



Almond Board of California

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## FOOD QUALITY & SAFETY PROGRAM PUBLISHED PAPER SUMMARY

Danyluk, Michelle, L.J. Harris, and D.W. Schaffner. 2006. **Monte Carlo Simulations assessing the risk of Salmonellosis from consumption of almonds.** J. Food Prot. 69(7):1594-1599.

The aim of the study was to perform a quantitative assessment of the risk of the general population contracting salmonellosis from consumption of raw almonds. This was done by taking into account factors that become important after almonds reach the processor. The risk associated with the consumption of raw almonds and the risk reduction associated with almonds treated with a theoretical 5-log reduction process using a standard commercial process was calculated. A  $\beta$ -Poisson model for the dose-response relationship for Salmonella was obtained from published literature. The simulation estimated a 78% chance of one or more cases of salmonellosis per year from consumption of raw almonds. The results of this study suggest that the risk of one or more U.S. cases of salmonellosis per year from consumption of raw almonds can be reduced from 78% to less than 1% by using a process achieving a 5-log reduction in Salmonella by using a commercial treatment such as propylene oxide.

Danyluk, Michelle, T.M. Jones, S.J. Abd, F. Schlitt-Dittrich, M. Jacobs and L.J. Harris. 2007. **Prevalence and amounts of *Salmonella* Found on Raw California Almonds.** J. Food Prot. 70 (4):820-827.

The development of product-specific quantitative microbial risk assessments rely heavily on data on the prevalence and populations of pathogens in individual foods. A salmonellosis outbreak in 2002 to 2001 associated with the consumption of raw almonds provided an opportunity to evaluate the levels of Salmonella in the recalled product. The levels of Salmonella determined by a three-tube most-probable-number (MPN) method were  $8.5 \pm 1.3$  MPN/100g. 35 different serotypes of Salmonella were represented in the 81 total isolates.

Danyuk, Michelle, AR Uesugi, LJ Harris. 2005. **Survival of *Salmonella* Enteritidis PT 30 on Inoculated Almonds after commercial fumigation with Propylene Oxide** J. Food Prot. 68 (8):1613-1622.

Propylene oxide (PPO) is commonly used to reduce microbial populations in U.S. Bulk raw almonds, but the process has not been validated for reduction of foodborne pathogens. The reduction of *Salmonella* Enteritidis phase type (PT) 30 inoculated onto almonds was evaluated after exposure to a standard commercial PPO treatment. Almonds were inoculated with *Salmonella* Enteritidis PT 30 to approximately 8.0 log CFU/g after drying. Inoculated almonds were placed in bags designed for gaseous sterilization and positioned in the center of 900-kg bins or 22.7-kg boxes of warmed almonds. Almonds were further warmed to an initial temperature of 23 to 34°C, treated with PPO (0.5 kg/m<sup>3</sup>) for 4h, and held for 0 or 2 days at 38 to 43°C followed by storage for 2 to 5 days at 15 to 18°C. *Salmonella* Enteritidis were consistently reduced by >5.0 log CFU/g (5.2 to >8.6 log CFU/g) when initial counts were compared with counts obtained 5 days after PPO treatment. Reductions of 1.2 to 4.4 log CFU/g occurred during post-PPO storage. Reductions were not significantly improved (P < 0.05) when almonds were held at 38 to 43°C after PPO treatment. PPO residues were >400 ppm immediately after removal from the PPO chamber and declined to <300 ppm during post-PPO storage. PPO is an effective treatment for reducing population of *Salmonella* Enteritidis PT 30 on bulk almonds.

The Almond Board of California welcomes the participation of all industry members and does not discriminate on the basis of race, color, national origin, sexual orientation, gender, marital status, religion, age, disability or political beliefs

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Pao, Steven, A. Kalantari, and G. Huang. 2006. **Utilizing acid sprays for eliminating *Salmonella enterica* on raw almonds.** J. Food Sci. 71:M14-M19.

The results of this study showed that 5-log reductions on TSA and XLD counts of *Salmonella enterica* can be achieved under laboratory conditions using 10% citric acid by (1) the combination of shelling, 1 spraying, and 3 d of storage, (2) the combination of shelling 2 sprayings and 1 d of storage, or (3) the combination of shelling and 3 sprayings.

Uesugi, Aaron R., M. D. Danyluk, R. E. Mandrell, J. L. Harris. 2007. **Isolation of *Salmonella* Enteritidis Phase Type 30 from a Single Almond Orchard over a 5-year Period.** J. Food Prot. 70(8):1784-1788.

In 2001, *Salmonella* Enteritidis phase type (PT) 30 was isolated from drag swabs of 17 61-ha almond orchards on three farms linked to an outbreak of salmonellosis associated with consumption of raw almonds. The objective of this study was to evaluate the long-term persistence of *Salmonella* Enteritidis PT 30 in one of the almond orchards associated with the outbreak. Swabs were pulled along the orchard floor in a standardized manner for 55 m. At each sample time, two pooled samples were collected from each orchard quadrant. Swabs were enriched for *Salmonella* using a delayed secondary enrichment procedure developed for isolation of *Salmonella* from poultry houses. Suspect *Salmonella* isolates were selected, confirmed, serotyped and phage typed, and pulsed-field gel electrophoresis (PFGE) patterns were determined after cleavage with *Xba*I and *Bin*I. *Salmonella* was recovered infrequently from pooled samples collected from January through July (3 of 56 samples, 5.3%). In general, *Salmonella* isolation frequency per sample time increased during and immediately after the harvest, when large amounts of dust were generated in or near the orchard; August, 4 (20%) of 20 samples; September, 13 (20%) of 64 samples; October, 27 (42%) of 64 samples; November, 4 (25%) of 16 samples; and December, 2 (25%) of 8 samples. All 53 *Salmonella* isolates during the 5 years were identified as *Salmonella* Enteritidis PT 30, and two PFGE patterns that differed by a presence of an approximately 40-db fragment were identified. These data demonstrate the potential for long-term environmental persistence of *Salmonella* in almond orchards.

Uesugi, Aaron, L. Harris. 2006. **Growth of *Salmonella* Enteritidis Phage Type 30 in Almond and Shell Slurries and Survival in Drying Almond Hulls.** J. Food Prot. 69(4):712-718.

This study aims to document weather conditions during the 2000 almond harvest, to determine whether there was real potential for growth of *Salmonella* Enteritidis PT 30 in hull or shell slurries and to evaluate the survival of *Salmonella* Enteritidis PT 30 on wet almond hulls during drying. The study showed that both hull and shell slurries supported rapid growth of *Salmonella* Enteritidis PT 30 at 24°C, while slurries containing hulls also supported growth at 15°C. Maximum concentrations of *Salmonella* Enteritidis PT 30 concentrations of 6.2 and 7.8 log CFU/ml were found at 15° and 24°C respectively. Rain as a factor was not found to be the sole cause of the outbreak, as analysis of almond industry shipping records revealed that approximately 60% of outbreak-associated almond had not been exposed to rain. Data provides evidence that wet almonds may be at a greater risk for high concentrations of *Salmonella*.

Uesugi, Aaron, M. Danyluk, and L. Harris. 2006. **Survival of *Salmonella* Enteritidis Phage Type 30 on Inoculated Almonds Stored at -20, 4, 23, and 35°C.** J. Food Prot. 69(8):1851-1857.

The aim of this study was to evaluate the survival of *Salmonella* on raw almond surfaces utilizing different inoculum levels (0.22, 0.28, 0.29, and 0.22 log CFU/month, respectively), different time periods. Kernels inoculated to 7.1 or 8.0 log CFU per almond after drying were stored for 171 or 550 days, respectively, at selected temperatures, including -20 +/- 2° C, 4 +/- 2°C, 23 +/- 3°C, and 35 +/- 2°C. No significant reductions of *Salmonella* were observed during storage at -20 and 4°C over 550 days. Significantly greater reductions were observed during the 24-h drying period when broth-collected cells were used as the inoculum, which suggested that cells collected from agar lawns were more resistant to drying. However, after initial drying, the rates of reduction at 23°C did not differ significantly between the inoculum preparation methods. The results from this study suggest *Salmonella* Enteritidis PT 30 survives for long periods on almond kernels under a variety of common storage conditions.