Application Note AN-NIR-123

# 利用近红外光谱(NIRS)分析面粉

## 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).

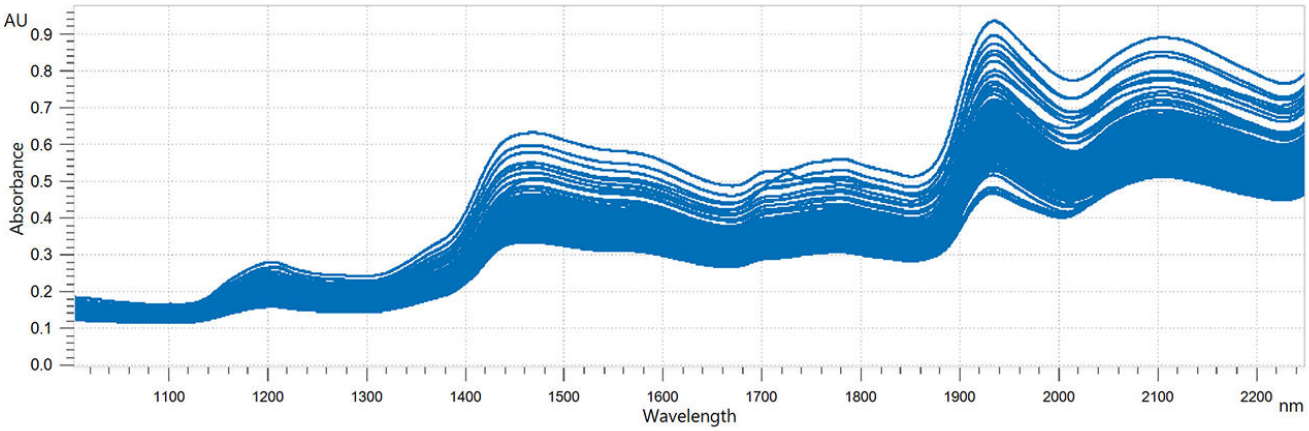


**Figure 2.** Overlaid NIR spectra of flour samples. Data was obtained with an OMNIS NIR Analyzer Solid.

## Result moisture in flour

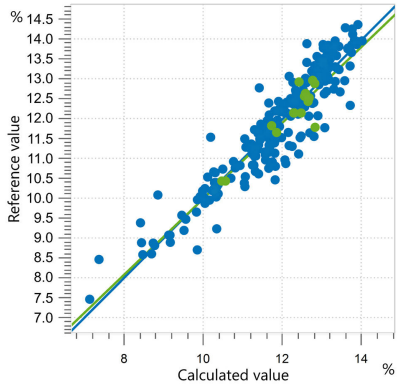


**Figure 3.** Correlation diagram and the respective FOMs for the prediction of moisture in flour. Blue dots represent calibration samples; green dots represent samples used to validate the model.

| 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

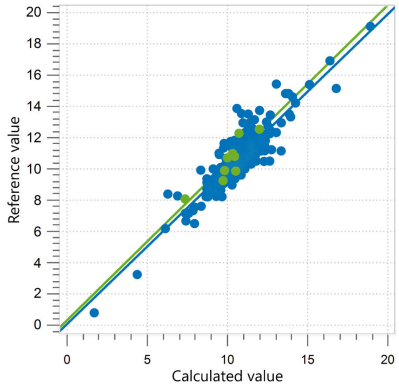


**Figure 4.** Correlation diagram and the respective FOMs for the prediction of protein in flour. Blue dots represent calibration samples; green dots represent samples used to validate the model.

| 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

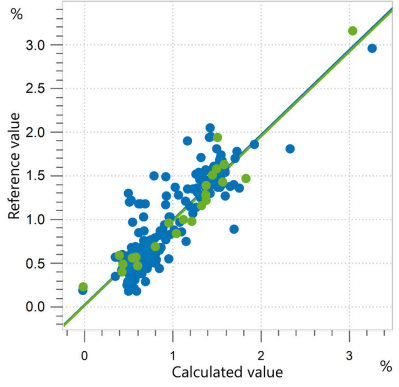


**Figure 5.** Correlation diagram and the respective FOMs for the prediction of ash in flour. Blue dots represent calibration samples; green dots represent samples used to validate the model.

| 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

**适合固体和粘性样品的近红外光谱仪。**

OMNIS NIR Analyzer 是一种按照瑞士质量标准开发和生产的近红外光谱 (NIRS) 解决方案,用于整个生产链的常规分析。使用新技术和嵌入先进 OMNIS Software 反应在该 NIR 光谱仪的速度、可操作性和灵活使用上。

OMNIS NIR Analyzer Solid 的优点概览:

- 在 10 秒以内测量固体和粘性样品
- 自动化多位置测量,即使在样品不均匀时,也能够获得可重现的结果
- 方便地嵌入自动系统,或者与其它分析技术(滴定)关联
- 支持大量样品容器

### OMNIS NIR100 mm

适合大样品容器的大支架 OMNIS NIR,100 mm (6.07402.110)。

允许明确地定位样品容器和旋转样品容器。

### OMNIS NIR100 mm

用于在不同样品位置处通过反射采集粉末和颗粒反射光谱的大样品容器。

兼容:

- 大支架 OMNIS NIR,100 mm (6.07402.100)


### OMNIS

允许单机版 OMNIS 软件在一台 WindowsTM 计算机上运行。

特性:

- 该许可证已含有一份 OMNIS 设备许可证。
- 须通过万通许可授权平台进行激活。


### Quant Development

用于在独立 OMNIS Software 安装套件中编写和编辑量化模型的软件许可证。