



Application Note AN-NIR-115

# Multiparameter quality control of palm oil with NIR spectroscopy

Obtain fast and reliable results without using any chemicals

Palm oil is currently the most widely produced and consumed vegetable oil globally and is used as a raw material in many industries. Crude palm oil (CPO) is used in various edible products, including cooking oil, margarine, and processed foods. CPO can be refined to remove impurities and improve color, flavor, and odor. Several steps are involved (e.g., degumming, neutralization, bleaching, deodorization) to produce refined bleached deodorized palm oil (RBDPO).

RBDPO is used for frying purposes and is also found in foods like instant noodles and ice cream.

If the palm oil composition is found to be out of specification during production, the process stops, and the oil is recycled. Determination of key quality parameters like iodine value and the fatty acid profile of palm oil can be determined easily in just a few seconds without sample preparation using near-infrared spectroscopy (NIRS).

## EXPERIMENTAL EQUIPMENT

In this application, 20 samples of crude palm oil (CPO) and 30 samples of refined, bleached, deodorized palm oil (RBDPO) were kept in a water bath at 60 °C for at least 30 minutes to liquify them. All samples were measured with an OMNIS NIR Analyzer Liquid in transmission mode at 60 °C using 8 mm disposable vials. Data acquisition and prediction model development were performed with OMNIS software. Gas chromatography (GC) was used as a reference method after the methyl esterification of the fatty acids. The concentration of the fatty acids was derived from the corresponding peak area. Determination of iodine value in palm oil was possible by a calculation from the combined concentrations of oleic acid (18:1) and linoleic acid (18:2) according to the obtained fatty acid composition of palm oil.

Another set of CPO samples (681) was used to determine the water content. These samples were treated in the same manner as described above and measured using NIR spectroscopy. Karl Fischer (KF) titration was used as a standard method in this case.



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

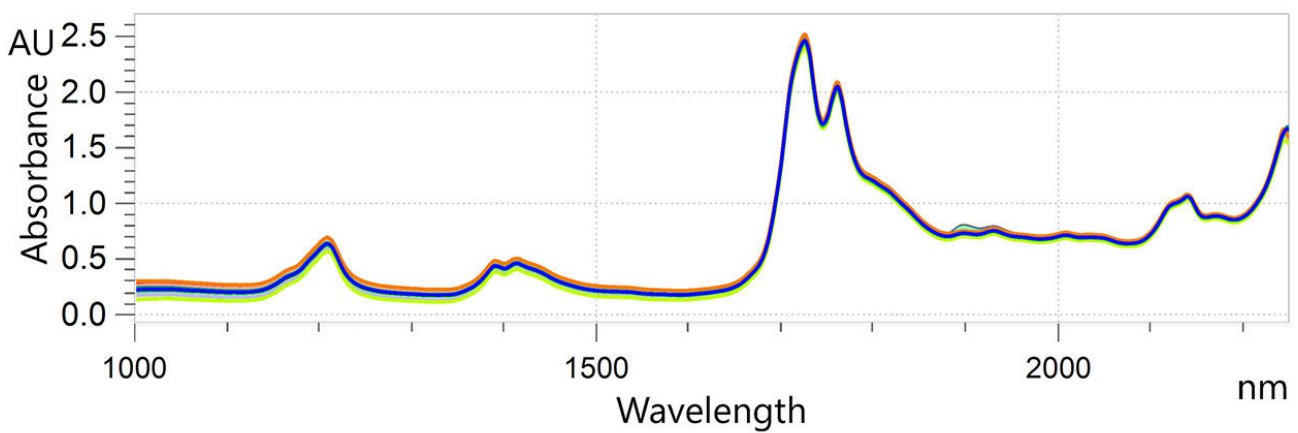
**Table 1.** Hardware and software equipment overview.

Equipment	Metrohm number
OMNIS NIR Analyzer Liquid	2.1070.0010
Holder OMNIS NIR, vial, 8mm	6.07401.070
Disposable vial, 8mm, transmission	6.7402.240
OMNIS Stand-Alone license	6.06003.010
Quant Development software license	6.06008.002

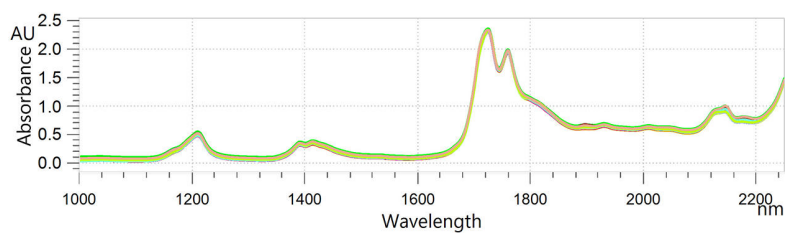
## RESULT

The measured NIR spectra of CPO (Figure 2) and of RBDPO (Figure 3) were used to create prediction models for the quantification of iodine value (IV), linoleic acid (18:2), oleic acid (18:1), and palmitic acid (16:0) for the two different palm oils. A quantification model was created for water content present in palm oil using another set of CPO samples.

The quality of the prediction models was evaluated using correlation diagrams (Figures 4–12) which display a high correlation between the NIR predictions and the results given by primary methods (i.e., GC and KF titration). The respective figures of merit (FOM) display the expected precision and confirm the feasibility during routine analysis.

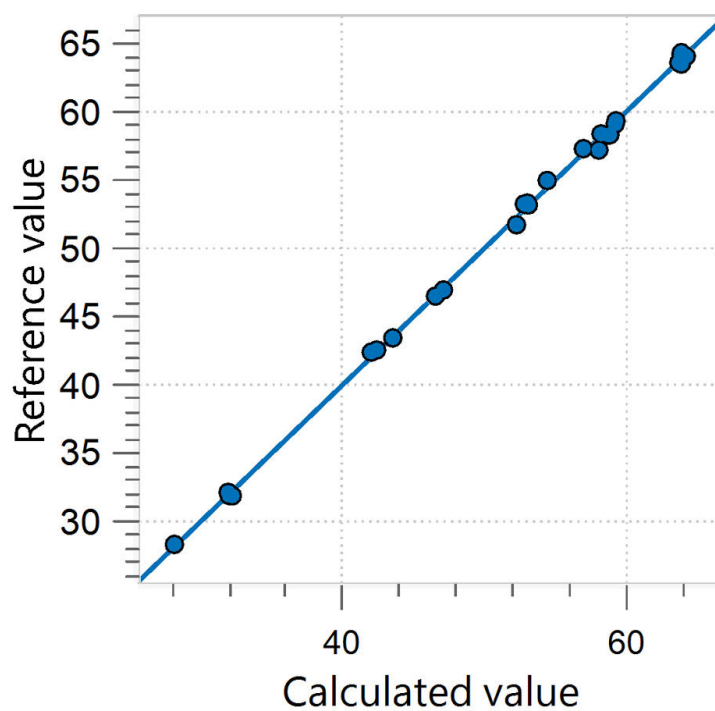


**Figure 2.** Overlay of NIR spectra from CPO samples analyzed on an OMNIS NIR Analyzer Liquid at 60 °C.



**Figure 3.** Overlaid NIR spectra of RBDPO samples analyzed on an OMNIS NIR Analyzer Liquid at 60 °C.

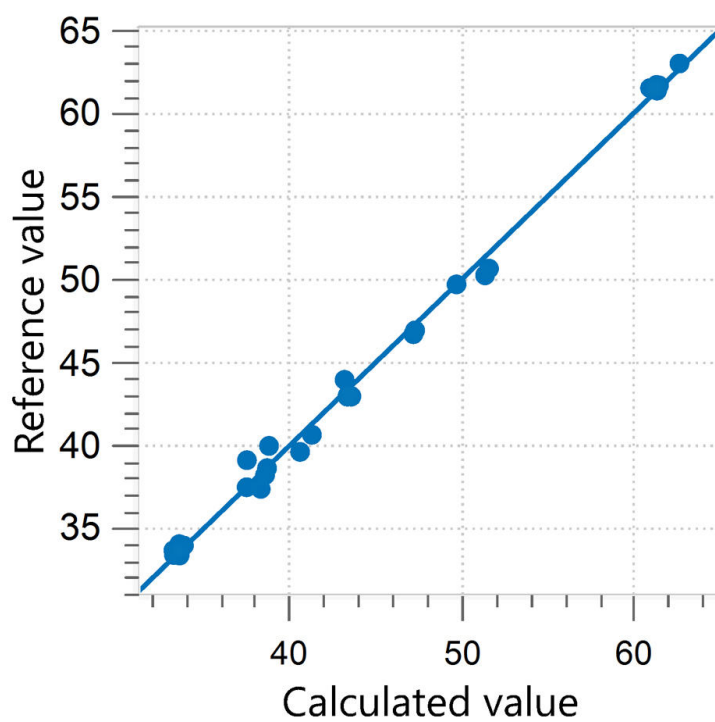
## RESULT IV IN RBDPO



**Figure 4.** Correlation diagram and the respective figures of merit for the prediction of iodine value in RBDPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC(mg/100g)	SECV(mg/100g)	R2CV
IV	0.31	0.34	0.999

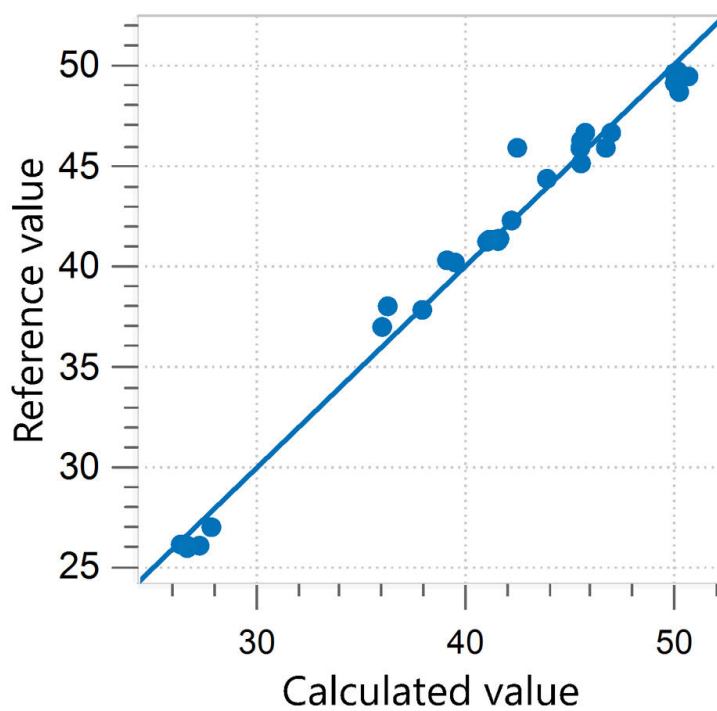
## RESULT PALMITIC ACID (16:0) IN RBDPO



**Figure 5.** Correlation diagram and the respective figures of merit for the prediction of palmitic acid (16:0) in RBDPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC (%)	SECV (%)	R2CV
16:0	0.53	0.63	0.996

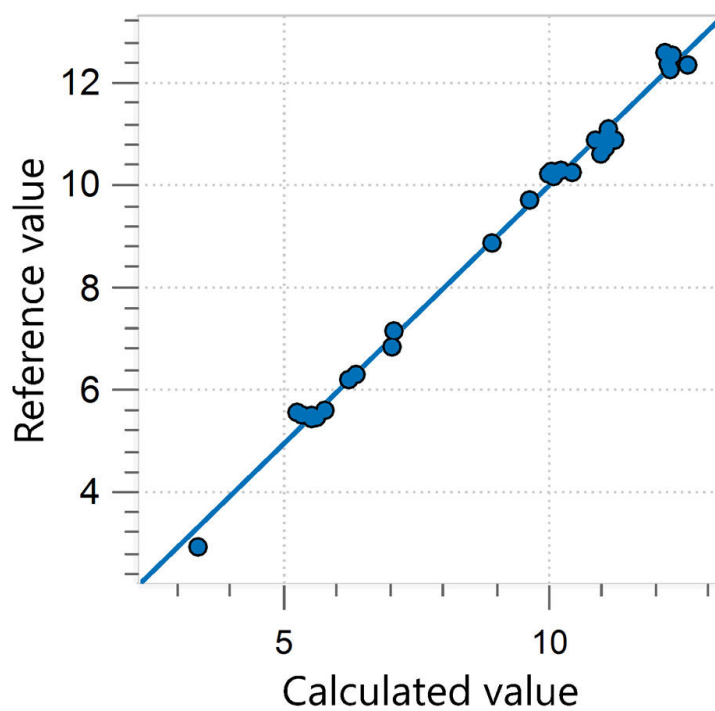
## RESULT OLEIC ACID (18:1) IN RBDPO



**Figure 6.** Correlation diagram and the respective figures of merit for the prediction of oleic acid (18:1) in RBDPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC (%)	SECV (%)	R2CV
18:1	0.75	0.98	0.985

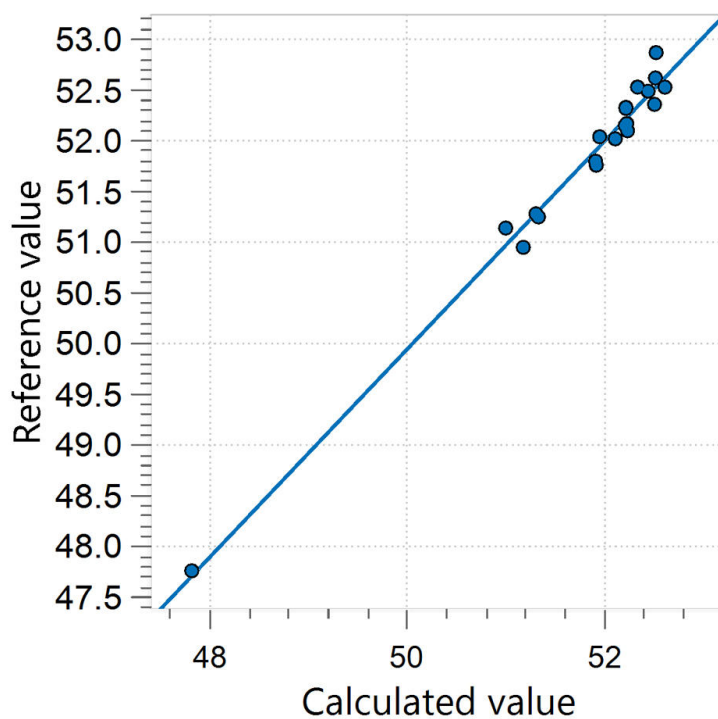
## RESULT LINOLEIC ACID (18:2) IN RBDPO



**Figure 7.** Correlation diagram and the respective figures of merit for the prediction of linoleic acid (18:2) in RBDPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC (%)	SECV (%)	R2CV
18:2	0.14	0.21	0.994

## RESULT IV IN CPO

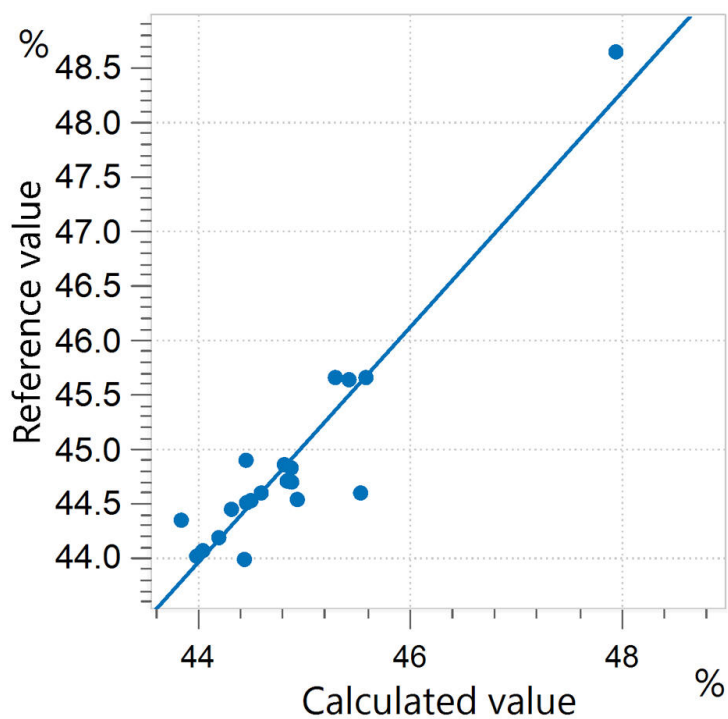


**Figure 8.** Correlation diagram and the respective figures of merit for the prediction of iodine value in CPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC(mg/100g)	SECV(mg/100g)	R2CV
IV	0.11	0.14	0.984



## RESULT PALMITIC ACID (16:0) IN CPO



**Figure 9.** Correlation diagram and the respective figures of merit for the prediction of palmitic acid (16:0) in CPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC(%)	SECV(%)	R2CV
16:0	0.11	0.14	0.984

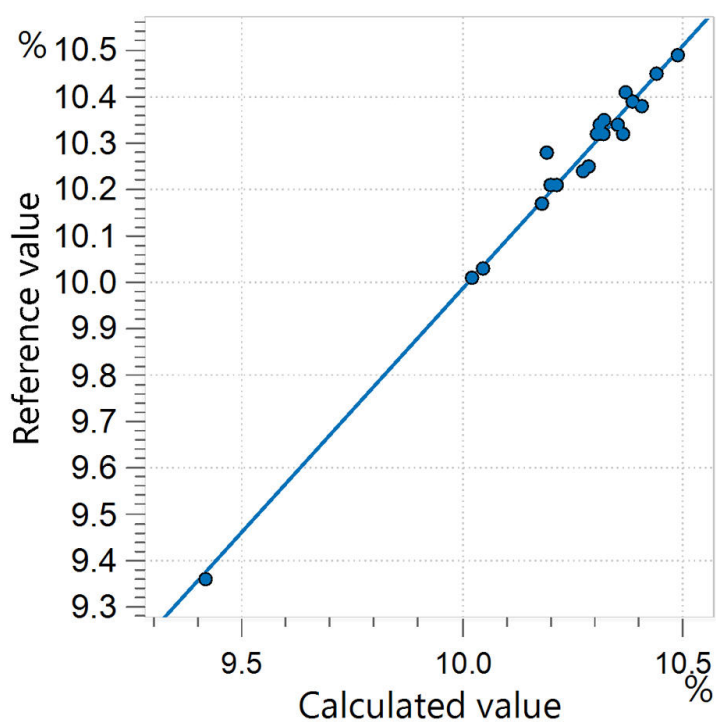
## RESULT OLEIC ACID (18:1) IN CPO



**Figure 10.** Correlation diagram and the respective figures of merit for the prediction of oleic acid (18:1) in CPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC(%)	SECV(%)	R2CV
18:1	0.12	0.14	0.969

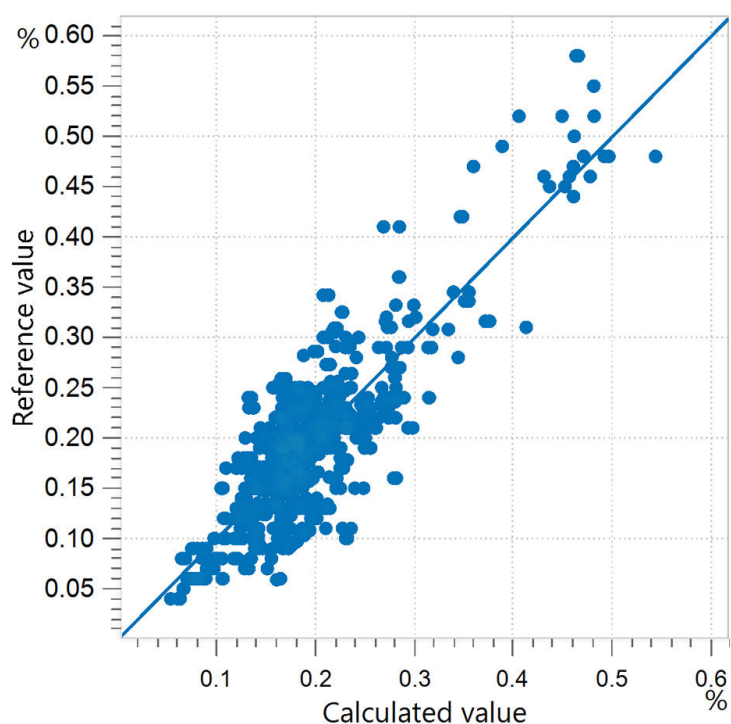
## RESULT LINOLEIC ACID (18:2) IN CPO



**Figure 11.** Correlation diagram and the respective figures of merit for the prediction of linoleic acid (18:2) in CPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using GC.

Parameter	SEC(%)	SECV(%)	R2CV
18:2	0.02	0.03	0.984

## RESULT WATER CONTENT IN CPO



**Figure 12.** Correlation diagram and the respective figures of merit for the prediction of water content in CPO using an OMNIS NIR Analyzer Liquid. The reference values were evaluated using KF titration.

Parameter	SEC(%)	SECV(%)	R2CV
Water	0.044	0.044	0.714

## CONCLUSION

This Application Note displays the benefit of using the OMNIS NIR Analyzer Liquid for routine analysis in laboratories that measure various palm oil quality parameters. Compared to other conventional methods like Karl Fischer titration and GC,

determinations with NIR spectroscopy do not require any sample preparation or chemical reagents. This ultimately leads to a reduction in workload (Table 2) and costs.

**Table 2.** Time to result overview for the parameters of iodine value, fatty acid composition, and water content in palm oil by standard methods.

Parameter	Method	Time to result
Iodine value, Fatty acid composition	Gas chromatography	30 min sample preparation (Methyl esterification + sample preparation) + 20 min GC
Water content	KF titration	10 min per sample

Internal reference: AW NIR CH-0066-042023

## CONTACT

Metrohm Italiana Srl  
Via G. Di Vittorio, 5  
21040 Origgio (VA)

[info@metrohm.it](mailto:info@metrohm.it)

## CONFIGURATION



### OMNIS NIR Analyzer Liquid

Spettrometro nel vicino infrarosso per campioni liquidi.

OMNIS NIR Analyzer è la soluzione per spettroscopia nel vicino infrarosso (NIRS) sviluppata e prodotta secondo gli standard di qualità svizzeri utilizzabile per l'analisi di routine lungo l'intera catena di produzione. L'uso delle più recenti tecnologie e l'integrazione nel moderno OMNIS Software si riflettono nella velocità, operatività e flessibilità d'uso di questo spettrometro NIR.

Panoramica dei vantaggi di OMNIS NIR Analyzer Liquid:

- Misurazioni di campioni liquidi in meno di 10 secondi
- Controllo della temperatura sul campione da 25 °C a 80 °C
- Rilevamento automatico dell'inserimento e del prelievo del contenitore portacampione
- Facile integrazione in un sistema di automazione o collegamento con altre tecnologie di analisi (titolazione)
- Supporto di numerosi contenitori portacampione con diverse lunghezze del cammino

### Supporto OMNIS NIR, vial, 8 mm

Supporto per vial per OMNIS NIR Analyzer per vial monouso da 8 mm (6.7402.240).





#### Vial monouso, 8 mm, trasmissione, num. 100

100 vial monouso in vetro (borosilicato) con lunghezza del cammino ottico di 8 mm per l'analisi di liquidi in trasmissione. I vial monouso sono forniti con i relativi tappi di chiusura (numero di pezzi = 100).

Compatibile con:

- Supporto OMNIS NIR, vial, 8 mm (6.07401.070)
- DS2500 holder per vial usa e getta da 8 mm (6.7492.020)

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#### Licenza OMNIS Stand-Alone

Consente l'utilizzo stand-alone del software OMNIS su un computer Windows™.

Caratteristiche:

- la licenza contiene già una licenza per strumenti OMNIS.
- Deve essere attivata tramite il portale licenze Metrohm.
- Non è trasferibile su di un altro computer.

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#### Licenza software Quant Development

Licenza software per la creazione e l'elaborazione di modelli di quantificazione in un'installazione Stand-Alone di OMNIS Software.