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Starch deficiency in plant mutants and its influence on photosynthetic and post-photosynthetic carbon isotope fractionations

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Carbon isotope fractionations occurring during and after CO_2 fixation shape the carbon isotope composition (i.e. d13C) of plant material and respired CO_2. However, responses of 13C fractionations to diel variation in the leaf starch metabolism are not fully understood.
Here we measured d13C of organic matter (d13COM), concentrations and d13C of potential respiratory substrates, d13C of dark-respired CO_2 (d13CR), and gas-exchange in leaves of starch-deficient plastidial phospho¬gluco¬mutase (pgm) mutants and wild type plants of four species (Arabidopsis thaliana, Mesembryanthemum crystallinum, Nicotiana sylvestris, and Pisum sativum).
The strongest d13C response to the pgm-induced starch deficiency was observed for N. sylvestris, with more negative d13COM, d13CR, and d13C values for assimilates (i.e. sugars, starch) and organic acids (i.e. malate, citrate) in pgm mutants than in wild type plants during a diel cycle. The genotype differences in d13C values could be largely explained by differences in leaf gas-exchange. In contrast, the PGM-knockout effect on post-photosynthetic 13C fractionations via the plastidic fructose-1,6-bisphosphate aldolase reaction or during respiration was small.
We conclude that the d13C changes caused by the pgm-induced starch deficiency are primarily explained by photosynthetic 13C fractionations. Our results stress the importance of mutants for studying isotope fractionations in plants.