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Effect of Cellular Water Transport on Deformation of Food Material during Drying

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Abstract : Drying is a food processing technique where simultaneous heat and mass transfer take place from surface to the center of the sample. Deformation of food materials during drying is a common physical phenomenon which affects the textural quality and taste of the dried product. Most of the plant-based food materials are porous and hygroscopic in nature that contains about 80-90% water in different cellular environments: intercellular environment and intracellular environment. Transport of this cellular water has a significant effect on material deformation during drying. However, understanding of the scale of deformation is very complex due to diverse nature and structural heterogeneity of food material. Knowledge about the effect of transport of cellular water on deformation of material during drying is crucial for increasing the energy efficiency and obtaining better quality dried foods. Therefore, the primary aim of this work is to investigate the effect of intracellular water transport on material deformation during drying. In this study, apple tissue was taken for the investigation. The experiment was carried out using 1H-NMR T2 relaxometry with a conventional dryer. The experimental results are consistent with the understanding that transport of intracellular water causes cellular shrinkage associated with the anisotropic deformation of whole apple tissue. Interestingly, it is found that the deformation of apple tissue takes place at different stages of drying rather than deforming at one time. Moreover, it is found that the penetration rate of heat energy together with the pressure gradient between intracellular and intercellular environments is the responsible force to rupture the cell membrane.

Keywords : heat and mass transfer, food material, intracellular water, cell rupture, deformation
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