



Application Note – N°. 835/2024

How NIR supports any meat production facility

Abstract: By harnessing the power of NIR spectroscopy, meat producers can quickly and non-destructively analyze meat composition, ensuring optimal parameters such as fat content, moisture levels, and protein concentration. This real-time data enables precise adjustments in processing, minimizing waste, and optimizing yield. ProxiMate™ NIR and the NIR-Online sensors, e.g. the X-Sential™, with their robustness and flexibility can streamline meat production operations, making them invaluable tools for modern and efficient meat processing.



1. Introduction

The meat industry faces many challenges regarding economic efficiency, legislative labelling requirements, and customer awareness regarding product quality and nutritional value. A reliable, rapid method is required to give accurate and consistent readings of quality parameters during incoming inspection, production process, and final product control. NIR as a multiparameter analysis technique can support and streamline your production at any stage.

2. Equipment for Process and Quality Control

BUCHI offers robust NIR instruments that are fit for the harshest environments and meet your needs with various configuration possibilities.

The [ProxiMate™ NIR](#) at-line instrument is available in two different modes. The Up-View mode ensures consistent product–detector distance and the Down-View mode in combination with plastic or metal sample cups is very beneficial for areas where glass is prohibited. With its IP69 certification, integrated PC and touchscreen, and its ease-of-use, ProxiMate™ is the perfect fit for batch analysis or final product control.

The NIR-Online process sensors, [X-Sential™](#) and [X-One](#), are even more flexible. They are directly installed in the production lines and monitor the product flow continuously. Many accessories are available that allow easy integration into the manufacturing process, ensuring the monitoring of crucial production steps. For example, in mixers and chutes, contactless measurements over conveyor-belts, or directly in pipes for liquid measurements.

Both, at-line and on-line systems, offer the possibility for additional Vis detectors to measure the color of your samples and products.

3. NIR in Meat Processing

NIR can be applied along the **complete meat production process chain** ^[1], from the slaughterhouse ^[2], cutting and de-boning stages, to processes such as grinding, mixing, curing, or boiling, until the final products.



Frequent and rapid batch analysis as well as continuous online monitoring support the **optimization of processes in meat manufacturing**, such as:

- Fast subsequent processing of raw meat parts.
- Control of lean/fat meat ratio. ^[3]
- Control of dosing and mixing steps.
- More consistent production according to the recipe.
- Redness and color measurements to meet customer expectations.

BUCHI NIRsolutions™ enable enhanced productivity and higher quality for maximum profit margins and support you in optimizing all stages of your production. Depending on your needs, at-line and on-line instruments can determine important process and quality parameters along your complete value chain (see Chapter 4).

The **return on investment** of NIR equipment can be calculated from a number of different aspects, such as lower consumption and costs of chemicals and reagents in contrast to the other analytical methods or reduced analysis time for operators.

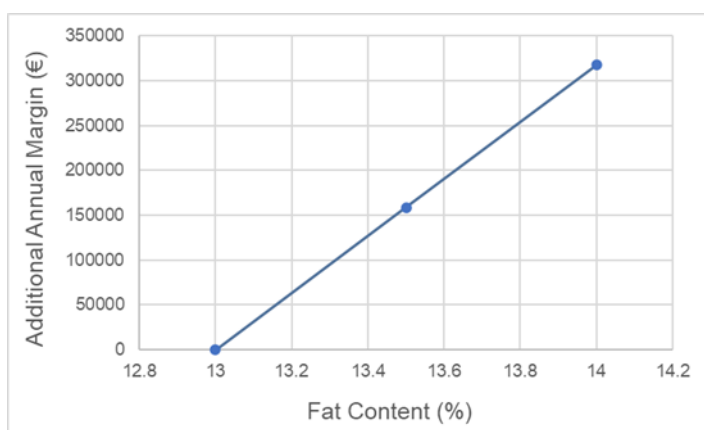
Let's take a look at an example: 3 measurements of fat and protein are conducted by wet chemistry techniques every day, 5 days a week. The cost of the reference analysis for one year, including the consumables, chemicals, and the work time of the operator, amounts to:

6 (measurements per day) x 250 (workdays per year) x 20 € (analysis cost) = 30,000 €.

In this scenario, the ProxiMate™ becomes **achieves an ROI of less than two years**. On top of that, the sample throughput per day can be increased largely compared to the reference methods, enabling more frequent analyses.

In addition to saving analysis costs, monitoring crucial process steps with the **X-Sential™** or **X-One** can **increase profit margins**. In the minced meat production, for example, monitoring the meat mixture with a NIR-Online sensor allows better control of the lean meat to fat ratio.

Imagine a production of 10,000 t of minced meat per year. The target fat value after mixing of lean and fatty meat is 14% but not above. The fat content in the lean meat is 7% on average and in the fatty meat it is 70%.



The price for the lean meat amounts to 3 €/kg, while the price for fatty meat is 1 €/kg.

With continuous NIR measurements, the production can be closely monitored, which allows to reduce the safety margin. Before applying NIR analysis to the process, the fat content in the product amounted to maximum 13% to assure product compliance. Now, the ratio of fatty to lean meat in the final product can be increased, which leads to higher yearly margins.

4. Sample Types and Parameters

All kinds of meat types can be analyzed including beef, pork, poultry, sheep, goat, and horse meat. Even processed meat products containing spices, herbs, and starch-based components are not a problem for NIR.

The only **sample preparation** needed for measurements with the ProxiMate™ is homogenization. This is especially required when the sample consists of distinct fatty and lean parts or when the product has a different exterior and interior composition, for example sausages with skin.



The NIR-Online sensors measure the product as it is presented in the process and hence no sample preparation is required.

NIR can determine **important quality parameters in raw and processed meat**, such as:

- Fat.
- Protein, CTP (connective tissue protein), BEFFE (meat protein free of CTP), Collagen.
- Moisture.
- Salt.
- Color.
- pH.
- Ash.
- Starch.
- Water activity.

BUCHI offers pre-calibrated applications for ProxiMate™ NIR that enable a smooth implementation of the system into routine use (see Tables 1 and 2, Figure 1–4).

To add parameters or customize applications, the unique AutoCal feature of the ProxiMate™, the X-Sential™, and X-One series makes calibration development as easy as possible. Only the reference values, but no expert knowledge, are required for calibration updates.

On top of that, it is possible to transfer calibration data from the laboratory to the process environment. Also, calibration databases from legacy instruments can be transferred and re-used.

Table 1: Raw Meat Applications for ProxiMate™ (November 2023).

Measurement Mode	Parameter*	Min	Max	R ²
Up View	Moisture	12.50	86.90	0.98
	Fat	0.10	83.20	0.99
	Protein	3.93	26.01	0.96
	BEFFE	2.21	24.70	0.96
Down View	Moisture	17.40	83.39	0.98
	Fat	0.10	83.20	0.99
	Protein	3.93	26.01	0.95
	BEFFE	2.21	24.70	0.94

*Data sets for CTP and ash are also available.

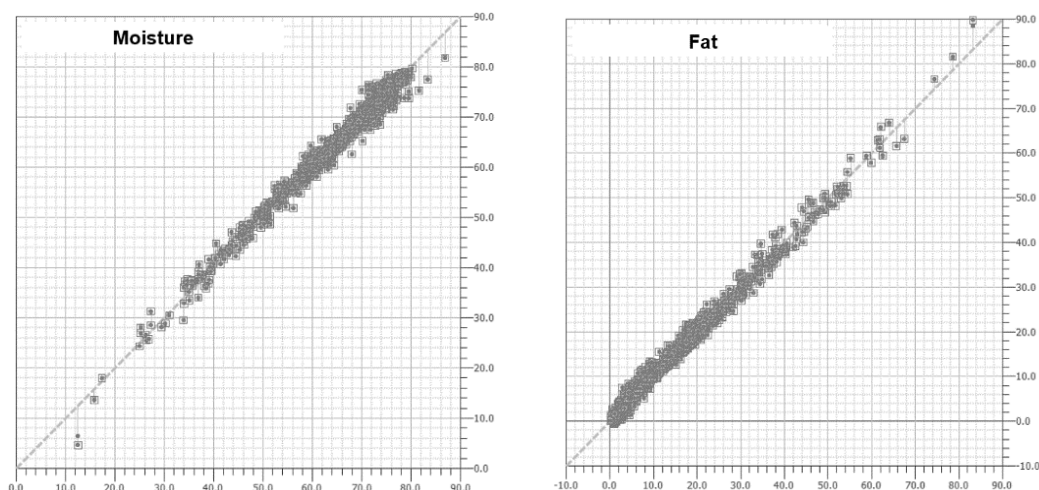


Figure 1: Predicted vs. reference values for the Moisture and Fat, Raw Meat Application Up View.

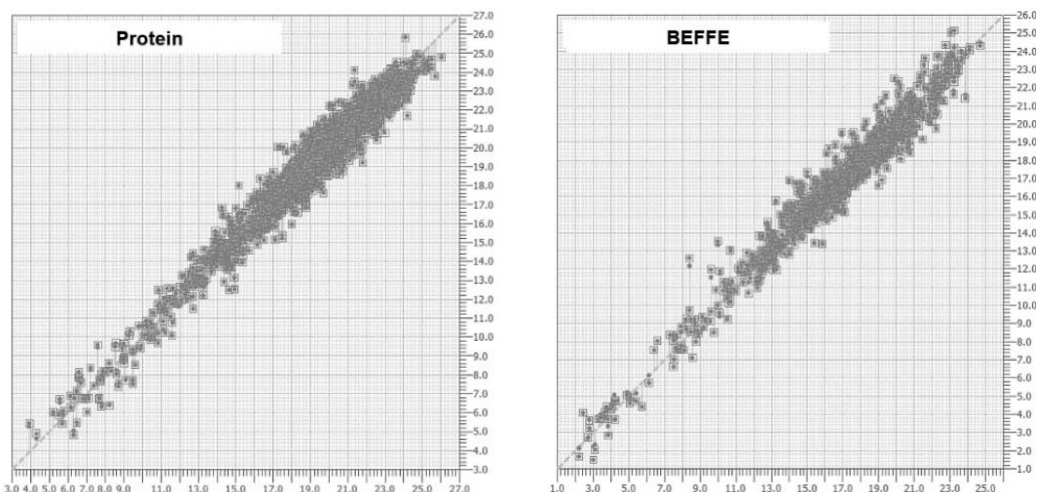


Figure 2: Predicted vs. reference values for Protein and BEFFE, Raw Meat Application Up View.

Table 2: Processed Meat Applications for ProxiMate™ (November 2023).

Measurement Mode	Parameter*	Min	Max	R2
Up View	Moisture	13.30	82.30	0.99
	Fat	0.30	74.11	0.99
	Protein	3.70	43.36	0.96
	BEFFE	2.30	35.14	0.95
Down View	Moisture	13.70	82.30	0.99
	Fat	0.30	74.11	0.99
	Protein	3.70	43.36	0.97
	BEFFE	2.30	35.14	0.95

*Data sets for CTP, salt, and ash are also available.

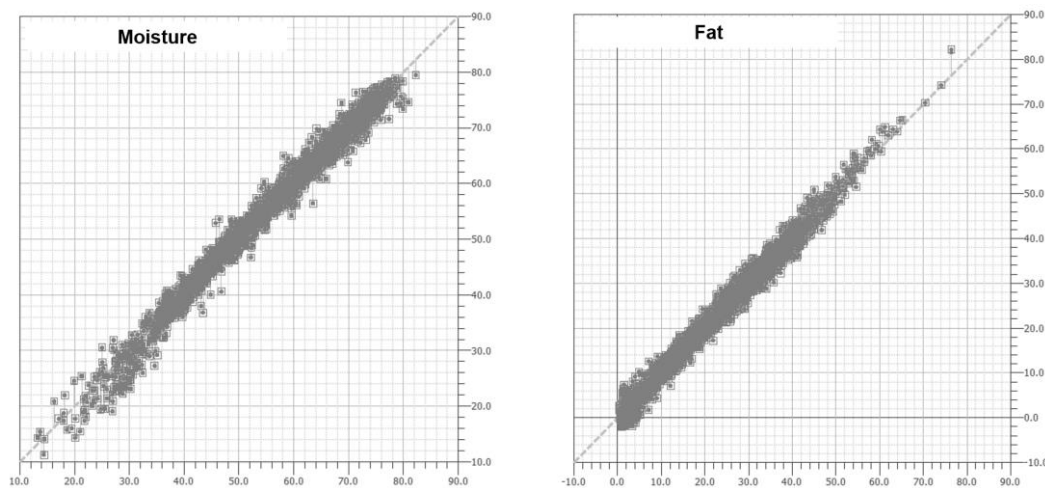


Figure 3: Predicted vs. reference values for the Moisture and Fat, Processed Meat Application Up View.

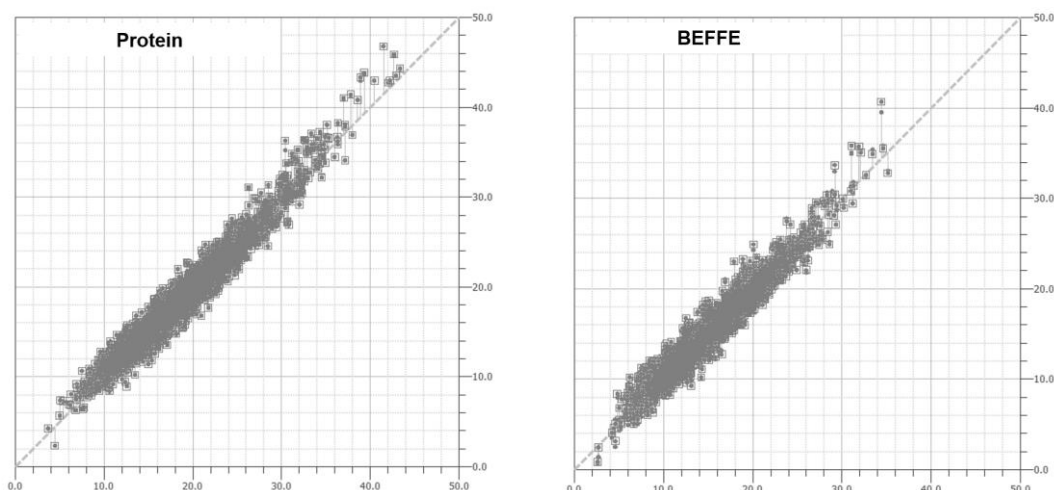


Figure 4: Predicted vs. reference values for Protein and BEFFE, Processed Meat Application Up View.

5. Conclusion

NIR spectroscopy is an invaluable tool for analysis, process optimization, and quality control in the meat industry. The technique can rapidly assess various parameters such as moisture, fat, protein, and many more. Efficient and reliable analysis helps to optimize meat production processes, to ensure product consistency, and to meet quality standards in a very cost-effective manner.

Robust and flexible NIR instruments that can be configured to meet individual requirements, such as the ProxiMate™ or the X-Sential™, are ideal partners for these challenging tasks.

6. Links

- Application Finder: [NIR Applications Finder \(buchi.com\)](https://www.buchi.com/nir-applications-finder)
- Blog: [Shallot Holmes & the Food Detectives](https://www.buchi.com/blog/shallot-holmes-the-food-detectives)
- NIR Technology Page: [NIR | Buchi.com](https://www.buchi.com/nir-technology)
- ProxiMate™: [ProxiMate™ | Buchi.com](https://www.buchi.com/proximate)
- NIR-Online X-Sential™: [NIR-Online X-Sential™ | Buchi.com](https://www.buchi.com/nir-online-x-sential)
- NIR-Online X-One: [NIR-Online X-One | Buchi.com](https://www.buchi.com/nir-online-x-one)
- Reference Methods: [Steam Distillation Instruments | Buchi.com](https://www.buchi.com/steam-distillation-instruments) [Extraction Instruments | Buchi.com](https://www.buchi.com/extraction-instruments)

7. References

- [1] A. Onopiuk, A. Poltorak, A. Wierzbicka, CyTA Journal of Food 2020, 18, 315.
<https://doi.org/10.1080/19476337.2020.1750095>
- [2] L. Vasconcelos, L. G. Dias, A. Leite, I. Ferreira, E. Pereira, S. Silva, S. Rodrigues, A. Teixeira, Foods 2023, 12, 470. <https://doi.org/10.3390/foods12030470>
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