

Application Note AN-NIR-148

Fish meal analysis by near-infrared spectroscopy

NIR spectroscopy reduces analysis time from hours to seconds

Regarding animal nutrition, fish meal is a premium source of omega-3 fatty acids, protein, and essential minerals. Due to its nutritional properties, it is not only widely used in aquaculture, but also as an additive to swine feed and poultry feed. To analyze the main quality components of fish meal, such as fiber, fat, protein, moisture, and ash content, multiple wet chemistry methods are usually needed.

Instead of waiting hours for the results from these wet chemical techniques, near-infrared spectroscopy (NIRS) delivers results within seconds without the use of chemicals. This allows manufacturers to execute frequent checks against product specifications and perform fish meal quality control with ease.

EXPERIMENTAL EQUIPMENT

More than 1700 samples of fish meal from different suppliers were analyzed with an OMNIS NIR Analyzer Solid (Figure 1) and a large sample cup. Every fish meal powder sample was measured in reflection measurement mode at five different positions to create an average spectrum. This minimizes sample inhomogeneities and results in a more representative NIR spectrum. Model development and validation was performed with the OMNIS Software.



Figure 1. The OMNIS NIR Analyzer Solid from Metrohm.

RESULT

The collected NIR spectra of fish meal samples (Figure 2) were used to create prediction models for the following parameters: protein, fat, moisture, ash, and fiber content. To validate the models, 25% of the data set was used to create an independent validation set. Correlation diagrams which display the relation between the NIR prediction and the lab values measured with standard methods are shown in Figures 3–8 together with the respective figures of merit (FOM). The standard errors displayed of cross validation (SECV) and standard errors of prediction (SEP) show the expected accuracy during routine analysis of fish meal in QC laboratories.

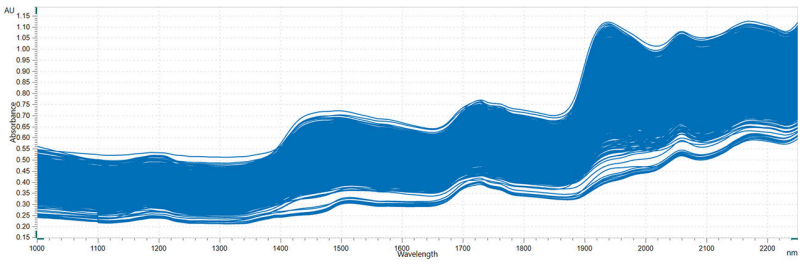


Figure 2. Spectral overlay of fish meal powder samples measured in reflection mode with an OMNIS NIR Analyzer Solid.

RESULT PROTEIN CONTENT

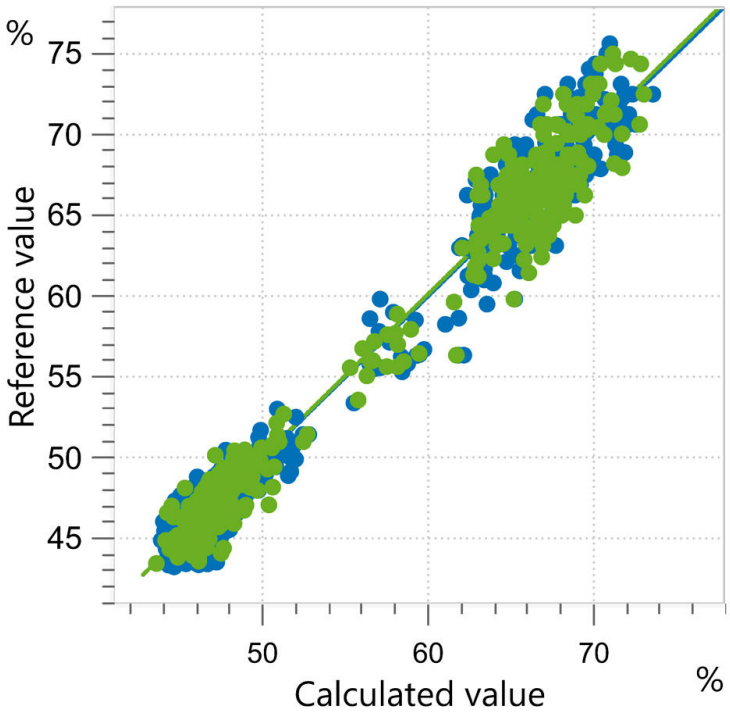


Figure 3. Correlation diagram and the respective FOMs for the prediction of protein content in fish meal using an OMNIS NIR Analyzer Solid. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.973	1.25	1.27	1.64

RESULT FAT CONTENT

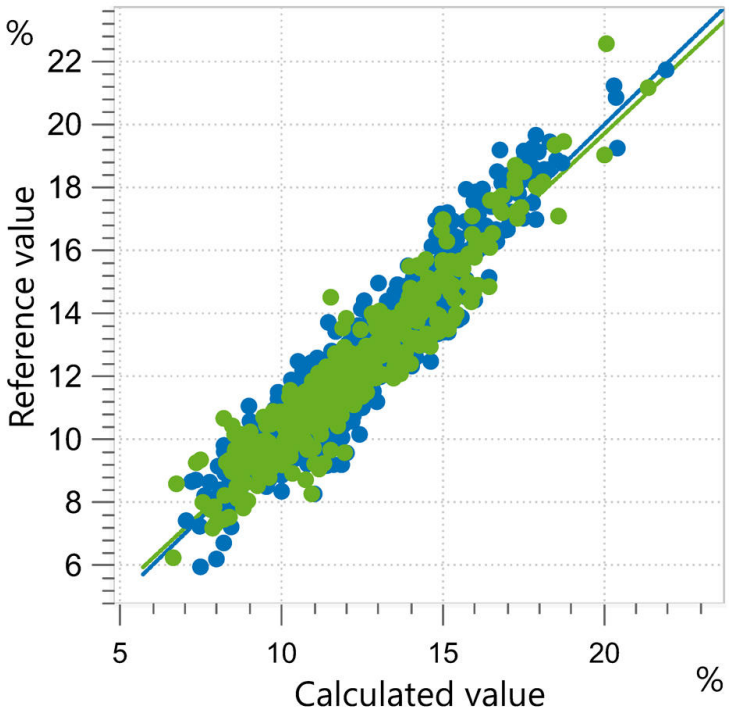


Figure 4. Correlation diagram and the respective FOMs for the prediction of fat content in fish meal using an OMNIS NIR Analyzer Solid. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.902	0.72	0.73	0.80

RESULT MOISTURE CONTENT

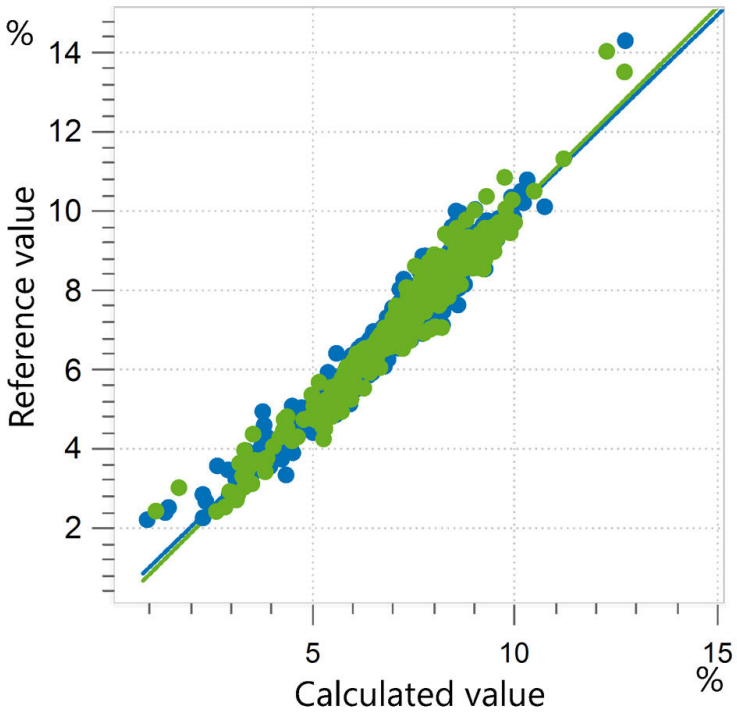


Figure 5. Correlation diagram and the respective FOMs for the prediction of moisture content in fish meal using an OMNIS NIR Analyzer Solid. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.955	0.27	0.28	0.35

RESULT ASH CONTENT

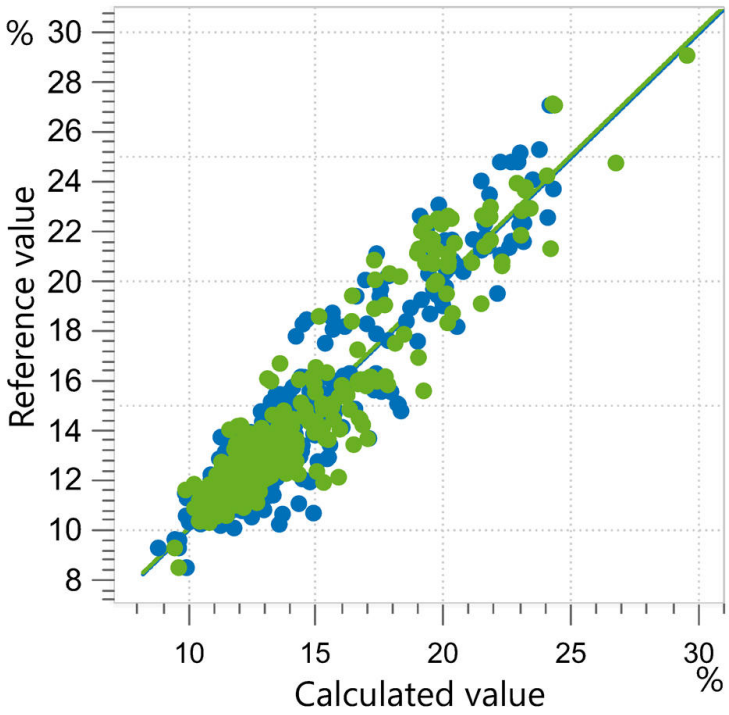


Figure 6. Correlation diagram and the respective FOMs for the prediction of ash content in fish meal using an OMNIS NIR Analyzer Solid. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.900	0.78	0.80	1.10

RESULT FIBER CONTENT

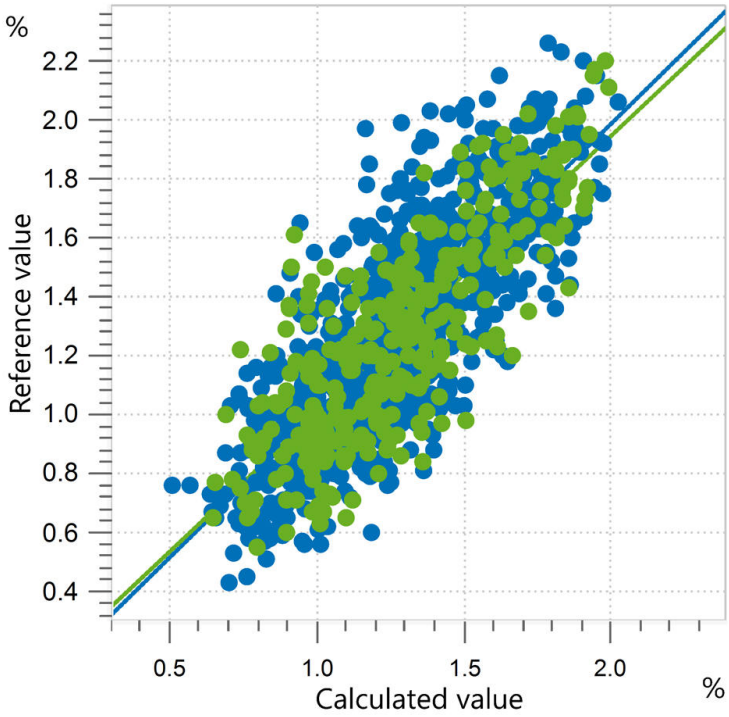


Figure 7. Correlation diagram and the respective FOMs for the prediction of fiber content in fish meal using an OMNIS NIR Analyzer Solid. The calibration dataset is shown in blue, and the external validation dataset is in green.

R^2	SEC (%)	SECV (%)	SEP (%)
0.647	0.21	0.22	0.21

CONCLUSION

This Application Note shows the feasibility of using near-infrared spectroscopy for fish meal feed analysis. The main composition parameters of protein, fat, ash, fiber, and water content are determined in seconds without the use of chemicals. NIRS helps to save costs and improve lab safety when compared to standard wet chemistry methods. By using NIRS for efficient multiparameter analysis, quality control laboratories can save hours of time per sample measurement (Table 1), resulting in much higher sample throughput.

Table 1. Overview of standard methods and time to result for the determination of key parameters in fish meal.

Parameter	Norm	Method	Time to analysis
Protein	ISO 5983	Kjeldahl method	~ 2–4 hours
Fat	ISO 6492	Hydrolysis and extraction	~ 7–10 hours
Moisture	ISO 6496	LOD: loss on drying	~ 5 hours
Fiber	ISO 6865	Acid-alkali digestion	~ 4–7 hours
Ash	ISO 5984	Oven furnace	~ 3–6 hours

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CONFIGURATION



OMNIS NIR Analyzer Solid

Near-infrared spectrometer for 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 Solid:

- Measurements of solids and viscous samples in less than 10 seconds
- Automated multi-position measurements for reproducible results, even with nonhomogeneous samples
- Simple integration in an automation system or link with additional analysis technologies (titration)
- Supports numerous sample vessels



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)



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.

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, fish meal, solid

OMNIS pre-calibration for the determination of protein, fat, moisture, fiber, and ash content in fishmeal using NIR spectroscopy.