Molecular Mechanisms of Biostabilization

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Certain organisms can withstand extremes of temperature and osmotic stress. They do so by accumulating osmolytes, and thus altering the thermodynamic state of their intracellular water. Mimicking nature, researchers have been devising techniques to stabilize and store different products ranging from foodstuff to drugs. However, processing of these products for storage involves cooling and/or desiccation, which are inherently surface-induced phenomena. As such, they induce temperature, concentration and pH gradients within the medium, causing segregation of solutes and macromolecules. Additionally, freezing causes solute rejection, creating regions of high solute concentration in the medium. Freezing-induced partitioning of the solution into different thermodynamic phases (an ice phase, a freeze-concentrated liquid phase, and maybe even a precipitate solute phase) induces spatial segregation of the solutes within the solution, exposing them to different microenvironmental conditions. The local microenvironment continues to evolve as the medium is cooled/desiccated further and eutectic or crystalline phases form or as the freeze-concentrated region vitrifies. In this presentation, we present out recent research on detecting and quantifying microheterogeneity in frozen and desiccated formulations using conventional FTIR, the IRENI beamline and confocal Raman Spectroscopy.