



Freeze-drying and food matrix architecture

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Abstract: Freeze-drying is one of the complex unit operations in food processing (heat and mass transfer), although the technique dates back several centuries (the Inca peoples of the Peruvian Andes). Mainly, lyophilization describes dehydration of water from frozen product with the intervention of vacuum. The operation presents some constraints generated by: (1) the nature/complex structure of the food matrix; (2) structural and psycho-chemical changes induced during processing, (3) correlation with appropriate control techniques; (4) the absence of real models and simulations of the phenomenon. It is known that physical changes induced by the food during lyophilization are conditioned by the matrix (microstructure) of the product. Studies describe lyophilization as a three-step process: (1) freezing [$-40 \div (-)60^\circ\text{C}$]; (2) sublimation ($1 \div 0.1$ mmHg, $-20 \div (-)25^\circ\text{C}$); (3) desorption ($10^{-2}10^{-3}$ mm Hg, $20 \div 65^\circ\text{C}$). If water is the solvent, technically, lyophilization can be performed at a pressure of 4.58 mmHg and 0°C . On the other hand, the presence of cellular hydration water in the food matrix decreases the crystallization temperature below 0°C , conditioned by geometry, thickness of hydration layer and the entropy of the system. Although it is difficult to remove hydrating water and replace it with vacuum, is it easy to replace it with another molecular lawyer.

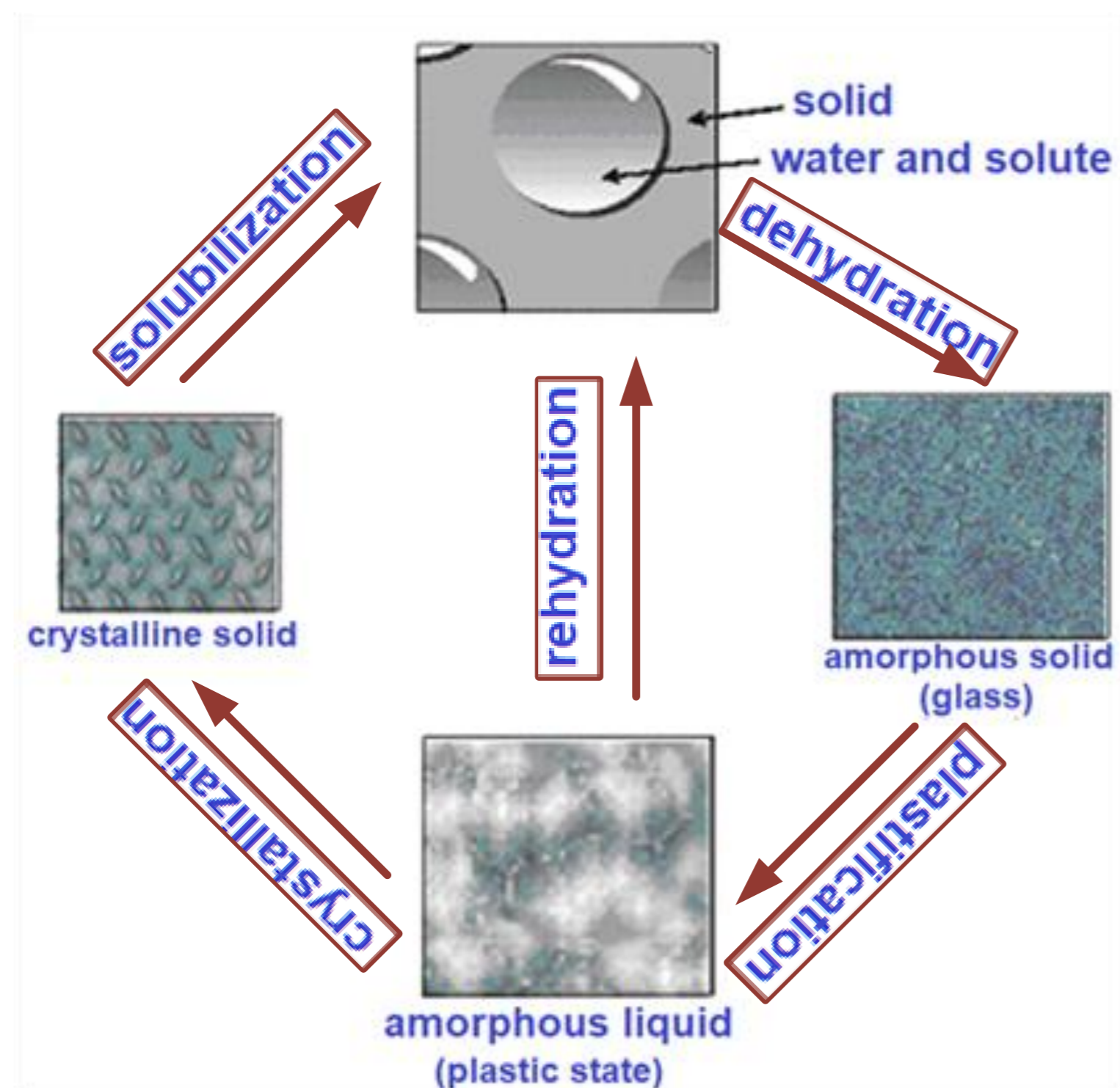


Fig. 1. Phase (glass) transition in the food matrix[1]

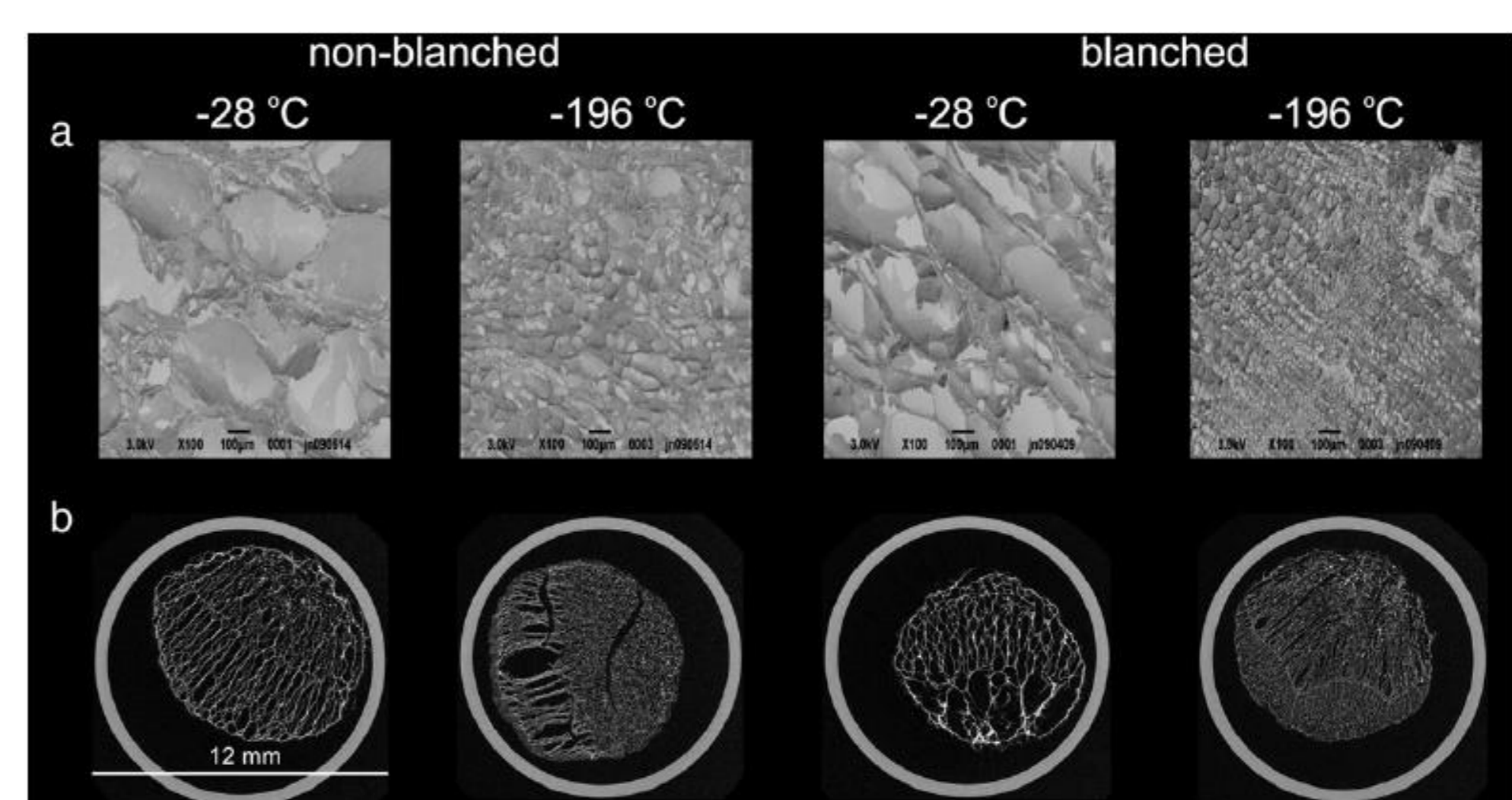


Fig. 2. (a) SEM and (b) μCT images of carrot tissue freeze-dried at -28 and -196°C , with and without blanching pre-treatment [2].

Conclusions

Under these conditions, the difficulties that may arise in the case of complete dehydration cannot be anticipated. The water present in the form of a narrow and viscous coating is difficult to remove, even if the attractive forces of the hydrophilic surface are moderate. The phenomenon is determined by the „strong” dependence between viscosity, freezing temperature and glass transition temperature.

Reference

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2. Adrian Voda et al, 2012, The impact of freeze-drying on microstructure and rehydration properties of carrot, Food Research International 49 (2012), p. 687–693

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