initial water source, etc.

7. **It is never as simple as it might seem**. Indeed, we know that pathogens can exist on plant tissue surfaces (or on process equipment) as constituents in a complex matrix known as a biofilm. Biofilms may be composed of naturally occurring microflora and be of no particular food safety consequence unless a contamination event occurs and pathogens become part of the biofilm. Biofilms can form very quickly; sometimes within hours of the contamination event, and many disinfectants and sanitizers do not penetrate the biofilm. In other words, the biofilm can serve to "protect" the pathogen from the oxidizing effects of many chemical sanitizers. The produce industry has constructed food safety programs that originate in the field to prevent contamination from ever occurring. It is important to note that while effective microbial control in water that contacts edible portions of a crop is a vital element of any food safety program; current water disinfection systems cannot eliminate established pathogens from product surfaces.

8. **Educate and train employees**. It is important for operators to emphasize personnel training. There are a number of university and industry vendor resources available to help operators develop training programs. Training needs to be conducted on multiple levels to reflect positions of authority. In one discussion session, a large processing company shared that they were developing a "wash system operator" position so that knowledgeable, well-trained staff was available on each shift to insure the systems were operated within set limits at all times. In essence, the concept of creating subject matter experts within individual operations was seen as an important step toward insuring proper water sanitation execution. It is important to develop specific SOPs for system operation and there may be a need to create basic templates that operators could use to model their documentation after.

9. **System design must be considered**. The wash, conveyance, or cooling system must be designed properly to insure proper water quality. Systems must be designed for the proper capacity so that product is loaded onto the system evenly to maintain optimal water to product ratios, i.e. the system is not overloaded so that the amount of disinfectant is overwhelmed by organic or microbial load. Other parameters may include: aeration and agitation, product contact time with the water/submersion, make-up water rates and countercurrent water flows. It is also important to engineer systems so that measuring probes are positioned properly, i.e. not right next to where sanitizer is added to the system. System calibration and proper maintenance of detection equipment is also essential.

10. **There is still much to be learned**. While our technical knowledge of water disinfection has improved in recent years, there is still much to be learned. We have a tendency to just want "somebody to tell us what to do". For example, several times during the breakout sessions, participants asked, "If I maintain 10 ppm chlorine, will I be ok?" The data that we have points toward each system needing to be evaluated on its own merits based on several variables already listed here. It is clear that for some systems and products 10 ppm of active chlorine would be a sufficient critical control point while in other system configurations with other products it may not be. The discussion around future research needs was valuable in so far as it was used in constructing the 2013 CPS request for proposals. The produce industry clearly needs a collection of pathogen surrogates that can be used for validation studies, a framework for designing validation studies and a mechanism for collecting and sharing industry data as a learning tool. There was also considerable discussion around the need to develop a protocol that can be used to compare different disinfectants. There are an increasing number of commercial products available and often operators are not sure how to reconcile product claims regarding efficacy.