Species variation in the hydrogen isotope composition of leaf cellulose is mostly driven by isotopic variation in leaf sucrose

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Experimental approaches to isolate drivers of variation in the carbon-bound hydrogen isotope composition (delta H-2) of plant cellulose are rare and current models are limited in their application. This is in part due to a lack in understanding of how H-2-fractionations in carbohydrates differ between species. We analysed, for the first time, the delta H-2 of leaf sucrose along with the delta H-2 and delta O-18 of leaf cellulose and leaf and xylem water across seven herbaceous species and a starchless mutant of tobacco. The delta H-2 of sucrose explained 66% of the delta H-2 variation in cellulose (R-2 = 0.66), which was associated with species differences in the H-2 enrichment of sucrose above leaf water (epsilon sucrose \unicode{x003B5}sucrose: -126% to -192 parts per thousand) rather than by variation in leaf water delta H-2 itself. epsilon sucrose \unicode{x003B5}sucrose was positively related to dark respiration (R-2 = 0.27), and isotopic exchange of hydrogen in sugars was positively related to the turnover time of carbohydrates (R-2 = 0.38), but only when epsilon sucrose \unicode{x003B5}sucrose was fixed to the literature accepted value of - 171 \unicode{x02212}171 parts per thousand. No relation was found between isotopic exchange of hydrogen and oxygen, suggesting large differences in the processes shaping post-photosynthetic fractionation between elements. Our results strongly advocate that for robust applications of the leaf cellulose hydrogen isotope model, parameterization utilizing delta H-2 of sugars is needed.
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