

The Stabilising Effect of the Disaccharides Trehalose and Sucrose

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Disaccharides are known to stabilise proteins and inhibit aggregation. Among these, trehalose is widely recognised as an effective stabiliser of proteins in aqueous environments, although its mechanism remains incompletely understood. In our studies, we demonstrate that both trehalose and sucrose, two structurally similar disaccharides, can stabilise proteins. Differential scanning calorimetry results indicate that trehalose increases the glass transition temperature of proteins in aqueous solutions, which is consistent with quasielastic neutron scattering experiments showing that trehalose slows protein dynamics to a greater extent than sucrose. However, sucrose was found to elevate the denaturation temperature slightly more than trehalose. These differences may be explained by results from molecular dynamics simulations and neutron diffraction experiments which reveal that trehalose does not bind directly to proteins, while sucrose shows a modest tendency to interact more directly with the protein surface. These findings suggest that, despite their structural similarity, the two disaccharides contribute differently to protein stability: trehalose appears to enhance the glass transition temperature and dynamic stability at lower temperatures near the glass transition, whereas sucrose supports the structural integrity and thermodynamic stability slightly more than trehalose.