Oxygen Uptake during Photosynthesis of Isolated Pea Chloroplasts

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Mass spectrometric analysis of the gas exchange of illuminated leaflets of 10–14 d old pea seedlings revealed not only 16O2-liberation from photosynthetic H216O-splitting, but also uptake of 18O2, applied to the gas phase of the reaction vessel. Isolated intact chloroplasts of such leaflets suspended in a medium containing NaHCO3 and glycerate 3-phosphate, on irradiation with blue (λ 448 nm) or red (λ 679 nm) light also produced 16O2 from water oxidation and consumed 18O2 from the gas phase. The two reactions were saturated at the same quantum fluence rates. Uptake of 18oxygen 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 16oxygenevolution was completely inhibited by DCMU (10−5 M). DBMIB (10−5 M), assumed to prevent electron flow from plastoquinone pool to the cytochrome b6/f-complex, suppressed photosynthetic oxygen evolution, but did not impair uptake of 18O2. 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 O2-uptake during photosynthesis is an additional means for providing ATP for photosynthetic CO2-reduction by increasing the proton gradient across the thylakoid membrane.

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