

# Mechanistic Understanding of Food Microbiological Safety: Multiphase Transport Through a Leaf Stomate During Vacuum Cooling

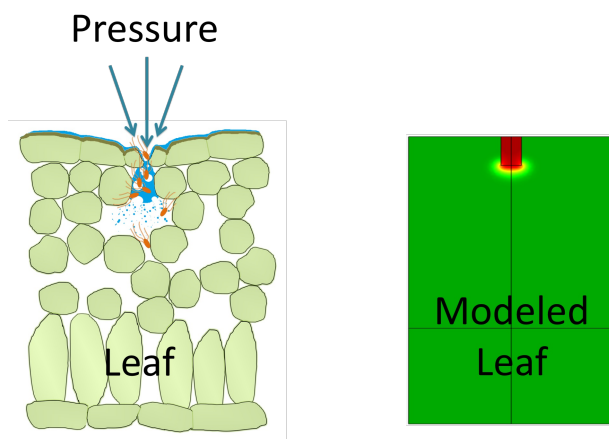
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## Abstract

Vacuum cooling is a common unit operation in the leafy greens industry and is considered as a very efficient approach to extend the shelf-life of fresh produce. However, during this popular process, bacteria can internalize into the produce. This emphasizes the need for better understanding of the internalization mechanisms and identification of the risk factors contributing to food-borne outbreaks. We developed and validated a coupled multiphase transport model to simulate internalization of pathogenic bacteria into fresh leafy greens during the vacuum cooling process. This mechanistic model includes transport of water and gas into/out of a leaf section through stomata, bacterial transport, and heat transfer in the leaf. The model was assumed to be axisymmetric around centerline of one stomatal opening. It was implemented in COMSOL Multiphysics® simulation software and solved for various conditions. The leaf structure was assumed as a porous media and a Darcy's Law module was used to solve for gas pressure within the porous zone. Vapor and air mass fractions were solved using a Transport of Concentrated Species module. The Transport of Diluted Species module was used to solve for water saturation and bacterial concentration. In addition, a Heat Transfer in Fluids module was applied to solve for temperature distribution within the leaf. The simulation results indicate that vacuum cooling helps internalization of bacteria by providing high pressure gradients when vacuum is being released.

## Figures used in the abstract



**Figure 1:** A mechanistic model developed by Mohsen Ranjbaran in Professor Datta's group predicts how human pathogenic bacteria infiltrate into the tissue of leafy vegetables through stomatal openings during a vacuum cooling process. The project was funded by Grant 2014-70003-22357 from the USDA National Institute of Food and Agriculture.