Società Chimica Italiana
Divisione di Spettrometria di Massa

FONDAZIONE EDMUND MACH

DIFFA23

DIRECT INJECTION FOOD FLAVOUR ANALYTICS

BOOK OF ABSTRACTS

Fondazione Edmund Mach

San Michele all'Adige (TN), Italy

20 - 22 September 2023

1st International Symposium on
Direct Injection Food Flavour Analytics (DIFFA)

Edited by
Research and Innovation Centre
Fondazione Edmund Mach
Via Mach, 1
38010 San Michele All'Adige (TN) Italy
phone +39 0461615427
fax +39 0461650872
www.fmach.it
ISBN 9788878430600

P.14 PTR-MS applications inside the SISTERS project – Preventing food loss and waste of fresh vegetables by monitoring quality decay through VOCs emissions

Pedrotti Michele[1]*, Betta Emanuela[1], Khomenko Iuliia[1]

[1]Research and Innovation Centre, Fondazione Edmund Mach, Via Edmund Mach 1, 38010 San Michele all'Adige, Italy

*michele.pedrotti@fmach.it

Summary: The BulkBox (BB) is a new smart container designed to preserve freshness during transportation and storage of perishable products for reducing food losses and waste. The BB's effectiveness was evaluated for various fruits and vegetables (apples, mushrooms and bell peppers) by monitoring volatile organic compounds (VOCs) emissions using PTR-MS and GC-MS. Results showed the BB's potential in maintaining the freshness of some products along the supply chain.
Keywords: PTR-MS, respiration rates, food loss and waste.

1 Introduction

Vegetables and fruits accounts for almost half of the total food loss and waste (FLW) globally [1] due to their perishable nature and quality decay after harvest which may compromise consumers' freshness perception. Inside the project "SISTERS - Innovative systematic interventions for a sustainable reduction of food waste in Europe" (Horizon 2020, Grant Agreement No. 101037796), a smart container - the BulkBox (BB) – has been developed to reduce food losses and quality degradation during transportation and storage by exploiting passive modified atmosphere and the implementation of a sensor kit to monitor products' conditions in real time (e.g. CO_2, O_2, temperature and relative humidity).
In this work, volatile organic compounds (VOCs) emissions were monitored by proton transfer reaction mass spectrometry (PTR-MS) and gas chromatography mass spectrometry (GC-MS) to validate the BB efficacy in better preserving the freshness of different perishable products (Agaricus bisporus, bell peppers and apples) than conventional approaches for bulk transportation. For each product, refrigerated transportations from Spain to Italy (1700 km) of realistic product quantities (200-300 Kgs) were performed, followed by shelf-life experiments. BB performance was compared to regular transportation conditions by combining sensory and instrumental measurements on stored products including water loss, dry matter, texture parameters, color, appearance and VOCs emissions (PTR-MS and GC-MS).

2 Material and methods

In the case of Agaricus bisporus and bell peppers (cv Lamuyo), 2 BBs and one standard (pallet) were analyzed. After receiving the products from Spain, shelf-life experiments were conducted at two different conditions: refrigerated (T=2-7°C, RH=90-95%) and ambient conditions (T=20°C, RH not controlled) to simulate supply chain operations. PTR-MS measurements were realized at different times during the shelf life. Respiration rates and headspace analysis were performed. For respiration rates, products were sampled and put in a 1L glass jar hermetically closed for 30 minutes before being measured. For headspace analysis, samples were collected, grinded into powder and conserved at -80°C. When analyzed, samples were inserted into 20 mL glass vials equipped with PTFE/silicone

septa and mixed with an antioxidant solution before being measured through an adapted GC autosampler (MPS Multipurpose Sampler, GERSTEL).
In the case of apples (cv Gala), VOCs emissions from the BB were collected by using different methods: Tedlar bags, syringe-vials coupled to the autosampler (measured immediately and after storage at -80°C) and a gas canister.
All the measurements were performed with a PTR-ToF-MS 8000 apparatus (Ionicon Analytik GmbH, Innsbruck, Austria) with H_3O^+ as primary ion. The Selective Reagent Ion mode was also used with O_2^+ as primary ion mode to collect data about ethylene emissions.

3 Results

For both mushrooms and bell peppers, an evolution of the volatilome during shelf life was appreciated. A general increase in VOCs emissions was observed as the products quality decreased. Moreover, differences in some mass peaks were observed between the BB and the standard way of storage, especially as the shelf life progresses.
In the case of apples, when comparing the different sampling methods, sampling with the gas canister performed poorly in comparison to the other two methods (Tedlar bags and syringe-vials methods) both in terms of VOCs concentrations and repeatability. Tedlar bags and vials showed a similar performance for different mass peaks including m/z 33.034 (methanol), 117.089 (mix of esters) (Fig. 1) and other mass peaks tentatively identified as the most important esters in the apple aroma of different varieties. When frozen, the vials showed a slightly worse performance in terms of VOCs concentrations, probably due to evaporation and condensation.

4 Conclusions

The BB showed promising results as a possible solution to better preserve bell peppers quality along the food supply chain. PTR-MS was successfully applied to monitor respiration rates (including ethylene) and VOCs emissions during the shelf life of bell peppers, mushrooms and apples. In combination with sensory analysis and more classic analytical techniques like GC-MS, the technique is a valid tool for evaluating fresh products quality and BBs performance which depends on the respiration rates and the physiological characteristics of each product.

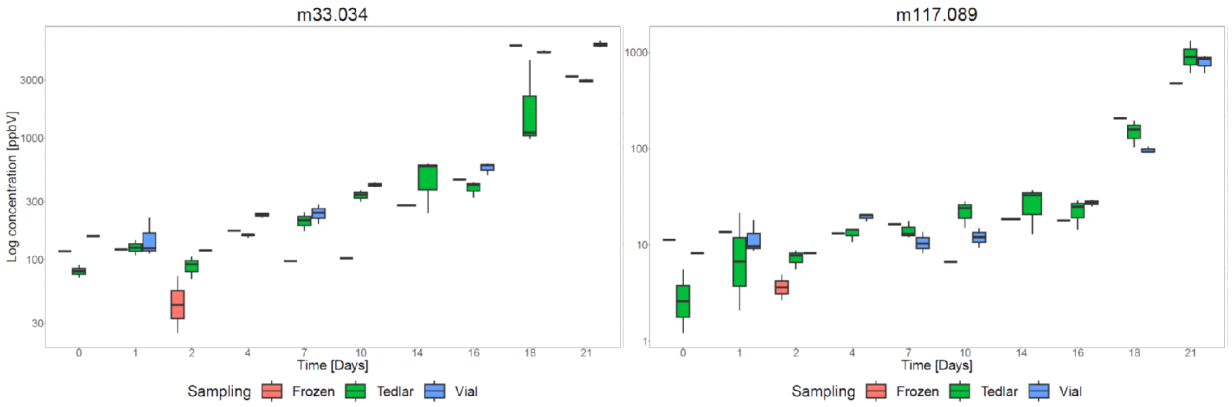

Figure 1. *Boxplots of m/z 33.034 (methanol) and 117.089 (T.ID mix of esters including ethyl butanoate, ethyl hexanoate, butyl acetate and isobutyl acetate). The average concentration of samples taken from the BB at different days with different sampling methods (Tedlar bags, syringe-vials and syringe-vials stored at -80°C) is showed.*

References

[1] Guo X., Broeze J., Groot J.J., Axmann H., Vollebregt H.M. *Sustainability, 12(18)* (2020).