DIALPAS, a New Non-destructive Spectral Sensor for Easy Real-time Sensitive Detection of Food Fraud

Luca Fiorani1\*, Florinda Artuso1, Emiliano De Dominicis2, Marco Gerevini3, Isabella Giardina1, Antonia Lai1, Ivano Menicucci1, Marcello Nuvoli1, Alessandra Pasquo1, Marco Pistilli1, Fabio Pollastrone1, Adriana Puiu1, Matteo Rinaldi4, Claudia Zoani5

1 FSN Department – ENEA, Via Enrico Fermi 45, 00044 Frascati, Italy, luca.fiorani@enea.it
2 Mérieux NutriSciences Italia, Via Fratta 25, 31023 Resana, Italy
3 Tecnoalimenti, Via Gustavo Fara 39, 20124 Milano, Italy
4 Orsell, Via Lametta 146, 41010 Limidi di Soliera, Italy
5 SSPT Department – ENEA, Via Anguillarese 301, 00123 Roma, Italy
\*Corresponding author

The increasing globalization of world trade, without mutual recognition of international standards, urgently requires new technologies for reliable assessment of food integrity. The DIM Laboratory of FSN Department – ENEA applies spectroscopic techniques to fraud detection in fruit juice, oil, oregano, milk, pollens, rice, saffron, and sea food. Although a wide range of cutting-edge methods are in the DIM Laboratory armoury – LIBS (laser induced breakdown spectroscopy), FTIR (Fourier-transform infrared spectroscopy), Raman spectroscopy, spectro fluorometry, remote sensing – its flagship technology is LPAS (laser photoacoustic spectroscopy). In a typical LPAS system (Fiorani L. et al., 2021), a laser beam is modulated at an audio frequency and injected into a resonant cell where it hits the investigated sample that absorbs the incident radiation. The sample therefore experiences a rise in temperature and volume, thus producing a pressure wave. In general, the sound detection subsystem is made of a microphone connected with a lock-in amplifier synchronized with the modulator. The output signal is proportional to the sample absorption and typical experiments are conducted in the “fingerprint region”, a large band of the infrared (IR) spectrum where many organic compounds can be identified. The studies carried out at the DIM Laboratory showed that LPAS has the following advantages: rapidity, sensitivity, specificity, simplicity, repeatability, in situ measurement, uncomplicated sampling, ease of use and cost-effectiveness. Current systems are based on quantum cascade laser (QCL) that can be continuously tuned in a large spectral range. This latter characteristic is very important for non-targeted approaches. Moreover, QCLs are robust and small, allowing one to develop a portable system for rapid detection of food fraud in industrial settings. Recently, DIALPAS – an improved approach of LPAS (patented) – spotted within seconds a significant economically motivated adulteration (EMA) on untreated samples with a limit of detection of a few percent.

**Keywords:** quantum cascade laser application, laser spectroscopy, photoacoustic technique, differential absorption, food fraud

**Acknowledgements:** This work has been funded by ENEA (TecHea project – deliberation of the board of directors no. 80/2018/CA and FoodSafety project – PoC program no. FSN202009) and Latium Region (TESLA project – POR FESR 2014-2020 no. A0375-2020-36403).

REFERENCES

Fiorani, L., Artuso, F., Giardina, I., Lai, A., Mannori, S., Puiu, A., 2021. Photoacoustic Laser System for Food Fraud Detection. Sensors 21, 4178. https://doi.org/10.3390/s21124178