Infrared Process for Surface Decontamination of Dry Onions and Developing a Computational Mathematical Model for Industrial Scale Process Design

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Because of their direct consumption, microbial contamination is a crucial food safety problem in fresh foods such as fruits and vegetables. In 2020, CDC reported an epidemic and recall about Salmonella strains in dried onions, and the objective of this study was to present the use of infrared processing for surface decontamination of dry onions and develop a computational model for industrial scale process design.

For this purpose, yellow dry onions were processed at 400 °C infrared source temperature in a lab-scale far infrared (FIR) for 120 s. This process assured the surface temperature to reach to 80 °C for 2-3 log-cycle reduction of Salmonella. The experimentally obtained temperature data along the surface and interior points were used to validate the developed (using Comsol v5.6 - Comsol AB, Stockholm, Sweden) mathematical model. Then, this validated model was used to design an industrial scale infrared system heating efficiency and temperature uniformity of the processed samples.

In the industrial system designs, the effects of cavity geometry, number of infrared sources, number of onion samples and their physical movement through the cavity on the temperature evolution were determined. Rectangular and hexagonal geometry cavities, with 36, 48 and 54 infrared sources, were designed and increased amount of onion samples was processed to determine the temperature uniformity. Then, the effect of the sample movement was determined while the distance among the samples significantly affected the temperature evolution.

In conclusion, FIR processing was determined to be an efficient surface decontamination approach for dry onions. In addition, industrial scale system designs were introduced as a sustainable process with an improved temperature uniformity and heating efficiency. Hexagonal cavity system with 36 infrared sources was determined to have 2073.6 kg/day capacity.