

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).

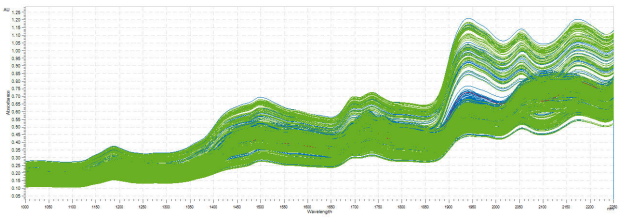
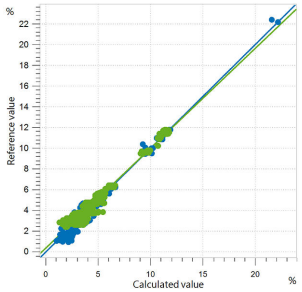


Figure 2. NIR spectra of milk powder samples. Data was obtained with an OMNIS NIR Analyzer. Spectra shown in blue have been used to calibrate the model, while green spectra have been used for validation.

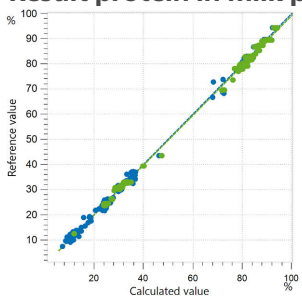
Result moisture in milk powder



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.

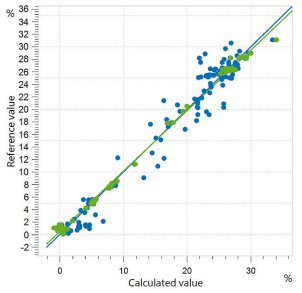
Result protein in milk powder



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.

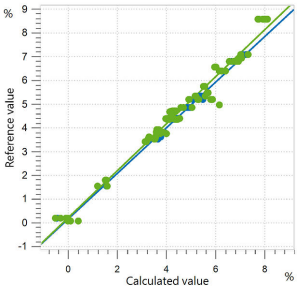
Result fat in milk powder



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.

CONTACT

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CONFIGURATION



OMNIS NIR Analyzer Liquid/Solid

Spectromètre proche infrarouge pour échantillons liquides, solides et visqueux.

L'OMNIS NIR Analyzer est la solution de spectroscopie proche infrarouge (NIRS) développée et produite selon les normes de qualité suisses pour les analyses de routine tout au long de la chaine de fabrication. L'application des technologies les plus récentes et l'intégration dans le logiciel OMNIS moderne se reflètent dans la vitesse, le maniement et la flexibilité d'utilisation de ce spectromètre NIR.

Apercu des avantages de l'OMNIS NIR Analyzer Liquid/Solid :

- Mesures d'échantillons liquides, solides et visqueux en moins de 10 secondes
- Mesure séquentielle rapide d'échantillons liquides et solides sans modification du système
- Intégration simple dans un système d'automatisation ou liaison avec d'autres technologies d'analyse (titrage)
- Prise en charge de nombreux récipients d'échantillon

Points forts des mesures de liquides :

- Régulation de température sur l'échantillon de 25 à 80 °C
- Détection automatique de l'échantillon

Points forts des mesures de matières solides :

- Mesures multi-positions automatisées pour des résultats reproductibles, même avec des échantillons non homogènes



Grand support OMNIS NIR, 100 mm

Grand support pour grand récipient d'échantillon OMNIS NIR, 100 mm (6.07402.110).

Permet un positionnement univoque du récipient d'échantillon et sa rotation.



Grande coupelle OMNIS NIR, 100 mm

Grand récipient d'échantillon pour l'enregistrement de spectres par réflexion de poudres et de granulés en différents points de l'échantillon.
Le fond en verre est en Gorilla® Glass résistant.
Compatible avec:

- Grand support OMNIS NIR, 100 mm (6.07402.100)

OMNIS
A WHOLE NEW LEVEL OF PERFORMANCE

Licence OMNIS autonome

Elle permet l'exploitation autonome du logiciel OMNIS sur un ordinateur WindowsTM.

Caractéristiques :

- La licence comprend déjà une licence pour appareils OMNIS.
- Elle doit être activée via le portail d'octroi de licences Metrohm.

OMNIS
A WHOLE NEW LEVEL OF PERFORMANCE

Licence logicielle Quant Development

Licence logicielle pour la création et l'édition de modèles de quantification dans une installation du logiciel OMNIS Stand-Alone.



Pré-calibration, poudre de lait, solide

Pré-calibration OMNIS pour la détermination de l'humidité, des protéines, de matières grasses et de la teneur en lactose du lait en poudre par spectroscopie NIR.