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THE SENSITIZED FLUORESCENCE OF CHLOROPHYLL A BY CAROTENOID

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The sensitized fluorescence of chlorophyll a (Chla) by carotenoid (Car) was studied. The transmission efficiency was estimated and the effect of accepter concentration on the transmission efficiency was analyzed.

1. INTRODUCTION

There is a large amount of algae in the natural world. In the pleurochloris, although there are only two kinds of photosyn pigments i.e. Chla and Car, photosynthesis still performs normally. This fact shows that there is energy transmission between Car and Chla. So studying the energy transmission between them is helpful to understanding the mechanism of primary reaction of photosynthesis.

The phenomena of the sensitizing of Car to the fluorescence of Chla were studied at room temperature. The efficiency of energy transmission and the type of interaction between Car and Chla were estimated in this work.

2. EXPERIMENTAL

The optical measurements were performed with the RF-520 Dual Beam difference Spectrofluorophotometer and the UV-200 Spectrophotometer. The samples were separated from spinach by chromatograpy.

3. RESULTS AND DISCUSSION

3.1. The sensitization fluorescence of Chla by Car

Exciting Chla and mixed solution of Car and Chlas with the light of 454 nm, it is found that the intensity of Chla in the mixed solution was twice as large as that in the pure Chla solution. This is an evidence of energy transmission between Car and Chla. By measuring the quenching of fluorescence of the energy donor Car, following formula can be used to estimate the transmisson efficiency between Car and Chla:

$$T = 1 - f^{S,A} / f^{S} \qquad (1)$$

Where, $f^{S,A}$ and f^{S} are the intensities of Car in benzene solution with and without Chla, respectively. When the concentrations of Car and Chla were $1X10^{-4}$M and $5X10^{-7}$M respectively, the transmission efficiency from Car to Chla is T = 0.55.

3.2. The Forster's critical distance of energy transmission between Car and Chla.

Forster showed the mechanism of resonance transmission of energy and gave the rate of energy transmission between donor and accepter as below:

$$K_{(S^*-A^*)} = \frac{9000 \ln 10 k^2 P_S}{128 \pi^5 n^4 t_S N_\circ r^6} \int f_S(v) E_A(v) v_\circ^{-4} dv \qquad (2)$$

Where, S and A are energy donor and accepter, k is the space factor, P_S is the fluorescence yield, n is the index of refraction of the solvent, $N_\circ$ is Avogadro number, v is the wave number, E is the molar absorptivity.

When K is equal to the rate of deexcitation of spontaneous radiation of energy donor, namely, $K \cdot t_S = 1$, we get

$$R_\circ^6 = 8.8 \ X \ 10^{-25} P_S k^2 n^{-4} \int f_S(v) E_A(v) v_\circ^{-4} dv \qquad (3)$$

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Substituting the experimental data into (3), we get $R_\circ$ = 35.54Å, the $R_\circ$ is Forster critical distance.

3.3. The effect of concentration of Chla on the efficiency of energy transmission

The luminescence of Chla was increased and the luminescence of Car was decreased with increasing of concentration of Chla. This fact showed that when the concentration of Chla was increased the interactive distance between the donor and accepter was decreased and the efficiency of energy transmission was increased.

The transmission efficiency between donor and accepter is

$$T = K / (t_s^{-1} + K) \qquad (4)$$

Substituting (3) into (2), we get

$$K_{(S^*-A^*)} = 1 / t_s R_\circ^6 r^{-6} \qquad (5)$$

and substituting (5) into (4), we get

$$T = R_\circ^6 / (r^6 + R_\circ^6) \qquad (6)$$

Using the value of T taking from (1), we can get the interactive distance r between donor and accepter,

$$c^2 r^6 \doteq 3 \times 10^{-4}\ M^2\ \text{Å} \doteq \text{constant}(A) \qquad (7)$$

Substituting (2) into (6), we get

$$T = R_\circ^6\, c^2 / (c^2 R_\circ^6 + A) \qquad (8)$$

Under normal conditions the concentration of Chla in chloroplast of algae is 10^{-3}M. According to formula (8), at this concentration of Chla the efficiency of energy transmission between Car and Chla is about 100%. This result consists with many reports.

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