Determination of geographical origin and authenticity of olive oil using stable isotope approach

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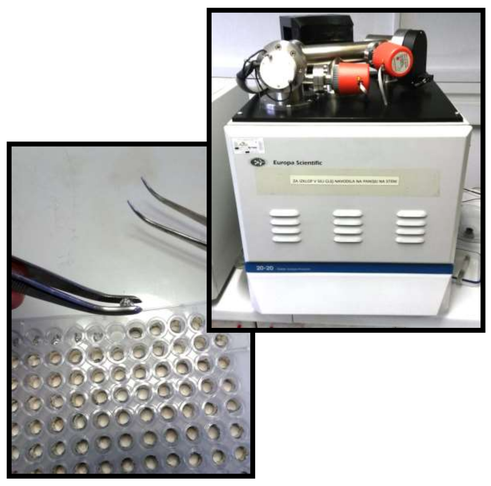
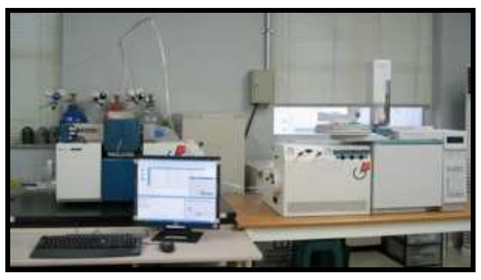
The use of stable isotopes of hydrogen, carbon and oxygen in oil and carbon in individual fatty acids is presented. A study was performed on olive oil samples from different regions (Brda, Slovenia, Istria, Croatia, and Montenegro). In addition, sensory and chemical analyses were obtained and all the samples were classified in accordance with Regulation EEC/2568/91 and related annexes (the last No.1989/2003) as extra virgin olive oils. All measurements performed on genuine olive oils were used to upgrade the database in 2006, 2007 and 2008.

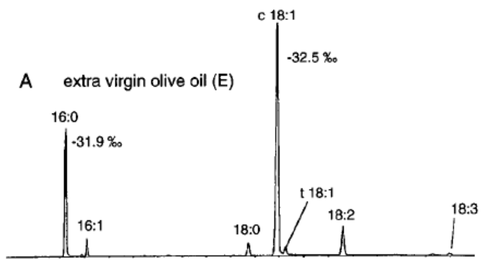
Materials and methods

- Samples from different varieties including *Istrska belica, Leccino, Maurino, Frantoio* from 2006-2008
- Sensory and chemical analysis (sterols)
- Hydrogen, carbon and oxygen isotope analysis on bulk samples – EA-IRMS, HT/EA pyrolysis IRMS
- Chemical characterization of individual fatty acids: GC-MS
- Carbon isotope analysis of individual fatty acids: GC-C-IRMS

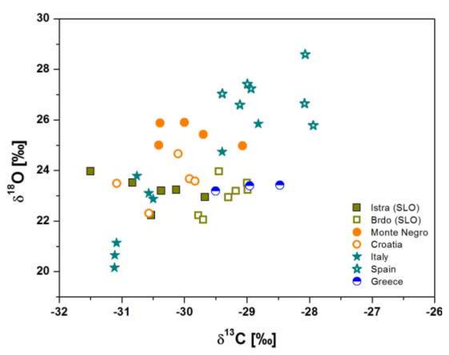


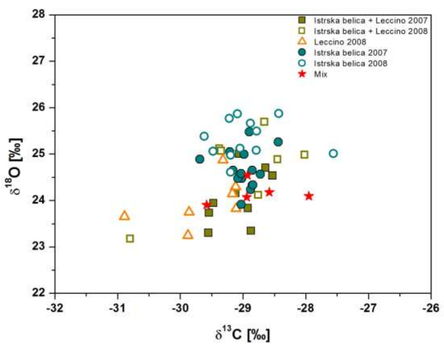
Results





The bulk olive oil samples all have isotopic compositions between –31.6‰ and –29.1‰ and a similar range of $\delta^{13}C$ values in individual fatty acids. Oils from Istria, Slovenian and Montenegro had slightly lower $\delta^{13}C$ values and showed greater variability. We also observed an increased variability in fatty acid composition in oils from different cultivars from Montenegro.

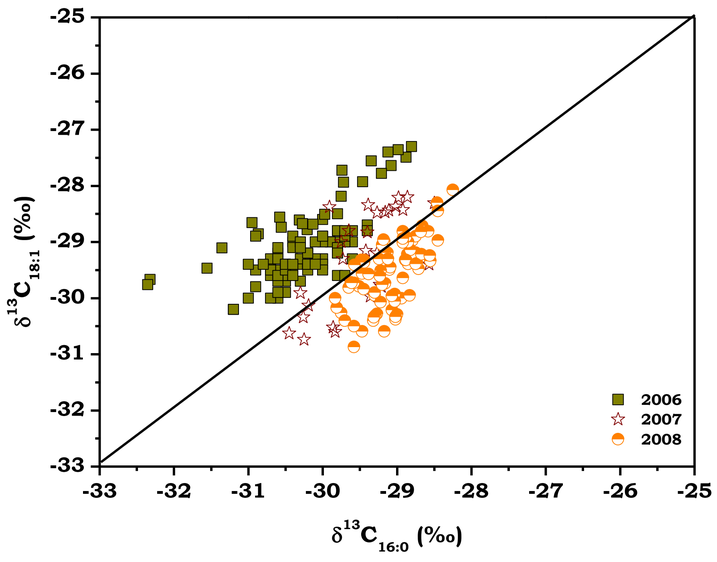


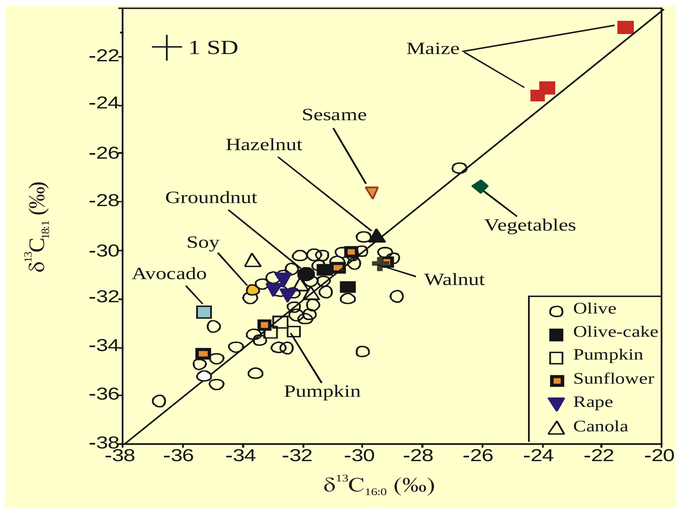


In the case of the $\delta^{18}O$ values, these increased from Brda in Slovenia (23.2 ±0.3‰) to Montenegro (25.4 ± 0.5‰), while $\delta^{2}H$ values decreased from –150 ± 5‰ in Brda to –153 ± 3‰ Montenegro.

Discussion

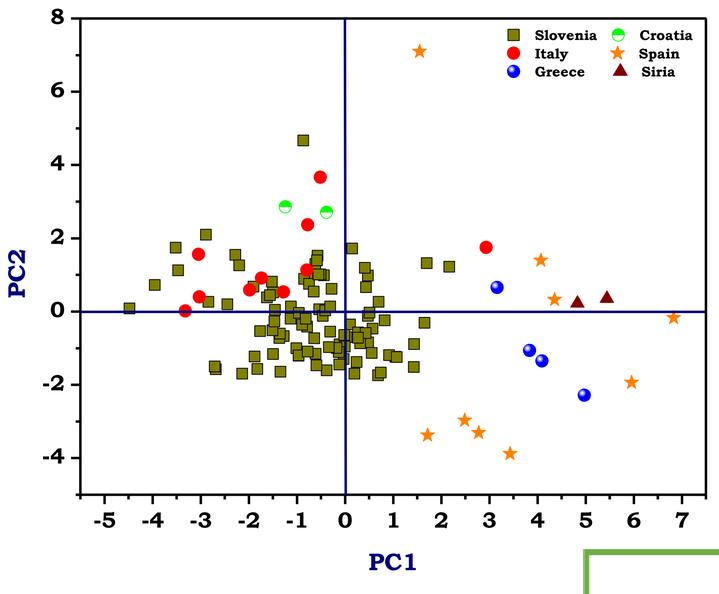
Authenticity



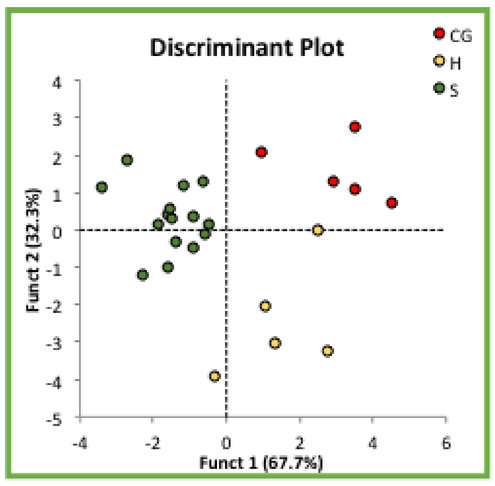


The $\delta^{13}C$ values also depend not only on geographical origin but also on the year of production. In all three sampling periods the ratio of $\delta^{13}C_{16:0}$:$\delta^{13}C_{18:1}$ deviates from 1:1, which unfortunately means that that this ratio cannot be used as an indicator of adulteration that had been anticipated in previous studies.

Geographical origin



Measurements of isotopic composition of genuine olive oils and fatty acids in combination with $\delta^{18}O$ and $\delta^{2}H$ values were further used to determine the geographical origin of olive oil. The most significant variables were $\delta^{13}C_{18:1}$, $\delta^{13}C$ of oil and $\delta^{13}C_{18:0}$ with the overall variability of 83%.



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