ON THE RELATION BETWEEN SIZE AND PHOTOCHEMICAL ACTIVITY OF FRAGMENTS OF SPINACH GRANA

by

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Grana fragments were prepared by supersonic disintegration of a grana suspension and by subsequent fractional centrifugation. The photochemical activity was studied in the HILL reaction using quinone as a hydrogen acceptor. The activity of these suspensions was expressed as a percentage of that of a non-vibrated control.

In order to determine the particle size, electron-micrographs were taken; the diameter of all particles occurring in a square μ was measured at a magnification of 32,500.

The reliability of these methods was checked by various informative experiments.

A pronounced activity decrease was found to occur on diminishing the particle size below 10^6 A^3. Assuming with RABINOWITCH[1] that the chlorophyll concentration in the grana amounts to 0.06–0.2 *M*, it was computed that a particle of this critical size contains 40 to 120 chlorophyll molecules. The inactivation of the particles by reduction of their size below the critical volume proved to proceed gradually. The activity was totally lost in particles of a volume of about $2 \cdot 10^5$ A^3.

The results obtained can be explained by assuming that one molecule of a photosynthetically active enzyme occurs per about 100 chlorophyll molecules. In flashing light experiments with intact *Chlorella* cells, CLENDENNING and EHRMANTRAUT[2] showed that the period needed for the completion of the dark reaction is the same for the reduction of carbon dioxide as well as of quinone. From these data they concluded that, most likely, the same enzyme participates in both processes. This suggests that we may be correct in assuming that the rate-limiting enzyme in the flashing light experiments of EMERSON AND ARNOLD[3] is identical with the enzyme occurring per 100 chlorophyll molecules as it was concluded from our experiments. This means that this enzyme is not directly involved in carbon dioxide reduction.

EMERSON AND ARNOLD[3] demonstrated that 2500 chlorophyll molecules are present per one carbon dioxide molecule reduced per flash at saturation. If we assume that the above-mentioned limiting enzyme is able to allow the reduction of one carbon dioxide molecule during its working period, it follows that this enzyme occurs in a concentration 1/2500 of that of chlorophyll.

If we furthermore assume that the carbon dioxide reduction as measured by EMERSON AND ARNOLD[3] is a ten-quanta reaction, whilst the blocking of the above enzyme requires the absorption of n quanta, the number (N) of chlorophyll molecules present per one enzyme molecule amounts to:

$$N = n/10 \cdot 2500$$

Since, in our experiments, N proved to amount to about 100, n can be calculated to be about $\frac{1}{2}$. However, since the quantities used for the computation of n are only approximations, we may merely suggest that the value of n is of the order of magnitude of unity. This would mean that the process in which the mentioned enzyme acts in photosynthesis is the result of a one-quantum reaction.

Formally we may call a combination of one enzyme molecule with a number of chlorophyll molecules, in some way related to this enzyme, a photosynthetic unit. In this manner even FRANCKS'[4] conception agrees with this unit definition. However, since there is as yet no definite evidence either of some structure or of the way in which the chlorophyll molecules correspond with an active centre, we prefer to refrain from the use of the term "unit".

A detailed report of this study will be published in a forthcoming issue.

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Received September 12th, 1952

* This investigation has been made possible by a grant of the Netherlands Organisation for Pure Research (Z.W.O.).