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# Impact of Tomato Varieties and Maturity State on Susceptibility of Tomatoes to *Salmonella*[1]

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From 1998 to 2007, fresh fruits, vegetables, spices, and nuts were commonly linked with outbreaks of human gastroenteritis (Batz, Hoffman, and Morris 2011). Non-typhoidal *Salmonella* has emerged as one of the problematic human pathogens associated with fresh produce, nuts, and complex foods containing them (Batz, Hoffman, and Morris 2011; DeWaal, Tian, and Plunkett 2009). This fact sheet was produced to provide up-to-date information about tomato production practices and their relationships with Salmonella. This information should be useful for county UF/IFAS Extension agents in their vegetable education programs.

Even though *Salmonella* has long been considered a zoonotic pathogen (i.e., communicable from animals to humans), it is clear that human salmonellosis is also likely to result from the consumption of plant-based (mostly raw) foods. Thus, it appears that *Salmonella* and pathogenic *E. coli* may persist on plants between encounters with their animal hosts as a part of their normal lifecycle. Recent research indicates that the outcomes of plant interactions with *Salmonella* and pathogenic *E. coli* to some extent depend on the plant host: colonization of plant tissues varied not only among plant species, but also among plant varieties (Jablasone, Warriner, and Griffiths 2005; Barak, Kramer, and Hao 2011; Klerks et al. 2007; Quilliam, Williams, and Jones 2012). This raises the intriguing possibility that cultivar selection could be used to identify crop varieties that may be less conducive to proliferation of human pathogens.

Figure 1. Tomatoes of different varieties at different maturity stages are cued for testing for their resistance to *Salmonella*
*Credits:* Max Teplitski, UF/IFAS

Several recent studies compared the extent to which tomato genotype affects the colonization of plant tissues by *Salmonella* (Barak, Kramer, and Hao 2011; Marvasi, Noel, et al. 2014). Overall, none of the tested tomato varieties

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were completely "resistant" to *Salmonella*, although there were hundred fold differences in the population sizes of the pathogen on tomatoes and within fruit tissues (Barak, Kramer, and Hao 2011; Marvasi, Noel, et al. 2014). In a limited survey of tomato varieties, there were no detectable patterns in susceptibility of heirloom or commercial varieties/hybrids to *Salmonella*. However, cherry tomatoes were generally less conducive to proliferation of *Salmonella* (Marvasi, Noel, et al. 2014). Tomatoes carrying ripening mutations (*rin* [ripening-inhibitor], *nor* [nonripening], *Nr* [never-ripe]) were significantly less conducive to *Salmonella* proliferation (Barak, Kramer, and Hao 2011; Marvasi, Noel, et al. 2014). However, the biochemical basis of why these mutants are less susceptible to *Salmonella* is not yet known.

Significant differences in the *Salmonella* colonization of tomatoes at different maturity stages have been observed (Marvasi, Cox, et al. 2013; Shi et al. 2007) and are consistent with the observation that ripe fruits are generally more susceptible to opportunistic pathogens. Differences in proliferation of *Salmonella* in mature and immature tomatoes did not seem to depend on the pigmentation of the ripe fruit (e.g., red, yellow, pink, brown, or green). How well do these differences observed in the greenhouse correlate to the susceptibility of field-grown tomatoes to *Salmonella*? When four tomato varieties—Bonny Best, Florida 47, Sebring, and Solar Fire—were tested in the field, their levels of susceptibility to *Salmonella* did not closely correlate to those observed in the greenhouse studies (Marvasi, Noel, et al. 2014). What is responsible for these observed differences is not yet clear; however, crop production practices and diversity of the microbial communities associated with fruits are known to affect the outcomes of interactions between human pathogens and crops (Marvasi, Cox, et al. 2013; Gutierrez-Rodriguez et al. 2012; Lopez-Velasco et al. 2012; Poza-Carrion, Suslow, and Lindow 2013; Williams et al. 2013).

Under the field conditions and in greenhouse tests, ripe tomatoes supported more rapid proliferation of *Salmonella* than immature green tomatoes (Shi et al. 2007; Marvasi, George, et al. 2014; Marvasi, Hochmuth, et al. 2013). Final cell numbers of *Salmonella* were, on average, tenfold higher in ripe tomatoes compared to the unripe tomatoes under the same conditions. In each season, there were samples in which *Salmonella* populations within red ripe tomatoes increased by at least $10^5$ from the initial dose of ~ $10^2$ cells.

## Conclusions

Once contaminated, red ripe tomatoes are significantly more conducive to proliferation of *Salmonella* than green or partially ripe tomatoes. Cherry tomatoes tend to be less conducive to proliferation of *Salmonella*, compared to larger-fruited tomatoes. Generally, susceptibility of tomatoes to *Salmonella* did not correlate with fruit color (yellow, ivory, brown, pink, red) or with whether a variety was heirloom or a modern commercial hybrid. However, levels that *Salmonella* reached in fruits of different varieties were tomato genotype–dependent. Under some field conditions, tomatoes carrying ripening-related mutations were less conducive to proliferation of *Salmonella*.

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