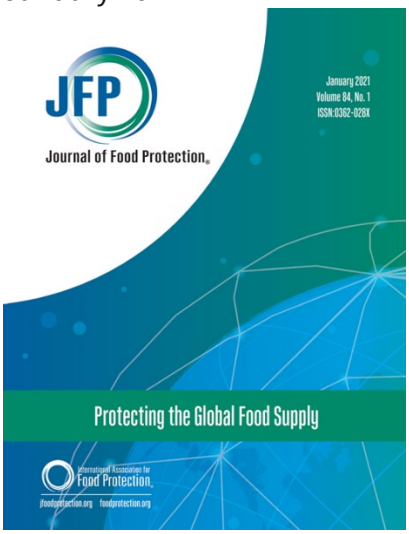
Volume 84, Issue 1
January 2021



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RESEARCH ARTICLE| AUGUST 20 2020

Modeling the Effects of Product Temperature, Product Moisture, and Process Humidity on Thermal Inactivation of *Salmonella* in Pistachios during Hot-Air Heating

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J Food Prot (2021) 84 (1): 47–57.

https://doi.org/10.4315/JFP-20-221

Article history

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ABSTRACT

Prior efforts to model bacterial thermal inactivation in and on low-moisture foods generally have been based on isothermal and iso-moisture experiments and have rarely included dynamic product and process variables. Therefore, the objective of this study was to test appropriate secondary models to quantify the effect of product temperature, product moisture, and process humidity on thermal inactivation of *Salmonella* Enteritidis PT30 on pistachios subjected to dynamic dry- or moist-air heating. In-shell pistachios were inoculated with *Salmonella* Enteritidis PT30, equilibrated in controlled-humidity chambers (to target water activities [a_w] of 0.45 or 0.65), and in some cases, subjected to a presoak treatment prior

to heating in a laboratory-scale, moist-air convection oven at multiple combinations (in duplicate) of dry bulb (104.4 or 118.3°C) and dew point (~23.8, 54.4, or 69.4°C) temperatures, with air speed of ~1.3 m/s. *Salmonella* survivors, pistachio moisture content, and a_w were quantified at six time points for each condition, targeting cumulative lethality of ~3 to 5 log. The resulting data were used to estimate parameters for five candidate secondary models that included combinations of product temperature, product moisture, a_w, and/or process dew point (coupled with a log-linear primary model). A model describing the *D*-value as a function of temperature and dew point fit the data well (root mean squared error [RMSE] = 0.86 log CFU/g); however, adding a term to account for dynamic product moisture improved the fit (RMSE = 0.83 log CFU/g). In addition, product moisture content yielded better model outcomes, as compared with a_w, particularly in the case of the presoaked pistachios. When validated at the pilot scale, the model was conservative, always underpredicting the experimental log reductions. Both dynamic product moisture and process humidity were critical factors in modeling thermal inactivation of *Salmonella* in a low-moisture product heated in an air-convection system.

HIGHLIGHTS

- *Salmonella* inactivation under dynamic conditions was modeled in pistachios.
- Product temperature, moisture, and process humidity affected *Salmonella* lethality.
- Including all three variables in inactivation models improved model accuracy.
- The best-fitting model was conservative when validated at the pilot scale.
- More validation data are needed prior to using this model at the commercial scale.