

Salmonella risk is enhanced by onion condition or defect

Summary

Salmonella recalls have been associated with onions of different day-length varieties, most notably long-day onions. However, most food safety research has been conducted on long-day onions. Therefore, there is a gap in knowledge regarding the impact of onion variety on risk. Onion photoperiod varieties differ in physico-chemical characteristics and curing methods. For example, short-day onions have higher moisture and sugar content that may contribute to bacterial rot and enhance *Salmonella* growth. Moreover, short-day onions are cured and stored differently than long-day onion varieties. This study aims to bridge the knowledge gap between onion attributes and their impacts on foodborne pathogen risk.

Objectives

- Objective 1: Determine the effect of onion condition and defect on *Salmonella*.
- Objective 2: Characterize the specific onion attributes that impact safety and quality.
- Objective 3: Evaluate different post-harvest handling practices for their impact on *Salmonella*.

Methods

Study 1: Three-strain cocktails of *Salmonella* or *E. coli* O157:H7 were inoculated (~4 log CFU/g) on diced short-, long-, and dehydrator varieties. They were stored at 6-10°C for 14 days and sampled periodically. The onion variety impact on pathogen dynamics was determined using linear mixed modeling ($\alpha < 0.05$).

Study 2: A three-strain cocktail of *Salmonella* (~2 log CFU/g) was inoculated alone or co-inoculated with plant pathogens (*P. ananatis* and *P. agglomerans*). Inoculation methods included internalization and spot inoculation on mechanically damaged bulb onions. Onions were incubated at 12 and 20°C for 7 days (sampling daily).

Study 3: Temperature data were extracted from the North American Regional Reanalysis climate database (years 2020–2024). The daily grand mean was calculated from eight three-hourly means.

Results to Date

Study 1: *Salmonella* minimum growth temperature: short- and long-day = 8°C; dehydrator = 9°C. *E. coli* O157:H7 minimum growth temperature: short-day = 8°C; long-day = 9°C; dehydrator = 10°C. Onion variety significantly affected pathogen dynamics ($P < 0.05$; Fig. 1).

Study 2: Bulb onion surfaces did not support *Salmonella* growth at 20°C unless they were damaged or decayed. *Salmonella* growth was inhibited at 12°C regardless of damage or decay (Fig. 2,3, and 4)

Study 3: Variations in ambient environmental conditions were observed throughout the US during onion curing periods (Fig. 5).

Benefits to the Industry

The results of this project will benefit the onion industry by addressing critical knowledge gaps on how variety, quality, and curing practices influence *Salmonella* and *E. coli* O157:H7 on both whole and fresh-cut onions. This work will generate data on pathogen dynamics under cold-chain-relevant conditions, providing insight into survival and potential growth across different onion types. It will also evaluate how quality deterioration, including tissue breakdown from bacterial rot, impacts pathogen behavior during retail storage and handling. In addition, the project will compare field versus artificial curing to understand differences in pathogen die-off and persistence. Together, these findings will support more specific guidance, enabling growers, packers, and fresh-cut processors to better manage risk and strengthen food safety outcomes.

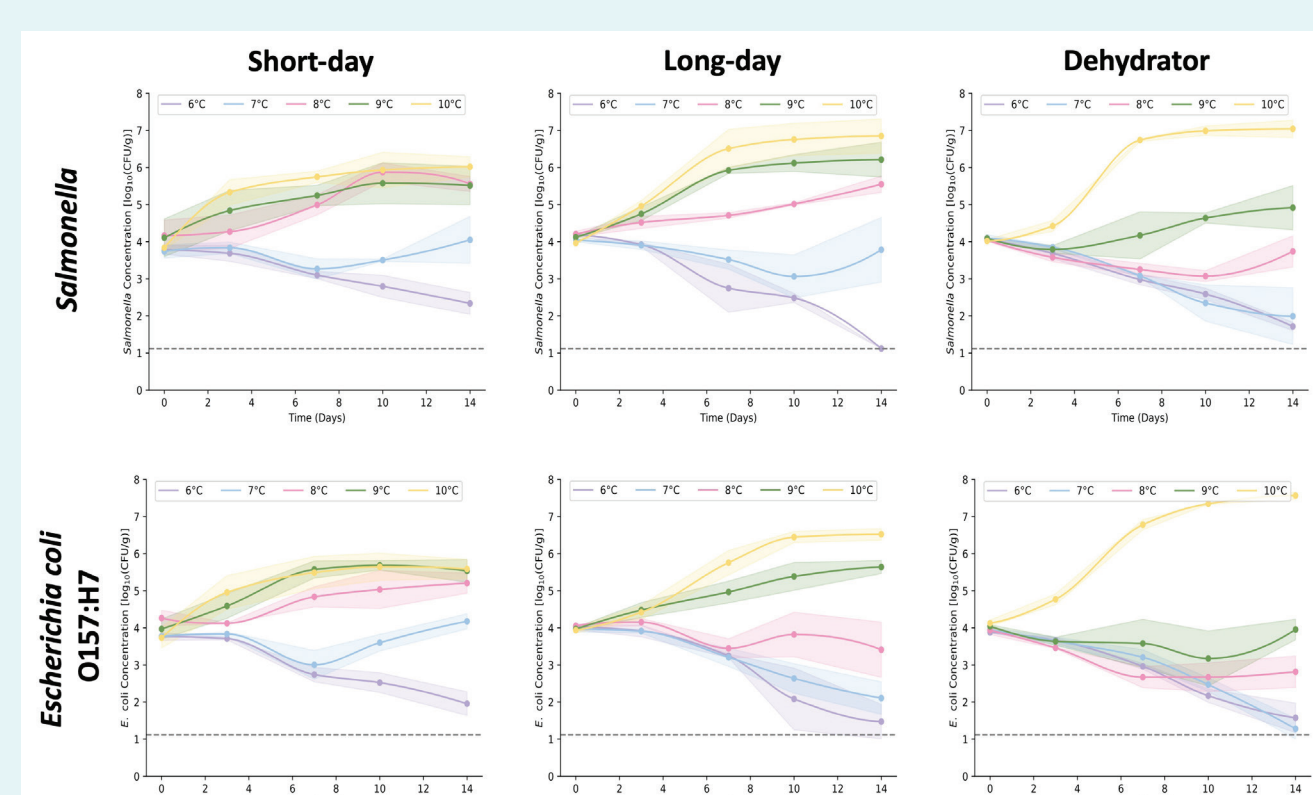


Figure 1: *Salmonella* and *Escherichia coli* O157:H7 behavior on short-day, long-day, and dehydrator onion varieties under refrigerated storage (6–10°C). Solid lines represent mean population levels, and shaded regions indicate ± 1 standard deviation.

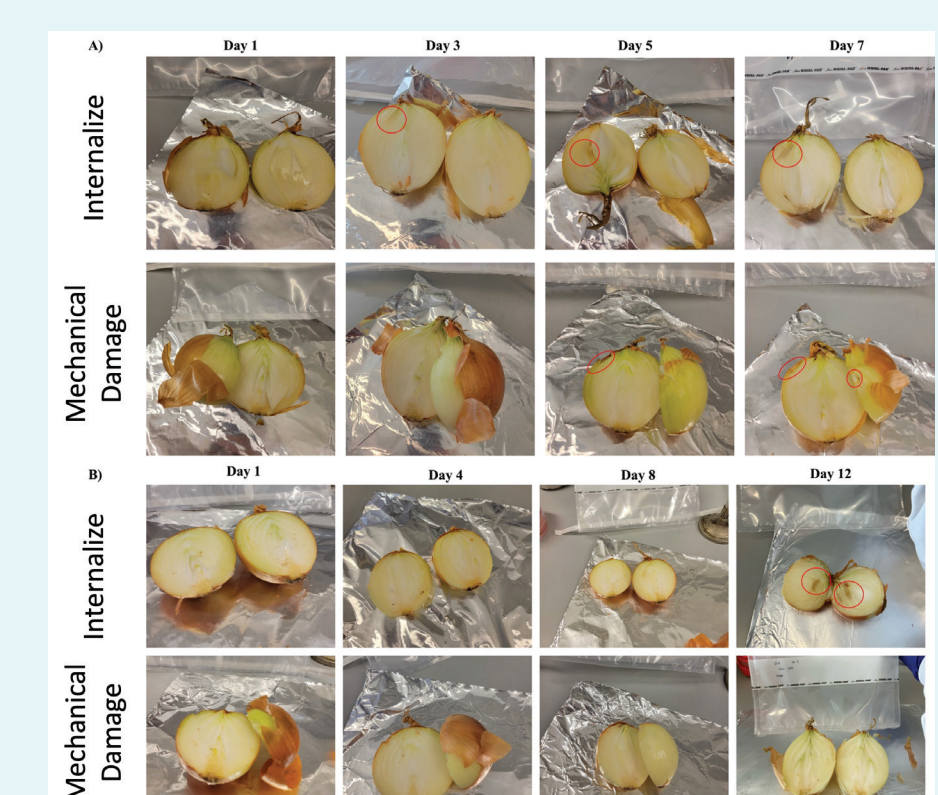


Figure 2: Progression of onion bulb decay in co-inoculated onions incubated at 20°C. Areas labeled with the red circle were locations showing signs of decay. Bulb decay occurred in all three trials of co-inoculated onions incubated at 20°C.

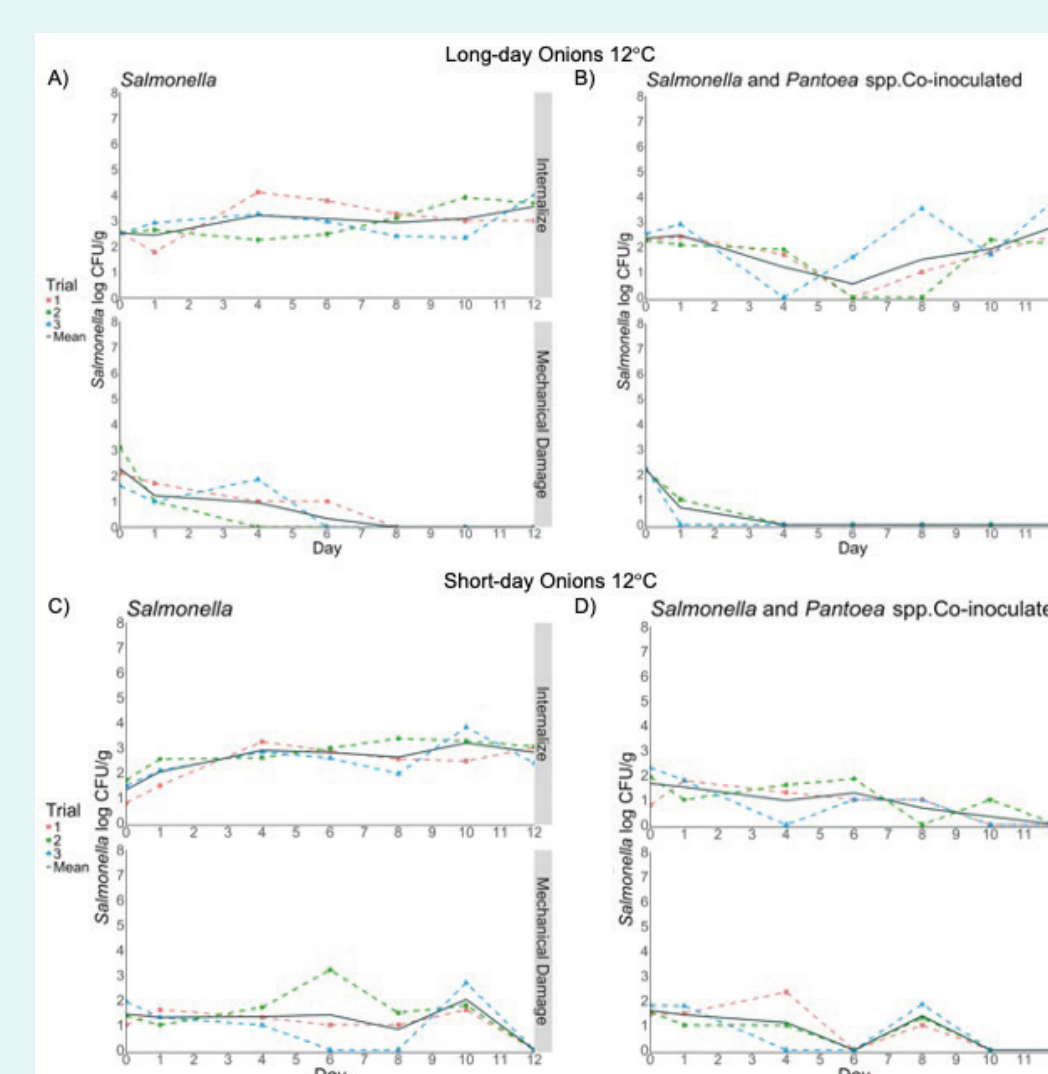


Figure 3: *Salmonella* concentration in long-day (A & B) and short day (C & D) onions inoculated with either the *Salmonella* cocktail only (A & C) or co-inoculated with plant pathogens (*Pantoea ananatis*, *Pantoea agglomerans*) (B & D). Two inoculation methods are shown: internalize culture into onions (the top figure of each panel) or spot inoculation on a mechanically damaged surface (the bottom figure of each panel). Onions were stored at 12°C for 12 days, and *Salmonella* concentration was enumerated on day 1, 4, 6, 8, 10 and 12.

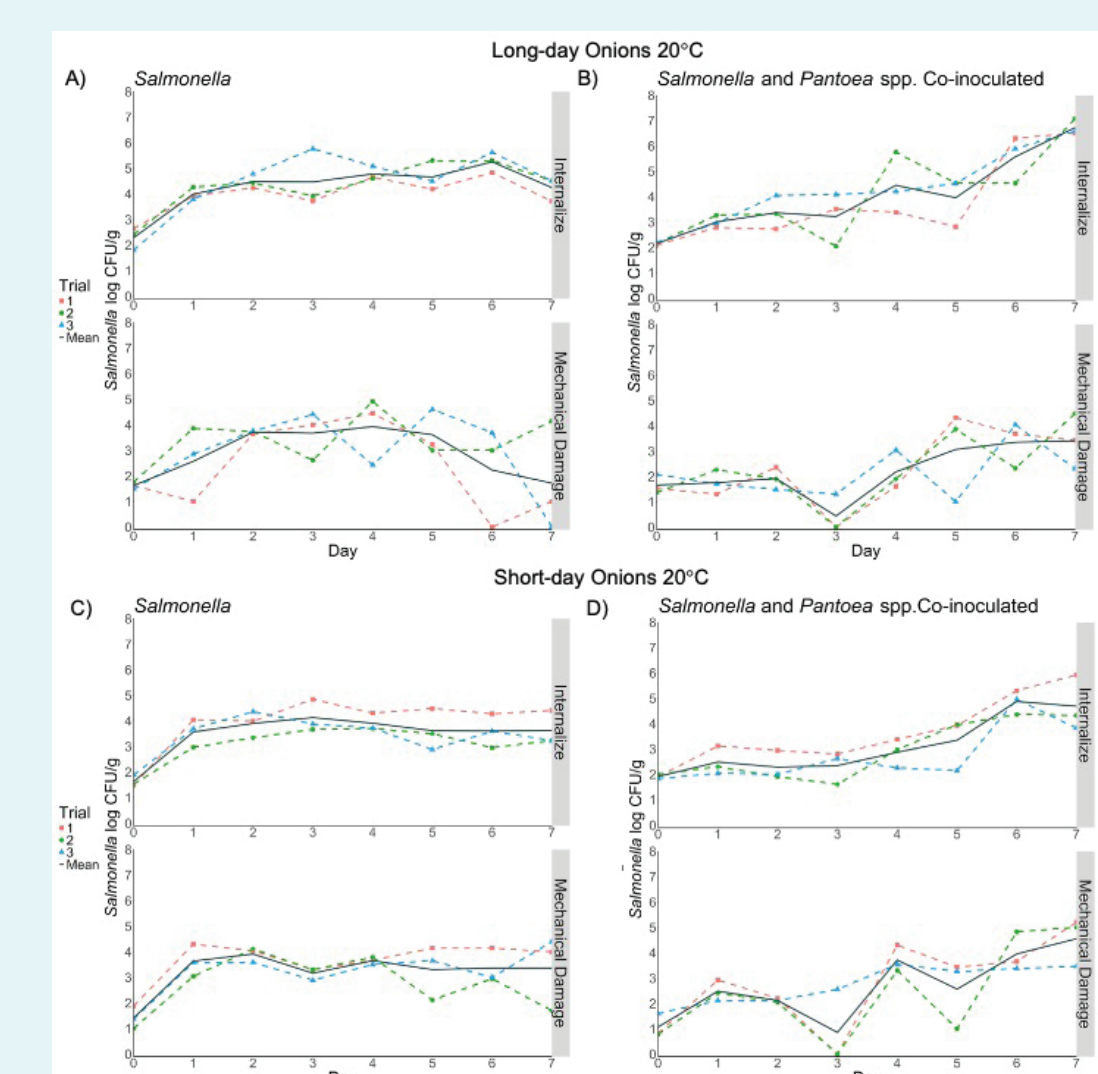


Figure 4: *Salmonella* concentration in long-day (A & B) and short day (C&D) onions inoculated with either the *Salmonella* cocktail only (A & C) or co-inoculated with plant pathogens (*Pantoea ananatis*, *Pantoea agglomerans*) (B & D). Two inoculation methods are shown: internalize culture into onions (the top figure of each panel) or spot inoculation on a mechanically damaged surface (the bottom figure of each panel). Onions were stored at 20°C for 7 days, and *Salmonella* concentration was enumerated on each day.

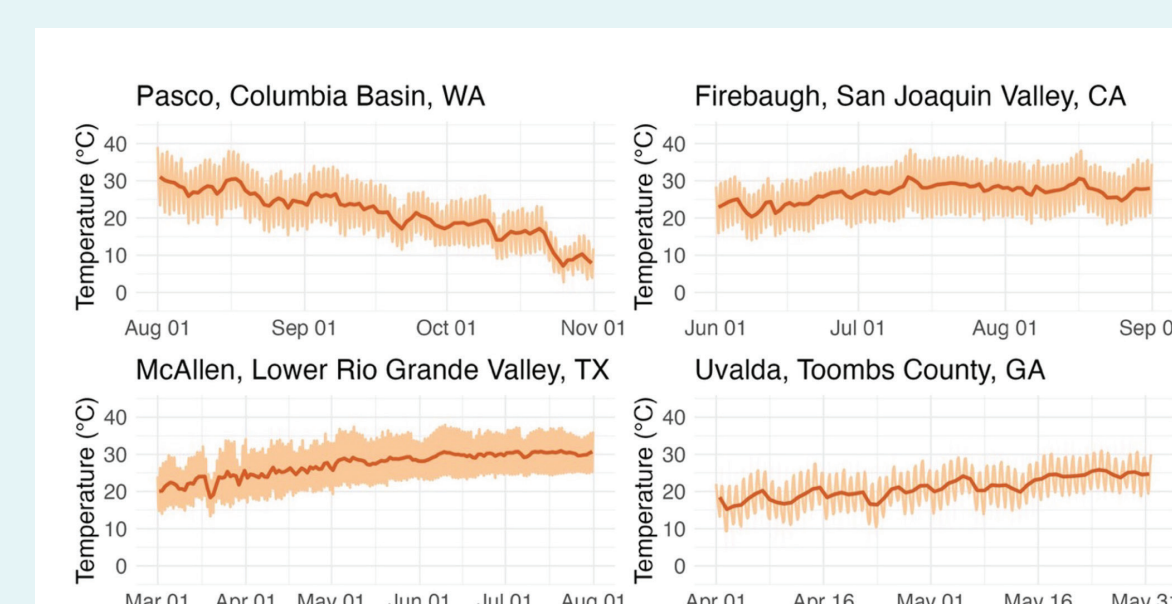


Figure 5: Summary of air temperature data at the 2-meter level. Air temperature data averaged across 2020–2024 for four selected locations. The light orange lines denote the 5-year means for each 3-hourly time point. The dark orange lines denote daily grand mean air temperature, averaging eight 3-hourly readings across five years per day.



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