Effects of Freezing in Dried Cranberry Production

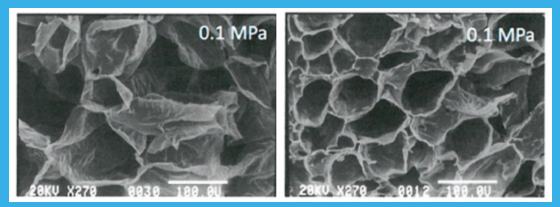
Errando B. Jayapurna (ChE), Logan Mies (ME), Stephen Stephansky (ChE), & Valentina Zapata (ChE)
Advisors: Stephen J. Kmiotek (ChE) & Sarah Jane Wodin-Schwartz (ME)

Abstract

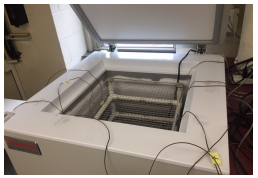
The purpose of this project was to study and identify the effects of different freezing conditions on cranberries for Ocean Spray's Sweetened Dried Cranberry (SDC) Production Line. This involved developing a lab-scale process which yields batches of frozen cranberries that underwent uniform freezing conditions. By understanding how different freezing conditions affect the cellular structure of cranberries, these effects can be better accounted for during the SDC manufacturing process. Fast freezing was found to promote more uniform freezing than slower freezing conditions.

Background

The rate at which fruit freezes affects both the chemical and physiological aspects of the food [1]. In slow freezing, ice crystals grow in extracellular locations, resulting in fewer but larger ice crystals [2]. Fast freezing produces many small ice crystals that form in the extracellular and intracellular medium. Therefore, fast freezing is usually preferable than slow freezing because it results in less damage to cell walls [1].



Slow Freezing Fast Freezing



Freezing

A RevcoTM Ultra-Low Temperature Freezer was used to freeze cranberries to -25°C and -40°C at two different rates.

Slicing

An Alligator® Slicer was used to slice frozen berries in 5 mm slices.

Extraction

Sliced berries were placed in water at a 3:1 ratio by weight. A custom built mixer was used to agitate the contents for 12 hours.

Infusion

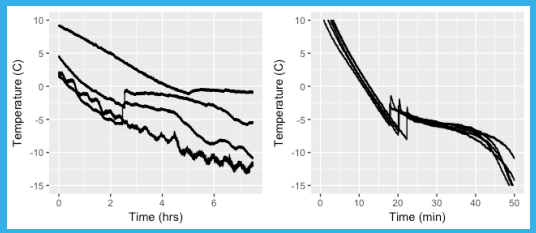
Extracted berries were placed in infusion syrup at a 9:1 ratio by weight. Gently stirred at 120°F for 12 hours.

Drying

A Magic Mill ® MFD-1010 Food Dehydrator was used to dry the infused berries at 167 °F for 20 hours.

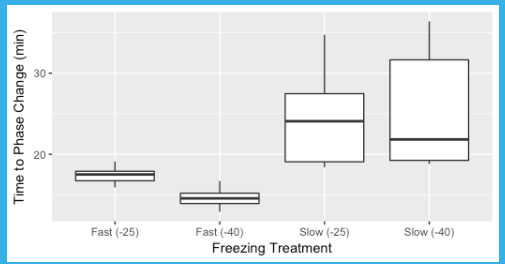
Results

Initial lab scale process runs led to variability between cranberry freezing curves, making variable traceability difficult in downstream lab scale processing. Our team's focus shifted to achieve uniform freezing throughout different freezer locations. By incorporating a rack and a mini fan, uniform freezing curves for all berries was accomplished.



Uniform Freezing

Fast freezing involved setting the temperature directly from the maximum freezer temperature (-10°C) to the final temperature (-40°C or -25°C). Slow freezing temperature rate was -3°C/hr. It was found that fast freezing had a more uniform time-to-phase-change than slow freezing.



[1] ASHRAE, Handbook of Refrigeration. SI version.Atlanta, GA: American Society of Heating, Refrigerating,and Air-Conditioning Engineers, Inc., 1994, [2] Petzold, G., & Aguilera, J. M. (2009). Ice Morphology: Fundamentals and Technological Applications in Foods. Food Biophysics
[3] Mahadevan, S., Salvi, D. and Karwe, M. V. (2016), High Pressure Enhanced Infusion in Fresh and Frozen Thawed Cranberries: A Comparative Study. J Food Process Eng