Application Note AN-NIR-129

近红外光谱技术(NIRS)在干性宠物食品分析中的应用

Rapid determination of moisture, protein, fat, and ash

Pet food testing involves accurate monitoring and control of moisture, protein, fat, and ash content. This allows pet food manufacturers to satisfy nutritional adequacy requirements, meet regulatory guidelines, and provide high-quality foods to pet owners.

Traditional analysis methods are often slow and labor-intensive. Near-infrared (NIR) spectroscopy provides a fast, nondestructive alternative for analyzing these key quality control parameters with minimal sample preparation. This study evaluates the use of NIR spectroscopy in the pet food industry for efficient and reliable quality control during dried pet food production.

EXPERIMENTAL EQUIPMENT

199 dried pet food samples (mainly dog and cat food) from different suppliers were analyzed in whole and ground forms on an OMNIS NIR Analyzer Solid (Figure 1). The samples were added to 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 such as ISO 6496 (moisture), ISO 5983 (protein), ISO 5984 (ash), and ISO 6492 (fat).

Figure 1. OMNIS NIR Analyzer 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 3–10 together with the respective figures of merit (FOM).

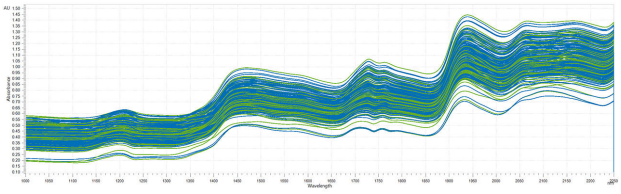
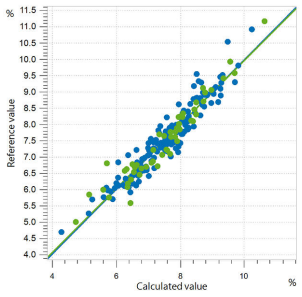


Figure 2. NIR spectra of pet food samples. Data was obtained with an OMNIS NIR Analyzer Solid. Spectra shown in blue have been used to calibrate the model, while green spectra have been used for validation.

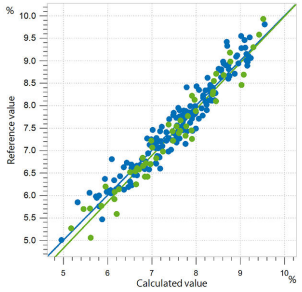
Result moisture in dried pet food (whole)



Figures of Merit	Value
R2	0.921
Standard Error of Calibration	0.32%
Standard Error of Cross-Validation	0.34%
Standard Error of Prediction	0.34%

Figure 3. Correlation diagram and the respective FOMs for the prediction of moisture in dried pet food (whole) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

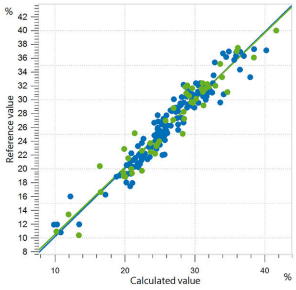
Result moisture in dried pet food (ground)



Figures of Merit	Value
R2	0.948
Standard Error of Calibration	0.25%
Standard Error of Cross-Validation	0.26%
Standard Error of Prediction	0.28%

Figure 4. Correlation diagram and the respective FOMs for the prediction of moisture in dried pet food (ground) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

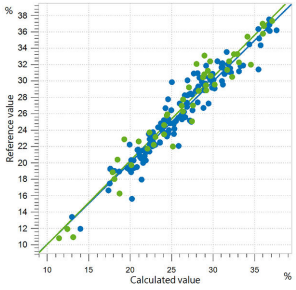
Result protein in dried pet food (whole)



Figures of Merit	Value
R2	0.932
Standard Error of Calibration	1.43%
Standard Error of Cross-Validation	1.51%
Standard Error of Prediction	1.71%

Figure 5. Correlation diagram and the respective FOMs for the prediction of protein in dried pet food (whole) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

Result protein in dried pet food (ground)

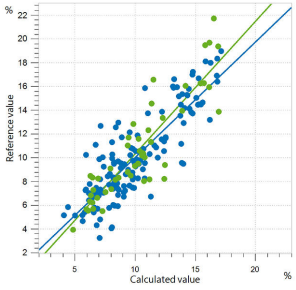


Figures of Merit	Value
R2	0.942
Standard Error of Calibration	1.32%
Standard Error of Cross-Validation	1.39%
Standard Error of Prediction	1.55%

Figure 6. Correlation diagram and the respective FOMs for the prediction of protein in dried pet food (ground) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

RESULT

Result fat in dried pet food (whole)

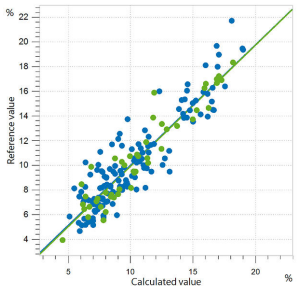


Figures of Merit	Value
R2	0.795
Standard Error of Calibration	1.81%
Standard Error of Cross-Validation	1.89%
Standard Error of Prediction	1.99%

Figure 7. Correlation diagram and the respective FOMs for the prediction of fat in dried pet food (whole) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

RESULT

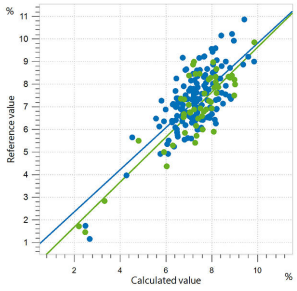
Result fat in dried pet food (ground)



Figures of Merit	Value
R2	0.889
Standard Error of Calibration	1.45%
Standard Error of Cross-Validation	1.52%
Standard Error of Prediction	1.25%

Figure 8. Correlation diagram and the respective FOMs for the prediction of fat in dried pet food (ground) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

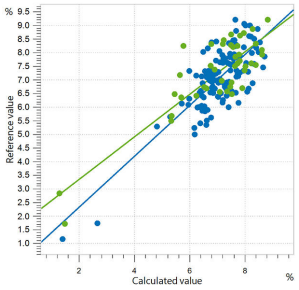
Result ash in dried pet food (whole)



Figures of Merit	Value
R2	0.733
Standard Error of Calibration	0.81%
Standard Error of Cross-Validation	0.88%
Standard Error of Prediction	0.95%

Figure 9. Correlation diagram and the respective FOMs for the prediction of ash in dried pet food (whole) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

Result ash in dried pet food (ground)



Figures of Merit	Value
R2	0.733
Standard Error of Calibration	0.62%
Standard Error of Cross-Validation	0.71%
Standard Error of Prediction	0.83%

Figure 10. Correlation diagram and the respective FOMs for the prediction of ash in dried pet food (ground) using an OMNIS NIR Analyzer Solid. Blue dots represent calibration samples, green dots represent samples used to validate the model.

CONCLUSION

This Application Note demonstrates the feasibility of using NIR spectroscopy for the analysis of several pet food quality parameters, including protein, moisture, fat, and ash. Results indicate that lower prediction errors can be obtained when grinding pet food samples before their analysis. A comparison between different methods used for the analysis of pet food clearly highlights the significant time-saving potential of NIR spectroscopy (**Table 1**).

Furthermore, the simplicity of the analysis and the availability of a pre-calibrated instrument, using the **pre-calibration, dry pet food, solid** (6.06008.027), make both the implementation and the application of NIR spectroscopy with OMNIS NIRS straightforward.

Table 1. Overview of time effort for the analysis of different parameters in pet food by traditional methods and NIR spectroscopy.

Parameter	Standard	Process	Estimated time
Moisture	ISO 6496	Oven drying	2.5 hours
Protein	ISO 5983	Kjeldahl method	4.0 hours
Fat	ISO 6492	Soxhlet extraction	4.0 hours
Ash	ISO 5984	Incineration	4.0 hours
Moisture, protein, fat, ash	ASTM D6122	NIR spectroscopy	1.0 minute

CONTACT

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CONFIGURATION

OMNIS NIR Analyzer Solid

适合固体和粘性样品的近红外光谱仪。

OMNIS NIR Analyzer 是一种按照瑞士质量标准开发和生产的近红外光谱 (NIRS) 解决方案,用于整个生产链的常规分析。使用新技术和嵌入先进 OMNIS Software 反应在该 NIR 光谱仪的速度、可操作性和灵活使用上。

OMNIS NIR Analyzer Solid 的优点概览:

- 在 10 秒以内测量固体和粘性样品
- 自动化多位置测量,即使在样品不均匀时,也能够获得可重现的结果
- 方便地嵌入自动系统,或者与其它分析技术(滴定)关联
- 支持大量样品容器

OMNIS NIR100 mm

适合大样品容器的大支架 OMNIS NIR,100 mm (6.07402.110)。

允许明确地定位样品容器和旋转样品容器。

OMNIS NIR100 mm

用于在不同样品位置处通过反射采集粉末和颗粒反射光谱的大样品容器。

兼容:

- 大支架 OMNIS NIR,100 mm (6.07402.100)

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