Effect of pressure on the secondary structure of designed peptides

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Pressure is a vitally important physical parameter to determine thermodynamics of protein folding. Although, as has long been known, pressure induces proteins to unfold, the mechanism is still under debate. From the viewpoint of the structural hierarchy of proteins, elucidating effect of pressure on secondary structures is crucial step to unravel the mechanism. The present study focused on designed peptides, which form secondary structures by themselves without tertiary structural interactions, as models of protein's secondary structures.

Chapter 1 described the purpose and the background of the present thesis. In chapter 2, the effect of pressure on AK20 forming a monomeric α-helix was investigated. An increase in the intensity at 1633 cm-1 and narrowing of the bandwidth of the infrared amide I' band of AK20 indicates that pressure induces the α-helix to fold. The change in the partial molar volume upon helix-coil transition at 4.5~69.5 C were distributed in the range of 0.87~1.4 cm3 mol-1 res-1. In chapter 3, the effect of pressure on GCN4-p1 forming amphipathic α-helices was investigated. The change in the amide I' intensity indicates that pressure induces the helices to fold. In chapter 4, the effect of pressure on the peptides forming a β-hairpin structure was investigated. The changes in the amide I' intensities by pressure indicate that pressure induces the β-hairpin structures to unfold. The result also showed that the magnitude of the volume change becomes lager, as the β-strand is longer. Fluorescence resonance energy transfer measurement indicated that pressure increases the end to end distance of the β-hairpin peptide. In chapter 5, it is concluded that the volume change upon unfolding of an α-helix structure is positive and that of a β-hairpin is negative. Based on these, a possible mechanism underlying pressure-induced unfolding of proteins was proposed.