

Title Migration of *Salmonella enteritidis* PT 30 through Almond Hulls and Shells
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Abstract

Recent outbreaks of salmonellosis from consumption of raw almonds have generated interest in potential modes of contamination of this nutmeat. The ability of *Salmonella enteritidis* PT 30 to migrate through almond hulls and shells was evaluated in two ways. Shell halves from five varieties of almonds were glued inside Petri dish lids so that the outer shell only was submerged in a suspension of *S. enteritidis* PT 30 (10^6 CFU/ml in Butterfield's buffer) placed in the bottom half of the Petri dish. Following incubation for 24 h at $24\pm 2^\circ\text{C}$, the inside of the shell was swabbed, streaked directly onto XLD agar and incubated for 24 h at $35\pm 2^\circ\text{C}$. The swab was transferred into 25 ml of lactose broth and enriched using standard methods. *S. enteritidis* was isolated from the inside of almond shells by both direct swabbing (14/30) and enrichment (30/30). Additionally, intact whole almonds (hulls, shells, and kernels) were soaked 24 to 72 h at $24\pm 2^\circ\text{C}$ in buffer containing 10^3 to 10^9 CFU/ml of green fluorescent protein (GFP)-labeled *S. enteritidis* P 30. After incubation, populations of *S. enteritidis* PT 30 were 10^8 to 10^9 CFU/ml regardless of initial inoculum level. Almonds were drained and the kernel removed using aseptic techniques. GFP-*Salmonella* was detected on almond kernels, outer and inner shells, and on and within the hull by confocal laser scanning microscopy. These combined data provide direct evidence that wet conditions allow for *Salmonella* multiplication and migration through the hull and the shell, thus providing a means by which almond kernels may become contaminated.