



DETERMINATION OF THE SHELF LIFE OF PERISHABLE FOODS USING GAS SENSORS

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Aim. The aim of the present work is to develop a novel, rapid and low-cost system to detect early spoilage and estimate the shelf life of highly perishable foods, based on the monitoring of Total Volatile Organic Compounds (TVOCs) released during storage, using a metal oxide semiconductor (MOX) gas sensor (ENS160).

Methods. eight categories of perishable products (fresh fish products, minced meat and meat preparations) were stored under refrigerated conditions and analysed, at regular intervals, to determine shelf life through microbiological analysis (enumeration of *Pseudomonas* spp., lactic acid bacteria and — in the case of fish products — Specific Spoilage Organisms) and sensory analysis. A 10 g aliquot of each of the aforementioned matrices was placed in an airtight plastic container, kept both at refrigeration temperature and at 20 °C (accelerated spoilage), inside which a MOX gas sensor enabled for the continuous determination of TVOCs was installed. The wireless connection of the sensor to a dedicated platform allowed, in addition to acquiring the traces in CSV format, also to monitor their trend in real time, highlighting the moment at which the trend underwent substantial changes; monitoring, for all the evaluated samples, was therefore stopped (with times varying according to the food matrix) after the identification of an inflection point (λ), be-

yond which a sudden increase in TVOC concentration was observed. This temporal evolution was modelled using a logistic equation which made it possible to accurately characterize the onset time of λ .

Results. for all the food matrices considered, the microbiological parameter consistently associated with the onset of marked organoleptic alterations was the *Pseudomonas* spp. count, for which it was possible to identify, in agreement with the reference literature, a Minimum Spoilage Level of approximately 6 log CFU/g; the onset time of λ was consistently associated with the attainment of such loads. The application of accelerated storage conditions significantly reduced the time required to estimate product shelf life, while maintaining a reliable correspondence with the spoilage dynamics observed under refrigeration.

Conclusions. The combination of TVOC detection using low-cost sensors and the mathematical modelling of their trend provides a rapid, non-destructive and economically sustainable tool for early spoilage detection and shelf-life estimation. In particular, the identification of the TVOC inflection point (λ) as an indicator of the onset of spoilage microbiota growth highlights the potential of this technology for future real-time food quality monitoring systems and smart shelf-life prediction applications.