Characterization of olive oil by carbon isotope analysis of individual fatty acids: Implications for authentication and palaeoclimatological changes in the Mediterranean Basin

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The olive tree is the oldest (~600 B.C.) cultivated tree in the soils around the Mediterrranean basin. Olive oils are available in different qualities in the EU countries. In this communication we present the chemical and isotopic composition of the fatty acids of olive oils of distinct quality grade from the most important European Union (EU) producer countries. The analytical approach utilized combined capillary column gas chromatography - mass spectrometry (GC/MS) and the novel technique of compound specific isotope analysis (CSIA) through gas chromatography coupled to a stable isotope ratio mass spectrometer (IRMS) via a combustion (C) interface (GC/C/IRMS). This approach provides further insights into the control of the purity and geographical origin of oils sold as cold pressed *extra virgin olive oil* with certified origin appellation. The results indicate that substantial enrichment in heavy carbon isotope (^{13}C) of the bulk oil and of individual fatty acids are related to (1) a thermally induced degradation due to deodorization or steam washing of the olive oils and (2) the potential blend with refined olive oil or other vegetable oils. The interpretation of the data is based on principal component analysis of the fatty acids concentrations and isotopic data ($\delta^{13}C_{oil}$, $\delta^{13}C_{16:0}$, $\delta^{13}C_{18:1}$) and on the $\delta^{13}C_{16:0}$ *vs* $\delta^{13}C_{18:1}$ covariations. The differences in the $\delta^{13}C$ values of palmitic and oleic acids are discussed in term of biosynthesis of these acids in the plant tissue and admixture of distinct oils. The results demonstrate the importance of elucidating the metabolism and biosynthesis (chain elongation and unsaturation) of the fatty acids which cause the $^{13}C/^{12}C$ discriminations observed in the individual lipids of the vegetable oils, in order to better utilize the $\delta^{13}C$ values as indicators of adulteration and environmental changes. The effects of environment or physical factors on the carbon isotope composition of plant and trees have revealed long-term trends in the global environment changes, including the increased atmospheric CO_2 excess (e.g. Freyer and Belay, 1983; Walcroft *et al.*, 1997). The Mediterranean region is highly affected by population increases, industrial expansion, and anthropogenic or accidental biomass burning (e.g. forest fires at Sothern France and Spain). The subject of a current project is to trace the palaeoclimatic changes in this region by using carbon isotope composition of the major fatty acids in genuine olive oil. This will enable reconstruction of climate variabilities in the late Holocene in Central Europe.

References

Freyer, H.D. and Belacy, N. (1983) *J. Geophys. Res.*, **88**, 6844–52.

Kiritsakis, A.K. (1991) *Olive oil*, 191 p., American Oil Chemists' Society, Champaign, Illinois.

Walcrof, A.S., Silvester, W.B., Whitehead, D. and Kelliher, F.M. (1997) *Austr. J. Plant Physiol.*, **24**, 57–68.