CENTER for PRODUCE SAFETY

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Key Learnings from Second Annual CPS Symposium in Orlando, FL

Davis, California. August 10, 2011 -- On June 28, 2011 the Center for Produce Safety (CPS) held its second annual Produce Research Symposium in Orlando, Florida. The symposium featured the presentation and discussion of sixteen CPS-funded research projects from eight different institutions, and the display of 22 research posters providing updates on CPS-funded research projects. For the first time, the poster session also featured 5 posters depicting FDA research projects on food safety in produce. The abstracts for these research projects and posters can be found on the CPS website: www.cps.ucdavis.edu. The key findings presented are the impressions of Robert Whitaker, PhD, CPS Technical Committee Chairman and Chief Science and Technology Officer of the Produce Marketing Association. Comments and feedback from the CPS Technical Committee are included in the key learnings. In conjunction with CPS's ongoing mission to translate research, we have provided a glimpse of the key research findings, discussions points, observations and highlights from the symposium.

1. **More resilient wash water chemistries are emerging**. The commercial product, T128 is representative of the "next generation" of chemical wash water sanitation systems. The data generated thus far indicates T128 may act by preserving or "protecting" active chlorine under conditions where increasing organic loads in wash water systems would normally deplete chlorine. In effect, T128 may act as a "safety net" by providing operators protection from cross contamination. Over time, as organic load builds in wash water using traditional sodium hypochlorite wash water treatment, the amount of active chlorine sanitizer decreases owing to interactions with organic materials. This condition may permit pathogens, if present, to survive in the wash water and cross contaminate the produce as it moves through the system. T128 works by protecting active chlorine as organic loads increase thus diminishing cross contamination risks. While preliminary work has been performed using leafy greens experimental systems, it bears watching to see what applications T128 may have with other commodities.
2. **Organic load is a critical factor in wash water systems**. Aqueous chlorine dioxide (ClO_2) has been adopted as a wash water sanitation approach for several fruit and vegetable wash systems; including tomatoes. However, on-site surveys conducted in tomato flume systems and dump tanks show that high organic loads that build up specifically in tomato dump tank water over time severely impact an operator's ability to maintain 1≥≤3 ppm ClO_2 as mandated by current T-GAP metrics. This challenge is a shared concern in many dump tank systems with other commodities. It is critically important to monitor non-product organic load in wash water to ensure proper levels of sanitizers are available to prevent cross contamination. Practical steps to reduce vine and leaf trash at harvest would help minimize the rapid rate of antimicrobial oxidizer loss.
3. **We may need to re-think our use of ORP as a measure to verify a preventative control**. Oxidation reduction potential or ORP has been used in the produce industry for several years as an indirect, single-value measure of active chlorine in wash water systems. Higher values, measured in millivolts (mV), reflect a stronger antimicrobial status of the water. In-line or portable sensors are relatively inexpensive and provide real-time values that operators can use to make automated or manual adjustments for pH and chlorine addition to the wash system. While it has been well understood that ORP does not directly measure active chlorine in wash water or dump tank systems, the relative ease of using the system to approximate wash water status and availability of validation study data in diverse systems has resulted in operational acceptance. Data presented at the Symposium indicate that ORP does not always adequately

describe levels of active sanitizers or the associated reduction in microbial loads in water. Accurate measurement and sensor-controlled response time can be confounded by temperature and complex inorganic or organic materials in the wash water. Indeed, data were presented that show ORP levels that meet specifications while actual measures of sanitizer fell well below desired levels.

4. **<u>As more research on wash water systems emerge, industry practices will change to reflect our increased knowledge</u>**. The research presented on tomato wash water systems (points 2 and 3) represents the natural progression in the development of effective food safety practices. Industry's well-intentioned efforts to set measurable parameters for tomato wash water and dump tank systems were based on the best-available data and technical innovation. As the industry and the research community fill information gaps, more effective dump tank options and wash water sanitation systems and monitoring devices will emerge. Current industry practices include co-treatment of the dump water with other approved antimicrobial formulations to compensation for the limitations that are being determined for a single chemistry approach.
5. **<u>A "brush-bed wash" system for tomato washing may hold promise</u>**. Validation data was presented using a lab-scale "brush-bed wash" system for round tomatoes. The system uses a combination of roller brushes and a water spray containing a sanitizer to clean and sanitize tomatoes. The two-step combination of a physical brushing and a water/sanitizer spray (25 to 100 ppm) was shown to result in a >3-log reduction in surface microbes. This pilot-scale process also may mitigate the risk of cross contamination compared to water-bath systems where tomatoes are floated in water that may have high organic chemical loads. Obviously, a great deal of testing still needs to be done from both a scientific and operational perspective to validate this "brush-bed wash" approach.
6. **<u>Validation is an important concept for the produce industry to consider as we implement preventative controls</u>**. As a result of *Salmonella* contaminations associated with almonds, the almond industry implemented procedures designed to achieve a 4-log reduction of *Salmonella enteritidis* P130. Research results presented at the Symposium validated that the prescribed methods for almond storage, moisture level and roasting temperatures are indeed effective in achieving 4-log reductions. In a broader sense, these data also demonstrate the importance of validating the effectiveness of preventative controls using science and experimentally-derived data.
7. **<u>Zero- valent iron holds promise as a water purification system</u>**. Preliminary results describing water purification via the use of scrap iron and sand filters might provide a low cost method to remove contaminants from higher risk irrigation water sources, e.g. surface water sources. When iron fragments are stratified and separated by sand layers, water can be passed through this "filter." It has been shown that *Salmonella* and *E. coli* O157:H7 mixed into the water is bound by the iron, and in some cases, inactivated. While there remains considerable work to be done to translate lab-scale experiments to operationally practical irrigation water purification systems, the technology holds promise as zero energy and renewable method to reduce pathogen contamination. As discussed at the Symposium, the quality of agricultural water is a global issue and perhaps the approach of employing zero-valent iron may provide a solution.
8. **<u>Attenuated *E. coli* O157:H7 does not survive in Salinas Valley production environments</u>**. Similar to data presented at the first CPS Research Symposium, experiments employing attenuated *E. coli* O157:H7 applied to soil or spinach leaves demonstrated that the pathogen does not survive well under in-field environmental conditions. These data clearly point out the importance of performing risk assessments on fields prior to harvest as potential contamination events closer to the time of harvest may be of a higher priority to identify than events further from harvest. Interestingly, attenuated *E. coli* O157:H7 inoculated into organic fertilizers or contaminated plant materials disked back into the soils, can survive for extended periods of time. Association with organic materials in the soil seems to aid survival. This will be an important area of research to continue to follow.
9. **<u>Produce industry data has "stories to tell."</u>** The produce industry currently collects vast amounts of food safety related data every day. This data runs from food safety audits to water testing and sanitation

verification to product testing data. While there are a number of challenges (e.g. protection of proprietary information) the data collective by the industry may provide valuable insights that could inform risk assessment and management and guide future research. However, aside from breaching the hurdle for protecting the proprietary nature of some of this data, it will also be important to access not only the raw data itself, but also be able to evaluate the contextual observations that go with it to identify priority risk factors and future research needs. Once key risk factors are better understood, and confirmatory research conducted, effective risk management strategies can be developed. The produce industry needs to continue to work toward the development of mechanisms to make food safety data available to the research community.

10. **Plant genetics and physiology may play a role in pathogen survival**. Two research programs hinted at the role plant genetics may play in pathogen contamination and survival on spinach leaves and tomato fruits. Historically the industry and the research community have focused on a better understanding of the growing environment, pathogen vectors and the genetic and physiological attributes of the pathogen. The data presented on *Salmonella* survival on a broad collection of tomato varieties and *E. coli* interactions with slow and fast-growing spinach leaves may indicate that the genetic and physiological state of the plant may also impact survival of pathogens on plant surfaces. It is unclear whether it may be possible to select for genetic resistance to human pathogens in the future, but a better understanding of plant/human pathogen interactions will help inform future research and risk management strategies.
11. **There is still much to be learned about norovirus and produce**. The Centers for Disease Control (CDC) ascribes a high proportion of foodborne illness to norovirus. Data was presented at the Symposium that indicates norovirus can be taken up into plant tissues. These experiments were conducted using very high inoculum levels under laboratory conditions that may not actually reflect field or process-level conditions. These experiments also suggest that the norovirus may survive for up to five days in plant tissues. Clearly much more research is required in this area to better describe the risk norovirus represents to fruit and vegetable production.
12. **Microbial populations on Romaine leaves (phyllosphere) may be used to determine if conditions support or antagonize pathogen survival**. We sometimes fail to realize that the surfaces of fruits and vegetables support a vibrant and essential microbial community. The microorganisms that live on plants often provide protection against harmful plant pathogens and can often provide digestive benefits to humans who consume fruits and vegetables. At the 2010 CPS Symposium we heard how these microorganisms that live on Romaine lettuce, termed the “phyllosphere” may be used as a predictive index. Some populations of bacteria on the leaves may indicate that the conditions exist to support human pathogen survival (e.g. *E. coli* O157:H7). In other cases, certain bacterial groups might be an easily ranked index for environmental conditions unfavorable for human pathogen survival or shown to be antagonists for pathogen survival. Data presented in 2011 indicate that the indexing concept may indeed be valid as correlations were shown to exist between specific bacterial species in the Romaine lettuce phyllosphere that support or antagonize the survival of a plant pathogen *Xanthomonas campestris*. Identification of indicator species for E. coli O157:H7 was not successful within the scope of these experiments owing to the fact that samples positive for this pathogen were not found. Additional research is required to confirm the value of this approach in predicting the potential survival of contaminating human pathogens.

Outside of these important research findings and trends, it was also very apparent that CPS provides a unique opportunity where prominent food safety scientists can come together with the produce industry and regulatory experts to conduct research projects that address the specific and practical needs of the industry. The data generated from these programs can be used by the industry to permit more effective risk assessments and to develop validated risk management tools.
