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# Radiation Chemical Studies of Protein Reactions: Effect of Post-irradiation on Viscosity

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## Synopsis

Protein was irradiated by gamma rays from a cobalt 60 source. At different times after irradiation, the reactivity decay of the irradiated protein was examined. An empirical equation for the reactivity decay was obtained.

## INTRODUCTION

It is well known that reactivity of irradiated molecules varies with the time after irradiation.[1-5] Since the effect of radiation on protein reaction is a problem of general interest,[6-8] it was therefore felt to investigate the effect of postirradiation on the change in shape of the external envelope of the protein molecule.

The urea denaturation of protein was selected as the change in the shape of the external envelope of the protein molecule. The determination can be followed conveniently by measuring the viscosity of the solution as a function of time after gamma irradiation.[6-8]

## EXPERIMENTAL

### Materials

Albumin and urea used in this work were commercial materials produced by the Kanto Chemical Co., Inc.

### Apparatus and Procedure

An irradiation source containing about 300 curies of $^{60}$Co was used. The dose rate in this work was $1.7 \times 10^3$ R/hr. The solid albumin was irradiated in air at room temperature. At different times after irradiation the irradiated albumin was dissolved in distilled water and mixed with urea solution. The viscosity was then measured.[6]

## RESULTS

The changes in reduced viscosity of albumin at different times after gamma irradiation were studied, with 3% albumin in 10*M* urea, $10^3$R, and 30°C. The results are shown in Figure 1.

From this it is clear that the decrease in the reduced final viscosity ($\eta$) with lapse of time after irradiation indicates a postirradiation effect in the protein molecule.

## DISCUSSION

As stated above, it is known that the reactivity of an irradiated molecule varies with the time after irradiation.[1-5] A discussion of the postirradiation effect on the change in shape of the external envelope of the protein molecule follows. The change in shape of the external envelope of the protein molecule is estimated from the change in reduced viscosity, and this change is given in Figure 1. The relation between the change in reduced

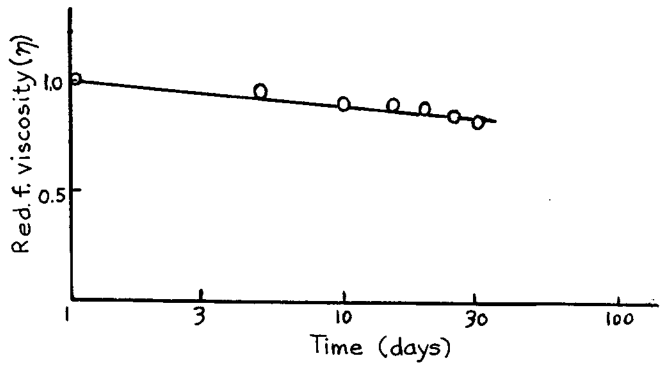


Fig. 1. Relation between final reduced viscosity and time after irradiation.

viscosity and the time after irradiation is related to that between the change in shape of the external envelope of the protein molecule and the time after irradiation. When the concentration of protein and of urea and the radiation dose are all constant, a change with time after irradiation results in the change in reduced viscosity required for the change in shape of the external envelope of the protein molecule. The reaction mechanism must, therefore, depend on the time after irradiation. If the main processes for the reactivity of protein are assumed to be

$$\text{P—P} \xrightarrow{h\nu} \text{P}^* + \text{P}^* \tag{1}$$

$$\text{P}^* + \text{P}^* \rightarrow \text{P—P} + E_a, \tag{2}$$

where P—P is the protein molecule, P* is the irradiated protein molecule, and $E_a$ is the activation energy of gamma rays, then the reactivity decay step may be eq. (2), which means that the observed viscosity change is related to the time after irradiation. Therefore the response of the change in shape of the external envelope of the protein molecule to the time after irradiation can be determined by measuring the reduced viscosity.

If in the system $t$ is time after irradiation and $a$ and $b$ are adjustable constants, then one obtains

$$\text{red.f.}(\eta) = a - b \log t. \tag{3}$$

This formula agrees with the experimental data plotted in Figure 1.

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