International Measurement Confederation (IMEK0)
TC 23 "Metrology in Foods and Nutrition"
7th IMEKOFOODS International Conference. Worldwide food trade and consumption: quality and risk assessment
25-27 October 2023, Maisons-Alfort/Paris, France

Smart spectroscopic sensors and Internet of Things for the agrifood: some practical applications from METROFOOD-IT

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The need for more effective and powerful analytical tools and methods for assessing food quality, safety and authenticity, traceability, and sustainability of agrifood productions is nowadays more and more increasing. This is not limited to the use of innovative analytical methods but extends to the application of more comprehensive approaches and advanced data management. It also encompasses the so called "industry 4.0" and the digitalisation of the agrifood systems as the process of advanced digital technologies such as smart sensing and Internet of Things (IoT), blockchain e distributed ledgers, Artificial Intelligence (AI), Edge and 5G applications, and App-based services.

METROFOOD-IT - the *Italian Research Infrastructure for Metrology and Open Access Data in support to the Agrifood*, in relation to the ESFRI METROFOOD-RI for the domain Health and Food – is highly engaged in supporting the agrifood system and its digitalisation providing high-level metrology services in food and nutrition. Besides analytical lab facilities and experimental facilities like experimental fields, processing plants and kitchen labs, the electronic component provides an accessible platform for sharing and integrating data, knowledge, and information and works for enhancing ICT application in the agrifood, integrating computational modelling, industrial and laboratory-based solutions via upcoming approaches such as IoT, blockchain, and AI.

The case of the "Smart Spectroscopical Sensors and IoT" Operating Unit hosted by ENEA is presented. Through infrared (IR) spectroscopy, laser induced breakdown spectroscopy (LIBS) and spectrofluorometry, it develops a wide range of smart sensors including imaging and remote sensing systems, as well as portable devices such as the Laser Photoacoustic Spectroscopy (LPAS) system for quality control along the agrifood chain, rapid characterisation of safety parameters and identification of food frauds. The smart sensors can be connected to a "remote desktop" allowing the interested end users to carry out experiments via the web (Internet of Sensors), thus representing a VirtualLab. Through this system, a "FoodDB", i.e., a flexible/scalable database collecting all the spectroscopic data for rapid characterisation of foods collected by the smart sensors, is being implemented and populated. The facility provides services to different interested users from the agrifood, mostly researchers and food businesses, such as the one focused on "open data of spectroscopical signatures for food frauds", in form of remote and virtual access.

Keywords: smart sensors, Internet of Things (IoT), portable devices, food safety, food frauds

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