THE IDEAL GLASS TRANSITION TEMPERATURE AND FRAGILITY PARAMETER FOR DIMERIC BOVINE β-LACTOGLOBULINE AQUEOUS SOLUTIONS

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β-Lactoglobulin is a major protein of the whey fraction of the milk of many mammals. At physiological conditions, bovine β-lactoglobulin (BLG) molecules form dimers. By using an Ubbelohde-type capillary microviscometer the viscosity measurements on aqueous solutions of BLG in the dimeric form, i.e. at concentrations above 118 kg/m^3 and up to 444 kg/m^3 were made. At each fixed concentration, the viscosity has been measured at temperatures ranging from 5°C to 55°C in 5°C intervals. The viscosity-temperature dependence has been quantitatively discussed on the basis of the Vogel-Tammann-Fulcher's equation. The three parameters of this equation: the ideal glass transition temperature (T_o), the fragility parameter (F) and the high temperature limit of viscosity (W) have been obtained by using the non-linear least square method. As appears, T_o of the solution ($T_{o,s}$) increases nonlinearly with increasing concentration of dissolved proteins (c) according to the relation:

$$T_{o,s} = \frac{c}{\alpha + c}(T_{o,p} - T_{o,w}) + T_{o,w}$$

where α is a parameter, and $T_{o,p}$ and $T_{o,w}$ are the ideal glass transition for protein and water, respectively. Because the ideal glass transition for water is known ($T_{o,w}$ = 147K), $T_{o,p}$ and α were only taken as the adjustable parameters. The best fitting was obtained for $T_{o,p}$ = (291 ± 8.5) K and α = (970 ± 76.5) kg/m^3. The fragility parameter F, in turn, enables on classification of the glass-forming systems onto strong and fragile liquids. It decreases with increasing concentration of BLG from about 2.9 (c = 119 kg/m^3) up to about 2 (c = 444 kg/m^3). It indicates that the aqueous solutions of BLG belong to extremely fragile class of liquids. The last parameter (W) obtained for BLG (taken in logarithmic scale) depends linearly on concentration.