

Authentication and classification of strawberry varieties by near infrared spectral analysis of their leaves

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Introduction

In Mexico, Irapuato is known as the Capital of Strawberries. *Fragaria x ananassa* was introduced by the Spaniards in the XI century. Since then it has become an icon for Irapuato, Guanajuato in Mexico. Most of the strawberry production is exported, principally to Asian countries like Japan where they demand a very high quality product. Most techniques to check crop status such as compositions are time-consuming and destructive. Therefore, a rapid and cheap tool is needed to verify the quality of many food items. Near infrared (NIR) spectroscopy¹ is known as one of the widely used non-destructive techniques. The NIR instrument is a fast and inexpensive analytical tool that could be used to classify, identify and authenticate a wide range of foods and food items. Therefore, the major objectives of this study were to provide a new insight into the authentication of two wildtype species and three varieties and to correlate the results with geographical origin and the propagating method used.

Materials and methods

Three weeks-old plants of five different strawberry varieties (*Fragaria x ananassa* Duch. cv Camarosa-California, Camarosa-Cinvestav, Seascape, *F. chiloensis* and *F. virginiana*) were cultivated *in vitro* first, then transferred to pots with special soil and grown in a greenhouse at Cinvestav. All varieties were acquired from California (USA). After eight months, ten leaves from each variety were collected. Transmittance spectra of each leaf were recorded over a range of 10,000–4,000 cm⁻¹, 32 scans of each leaf were collected at the resolution of 4 cm⁻¹ with a Paragon IdentiCheck FT-NIR System Spectrometer. Spectra of both sides of the leaves and of the vascular system (N) were recorded. The number of replicates varied from 40 to 47 for each leaf. All spectra were analysed using principal component analysis (PCA) and soft independent modelling class analogy (SIMCA). The optimum number of components to be used in the regression was automatically determined by the software (13–17).

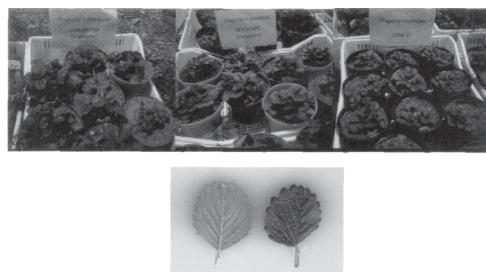


Figure 1. Some of the biological materials used in this study.

Results and discussion

All strawberry varieties displayed a very similar spectrum in the NIR range (10,000–4,000 cm⁻¹). However, the small differences among them allowed us to establish inter-class distances

Table 1. Inter-class distances among all strawberry varieties.

Samples	Seascape	Cam-CA	Cam-Cin	Virginiana	Chiloensis
Seascape	—	4.24	8.62	9.98	15.91
Cam-CA	—	—	5.74	14.48	19.68
Cam-Cin	—	—	—	19.18	29.32
virginiana	—	—	—	—	28.99

Table 2. Percentages of recognition and rejection among strawberry varieties.

Strawberry Variety	Recognition	Rejection
Seascape	100 (44 / 44)	93 (210 / 226)
Cam-CA	95 (40 / 42)	97 (222 / 228)
Cam-Cin	95 (41 / 43)	97 (221 / 227)
virginiana	100 (47 / 47)	100 (223 / 223)
chiloensis	96 (46 / 48)	100 (222 / 222)

and, therefore, the identification of all materials becomes possible. Camarosa was the only variety grown from the same shoot but propagated by a different method (direct or *in vitro*). Seascape from California presented the shortest inter-class distance (Table 1) to Camarosa California (this distance is even shorter than the inter-class distance between Camarosa samples). On the other hand, the Seascape variety presented the smallest rejection percentage among all varieties (more similarities with the rest of the samples) and it had a short inter-class distance to *F. chiloensis*. This means that it conserves some of its ancestral characteristics. Five different clusters can be observed in Figure 2. It can also be observed that the larger differences are displayed among wildtype samples, *F. chiloensis* (A) and *F. virginiana* (B). Camarosa-California (C) and Camarosa-Cinvestav (D) (*in vitro*) displayed a small overlapping region between them. Seascape samples are localised in (E). Figures 3 shows the validation methods for *F. chiloensis* and *F. virginiana*, in which samples with a N in their nomenclature

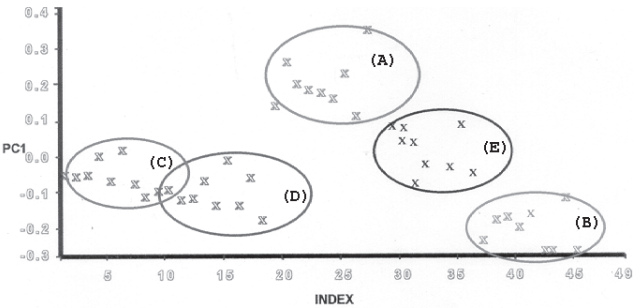


Figure 2. Clusters formed of the five strawberry varieties.

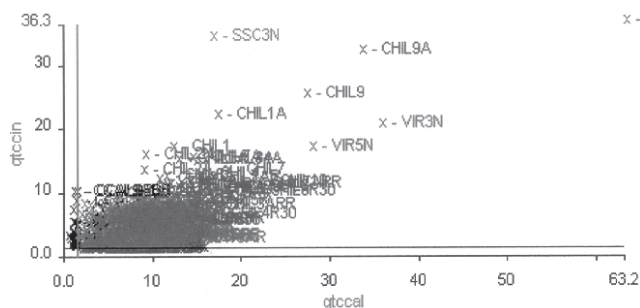


Figure 3. Validation method using Camarosa-California and Camarosa-Cinvestav.

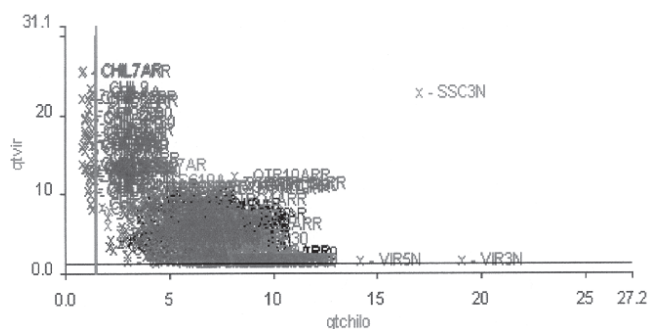


Figure 4. Validation method using *F. virginiana* and *F. chiloensis*.

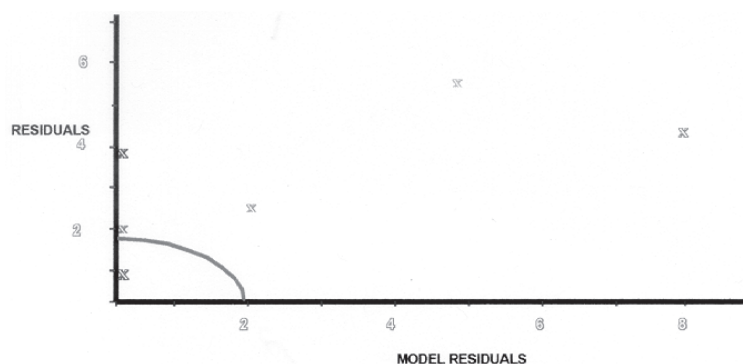


Figure 5. Classification of an unknown.

presented different behaviour. As for Seascape-CA and Camarosa-CA in Figure 4, it can be observed that only SSN (outlier) is out from the minimum distance allowed and the reason is that the spectrum of this leaf includes part of the nerve. Finally, Figure 5 show an example of a classification, where a leaf from an unknown strawberry variety was analysed using a blind number and it was positively classified (corresponding to the X inside the angle in Figure 5). Therefore, it can be concluded that NIR en-

ables the authentication of all strawberry varieties and their geographical origin as well. It was also possible to form subclasses of the same materials. The results presented showed that NIR spectroscopy is a very powerful and promising analytical tool.

Conclusions

It was possible to create methods to classify and authenticate strawberry varieties by near infrared spectroscopy. Seascape variety was the sample that presented the largest similarities to other varieties, especially to Camarosa-California and *F. chiloensis*. On the other hand, the largest inter-class distance was observed for the two wildtype strawberry samples. Only *F. virginiana* displayed 100% recognition and 100% rejection and it is highly probable that Seascape is a cultivated variety with an *F. virginiana* ancestor. This study presented an overall of 14.1% of misclassified samples.

References

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