KDPG aldolase modulates the photosynthetic carbon yield in *Synechococcus elongatus* PCC 7942

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Glycogen degradation during the night plays a crucial role in the survival and growth of cyanobacteria. Being single celled, photosynthesis and respiration are well connected in cyanobacteria and various glycolytic pathways are involved in the generation of energy and accumulation of metabolites. The oxidative pentose phosphate pathway has been known to modulate NADPH levels and provide intermediates to kickstart photosynthesis under light/dark growth conditions. However, the interconnection of respiratory pathways is still not entirely clear. In this study, we focused on the role of the Entner-Doudoroff (ED) pathway. Based on biochemical assay and Gas Chromatography-Mass spectrometry (GC-MS) metabolite analysis, we found that ED pathway does not operate in the cyanobacterium *Synechococcus elongatus* PCC 7942. These results were confirmed by the absence of enzyme 6-phosphogluconate dehydratase and lack of KDPG detection in crude cell lysates under both light and dark conditions. However, the mutant lacking KDPG aldolase (Eda) exhibits a bleaching phenotype under light, indicating a potential role for Eda in cyanobacterial metabolism. Therefore, we investigated the potential substrates of Eda. Through *in vitro* enzyme assay studies, we demonstrated that Eda functions as an oxaloacetate decarboxylating enzyme, with a K_m=0.473mM, V_{max} =0.680 µmolmin^{-1}mg^{-1} and k_{cat}/K_m= 437s^{-1}M^{-1} for oxaloacetate under *in vitro* conditions. This activity is further regulated by NADP$^+$ levels in cells to temporarily bypass the TCA cycle during periods of excess NADPH and ATP consumption through amino acid synthesis. This revelation of Eda's function and regulation contributes to our understanding of cyanobacterial metabolism and primary productivity under varying environmental conditions.

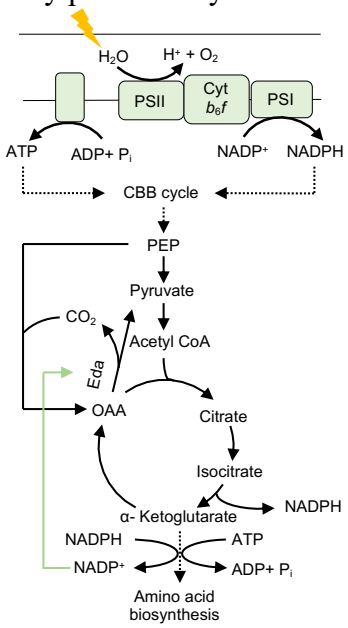

Figure.1. Proposed model showing KDPG aldolase regulation in photosynthetic yield and energy balance in *Synechococcus elongatus* PCC 7942.