Decreasing photorespiration: Glycolate oxidase or glycolate dehydrogenase – it makes a difference

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Photorespiration in plants is a wasteful process and diminishing it would have positive effects on plant growth and plant water- and nitrogen usage. A decrease in photorespiration might be achieved by introducing a glycolate catabolic pathway in chloroplasts. Such a pathway could be created using a malate synthase and a glycolate dehydrogenase. To determine whether the *Arabidopsis thaliana* glycolate dehydrogenase, showing homology to D-LDHs from other organisms (AtD-LDH), could be used it was heterologously expressed in *E. coli*, purified and characterized at the biochemical and structural level. The recombinant protein was found to be an FAD-containing flavoprotein capable of catalyzing the oxidation of D- and L-lactate, D-2-hydroxybutyrate, glycerate and glycolate using cytochrome c as electron acceptor. AtD-LDH shows a clear preference for D-lactate, with a catalytic efficiency 200- and 2000-fold higher than that for L-lactate and glycolate, respectively. Moreover, loss-of-function plants showed impaired growth in the presence of D-lactate or methylglyoxal. We propose that the protein is a D-LDH that *in planta* participates in the methylglyoxal pathway. Additionally, a paralogue of AtD-LDH was also identified and expressed in *E. coli*. The purified recombinant protein oxidized D-2-hydroxyglutarate with high specificity. *In planta* the gene is co-expressed with several genes involved in ß-oxidation, branched chain amino-acid and chlorophyll degradation. It is proposed that the gene product could act during the mobilization of alternate substrates from proteolysis and/or lipid degradation. None of these enzymes can thus be used for the envisioned pathway.