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Application Note

Identification of edible oil authenticity by mobile NIR spectroscopy

with the Liquid Analysis Stamp Kit for the trinamiX PAL One spectrometer

Introduction

NIR spectroscopy provides a fast, reliable, and non-destructive method for identifying and quantitatively analyzing samples. By miniaturizing traditional benchtop spectrometers into handheld and portable devices, trinamiX has made NIR spectroscopy accessible for on-field use, even for non-laboratory users. The trinamiX PAL One has already proven successful, primarily in measuring solid samples from the agricultural sector and the recycling industry.

In response to the growing demand for reliable quality checks of liquids, trinamiX has developed the Liquid Analysis Stamp Kit for the PAL One spectrometer. This accessory enables the identification of high-quality liquid products, including viscous materials. With this kit, users can instantly test liquid samples for authenticity without the need for additional chemicals or laboratory infrastructure. The following showcases the identification of edible oils, illustrating how the kit can be used to detect the adulteration of premium extra virgin olive oil with less expensive oils, such as sunflower oil.

Figure 1: trinamiX PAL One NIR spectrometer with the Liquid Analysis Stamp Kit.

Liquid Analysis Stamp Kit – Specifications

Material	: sandblasted aluminum
Optical path length	: 0.4 & 0.1 mm
Vials	: D = 22 mm, d = 20 mm
Sample volume	: ca. 0.2 ml.
Wavelength	: 1450 – 2450 nm

Materials and Methods

Unlike solid samples, which are measured using diffuse reflection mode, liquid samples require a different approach known as transflection mode. This method involves transmitting NIR light through the sample and reflecting the transmitted light off a reflector positioned behind the sample. The Liquid Analysis Stamp Kit includes a stamp with spacings of 200 µm and 500 µm, resulting in optical path lengths of 400 µm and 1000 µm when inserted into a glass vial filled with the liquid to be analyzed. For this demonstration, a path length of 1000 µm was chosen to achieve high absorbance.
Three trinamiX PAL One handheld spectrometers were utilized in the experiments. Each sample, which included olive oil, coconut oil, sunflower oil, sesame oil, canola oil, and a mixture of olive and sunflower oil (1:1, V/V), was divided into three flat-bottom glass vials with plain tops. The trinamiX stamp was then placed in each vial to create a thin liquid film. Each sample underwent three scans, with the vials rotated after each scan, ensuring that all samples were measured using each of the three spectrometers.

Results and Discussion

The measurements of the oil samples resulted in the averaged spectra shown in *Figure 2*. All spectra of the different oil samples show similar bands for the characteristic *C, H* overtone and combination vibrations found in oils. Chemically, these oils are quite similar, as they primarily consist of di- and triglycerides—molecules with a glycerin backbone bonded to various fatty acids. However, the variations in fatty acids serve as a unique fingerprint for NIR spectroscopy, enabling the identification of potential adulterants based on their distinct spectroscopic properties, as illustrated in *Figure 3*.

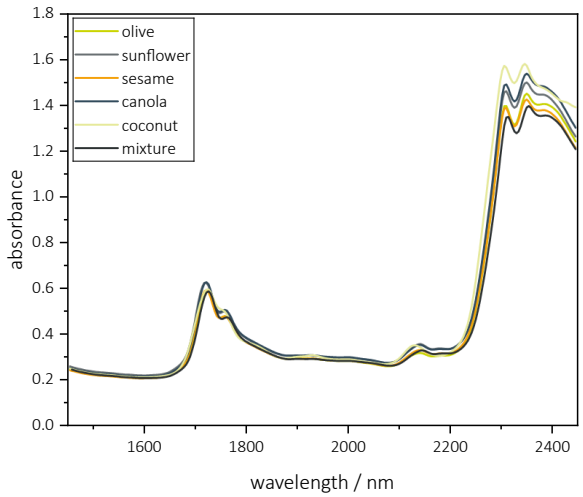

Figure 2: NIR spectra (1450 – 2450 nm) of different oil samples.

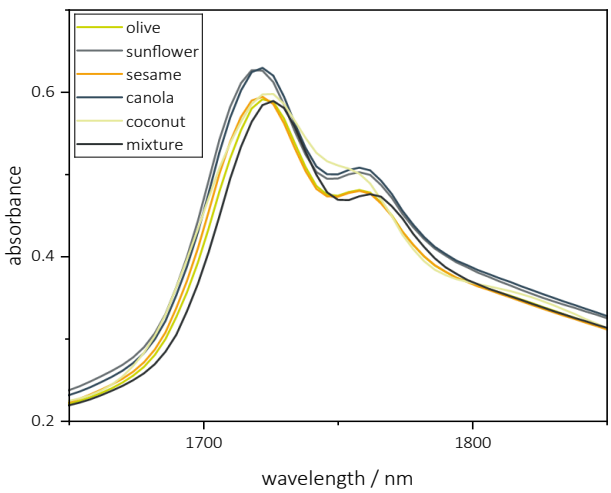

Figure 3: Cutout of the NIR spectrum (1700 – 1800 nm).

These differences allow for the identification of various oil types, and even the mixture of olive and sunflower oil produced a spectrum that distinctly differed from those of the pure compounds, as indicated by a shift in the wavelength of the bands. This variation can be utilized to determine the type of oil present and to detect potential adulterations.

Figure 4 illustrates the distribution of predicted results in comparison to the actual sample types during cross-validation. Even with this basic showcase model, only 6 out of 595 predictions were inaccurate, demonstrating the significant potential of this technology for process and quality control applications. All 135 measurements of olive oil accurately predicted the correct oil type. However, 4 samples of sesame oil were misidentified as sunflower oil (indicated in orange), and 2 samples of sunflower oil were incorrectly classified as sesame oil.

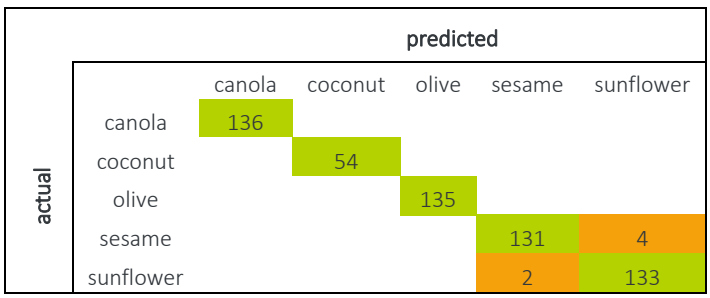

Figure 4: Comparison of predicted oil type vs. actual.

Conclusion

The Liquid Analysis Stamp Kit for the trinamiX PAL One spectrometer facilitates the identification and basic analysis of liquid samples, as demonstrated in this application note on edible oils. This user-friendly accessory delivers rapid, straightforward, and reliable results for the qualitative analysis of liquids.