

Application Note AN-NIR-128

近红外光谱技术在奶粉分析中的应用

Determination of moisture, fat, lactose, and protein content

For milk powder producers, final product control is essential to meet strict regulatory standards, guarantee comprehensive quality assurance, ensure consistent nutritional quality, and extend shelf life. These are all especially important for infant formula and dairy ingredients used in sensitive applications.

Near-infrared spectroscopy (NIRS) is a fast, reagent-free method for measuring key quality parameters such as moisture, protein, lactose, and fat content directly in milk powder. The NIRS solution requires no sample preparation, enabling real-time monitoring either in the lab or directly on the production line. This allows producers to react quickly to process variations, minimize waste, and maintain product integrity batch after batch.

EXPERIMENTAL EQUIPMENT

More than 600 samples of powdered milk from different suppliers were analyzed on an OMNIS NIR Analyzer (**Figure 1**). The different milk powders were placed into an OMNIS sample cup and analyzed in diffuse reflection mode. To include sample variety, the sample rotated during measurement to collect spectra from different locations. The automatically averaged spectra were used for model development. Reference values were obtained by official methods, e.g., AOAC 927.05 (moisture), AOAC 939.02 (protein), and AOAC 932.06 (fat). For the lactose content determination, a phenol-sulfuric acid method was used.



Figure 1. OMNIS NIR Analyzer Liquid/Solid.

RESULT

The obtained NIR spectra (**Figure 2**) were used to create prediction models for the different reference parameters. An external validation set was used to verify the predictive performance of the calculated prediction models. Correlation diagrams which display the relation between the NIR prediction and the reference values are shown in **Figures 3–6** together with the respective figures of merit (FOM).

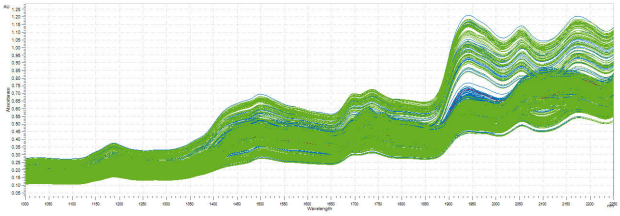
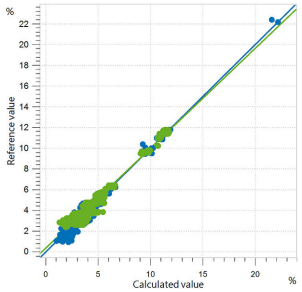


Figure 2. NIR spectra of milk powder samples. Data was obtained with an OMNIS NIR Analyzer. Spectra shown in blue have been used to calibrate the model, while green spectra have been used for validation.

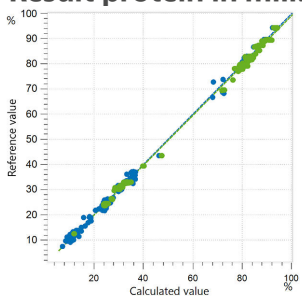
Result moisture in milk powder



Figures of Merit	Value
Number of samples	638
Range	0.94 – 22.40%
R2	0.977
Standard Error of Calibration	0.44%
Standard Error of Cross-Validation	0.48%
Standard Error of Prediction	0.47%

Figure 3. Correlation diagram and the respective FOMs for the prediction of moisture content in milk powder using an OMNIS NIR Analyzer. Reference values were obtained according to AOAC 927.05.

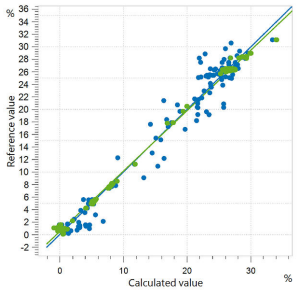
Result protein in milk powder



Figures of Merit	Value
Number of samples	666
Range	7.44 – 94.34%
R2	0.999
Standard Error of Calibration	0.94%
Standard Error of Cross-Validation	1.07%
Standard Error of Prediction	1.00%

Figure 4. Correlation diagram and the respective FOMs for the prediction of protein content in milk powder using an OMNIS NIR Analyzer. Reference values were obtained according to AOAC 939.02.

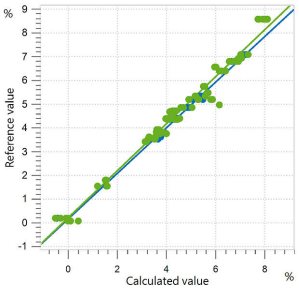
Result fat in milk powder



Figures of Merit	Value
Number of samples	552
Range	0.09 – 31.12%
R2	0.992
Standard Error of Calibration	1.64%
Standard Error of Cross-Validation	1.68%
Standard Error of Prediction	0.74%

Figure 5. Correlation diagram and the respective FOMs for the prediction of fat content in milk powder using an OMNIS NIR Analyzer. Reference values were obtained according to AOAC 932.06.

Result lactose in milk powder



Figures of Merit	Value
Number of samples	130
Range	0.08 – 8.58%
R2	0.977
Standard Error of Calibration	0.07%
Standard Error of Cross-Validation	0.16%
Standard Error of Prediction	0.36%

Figure 6. Correlation diagram and the respective FOMs for the prediction of lactose content in milk powder using an OMNIS NIR Analyzer.

CONCLUSION

This Application Note presented the analysis of milk powder using NIR spectroscopy. Models for several quality parameters (fat, protein, lactose, and moisture content) were created. Independent validation samples confirmed the robustness and reliability of the models, with high correlation coefficients and low prediction errors achieved across all parameters. Notably, the dataset included samples from diverse global origins, capturing a broad range of product variability. This study shows that NIRS can be successfully integrated into the quality control workflow for dairy powder analysis.

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CONFIGURATION



OMNIS NIR Analyzer Liquid/Solid

用于液体、固体和粘稠样品的近红外光谱仪。

OMNIS NIR Analyzer 按照瑞士质量标准开发和制造,是用于整个生产链中常规分析的近红外光谱(NIRS)解决方案。最新技术的应用以及与现代 OMNIS Software 的集成,体现在这款 NIR 光谱仪的速度、操作性和灵活应用上。

OMNIS NIR Analyzer Liquid/Solid 的优势概览:

- 液体、固体和粘稠样品测量时间小于 10 秒
- 无需系统转换即可快速连续测量液体和固体样品
- 可轻松集成至自动系统,或与其它分析技术(滴定)联用。
- 支持多种样品容器

液体测量的亮点:

- 样品温度调节范围为 25–80 °C
- 样品的自动检测

固体测量的亮点:

- 自动多位置测量,确保即使在非均质样品中也能获得可重现的结果



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进行粉末和颗粒光谱记录的大样品容器。

玻璃底板由坚固耐用的 Gorilla® 玻璃制成。

兼容:

- 大支架 OMNIS NIR,100 mm (6.07402.100)

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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。



通过 NIR 光谱测定奶粉中湿度、蛋白质、脂肪和乳糖含量的 OMNIS 预校准。