

Application Note AN-NIR-128

Milk powder analysis by near-infrared spectroscopy

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).

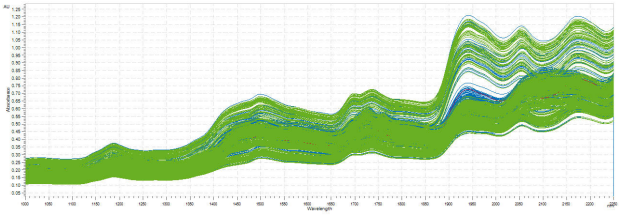
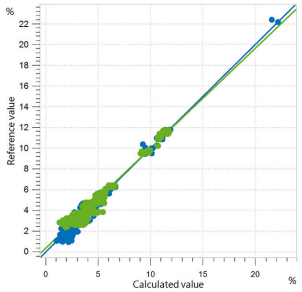


Figure 2. NIR spectra of milk powder samples. Data was obtained with an OMNIS NIR Analyzer. Spectra shown in blue have been used to calibrate the model, while green spectra have been used for validation.

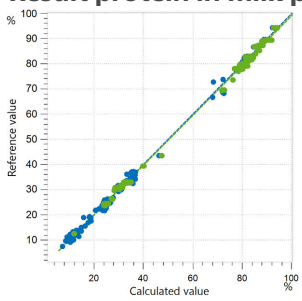
Result moisture in milk powder



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.

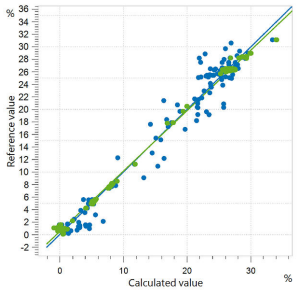
Result protein in milk powder



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.

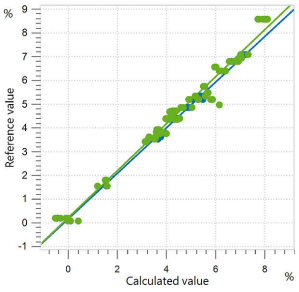
Result fat in milk powder



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

Near-infrared spectrometer for liquid, 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 Liquid/Solid:

- Measurements of fluid, solid, and viscous samples in less than 10 seconds
- Fast sequential measurement of liquid and solid samples without conversion of the system
- Simple integration in an automation system or link with additional analysis technologies (titration)
- Supports numerous sample vessels

Highlights of measurements of liquids:

- Temperature control on the sample from 25–80 °C
- Automatic detection of the sample

Highlights of measurements of solids:

- Automated multi-position measurements for reproducible results, even with nonhomogeneous samples



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)

OMNIS
A WHOLE NEW LEVEL OF PERFORMANCE

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.

OMNIS
A WHOLE NEW LEVEL OF PERFORMANCE

Software license Quant Development

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



Pre-calibration, milk powder, solid

OMNIS pre-calibration for determination of moisture, protein, fat, and lactose content in milk powder using NIR spectroscopy.