A COLD-RESISTANT RUBISCO WITHOUT SMALL SUBUNIT EXHIBITS THE HIGHEST TURNOVER NUMBER TOWARDS CO_2

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Key Words: Rubisco, photosynthesis rate, high turnover number, cold-resistant

Ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco) has long been a primary engineering target to improve photosynthesis efficiency due to its slow catalytic rate towards CO_2. However, the difficulty in finding and engineering a fast Rubisco over the past decades bring about the confusion that whether a constraint exists in Rubisco's catalytic potential. Here, we screened 29 Rubiscos with different forms, which were originated from microbes from different genera in different living environments. A highly active form II Rubisco was found. It showed 4.2- and 2.8-fold increased specific carboxylation activity and turnover number compared with those of Rubisco from *Synechococcus* PCC7002, the known fastest Rubisco in nature. Interestingly, even in ice-cold water (0^{o}C), it was able to fix CO_2 at a rate which was 63% of that of 7002 Rubisco at 37^{o}C. Integration of this highly active Rubisco into *S. elongatus* PCC7942 improved its specific growth rate and photosynthetic rate by 50% and 100%, respectively. Structural analysis revealed that it was a hexamer with three pairs of large subunit homodimers around a central 3-fold symmetry axis. The loop 6 and C terminus were crucial for its high carboxylation activity. The lack of small subunit and no need for any chaperon for its heterologous expression/assembly making its further manipulating in plant and molecular engineering in *E. coli* much easier.

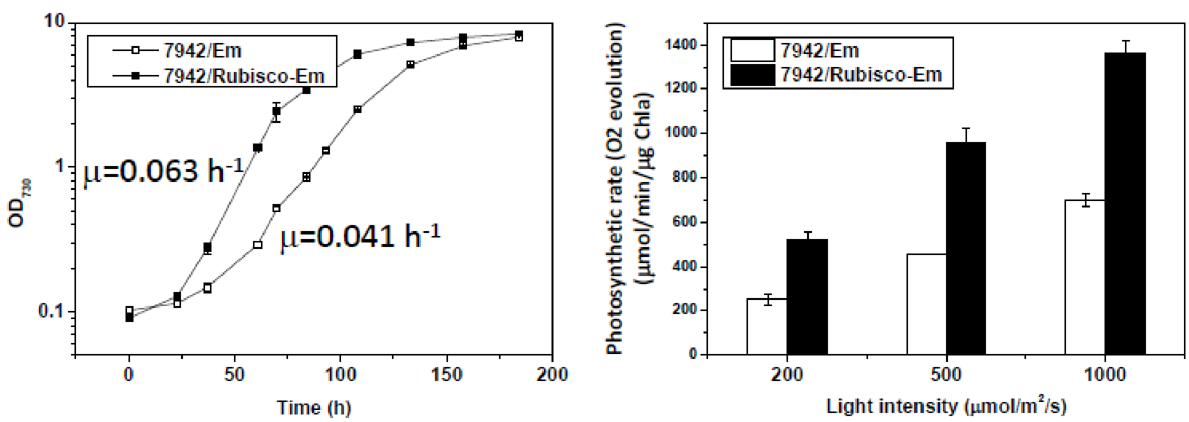

Figure 1 – Integration of this highly active Rubisco significantly improved the growth rate and photosynthetic rate of S. elongatus PCC7942.