Reassessment of the Redox Potential of P740:
The Primary Electron Donor in Photosystem I
of the Chlorophyll d Containing Cyanobacterium,
Acaryochloris marina

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Abstract  The oxidation potential of the primary
electron donor P740 of photosystem I (PS I)
of the chlorophyll d dominated cyanobacterium,
Acaryochloris marina, has been reinvestigated.
We find a midpoint potential of about 450 mV in a
photosystem I-enriched membrane fraction as well
as in thylakoids, which is significantly higher than
that originally reported by Hu et al. (1998). This
value, which is, indeed, very similar to that found
for P700 in chlorophyll a dominated organisms,
is in agreement with results of Bailleul et al. (this
Congress). In addition, the extinction difference
coefficient for the oxidation of the primary donor
has been determined and a value of 45 (±4) mM⁻¹
cm⁻¹ at 740 nm was obtained.

Keywords  Acaryochloris marina, chlorophyll d,
photosystem I, P740, P700, redox potential

Introduction

The chlorophyll (Chl) d dominated cyanobacterium,
Acaryochloris marina, has excited a great deal of
interest since it was discovered in 1996. This is
because the excited state energy gap of Chl d is
~0.1 V less than that of Chl a, which is the charge
stabilizing Chl in all other oxygenic organisms. In
photosystem I (PS I) of A. marina the donor is a
dimer probably composed of one chlorophyll d and
one chlorophyll d’ which is the 13² epimer of Chl
d. Due to its bleach maximum, it was named P740
(Hu et al. 1998). Hu et al. (1998) reported the redox
potential of P740 to be much lower than that of
P700, 335 mV which would be nearly isopotential
with redox potential of cytochrome f (measured
in Chl a organisms). On the other hand, the oxida-
tion potential of Chl d in organic solvents was
recently found to be more positive than that of Chl
a. Therefore, we remeasured the redox potential
of P740 in PS I-enriched detergent solubilized
membrane fractions and thylakoids from A. marina and
find that it is not as low as was originally proposed
by Hu et al. (1998).
The Primary Electron Donor in Photosystem I of Acaryochloris marina

Materials and methods

Sucrose gradient fractionation of isolated A. marina thylakoids was carried out as in Chen et al. (2005b) and Schlodder et al. (2007). The third band from the top (F3) is enriched in PS I but still contains a mixture of PS I trimers and PS II dimers (Chen et al. 2005a).

Chemically induced oxidized-minus-reduced steady state absorption spectra of various A. marina samples were measured using a Cary spectrophotometer (or a Shimadzu UV2501) by adding 1 mM potassium ferricyanide, initially, to oxidize the primary donor, and subsequently 2 mM sodium ascorbate to reduce it.

Time resolved absorption changes were measured as in Schlodder et al. (2007).

Redox titrations of the primary donor (P740) of A. marina PS I were performed by measuring the initial extent of the flash-induced absorbance change at 826 nm due to the oxidation of P740 as a function of the potential of the medium adjusted by adding ferricyanide and ferrocyanide. The midpoint redox potential value was obtained by fitting the data with a one-electron Nernst equation.

The difference between the molar extinction coefficients of P740⁺ and P740 at 740 nm was determined by measuring the flash-induced absorption change of N,N,N',N'-tetramethyl-p-phenylenediamine dihydrochloride (TMPD) as described by Hiyama and Ke (1971).

Results

P740⁺/P740 absorption difference spectra at room temperature

Figure 1 shows the room temperature (P740⁺/P740) absorption difference spectrum of PS I complexes from A. marina in the Qᵥ region. It resembles closely that reported by Hu et al. (1998). The absorbance difference spectrum exhibits a very broad bleaching band which probably results from the overlap of two bands centred at 740 and 730 nm.

The zero crossing in the red region is at about 774 nm. A sharp bleaching band appears at 711 nm. In addition, bleaching bands at 693 and 660 nm are observed. The zero crossing on the short wavelength

**Fig. 1** Spectrum of the flash-induced absorbance changes due to the oxidation of P740 in the wavelength region between 580 and 790 nm measured in a PS I-enriched sample