



Application Note AN-NIR-125

采用近红外光谱技术测定橄榄油品质参数及掺假检测

Near-infrared spectroscopy reduces costs and chemical waste

Olive oil quality depends on many factors, such as time spent processing olives after harvest, the production process itself, and olive variety. Due to its high price, virgin olive oil in particular is one of the most vulnerable vegetable oils for food fraud. Many parameters are used to determine the oil quality including the iodine value, free fatty acids (FFA), refractive index, fatty acid composition, and aging indicators

such as peroxide value (PV), K232, and induction time. Traditional analysis techniques for olive oil testing like titration or gas chromatography (GC) often require hazardous solvents which can pose health risks and increase laboratory costs. In contrast to these standard methods, the analysis with near-infrared spectroscopy (NIRS) helps to increase productivity and reduce costs, providing quick results for olive oil quality control

EXPERIMENTAL EQUIPMENT

A selection of olive oils with varying quality (137 samples) were measured on the OMNIS NIR Analyzer Liquid (Figure 1) in transmission mode (1000–2250 nm) using 8 mm disposable vials. The vial temperature was set and monitored at 40 ° C with the built-in vial sensor to ensure consistent measurement performance. The OMNIS software was used for all data acquisition and prediction model development.



Figure 1. The OMNIS NIR Analyzer and a sample filled in a disposable vial.

The obtained NIR spectra (Figure 2) were used to create a prediction model for quantification of all parameters: iodine value, FFA, refractive index, K232, PV, induction time, palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2), and alpha-linolenic acid (C18:3). The quality of the prediction models was evaluated using correlation diagrams (Figures 3–8) which display a high correlation

between the NIR prediction and the standard reference methods for all parameters. Of the 137 samples measured, 25% were selected as validation set and 75% as calibration set. The respective figures of merit (FOM), shown for the following figures and in Table 2, display the expected precision and confirm the feasibility during routine analysis.

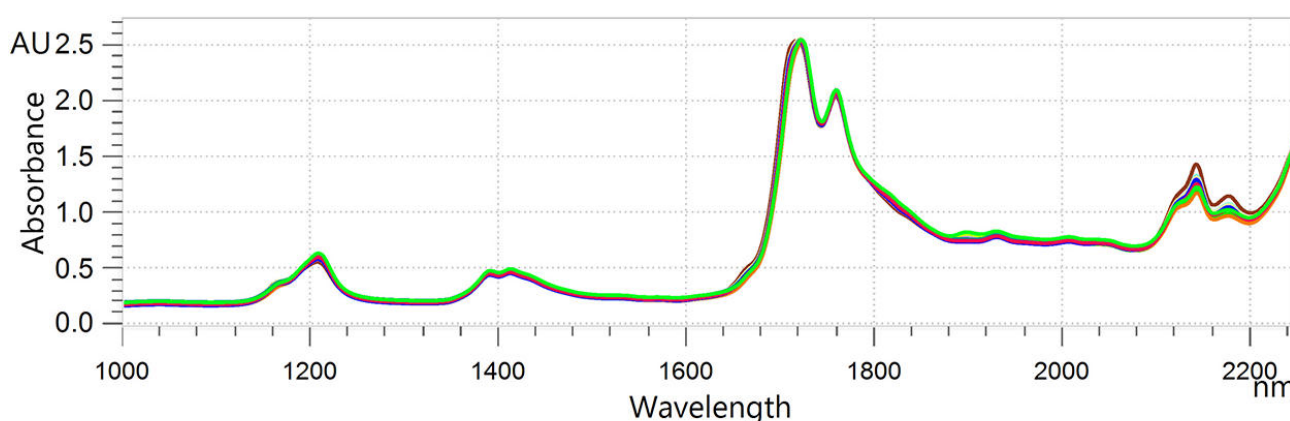


Figure 2. NIR spectra of olive oil samples analyzed on an OMNIS NIR Analyzer Liquid with 8 mm vials.

Result iodine value



Figure 3. Correlation diagram and the respective FOMs for the prediction of iodine value in olive oil. Lab values were evaluated using GC.

Parameter	SEC (mg/100 g)	SECV (mg/100 g)	SEP (mg/100 g)	R ² CV
IV	0.38	0.40	0.38	0.974

Result K232

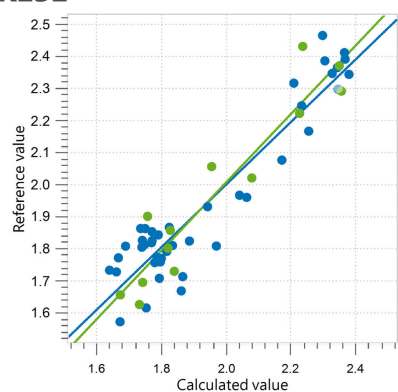


Figure 4. Correlation diagram and the respective FOMs for the prediction of K232 in olive oil. UV analysis was used to obtain the lab values.

Parameter	SEC	SECV	SEP	R ² CV
K232	0.067	0.086	0.090	0.864

Result C16:0 fatty acid content

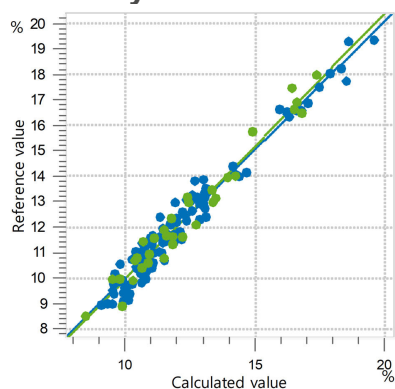


Figure 5. Correlation diagram and the respective FOMs for the prediction of C16:0 content in olive oil. Lab values were evaluated using GC.

Parameter	SEC (%)	SECV (%)	SEP (%)	R ² CV
C16:0	0.32	0.38	0.48	0.962

Result C18:1 fatty acid content

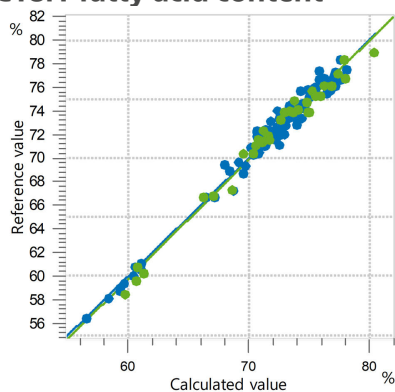


Figure 6. Correlation diagram and the respective FOMs for the prediction of C18:1 content in olive oil. Lab values were evaluated using GC.

Parameter	SEC (%)	SECV (%)	SEP (%)	R ² CV
C18:1	0.63	0.69	0.75	0.980

Result C18:2 fatty acid content

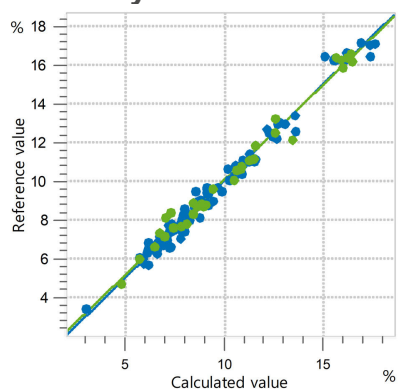


Figure 7. Correlation diagram and the respective FOMs for the prediction of C18:2 content in olive oil. Lab values were evaluated using GC.

Parameter	SEC (%)	SECV (%)	SEP (%)	R ² CV
C18:2	0.32	0.38	0.43	0.985

Result induction time

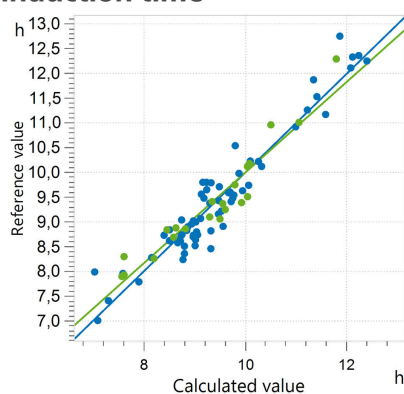


Figure 8. Correlation diagram and the respective FOMs for the prediction of olive oil induction time. Lab values were evaluated with a Rancimat.

Parameter	SEC (h)	SECV (h)	SEP (h)	R ² CV
Induction time	0.30	0.35	0.34	0.908

Table 2. Figures of merit for the parameters of stearic acid, α -linolenic acid, FFA, peroxide value, and refractive index in various olive oils.

Parameter	SEC	SECV	SEP	R2CV
Stearic acid (C18:0)	0.12%	0.22%	0.22%	0.778
α -linolenic acid (C18:3)	0.05%	0.05%	0.05%	0.633
FFA	0.03%	0.04%	0.04%	0.746
Peroxide value	0.72 meq/kg	0.83 meq/kg	1.01 meq/kg	0.719
Refractive index	0.00011	0.00012	0.00012	0.998

CONCLUSION

This Application Note displays the positive attributes of olive oil analysis with near-infrared spectroscopy. Compared to time-consuming conventional analytical methods, measurements performed with NIRS do not need any sample preparation. This ultimately leads to a workload

reduction (**Table 3**) and reduced costs.

Aside from the parameters shown in this Application Note, additional olive oil quality parameters like sterol content or moisture content can also be determined with NIRS.

Table 3. Time to result overview for the measurement of iodine value, FFA content, refractive index, K232, induction time, and fatty acid composition in olive oils by standard analytical methods.

Parameter	Method	Time to result
Iodine value	Gas chromatography	~30 minutes per sample
FFA content, Peroxide value	Titration	~15 minutes per sample
Refractive index	Refractometer	~5 minutes per sample
K232	UV absorption	~5 minutes per sample
Fatty acid composition	Gas chromatography	~30 minutes per sample
Induction time	Rancimat	~1–15 hours per sample

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OMNIS NIR Analyzer Liquid

适合液体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 Liquid 的优点概览:

- 可在 10 秒以内测量液体样品
- 对 25° C – 80° C 的样品进行温度控制
- 自动识别样品容器的插入和取出
- 方便地嵌入自动系统,或者与其它分析技术(滴定)关联
- 支持大量不同路径长度的样品容器



OMNIS NIR8 mm

适合 8 mm 一次性小管的 OMNIS NIR Analyzer 的小管支架 (6.7402.240)。



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8 mm 100

100 个玻璃(硼硅)一次性样品瓶,具有 8 mm 的光路长度,适用于分析透射中的液体。一次性样品瓶交付时带有所属的螺旋塞(件数 = 100)。

兼容:

- 支架 OMNIS NIR,小管,8 mm (6.07401.070)
- DS2500 支架适用于 8 mm 一次性样品瓶 (6.7492.020)

OMNIS

允许单机版 OMNIS 软件在一台 Windows™ 计算机上运行。

特性:

- 该许可证已含有一份 OMNIS 设备许可证。
- 须通过万通许可授权平台进行激活。

Quant Development

用于在独立 OMNIS Software 安装套件中编写和编辑量化模型的软件许可证。