Application Note – N°. 902/2025

On-Site milk analysis with ProxiScout™

Abstract: The ability to accurately measure milk composition is crucial for dairy quality control, ensuring product consistency, and optimizing feed management. The ProxiScout™ handheld NIR scanner provides a rapid, cost-effective, and non-destructive solution for on-site milk analysis. This study evaluates the accuracy and performance of ProxiScout™ in predicting fat, protein, and lactose content in raw milk samples, demonstrating its alignment with ICAR standards.

1. Introduction

Milk quality assessment is essential across the dairy supply chain, from farm-level production to final processing. Traditional laboratory-based methods, such as Fourier Transform Infrared (FTIR) spectroscopy, provide precise measurements but are expensive, time-consuming, and require specialized infrastructure. Near-Infrared (NIR) spectroscopy presents a portable, non-destructive alternative, enabling real-time milk composition analysis.

This study investigates the effectiveness of ProxiScout™ in determining fat, protein, and lactose content in milk, offering a practical solution for dairy farmers, quality control laboratories, and processing plants.

2. Equipment

The ProxiScout™ handheld NIR scanner was used to collect spectral data from raw milk samples. This device allows for quick and easy operation with minimal training, making it ideal for on-site analysis. The scanner utilizes diffuse reflectance spectroscopy to capture spectral fingerprints, providing instant, reliable results.

Figure 1: ProxiScout™ Scanner used for on-site analysis of raw milk.

- Setup: Diffuse reflection.
- Spectral Range: 1350–2550 nm.

3. Chemicals and Materials

Samples:

- Total Samples: 110 raw milk samples were collected from multiple farms.
- Diversity: Samples were sourced from three different breeds and five distinct herds to ensure variability.
- Collection Method: Each sample was obtained from a separate animal, reflecting real-world dairy variations.

Measurement Conditions:

- Scan Time: 5 seconds per sample.
- Resolution: 16 nm at λ = 1,550 nm.
- Spot Size: 10 mm^2.
- Temperature: Room temperature.
- Averaging: Each sample was measured three times, with the results averaged for analysis.

4. Procedure

4.1 Reference Methods

- Destructive chemical analysis was conducted to determine the fat, protein, and lactose content of the milk samples.
- The reference laboratory values were used to calibrate and validate the NIR-based predictive models.

4.2 Calibration Model Development

Partial Least Squares (PLS) regression models were developed to establish a linear relationship between the spectral data and laboratory-measured milk component values. The models were optimized using:

- 90% of samples for calibration.
- 10% of samples for validation (unseen during model development).

4.3 Data Analysis

To assess the performance of the Partial Least Squares (PLS) model, a cross-validation technique was employed. This involved calculating the prediction error (root mean square of errors for all samples) and the coefficient of determination (R^2CV) between predicted contents and the reference data obtained from chemical analysis. The cross-validation technique entails dividing the data into calibration and validation sets. The calibration set is utilized for training the PLS model, while the validation set is reserved for evaluating the model's performance.

5. Result

5.1 Model Performance Metrics

In each iteration, the validation and calibration sets are combined, and a new portion of data is designated as the validation set. The process is then repeated, involving model training and validation on the updated sets. This iterative procedure continues until each sample has been represented at least once in the validation set, thereby providing a comprehensive assessment of the PLS model's predictive capabilities. Results from the cross-validation are shown in Figure 2.

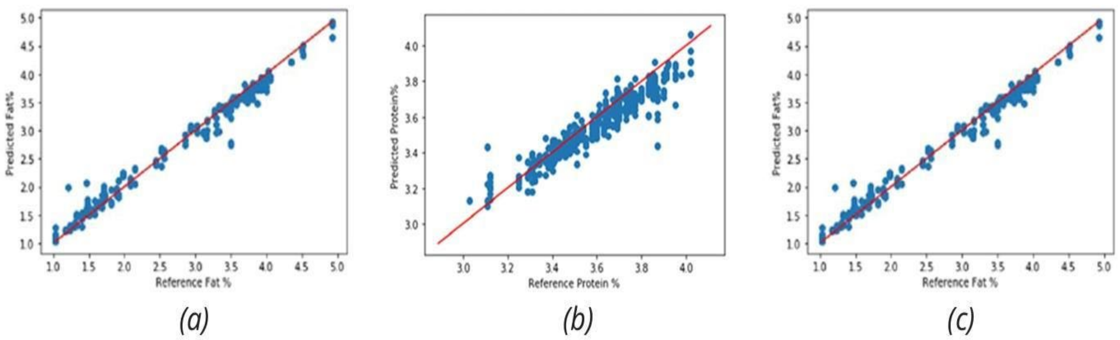

Figure 2: The relation between the reference data (chemical analysis) and the predicted results from our model. Each dot represents a test sample where the x-coordinate is the reference value, and the y-coordinate is the model prediction. The red line represents the ideal model and R^2 (ideal value is 1) shows how far the model deviates from the ideal one.

Table 1: Model prediction results.

	Calibration		Validation			
	R^2	**RMSE**	**R^2**	**RMSE**	**SEP**	**Bias**
Fat	0.984	0.158	0.991	0.167	0.147	0.096
Protein	0.891	0.078	0.979	0.127	0.131	-0.033
Lactose	0.818	0.105	0.767	0.111	0.114	0.033

5.2 Key Observations

- High correlation between predicted and reference values indicates strong model accuracy.
- Low RMSE values confirm precise measurements.
- The ability to perform non-destructive analysis allows real-time quality control at various stages of milk production.

6. Conclusion

6.1 Comparison to Standard Methods

- Results from ProxiScout™ closely matched those obtained from traditional FTIR-based chemical analysis.
- Unlike laboratory methods, ProxiScout™ provides instant results, eliminating sample transport and processing delays.

The ProxiScout™ handheld NIR scanner offers a reliable and portable solution for on-site milk analysis. By enabling dairy farmers and processors to measure fat, protein, and lactose content in real-time, it improves decision-making, enhances quality control, and optimizes production efficiency. Its cloud connectivity further ensures data accessibility for monitoring and compliance.

7. References

[1] International Committee for Animal Recording. (n.d.). ICAR – Network. Guidelines. Certifications: ICAR (International Committee for Animal Recording) standards for milk composition analysis

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[3] Zhu, D., Chen, J., & Peng, Y. (2019). Rapid and non-destructive determination of milk fat content using near-infrared spectroscopy technology combined with chemometrics methods. Journal of Food Composition and Analysis, 82, 103237: Spectroscopy-based methods for milk quality assessment