Oxygen Uptake during Photosynthesis of Isolated Pea Chloroplasts

Norbert Grotjohann, David Messdaghi and Wolfgang Kowallik

Lehrstuhl für Stoffwechselphysiologie, Fakultät für Biologie, Universität Bielefeld, Postfach 100131, D-33501 Bielefeld, Germany

Z. Naturforsch. **54c,** 209–219 (1999); received October 5/November 13, 1998

Pisum sativum, Chlororespiration, ^{18}Oxygen Consumption, Photophosphorylation, Intact Isolated Chloroplasts

Mass spectrometric analysis of the gas exchange of illuminated leaflets of 10–14 d old pea seedlings revealed not only $^{16}O_2$-liberation from photosynthetic $H_2{}^{16}O$-splitting, but also uptake of $^{18}O_2$, applied to the gas phase of the reaction vessel. Isolated intact chloroplasts of such leaflets suspended in a medium containing $NaHCO_3$ and glycerate 3-phosphate, on irradiation with blue (λ 448 nm) or red (λ 679 nm) light also produced $^{16}O_2$ from water oxidation and consumed $^{18}O_2$ from the gas phase. The two reactions were saturated at the same quantum fluence rates. Uptake of ^{18}oxygen was not affected by inhibitors of mitochondrial respiration (alternative pathway included), such as rotenone (5×10^{-5} M), antimycin A (5×10^{-6} M), KCN (10^{-3} M), SHAM (10^{-3} M), or propylgallate (10^{-3} M). It was, however, absent, when photosynthetic ^{16}oxygen evolution was completely inhibited by DCMU (10^{-5} M). DBMIB (10^{-5} M), assumed to prevent electron flow from plastoquinone pool to the cytochrome b_6/f-complex, suppressed photosynthetic oxygen evolution, but did not impair uptake of $^{18}O_2$. A similar result was obtained at application of 4×10^{-5} M antimycin A.

The data are interpreted to show a drain off to molecular oxygen of light-excited electrons from the photosynthetic electron transport chain at the site of plastoquinone pool during photosynthesis. This corresponds to chlororespiration, originally described for *Chlamydomonas* in darkness by Bennoun (1982). It is discussed, whether O_2-uptake during photosynthesis is an additional means for providing ATP for photosynthetic CO_2-reduction by increasing the proton gradient across the thylakoid membrane.

Reprint requests to Prof. Dr. Wolfgang Kowallik or PD Dr. Norbert Grotjohann. Fax: 0521-106-6039, e-mail: W.Kowallik@Biologie.Uni-Bielefeld.de, e-mail: Norbert.Grotjohann@Biologie.Uni-Bielefeld.de