Dependence of the Flash-Induced Oxygen Evolution Pattern on the Chemically and Far Red Light-Modulated Redox Condition in Cyanobacterial Photosynthetic Electron Transport

Susanne Spiegel and Klaus P. Bader[a*]

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

[a] Present address: Institut für Biomedizin und Umweltconsulting (IFBUC), Meisenstraße 96, D-33607 Bielefeld. Fax: +49-521-2997377. E-mail: bader@ifbuc.com

* Author for correspondence and reprint requests

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Flash-induced photosynthetic oxygen evolution was measured in cells and thylakoid preparations from the coccoid cyanobacteria *Synechocystis* sp. PCC 6803 and *Synechococcus* sp. PCC 7942 and from the filamentous cyanobacterium *Oscillatoria chalybea.* The resulting characteristic flash patterns from these cyanobacteria can be chemically altered by addition of exogenously added substances like CCCP, DCPiP and inorganic salts. Potassium chloride, manganese sulfate and calcium chloride affected the sequences by specific increases in the flash yield and/or effects on the transition parameters. Chloride appeared to exert the strongest stimulatory effect on the oxygen yield. In comparison to chloride, both manganese and calcium did not significantly stimulate the flash amplitudes as such, but improved the functioning of the oxygen evolving complex by decreasing the miss parameter α. Particular effects were observed with respect to the time constants of the relaxation kinetics of the first two flash signals Y_1/Y_2 of the cyanobacterial patterns. In the presence of the investigated chemicals the amplitudes of the first two flash signals (Y_2 in particular) were increased and the relaxation kinetics were enhanced so that the time constant became about identical to the conditions of steady state oxygen flash amplitudes. The results provide further evidence against a possible participation of either PS I or respiratory processes to Y_1/Y_2 of cyanobacterial flash patterns. Dramatic effects were observed when protoplasts from *Oscillatoria chalybea* or cells from *Synechocystis* sp. PCC 6803 and *Synechococcus* sp. PCC 7942 were exposed to weak far red background illumination. Under these conditions, Y_2 (and to a smaller extent Y_1) of otherwise unchanged flash sequences were specifically modified. Y_2 was substantially increased and again the relaxation kinetics were accelerated making the signal indistinguishable from a Y_{ss} signal. From the mathematical fit of the sequences we conclude that S_2 contributes to 10–20% of the S-state distribution (in comparison to 0% in the control). Thus, far red background illumination might represent a valuable means for photosynthetic investigations where high amounts of S_2 are required like *e.g.* EPR measurements. In such experiments the corresponding EPR signals appeared substantially enhanced following far red preillumination (Ahrling and Bader, unpublished observations). Our results clearly show that the ‚controversial results' from parts of the literature suggesting the participation of different mechanisms (net oxygen evolution, inhibited uptake processes etc.) are *not* required to explain the flash-induced oxygen evolution in cyanobacteria: the seemingly ‚incompatible' conditions and conformations can be perfectly interconverted by different modulation techniques (chemicals, far red) of the respective redox condition within the water oxidation complex of photosynthesis.

Key words: Photosynthesis, Far Red Light, Cyanobacteria