NIR APPLICATION NOTE NIR-135

Quality control of honey with NIR spectroscopy

Simultaneous determination of color and glucose, fructose, sucrose, maltose, and turanose content with results in seconds

Honey is mainly comprised of the sugars glucose and fructose, which make up to 85% of its total weight. It additionally contains sucrose, a disaccharide composed of fructose and glucose, and other disaccharides such as maltose and turanose—present in concentrations from 0.5 to 3.5% [1]. The sugar content of honey is usually measured with high performance liquid chromatography (HPLC). Honey's color is a quality attribute evaluated by consumers and is an important sensory property in the beekeeping market. Internationally, different types of honey are classified using the Pfund color scale. All of these honey quality parameters can be measured simultaneously in just a few seconds without any sample preparation using near-infrared spectroscopy (NIRS).

Metrohm

EXPERIMENTAL EQUIPMENT

Pure honey samples were measured with an OMNIS NIR Analyzer Solid (**Figure 1**). All measurements were performed in transflection mode (1000–2250 nm) using a 2 mm gap size reflector and 28 mm disposable vials (**Table 1**). OMNIS Software was used for all data acquisition and prediction model development.

HPLC was the reference method used to measure the concentration of glucose, fructose, sucrose, maltose, and turanose in honey. Color was measured using a Pfund colorimeter and the Pfund scale, which ranges from 0 to 140 mm (from very light-colored honey up to the darkest honey).

Table 1. Hardware and software equipment overview.

Equipment	Article number
OMNIS NIR Analyzer Solid	2.1071.0010
Small reflector OMNIS NIR, 2 mm	6.07402.920
Disposable vials, 28 mm, reflection	6.7402.140
OMNIS Stand-Alone license	6.06003.010
Software license Quant Development	6.06008.002

Figure 1. The OMNIS NIR Analyzer Solid from Metrohm.

RESULT

The obtained NIR spectra of honey samples (**Figure 2**) were used to create prediction models for quantification of glucose, fructose, sucrose, maltose, and turanose content, as well as color. The quality of the prediction models was evaluated using correlation diagrams (**Figures 3–8**) which display a very high correlation between the NIR prediction and the reference values. The respective figures of merit (FOM) display the expected precision of a prediction during routine analysis.

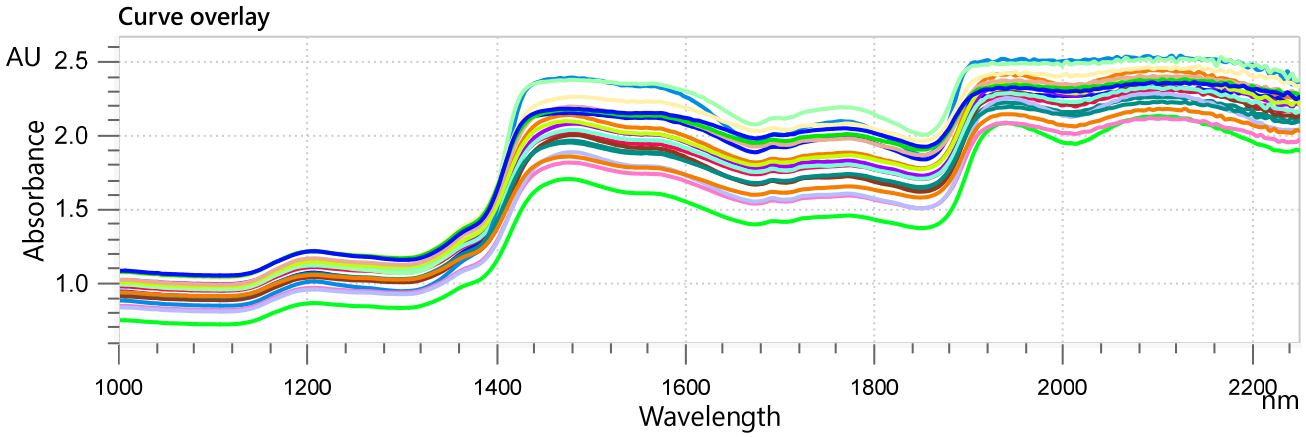
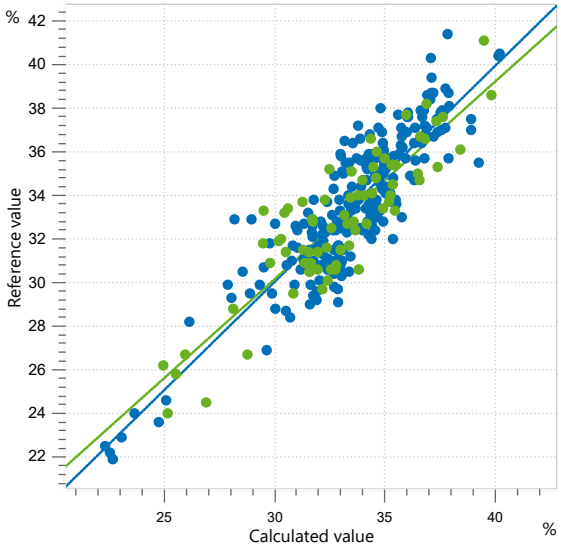


Figure 2. NIR spectra of honey analyzed on OMNIS NIR Analyzer Solid.

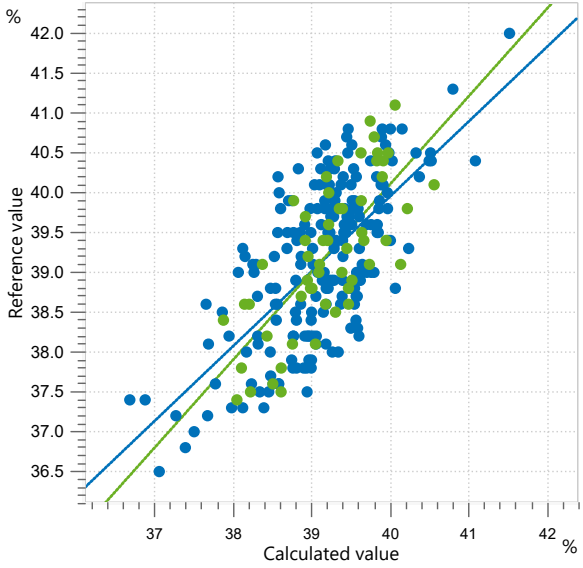
RESULT HONEY GLUCOSE CONTENT



R^2	SEC (%)	SECV (%)	SEP (%)
0.781	1.51	1.56	1.52

Figure 3. Correlation diagram and the respective figures of merit for the prediction of glucose content in honey. Reference values were obtained with HPLC.

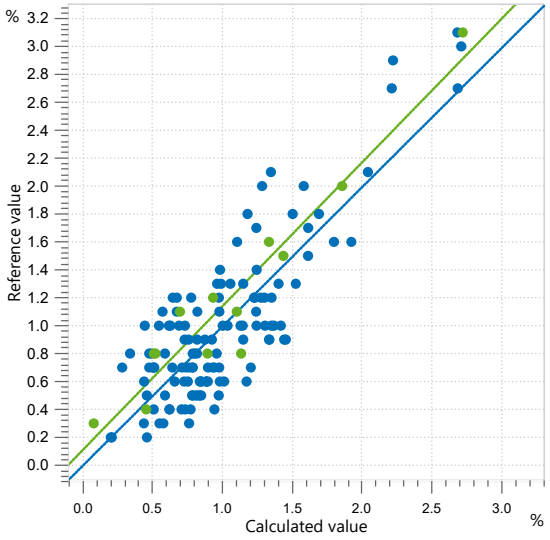
RESULT HONEY FRUCTOSE CONTENT



R^2	SEC (%)	SECV (%)	SEP (%)
0.527	0.67	0.73	0.64

Figure 4. Correlation diagram and the respective figures of merit for the prediction of fructose content in honey. Reference values were obtained with HPLC.

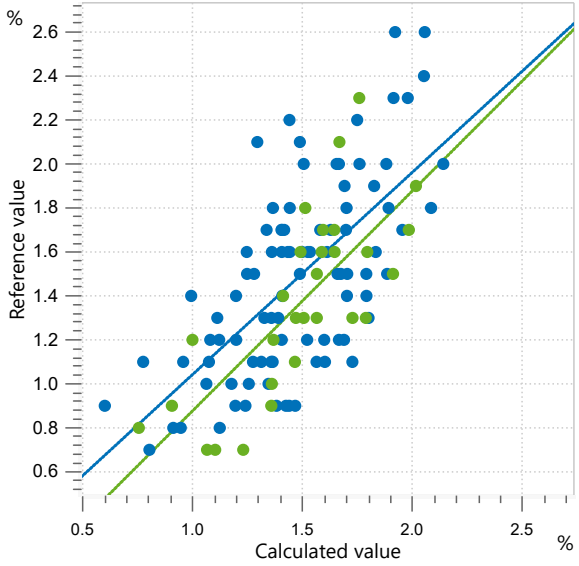
RESULT HONEY SUCROSE CONTENT



R^2	SEC (%)	SECV (%)	SEP (%)
0.917	0.29	0.32	0.25

Figure 5. Correlation diagram and the respective figures of merit for the prediction of sucrose content in honey. Reference values were obtained with HPLC.

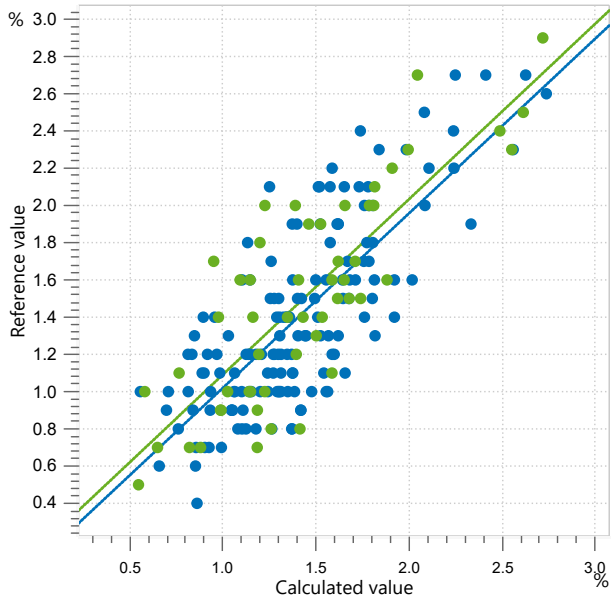
RESULT HONEY MALTOSE CONTENT



R^2	SEC (%)	SECV (%)	SEP (%)
0.557	0.30	0.33	0.30

Figure 6. Correlation diagram and the respective figures of merit for the prediction of maltose content in honey. Reference values were obtained with HPLC.

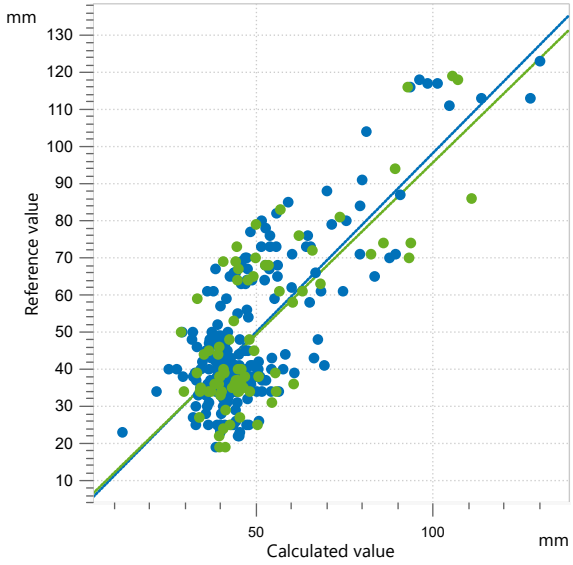
RESULT HONEY TURANOSE CONTENT



R^2	SEC (%)	SECV (%)	SEP (%)
0.665	0.30	0.31	0.33

Figure 7. Correlation diagram and the respective figures of merit for the prediction of turanose content in honey. Reference values were obtained with HPLC.

RESULT COLOR



R^2	SEC (mm)	SECV (mm)	SEP (mm)
0.578	12.56	13.56	14.58

Figure 8. Correlation diagram and the respective figures of merit for the prediction of color in honey. Reference values were obtained with a Pfund colorimeter.

CONCLUSION

This Application Note displays the benefits of using near-infrared spectroscopy for quality control of honey. Color, along with glucose, fructose, sucrose, maltose, and turanose content can be measured simultaneously in only a few seconds.

Measurements performed with NIR spectroscopy do not need any sample preparation nor solvents, saving users time and money. By using NIRS, only one analytical technology is required for sample measurement, compared to other conventional methods (**Table 2**). Finally, NIRS does not require skilled technical operators to perform the measurements, unlike HPLC.

Table 2. Overview of analytical methods used for the determination of reference values in honey.

Parameter	Method	Time to result
Glucose, fructose, sucrose, maltose, turanose	HPLC	~5 min (preparation) + ~40 min (HPLC)
Color	Pfund Method	~5 min

REFERENCE

[1] Kolayli, S.; Boukraâ, L.; Şahin, H.; et al. Sugars in Honey. In *Dietary Sugars: Chemistry, Analysis, Function and Effects*; 2012; pp 3–15.

Analytes:	**Carbohydrates – monosaccharides, disaccharides; Physical parameters – viscosity, density, etc.**
Matrix:	**Food – sweets; Food – animal sources**
Industry:	**Food & beverage**
Standards:	**ASTM E1655**
Method:	**Spectroscopy (NIRS/Raman)**