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Linking oxygen isotope enrichment in leaf water with hydraulic conductivity and mesophyll conductance for CO2 in grapevine

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Within the last three decades, mechanistic understanding of fractionation processes of leaf water isotopes has increased considerably. Briefly, the isotopic composition of mean lamina leaf water reflects variations in 1) source water isotope signature (i.e. xylem water) and 2) the evaporative enrichment during transpiration. The diffusion of enriched water from the sites of evaporation to the rest of the leaf is counteracted by the input of unenriched water through the transpiration flow, what is known as the *Péclet* effect. The *Péclet* effect is mainly determined by the magnitude of the transpiration flow, modulated by the "scaled effective path length" (L), a fitting parameter that must be determined empirically. Up to now, L has been generally assumed to be a species-specific constant, associated to the anatomical properties of the leaf. However, short-term variations in leaf parameters in response to environmental conditions might cause changes in L, as has been recently confirmed by experimental studies. Although some attempts have been made to relate L with measurable leaf parameters, the mechanistic reasons underlying observed L differences are still unclear. Thus, there is a need to characterise the variability of this parameter, and in particular to further assess whether or not it can change with environmental conditions. In this context, the aim of this work was to establish a link between L and measurable physiological variables that are likely to respond to similar processes in the mesophyll. For this purpose, we studied simultaneously the response of leaf lamina hydraulic conductivity (*Kh*), mesophyll conductance for CO2 (g_m) and leaf water isotope enrichment to drought and vein severing in grapevine. We hypothesised that restrictions in water pathways caused by drought and/or vein severing would result in a concomitant increase in leaf lamina resistance and L. As a secondary hypothesis, we proposed that, provided that these changes partly involve variations in the intracellular pathway, a similar response should be found in mesophyll conductance for CO_2. Our results showed that L was strongly related to mesophyll variables, such as *Kh* or g_m, showing more consistent relationships than with other variables that are included as input parameters for the models, such as transpiration. On the other hand, the strong correlation found between L and g_m supports the idea that water and CO_2 share an important part of their diffusion pathways through the mesophyll.

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