Radiation-Induced Sol-Gel Transition of Protein: Effects of Radiation on Optical Rotation

Ionizing radiation influences strongly the chemical and conformational properties of biological macromolecules.[1,2] Some biological macromolecules, such as proteins, form a hydrogel.[3-5] Since the mechanism of the sol-gel transition of protein is a topic of general interest, it was decided to investigate the effects of radiation on the conformational property of protein. Gelatin was selected as the protein molecule, since it was described in a previous report.[6]

The changes in the conformational property can be followed conveniently by measuring the optical rotation of the irradiated protein.

EXPERIMENTAL

Materials

Gelatin and all other reagents used in this work were the same as those described previously.[6]

Apparatus and Procedure

In irradiation, the solid gelatin was irradiated by ^{60}Co gamma rays in air at room temperature at a dose rate of 1.0×10^5 rad/h.

In polarimetry, the irradiated solid gelatin was dissolved in 0.2 *M* KCl solution at room temperature and held at desired temperature for 2 h. Then the optical rotation of the solution was measured with a Horiba polarimeter.

In the calculation of the activation energy required for conformational change of gelatin molecule, the general linearity of plot $\log[\alpha]$ versus $1/T$ indicates a constant activation energy for conformational change and the valid application of the Andrade equation over a range of temperatures. The following relation for the shift in optical rotation with temperature was thus employed

$$[\alpha] = A\,e^{-E/RT}$$

where E is the activation energy (kcal/mol) of conformational change; T, absolute temperature; R, gas constant, 1.987 cal/mol and A, an adjustable constant.

RESULTS AND DISCUSSION

The changes in specific rotation of gelatin at various radiation doses were studied with 0.6% gelatin in 0.2 *M* KCl. Figure 1 shows the relation between the values of the specific rotation and the radiation dose. Also, the changes in activation energy required to induce conformational change of gelatin with irradiation were estimated from a plot of $\log[\alpha]$ versus $1/T$. Figure 2 shows the relation between the values of the activation energy and the radiation dose. From these results it is clear that the specific rotation and the activation energy are decreased depending upon the irradiation. If such changes in optical rotation and activation energy with irradiation are due to destruction of the conformational order of gelatin molecule, increased radiation should result in further destruction, and the optical rotation and the activation energy should continue to decrease. This corresponds to the observed optical rotation and activation energy changes (see Figs. 1 and 2).

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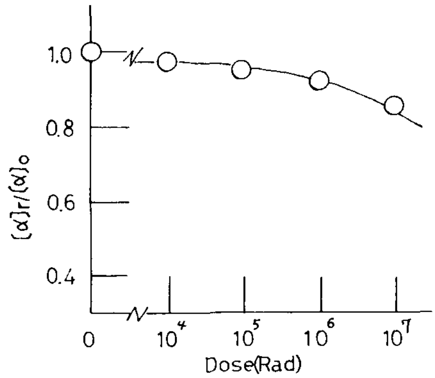

Fig. 1. Specific rotation ratio ($[\alpha]r/[\alpha]o$) versus radiation dose. Conditions: 0.6% gelatin in 0.2 *M* KCl at 15°C.

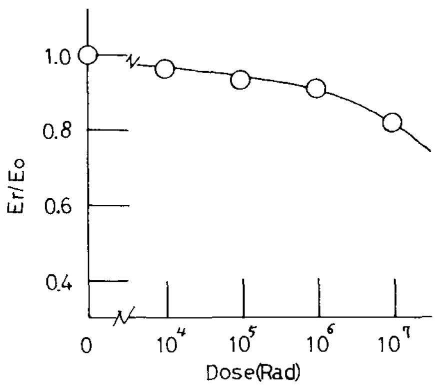

Fig. 2. Activation energy ratio (E_r/E_o) versus radiation dose.

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