Use of NIR spectroscopy for the determination of internal quality of entire apples

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Introduction

This work is perform in the framework of the HiDRAS program (High - Quality Disease Resistant Apples for a Sustainable agriculture). The aim is 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 Vitamin C, total polyphenol and sugar contents (brix).

Material and methods

Samples

In this study, a large amount of apple samples (n= 2500) were collected to cover a broad variability including several varieties and cultivars harvested between 2004 and 2007. Figure 1 presents the PCA analysis showing the homogenous distribution of the samples.

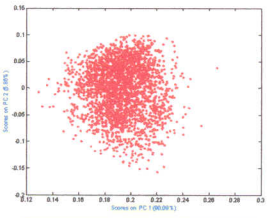

Figure 1 – Apple spectra : Principal Component Analysis

Wet chemistry

Concerning the reference values, the content of vitamin C was determined by HPLC (figure 2), the total polyphenol content was obtained by the Folin-Ciocalteau method and the sugar content was obtained on the basis of a polarimetric Brix determination.

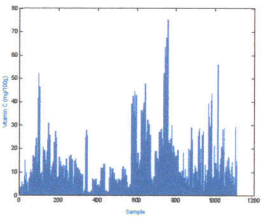

Figure 2 – Distribution of vitamin C

Data acquisition

The spectra were acquired by a FOSS NIRSystems 6500 scanning monochromator (400-2500, 2 nm) with the DCA module (Direct Contact Analysis) (figure 3). 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.

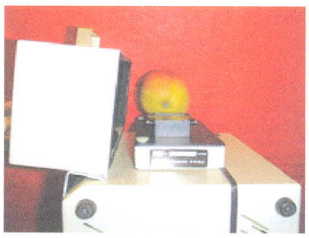

Figure 3 – FOSS-NIRSystems 6500 with Direct Content Analysis

Data teatment

The Winisi III package was used for preparing the spectra and for the exploratory analysis by Principal Component Analysis (PCA). Calibration models have been developed by using the Least Squares Support Vector Machine (LS-SVM) algorithm built in a Matlab environment (Matlab 7.5.0 R2007b). The database has been split into calibration and test sets. The LS-SVM models have been constructed using the calibration set and validated using the test set.

Results and discussion

The best results have been obtained with a Savitsky-Golay first derivative (9,2,1) as preprocessing. The accuracy obtained with the LS - SVM regression technique (see table 1) allows a good estimate of the internal quality of entire apples. Figure 4 shows the scatter plots obtained on the validation sets for the criteria under investigation.

Table 1 – Characteristics of the apple data base and performances of the LS - SVM models

					Calibration			Validation		
Criteria	**Units**	**Min-Max**	**Mean**	**SD**	**n**	**SEC**	**SD/SEC**	**n**	**SEP**	**SD/SEP**
Vitamin C	mg/100g DM	0.27 - 75.0	13.5	12.4	800	3.4	3.7	295	4.9	2.0
Polyphenol	µg/g	276 – 7300	1186	720	2000	178	4.1	627	140	5.1
Brix	° brix	7.2 – 20.9	12.3	1.6	1000	0.45	3.6	853	0.37	4.3

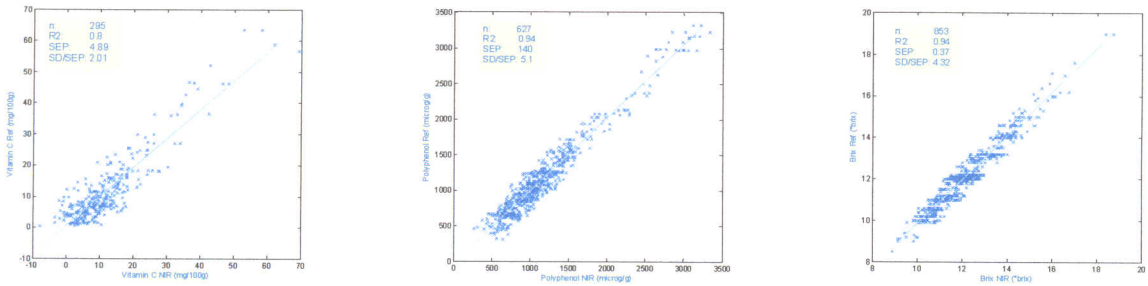

Figure 4 – Scatter plots obtained for the criteria under investigation.

Conclusion

- The achieved results indicate that NIR could be used in breeding programs to assess the internal quality of entire apples.
- Although the vitamin C content is rather low, as it is concentrated in the outer layer of the fruits, NIR in reflectance mode can be used to have an estimate of low concentration levels of Vitamin C.
- The total polyphenols determined by the Folin-Ciocalteau method can be predicted by NIR
- The sugar content can also be determined by predicting the Brix of entire fruits

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