Leaf water deuterium enrichment shapes leaf wax n-alkane δD values of angiosperm plants I: Experimental evidence and mechanistic insights

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Leaf wax n -alkanes of terrestrial plants are long-chain hydrocarbons that can persist in sedimentary records over geologic timescales. Since meteoric water is the primary source of hydrogen used in leaf wax synthesis, the hydrogen isotope composition (δD value) of these biomarkers contains information on hydrological processes. Consequently, leaf wax n -alkane δD values have been advocated as powerful tools for paleohydrological research. The exact kind of hydrological information that is recorded in leaf wax n -alkanes remains, however, unclear because critical processes that determine their δD values have not yet been resolved. In particular the effects of evaporative deuterium (D)-enrichment of leaf water on the δD values of leaf wax n -alkanes have not yet been directly assessed and quantified. Here we present the results of a study where we experimentally tested if and by what magnitude evaporative D-enrichment of leaf water affects the δD of leaf wax n -alkanes in angiosperm C3 and C4 plants. Our study revealed that n -alkane δD values of all plants that we investigated were affected by evaporative D-enrichment of leaf water. For dicotyledonous plants we found that the full extent of leaf water evaporative D-enrichment is recorded in leaf wax n -alkane δD values. For monocotyledonous plants we found that between 18% and 68% of the D-enrichment in leaf water was recorded in the δD values of their n -alkanes. We hypothesize that the different magnitudes by which evaporative D-enrichment of leaf water affects the δD values of leaf wax n -alkanes in monocotyledonous and dicotyledonous plants is the result of differences in leaf growth and development between these plant groups. Our finding that the evaporative D-enrichment of leaf water affects the δD values of leaf wax n -alkanes in monocotyledonous and dicotyledonous plants – albeit at different magnitudes – has important implications for the interpretation of leaf wax n -alkane δD values from paleohydrological records. In addition, our finding opens the door to employ δD values of leaf wax n -alkanes as new ecohydrological proxies for evapotranspiration that can be applied in contemporary plant and ecosystem research.

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