Complexation Thermodynamics and Chiral Discrimination of Various Guests by Native and Modified Cyclodextrins. A Microcalorimetric Study.

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天然および修飾シクロデキストリンによる包接の熱力学と不斉識別. 微少熱量測定による研究

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The comprehensive microcalorimetric study on chiral discrimination of various guests by native and modified cyclodextrins was consisted of two parts: 1. chiral discrimination of various guests by native cyclodextrins (predominantly by β-cyclodextrin); 2. chiral discrimination of various guests by modified cyclodextrins ((predominantly by mono- and di-aminated cyclodextrins);

1. The complex stability constant (K), standard free energy (ΔG_i), enthalpy (ΔH_i), and entropy (ΔS_i) for the 1:1 inclusion complexation of 43 enantiomeric pairs of chiral guests with β-cyclodextrin at 25 ¡C have been determined by microcalorimetry. The overall complexation thermodynamics are related to variations in the structure of the cyclic and acyclic guest, including its aromatic or aliphatic nature, the chain length, branching, flexibility, charge, and incorporated oxygen atom. The differences in the thermodynamic parameters due to the chirality are comprehensively discussed in terms of the stereochemistry, skeleton, chain length, and functional groups of the guest, and the mode of penetration upon inclusion complexation. The enthalpy-entropy compensation plot, using the differential thermodynamic parameters ($\Delta\Delta H_i$ and $T\Delta\Delta S_i$ at 298.15 K) for the chiral recognition equilibrium, gave an excellent straight line of unit slope, from

which the isokinetic, or isoenantiodifferentiating, temperature was calculated as 25 ¡C for this chiral recognition system using a β-cyclodextrin host.

2. The stability constant (K), standard free energy ($\tilde{}\ G_{¡}$), enthalpy ($\tilde{}\ H_{¡}$), and entropy ($\tilde{}\ S_{¡}$) for the complexation of 6-amino-6-deoxy-β-cyclodextrin and several diaminated β-cyclodextrins with more than 50 negatively- or positively-charged as well as neutral guests, including 22 enantiomer pairs, have been determined in aqueous phosphate buffer (pH 6.9) at 298.15 K by titration microcalorimetry. The thermodynamic parameters obtained in this study and the relevant data for native β-cyclodextrin indicate that the complexation and chiral discrimination behavior of the cationic host with charged guests are governed by the critical counterbalance between the electrostatic interactions of the charged groups in host and guest and the conventional intra-cavity interactions of the hydrophobic moiety of guest, such as hydrophobic, van der Waals, solvation/desolvation, and hydrogen bonding interactions.