

Minimizing Risk in Multiple-Use Containers

Reusable plastic containers for shipping fresh products pose a risk of contamination from ineffective washing and sanitation processes | BY Trevor V. Suslow, PHD; University of CA, Davis

Dedicated food safety professionals do more than manage their company's risk by becoming skilled at passing audits. Nowhere is this more true or needed than in the fresh produce industry. Whether raw agricultural commodities (RAC), minimally-processed fruits, vegetables, or other edible horticultural crops (hereafter collectively called *fresh produce* for simplicity), assessing hazards and defining both risk potential and risk exposure have become an evolving and expanding systems-based focus in food safety planning. In anticipation of the final rules fulfilling provisions of the Food Safety Modernization Act (FSMA), produce-buying customer specifications, and global standards for prerequisite programs, a deeper analysis of diverse system inputs as sources of contamination and cross-contamination is being applied across the supply and marketing chain.

Without question, this increasing recognition that the "devil is in the details" may be attributed to the numerous recalls of RAC and minimally-processed produce in recent years. These recalls, often encompassing multiple lots, several weeks of production or entire seasonal shipments, are largely triggered by detection of foodborne pathogens in random testing programs. Distinct from the goal of preventing unknowing shipment of adulterated produce that may result in consumer illness or outbreak, minimizing the potential of positive outcomes from internal or external finished product testing for pathogens has prompted the industry to seek risk reduction measures in under-evaluated system components. In 2014 alone, we can identify more than 18 non-outbreak recalls of diverse fresh produce and tree nuts as the result of the identification of pathogens, including shigatoxin-producing *E. coli*, various *Salmonell*a serovars, and *Listeria monocytogenes*, on product introduced to interstate commerce. The full economic impact ripple effect of these incidents, from suppliers to receivers in foodservice and retail outlets, can be substantial as evidenced by the large recall of California stone fruit during the summer of 2014. Other recalls and actual outbreak incidents just before and, especially,

closely following the various Listeria associated recalls have activated a broad *call to action* within the industry not experienced since the 2006 *E.coli* outbreak on spinach and among the cantaloupe category during and following the 2011 *L. monocytogenes* outbreak originating from a single Colorado shipper.

An expanding view of Food Contact Surfaces (FCS)

Driven by this increasing concern applied to the expanding view of system control points and presumptive contamination transfer surfaces, practices associated with food safety assurances applied to multiple-use containers are being scrutinized. In the fresh produce supply-chain, multiple-use containers encompass many different types of containers, fabrication materials, and system uses. Multiple-use containers may be divided into two broad categories based on ownership and control of the containers. Simplistically, these include exclusively internal (closed-loop) systems or multiple-user pool system containers with limited traceability and knowledge of prior use-history, potentially among many international shippers and receivers. An additional category of concern is the widespread practice of single-use produce packing containers that are handled as reusable containers and find their way into both interstate commerce and local-grown produce which is direct-marketed. This topic will be covered briefly later in this article.

Each of these forms of multiple-use containers fit appropriately into any system analysis of food contact surface cleanliness and sanitation programs. The uncertainty of the potential for diverse primary and secondary use of these containers to serve as vectors of contamination, within and among lots, does not negate the necessity to include their consideration in a comprehensive preventive control program. Whether an internal, closed-loop system or a pool-system of reusable units, these containers intended for multiple-cycles of use with fresh produce may contact product directly during practices which include;

- Harvest accumulation for subsequent postharvest handling within the containers or after transfer to a sort-grade-packing system (may include pre-packing quality and decay control treatments—immersion or floatation removal from containers --cooling-- chilled or heated wash -- refilling quality and size-sorted produce into original or different containers – short pre-shipment storage or longer hold times in cold storage followed by shipping in the same containers or packing from larger bulk containers into final shipping containers)
- Harvest accumulation for subsequent postharvest handling within the containers following a similar process flow as above, though generally fewer steps, and direct shipment to fresh processors or foodservice and retail receivers
- Harvest and direct placement in final shipping containers for display-ready presentation at retail point-of sale (typically only air-cooled with no direct application of water for quality or wash-cooling treatments)
- Postharvest accumulation of various quality and size grades, following handling by above treatments, for subsequent packing in single-use or reusable shipping containers. This packing is typically a combination of corrugated fiberboard cartons and reusable plastic containers (RPC)

In addition to direct FCS interactions with fresh produce there is the likely potential for indirect transference of contamination from external container surfaces during stacking but more broadly by water transport. Soil, non-product organic matter (e.g. leaf matter, non-crop vegetation, decayed or damaged crop), and other foreign objects may be introduced into water dumps and flumes in recirculating wash or cooling systems, onto dump tables and spray-brush beds and conveyors during harvest container inversion. In some systems the reusable harvest container, which may be wood or plastic, is introduced into a flotation tank or pool to gently release the produce to a water conveyance system to minimize bruising and other forms of injury. These container-adherent potential sources of contamination are often acquired in the produce field or orchard. Adhering soil and some of the non-product organic matter is impacted onto multiple crevices on the footings, corners, bottoms, and sides of containers, most pronounced with RPC, if placed directly on the soil of row crops the orchard floor. In water-based postharvest handling systems, there is the high risk potential for any microbiological contamination to be broadly spread among multiple containers in a single lot and among multiple lots if the water quality is not maintained under high process control standards.

In a closed-loop system, these containers are typically cycled back into harvest operations, which may involve a single grower or farm location or be co-mingled and distributed to multiple farm locations and among multiple growers. Invariably, these are dedicated use containers that only hold produce. In pool-system RPC use, these containers are shipped to a processor or retail distribution center and ultimately consolidated and shipped back to a RPC-owner depot for distribution back directly to a growers harvest location, shipping yard, or to a secondary container distributor. Regionally, these may be commonly used or reserved for produce packing but many pool-RPC pass through many non-produce operations as well.

The challenge of cleaning and sanitizing multiple-use plastic containers

For growers and produce handlers with a closed-loop RPC system for harvest and wash-cooling operations, it is fair to expect that full responsibility for meeting expectations for FCS cleanliness between cycles-of-use resides with that company. In this regard, many of the questions that arrive at my desk are seeking Best Practice guidance for sanitizing of harvest totes and bins and appropriate schedules for routine and deep cleaning. This is not a new subject matter for the produce industry, especially in the tree fruit category, as problems' arising from cross-contamination with postharvest decay microbes, primarily fungal pathogens, has been a longstanding issue. As with more recent concerns for human pathogen transference, this carryover contamination is generally an implementation barrier rather than a lack of evidence and protocols for proper cleaning and sanitation or disinfection with available chemistries'. For the purpose of this article, the focus will be on plastic/polymer containers, intentionally avoiding the issue of wood bins and wire-bound wood crates that become multiple uses packing and shipping units. There are relatively few current studies that provide cleaning and sanitization validation data and address the establishment of a Master Sanitation Schedule for multiple-use plastic containers with much more than a finger-in-the-wind best guess. Naturally, in the absence of hard data that covers a multitude of conditions and practical logistics and harvest/shipping unit availability, there is a wide range of management schemes that are rigorously or more loosely followed within each company. In many operations, practical inabilities to allow adequate

time for complete drying post-washing, originally to minimize the issues of fungal decay spore germination during refilling with produce, the standard practice is a simple bin or tote inversion to clear most adhering soil and leaf trash. More recently this has been retained due to concerns for residual moisture, in produce operations meant to remain dry, elevating the risk of survival and growth of pathogens such as *Salmonella* and *L. monocytogenes*. In these cases, cleaning and sanitation is typically conducted between seasons. In both wet and dry applications it is common, but not uniform, that single-use polymer liners are placed inside of multiple-use harvest and shipping containers to alleviate the concern for incomplete or inadequate sanitation options.

For growers, handlers, and shippers that use RPC, for direct field-pack or packing post-cooling, washing, and grading steps, there has always been an inherent understanding and expectation that these pool-system units would be delivered between each use in a clean and sanitary condition. Whether using pool RPC by preference or to conform to customers' requests and requirements, suppliers have point to a lack of control and knowledge of the cleaning and sanitizing practices by the central RPC provider. Produce quality and safety specifications derived primarily from buyer mandated criteria have expanded, especially over the past 5 years, to include all forms of packaging and packing materials. Although there has certainly been a level of grumbling over the years about where the RPC was last in non-produce uses, both food and non-food shipping, it wasn't until the recent release of a 'RPC cleanliness' study report by Dr. Keith Warriner, University of Guelph, that the issue heated up. In response to that media-based communication, multiple concerns from grower/shippers and produce handlers were shared anew across the U.S. Issues raised related to foreign objects, impacted soil, decaying organic matter, presumptive excess cleaner deposits, excess free water, and the perennial, multiple adherent stickers and sticker-adhesives made it apparent that the concerns raised by the Guelph report were note likely regionally-limited issues.

The issue of excess free water, alone, within a folded RPC arriving for packing fresh produce is significant for many packers as any water in contact with the dry surface of produce such as dry onions, garlic, and items with a tender calyx (stem-cap), such as many types of eggplant, will likely stimulate decay microbes to infect. In some areas, this moisture with evaporate quickly if erected RPC sit out in the field for even a short time but this is not always the case in high humidity field environments or in many packing facility rooms. Packers have commented that they assign crews to hand wipe RPC prior to use to remove pooled water.

Since the initial Guelph study, we conducted a similar microbiological survey in CA over a six-week period and a second, expand study was conducted by Dr. Warriner. These reports are available online and the collective outcomes uniformly point to an inconsistency of microbiological cleanliness which would be prudent to address among RPC providers. While our study did not specifically address the issue of actual pathogen detection, by design, the relatively high numbers of viable bacteria on the interior surface of the RPC swabbed strongly indicates a that current cleaning and sanitation practices lack the rigor needed or expected by their customers. In the UCD survey, while many individual RPC were below the limit of detection, < 0.9 CFU/swab) would be classified a 'clean' (< 60 CFU/ cm^2), individual RPC across pallets and sampling dates exceeded log 5 CFU/swab nine of twenty-four times or 37.5% and the range of outcomes exceed log 6 CFU/swab two times or 8.3%. Details of the methods

used and study outcomes are contained within the current online report, to expedite availability to the industry in a more lay-technical presentation, and a more formal journal manuscript is being developed with additional evaluations and reported data.

Current actions and corrective measures

Fortunately, regardless of the impetus for change, a major RPC provider has been taking steps to improve handling at their central depots and stabilize confidence in pool–system contribution to supply-chain food safety.

Switching exclusively to single-use packing units for shipping to processors and other market receivers is clearly one option to essentially eliminate concerns for cleanliness of FCS containers with intimate product contact points. Naturally, protection from contamination during staging and use in field harvest or during on-site storage at a packing or fresh-cut processing facility is an essential and long-standing expectation in all prerequisite produce safety programs. Single-use liners also greatly reduce concern with diverse multiple-use shipping containers; however this practice is not always applicable with some produce handling systems. For example, these liners will interfere with prompt cooling or drying of product and may be associated with a greater level and persistence of condensation on product leading to decay and food safety concerns. In a recently completed study of the microbiological status of single-use corrugated packing containers, representing six different manufacturers, the third-party findings supported the expectation that the FCS area was 'clean' and well below presumptive comparable standards derived from the Guelph study.

While adopting single-use only packaging policies among shippers and receivers would alleviate concerns for all forms of multiple-use packaging, this is not a realistic approach. Until such time as there is abundant evidence that RPC units arrive from a depot in an acceptable condition as a sanitized and dry FCS, ready to receive fresh produce, we recommend that growers and shippers adopt a consistent inspection protocol for each pallet received. We strongly recommend that inspection be combined with replicated ATP-bioluminescence swabs to support visual inspection and, over time, design and implementing a random ten-RPC swab protocol for Total Enterobacteriaceae and Total Thermotolernat Coliforms. This data should be provided openly to RPC providers and receiving customers in order that overall system improvement may be broadly supported and expedited. To support this standardized protocol we are developing additional validation data to strengthen science-basis the guidance values for cleanliness presented in Table 1.

Table 1. Example of interim guidance for ATP and Aerobic Plate Count outcomes of harvest and shipping container microbiological swab-analysis

General ATP-bioluminescence Unit Reading Outcome (Relative Light Units – RLU)	Hard Surface Cleanliness Expectation Outcome	Typical Correlative Aerobic Plate-Count Expectation
< 50 RLU	Acceptable - 'Very Clean'	< 60 CFU/cm^2
100 < x < 300 RLU	Acceptable – 'Reasonably Clean'	< 500 CFU/cm^2
300 < x < 1,000 RLU	Corrective Action Needed ➢ Re-clean & sanitize ➢ Re-test before use	1,500 < x < 3,000 CFU/cm^2
> 1,000 RLU	Unacceptable – Immediate Corrective Action Needed ➢ System analysis ➢ Re-training ➢ Sanitizer selection and use review	> 5,000 CFU/cm^2

Resources and Citations

Colley, D. 2015. The Produce News. Available at http://producenews.com/more-what-s-new/15126-corrugated-industry-stands-solid-on-new-package-cleanliness-research-and-sustainability-facts (Verified 2/20/15)

Sholberg, Peter L. 2004. Bin and Storage Room Sanitation. Washington State University Tree Fruit Research and Education Center. Available at http://postharvest.tfrec.wsu.edu/PC2004F.pdf (Verified 2/18/15)

Suslow, T. V. et al. 2014. Assessment of General RPC Cleanliness As Delivered for Use in Packing and Distribution of Fresh Produce. Available on request. tvsuslow@ucdavis.edu

US FDA. 2014. 2014 Recalls, Market Withdrawals & Safety Alerts. Available at http://www.fda.gov/Safety/Recalls/ArchiveRecalls/2014/default.htm (Verified 2/18/15)

Warriner, K. 2013. Microbiological Standards for Reusable Plastic Containers within Produce Grower Facilities, Available at http://www.cccabox.org/pdf/RPC_Report_August_2013.pdf (Verified 2/18/15)

Warriner, K. 2014. Containers Used to Ship Produce Fall Short of Safety Standards for Two Consecutive Years. Available at http://www.cccabox.org/pdf/Press%20Release_CCCA-Oct27.pdf (Verified 2/18/15)