Near infrared technology to support the Andalusian olive oil industry

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Introduction

The chemical composition and quality of virgin olive oil may be influenced by genotype and different agronomic and technological factors. Andalucia (southern Spain) is the world's largest producer of olive oil and the growing surface reaches 61.1% of all of Spain, with around 1.5 million hectares. Differences in climate, soil composition, and harvesting methods result in olive fruits and oils of varying quality. Therefore, olive tree growers and industries access the nutritional status of the tree through soil and leaf analysis, and analyze the fruits entering into each olive oil plant. The large growing surface and the competitiveness existing in the olive oil market, brings a huge demand for services to provide analytical support. This paper presents some of the results obtained in one Andalusian Official laboratory, which has already implemented NIRS technology to demonstrate its potential to improve the analytical support offered to the Andalusian olive oil industry.

Material and methods

Four data sets of samples of olive leaves, soils, olive fruits (intact) and olive paste from several consecutive years (2002–2008) have been used to develop NIRS calibration equations for the most demanded analytical parameters for those products. Reference data were obtained following official methods. Olive leaf samples were dried and milled to 1 mm before analysis. Soil samples were dried at 40°C in a forced-air oven for 24 h, crushed and sieved to 2-mm. Olive paste samples were obtained after crushing and mixing the fruits. Spectra were collected in reflectance mode using a FOSS-NIRSystems 6500 SY-I monochromator (400–2500 nm, with 2 nm wavelength intervals) equipped with a sample transport module. Olive leaves were analysed in standard circular reflectance cups, using the sample cup holder accessory; soil and olive paste samples were analyzed in

quartz cell cups, and a natural product sample cup was used for olive fruits. The WinISI software package version 1.50 was used for the chemometric treatment of data. Modified Partial Least Squares (MPLS) and cross-validation were applied for regression purposes. Different spectral regions were tested; SNV and Detrending treatments were applied for scatter effect correction, and several first and second derivative treatments were also evaluated. The statistics used to select the best equations were, among others, standard error of cross-validation (*SECV*), coefficient of determination for cross-validation (r^2), and *RPD* or ratio of the standard deviation (*SD*) of the original reference data to the *SECV.*

Results and discussion

Table 1 shows statistics of relevant parameters for soils, leaves and olives (intact and paste).

Highly accurate equations have been obtained in all cases (Table 1), with *RPD* values similar to or exceeding 3.

The comparison of results obtained in olives indicates greater precision and accuracy of the calibrations developed with the ground product, in paste. However, taking into account the work and time involved in milling the product, and the higher number of samples in the olives paste calibration set, the results obtained in intact olives were satisfactory. The results confirm the viability of NIR to provide a single instrumentation to deal with all analytical requirements needed in the oleic sector.

Table 1. Calibration statistics of the main parameters (% w/w) evaluated in olive leaves, soils, olive fruits and olive paste.

Product	Parameter	*N*	MEAN[a]	*SD*[b]	*SECV*[c]	r^{2d}	*RPD*[e]
Olive leaves	N	568	1.55	0.22	0.05	0.95	4.4
	P	698	0.11	0.03	0.01	0.80	3.0
	K	1500	0.88	0.23	0.06	0.92	3.8
Soils	Organic matter	608	1.44	0.69	0.21	0.91	3.3
	Organic nitrogen	519	0.09	0.04	0.01	0.90	4.0
Olive fruit (intact)	Oil content	804	23.26	3.98	1.37	0.88	2.9
	Moisture	803	47.35	6.72	1.66	0.94	4.1
Olive paste	Oil content	1446	21.70	4.34	0.74	0.97	6.4
	Moisture	1436	49.25	6.93	0.93	0.98	7.2

[a] Mean of the calibration set; [b] Standard deviation; [c] Standard error of cross-validation;
[d] Coefficient of determination of cross-validation; [e] *RPD*: ratio *SD/SECV.*