Non-destructive pome and stone fruit phenotyping in a European project aiming at breeding specific fruit cultivars better suitable for organic agriculture

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The European InnOBreed Project (2022-2026) aims to promote the breeding of organic crops in fruit sector and improve the fruit performance. The objective of one specific task of this project is to deliver high-throughput, efficient and robust tools to evaluate the fruit organoleptic and nutritional quality. As fruit quality evaluation is time consuming, NIR spectroscopy has been chosen as it allows a non-destructive and rapid fruit phenotyping and would contribute to improve the practices in breeding and selection programs of pome and stone fruit trees.

Experiments were carried out in 2023 and 2024 by partners involved in this project, mainly on apple, pear, apricot and peach. Depending on the expertise of each partner, a panel of representative varieties of each species was characterized at harvest and after a period of post-harvest (few days) or storage (apple). Different NIR spectrometers were used, including 4 benchtop and 9 handheld ones. Among quality traits defined as reference data, firmness, color (L*a*b), Soluble Solids Content (SSC, °Brix), titratable acidity (TA) and dry matter content were evaluated for organoleptic traits and content of fibers and polyphenols for nutritional quality.

Results on apricot, as part of the INRAE experiment:

For apricot, 200 and 350 fruits were individually characterized in 2023 and 2024 respectively, with the acquisition of spectral and physicochemical data. Two types of spectra were acquired, from 400 to 1100 nm using a handheld spectrometer (F750, Felix instruments) and from 900 to 2500 nm using a benchtop spectrometer (MPA, Bruker) (Figure 1 A and B). Both spectral areas were informative. When the visible zone was taken into account (Figure 1a), apricot fruits were mainly discriminated on PC1 according to their skin color, ranging from white on the left to red on the right of the graph. When the spectral area corresponded to the near infrared region (Figure 1b), the discrimination of apricot fruits was done on PC2 according to the years, in relationship with their composition, probably in dry matter, sugars and organic acids, as is generally observed between years.

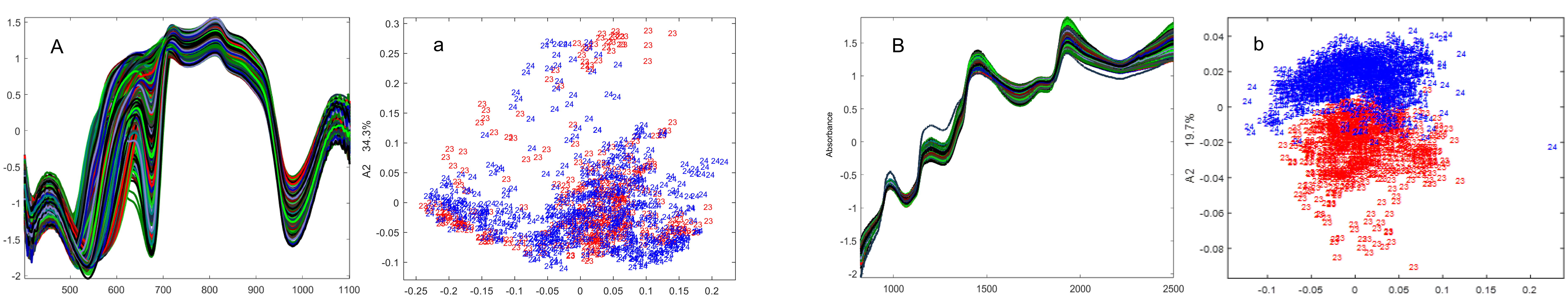

Figure 1: Data of apricot with spectra acquired with A, a portable spectrometer (Felix instruments) and B, a benchtop spectrometer (MPA, Bruker) and the biplot of samples scores from the Principal Component Analysis (PCA) performed on spectral data with a, in the range between 400 and 1100 nm (Felix instruments) and b, between 900 and 2500 nm (MPA, Bruker),

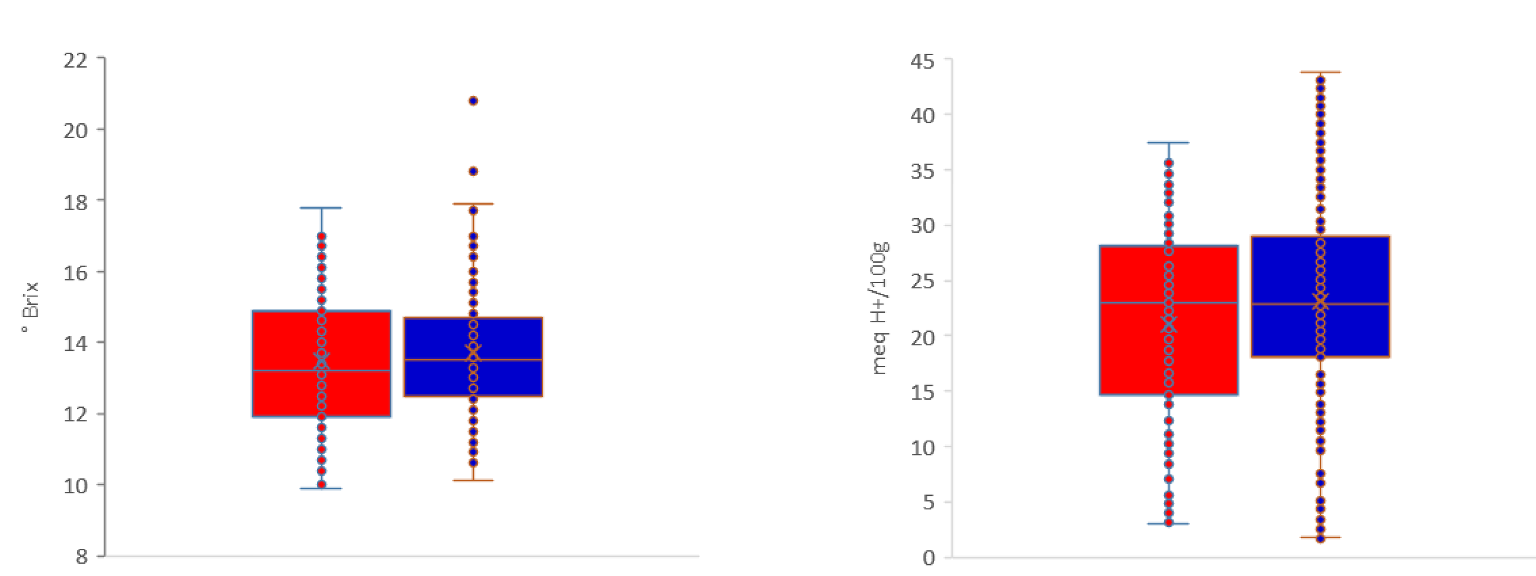

Figure 2: Box Plot showing the distribution of data for SSC (soluble solids content) and TA (Titratable acidity) in apricot fruit in 2023 and 2024.

The data acquisition is still in progress. Preliminary results look promising on apricot as SSC was predicted with R^2 of 0.9, RMSE of 0.86 °Brix and RPD of 3.1 using the handheld spectrometer (F-750 Felix Instruments) in relationship with the observed variability of this parameter (Figure 2). As expected, the prediction was not as good for TA (R^2 of 0.77). Overall, the results obtained with this handheld spectrometer were very close to those obtained with a benchtop spectrometer (Bureau et al., 2009). Further modeling will be carried out on apricot with the other quality parameters such as firmness, skin color, dry matter, and content of fibers and polyphenols.

Bureau et al., 2009, Food Chemistry 113, 1323-1328

The next step will be to integrate the data acquired on all fruit species, including fruit phenotyping and spectra, into a single database, in order to propose a non-destructive tool using visible-infrared spectroscopy and models of quality traits prediction for fruit phenotyping in breeding programs.

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