Session 5 – Microbiomes preservation and exploitation

XLII European Culture Collections' Organisation (ECCO)
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18 -20 September 2024

Direct Injection Mass Spectrometry for the Real-Time Volatilomics in Food System Microbiomes: the Potential of Providing Temporal Dimension in Multi-Omics Studies

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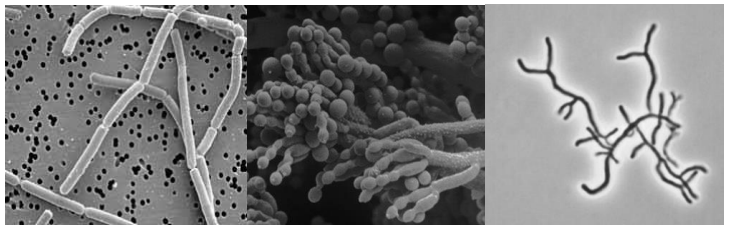
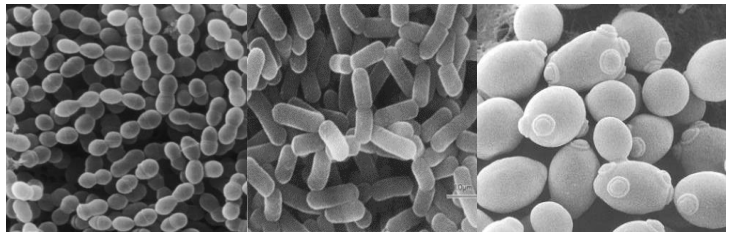


Fermentation: the leading example of bioprocess



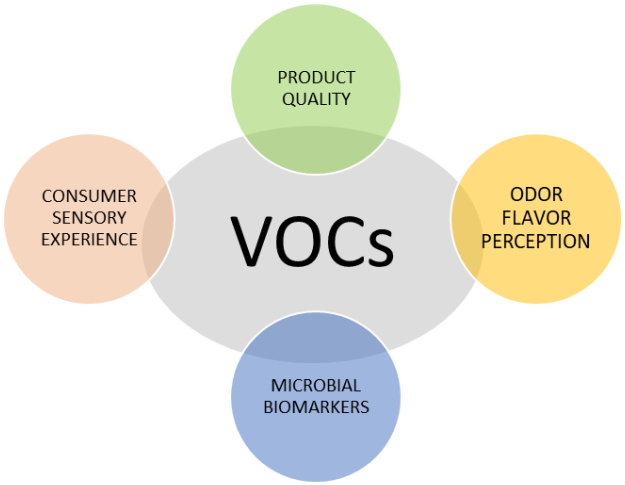
‘Omics’ technologies: Metabolomics studies

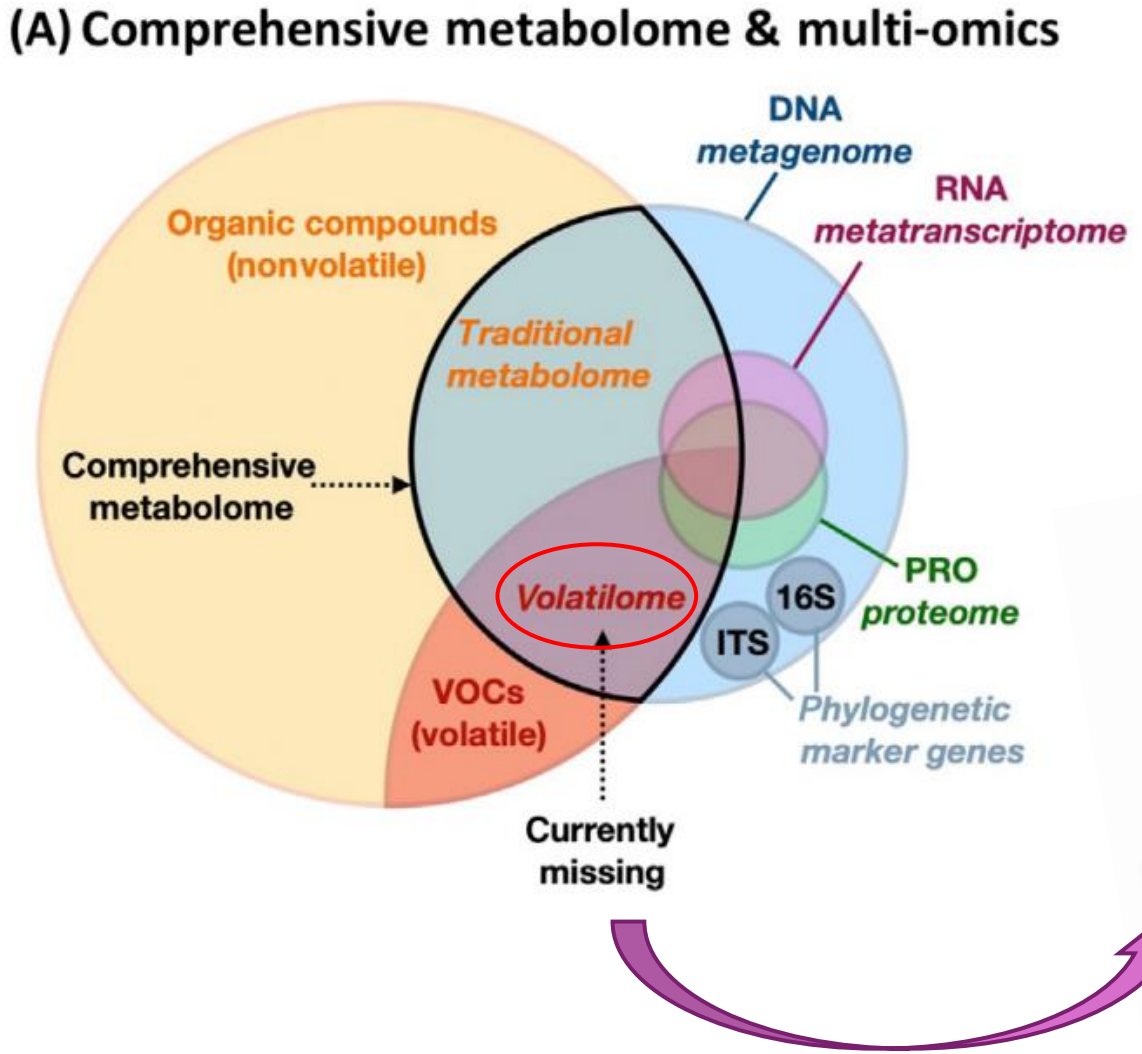
Review

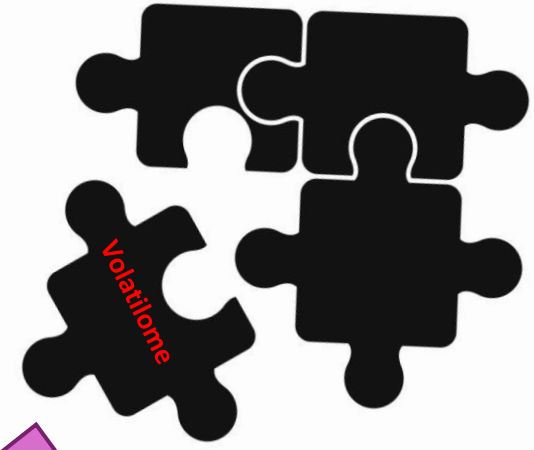
Capturing the microbial volatilome: an oft overlooked 'ome’

DOI

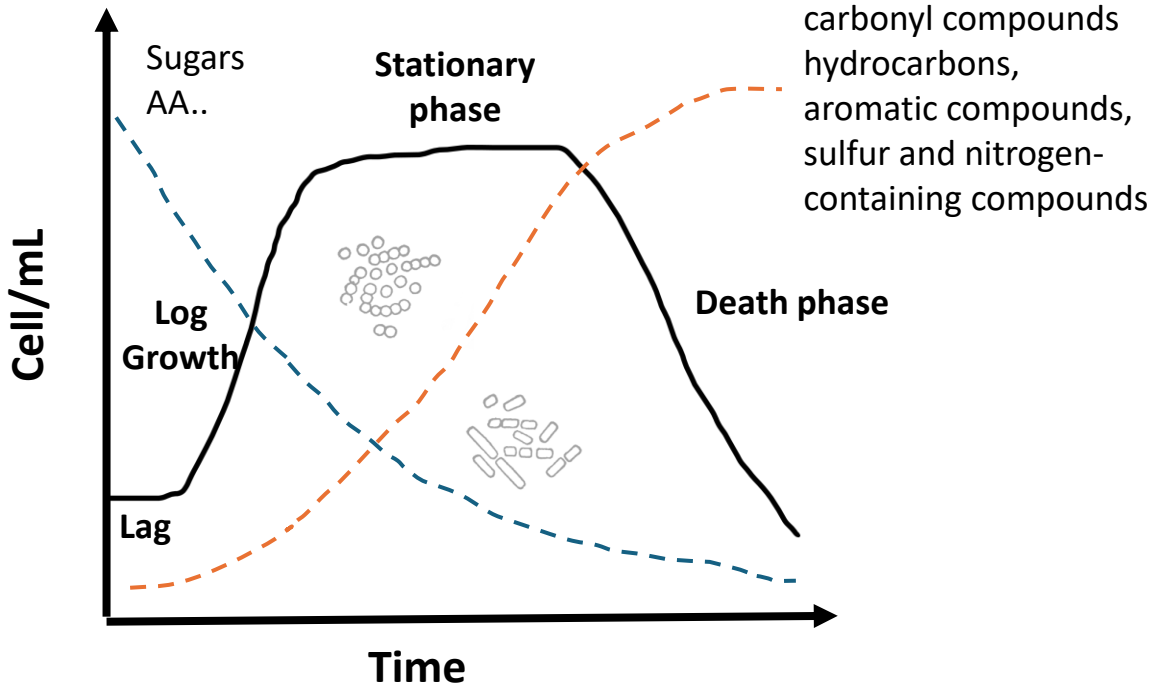
10.1016/j.tim.2021.12.004







Microbial growth curve



alcohols
carbonyl compounds
hydrocarbons,
aromatic compounds,
sulfur and nitrogen-containing compounds

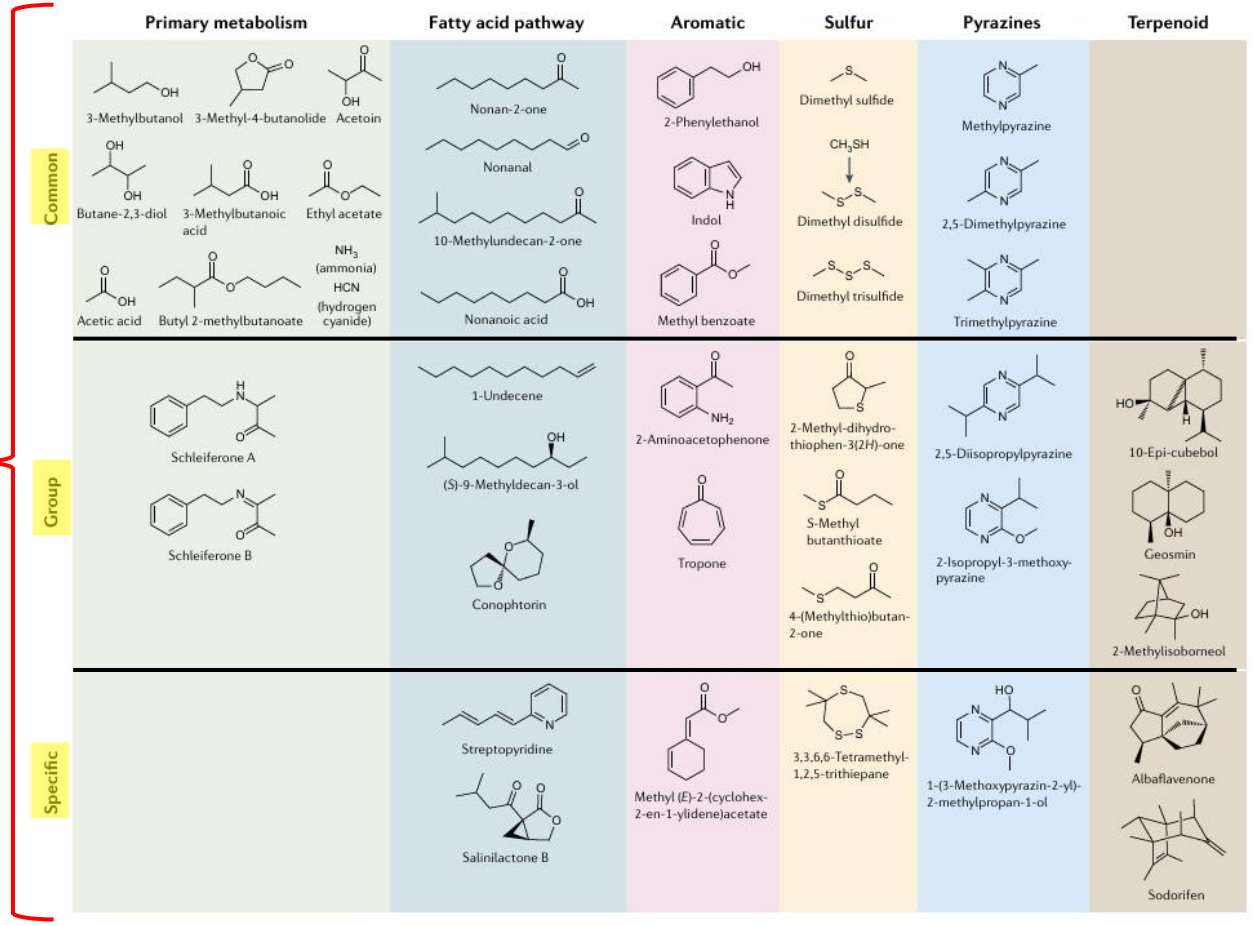


Fig. 5 | **Major biosynthetic pathways of microbial volatile organic compounds.** Examples of common, group and specific volatile compounds. Strain-specific signatures are difficult to find among the primary metabolism-derived compounds. There are no commonly emitted terpenes.

Weisskopf *et al.*, 2021

Volatile Organic Compounds Monitoring

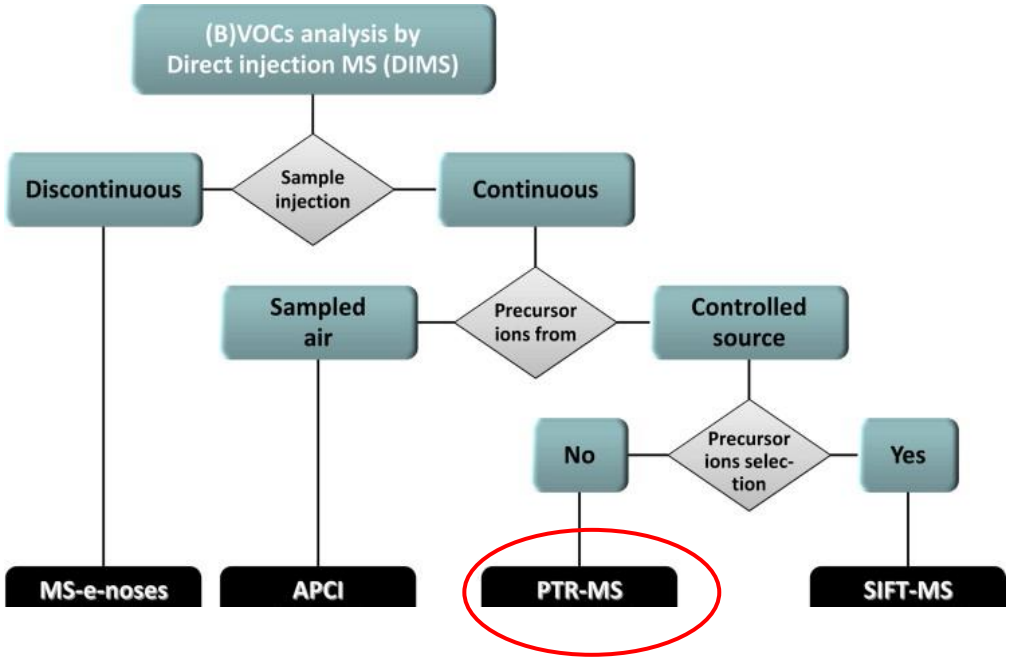
Proton Transfer Reaction (PTR), combined with a Time-of-Flight (ToF) Mass Spectrometer (MS)

Review

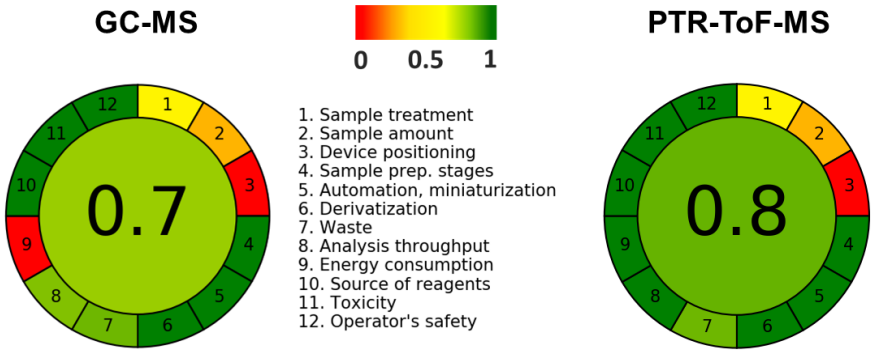
PTR-MS: a green alternative for food volatilome profiling

DOI

10.1016/j.greeac.2022.100041



GREEN



- **RAPID**
- ON LINE MONITORING
- MASSIVE SCREENINGS
- BIOPROCESS STUDY
- VERSATILE APPROACH

Applications of PTR-MS in Food Science and Technology

Chapter

Real-Time Monitoring of Flavoring Starter Cultures for Different Food Matrices Using PTR-MS

DOI

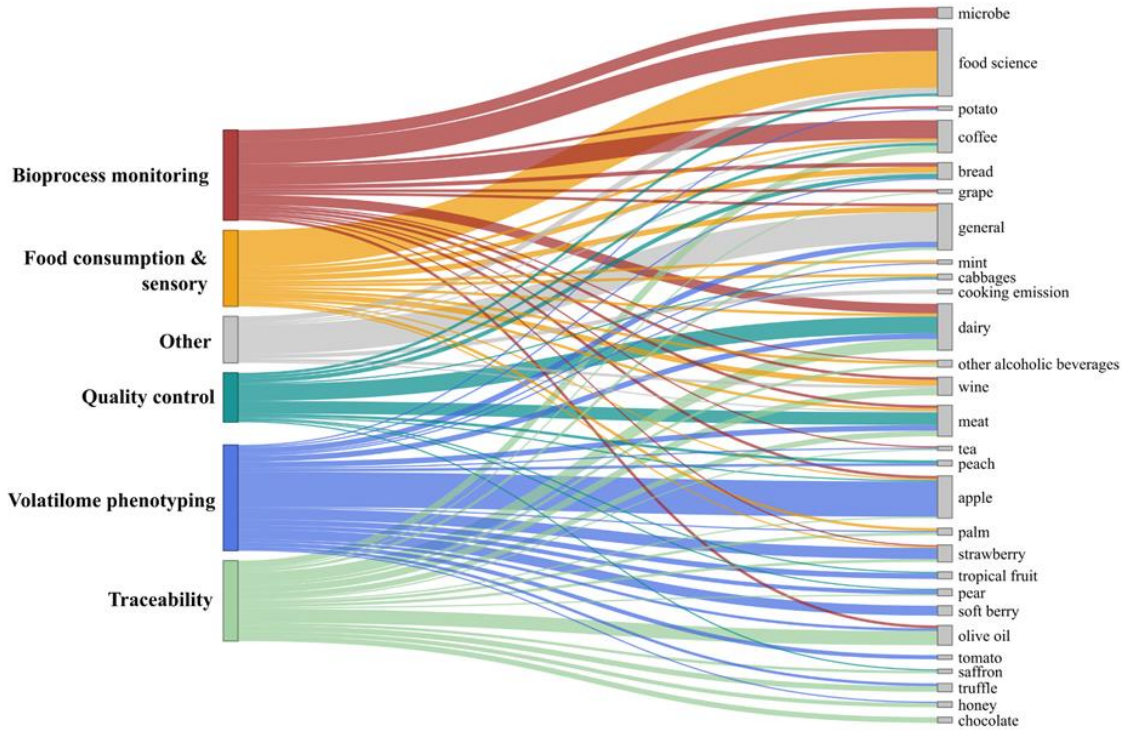
10.1021/bk-2021-1402.ch010

Review

PTR-MS: online and rapid determination of volatile organic compounds of microbial origin

DOI

10.1007/s00253-015-6528-y



SUSTAINABLE

Low energy input food processing
Sustainable biotechnologies
Improving nutritional and functional value
Reduction of additives and food clean label
Microbial biodiversity valorisation
Geographical Indications and food heritage
Design of plant-based alternatives

FERMENTATION

GREEN

Rapid determination with high sensitivity and accuracy
No extraction, derivatisation, nor toxic wastes
Automation: autosampler and tailored data analysis
On-line and real-time measurements
Multi-analytes high throughput approach
Bioprocess monitoring and massive screenings

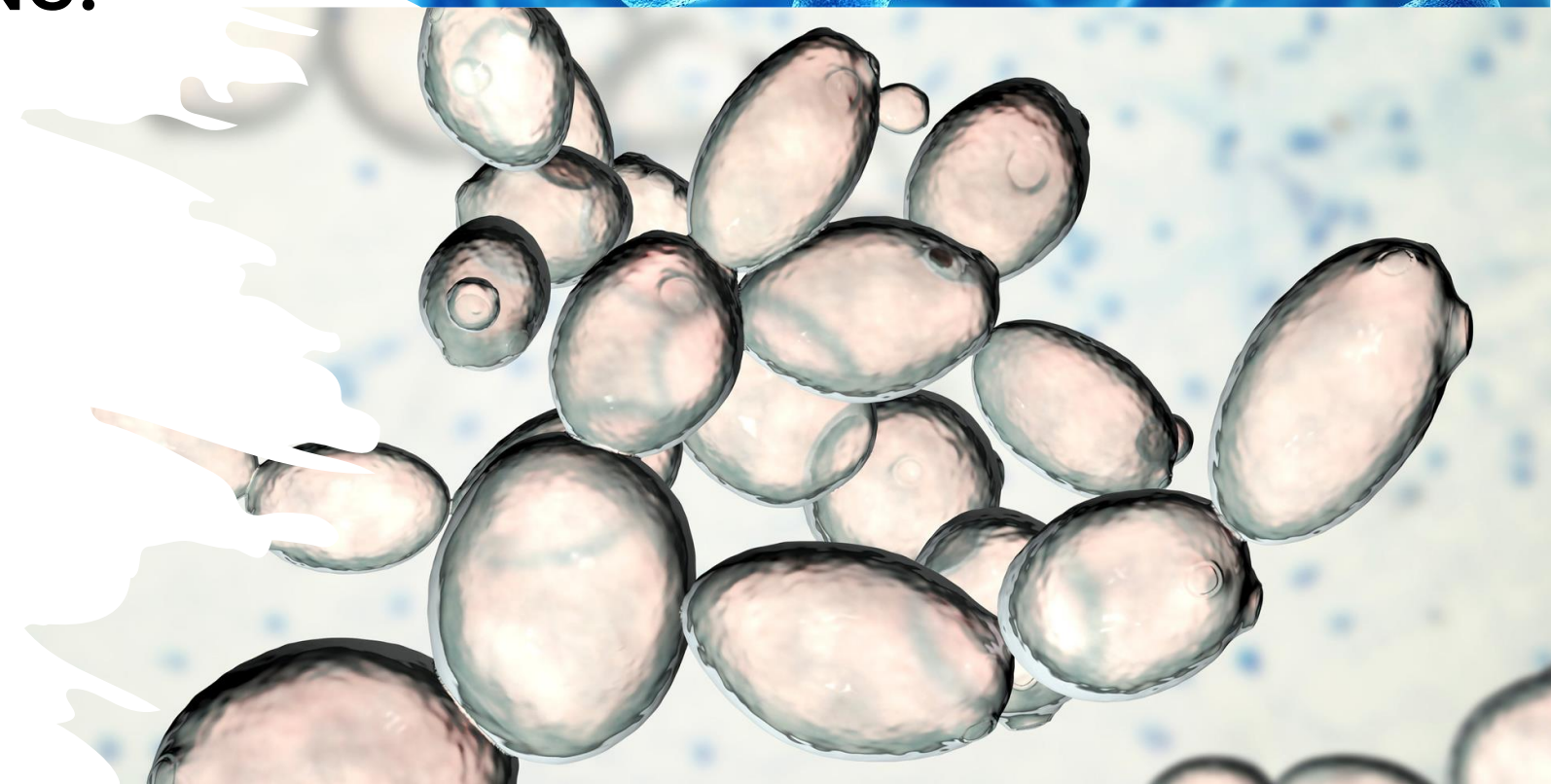
PTR (DIMS-ToF-MS)

CASE STUDIES

Volatilome of single culture

BIOPROCESS MONITORING:

1. Lactic acid bacteria
2. Yeasts



1

Case study

Volatome

different LAB strains

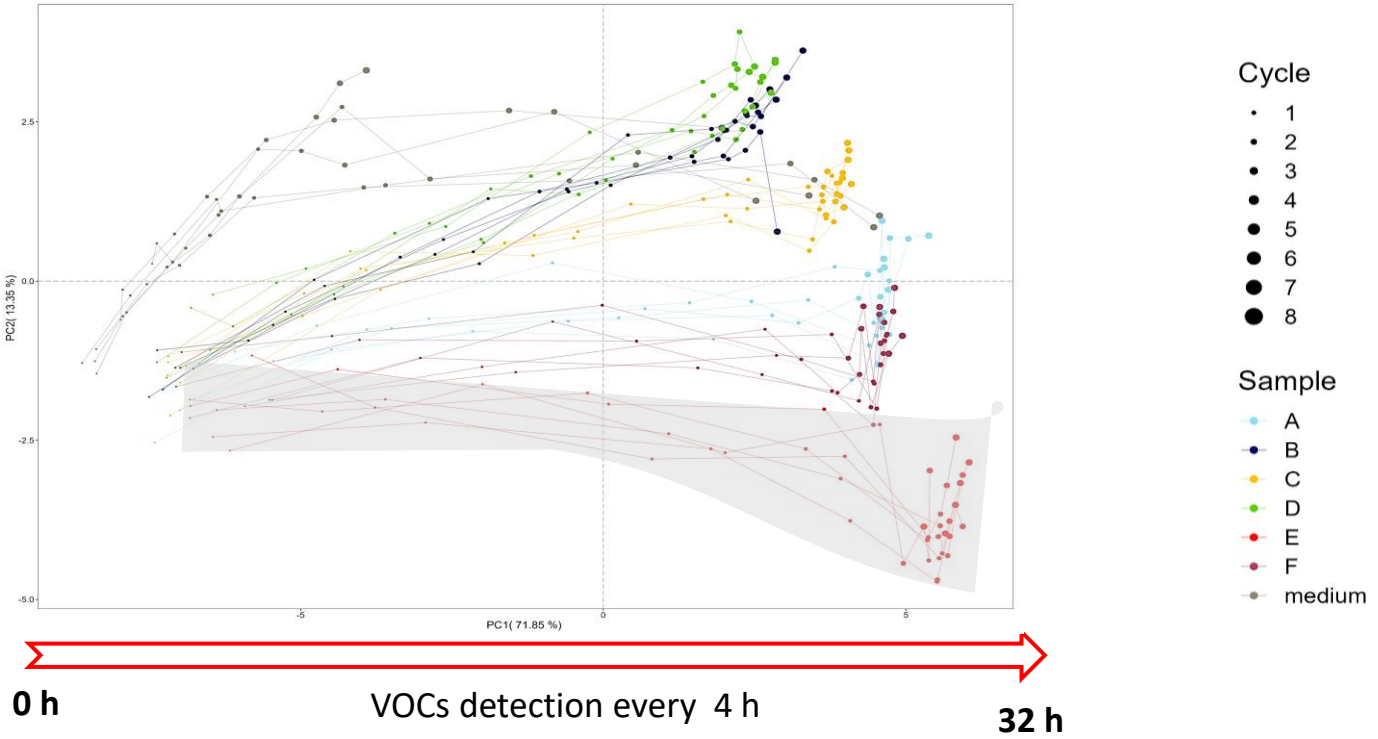
Matrix

Microbiological medium

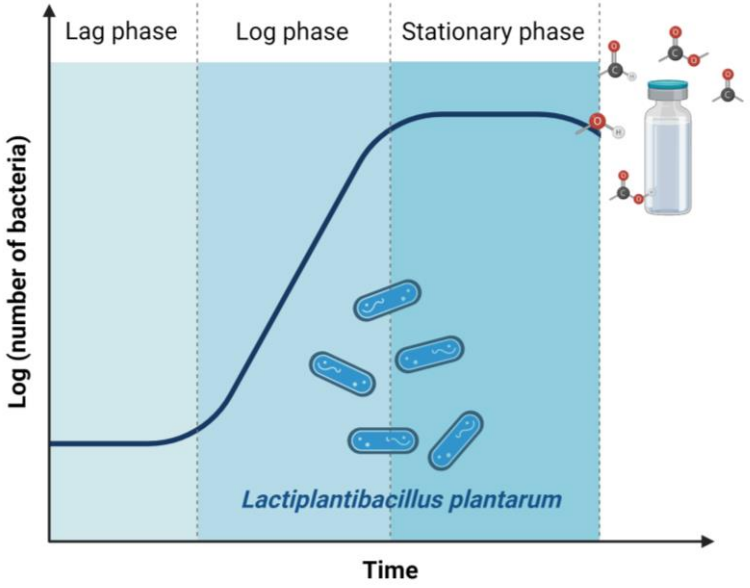
Six strains of *Lactiplantibacillus plantarum*

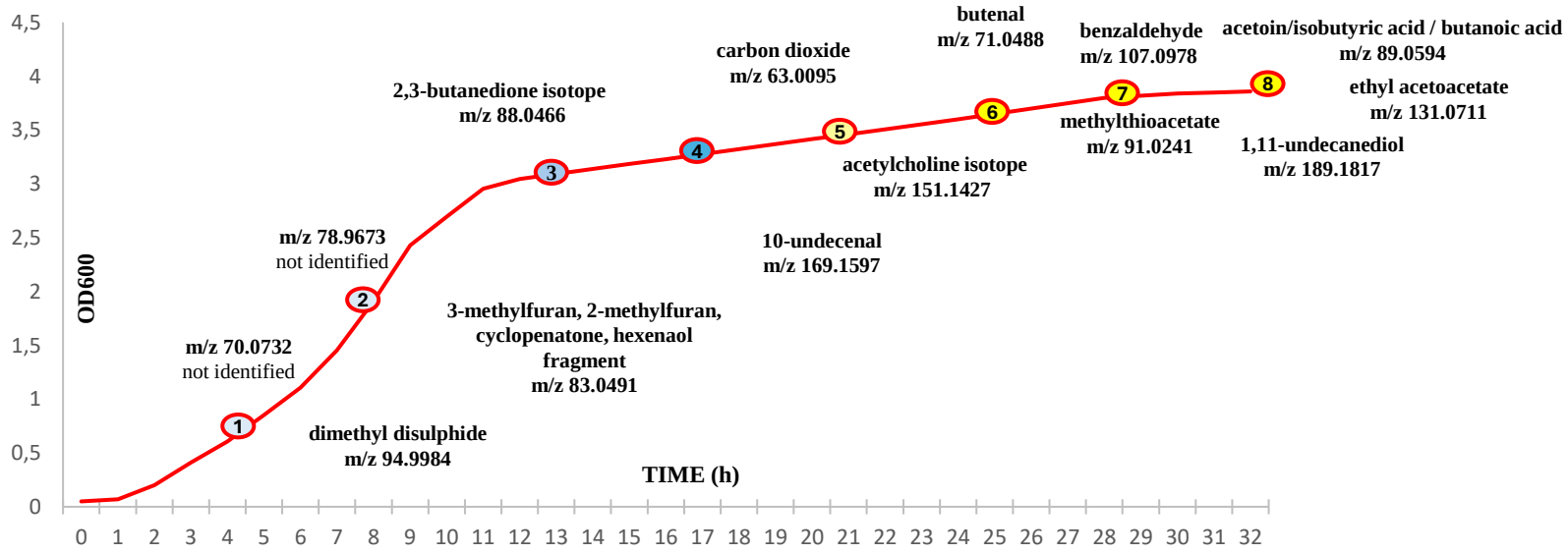
A B C D E F

(two laboratory strains and four from different ecological niches)



Optimal condition: T 30°C & pH 6.2





2

Case study

Volatome different yeast strains

Matrix

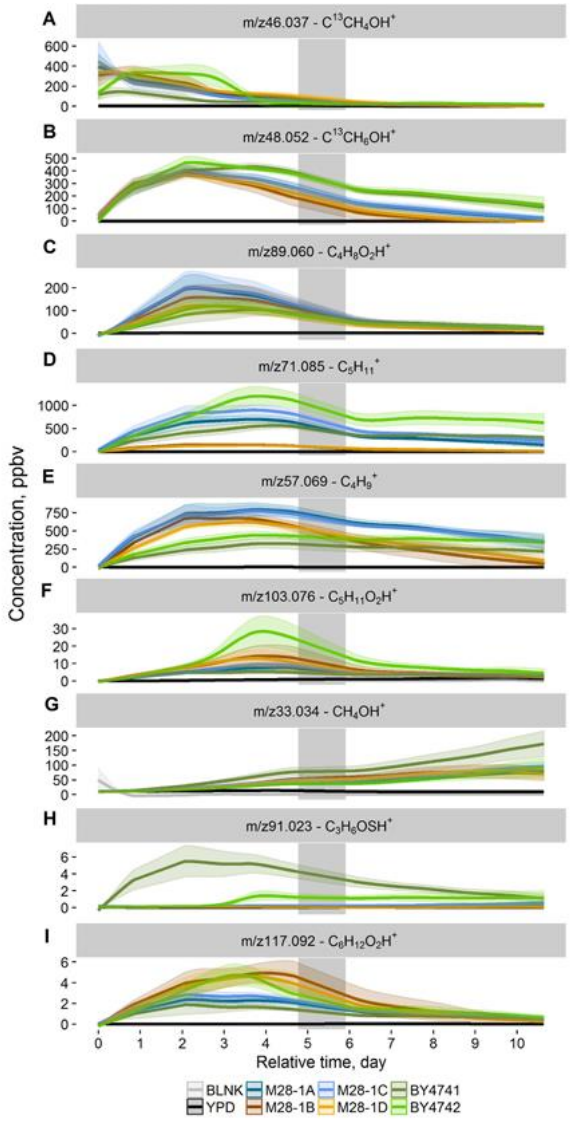
Microbiological medium

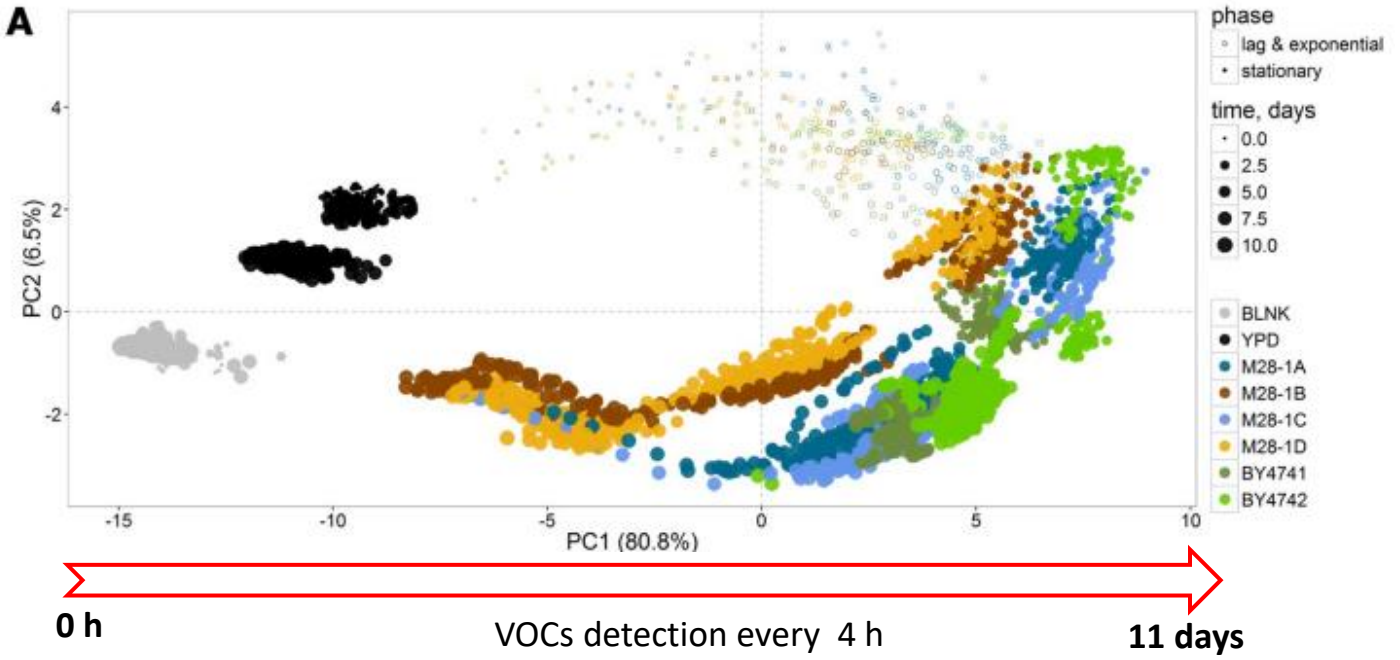
DOI

10.1007/s11306-017-1259-y

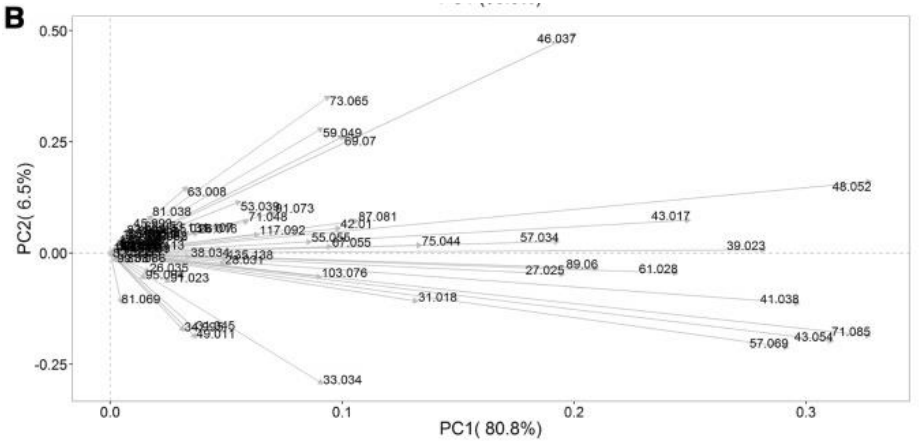
Six different *Saccharomyces cerevisiae* strains (four meiotic segregants of a natural strain and two laboratory strains)

Curves of selected mass peaks tentatively identified





General picture of yeast colonies' VOC profiles evolution during the 11 days showing the drastic differences with growth



CASE STUDIES
Volatilome of microbiome

SCREENING/CHARACTERIZATION ANALYSIS:

1 Bread

2 Table olive

BIOPROCESS MONITORING:

3 Grape juice and must

4 Milk and cream

1

Case study
Volatilome of sourdoughes
Matrix
Bread

18 types of dough (200 g), with different combinations of cereal flours, microbial resources and insect flour.

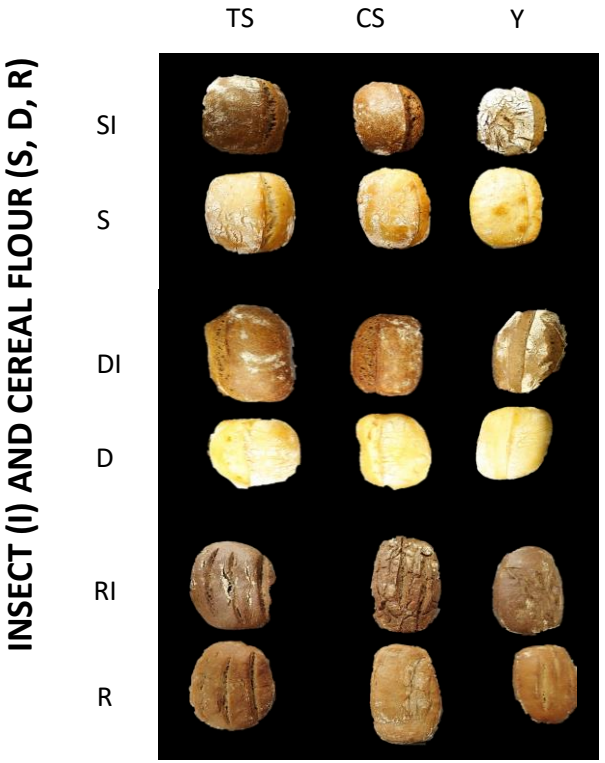
Leavening agent
Brewer's yeast (Y)
Commercial sourdough (CS)
Traditional Trentino sourdough (TS)

Flour

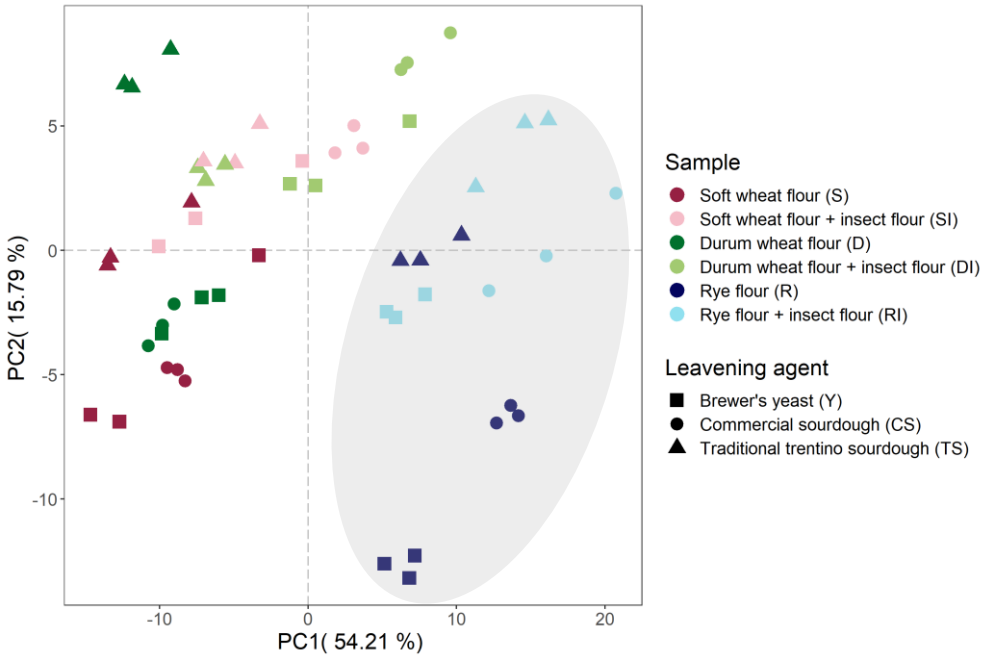
Cereal
Soft wheat (S)
Durum wheat (D)
Rye (R)

Insect
Cricket 15% (I)

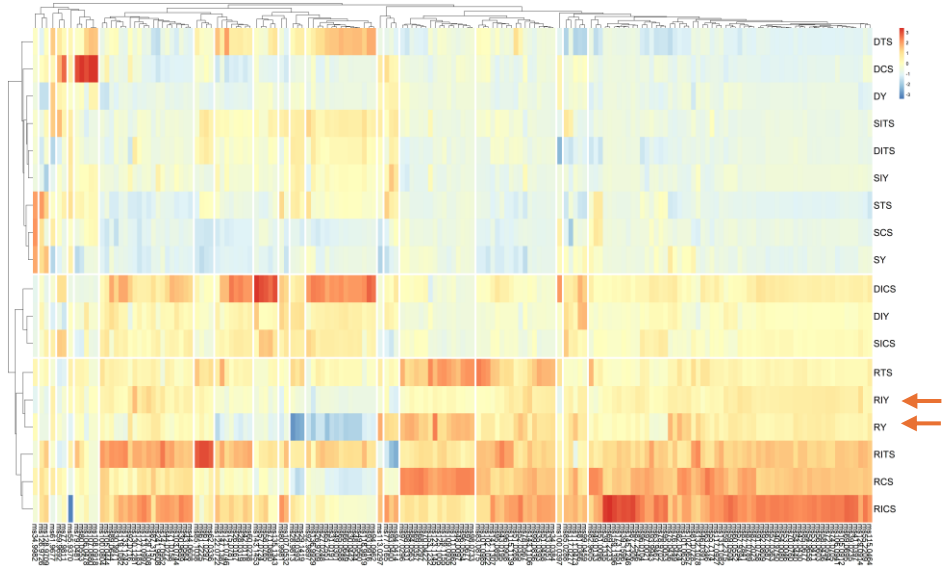
LEAVENING AGENT



PCA based on PTR-MS data



Heatmap based on PTR-MS data



2

Case study

Volatilome of two different fermentation

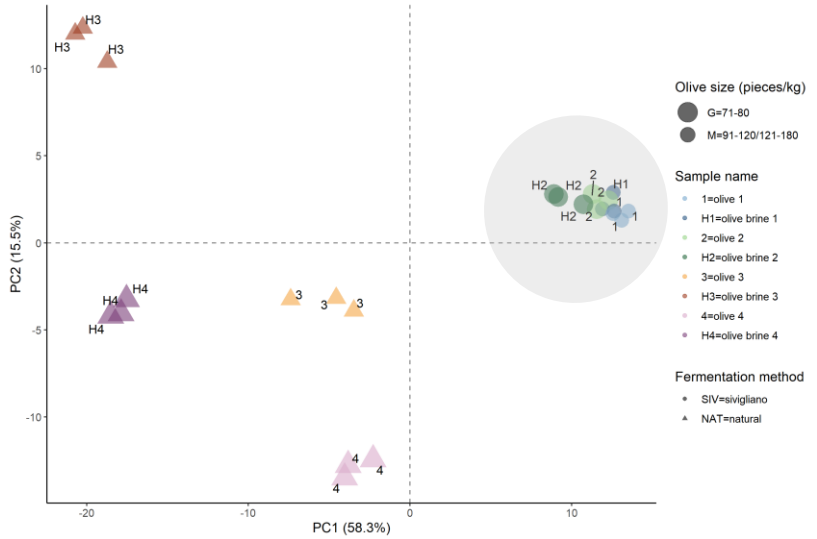
Matrix

Table olive and brine

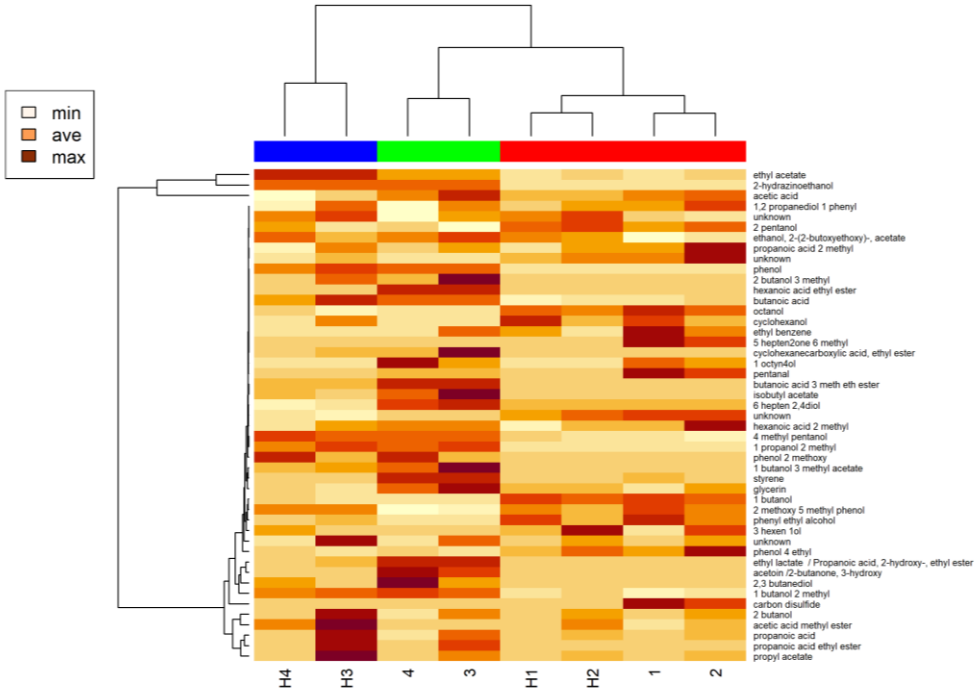
Description of table olives (1, 2, 3 and 4) and respective brines (H1, H2, H3 and H4) under evaluation.

Sample name	Matrix	Size (pieces/kg)	Fermentation mode
1	olive fruit	M	SIV
H1	brine	-	SIV
2	olive fruit	G	SIV
H2	brine	-	SIV
3	olive fruit	M	NAT
H3	brine	-	NAT
4	olive fruit	G	NAT
H4	brine	-	NAT

PCA based on PTR-MS data



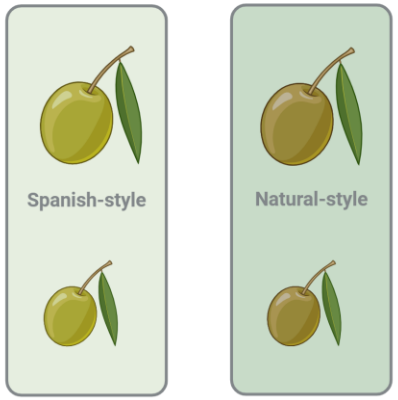
Heatmap based on GC-MS data

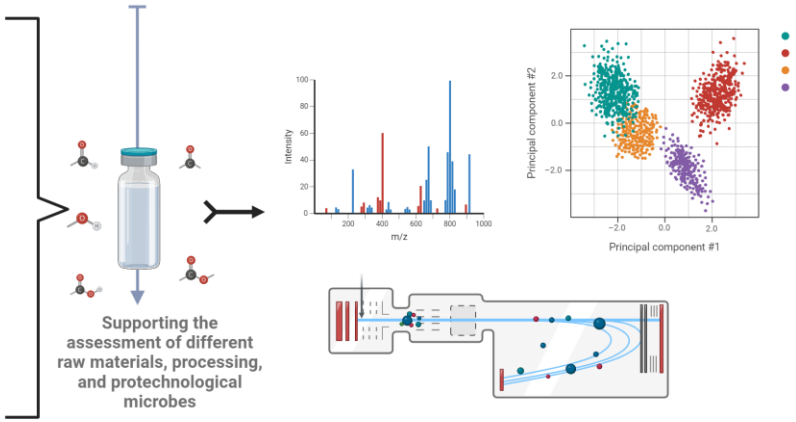


Apulian olives, 'Bella di Cerignola' variety

G
71-80
pieces/kg

M
91-120/
121-180
pieces/kg





FERMENTED TABLE OLIVES (food) → VOCs (analitical target) → PTR-TOF-MS (analitical tool)

3

Case study

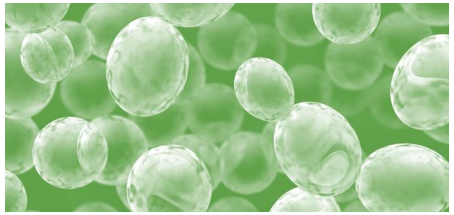
Interaction among starter cultures: alcoholic fermentation

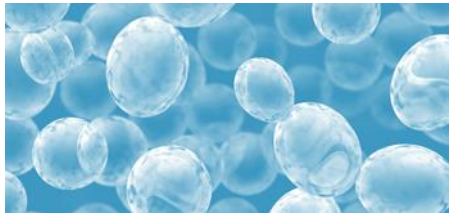
Matrix

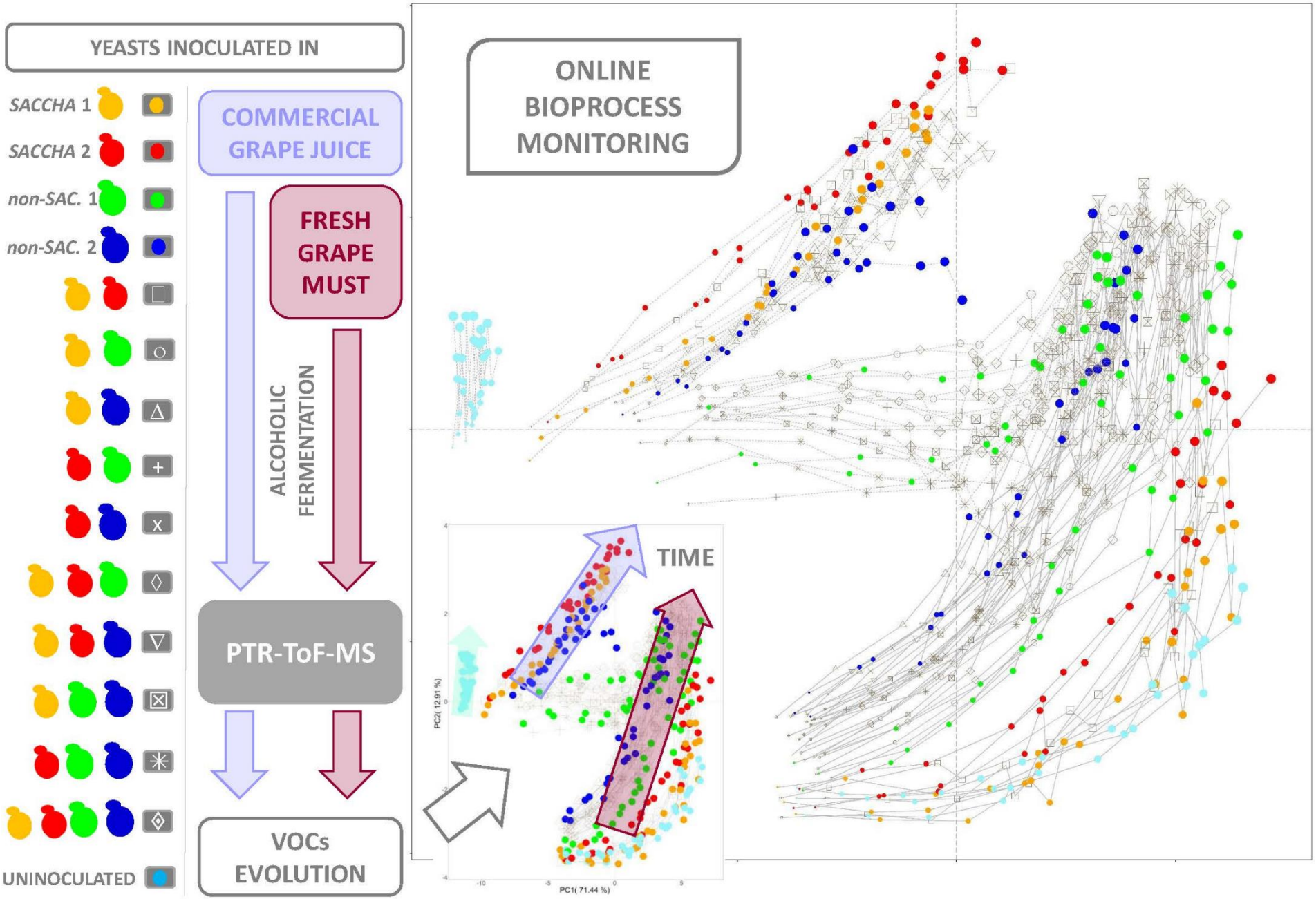
Wine

DOI

10.3390/fermentation6020055







4

Case study

Volatilome of starter

Matrix

Milk/Cream

Matrix

Milk

Cream

(50% diluted with milk)

Treatment

Pasteurization

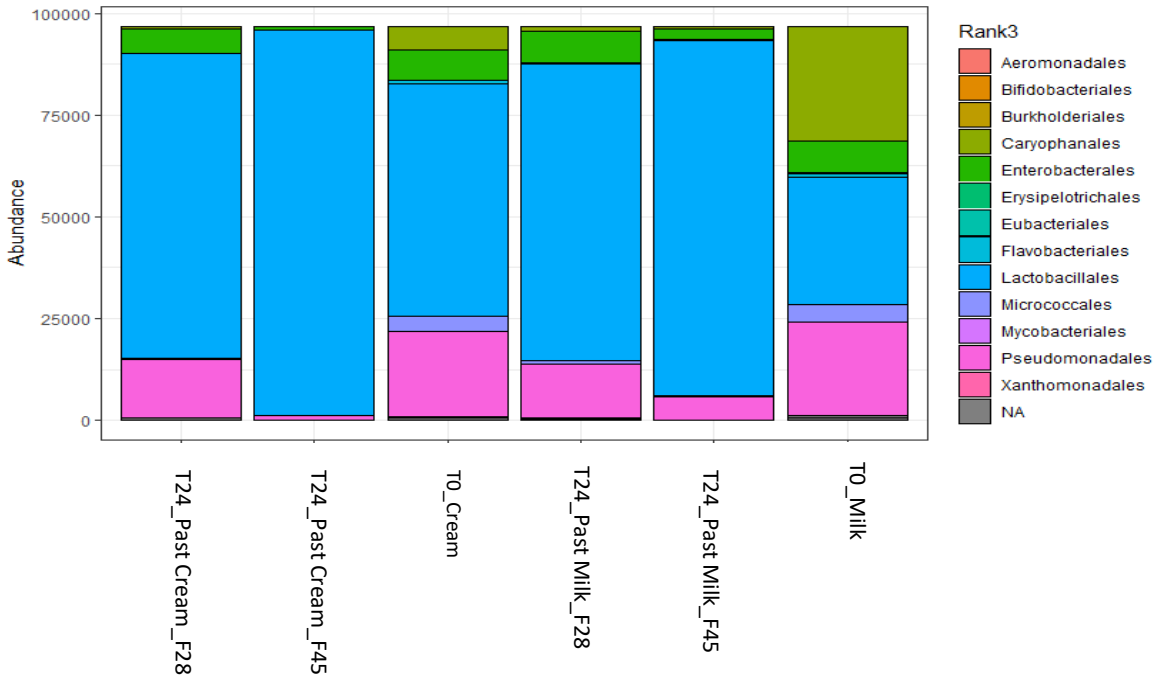
Not pasteurization

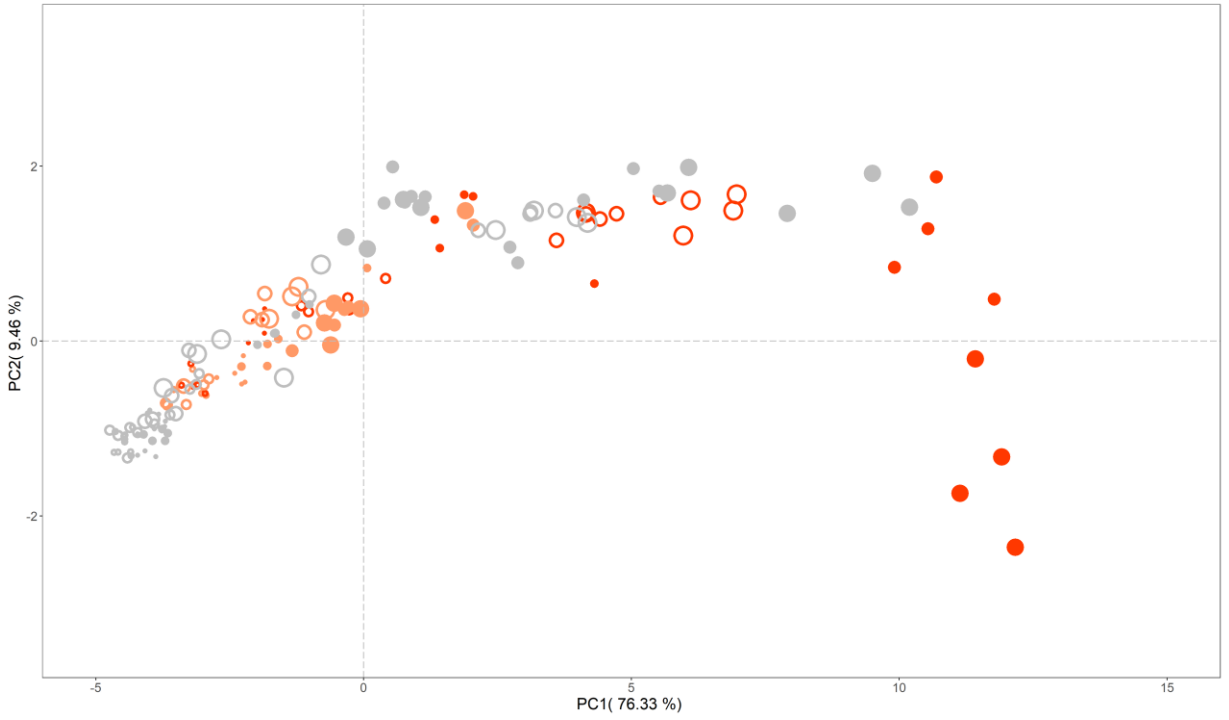
Fermentation temperature

28°C

45°C

Taxa_V3-V4

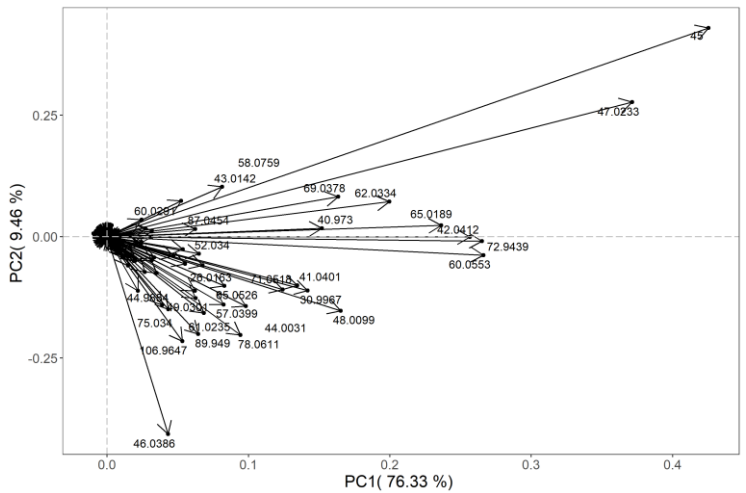




0 h

VOCs detection every 6 h

24 h



Fermentation Temperature

- 28°C
- 45°C

Cycle

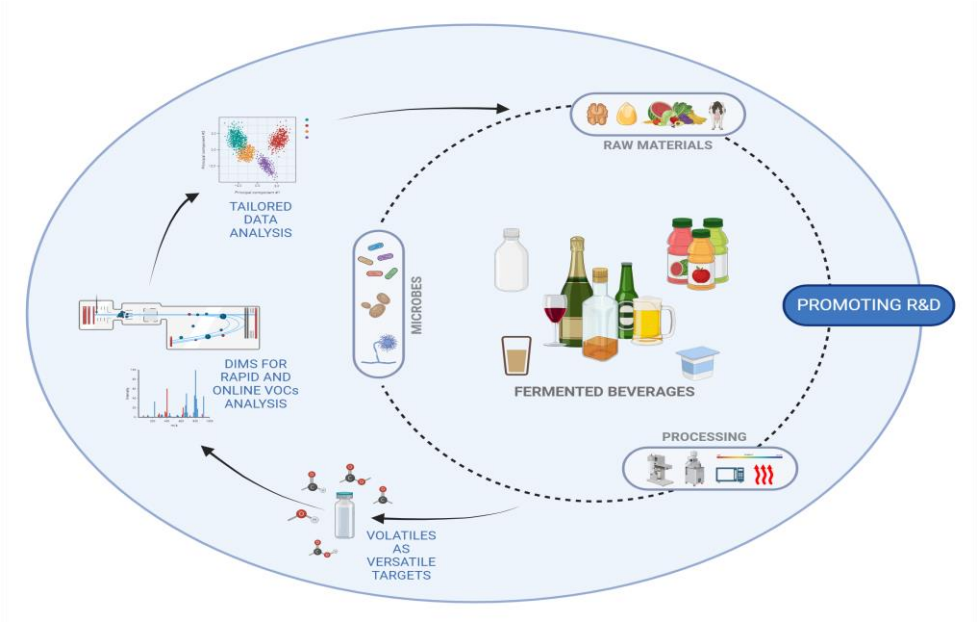
- 1
- 2
- 3
- 4

Sample

- Pasteurized milk (M_P)
- Non-pasteurized milk (M_NP)
- Pasteurized cream (C_P)
- Non-pasteurized cream (C_NP)

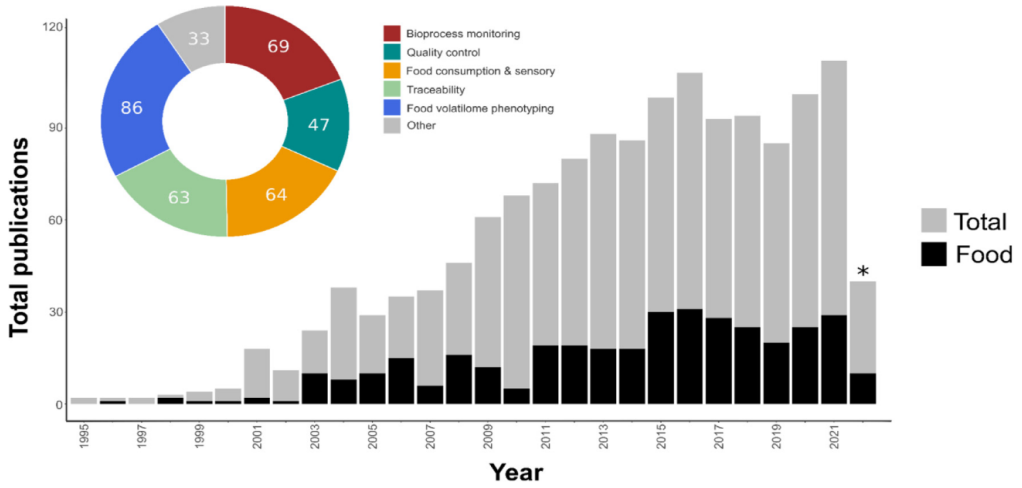
Studies on ‘Volatilome’ for a deeper understanding

Variables involved in a fermented food process and analysis.



Corvino *et al.*, 2024
DOI: 10.1111/ijfs.17398

The total number of manuscripts by year related to the general PTR-MS topic in grey and to food science and technology in specific in black.



Mazzucotelli *et al.*, 2022
DOI:10.1016/j.greeac.2022.100041

Thank you for attention!

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