

Application Note AN-NIR-144

Analyse du perméat de lactosérum avec NIRS

Surveillez facilement les process de production laitière en quelques secondes

Le perméat de lactosérum, un sous-produit de la fabrication de la poudre de protéine de lactosérum, contient des quantités élevées de lactose, de phosphate et de minéraux. En raison de son gout sucré et doux, le perméat de lactosérum est souvent utilisé dans la boulangerie et la fabrication de chocolat.

La clé pour optimiser la production de perméat de lactosérum est de contrôler les flux de production en temps réel. Il est important de surveiller le processus de production à l'aide de techniques d'analyse à haut débit afin de maximiser le rendement et de garantir une qualité élevée du produit. La spectroscopie proche infrarouge (NIRS) est une technique d'analyse rapide et sans produits chimiques qui peut prendre en charge ce type de test. La spectroscopie NIR permet de mesurer simultanément les paramètres de qualité les plus importants (protéines, lactose, humidité, cendres, pH et phosphate) dans le perméat de lactosérum sans aucune préparation d'échantillon. La solution NIRS est rapide, facile à utiliser et peut être utilisée en ligne ou hors ligne dans un laboratoire de contrôle qualité.

EXPERIMENTAL EQUIPMENT

158 whey permeate samples were analyzed on a Metrohm NIR Analyzer equipped with a small cup accessory. All measurements were performed in reflection mode (1000–2250 nm). Metrohm software was used for data acquisition and prediction model development.

RESULT

The obtained NIR spectra (Figure 1) were used to create prediction models for the parameters of lactose, moisture, pH, ash, phosphate, and protein content. Spectral data was preprocessed, and wavelength selection was used to improve the accuracy of the models. All models were validated using an independent validation set with a sample size of 25%. The quantification models show a high correlation with the laboratory data of > 0.80 (R2P), except lactose with a value of 0.70 (R2P).
Correlation diagrams, together with the respective figures of merit (FOM), are displayed in Figures 2–7 which display the expected precision for routine analysis.

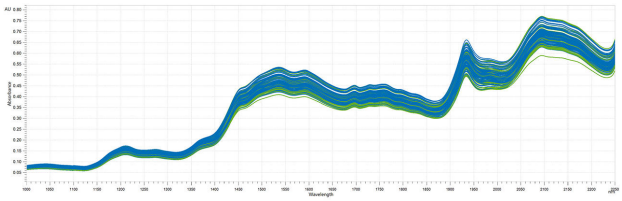


Figure 1. Selection of NIR spectra of whey permeate samples. Blue represents calibration samples, while green represents validation set samples. Data was obtained with a Metrohm NIR Analyzer.

Result protein content

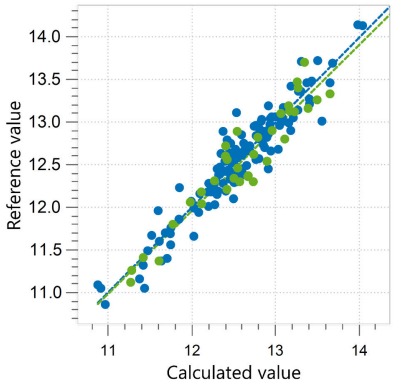


Figure 2. Correlation diagram and the respective figures of merit for the prediction of protein content in whey permeate using a Metrohm NIR Analyzer. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.899	0.18	0.19	0.21

Result lactose content

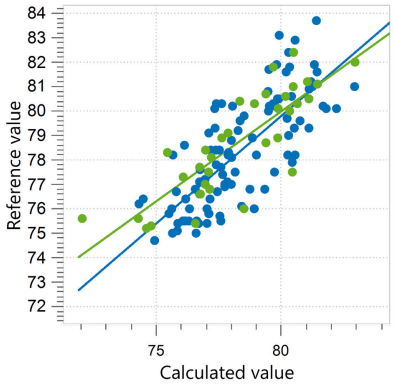


Figure 3. Correlation diagram and the respective figures of merit for the prediction of lactose content in whey permeate using a Metrohm NIR Analyzer. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.689	1.22	1.44	1.41

Result moisture content

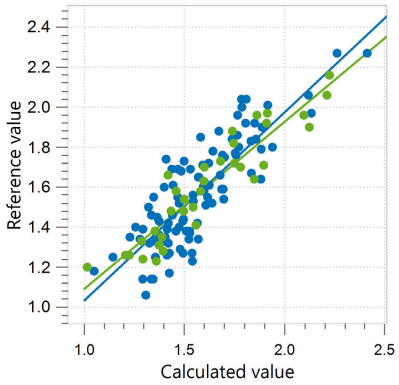


Figure 4 Correlation diagram and the respective figures of merit for the prediction of moisture content in whey permeate using a Metrohm NIR Analyzer. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.864	0.13	0.14	0.11

Result ash content

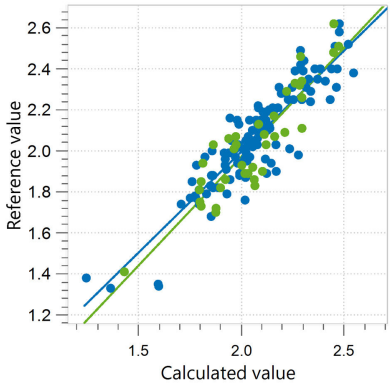


Figure 5. Correlation diagram and the respective figures of merit for the prediction of ash content in whey permeate using a Metrohm NIR Analyzer. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.813	0.09	0.10	0.11

Result phosphate content

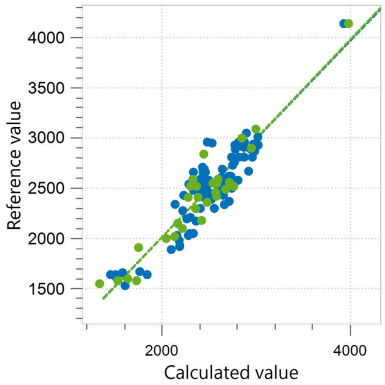


Figure 6. Correlation diagram and the respective figures of merit for the prediction of phosphate content in whey permeate using a Metrohm NIR Analyzer. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (ppm)	SECV (ppm)	SEP (ppm)
0.909	158	171	156

Result pH value

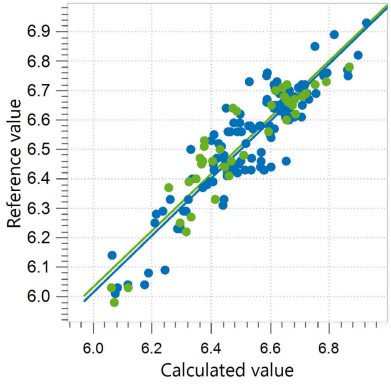


Figure 7. Correlation diagram and the respective figures of merit for the prediction of pH value in whey permeate using a Metrohm NIR Analyzer. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC	SECV	SEP
0.862	0.07	0.08	0.08

CONCLUSION

This Application Note demonstrates the feasibility of using NIR spectroscopy for whey permeate quality control. Near infrared-spectroscopy is a rapid, nondestructive analytical technique that can monitor the production process of dairy products. Aside from the analysis of whey permeate, the whey protein production stream can also be monitored by NIRS.

Table 1. Overview of ISO norms for the different parameters used for determining the reference values of the whey permeate samples.

Parameter	Method
Lactose	ISO 22662:2024 Milk and milk products – Determination of lactose content by high-performance liquid chromatography
Protein	ISO 8968-1:2014 Milk and milk products — Determination of nitrogen content Kjeldahl method
Moisture	ISO 5537:2023 Dried milk and dried milk products — Determination of moisture content with loss on drying
Ash	ISO/DIS 9877 Milk and milk products — Determination of ash content by incineration

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