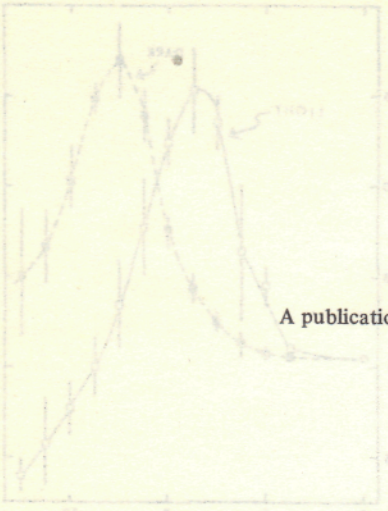

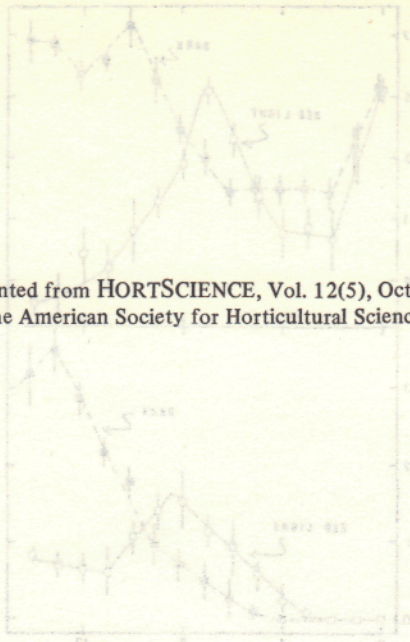

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Red Light Advances Respiration and Ethylene Evolution in Ripening Tomatoes[1]

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Abstract. **Mature-green tomatoes (*Lycopersicon esculentum* Mill.) irradiated with red light, display an advance of 3 days in pigment changes, climacteric rise, and ethylene production.**

Light has been shown to enhance carotenoid biosynthesis in ripening tomatoes (4,8) and the process is partially mediated by phytochrome (9). The presence of phytochrome in tomato fruit was recently demonstrated conclusively by *in vivo* measurement (6). It was of interest to examine whether the effect of light is limited to biosynthesis of carotenoids by comparing physiological parameters such as the respiration climacteric pattern and ethylene production of light-treated and control tomatoes during ripening.

Mature-green 'Cal Ace' tomatoes were grown at the USDA station in Beltsville, Maryland and later obtained from a commercial packinghouse in California and shipped to Beltsville by air for replicate experiments. Tomatoes were sorted for uniform size, color, weight, and maturity. Maturity was based on differential optical density measurement (11). Twelve tomatoes were placed in each of 2 identical Percival growth chambers with one used for red light treatment at 14 hr/day

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and the other for dark control. The tomatoes were maintained at 23 ± 0.5°C and high relative humidity as described previously (4,9).

For measurement of CO_2 and ethylene production, the tomatoes were removed daily from the chambers and enclosed individually in wide mouth 1 pint jars covered with black cloth. The jars were held at 20°C and ventilated with filtered, humidified air metered at a rate of about 10 ml/min. The air was cleaned of contaminants including ethylene by passing through a Purafil filter before being metered. After 2 hr of incubation in the dark, duplicate gas samples were withdrawn from each jar and analyzed for CO_2 with a Fisher-Hamilton model 29 gas partitioner. After 2 more hr of incubation, duplicate gas samples from each jar were analyzed for ethylene with a Hewlett Packard Model 7620A gas chromatograph equipped with Model 3370B integrator and teletype printout system (6). The tomatoes were then returned to the chambers for light treatment.

The respiration rates and ethylene production of each fruit were calculated, and the average and standard deviation of the results are shown in Fig. 1. The climacteric rise and ethylene production were advanced by about 3 days in tomatoes treated with red light. The maximum rates of CO_2 and of ethylene production were somewhat higher in dark control than in light-treated fruit. At the breaker stage (day 7 for red light-treated fruit and day 10 for dark-treated fruit), the rates of ethylene production by light-treated and dark-control fruit were similar. Fig. 1 shows that the respiration rate at breaker stage was slightly higher in control than in light-treated fruit. This difference probably was not significant, because the rate at the preclimacteric minimum was slightly higher for the control than for the light-treat fruit. Boe et al. (2) reported that the respiration rates of tomatoes after 5-8 days of light treatment were slightly lower than those of the dark control. In our study, tomatoes that ripened under the influence of red light were normal in all ripening characteristics as reported previously (5). Khudairi (7) reported that ethylene production is accelerated by red light and delayed by far red light but showed no dark control. In our experiment, the ethylene produced by the tomatoes exposed to red light was probably sufficient to promote normal ripening.

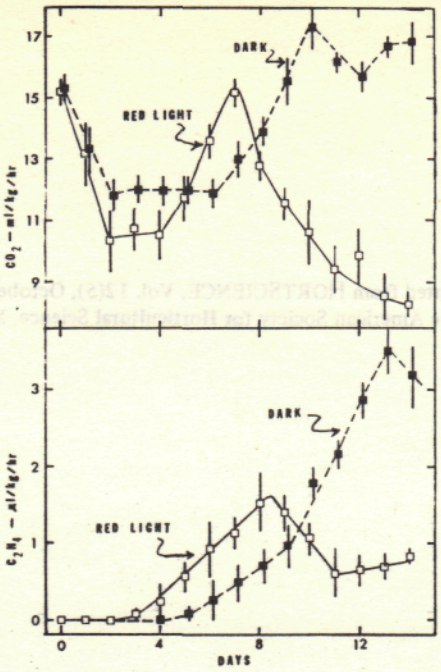

Fig. 1. Rate of CO_2 and ethylene production at 20°C by 'Cal Ace' tomatoes treated for 14 hr daily with red light or kept continuously in dark. Lines connect the average values calculated from individual fruit. The vertical bars represent the standard deviation.

Pigment changes as determined by ΔOD (510–600 nm) readings (10) were also advanced by about 3 days when fruit were exposed to red light (Fig. 2). Fruit with a ΔOD (510–600 nm) of +1.4 indicates the tomato is at 'breaker' stage (11). The patterns of pigment change in light-treated and dark control tomatoes were similar.

The above results suggest that red light accelerates other aspects of tomato ripening in addition to the biosynthesis of carotenoids (8,9). Red light irradiation induced the conversion of P_r to P_{fr}, presumably the physiologically active form of phytochrome. According to current theory, the reaction mechanism of phytochrome is to change the membrane permeability of cells (3). Biale (1) has proposed that change in membrane permeability accounts for all the anabolic and catabolic activities in fruit ripening. The effect of red light on tomato ripening via phytochrome activation fits well into this proposal.

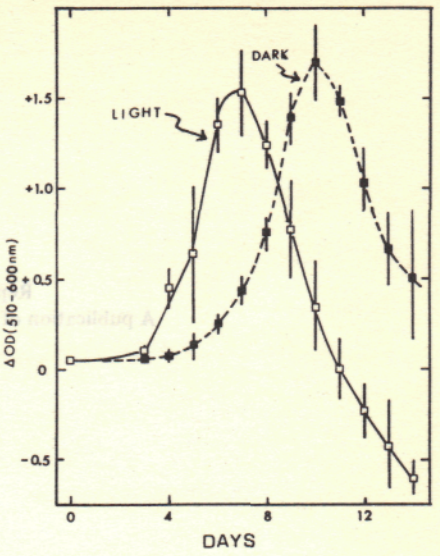

Fig. 2. Pigment changes as indicated by ΔOD (510–600 nm) values of 'Cal Ace' tomatoes treated with red light or kept in dark at 23°C. Vertical bars represent the standard deviations.

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