Geophysical Research Abstracts
Vol. 21, EGU2019-9079, 2019
EGU General Assembly 2019

Mechanistic oxygen and hydrogen isotope models can predict the geographic origin of fruit

Florian Cueni (1,2), Daniel B. Nelson (1), Markus Boner (2), and Ansgar Kahmen (1)

(1) University of Basel, Botany, Department of Environmental Sciences, Switzerland (florian.cueni@unibas.ch), (2) Agroisolab GmbH, Jülich, Germany (m.boner@agroisolab.de)

Consumers are paying increasing attention to the geographic origin of agricultural products. Analytical tools allowing independent verification of the geographical origin of a product are thus in high demand for food quality control. Several descriptive tools using stable isotopes for origin analysis are used today, typically relying on time-consuming and expensive collection of reference data sets and lacking the capacity to account for interannual climate variability. In contrast, applications using mechanistic plant physiological water isotope (oxygen and/or hydrogen) models can potentially provide a faster, cheaper, and more adaptive way to predict the origin of agricultural products. However, such models require detailed knowledge of fractionation processes and water fluxes through a given agricultural crop. Here we present results from an experiment where we test if the Craig & Gordon model, originally developed for δ2H and δ18O values in evaporating water bodies and later adapted for leaf water, can also predict the δ2H and δ18O values of tissue water, and be used to constrain the isotopic composition of various organic compounds in strawberries and raspberries.

We grew sixty strawberry and sixty raspberry plants in climate-controlled growth chambers at 30%, 50%, and 70% relative humidity using water with a fixed isotopic composition to induce varying degrees of leaf water isotopic enrichment. These experimental conditions permitted direct measurement of oxygen and/or hydrogen isotope fractionation between source water and leaf/berry tissue water, bulk material, cellulose, sugars, and lipids (n-alkanes). Our results reveal that waters in leaves and berries are both enriched relative to source water, but that for all three treatments the isotopic enrichment of berry water is weaker than that of leaf water. Fitting the two-pool-modified Craig & Gordon model to the experimental data reveals that these differences can be explained by different fractions of unenriched xylem water (f) in the tissue water of berries compared to leaves. The partitioning of unenriched xylem water and enriched leaf water in the total berry tissue water did not show any significant difference between the species and treatments for either hydrogen or oxygen. These results suggest that the two-pool-modified Craig & Gordon model is also applicable to berry water. Preliminary validation tests of this model with data from field samples also confirm the findings. Yet, a precise application of the model requires prior knowledge of the fraction of unenriched xylem water (f) in the fruit. Further results also suggest constant fractionation from leaf water to bulk material δ18O values in leaves and berries (εbio +26.4‰ SD ±3.3‰), to δ18O values in sugars (εbio +30.6‰ SD ±1.3‰), and δ2H values in n-alkane lipids (εbio -194.1‰ SD ±15.4‰).

Our study highlights that if the model relevant parameters (f and εbio) for a given berry can be quantified, modeled berry water and organic isotope values are likely capable of producing precise prediction models for samples of unknown origin.