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

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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

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