Non-destructive evaluation of storage potential of clingstone peaches by NIRS using PCA and SIMCA

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Introduction

Approximately 4.2 million cartons of canned peaches are produced annually in South Africa.[1] The industry, however, suffers huge losses due to internal breakdown during cold storage before canning.[2] Internal breakdown is a general term applied to the changes in flesh texture, loss of structural integrity, discolouration (browning) of the internal tissue and increased susceptibility to decay. In the case of peaches and nectarines internal breakdown is known as wooliness or mealiness.[3] Internal breakdown is also known as chilling injury, as it usually occurs during cold storage.[3,4] Currently no objective procedure exists to classify fruit according to storage potential upon delivery to the factory. All decisions are based on subjective evaluations by trained workers. The canning industry needs an objective and non-destructive method to identify whether or not peaches will develop internal breakdown during cold storage.[1]

Near infrared spectroscopy (NIRS) can provide rapid and non-destructive quantitative measurements of internal properties in peaches, such as soluble solids content (SSC), firmness, chlorophyll content, sugar content, soluble solids/acid ratio and titratable acidity.[6-9]

Some analytes or attributes are not expected to be analysed by NIRS, because they do not absorb in the NIR region or are present in trace amounts. The information could, however, be embedded in the spectra.[10] With this in mind, the possibility exists to perform qualitative measurements of storage potential in peaches using reflectance spectra with subjective evaluations as reference data.

The aim of this study was firstly, to develop a NIRS calibration to non-destructively predict SSC in fresh clingstone peaches and confirm light penetration into the fruit during FT-NIR analysis. Secondly, to use principal component analysis (PCA) and soft independent modeling by class analogy (SIMCA) to objectively determine storage potential in fresh clingstone peaches, based on NIRS spectral data and subjective quality evaluations.

Materials and methods

Samples

Peaches of different cultivars were collected over an eight-week period during the 2003 harvesting season for the SSC calibration (n = 330). Kakamas peaches from one harvest week were analysed (n = 160) for development of the storage potential model. NIRS analyses were performed upon arrival (21°C) and the fruit were not washed or treated with chemicals prior to analyses. After spectral analyses the fruit were subjected to cold storage (-0.5°C) for a period of two weeks, followed by subjective evaluations and SSC measurements.

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Spectral acquisition

The absorption spectra (645 - 1201 nm at 2 nm intervals) were measured on each half (180° apart) of each intact fruit using a Perkin Elmer FT-NIR Identicheck™ V2.0 System.

Soluble solid content measurement

The SSC, expressed as °Brix, was determined (n = 330) with an Atago N1 hand refractometer on each half (180° apart) of the peach.

Subjective evaluation

Presence/absence of internal breakdown, loosening of the skin and adhesion of the flesh to the stone after removal of the stone was noted.

Results and discussion

Peach spectra are shown in Figure 1. Spectra pretreated with multiplicative scatter correction (MSC) are shown in Figure 2.

A PLS (partial least squares) regression model for SSC (Figure 3) of acceptable accuracy was obtained using spectra (pretreated with MSC) of peaches of all cultivars over the eight-week period and with good storage quality. A correlation of r = 0.8 and SEP (standard error of prediction) of 1.37°Brix was obtained. This corresponded well with results obtained by Peiris *et al.*[7]

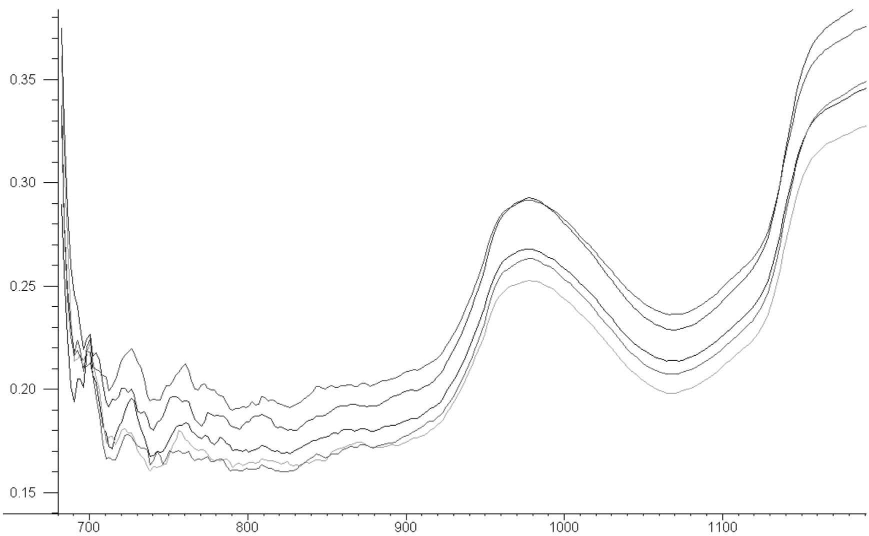

Figure 1. Example of raw spectra of peach samples.

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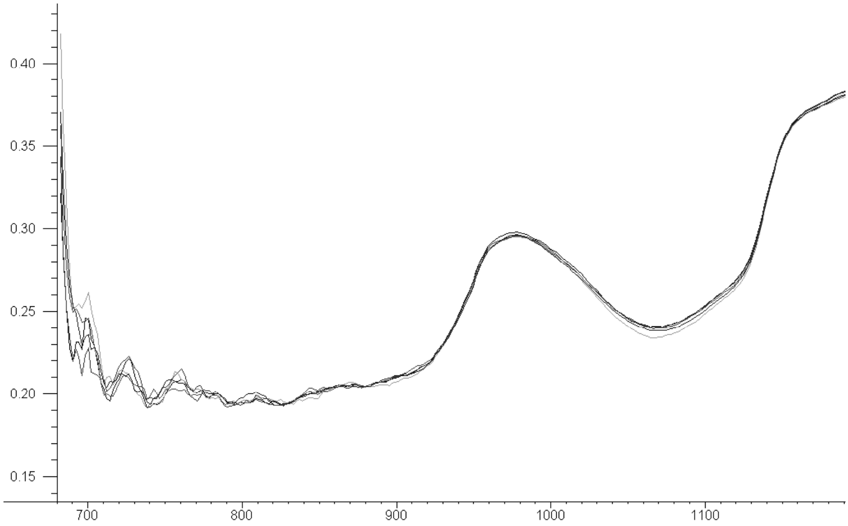

Figure 2. Example of peach spectra pretreated with MSC.

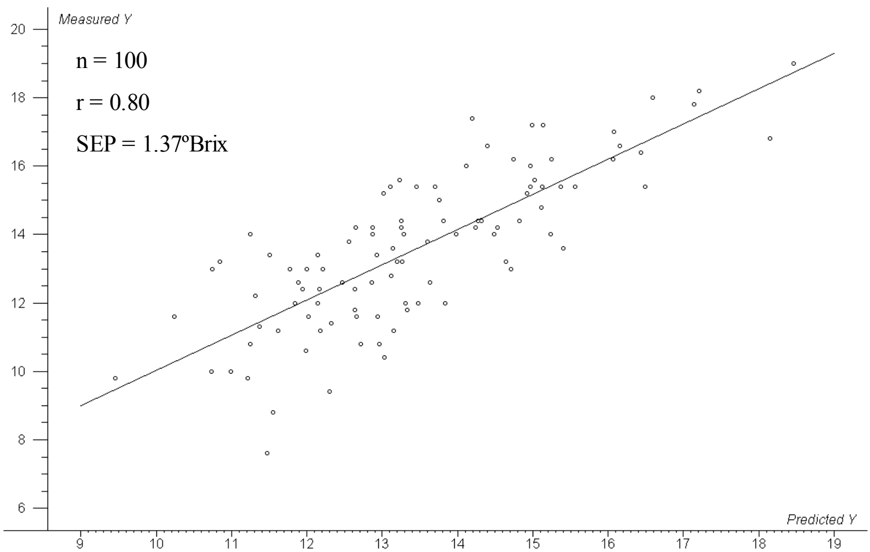

Figure 3. Validation plot of SSC (°Brix) values.

PCA was performed on the NIR reflectance spectra to investigate the differences in the principle component space. PCA separated the samples with good storage potential from those with poor storage potential within one cultivar and one week of harvest. The PCA plot (Figure 4) of two sets (good and poor storage quality) of Kakamas peaches, indicated possibility to develop SIMCA models to predict storage potential.

SIMCA models (Figures 5-6) indicated the ability to distinguish between peaches with good and poor storage potential. Si (distance to model) vs. Hi (distance to model center) is illustrated in Figures 7-8 where peaches with good storage quality were validated with the two respective SIMCA models.

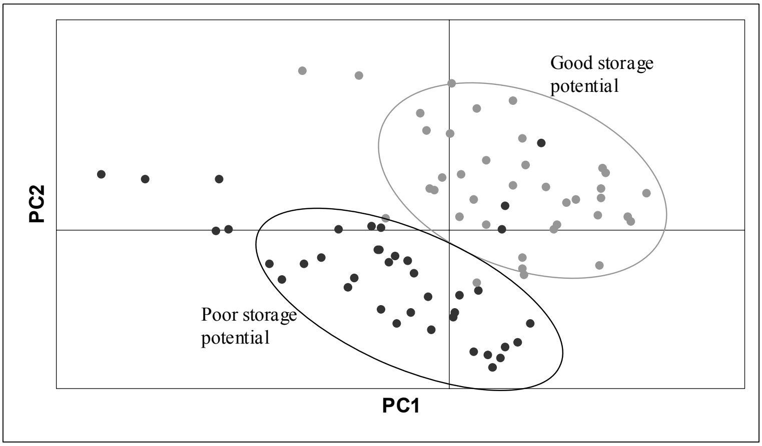

Figure 4. PCA clustering of peaches with good and poor storage quality, respectively.

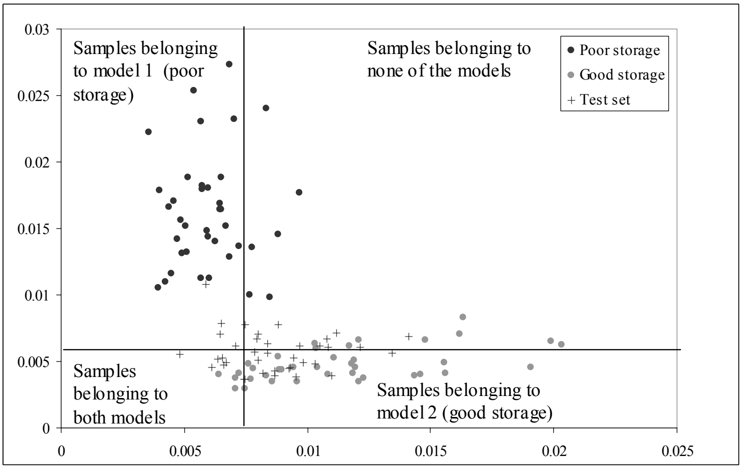

Figure 5. Coomans plot (Si vs. Si) to determine the class membership of a test set with good storage potential.

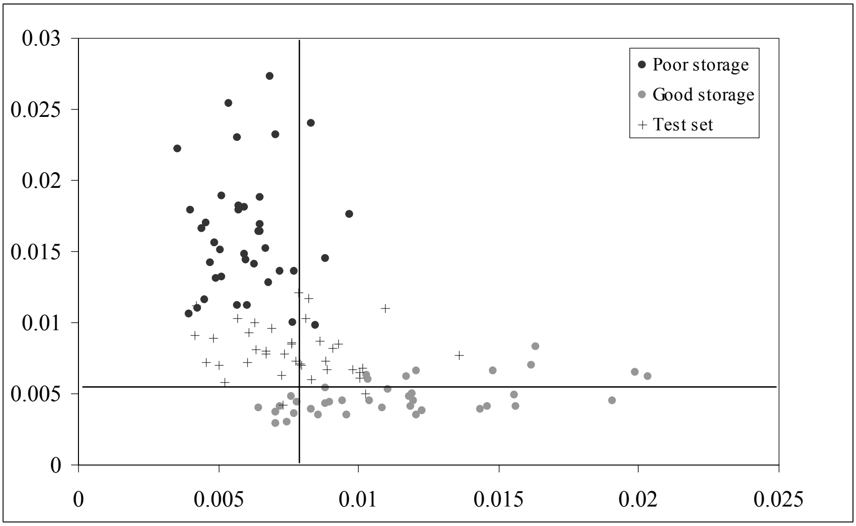

Figure 6. Coomans plot to determine the class membership of a test set with poor storage potential.

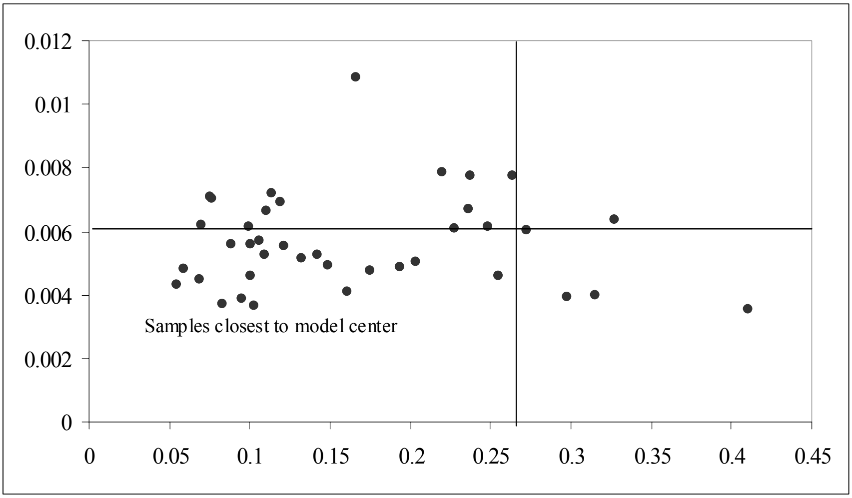

Figure 7. Si vs. Hi plot indicating membership of the validation set (good storage quality) to the prediction model for good storage quality.

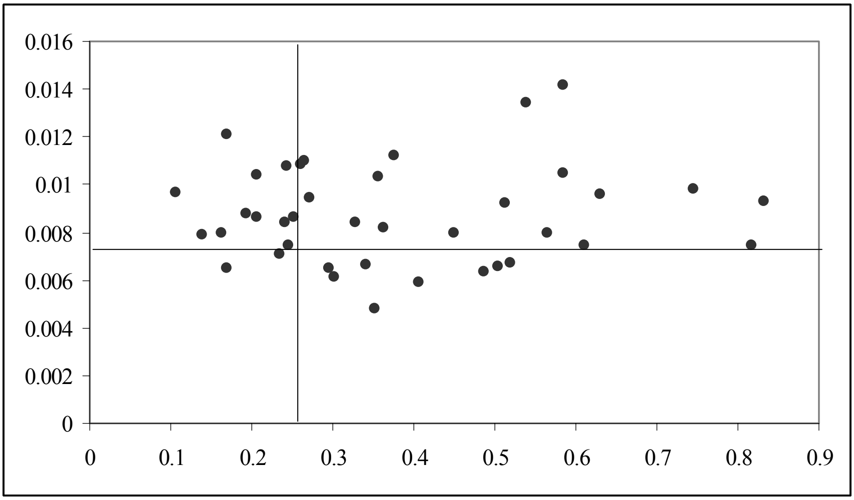

Figure 8. Si vs. Hi plot indicating membership of the validation set (good storage quality) to the prediction model for poor storage quality.

Conclusion

FT-NIR light penetration into intact clingstone peaches was confirmed and NIRS could be used to predict SSC successfully. It is suggested that SIMCA models based on NIRS spectra and subjective evaluations could be used to predict storage potential within peach cultivars within one week of harvest. Future research is needed to investigate results over the entire season and cultivar range and to apply further classification techniques.

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