Focused attention on recent produce-related foodborne illness outbreaks has lead to interest at many government levels to establish appropriate food safety regulations. For simplicity, general cross commodity regulations may be written, and while useful, they also have many limitations. For example, food safety risks associated with tree crops such as citrus are inherently different to those associated with transitional row crops. In the absence of data, regulators may be required to “guess” at what appropriate food safety standards may be.

A quantitative microbial risk assessment is one way to organize data and expert opinion into models to quantitatively estimate risks associated with the entire production continuum. They also provide a framework for identifying critical data gaps and evaluating the overall effectiveness of risk-reduction strategies.

The objective of this project was to establish a quantitative microbial risk assessment for citrus. Model development has been based upon a flow diagram developed then separated into two distinct sections – pre-harvest/harvest and post-harvest – to evaluate distinct factors common to specific unit operations in each.

During data procurement it became apparent that significant data gaps exist. At the pre-harvest/harvest level, unit operations present that were identified to have an impact on risk included: water quality, pest control, site selection, foliar sprays, canopy management, frost control, and harvesting method. Foliar sprays and frost control were then lumped together under water quality. Harvesting method, specifically number of fruit that come in contact with the ground, was identified as the factor having the highest impact on risk. In post-harvest, survival of pathogens during storage, location of pathogen contamination, removal of pathogens during washing and waxing, and influence of minor damage on the surface of fruit all were discussed as important unit operations. Limited data exists for most of these operations.

Figure 1. Transfer of non-virulent Salmonella from the equator of whole citrus to the peel, edible sections and hands during the hand peeling of five citrus varieties (n = 36 for each variety).
During the initial model development and discussion with industry members, the influence of the citrus peel on risk to consumers was discussed. The waxy surface of citrus fruits provides conditions suitable for bacterial adherence. Citrus fruit are commonly hand peeled prior to eating; the potential for pathogen transfer from the peel to the edible portion of the fruit during this step may exist.

Studies were undertaken to evaluate transfer of a non-virulent *Salmonella* during hand peeling of five citrus varieties (Valencia orange, Navel orange, Satsuma mandarin (grown in California), Marsh grapefruit (grown in Texas), and Mineola Tangelo (grown in Florida). Bacterial inoculums was placed onto either the stylar, equator, or stem ends of the citrus and allowed to dry before hand peeling. Six volunteers peeled the citrus with no instructions. Transfer from the whole citrus to the peel, edible portion, and hands were measured. Transfer from inoculation at the equator is shown in Figure 1. Transfer from the equator to the edible portion ranged significantly for each variety but was highest in Navel, Valencia and Satsuma, where up to 30% of the pathogen transferred to the edible sections. Pathogen transfer from the whole fruit to the edible portions and hands was observed regardless of the location of inoculation.

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