

# Investigating the relationship between olive oil bulk $\delta^{13}\text{C}$ values , n-alkane $\delta^{13}\text{C}$ and $\delta\text{D}$ values, and climatic conditions: Implications for geographical characterization

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There is high demand for new techniques to assist the geographic characterization of quality foodstuffs as part of food security and authentication programs. Bulk stable isotope methods have previously shown great promise in this area. The main aim of our study was to investigate the potential of employing compound-specific analysis of n-alkanes in extra virgin olive oils as a new tool for food authentication. Furthermore, we investigated the influence of local environmental and climatic factors on the  $\delta\text{D}$  and  $\delta^{13}\text{C}$  values of these compounds. Extra virgin olive oil samples for compound-specific work were selected from the largest and most comprehensive survey of bulk  $\delta^{13}\text{C}$  natural variability across Italy. In the bulk  $\delta^{13}\text{C}$  survey more than 730 olive oil samples were collected directly from producers along with information relating to the exact location, cultivars, plant cultivation, and climatic parameters. This bulk olive oil  $\delta^{13}\text{C}$  survey has already shown a geographic N-S gradient of isotopic values across the Italian territory, although it is not sufficiently distinct to trace the origin of samples from the consumer market. Results show that compound-specific  $\delta^{13}\text{C}$  values of n-alkanes in olive oil are better than bulk  $\delta^{13}\text{C}$  at distinguishing the geographic locations of the oils as they have wider isotopic variations compared to the bulk  $\delta^{13}\text{C}$  values. Our results also show that n-alkanes  $\delta\text{D}$  values correlate positively with mean annual temperatures and negatively with the annual amount of precipitation. In contrast, the  $\delta^{13}\text{C}$  values of the n-alkanes are not correlated with temperature and annual precipitation. This is likely associated to different cultivation practices, such as artificial irrigation versus natural watering, that potentially influence plant physiological response to local climatic conditions at a certain region, and should be taken into account when using stable isotopes for geographical authentication of olive oils.