

## NIRS for the Determination of Internal Quality of Entire Apples

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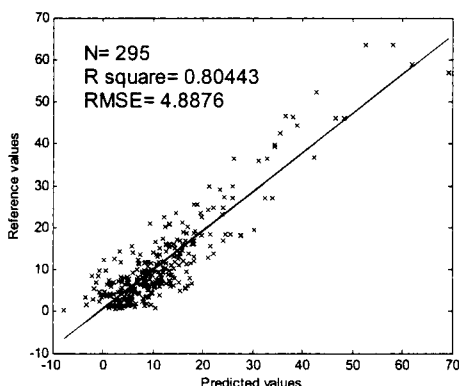
**[Introduction]** This work was developed under the framework of the HiDRAS program (High - Quality Disease Resistant Apples for a Sustainable agriculture, 2003-2007, <http://users.unimi.it/hidras/>). This program aimed to build up a specific apple data base, which should allow the breeders to make a much better use of the tremendous diversity conserved in many European Genetic Resources collections. The present work investigated the use of NIR to assess the internal quality of apples by determining three important factors namely Vitamin C, total polyphenol and sugar content.

**[Materials and Methods]** In this study, a large amount of apple samples (n= 2500) have been collected to cover a broad variability. The dataset includes several varieties and cultivars harvested between 2004 and 2007. The spectra were acquired by a FOSS NIRSystems 6500 scanning monochromator (400-2500, 2 nm) with the DCA module (Direct Contact Analysis). The instrument is placed upside down in order to place the fruit directly on the detector's window. To integrate the variability of the fruit, 4 measurements have been performed by rotating the apple. The Winisi III package was used for preparing the spectra and for visualization using Principal Component Analysis (PCA). Calibration models have been developed by using the Support Vector Machine (SVM) algorithm built in a Matlab environment (Matlab 7.5.0 R2007b). The SVM models were optimized and validated by using an independent test set. Concerning the reference values, the content of vitamin C was determined by HPLC, the total polyphenol content was obtained by the Folin-Ciocalteu method and the sugar content was obtained on the basis of a polarimetric Brix determination.

**[Results and Discussion]** The best validation results have been obtained with a Savitsky-Golay first derivative (9,2,1) as preprocessing. The accuracy obtained with the SVM regression technique (Table 1) allows a good estimate of the internal quality of entire apples. Figure 1 shows the scatter plot obtained on the validation set for the determination of Vitamin C. Although the content is rather low, as it is concentrated in the outer layer of the fruits, NIR in reflectance mode can still be used to determine low concentration levels of Vitamin C. These results indicates that NIR could be used in breeding programs to assess the internal quality of entire apples.

**Table 1.** Characteristics of the apple data base and performance of the SVM models.

Constituents	Sample characteristics				Calibration		Validation		
	Units	Range	Mean	SD	n	SEC	n	SEP	(SD/SEP)/(SD/SEC)
Vitamin C	mg/ 100g DM	0.27 - 75.0	13.5	12.4	800	3.38	295	4.89	2.01/3.67
Polyphenol	µg/g	276 - 7300	1186	720	2000	177.6	634	212	3.40/4.05
Brix	° brix	7.2 - 20.9	12.3	1.6	1000	0.45	850	0.66	2.42/3.56



**Figure 1.** Vitamin C : results for the validation set using the SVM model.