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Preferential Solvation and Thermal Stability of Proteins in Aqueous Solutions of Sugars and Polyols

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It is well known that the thermal stability of proteins is generally increased by the addition of sugars and polyols, but decreased by the addition of urea and guanidine hydrochloride. Such effects of cosolvents on the protein stability are related to the protein preferential solvation; that is, stabilizers such as sugars are excluded from proteins, while denaturants such as urea are adsorbed to proteins. The strength of the preferential interaction has been represented by a preferential interaction parameter, $\xi_3 = (\partial g_3/\partial g_1)_{T,\mu 1,\mu 3}$, where g_i, μ_i, and T is the concentration of component i, the chemical potential of component i, and temperature, respectively, and in a three-component system, water is designated as component 1, protein as component 2, and the cosolvent as component 3. The value of ξ_3 can be determined by densimetry, but the experimental data of ξ_3 have been limited.

Recently, we demonstrated that small-angle X-ray scattering (SAXS) was useful in quantifying the preferential solvation of proteins in aqueous solutions of sugars [1]. In addition to this, we can also provide a simple method for calculating ξ_3 on the basis of the SAXS data. For the validation of this method, we measured SAXS of lysozyme in aqueous solutions of glucose, sorbitol and glycerol, and calculated ξ_3 for these systems. The obtained values of ξ_3 were close to the literature values based on the densimetric experiments [2-4].

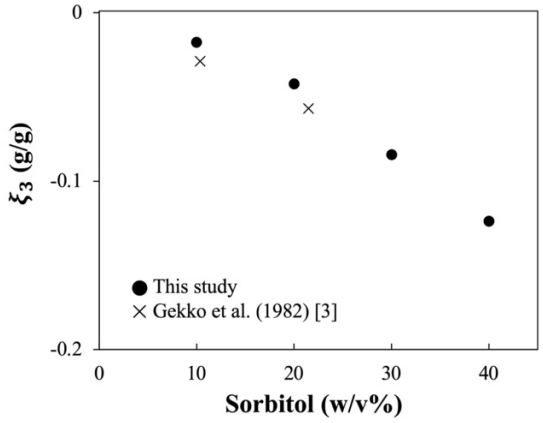

FIGURE 1. Preferential interaction parameter ξ_3 of lysozyme in sorbitol-water mixtures as a function of sorbitol concentration calculated from the SAXS data (this study, ●) and the densimetric data (Gekko et al. [3], ×).

REFERENCES

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