RESEARCH COMPLETED

Assessing Postharvest Food Safety Risks and Identifying Mitigation Strategies for Foodborne Pathogens in Pistachios

SUMMARY

Growth curves were determined for *Salmonella*, and in some cases *Escherichia coli* O157:H7, and *Listeria monocytogenes*, on in-hull pistachios and hulled floater and sinker pistachios. Reductions of *Salmonella* during pistachio drying were estimated. These data and industry input were used to estimate the impact of delays during the postharvest handling of pistachios. Delays in drying influenced levels of *Salmonella* in floater pistachios and, to a lesser extent, in sinker pistachios. The heat resistance of *Salmonella*, *E. coli* O157:H7, *L. monocytogenes*, and surrogate *Enterococcus faecium* under dry and moist heat conditions was characterized. The data support *Salmonella* as the appropriate target pathogen for pistachios and provide evidence that thermal processes validated for this organism will reduce *E. coli* O157:H7 and *L. monocytogenes* by similar or greater levels. The data support the use of *E. faecium* NRRL 2354 as a surrogate organism for validating thermal processes in reducing *Salmonella* on pistachios.

OBJECTIVES

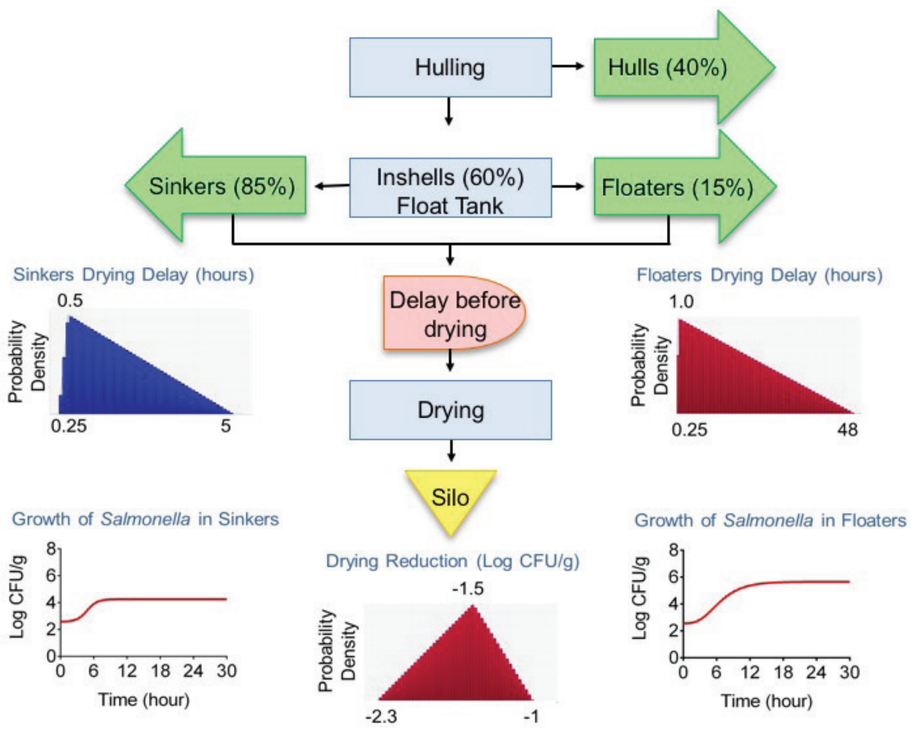
Objective 1. To identify points during postharvest handling of pistachios where foodborne pathogens (*Salmonella*, *E. coli* O157:H7 and *L. monocytogenes*) may be reduced, controlled or amplified.

Objective 2. To determine the impact of pistachio moisture and nut form (kernel or inshell) on the heat sensitivity of *Salmonella*, *E. coli* O157:H7, *L. monocytogenes*, and *E. faecium* inoculated pistachios.

METHODS

A cocktail of *Salmonella*, *E. coli* O157:H7 or *L. monocytogenes* was inoculated at 3 log CFU/g of in-hull or hulled pistachios and incubated under commercially-relevant conditions (37°C and 90% RH). Growth curves were developed over a 30 h period. A quantitative model of *Salmonella* growth was derived from laboratory and industry data (Fig. 1). Simulations were run using Monte Carlo simulation software (@RISK, Palisades Decision, Newfield NY). In-shell pistachios or pistachio kernels were inoculated at a target inoculum level of 9 log CFU/g with single strains of *E. faecium*, *Salmonella*, *E. coli* O157:H7, or *L. monocytogenes*. The survival of *E. faecium*, *Salmonella* Enteritidis PT 30 (control), and several strains of *Salmonella*, *E. coli* O157:H7, and *L. monocytogenes* inoculated onto inshell pistachios was compared after exposure to hot oil (dry heat), hot water (moist heat), and a hot oven (dry heat). Survivor curves were determined for the most resistant strains.

Figure 1. Pistachio harvest flow diagram and parameters used in model development



RESULTS TO DATE

There was no significant difference in the growth of *Salmonella* on early or late harvest in-hull pistachios but the growth rate and final concentrations of *Salmonella* on floaters was significantly ($P < 0.05$) higher than that on sinker pistachios. Growth of *Salmonella* on inshell pistachios with <25% or >25% hull adhering to the shell surface was similar for the first 8 h of incubation. After 8 h, no growth of *Salmonella* was observed for floaters with <25% hull but populations increased on pistachios with >25% hull (Fig. 2). The model of postharvest handling predicted greater populations of *Salmonella* on floater pistachios, with drying delays having the greatest influence on final levels (Fig. 3). Growth of *Salmonella* was similar to *E. coli* O157:H7 and greater than *L. monocytogenes* (Fig. 2B). The heat resistance of *Salmonella* was similar to *E. faecium* (Fig. 4), and the same as or greater than strains of *E. coli* O157:H7 and *L. monocytogenes,* under dry and moist conditions.

BENEFITS TO THE INDUSTRY

These data support *Salmonella* as the appropriate target pathogen for pistachios and provide strong evidence that thermal processes validated for this organism will reduce *E. coli* O157:H7 and *L. monocytogenes* by similar or greater levels. The data also provide evidence that *E. faecium* NRRL 2354 is an appropriate surrogate organism for validating thermal processes for pistachios. The quantitative model developed by this project provides a tool that the industry can use to evaluate potential food safety risks associated with harvest delays.

Figure 2. Growth of *Salmonella* on floater pistachios with or without adhering hull (A) and growth of *Salmonella*, *E. coli* o157:H7 and *L. monocytogenes* on floater pistachios

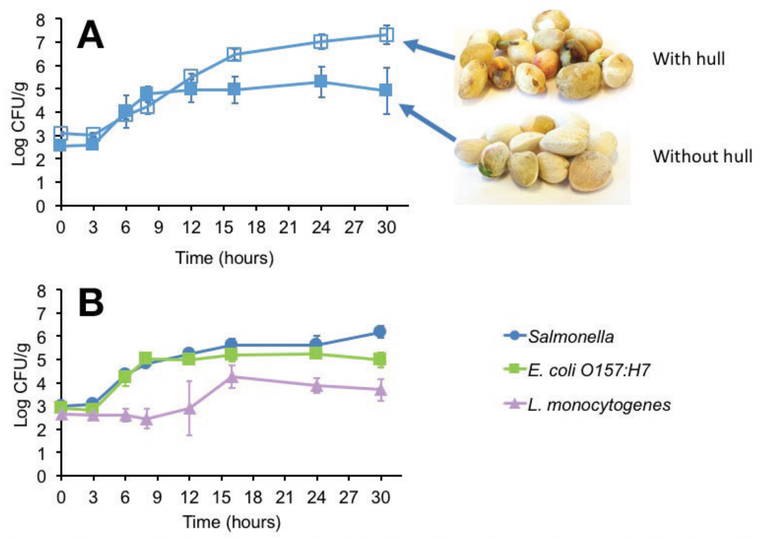


Figure 3. Final predicted *Salmonella* concentration on sinkers and floaters (A), modified output after decreasing the delay to drying for floaters (B)

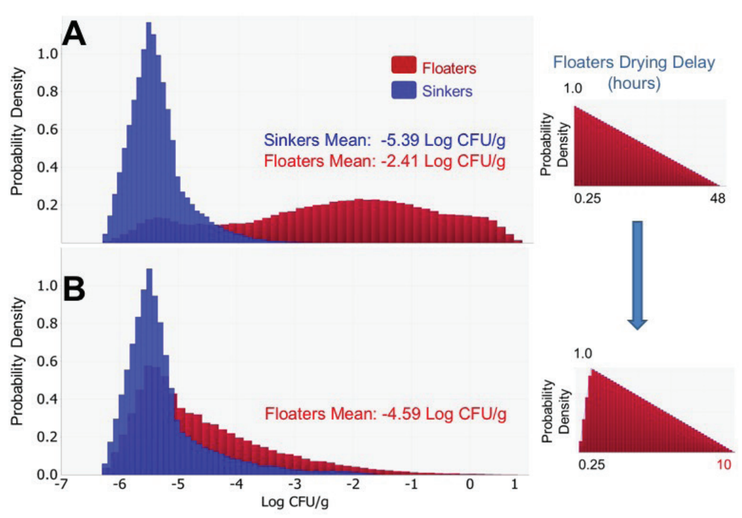
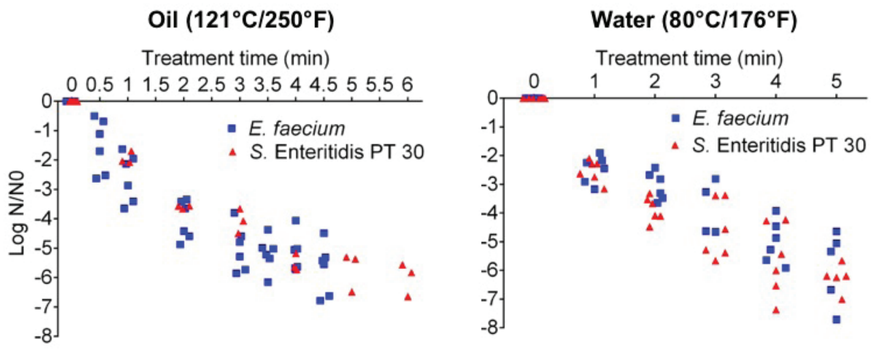


Figure 4. Reduction of *E. faecium* and *S.* Enteritidis PT 30 on pistachios after exposure to hot oil or hot water



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