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The Application of Raman Spectroscopy in Olive Oil Analysis

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Abstract : Extra virgin olive oil (EVOO) is a complex matrix mainly composed by fatty acid and other minor compounds, among which carotenoids are well known for their antioxidative function that is a key mechanism of protection against cancer, cardiovascular diseases, and macular degeneration in humans. EVOO composition in terms of such constituents is generally the result of a complex combination of genetic, agronomical and environmental factors. To selectively improve the quality of EVOOs, the role of each factor on its biochemical composition need to be investigated. By selecting fruits from four different cultivars similarly grown and harvested, it was demonstrated that Raman spectroscopy, combined with chemometric analysis, is able to discriminate the different cultivars, also as a function of the harvest date, based on the relative content and composition of fatty acid and carotenoids. In particular, a correct classification up to 94.4% of samples, according to the cultivar and the maturation stage, was obtained. Moreover, by using gas chromatography and high-performance liquid chromatography as reference techniques, the Raman spectral features further allowed to build models, based on partial least squares regression, that were able to predict the relative amount of the main fatty acids and the main carotenoids in EVOO, with high coefficients of determination. Besides genetic factors, climatic parameters, such as light exposition, distance from the sea, temperature, and amount of precipitations could have a strong influence on EVOO composition of both major and minor compounds. This suggests that the Raman spectra could act as a specific fingerprint for the geographical discrimination and authentication of EVOO. To understand the influence of environment on EVOO Raman spectra, samples from seven regions along the Italian coasts were selected and analyzed. In particular, it was used a dual approach combining Raman spectroscopy and isotope ratio mass spectrometry (IRMS) with principal component and linear discriminant analysis. A correct classification of 82% EVOO based on their regional geographical origin was obtained. Raman spectra were obtained by Super Labram spectrometer equipped with an Argon laser (514.5 nm wavelenght). Analyses of stable isotope content ratio were performed using an isotope ratio mass spectrometer connected to an elemental analyzer and to a pyrolysis system. These studies demonstrate that RR spectroscopy is a valuable and useful technique for the analysis of EVOO. In combination with statistical analysis, it makes possible the assessment of specific samples' content and allows for classifying oils according to their geographical and varietal origin.

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