Application Note
November 2015

Non-destructive Measurements of Total Soluble Solids and Dry Matter content in Apple (*Malus spp.)*

Dry matter (DM) content, the inverse of water content, is a strong metric for determining consumer preference and storability of apples. Orchard harvest can be timed with peak DM content to maximize quality in apples. Sugar (Total Soluble Solids (TSS) or ºBrix) content is regularly measured in apples throughout development and storage. Using traditional methodology, TSS and DM content measurements are destructive and time-consuming. To determine effectiveness and viability of the F-750 Produce Quality Meter for non-destructive measurements of TSS and DM in apples, a modeling study was conducted on 40 apple cheeks. Destructive reference values were correlated with the non-destructive spectral data collected with the F-750 using F-750 Model Builder Software, and results show that the F-750 Produce Quality Meter precisely and non-destructively measures TSS and DM in apples, with a calculated Root Mean Square Error of Prediction (RMSEP) of 0.59 ºBrix TSS and 0.51% DM.

Materials and Methods:

Figure 1. Fruit presentation for measuring apples with the F-750.

In October 2015, 40 apple cheeks were used to create a new model for the F-750 Produce Quality Meter. Ready-to-eat apples from Granny Smith, Gala, Fuji, Jazz, Red Delicious, Jonagold, and Golden Delicious varieties were selected across a range of sizes. Using the screws on the lens housing as alignment markers, apples were consistently presented and scanned on the F-750 Produce Quality Meter at room temperature (20ºC). Next, the same apple regions scanned with the F-750 were destructively measured for Dry Matter (DM) using the method described in Felix Instruments Mango Standard Operating Procedure (SOP). The spectral range of 729-975 nm was used by F-750 Model Builder Software to detect correlations between the F-750 spectral signal and corresponding DM values. The resulting regression data was analyzed for linearity, root mean square error, and leave-one-out cross validation error to determine the applicability and accuracy of the created model. A second population of 28 apples, including Jonagold, Gala, Granny Smith, and Braeburn and Pink Lady, were measured with the F-750 and used to independently validate the apple model.

Results and Discussion:

Results show that the F-750 Produce Quality Meter precisely, simultaneously, and non-destructively measures the TSS and DM of apples. A strong correlation between spectral data and collected reference values is illustrated by a model prediction R^2 of 0.83 for TSS and R^2 of 0.94 for DM. Figure 2 displays this correlation and demonstrates the consistency of measurement.

A calculated RMSEP of 0.59 ºBrix TSS and 0.51% DM further illustrates the accuracy of the created model. This RMSEP value indicates the average uncertainty for a given measurement when the model is loaded onto the F-750 and used to predict TSS and DM. The RMSEP is equivalent to the expected uncertainty within 68% of all predictions.

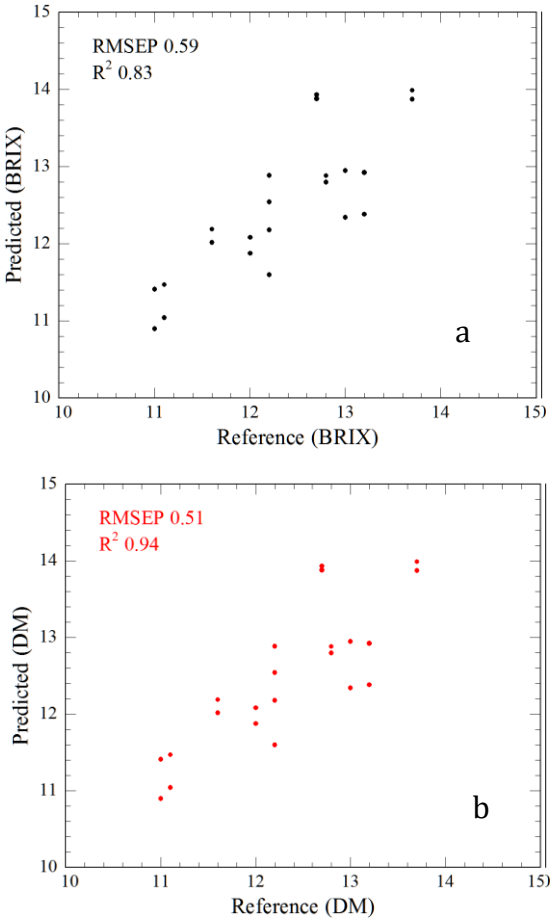

Figure 2. F-750 prediction value against reference method value of Total Soluble Solids (a) and Dry Matter (b) in apples.

Conclusions:

The F-750 Produce Quality Meter accurately predicted Total Soluble Solids (TSS) and Dry Matter (DM) in apples. Other tests and research findings have demonstrated the ability to measure other important internal fruit metrics with the NIR technology. Similar results are expected for the F-750 Produce Quality Meter with other apple varieties and traits.

Further Reading and Supporting Science:

McGlone, A., Jordan, R., Seelye, R., Clark, C. (2003). Drymatter – a better predictor of the post-storage soluble solids in apples? *Postharvest biology and technology*, 28: 431–435.

Moons, E., Sinnaeve, G. and Dardenne, P. (2000). Non Destructive Visible and NIR Spectroscopy Measurement for the Determination of Apple Internal Quality. *Acta Hortic*. 517, 441-448.

For more information about commodities tested with the F-750, visit www.felixinstruments.com.