

Application Note AN-NIR-123

# Flour analysis by near-infrared spectroscopy (NIRS)

## NIR flour analysis determines moisture, protein, ash, gluten, starch, and rheological properties within seconds

Monitoring ash content, along with key quality parameters such as protein and moisture content, can significantly enhance the milling yield of flour. Next to these chemical parameters, rheological parameters like baking strength or tenacity influence the product quality. Near-infrared (NIR) spectroscopy enables chemical-free quality control of both chemical and rheological parameters, producing results within seconds. This simple, efficient, and rapid analysis method is ideal for continuous quality checks and can be implemented in laboratory settings or atline, requiring minimal training for effective use.

## EXPERIMENTAL EQUIPMENT

A total of 237 flour samples, including wheat flour, spelt flour, and other types, were analyzed on a Metrohm OMNIS NIR Analyzer Solid (Figure 1) with the large cup OMNIS NIR, 100 mm and OMNIS software. The samples were filled into the sample cup and analyzed in diffuse reflection mode. To include sample variety, the sample cup rotated during measurement to collect spectra from different locations. The automatically averaged spectra were used for model development. Reference values for moisture, protein, and ash content were obtained with the respective primary methods: moisture analysis followed AOAC 953.10, protein according to AOAC 2001.11, and ash content followed AOAC 923.03.



**Figure 1.** OMNIS NIR Analyzer Solid

**Table 1.** Hardware and software equipment overview.

| Equipment | Article number |
|---|---|
| OMNIS NIR Analyzer Solid | 2.1071.0010 |
| Large holder OMNIS NIR, 100 mm | 6.07402.100 |
| Large cup OMNIS NIR, 100 mm | 6.07402.110 |
| OMNIS Stand-Alone license | 6.06003.010 |
| Quant Development software license | 6.06008.002 |

## RESULT

The obtained NIR spectra (Figure 2) were used to create prediction models for the different reference parameters. Correlation diagrams which display the relation between the NIR prediction and the reference values are shown in Figures 3–5 together with the respective figures of merit (FOM).

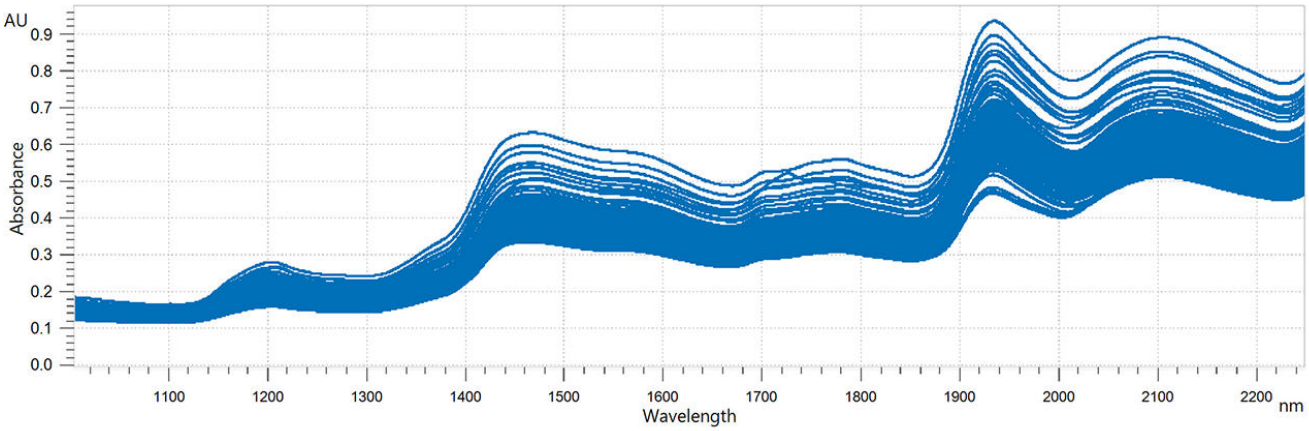



**Figure 2.** Overlaid NIR spectra of flour samples. Data was obtained with an OMNIS NIR Analyzer Solid.

## Result moisture in flour

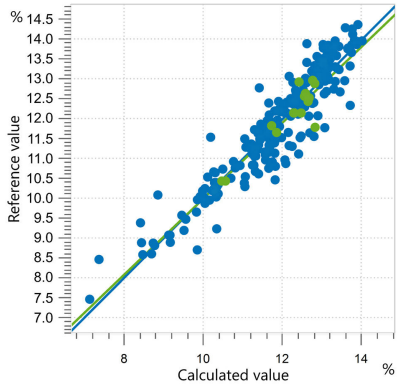



**Figure 3.** Correlation diagram and the respective FOMs for the prediction of moisture in flour. Blue dots represent calibration samples; green dots represent samples used to validate the model.

| Figures of Merit | Value |
|---|---|
| $R^2$ | 0.827 |
| Standard Error of Calibration | 0.47% |
| Standard Error of Cross-Validation | 0.48% |

**Result protein in flour**

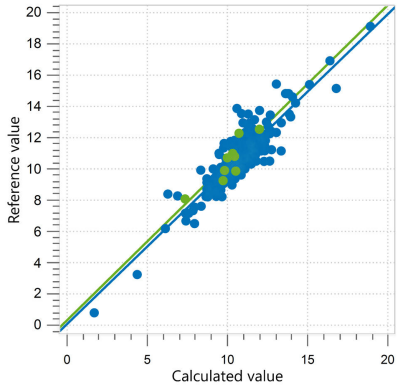



**Figure 4.** Correlation diagram and the respective FOMs for the prediction of protein in flour. Blue dots represent calibration samples; green dots represent samples used to validate the model.

| Figures of Merit | Value |
|---|---|
| $R^2$ | 0.789 |
| Standard Error of Calibration | 1.89% |
| Standard Error of Cross-Validation | 2.68% |

**Result ash in flour**

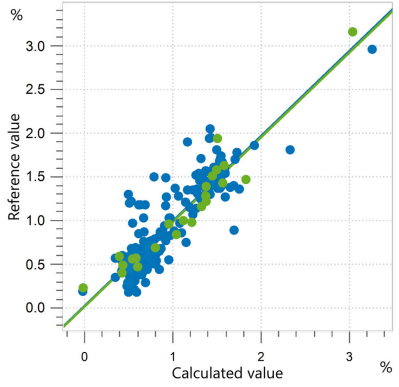



**Figure 5.** Correlation diagram and the respective FOMs for the prediction of ash in flour. Blue dots represent calibration samples; green dots represent samples used to validate the model.

| Figures of Merit | Value |
|---|---|
| $R^2$ | 0.929 |

| | |
|---|---|
| Standard Error of Calibration | 0.221% |
| Standard Error of Cross-Validation | 0.231% |

**Table 2.** Aside from the key quality parameters, additional parameters can be determined in flour using near-infrared spectroscopy.

| Parameter | Range | SEC | SECV | R2CV |
|---|---|---|---|---|
| Gluten | 15–35% | 1.39% | 1.40% | 0.918 |
| Starch | 15–26% | 0.86% | 0.97% | 0.755 |
| Baking strength | 36–444 | 29.94 | 30.75 | 0.919 |
| Elasticity index | 30–65 | 2.32 | 2.67 | 0.906 |
| Tenacity | 43–382 | 20.00 | 21.69 | 0.910 |

## CONCLUSION

This Application Note shows the feasibility of using NIR spectroscopy for the analysis of several quality parameters in flour. With no chemicals involved, near-infrared spectroscopy is an ideal way to avoid time-consuming sample preparation and reduce costs. NIRS instruments from Metrohm allow users to not only to monitor the flour milling process, but also to predict the rheological properties of the dough the flour is produced with.

## CONTACT

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## CONFIGURATION



OMNIS NIR Analyzer Solid

Near-infrared spectrometer for solid and viscous samples.

Developed and produced in accordance with Swiss quality standards, the OMNIS NIR Analyzer is the near-infrared spectroscopy (NIRS) solution for routine analysis along the entire production chain. Its application of the latest technologies and its integration in the modern OMNIS Software are reflected in its speed, operability and flexible utilization of this NIR spectrometer.

Overview of the advantages of the OMNIS NIR Analyzer Solid:

- Measurements of solids and viscous samples in less than 10 seconds
- Automated multi-position measurements for reproducible results, even with nonhomogeneous samples
- Simple integration in an automation system or link with additional analysis technologies (titration)
- Supports numerous sample vessels



Large holder OMNIS NIR, 100 mm

Large holder for large sample vessel OMNIS NIR, 100 mm (6.07402.110).

Permits unambiguous positioning of the sample vessel and the rotation of the sample vessel.



Large cup OMNIS NIR, 100 mm

Large sample vessel for the spectra acquisition of powders and granulates in reflection at various sample positions.

The glass bottom is made of resistant Gorilla® Glass.

Compatible with:

- Large holder OMNIS NIR, 100 mm (6.07402.100)

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### OMNIS Stand-Alone license

Enables stand-alone operation of the OMNIS software on a WindowsTM computer.

Features:

- The license already includes one OMNIS instrument license.
- Must be activated via the Metrohm licensing portal.

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### Software license Quant Development

Software license for the creation and editing of quantification models in a stand-alone OMNIS Software installation.