Solution thermodynamical analysis of the interaction between salts and food components

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Summary

The mutual interaction of salts and food components were investigated through the analysis of the water activity measured by the freezing-point depression. The measurement of freezing-point depression, as compared with the measurement of the relative humidity, is easier, rapid in the measurement time, and applicable to the system including volatile components.

The concentration dependency of the water activity (a_W) of aqueous solutions of salts, such as NaCl, KCl and LiCl, was described well by the following two parameter equation for the activity coefficient of water (γ_W).

$$a_W = X_W \gamma_W \qquad (2)$$

$$\ln \gamma_W = \alpha X_S{}^2 + \beta X_S{}^3 \qquad (3)$$

where, X_W and X_S are the molar fraction of water and solute, respectively. Although the concept of water activity is useful in the food preservation through the effect on the growth of microorganisms, no information on the solution structure is given by the water activity. Therefore, the relatinship between the activity coefficient of water and the solution structure was analyzed. The parameters α and β in the Eq.(2) were proved to have a good correlation with the B-coefficient of viscosity for the solutions of monovalent ions. As the B-coefficient of viscosity is established to be an index of the solution structure, the parameters α and β in Eq.(2) can be a new index of the solution structure.

The solute-solute interaction was analyzed from the difference in the water activities measured and predicted by the theory neglecting the solute-solute interaction for multicomponent systems including salts. Apparently the solute-solute interaction was very weak for the solution of salt mixed with sugars and nonelectolytic polymers while it was strong for the system with salt mixed with organic acids (acetic acid, citric acid) or polyelectrolytes (xanthan, pectin).