Application Note AN-NIR-141

Rapid quality control of fruits and vegetables using NIR spectroscopy

Easily quantify firmness in apples and Brix in peaches and crushed tomatoes

Near-infrared (NIR) spectroscopy has emerged as a powerful, nondestructive analytical technique for quality control in the fruit and vegetable processing industry. This Application Note presents the use of NIR spectroscopy for the rapid monitoring of firmness in apples and °Brix in peaches and crushed tomatoes. These are critical parameters to verify the quality and freshness of various fruits and vegetables. Traditionally measured using destructive methods like penetrometry and refractometry, these fresh produce quality control attributes are critical indicators of ripeness, sweetness, and overall consumer acceptability.

EXPERIMENTAL EQUIPMENT

All samples were tested with a Metrohm near-infrared (NIR) spectrometer. The measurements were done in reflection mode using either a large sample cup or direct measurement (i.e., no holder). Metrohm software was used for all data acquisition and quantification model development.

RESULT

NIR spectroscopy was used to quickly measure firmness in apples and °Brix (sugar content) in peaches and crushed tomatoes (Figure 1). Calibration models were created for each product (Figures 2–4), and the results showed a strong match between the NIR predictions and standard lab quality parameters. The measurements were accurate and consistent, proving that NIRS is a reliable tool for monitoring fresh produce quality.

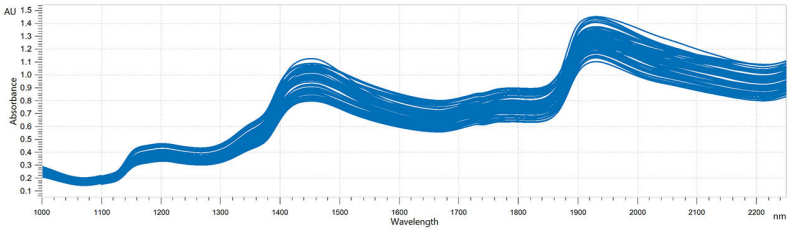

Figure 1. Near-infrared spectra of apple samples analyzed in reflection mode on a Metrohm NIR analyzer.

RESULT FIRMNESS IN APPLES

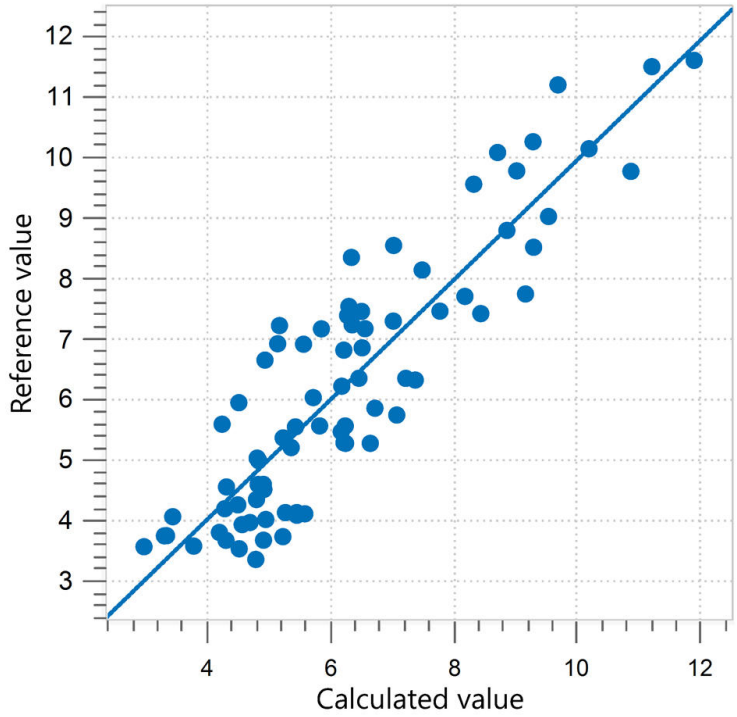

Figure 2. Correlation diagram and the respective figures of merit for the prediction of firmness in apples with a Metrohm NIR spectrometer. Blue dots represent the calibration dataset. No validation set was used in this example.

R^2	SEC (N)	SECV (N)
0.802	0.93	0.95

RESULT BRIX IN PEACHES

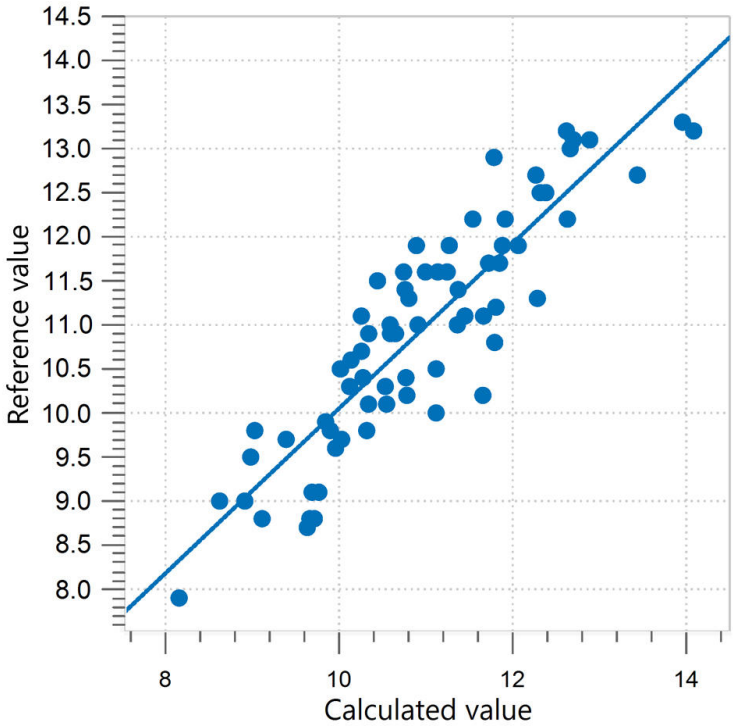

Figure 3. Correlation diagram and the respective figures of merit for the prediction of Brix in peaches with a Metrohm NIR spectrometer. Blue dots represent the calibration dataset. No validation set was used in this example.

R^2	SEC (°Bx)	SECV (°Bx)
0.798	0.53	0.58

RESULT BRIX IN CRUSHED TOMATOES

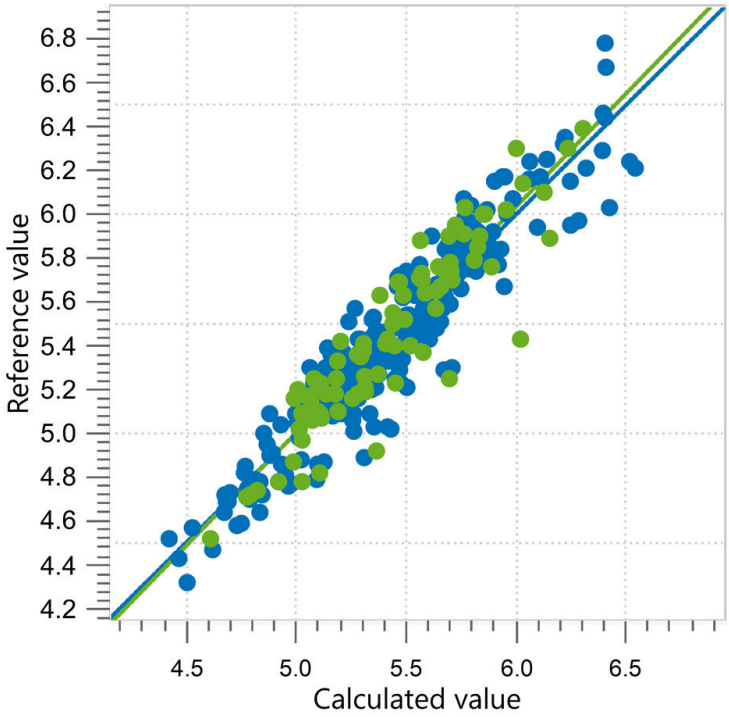

Figure 4. Correlation diagram and the respective figures of merit for the prediction of Brix in crushed tomatoes with a Metrohm NIR spectrometer. Blue dots represent the calibration dataset, and green dots represent the validation dataset.

R^2	SEC (°Bx)	SECV (°Bx)	SEP (°Bx)
0.846	0.14	0.14	0.16

CONCLUSION

This Application Note shows that NIR spectroscopy can easily measure firmness in apples, as well as °Brix in peaches and crushed tomatoes. When compared to traditional lab methods (Table 1), NIRS provides a faster, simpler, and nondestructive alternative with excellent accuracy and consistency.

All measurements proved to be consistent and fast, helping producers to monitor their fresh fruits and vegetables and deliver high-quality products to consumers.

Table 1. Overview of the reference methods usually suggested for the different parameters mentioned in this Application Note.

Parameter	Method
Firmness	Penetrometer
Brix	ISO 2173:2003 - Fruit and vegetable products — Determination of soluble solids — Refractometric method

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