Fostering the Transition to Sustainable Food Systems:
Embracing Novelty and Overcoming Challenges

17-19 November 2025 | Porto, Portugal

ABSTRACT BOOK

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A High-Throughput Direct-Injection Mass-Spectrometry Platform for Real-Time VOC Monitoring of Food Fermentation and Sensory Research

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Aim:
To develop an automated, high-sensitivity analytical platform for real-time monitoring of volatile organic compounds (VOCs) in agrofood applications, based on Direct Injection Mass Spectrometry—particularly Proton Transfer Reaction–Time-of-Flight Mass Spectrometry (PTR-ToF-MS). The system aims to enable data-rich analysis of microbial fermentation and aroma release, supporting the digital transition in food quality and sensory research.

Method:
An automated facility was established by coupling a dynamic headspace autosampler with PTR-ToF-MS. The platform allows for the simultaneous incubation and continuous VOC sampling from hundreds of samples. This method was applied to a range of fermentation models involving key food-related microorganisms (e.g., different yeasts and lactic acid bacteria, as well as complex microbiomes). In parallel, nose-space analysis was combined with dynamic sensory methods to monitor aroma release and perception during food consumption. VOC concentration profiles were aligned with time-resolved sensory data to study their correlation in both simplified and complex food matrices. Multivariate analysis and data mining techniques were extensively used to extract patterns and insights from PTR-ToF-MS data, and recent efforts have explored the integration of new artificial intelligence models for advanced data interpretation.

Results:
The integrated platform enabled high-throughput, real-time monitoring of VOCs across multiple fermentation processes. It proved effective for screening microbial strains, studying interactions, and optimizing process conditions, with potential benefits for product innovation and sustainability. In aroma perception studies, the combined chemical-sensory approach revealed that the relationship between in-nose VOC concentrations and perceived intensity is often complex and non-intuitive. For example, increased VOC release did not always correspond to stronger sensory perception, suggesting that other perceptual or contextual factors modulate the overall experience. These findings highlight the need for multi-dimensional datasets in sensory and consumer science, integrating volatilomics information.

Conclusion:
The proposed workflow supports the digital transition of food systems by enabling rapid, non-invasive, and data-rich monitoring of volatile markers in both fermentation and consumption contexts. While compound identification remains a limitation of direct injection mass spectrometry, ongoing developments such as ion mobility integration offer promising solutions. The inclusion of AI-driven data interpretation further strengthens this approach as a tool for sustainable and intelligent food innovation.