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Biochemical hydrogen isotope fractionation during biosynthesis in higher plants reflects carbon metabolism of the plant

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Compound-specific isotope analyses of plant material are frequently applied to understand the response of plants to the environmental changes. As it is generally assume that the main factors controlling δ^2H values in plants are the plant's source water and evaporative deuterium enrichment of leaf water, hydrogen isotope analyses of plant material are mainly applied regarding hydrological conditions at different time scales. However, only few studies have directly addressed the variability of the biochemical hydrogen isotope fractionation occurring during biosynthesis of organic compounds (ε_{bio}), accounting also for a large part in the δ^2H values of plants but generally assumed to be constant.

Here we present the results from a climate-controlled growth chambers experiment where tested the sensitivity of ε_{bio} to different light treatments. The different light treatments were applied to induce different metabolic status (autotrophic vs. heterotrophic) in 9 different plant species that we grew from large storage organs (e.g. tubers or roots). The results show a systematic ε_{bio} shift (up to 80 $\%_{,}$) between the different light treatments for different compounds (i.e. long chain n-alkanes and cellulose).

We suggest that this shift is due to the different NADPH pools used by the plants to build up the compounds from stored carbohydrates in heterotrophic or autotrophic conditions. Our results have important implications for the calibration and interpretation of sedimentary and tree rings records in geological studies. In addition, as the δ^2H values reflect also strongly the carbon metabolism of the plant, our findings support the idea of δ^2H values as an interesting proxy for plant physiological studies.