The Specific Volume of Bovine Serum Albumin in Multicomponent Solutions

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The specific volume of macromolecules is a critical parameter used in measurements of molecular weights from ultracentrifugation or small-angle X-ray scattering. According to previous results (1-4) the specific volume of proteins may change drastically in certain cases, and may cause erroneous molecular weight determinations (errors up to a factor of 2) if constant specific volume is assumed upon changing solvent conditions. Measurements were performed by determining the solution and solvent densities using a digital density meter (5).

Bovine serum albumin has been investigated in aqueous solutions of different salts, varying both the cation and anion, in a wide range of electrolyte concentration. After a slight downward bending of the $\phi^{\frac{1}{2}}$ vs. c_3 curve at small c_3, a linear increase of $\phi^{\frac{1}{2}}$ predominates; this range is sometimes followed by an asymptotic behaviour or slight decrease of $\phi^{\frac{1}{2}}$ (e.g. sodium citrate: $\Delta\phi^{\frac{1}{2}}/\Delta c_3 = 0.067$ $(cm^3g^{-1})/(mol\ l^{-1})$, $\Delta\phi^{\frac{1}{2}}$ max. 0.06 cm^3g^{-1}). The slopes of the linear increase may be correlated with the nature of the salt according to the Hofmeister series.

A similar behaviour was found in different buffer systems or in aqueous solutions of sugars. In the case of buffers the effect depends on the nature of the buffer components rather than its pH; in the case of sugars or polysugars, the effects can be correlated with the number of hydroxyl groups of the molecule.

Upon thermal, acid or basic denaturation, or in aqueous solutions of different denaturing agents (guanidine.HCl, urea, SDS), bovine serum albumin shows a non-linear decrease of $\phi^{\frac{1}{2}}$ which is sometimes overcompensated by an increase of $\phi^{\frac{1}{2}}$ at high c_3. The effects differ for different denaturants and with respect to additives like 2-mercaptoethanol, dithiothreitol, or salts. The results are comparable with the findings of viscometric studies.

The changes observed for $\Delta\phi^{\frac{1}{2}}$ may be attributed to a number of effects, for example charge screening, hydration, preferential ligand binding, unfolding of proteins etc. At present a clear-cut correlation cannot be given. It is evident that the results are not only valid for serum albumin, but also for other biopolymers, corresponding to the importance of charge and hydration for their structural characteristics.

(1-4) Durchschlag, H. et al., Hoppe-Seyler's Z.Physiol.Chem. (1978) 359, 1077-1078; (1980) 361, 237-239; Tuengler, P. et al. (1979) Anal.Biochem. 98, 481-484.
(5) Kratky, O. et al. (1969) Z.Angew.Phys. 27, 273-277.