Microalgae strains characterized by reduced antenna size may improve photosynthetic efficiency and biomass production

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Published: J. Appl. Phycol. 2022

In dense microalgae mass cultures, large light-harvesting antennas (LHA) embedded in the photosynthetic membranes limit light penetration into deeper cell layers at the expense of photochemical efficiency. In man-made bioreactors, an “ideal” strain should harvest only the amount of light that can be used and the rest can penetrate deeper into the culture layers. One possible way would be to reduce the size of LHA, thus decreasing the dissipation of excess light in the surface layers of microalgae cultures. In nature, such small-antenna strains would have reduced performance but might significantly improve productivity in the mass cultures in photobioreactors. These strains should be able to tolerate high outdoor irradiance in the light-exposed layers of cells and at the same time minimize mutual cell shading which enables greater light penetration to cells in the deeper culture layers. One can expect higher photosynthetic efficiency in dense cultures due to reduced over-saturation and the consequent wasteful dissipation of excess sunlight and a lower degree of photoinhibition of photosynthesis.

In our work photoacclimation of two *Chlorella* strains – g-120 and R-117 was studied in outdoor trials. The strain g-120, originally a heterotrophic strain, was characterized by a low Chl/biomass ratio (< 0.5% of dry weight), about four times lower compared to R-117. The aim was to correlate the functional and structural changes in the photosynthetic apparatus to culture growth, photochemical activity and chlorophyll (Chl)-protein composition of the two strains. We found that *Chlorella* R-117 is the normal full-antenna strain while *Chlorella* g-120 had the reduced antenna size as the large PSII-LHCII and PSI-LHCI oligomers were missing. Thus, the photosynthetic apparatus of *Chlorella* g-120 was less competent in comparison with the *Chlorella* R-117.

Unlike laboratory experiments, the outdoor cultures of the reduced antenna strain g-120 showed low photoacclimation due to inherited features of heterotrophic origin. It had low oxygen production and electron transport rate measured *in-situ* compared to the normal antenna R-117. Understandably, the strain g-120 revealed increased futile energy dissipation via NPQ and a higher respiration rate compared to *Chlorella* R-117. Thus, outdoor cultivation of *Chlorella* g-120 as the second step of the trophic conversion from heterotrophy to phototrophy did not show an expected increase in biomass production. In this view, the potential use of such microalgae strains for outdoor mass cultivation may not be as straightforward as anticipated from laboratory experiments.