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THE EFFECT OF ELECTROMAGNETIC FIELD ON ENZYMIC SUBSTRATES

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EDITORIAL NOTE

In three papers published elswhere[1-3], the author has presented experimental results and a theoretical discussion concerning the effect of an electromagnetic field on enzymic substrates. In view of the fact that the surprising results, with very important theoretical implications, have not yet been confirmed by others, the Editors have decided not to accept a fourth paper on the same topic, but to request the author to publish a detailed description of the experimental procedure used in order to enable others to repeat the experiments under exactly the same conditions.

The author agreed to this request and his paper is published herewith.

We have recently reported that the irradiation of an enzymic substrate S, with light ranging from the ultraviolet to the red spectral region, induces a particular type of physical $S \rightarrow S^*$ transition. The S^* state thus realized induces an initial rate effect detected through the increase of the $\Delta A \cdot \text{min}^{-1}$ during the course of the enzyme reaction, as compared with the control containing nonirradiated substrate run essentially under the same conditions[1]. The irradiation of the substrates (analytical grade level) is performed on *powder layers*, thinly spread on the bottom of small plastic cups. Superpositions of many crystalline layers must be avoided. The upper limit of the substrate weight is approximately 2–3 mg/cm^2. The irradiated samples are immediately dissolved in bidistilled water and the corresponding amount taken into the reaction mixtures. Irradiations may be performed with Hg lamps or with (common) tungsten lamps. For the Hg lamps, a *high-pressure type* (with a strong line spectrum in the visible region) is necessary. The medium or low-pressure Hg lamps give only poor effects. The power of the lamp is not a critical parameter. Absorbed powers ranging from 70 to 500 W for the Hg sources and from 70 to 250 W for the tungsten sources give similar effects. The beam of the lamps is collimated by a suitable slit, mounted at lamp level. No additional lenses or reflectors are introduced (Fig. 1A). The greatest effects (i.e. maximum of $S \rightarrow S^*$ yields) are induced with *light of* $\lambda = 546$ *nm*. The optical filters used to isolate this line must be of the Hg-mono type. The critical parameter of the filters *is not* the transmittance, but the bandwidth (Fig. 1B). For the tungsten lamp irradiations a clear $\Delta\lambda$ effect is recorded (*i.e.* the $S \rightarrow S^*$ yield decreases with the broadening of the filter bandwidth). The best results are obtained with a

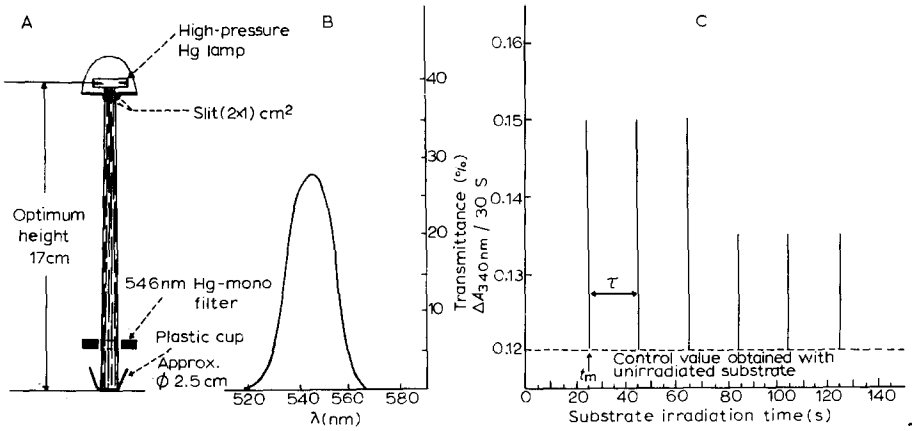

Fig. 1. A. The set-up for the substrate irradiation experiments. B. The effective bandwidth for the $\lambda = 546$ nm Hg-mono type of optical filters. C. Periodic enhancements of the glucose-6-phosphate dehydrogenase reaction rate, obtained with irradiated glucose 6-phosphate. Reaction mixture: glucose 6-phosphate(disodium), 1.24 μmoles; $MgCl_2$, 20 μmoles; NADP, 1.25 μmoles; in 0.05 M Tris–HCl buffer, pH 7.6; final volume 2.7 ml. The reaction is initiated at 26 °C with 0.20 μg enzymic protein (yeast source) and the $\Delta A_{340\ nm}$ recorded as a function of time. Layers of 2 mg glucose 6-phosphate are irradiated and dissolved in 0.5 ml bidistilled water. High-pressure Hg lamp; $\lambda = 546$ nm filter; distance, 17 cm; t_m value, 25 s; τ value, 20 s.

high pressure Hg lamp and a (sharp) monochromatic $\lambda = 546$ nm filter. All irradiations are performed in air and are perpendicular to the substrate powder target, as follows: The lamp is connected and the slit obturated with an opaque shield. The cup containing the substrate is positioned so that the powder surface is completely and homogeneously covered by the light spot. The irradiation is started with the removal of the shield and time is followed from this point with a stopwatch. On completion of irradiation time, the slit is quickly obturated again with the opaque shield. The modulation of the irradiation time—within 0.1 sec accuracy—gives reproducible effects. The optimum heights (from the target to the lamp filament) of the irradiation sources are between 14 and 22 cm for the Hg lamps, and between 12 and 14 cm for the tungsten lamps. With this experimental set-up, six periodic enhancements of the initial enzymic reaction rate are recorded, appearing like 'signals', *only at well-defined* substrate irradiation times (Fig. 1C). The minimum irradiation time that induces the first effect (t_m) as well as the τ-period that delimits two successive effects are entirely determined *by the enzyme*. They are new enzymic parameters. In this context, an alternative type of metabolic control mechanism has been advanced, on a theoretical as well as on an experimental basis[2,3].

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