

Changes in the quality of apple tissue subjected to different freezing rates during long-term frozen storage at different temperatures

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Frozen storage is an energy-intensive process. There have been attempts by the leading FMCG groups to reduce the energy consumption and carbon footprint of this process by looking at options like elevating the current used standard storage temperature i.e. -18°C (Morrison, 2022) to -12°C . In such an event, a reduction in energy consumption of 24% by elevating the temperature from -18°C to -12°C was achieved in a pilot trial of ice cream storage, with products still being sold and quality still maintained by reworking the microstructure and the matrix better suited to warmer temperatures. Such an outcome encourages exploring the higher storage temperature impact on other food matrices as it would benefit three axes i.e. energy/cost, environment, and operator.

This study was designed to test the impact of higher storage temperature on the quality attributes of apples during a prolonged storage period. For this, apples having different initial microstructures (from different freezing rates), were stored at -18 and -12°C and the quality was evaluated every 30 days during the 90 days. As expected, the initial freezing rate (static freezing (SF), rapid freezing (RF), and ultra-rapid freezing (URF) at 0.97, 8.27, and 28 cm h^{-1} , respectively) significantly affected the quality attributes (i.e. firmness, drip loss, and microstructure) after freezing and during the storage period. URF best preserved the quality attributes of apple samples immediately after freezing, while RF better preserved the quality during the storage period of 90 days. During frozen storage, the greatest change in texture happened in the first 30 days, beyond which the difference in firmness was not significant. Similarly, drip loss increased gradually with the increase in storage time. Samples stored at a lower temperature (-18°C) were significantly firmer and had lower drip loss than those at a higher temperature (-12°C). However, the difference was not that huge. At the end of 90 days, the damage to apple microstructure could not be prevented even at -18°C ; huge configuration changes in ice and cell morphology compared to day 0 were observed. This encourages similar studies focusing on different food matrices of various sizes to be conducted.