Effects of 4-[β-(Diethylamino)-Ethoxy]-Benzophenone upon Carotenogenesis in *Rhodospirillum rubrum*

**ERNEST P. HAYMAN** and **HENRY YOKOYAMA**

*Fruit and Vegetable Chemistry Laboratory, Western Region, United States Department of Agriculture, Agricultural Research Station, Pasadena, California 91106*

Received for publication 23 March 1976

Carotenoid production was determined in illuminated anaerobically maintained cultures of *Rhodospirillum rubrum* in media with and without 4-[β-(diethylamino)-ethoxy]-benzophenone. In treated cultures, lycopene—which normally is not produced by *R. rubrum*—accumulated as the predominant pigment, and total carotenoids increased five- to sixfold.

Since the introduction of bioregulators of carotenoid biosynthesis by Coggins et al. (1), more than one hundred such compounds have been developed in this laboratory. Nearly all the work to date has centered around the bioregulator's effects on fruit and on heterotrophic microorganisms, whereas photosynthetic organisms have been ignored. We now have investigated the effects of 4-[β-(diethylamino)-ethoxy]-benzophenone upon the photosynthetic bacterium *Rhodospirillum rubrum*. Hsu et al. (8, 9) determined that the compound inhibited cyclization in carotenogenesis and induced carotenoid biosynthesis in general on grapefruit and on Blakeslea trispora. Since this bioregulator inhibits cyclization, we wanted to study its effects on *R. rubrum* because, unlike the other systems studied, its normal complement of carotenoids consists of acyclic carotenoids only (2-6, 12, 13).

Growth of *R. rubrum* strain 1.1.1. in an 8-liter batch culture at 20°C was maintained anaerobically by bubbling a gas mixture of 95% N₂ and 5% CO₂ through the medium which was illuminated by two 300-W incandescent light bulbs 15 cm from the carboy. The medium was identical to that used by Davies (2). The bioregulator was added to the medium (100 μg/ml) 24 h after inoculation to minimize any inhibitory effects upon growth. Cells were harvested at the maximum stationary phase of growth by continuous-flow centrifugation, and the wet packed cells were disrupted by the method of Hayman et al. (7). The carotenoids were separated and identified by the methods of Davies (3).

The data in Table 1 are typical results. The hydrocarbon lycopene, which was absent in the control culture or *R. rubrum*, accumulated to 57.5% of the total carotenoids produced by the treated culture. That accumulation apparently was at the expense of the dimethoxy compound spirilloxanthin, which decreased from 80.0 to 10.6%. There were small increases in the mono- methoxy compound anhydrorhodovibrin and the monohydroxy compound rhodovibrin. The accumulation of total carotenoids increased five- to sixfold.

These results indicate that 4-[β-(diethylamino)-ethoxy]-benzophenone inhibited hydroxylation at the C1 and C1′ positions and induced carotenoid accumulation in general. Kleinig (11) observed the same two effects in *Myxococcus fulvus* treated with 2-(4-chlorophenylthio)-triethylamine hydrochloride but drew a different conclusion about the increased carotenoid synthesis. Kleinig's organism accumulated carotenoids at the end of the log phase of growth and was somewhat inhibited in its growth by the bioregulator.

Kleinig, therefore, attributed the increase in total carotenoids to changes in the environment at the end of log phase of growth rather than to derepression at the gene level as hypothesized by Hsu et al. (10). The results of our study, however, seem to support the conclusion of Hsu et al. (10). Carotenoids were observed to accu-
mulate throughout growth in *R. rubrum* and not only at the end of the log phase of growth. Because the bioregulator was added 24 h after inoculation, growth inhibition was less marked than in Kleinig's experiment (11) where the bioregulator was added immediately.

The carotenoids have been implicated in the photosynthetic process alternately as accessory pigments or as photoprotectors. The photosynthetic rates of *R. rubrum*, grown in a medium containing a bioregulator, at high and low light intensities should be studied.

**LITERATURE CITED**


