WAC – IVAS 2026

Wine Active Compounds - In Vino Analytica Scientia

BOOK OF ABSTRACTS

29 June – 3 July 2026

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Editorial

Dear participants,

It is with great pleasure that, on behalf of the organizing committee, we welcome you to the WAC-IVAS 2026 conference at Dijon, France, from June 29th to July 3rd, 2026. With nearly 250 registered researchers, this conference will provide the first opportunity in Bourgogne to present the latest advances in the various fields of analytical sciences applied to oenology (IVAS), as well as innovations in viticulture and oenology in the face of societal, environmental, and economic challenges (WAC). The seven sessions will feature up to 81 oral conferences, including 7 keynotes, plus 135 poster presentations, thus giving an outstanding voice to research in viticulture and enology from more than 15 different countries around the world.

All those who have contributed to the realization of WAC-IVAS 2026 are warmly thanked here. We extend our heartfelt thanks to Nathalie Koenders, Mayor of Dijon for offering the possibility to host this conference in one of the world's most iconic venues for discussing these topics in Burgundy: The Palace of the Dukes of Burgundy in Dijon. We are honored to host this congress under the high patronage of the OIV, which is also hosting us for the welcome event. For this, we extend our sincere thanks to its President, Yvette Van der Merwe, its Director General, John Barker, and its Deputy Director General, Yann Juban.

The organization of WAC-IVAS 2026 was made possible thanks to significant financial support from local institutional partners, private companies, and wine partners from Bourgogne and Jura. We would like to express our sincere gratitude to all of them.

This congress is a truly collaborative effort, and as such, we would like to thank all the members of both the IVAS and the WAC Scientific Committees who did a rigorous work of reviewing the poster and presentation proposals compiled in this Book of Abstracts. Last but not least, our warmest thanks go to all the teams at the Institut Universitaire de la Vigne et du Vin – Jules Guyot, the UNESCO Chair “Culture et Traditions Vitivinicoles”, and the GIP Bourgogne Jura Vigne et Vin, at the Université Bourgogne Europe, as well as the technical, administrative, and teaching staff who, through their dynamism and strong commitment, contributed to the extensive preparation of this event. We hope that you will enjoy the WAC-IVAS 2026 event.

Régis Gougeon and Maria Nikolantonaki, Coordinators of WAC-IVAS 2026

Welcome

Welcome to WAC-IVAS 2026, which is the 14th edition of In Vino Analytica Scientia (IVAS) held in partnership with Wine Active Compounds (6th edition).

The IVAS portion of this conference provides a forum for researchers to present advanced research on the analytical science of grapes, wine, and spirits. For almost 30 years, IVAS has enabled us to convene, share knowledge and forge connections, and now in 2026, we attend the first IVAS meeting in Dijon, France.

We are grateful for the opportunity to partner with the Wine Active Compounds conference in 2026. As a results the presentations will be covered by seven themes:

1. Chemical reactions in wine.
2. Chemical analysis of grapes, wines, spirits and by-products.
3. Nontargeted analysis and chemometrics.
4. Biotechnology, microbiology and genetic approaches towards better grape and wine quality.
5. Sensory analysis, wine styles and consumer preferences
6. Wine and health.
7. Innovations in viticulture and enology in the face of societal challenges, environmental challenges, economic challenges

The first four themes are traditional IVAS sessions, the latter two themes stem from WAC while theme 5 (dealing with sensory analysis) fuses together the WAC and IVAS sessions. The result is the opportunity to combine pure analytical science of grapes, wine and spirits, with more applied viticulture and oenology, and social sciences. The scientific proceedings will commence with Prof. Corinna Dawid's opening plenary lecture, and will be followed by no less than eighty two oral presentations over the five days. Attendees will also be able to explore numerous posters and to engage with the associated authors.

On behalf of the IVAS Scientific Committee, we extend our gratitude to the Local Organising Committee, led by Prof Régis Gougeon and Prof Maria Nikolantonaki. We certainly have an exciting week ahead of us whereby we can gain insight into cutting-edge research whilst sampling the prestigious wines of Burgundy and visiting some of the regions famous wineries.

We hope you have a great time and look forward to meeting you at WAC-IVAS 2026!

Prof. Andrew Clark
Conference President

Prof. Chantal Maury
Chair of the Scientific Committee

Committees

IVAS Scientific Committee

Andrew CLARK – President - Professor of Wine Science at Charles Sturt University, The Gulbali Institute.

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Panagiotis ARAPITSA - Researcher, Fondazione Edmund Mach

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Aurélie ROLAND - Associate Professor in Enology and Biochemistry of Aroma Compounds

Joana AMARAL - Professor at Department of Chemical and Biological Technology of the Polytechnic Institute of Bragança, Research member of the Mountain Research Center (CIMO) and Chair of the Food Chemistry Division (FCD) of the EuChemS

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Luciano MAFFI - Associate Professor at the Department of Economics and Business of the University of Parma

Gilles de REVEL - Professor of Enology at the University of Bordeaux and a researcher at the Enology Unit of the Institute of Vine and Wine Sciences (ISVV)

Markus RIENTH - professor of viticulture at the University of Viticulture and Oenology in Changins, part of the HES-SO (University of Applied Sciences Western Switzerland)

Chloé ROULLIER-GALL - Associate Professor at the University of Burgundy Europe (UMR PAM – Institut Universitaire de la Vigne et du Vin)

Celestino SANTOS-BUELGA - Associate Professor at the University of Burgundy Europe (UMR PAM – Institut Universitaire de la Vigne et du Vin)

Cédric SAUCIER - Professor at the University of Montpellier

Elizabeth TOMASINO - Dr. Elizabeth Tomasino is a Professor of enology at Oregon State University and a core member of the Oregon Wine Research Institute.

Raphaëlle TOURDOT-MARECHAL - Professor in Microbiology/Oenology at University Bourgogne Europe - University Institute of Vine and Wine (IUVV)

Organizing Committee

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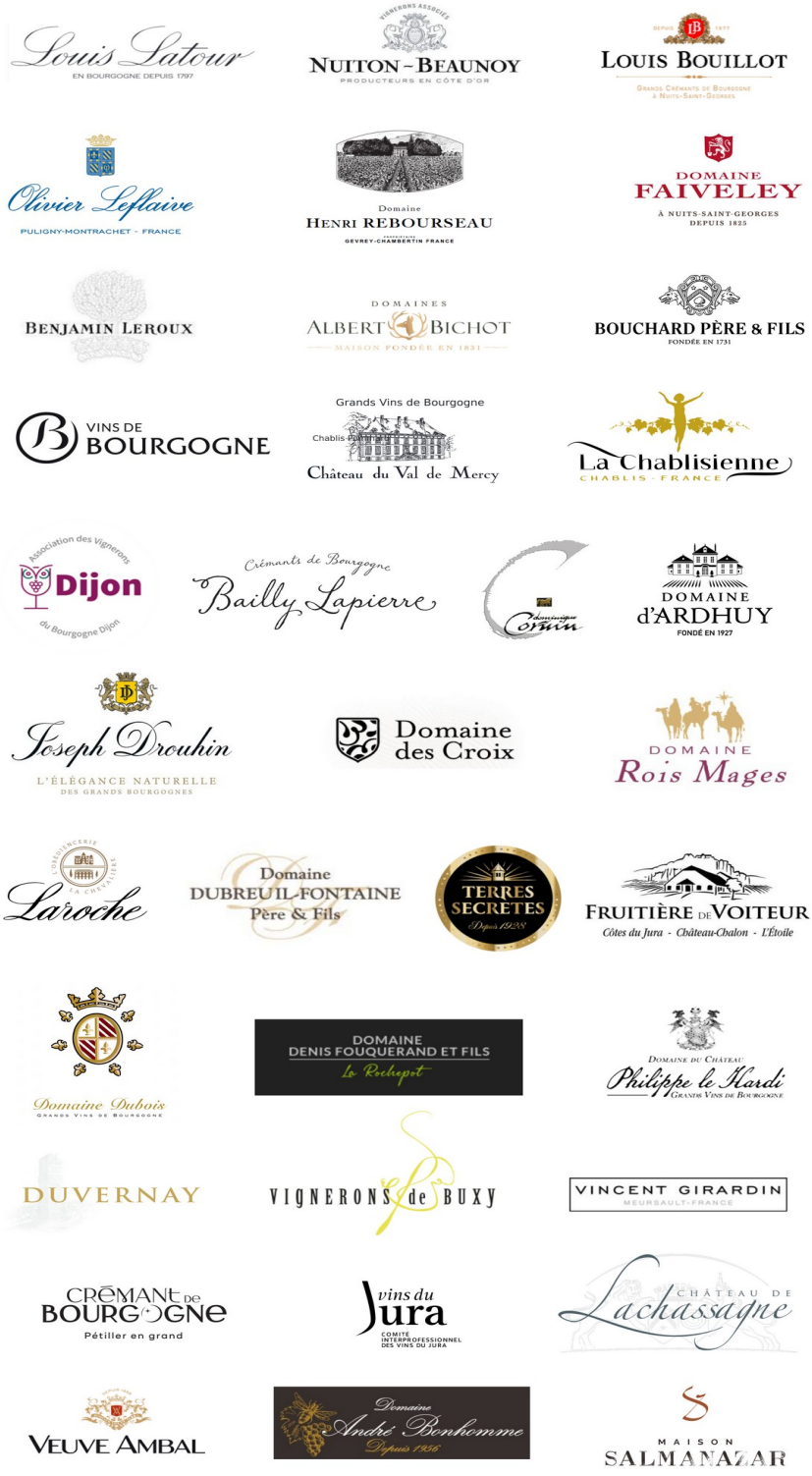

Program

Programme at a glance

WAC – IVAS 2026 · Dijon · 29 June – 3 July 2026

Monday June 29th, 2026

13.00 WELCOME, COFFEE, REGISTRATIONS, MOUNTING POSTERS

13.45 OFFICIAL OPENING OF THE CONFERENCE

14.30 Opening Plenary Lecture
Prof. Corinna DAWID, Technical University of Munich, Germany
Molecularization of the taste space of wine

SESSION I – Chemical reactions in wine (stability, aroma, aging…)
Chairs: Andrew Clark, Maria Nikolantonaki

15.15 Keynote
David JEFFERY, The University of Adelaide, Australia
Adventures with polyfunctional thiols: Biogenesis, reactivity, and chirality

15.45 Oral communication 1
Emilie Suhas, Identification, distribution and sensory contribution of (R/S)-abhexone enantiomers to the aroma of old red wines

16.00 Oral communication 2
Peggy Rigou, Molecular insights into the interactions between wine aroma compounds and soluble fractions of specific yeast derivatives: A spectroscopic study

16.15 Pause, poster session

SESSION I – following
Chairs: Aurélie Roland, Cédric Saucier

16.45 Oral communication 3
Gael Boulot, Blue-light photooxidation as a novel radical initiation method for EPR assessment of white wine oxidative stability

17.00 Oral communication 4
Leonardo Vanzo, Seeing through the glass: Through-bottle VIS-NIR screening for the real-time detection of light exposure in bottled rosé wines

17.15 Oral communication 5
Emilie Paudois, New insights on acescence in sweet wines: first evidence of ethyl acetate formation during bottle aging by isotopic filiation

17.30 Oral communication 6
Céline Poncet-Legrand, Polysaccharide structure of mannoproteins determines their functional interaction with grape seed tannins

17.45 Short oral communication 1
Mariona Gil i Cortiella, Protective colloids in traditional-method sparkling wines: effects on chemical composition, sensory properties, and tartrate stability

17.52 Short oral communication 2
Songyu Liu, Impact of co- and sequential inoculation of *Saccharomyces cerevisiae* and lactic acid bacteria on the aroma profile of New Zealand Pinot noir wines

17.59 Short oral communication 3
Danielle J. Fox, Glutathione addition alters tannin composition and astringency of Petite Verdot wines

18.06 Short oral communication 4
Julie Chanut, Oxygen transfer and reactivity in a corked bottle during storage

18.13 Short oral communication 5
Xinyi Zhang, The influence of Cu fractions in wine on sulfur dioxide to oxygen consumption ratios

18.20 Closure of the day

19.00 Welcome drink / OIV

Tuesday June 30th, 2026

SESSION II – Chemical analysis of grapes, wines, spirits and by-products
Chairs: Axel Marchal, Natalia-Quijada-Morin

8.30 Keynote
Susan Ebeler, University of California, Davis, USA
Understanding Wine Flavor: Complex Interactions, Analytical Advances, Future Opportunities

9.00 Oral communication 7
Florian Kiene, Identification and sensory properties of novel 3-sulfanylhexan-1-ol esters in wine

9.15 Oral communication 8
Roberto Salvatore Di Fede, Identification and quantification of furaneol-β-glucoside by LC-MS/MS in berries and wine during ripening and winemaking

9.30 Oral communication 9
Lena Keller, From grapes to data: rapid must characterization using benchtop NMR spectroscopy

9.45 Oral communication 10
Véronique Vacchina, Multi-isotopic dilution QQQ-ICP/MS for high geographical discrimination of origin and quality assessment in wine: developing a world database and demonstration of its potential of applications

10.00 Short oral communication 6
Florian Bahut, Decoding antioxidant mechanisms in specific inactivated yeast

10.07 Short oral communication 7
Gauthier Lagarde, Understanding the occurrence and evolution of thiophenols in wine

10.15 Pause, poster session

SESSION II – following

Chairs: Chantal Maury, Raffaele Guzzon

11.00 Oral communication 11
Julie Gisquet, Expanding white wine peptide coverage through an integrated LC-MS workflow

11.15 Oral communication 12
Andre P. Kalenak, Optimization of sorbent sheet geometry for high-throughput targeted odorant analysis

11.30 Short oral communication 8
John Carlos, Peptide profiling and antioxidant capacity of white grape juice using LC-MS approach

11.37 Short oral communication 9
Francesco Maioli, Influence of berry skin cuticular wax on smoke-derived volatile phenol uptake in grapes

11.44 Short oral communication 10
Renata Villalobos Enriquez, Phenolic compounds evolution of still dry Chenin blanc wines during oak barrel aging on lees

11.51 Short oral communication 11
Marianne Gosset, AF4 – UHPLC: Two-dimensional separation of macromolecules in monovarietal white wines from south-western France

12.00 Lunch

SESSION III – **Nontargeted analysis and chemometrics**
Chairs: Panagiotis Arapitsas, Chloé Roullier-Gall

13.45 Keynote
Pietro FRANCESCHI, Fondazione Edmund Mach, Italy
Bridging the gap: Integrating advanced data science with untargeted grape metabolomics

14.15 Oral communication 13
Lantomalala Elsa Razafindrabenja, How closure oxygen permeability impacts tannin evolution in long-term aged red wines: breaking analytical barriers using UHPLC–UHRMS metabolomics and MS/MS-based molecular networking

14.30 Oral communication 14
Ignacio Arias-Pérez, Redox-dependent metabolomic signatures of red wine aging

14.45 Oral communication 15
Julie Miranda, Exploring the relationship between wine chemical composition and its permissiveness to *Brettanomyces bruxellensis* via untargeted metabolomics

15.00 Oral communication 16
Pol Gimenez-Gil, Do wine lees derived biomolecule mixtures lead to enhancing the grapevine innate immunity? A metabolomic study on *Vitis vinifera* leaves

15.15 Pause, poster session

SESSION III – following
Chairs: Silvia Rocha, Sébastien Nicolas

15.45 Oral communication 17
Belén González-Martínez, Comprehensive profiling of glycosidic aroma precursors in grapes via semi-preparative LC fractionation, GC-MS and UHPLC-MS analysis

16.00 Oral communication 18
Marie Belair, Untargeted GC-MS metabolomics to evaluate how red grape varieties and synthetic must impact volatile profiles of grape-associated fungi

16.15 Short oral communication 12
Shuyue Fan, Spectrofluorometric fingerprinting to track the evolution of red wine and model the relationship with compositional aspects

16.22 Short oral communication 13
Amaury Aumeunier, Metabolic plasticity of *Oenococcus oeni* driven by strain diversity and wine matrix composition

16.29 Short oral communication 14
D'Intino Leonardo, From vine to wine: integrating conventional and advanced analytical techniques to support breeding. A Barbera, Croatina, and Ervi pivotal study

16.36 Short oral communication 15
Yingxin Miao, Towards AI-guided process metrics with the rapid prediction of red wine mouthfeel

16.45 Closure of the day

Wednesday July 1st, 2026

SESSION IV – Biotechnology, microbiology and genetic approaches towards better grape and wine quality
Chairs: Aurélie Roland, Raffaele Guzzon

8.30 Keynote
Isabelle Masneuf-Pomarede, Bordeaux science Agro, France
Wine microbiology in a changing environment: Leveraging microbial biodiversity for biotechnological innovation

9.00 Oral communication 19
Sarah Ployon, Origin of fresh mushroom off-Flavor in grape must and wine: from linoleic acid breakdown to glycosylated compounds biosynthesis

9.15 Oral communication 20
Stéphanie Rollero, Unlocking the lipid potential of yeast derivatives

9.30 Oral communication 21

María Vázquez, Uncovering metabolic interactions between yeasts during wine alcoholic fermentation by non-targeted extracellular metabolomics

9.45 Oral communication 22
Amélie Cresson, Membrane vesicles of *Oenococcus oeni*: A tool for adaptation to wine-related stresses?

10.00 Pause, poster session

SESSION IV – following
Chairs: Ulrich Fischer, Raphaëlle Tourdot-Maréchal

11.00 Short oral communication 16
Raffaele Guzzon, Aromatic elegance in a changing climate: a three-year study on *Oenococcus oeni* variability and organic acid modulation in sparkling wine bases

11.07 Short oral communication 17
Phuti Lekokotla, Unravelling the killer activity of *Lachancea* species against the wine spoilage yeast *Brettanomyces bruxellensis*

11.14 Short oral communication 18
Scott Simonin, Exploring copper's role in metabolic modulation of *Lachancea thermotolerans* in winemaking conditions

11.21 Short oral communication 19
Julian Döbler, Impact of fermentation redox management on polyfunctional thiols in model wine

11.28 Short oral communication 20
Benoit Divol, Mitigating smoke taint in wine using microbes: a sustainable solution?

11.35 Short oral communication 21
Tania Paniagua-Martínez, *Metschnikowia pulcherrima* as a biocontrol tool for grapevine protection

11.42 Short oral communication 22
Pan Gu, Rapid Flow Cytometry Profiling of Yeast Cell-Wall Mannoproteins Across Wine Strains

11.50 Lunch

SESSION V – Sensory analysis, wine styles and consumer perceptions
Chairs: Susan Ebeler, Jordi Ballester

13.30 Keynote
Paola PIOMBINO, University of Naples Federico II, Italy
From wine styles to complexity: decoding the multisensory perception of wine through sensory diversity

14.00 Oral communication 23

Rebeca Fiedorowicz Bustos, Why wine aromas linger differently: a salivary proteome perspective on oral aroma retention

14.15 Oral communication 24
Justine Garbay, Biotechnological tools to preserve the complexity and the fruity quality of Bordeaux red wines

14.30 Oral communication 25
María Buñuel-Escudero, Evolution of Grenache wine sensory profiles across distinct climatic zones and ripening stages throughout two consecutive vintages.

14.45 Oral communication 26
Lik Xian Lim, Effects of oak aging on quality and sensory attributes of wines produced from smoke-exposed grapes

15.00 Pause, poster session

SESSION V – following
Chairs: Alvaro Peňa-Neira, Joana Amaral

15.30 Oral communication 27
Carole Honoré-Chedozeau, Diving into a glass of non-added sulphite wine: How information shapes consumer and professional acceptance?

15.45 Oral communication 28
Annegret Cantu, Sensory–chemical integration of perceived aging potential in red old vintage wines: a cross-cultural expert study

16.00 Short oral communication 23
Ulrich Fischer, Sensory differentiation among rosé wine styles using Merlot, Pinot noir and Dornfelder grapes sustained well the dealcoholization process

16.07 Short oral communication 24
Françoise Bensa, The influence of wine label visual codes on perceived quality

16.14 Short oral communication 25
Armin Schüttler, Chemosensory insights into perceived regional chardonnay typicity and its oenological and terroir drivers

16.21 Short oral communication 26
Ziyu Wei, EEG and fNIRS evidence for brain responses to three tannins: Implications for astringency surface sub-quality in red wine

16.28 Short oral communication 27
Sílvia M. Rocha, Pairing red wine and closure: a multimodal decoding of ortho and retronasal perception

16.45 Closure of the day

17.15 Meeting of the IVAS scientific committee

Thursday July 2nd, 2026

SESSION VI – Wine and health

Chairs: Régis Gougeon, Cédric Saucier

8.30 Keynote
Ray SUMANTRA, University of Cambridge, UK
Dietary bioactive compounds, healthy ageing, and cognition

9.00 Oral communication 29
Christine Lebel, How to communicate about wine in France?

9.15 Oral communication 30
Wen Ma, Oenological tannins as sulfur dioxide alternatives in white and red winemaking: Chemical, sensory, and health implications

9.30 Oral communication 31
Dominique Delmas, A grape-derived ally: how resveratrol disarms lipid-driven resistance to anticancer agents in colorectal cancer

9.45 Oral communication 32
Sándor Sipka, Antioxidant components of wines acting on human phagocytes and the proliferation of *Lactobacillus plantarum*

10.00 Pause, poster session

SESSION VI – following

Chairs: Dominique Delmas, Pablo Lacoste

10.45 Oral communication 33
Christian Chervin, Generation Z's attraction to sweetened red wines: CATA, penalty analyses and health aspects

11.00 Oral communication 34
Olivier Jacquet, The issue of sulfites in France at the beginning of the 20th century. Economic, political, and scientific origins of a unique situation between tradition and innovation

SESSION VII – Innovations in viticulture and enology in the face of societal challenges, environmental challenges, economic challenges

Chairs: Ulrich Fischer, Marielle Adrian

11.20 Oral communication 35
Rocío Gil-Muñoz, Enological impact of vineyard application of methyl jasmonate–loaded chitosan nanoparticles on ethanol reduction and wine quality preservation

11.35 Oral communication 36
Stéphane Bourque, Disinhibition of grapevine immune responses: an innovative strategy to improve plant defense inducers efficiency

11.50 Oral communication 37
Song (Sai) Yan, Evaluating the potential for particulate matter sensors to predict smoke taint risk in the vineyard

12.05 Short oral communication 28
Chen Liang, Transcriptome and metabolite profiling reveals correlation of smoke taint compounds accumulation in *Vitis vinifera* L. berries with phenylpropanoid pathway – the impact of plant growth regulators

12.12 Short oral communication 29
Vahideh RABANI, Evaluation of a novel chitosan-based defense elicitor for the reduction of fungicide and copper inputs while preserving yield, grape, and wine quality

12.20 Lunch

14.00 Departure Wine tour / City tour
17.30 Return Wine tour

19.00 GALA DINNER APERITIF
20.30 GALA DINNER

Friday July 3rd, 2026

SESSION VII – following
Chairs: Hervé Alexandre, Jorge Ricardo da Silva

9.00 Oral communication 38
Fabien Garces, Effect of common oenological treatments on grape must vitamin content and final wine volatile composition

9.15 Oral communication 39
Laura Brian, Development of a new process for wine dealcoholisation using supercritical CO2 extraction-distillation coupling

9.30 Oral communication 40
Chloé Abry, Microalgae extract in winemaking: a bio-based alternative to sulfites to fight Brettanomyces bruxellensis

9.45 Oral communication 41
Pascale Deneulin, Beyond the bottle: Consumer perceptions and systemic challenges in reusable wine packaging

10.00 Pause, poster session, congress photo

SESSION VII – following
Chairs: Chantal Maury, Régis Gougeon

10.45 Short oral communication 30
Ron Runnebaum, Selective adsorption of free volatile phenols in smoke-tainted wines

10.52 Short oral communication 31
Christian Philipp, Effects of membrane alcohol reduction on key aroma compounds, including rotundone, in austrian Grüner Veltliner

10.59 Short oral communication 32
Emma Alexandre, Preliminary study on valorizing fermentation CO_2 for ethanol removal by gas-liquid stripping

11.06 Short oral communication 33
Zoé Grolier, A novel lab-scale carbonation method for studying sparkling wines and oenological additives

11.15 Closing Keynote
Fabien GAVEAU, University Bourgogne Europe and University of Corte, France
Viticultural practice innovation in the light of history: novelties, heritages and blending of knowledge

11.50 Official closure, including poster awards and announcement of IVAS 2028 venue

12.30 Lunch boxes

Posters

(Presenter and poster title are listed below)

SESSION I – Chemical reactions in wine (stability, aroma, aging…)

P001 Alessio Altomare, Insights on colour stabilization towards yeast derivative products

P002 Azzurra Vella, Functional screening of non-Saccharomyces yeasts from grape must, manna, and honey for wine colour stability and aroma modulation

P003 Clara Cilindre, Influence of Underwater Storage Conditions on the Dissolved CO_2, Foam Properties and Color Evolution of Sparkling Wines

P004 Enrico Viola, Impact of maceration duration and microbial consortia on antioxidant capacity and colour characteristics of orange wines

P005 Fernanda Cosme, Alginic Acid as a Novel Strategy for Calcium Tartrate Stabilization in Wines

P006 Ghadi Abi Fadel, Impact of Compression on the Gas Permeability of Cork Stoppers

P007 Irene Dolce, Fermentation kinetics and copper adsorption capacity of commercial Saccharomyces and non-Saccharomyces yeasts

P008 Ignacio García-Estévez, Mapping oxidative evolution of wine polyphenols: Impact of medium composition on their oxidative degradation pathways

P009 Julie Chanut, Wine bottle overcapping wax: Is it an effective barrier to oxygen or just an aesthetic element?

P010 Céline Poncet-Legrand, Molecular insights to sorption of aroma compounds by insoluble fractions of specific yeast derivatives

P011 Leonardo Vanzo, Beyond single-marker analysis: Integrating FTIR fingerprinting for the pre-bottling assessment of light-strike susceptibility

P012 Leonardo Vanzo, Rapid prediction of free SO_2 loss in white wines using portable cyclic voltammetry

P013 Fernanda Cosme, Wine Tartaric Stabilization Treatments: Impact on Wine Quality

P014 Marco Bustamante, Enzymatic and chemical degradation kinetics in wine model solution by tyrosinase of selected phenolic compounds involved in browning

P015 Bin Tian, Wine age and style effects on polymeric phenolic profiles of Pinot noir wines

P016 Mónica Bueno, Factors Affecting Strecker Aldehyde Levels in Alcoholic Fermentation

P017 Nahikari PREVOST, Targeted and untargeted UHPLC-MS metabolomic approaches for the study of the stability of monovarietal wine samples over time

P018 Negin Seif Zadeh, Prié blanc sparkling wines from Mont Blanc: Altitude effects on the physical-chemical characteristics during second fermentation and ageing

P019 Pei Han, Determination of Chardonnay oxidative susceptibility through Strecker Aldehyde quantification and Spin-Trap/EPR spectroscopy

P020 Rebeca Fiedorowicz Bustos, Mucoadhesive properties of typical wine phenolic compounds and their capacity to modulate oral aroma retention under simulated wine tasting conditions

P021 Alberto De Iseppi, Commercial red wines under the lens: a snapshot of colloidal diversity

P022 Silvia Carlin, Impact of Closure System and Sulfur Dioxide Management on the Oxidative Evolution of Timorasso Wine

P023 Ignacio Ontañón, Metal-mediated reduction as a tool for estimating hydrogen sulfide (H_2S) and methanethiol (MeSH) precursor pools in wines

P135 Francesca Nicola, Rapid Assessment of Wine Oxidative Stability Combining Climatic Chamber Stress Tests and EPR Spectroscopy

SESSION II – Chemical analysis of grapes, wines, spirits and by-products

P024 Alice L. Dauphin, Studying the Redox State of Wines under Oxidative Processes with a Multi-Parametric Analysis

P025 Alvaro Peña-Neira, A Chemical Survey of Commercial Chilean Chardonnay Wines: Vintage-Related Variability in Phenolic, Polysaccharide and Color Composition

P026 Andriani Asproudi, Targeted and untargeted analytical approaches to distinguish barrel-aged from wines aged with alternative woods

P027 Arnaud Costis, Fate of Fresh Mushroom Off-Flavor Markers during Alcoholic Fermentation: Formation of Novel Acetylated Derivatives

P028 Francesco Maioli, Leveraging Volatile Sensing for Rapid Detection of Smoke-Derived Signatures in Grapes and Wines

P029 Catarina Cunha, Impact of spontaneous versus inoculated fermentation on the colour and phenolic profile of Nebbiolo wines from 32 vineyards

P030 Despina Lola, Modulating the chemical and sensory profile of Avgoustiatis grapes (Vitis Vinifera L.) and wines: The impact of irrigation and post-harvest dehydration under extreme Mediterranean thermal conditions

P031 Daniela Fonseca, Oenological potential of PIWI grape varieties assessed through volatile composition analysis by GC×GC-ToFMS

P032 Daniela Fracassetti, From amino acids to aroma: evaluation of grape aroma potential

P033 Denis Allieri, Impact of Ethanol Removal on Wine Composition: Nero d'Avola as Case Study

P034 D'Intino Leonardo, Beyond Oak: Impacts of Juniper versus Oak on Red-Wine Colour, Phenolic Composition, and Volatiles

P035 Paula Hoyuelos, Influence of terroir on the physicochemical and sensory composition of wines from the minority grape variety "Cenicienta" (Vitis vinifera L.) in Castilla y León (Spain)

P036 Giuseppe Mazzotti, Discovering Erbamat: characterization and oenological potential

P037 Guzmán Favre, Microwave and Submerged Cap Maceration Highlight Cultivar-Dependent Responses in Red Wine Phenolic Composition and Color

P038 Guzmán Favre, Development and Validation of a Spectrophotometric Method to Quantify Low-Molecular-Mass Flavan-3-ols in Grapes and Wines

P039 Ignacio García-Estévez, Grape pomaces from Spanish minority Vitis vinifera L. varieties as a valuable source of phenolic compounds

P040 J. Haffelder, Sustainable Strategies to Ensure Reliable Alcoholic Fermentation under Climate Change–Driven Alterations of Grape Must Composition

P041 Julia Hernandez, Developing a Green Sensory Approach to Taste Oak Ellagitannins

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Opening Plenary Lecture

Molecularization of the taste space of wine

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Keywords: aroma interactions, sensory studies, sensomics, taste

Flavor perception arises from complex interactions between volatile aroma compounds, non-volatile tastants, and the surrounding food matrix, ultimately translated into specific aroma and taste receptor responses. While the Sensomics approach has enabled the identification of key flavor compounds, their behavior within complex matrices such as wine remains insufficiently understood. In particular, interactions with macromolecular constituents can profoundly influence the release, stability, and sensory perception of flavor-active molecules. In this study, we combine advanced analytical and spectroscopic techniques, including UHPLC–MS and NMR-based interaction assays, with human sensory approaches to systematically investigate the molecular mechanisms governing flavor modulation in complex wine matrices. Using both model and real food systems, we elucidate how binding phenomena, non-covalent interactions, and matrix-driven partitioning influence volatile release and shape taste perception. By linking molecular-level interactions to sensory outcomes, this work contributes to a more predictive understanding of flavor formation and perception. The findings provide new opportunities for rational flavor design in food systems, enabling targeted modulation of sensory profiles through matrix engineering.

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Session I

Chemical reactions in wine (stability, aroma, aging…)

KS1 — Keynote

Adventures with polyfunctional thiols: Biogenesis, reactivity, and chirality

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Keywords: varietal thiol, wine aroma, analysis, stereochemistry, fermentation

Polyfunctional thiols are a class of potent odourants that contribute distinctive aromas to various wines.[1] Aside from "varietal thiols", typically associated with tropical and citrus characters, other polyfunctional thiols can impart roasted coffee, roasted nut, or struck flint characters as a result of different grape varieties and winemaking practices. Given their aroma impact, including in other foods and beverages,[2] knowledge of the formation and fate of polyfunctional thiols has received significant attention over the past two decades.[3] They are reactive compounds present at ultratrace levels and require specialised methods of analysis.[4] As an additional complexity, certain thiols exist as enantiomers that differ in odour quality and olfactory detection threshold. Stereochemistry is also an important feature of the odourless precursors found in grapes, which are transformed during fermentation under the control of various enzymes.[5,6] The liberated thiols are nucleophilic and subjected to various nonenzymatic transformations in an acidic and redox-active wine matrix, which could further modulate the sensory properties of wine.

Dedicated to understanding wine chemistry, our work has spanned from precursor identification and grape processing effects to fermentation studies, compound synthesis, and analytical method development. Investigations have focused on Sauvignon Blanc clone and region, the extent of precursor conversion, and stereochemical relationships between thiol precursors and volatile products. This includes exploring the reaction of polyfunctional thiols containing a 3-sulfanyl-1-alkanol arrangement of functional groups. Cyclisation mediated by acetaldehyde leads to oxathianes as a new class of chiral volatile sulfur compounds in wine, predominantly found in the *cis*-configuration. The work extends knowledge of the potential fate of polyfunctional thiols, which could have practical consequences for expression of wine aroma. Aspects of these "adventures" with polyfunctional thiols and precursors over almost 20 years will be presented. This will highlight the progression of a body of work dedicated to understanding the formation and modulation of these chemically interesting and sensorially important compounds in wine.

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O1 — Oral communication 1

Identification, distribution and sensory contribution of (R/S)-abhexone enantiomers to the aroma of old red wines

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Keywords: identification, abhexone, enantiomers, ageing bouquet, oxidation

The evolution of the aroma of red wines during bottle ageing is a complex phenomenon resulting from chemical changes that can, give rise to the characteristic ageing bouquet reminiscent of mint, truffle, empyreumatic or spicy notes. To the best of our knowledge, this evolution depends on intrinsic wine composition and on extrinsic storage factors, particularly the type and quality of the closure. The objective of this study was to identify markers of wine evolution in relation to bottle ageing. After 15 years of bottle storage, we analysed two samples of the same wine sealed with different stoppers that offered different sensory balances: from spicy and empyreumatic notes (low OTR 0.3 mg/year) to intense prune aromas (high OTR 4.5 mg/year). These samples were first analysed by gas chromatography coupled with olfactometry (GC-O) where an intense odorant zone (OZ) reminiscent of spicy and curry aroma was detected in low OTR wine (IRLpolar 2235, IRLnon-polar 1185) and characterized by using different analytical technics, including semi preparative HPLC fractionation combined with GC-O-MS analysis. Our analytical strategy led to identify (R/S)-5-ethyl-3-hydroxy-4-methylfuran-2(5H)-one in red wines also called (R/S)-abhexone. This chiral furanone can be found at high level in white wines, thanks to an aldol reaction involving propanal and α-ketobutyric acid. We validated a GC-MS/MS quantification method to study its distribution in different Merlot/Cabernet Sauvignon blend (n = 67). Concentrations are higher in older red wines, reaching several µg/L above the perception threshold (0.60 µg/L). Surprisingly, highest levels were not detected in oxidized red wines. Sensory analysis of increasing amounts of (R/S)-abhexone were carried out, demonstrating that it reduces the fruitiness of red wines while increasing the "spicy note" intensity. Pure abhexone enantiomers (R or S) were separated by semi preparative HPLC (chiral phase) whereas absolute configuration was determined by vibrational circular dichroism. Enantiomer distribution was evaluated by GC-MS/MS (polar pre-column and a chiral column). Analysis of red wines (n = 30) showed that (S)-abhexone was predominant (60–90 %) and the most odorous form (ten times more intense). These results improved our understanding of abhexone, an odorant marker that contributes to the sensory balance and complexity of old red wines.

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O2 — Oral communication 2

Molecular insights into the interactions between wine aroma compounds and soluble fractions of specific yeast derivatives: A spectroscopic study

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Keywords: Yeast derivatives, Aroma interactions, Fluorescence quenching, Stern-Volmer analysis, Protein binding

Yeast derivative products (YDP) are increasingly used in winemaking for their impact on sensory properties, yet their molecular interactions with wine aroma compounds remain poorly understood. This study investigated the binding mechanisms between soluble fractions of specific mannoproteins and yeast protein extracts with selected wine aroma compounds (β-damascenone, β-ionone, citral, and benzaldehyde) using fluorescence spectroscopy in model wine conditions. Soluble fractions were separated by molecular weight (< and > 10 kDa) to evaluate their specific contributions to aroma interactions. Steady-state fluorescence quenching revealed that only specific aroma compounds (β-damascenone, β-ionone, citral, benzaldehyde, and 4-ethylphenol) modified protein fluorescence, suggesting selective interactions with tryptophan residues. Stern-Volmer analysis confirmed static quenching mechanisms through complex formation, with binding constants ranging from 103 to 104 M^{-1}. Molecular weight fractionation demonstrated that the higher MW fraction (> 10 kDa) of the studied mannoproteins > 10 kDa exhibited the strongest binding affinity, while both high and low molecular weight fractions of the studied yeast protein extract showed significant interactions with tested aroma compounds. Hydrophobicity was identified as a key factor governing binding selectivity, with cyclic compounds (β-damascenone, β-ionone) showing stronger affinity than linear aldehydes. A blue shift in fluorescence emission spectra observed with β-ionone indicated specific interactions leading to increased hydrophobicity around tryptophan residues. Furthermore, ethanol concentration significantly modulated interactions with hydrophobic compounds, potentially by altering aroma solubility and protein conformation. These results provide a fundamental basis for understanding how the macromolecular composition of a yeast derivative can modulate the volatility and retention of key enological aromas.

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O3 — Oral communication 3

Blue-light photooxidation as a novel radical initiation method for EPR assessment of white wine oxidative stability

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Keywords: Electron Paramagnetic Resonance, radical chemistry, wine oxidative stability, photooxidation

Wine oxidation remains a major challenge for the wine industry, and robust tools to predict oxidative stability are still needed. Our group previously developed an EPR-based chemical oxidation assay to probe wine oxidative stability, relying on iron-catalysed Fenton initiation (Fe/H_2O_2) in the presence of the spin trap α-(4-pyridyl-N-oxide)-N-tert-butylnitrone (POBN) [1]. Oxidative reactivity is monitored through the kinetics of the POBN–1-hydroxyethyl radical adduct (POBN–1-HER), enabling discrimination of wines according to oxidative stability (2). Coupling chemically initiated EPR with LC–MS metabolomic profiling further revealed the key contribution of sulfur-containing compounds to oxidative stability, providing mechanistic markers to support interpretation of EPR responses (3,4). Here, we introduce a Fenton-free radical initiation strategy based on blue-light photooxidation at 385 nm of white wine in the presence of POBN, using an external irradiation cell followed by EPR detection. The protocol was optimized with respect to irradiation time (5, 10 and 20 minutes), irradiation power (10 to 1000 $W.m^{-2}$), and oxygen availability. Under the optimized conditions, 10 min irradiation at the selected blue-light power and a defined oxygenation state, radical formation was rapidly initiated and followed by a self-sustaining chain reaction. The resulting EPR spectrum displayed three doublets closely matching the POBN–1-HER signature obtained with chemical initiation, indicating similar radical pathways while avoiding the addition of chemical oxidants. The method was validated on 10 white wines from diverse French regions and benchmarked against our established chemical oxidation EPR assay. Photooxidation reproduced discriminating EPR responses relevant to oxidative stability classification. Overall, this work expands our EPR toolbox by establishing photooxidation as a controlled alternative to chemical initiation, while strengthening mechanistic insight into oxidative stability through complementary LC–MS profiling.

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O4 — Oral communication 4

Seeing through the glass: Through-bottle VIS-NIR screening for the real-time detection of light exposure in bottled rosé wines

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Keywords: light-strike, rosé wine, quality control, VIS-NIR spectroscopy

Ensuring the quality of rosé wine throughout the supply chain is a major challenge, as light exposure can rapidly induce the "light-strike" defect. While chemical markers can quantify the damage, their analysis is destructive and time-consuming. There is an urgent need for non-invasive diagnostic tools capable of verifying the storage history of sealed bottles, enabling quality control at every stage, from the winery to the retail shelf. This study evaluates in-bottle VIS-NIR spectroscopy (450-1050 nm) as a rapid, non-destructive tool for detecting light exposure. Thirty-six commercial rosé wines were monitored over 30 days of LED exposure (400-500 nm) or dark storage. To isolate storage-driven changes from glass-related interference, a T0-subtraction preprocessing was applied to baseline-corrected spectra. A Partial Least Squares Discriminant Analysis (PLS-DA) model was developed to classify wines based on their exposure status. Light exposure induced a distinct spectral response, characterized by decreased absorbance in the 450–500 nm region, consistent with riboflavin photodegradation. Despite the spectral interference of bottle glass and the compositional variability among 36 commercial wines, the T0-subtraction preprocessing effectively isolated light-induced changes. The PLS-DA model achieved 97.4% accuracy (training) and 98.0% (validation), with reliable classification already within 10 days of exposure. Our results demonstrate that through-bottle VIS-NIR spectroscopy is a reliable methodology for the real-time assessment of light exposure. This non-invasive screening tool could allow producers and distributors to implement proactive quality control along the entire supply chain, identifying "at-risk" lots before they reach the consumer. This approach paves the way for a new standard in shelf-life verification and brand protection for light-sensitive beverages.

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O5 — Oral communication 5

New insights on acescence in sweet wines: first evidence of ethyl acetate formation during bottle aging by isotopic filiation

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Keywords: Ethyl acetate, isotopic filiation, sweet wines, esterification

Ethyl acetate (EtOAc) is the main ester found in wines, formed primarily by yeasts during alcoholic fermentation and, to a lesser extent, by acetic bacteria contamination during barrel ageing. Its odor is characterized by solvent notes, which give wines their acescent note [1]. The concentrations measured can exceed 250 mg/L, which is higher than the detection threshold for EtOAc determined in ice wine (198 mg/L), thus altering the wine's aromatic expression [2]. Empirical observations have shown that this note, although absent at the time of bottling, frequently appears after a few years of bottle ageing. [3]. In the absence of bacterial contamination, microbial production alone cannot explain these high levels, as Saccharomyces cerevisiae generally produces no more than 50 mg/L of EtOAc during alcoholic fermentation [1]. To explain the increase in EtOAc after bottling, alternative formation pathways must be considered. The hypothesis of chemical formation of EtOAc during bottle ageing remains poorly documented and even rejected [1]. The aim of this study was to determine the origin of EtOAc formation during the bottle ageing of sweet wines. An isotopic filiation approach was used with supplementation of carbon-13-labelled acetic acid (AcOH-$^{13}C_2$) to identify a possible chemical esterification mechanism between acetic acid (AcOH) and ethanol. Two vintages were studied, with analytical monitoring over a period of one year. This experiment required the development of a specific method for quantifying AcOH and AcOH-$^{13}C_2$ by GC-MS. EtOAc and EtOAc-$^{13}C_2$ were quantified using HS-SPME-GC-MS. After four months of ageing, the formation of EtOAc-$^{13}C_2$ was observed exclusively in AcOH-$^{13}C_2$-supplemented samples, demonstrating esterification in the bottle. A Box-Behnken experimental design was used to study the influence of pH, temperature and initial AcOH concentration on the esterification reaction. The results showed that EtOAc formation was favored by a low pH, a high initial AcOH concentration and a high temperature. These results revealed a decisive role of the physicochemical conditions of wine on the kinetics of esterification in bottle. They shed new light on the origin of EtOAc in sweet wines and demonstrated a chemical pathway that was previously unexplained in the literature, opening up new perspectives for controlling the aromatic evolution of sweet wines during bottle ageing.

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O6 — Oral communication 6

Polysaccharide structure of Mannoproteins Determines Their Functional Interaction with Grape Seed Tannins

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Keywords: Mannoproteins; Isothermal Titration Calorimetry; Dynamic Light Scattering; Colloidal stability; Physico-chemical Interactions

Colloidal equilibria involving phenolic compounds are essential for the stability and sensory properties of red wines. Mannoproteins (MPs) are known to promote the colloidal stability of tannins, but the specific relationships between their polysaccharide structure and these functional properties remain poorly understood. This study explores how the structure of the polysaccharide moiety and the mannose/protein ratio impact interactions with grape seed tannins (ST) and the resulting colloidal behavior. High-molecular-weight (HMPs) and low-molecular-weight mannoproteins (LMPs) were isolated and purified from enzymatic extracts of four Saccharomyces cerevisiae strains: a reference strain (BY4742), its mutants ΔMnn4 (no mannosyl-phosphorylation) and ΔMnn2 (linear N-glycosylation backbone), and a selected wine yeast strain. Interactions between these fractions and purified grape seed tannins were characterized using Isothermal Titration Calorimetry (ITC), while the resulting colloidal aggregates were monitored over 30 days via Dynamic Light Scattering (DLS) and Nanoparticle Tracking Analysis (NTA). The results indicate that the polysaccharide-to-protein ratio significantly influences solubility in wine-like media; LMPs, with lower mannose content, showed a higher propensity for self-aggregation compared to MPs. ITC profiles revealed that all MPs, regardless of their polysaccharide structure, display similar low-affinity, non-covalent binding sites for tannins. However, DLS analyses showed that the colloidal outcomes were fraction-dependent: while LMPs induced rapid aggregation and sedimentation within 24 hours, MPs formed stable colloids whose size and concentration depended on the ST/MP ratio. Specifically, the branching degree of the polysaccharide moiety played a more critical role in solubility and stability than mannosyl-phosphorylation. These findings highlight that the structural characteristics of yeast mannoproteins are decisive factors in managing tannin-related instabilities in enology.

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Protective colloids in traditional-method sparkling wines: effects on chemical composition, sensory properties, and tartrate stability

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Keywords: tartaric acid salts, volatile compounds, soluble polysaccharides, quantitative descriptive analysis

Tartrate precipitation (potassium hydrogen tartrate, KHT, and calcium tartrate, CaT) is a major source of wine instability, particularly concerning sparkling wines, where it may induce gushing. While cold stabilization is effective, it is energy-intensive, whereas protective colloids offer a more sustainable alternative. An unstable Chilean Chardonnay base wine was divided into eighteen 10-L containers and subjected, in triplicate, to six treatments: untreated control, cold stabilization (0 °C for 7 days), carboxymethylcellulose (CMC, 7.5 g/hL), potassium polyaspartate (KPA, 10 g/hL), arabic gum (AG, 25 g/hL), and purified mannoprotein (MP, 20 g/hL). Two weeks later, sparkling wines were produced by the traditional method by adding tirage liqueur (to reach 20 g/L sugar, 2 g/hL bentonite, and ~10^6 yeast cells/mL; Lalvin EC1118™), bottled, and placed horizontally at 18–20 °C. After six months of lees aging, tartrate potential stability, general chemical composition, color, volatile profile, and sensory attributes were evaluated. Cold-treated wines exceeded the KHT instability threshold according to the mini-contact test, likely due to increased alcohol from secondary fermentation. AG and MP wines were at the threshold, whereas CMC- and KPA-treated wines were stable. Potential CaT instability [1] differed significantly ($p<0.05$) only between untreated and MP wines, which showed the lowest and highest stability, respectively. No differences were observed in main chemical parameters, although MP wines showed lower pH than AG wines ($p<0.05$). KPA wines exhibited lower lightness (L*) and higher absorbance at 420 nm, while cold-treated wines showed the lowest yellowness (b*) and absorbance at 420 nm. Thirteen of 36 volatile compounds (SPME-GC-MS) differed among treatments ($p<0.05$), with acetate esters showing the greatest variation and lowest levels in CMC wines compared with cold-treated ones. Aging-related compounds (vitispiranes) were highest in KPA and lowest in untreated wines. Sensory analysis rating 12 attributes considering visual, aromatic, and in-mouth perception revealed bakery notes ($p<0.002$), fruitiness ($p<0.013$), and aromatic intensity ($p<0.017$) as the most discriminant attributes, with MP and AG wines scoring higher for bakery notes and CMC and MP wines for fruitiness. Overall, tartrate stabilization strategies of base wine significantly influenced wine stability, volatile composition, and sensory perception of the resulting sparkling wines.

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SO2 — Short oral communication 2

Impact of Co- and Sequential Inoculation of Saccharomyces cerevisiae and Lactic Acid Bacteria on the Aroma Profile of New Zealand Pinot Noir Wines

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Keywords: Aroma, co-inoculation, lactic acid bacteria, Saccharomyces cerevisiae, sensory analysis

The use of Lactiplantibacillus plantarum as a malolactic starter in New World Pinot Noir production is a relatively recent development, and its sensory impact compared to the more established choice of Oenococcus oeni remains underexplored. This study investigates the effects of two commercial lactic acid bacteria (LAB) strains on the formation of aroma-active compounds and sensory characteristics in New Zealand Pinot Noir wines. The research compares co-inoculation and sequential inoculation of wine yeast and LAB, with samples collected at four timepoints throughout fermentation. In addition to the chemical analysis of volatile compounds, sensory evaluation was conducted using Napping and Check-All-That-Apply (CATA). Aroma evolution was found to be non-linear, with mid-fermentation representing a key transition stage in volatile evolution. Co-inoculation consistently resulted in fruitier and more floral wines, characterised by elevated levels of esters and terpenoids such as ethyl isobutyrate, ethyl phenylacetate and linalool. Sequential inoculation, by contrast, produced more developed aromatic profiles, with sensory descriptors such as butter, toast and vanilla linked to compounds like 2,3-butanedione and ethyl decanoate. Notably, wines produced under the same inoculation regime, regardless of which LAB species was used, showed highly similar chemical and sensory profiles, suggesting that species-specific effects were minimal under controlled conditions. Instead, the timing of LAB addition emerged as the dominant factor shaping aroma profiles. These findings provide practical guidance to winemakers on how the timing of bacterial inoculation affects aroma development, particularly in enhancing fruity and floral notes in Pinot Noir wines.

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SO3 — Short oral communication 3

Glutathione Addition Alters Tannin Composition and Astringency of Petite Verdot Wines

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Keywords: Procyanidin, glutathione, acetaldehyde, sulfur dioxide, tannin adducts

To understand how phenolic composition and structural modifications impact astringency, research scale (120L) Petite Verdot wines were made to allow for a full-factorial design altering pH (3.25, 3.5, 3.75, 4.0) and oxidative and reductive adjuvants (glutathione, GSH, sulfur dioxide, SO2, and acetaldehyde) in triplicate. HPLC-MS/MS (phloroglucinolysis), HPLC-QToF, and chemical assays were used to assess phenolic chemistry. Descriptive analysis was used to sensorially evaluate a sub-set of the treated wines using a trained panel. Lower pH wines had significantly less anthocyanins while having no effect on protein precipitable tannins or iron reactive phenolics. Only glutathione additions significantly reduced protein precipitable tannins, independent of pH. The oxidative or reductive adjuvants either increased (acetaldehyde) or negated (GSH, SO2) the natural progression of polymeric pigment formation. However, only sulfur dioxide was able to significantly retain the anthocyanins compared to the other treatments and control. Phloroglucinolysis of the control wines, showed the mean degree of polymerization (mDP) was significantly lower in low pH wines likely due to the labile nature of the interflavan bonds. The SO2 treated wines had significantly greater mDPs (1.4-2.3x larger) than the other treatments indicating a preservation effect. The terminal units epicatechin and catechin were impacted by pH and treatment with little to no interaction. The glutathione treated wines had lower concentrations of both terminal and extension units. Further the GSH treated wines uniquely had significantly higher percentages of catechin as terminal unit and lower percentages epicatechin as a terminal unit, which amplified at higher pH. QToF analysis of glutathione-catechin adducts showed a significant increase (29x higher) compared to the control, independent of pH. Flavan-3-ols and procyanidin dimers were only impacted by acetaldehyde treatments with inconsistent effects from pH. Multifactor analysis of sensory and chemical data revealed that the wines were primarily separated by treatment. Astringency and tannin concentration were inversely related to glutathione-treated wines. Surprisingly neither SO2, or acetaldehyde treated wines were different in astringency from the control. Aroma characteristics were only affected by the SO2 treatment, which correlated with baking spice and earthy ortho-nasal attributes.

Oxygen transfer and reactivity in a corked bottle during storage

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Keywords: Wine, Aging, Oxidation, Permeability, Cork

Oenological closures play a key role in wine aging by influencing oxygen ingress, enabling a slow oxygen supply that can favour wine maturation. This study aimed to improve understanding of oxygen transfer and reactivity mechanisms in a corked bottle of wine during bottle storage by identifying the different oxygen pathways and characterizing their kinetics from short- to long-term aging. To disentangle these mechanisms, the oxygen barrier properties of microagglomerated cork stoppers of varying lengths were investigated using a mini-bottle system over 18 months. Stoppers ranging from 6 to 42 mm were compressed into glass tubes (18.5 mm diameter, 70 mm length). The tubes were sealed under an inert argon atmosphere with a glass disc and stored either with or without 10 mL of a model wine solution to evaluate the influence of wine on oxygen transfer. Oxygen permeation was monitored by chemiluminescence during 18 months upon storage at 25 °C and 50% relative humidity. Several distinct transfer and reactivity mechanisms were revealed. The first corresponds to rapid oxygen equilibration between the gas and liquid phases of the model wine, occurring within approximately 15 days. Due to its fast kinetics, this mechanism can be neglected for long-term aging. A second mechanism involves the diffusion of oxygen initially trapped in the cork cells into the mini-bottle, resulting in a gradual oxygen increase. This process shows slow kinetics, lasting up to nine months in samples without model wine. In the presence of model wine, a decrease in oxygen concentration in the liquid phase was observed after four months, attributed to the extraction of phenolic compounds from cork and their reaction with oxygen dissolved in the wine. These processes also occurred over several months. Simultaneously, continuous oxygen permeation from the external environment through the closure system was observed, leading to a progressive long-term increase in oxygen concentration. Thus, cork closures mainly influence the oxygen concentration in the wine by initial oxygen release from the cork cells, chemical reaction of oxygen with the extracted phenolics, and long-term ingress of oxygen from the external environment. Better understanding of the kinetics of these overlapping mechanisms is essential for developing predictive models of oxygen transfer in bottled wine.

SO5 — Short oral communication 5

The influence of Cu fractions in wine on sulfur dioxide to oxygen consumption ratios

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Keywords: Cu binding profile, sulfur dioxide, oxygen, ascorbic acid

Sulfur dioxide is the most commonly used preservative for protecting wine against oxygen, whereby two molecules of total sulfur dioxide are consumed for each molecular of oxygen. Ascorbic acid can be added to white wines to assist sulfur dioxide in its antioxidant role, and can decrease the total sulfur dioxide consumed per molecule of oxygen to near 1:1. Increases in Cu concentration are well known to accelerate the reactions between oxygen and wine components, but the impact of the different Cu binding agents commonly found in wine on the total sulfur dioxide to oxygen consumption ratios is not certain. For this study, a white wine, white wine with ascorbic acid and red wine were each adjusted to three different Cu binding profiles via the addition of variable amounts of hydrogen sulfide. The Cu binding profiles of the wine were measured by bicinchonic acid that could distinguish Cu bound to either organic acids, certain thiol compounds or sulfide. After the treated wines were saturated with oxygen, the oxygen concentration, free and total sulfur dioxide and Cu binding profiles were measured periodically during storage of the wines at 17 °C. For the white wines with ascorbic acid, the rate of oxygen consumption was highly sensitive to the Cu binding profile, being accelerated by increased Cu organic acid concentrations. However, the Cu binding profile had no influence on the mole consumption ratio for total sulfur dioxide to molecular oxygen, or ascorbic acid to molecular oxygen, which was 1:1 for both sets of consumption reactions. For the red and white wines, without ascorbic acid, there was no significant difference in oxygen consumption rate or total sulfur dioxide to oxygen consumption ratios with the different Cu binding profiles. The latter consumption ratio was close to 2:1 for white wine and 1.5:1 for red wine. Therefore, the Cu binding profile did not influence the total sulfur dioxide to oxygen mole consumption ratios in any wines, and only impacted to oxygen consumption rate in white wines containing ascorbic acid.

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P001 — Poster

Insights on colour stabilization towards yeast derivative products

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Keywords: Yeast derivatives, Anthocyanin polymerization, Phenolic composition, Wine color stability

The colour stability of red wine is a desired and complex feature affected by anthocyanin structure and concentration, copigmentation phenomena, and interactions with other wine macromolecules, such as polysaccharides. The increased content of the latter compounds may help to stabilize the colour and, in this context, the use of yeast derivative products (YDPs) can represent a useful tool (1). However, the use of YDPs to modulate colour expression needs further investigations since the effect that YDPs on colour remains controversial and highly dependent to both wine and YDP. In this study, six YDPs with different physicochemical characteristics and belonging to different classes were evaluated for their impact on colour evolution and anthocyanin polymerization in two Italian red wines with relevant differences in phenolic profiles: Nebbiolo and Sangiovese wines. The wines, were supplemented with YDPs at 40 $g \cdot hL^{-1}$ and stored under accelerated aging conditions (35 ± 2 °C) for 10 weeks. Samples were collected after 3, 6 and 10 weeks and analysed for total phenolic index, anthocyanin profile and polymerization, and colour indexes. The two wines showed markedly different responses to YDP addition. In particular, a more pronounced effect was observed in Nebbiolo wine, showing higher levels of free anthocyanins and lower total polyphenols content in comparison to Sangiovese wine. One of the assayed inactivated yeasts (I1) promoted anthocyanin polymerization, leading to an increase of total polymeric pigments and colour intensity. On the contrary, mannoproteins MP4 appeared to limit the polymerization, as higher chroma and a* values and lower absorbance value at 620 nm were found. This effect could be correlated to the polysaccharide composition of YDPs; MP4 showed the major content of free polysaccharides exerting a protective effect towards monomeric anthocyanins. In contrast, little changes in polymeric pigment distribution were observed in Sangiovese wine added with YDPs. The negligible impact of YDPs can be ascribable to the higher levels of copigments already detected in Sangiovese wine. Overall, the results confirmed that YDP effects on wine colour depend strongly on the phenolic composition and on the specific properties of YDPs. Among the YDPs investigated, I1 and MP4 showed the most consistent and contrasting behaviours, highlighting the need for targeted YDP selection based on wine composition to optimize colour stabilization strategies.

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P002 — Poster

Functional screening of non-Saccharomyces yeasts from grape must, manna, and honey for wine colour stability and aroma modulation

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Keywords: non-Saccharomyces; anthocyanin adsorption; β-glucosidase activity; hydroxycinnamate decarboxylase activity

Ensuring colour stability in red wines represents a major technological and commercial challenge for the wine industry. Wine colour stability is influenced by biochemical and physical interactions between yeasts and anthocyanins during fermentation [1]. In addition to conventional fermentative traits, non-Saccharomyces yeasts may contribute to colour preservation or depletion depending on strain-specific characteristics such as anthocyanin adsorption, β-glucosidase activity [2], and hydroxycinnamate decarboxylase (HCDC) activity [3]. In this study, 163 non-Saccharomyces strains obtained from spontaneously fermenting grape must, manna, and honey were screened for oenological potential. Following a preliminary selection process based on ethanol tolerance (≥4% v/v), potassium metabisulfite resistance (100–250 mg/L), and low H2S and acetic acid production, 52 indigenous strains were retained and characterised together with five reference strains (57 strains in total). Anthocyanin adsorption was assessed on YEPD agar supplemented with grape-derived anthocyanins (pH 3.5). β-Glucosidase activity was evaluated using an esculin-glycerol agar assay (halo-based semi-quantitative classification). HCDC activity was determined on YEPD agar supplemented with p-coumaric acid. Marked strain-dependent variability was observed for all colour-related traits. Anthocyanin adsorption ranged from absent to high, with Metschnikowia pulcherrima and Hanseniaspora uvarum predominantly showing high adsorption, whereas Lachancea thermotolerans displayed mainly medium adsorption. Of the 57 strains analysed, 11 showed no detectable β-glucosidase activity, whereas most isolates exhibited medium to strong activity. HCDC activity was highly prevalent in H. uvarum, M. pulcherrima, and L. thermotolerans, whereas it was absent in Starmerella spp. and Citeromyces matritensis. The combined evaluation of adsorption and enzymatic traits emphasises the relevance of strain-level selection to balance aroma enhancement and colour preservation. Several strains, particularly within L. thermotolerans, exhibited balanced combinations of adsorption and enzymatic activities, underscoring the importance of strain-level selection for targeted red winemaking strategies aimed at enhancing colour stability and sensory complexity. These findings support targeted strain-level selection as a biotechnological approach to optimise colour preservation and aroma potential, with relevance for industrial red wine product

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P003 — Poster

Influence of Underwater Storage Conditions on the Dissolved CO_2, Foam Properties and Color Evolution of Sparkling Wines

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Keywords: Sparkling wines, underwater storage, effervescence, foam, color

Sparkling wines elaborated through the traditional method, are historically aged in thermoregulated or natural cellars, at temperatures around 13°C. This process of maturation on lees is crucial for the quality of the wines, as it modifies the chemical composition and impacts some key organoleptic properties including : effervescence, foam, color and aromatic profile. Environmental parameters such as temperature, humidity and light exposure are known to affect ageing kinetics. Interest in alternative ageing environments has emerged following the discovery of champagne bottles in a shipwreck under the Baltic Sea, in 2010[1]. Since then, several producers and researchers have explored underwater ageing, with still wines in the Mediterranean sea[2] and in the Northern Adriatic underwater springs[3].

In 2020, an original experiment was conducted with a prestigious crémant d'Alsace produced in Colmar. After a long period of ageing on lees, the wines were disgorged and the bottles were sealed with traditional cork stoppers. A total of 300 bottles were immersed underwater at a depth of 25 m in a freshwater lake (Colmar-Houssen nautical base). Another batch of bottles was stored in a traditional cellar. Every two years, bottles from both storage conditions were recovered and analysed to assess key physicochemical parameters: dissolved CO_2 content, bubbles and foam characteristics, and absorbance at 420 nm as an indicator of browning. After only two years of storage, wines aged underwater showed significantly higher dissolved CO2 content compared to cellar-stored wines, suggesting a reduced CO_2 loss under underwater conditions. After four years of storage, it seems that the underwater-stored sparkling wines had better foamability and foam stability than the wines stored in a cellar. The very different storage conditions likely influenced gas transfer and oxygen ingress through the cork stopper. Indeed, absorbance measurements at 420 nm revealed higher valuers for cellar-stored sparkling wines after four years, indicating greater oxidative evolution. These results suggest that underwater storage conditions, characterized by stable low temperatures and minimal light exposure, may slow ageing kinetics and preserve key quality attributes of sparkling wines. Further experiments are under investigation to better characterize the impact of underwater storage on the chemical profiles of these wines using metabolomic approaches.

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P004 — Poster

Impact of maceration duration and microbial consortia on antioxidant capacity and colour characteristics of orange wines

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Keywords: Orange wine, antioxidant capacity, colour, maceration, mixed fermentation

Orange wines, defined as white wines produced with prolonged skin maceration, have recently gained increasing attention due to their distinctive sensory profile and potential functional properties. The maceration process promotes the extraction of phenolic compounds from grape skins, which may influence antioxidant capacity, colour characteristics, and overall oenological features. However, the impact of maceration duration and microbial consortia, including non-Saccharomyces yeasts and lactic acid bacteria (LAB), on these parameters remains insufficiently explored. Therefore, this study aimed to investigate the antioxidant capacity and colour characteristics of white and orange wines produced under different maceration regimes and microbial inoculation strategies. Experimental trials included conventional white wines without maceration and orange wines subjected to short and long maceration periods, with or without sulphite addition. Alcoholic fermentation was conducted using Saccharomyces cerevisiae, alone or in combination with Starmerella lactis-condensi, followed in some trials by malolactic fermentation with Oenococcus oeni or Lactiplantibacillus plantarum. Antioxidant capacity was assessed using a modified DPPH assay and expressed as EC20 values [1], while colour parameters were measured using CIELab coordinates through spectrophotometric analysis. Results demonstrated that orange wines exhibited substantially higher antioxidant capacity compared to white wines, indicating up to 15-folds increase associated with skin maceration. Moreover, wines produced using mixed fermentations with non-Saccharomyces yeasts and LAB generally showed greater antioxidant capacity than those fermented with S. cerevisiae alone, suggesting a positive contribution of microbial diversity to phenolic composition and other antioxidant compounds. Colour analysis revealed significant differences between white and macerated wines, with maceration leading to decreased lightness (L*) and increased redness (a*) and chromaticity (C*), reflecting the enhanced extraction of phenolic compounds. Prolonged maceration further intensified these effects, producing darker and more intensely coloured wines. These results contribute to a better understanding of the biochemical and technological factors underlying the production of orange wines and highlight the importance of microbial selection in optimizing their functional and oenological properties.

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P005 — Poster

Alginic Acid as a Novel Strategy for Calcium Tartrate Stabilization in Wines

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Keywords: Calcium tartrate instability; Alginic acid; Sodium carboxymethylcellulose; Potassium polyaspartate; Cold stabilization

Calcium tartrate (CaT) instability is an increasingly relevant issue in bottled wines, mainly due to increasing calcium concentrations associated with climate change and certain winemaking practices. Unlike potassium hydrogen tartrate instability (KHT), CaT precipitation is a slow and difficult-to-predict phenomenon that often occurs after bottling and is not effectively prevented by traditional cold stabilization. Therefore, identifying new stabilizing agents is of significant interest. This study evaluated, the potential use of alginic acid as a new stabilizer to prevent CaT precipitation in wines, and its performance was compared with authorized stabilizers such as carboxymethylcellulose (CMC) and potassium polyaspartate [1]. The effectiveness of these additives was assessed by monitoring calcium tartrate precipitation through induced nucleation methods and by measuring changes in calcium concentration after treatment [2]. Alginic acid showed a better calcium stabilizer capacity compared with CMC, leading to a greater reduction in CaT precipitation and shifting most of the tested wines into the stability zone. Although the higher applied dose of alginic acid (300 mg/L) relative to CMC (200 mg/L) may have contributed to this effect, its enhanced performance is likely related to its strong anionic character, higher charge density, and pronounced affinity for calcium ions. These properties promote calcium complexation and reduce supersaturation. Contrary to previous concerns, potassium polyaspartate did not increase CaT instability in either stable or unstable wines. Instead, it showed a stabilizing performance comparable to that of CMC. These findings suggest that alginic acid represents a promising clean-label alternative for CaT stabilization, particularly given its regulatory authorization as a processing aid in winemaking. However, the results reflect only short-term stabilization effects. Further research is required to assess its long-term stabilization capacity, optimize application doses according to the initial level of instability, and evaluate potential impacts on the sensory characteristics of treated wines [3]. Funding: Project Vine&Wine Portugal—Driving Sustainable Growth Through Smart Innovation, Application n. ° C644866286-00000011, co-financed in the scope of the Mobilizing Agendas for Business Innovation, under Reg. (EU) 2021/241, in the Plano de Recuperação e Resiliência (PRR) to Portugal, na sua componente 5 - Capitalização e Inovação

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P006 — Poster

Impact of Compression on the Gas Permeability of Cork Stoppers

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Keywords: Wine, cork, ageing, compression, gas diffusion

Oenological closures play a crucial role in the preservation and evolution of still and sparkling wines in bottle. Approximately 21 billion stoppers are produced annually for the global wine industry with 13 billion being cork-based, originating from the bark of cork oak tree (Quercus suber L.). In fact, a gradual and minimal entry of oxygen and conservation of effervescence in the case of sparkling beverages play an essential role in wine ageing. Therefore, the mechanical reliability of these stoppers is not simply a matter of tradition or appearance, but a crucial factor in maintaining wine stability and supporting proper ageing. Cork stoppers are compressed to seal both still and sparkling wines. However, the exact relationship between the level of compression and the resulting gas barrier efficiency is not yet fully understood. For still wines, stoppers typically undergo a 23% diameter compression (40% volume), while sparkling wine stoppers reach a 40% diameter compression (70% volume). Current research indicates that for still wines, these compression levels have little impact on oxygen transfer. However, the much higher compression used for sparkling wines may play a more significant role in gas barrier efficiency and wine preservation. This study examines the gas permeability of still and sparkling cork stoppers at diameter compression levels ranging from 0% to 40% of their original size, aiming to characterize the relationship between deformation and the resulting gas barrier performance to establish the compression level at which the gas transfer rate (GTR) becomes stable enough for wine preservation. Using a manometric gas permeability device developed in-house, GTR measurements were conducted on stoppers to determine their intrinsic material permeability according to the compression level and subsequently within glass bottlenecks to evaluate the specific contribution of the cork-glass interface.[1] This research distinguishes between the permeability of the cork itself and the quality of the cork-glass interface. These findings help define the optimal compression needed to protect wine quality. This study offers a scientific basis for improving current bottling practices and understanding how cork performs under pressure.

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P007 — Poster

Fermentation kinetics and copper adsorption capacity of commercial Saccharomyces and non-Saccharomyces yeasts

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Keywords: copper removal; wine fermentation; biotechnological sustainability; copper stress

The extensive utilisation of copper-based fungicides in viticulture has resulted in the progressive accumulation of copper in vineyard soils and grape, and, consequently in must, raising concerns about its impact on yeast performance, fermentation efficiency, wine quality, and consumer safety. Substantial copper concentrations can inhibit yeast metabolism and modify fermentation kinetics, thereby potentially impacting the sensory profile of wine. The selection of yeast strains capable of adsorbing copper represents a sustainable biotechnological alternative to conventional chemical approaches. This study evaluated the fermentation performance and copper removal capacity of 15 commercial yeast strains, in addition to two control strains with known high and low copper adsorption capacities. The microbiological dynamics of Saccharomyces and non-Saccharomyces populations were monitored by plate counts. Fermentation trials were conducted in a modified YPD medium containing 30 ppm of $CuSO_4 \cdot 5H_2O$ and in grape musts supplemented with the same concentration for microfermentations. Growth behaviour, lag phase duration, and fermentation vigour were evaluated through the analysis of growth curves and CO_2 related weight loss measurements. During the initial phases of fermentation (24, 48 and 72 hours), the different strains exhibited distinct growth kinetics, with development profiles that were, in general, consistent with the inoculation concentration. In other cases, microbial counts increased progressively to 7.5–8.0 Log CFU/mL. Growth in modified YPD exhibited various adaptation patterns: some strains rapidly entered the log phase (10–13 h), whereas others showed an extended lag phase (20–27 h) before initiating robust growth. Fermentation progress, measured via CO_2 weight loss, revealed notable differences in both lag and log phases among the strains. The release of CO_2 within the first 48 hours of fermentation was shown to be a reliable predictor of the final fermentation vigour. ICP-OES quantification of residual copper showed a significant decrease from the initial concentration, with most samples reaching low final levels. Even if copper removal efficiency was strain-dependent, all strains demonstrated tolerance to high copper concentrations adopted, maintained active fermentation and significantly decreased residual copper. These finding confirm their potential for robust and sustainable applications in industrial-scale fermentation processes.

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P008 — Poster

Mapping oxidative evolution of wine polyphenols: Impact of medium composition on their oxidative degradation pathways

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Keywords: wine oxidation; oxidative degradation; degradation products; polyphenol degradation

Wine matrix is a complex and continuously evolving medium. The impact of oxygen in wine evolution is a vital factor that critically affects key organoleptic properties such as color or astringency. Moreover, the rising demand for low-alcohol and dealcoholized wines poses an additional challenge due to their heightened susceptibility to oxidation. This work studied the different oxidative pathways of polyphenols and the impact of ethanol on their oxidation. Given that wine characteristics are directly linked to polyphenol evolution, characterizing the different routes that polyphenols can undergo when exposed to oxygenation can provide a deeper understanding of oxygen management within the new trends in winemaking. For this purpose, different solutions containing anthocyanins, flavan-3-ols and/or phenolic acids were prepared to mimic wine-like conditions (5 g/L tartaric acid, 4 mg/L FeCl3, 0.4 mg/L CuSO4; pH = 3.6), varying ethanol percentage (0 – 13%), and polyphenol content and profile. Then, they were subjected to periodic oxygenation ensuring oxygen saturation with an optical oxygen probe. The evolution of phenolic compounds and the formation of degradation products were monitored over two months by means of HPLC-DAD-MS. For each family of compounds, different transformation pathways were identified. On the one hand, polymerization occurred in both anthocyanins and flavan-3-ols, with the formation of polymeric pigments or flavanols with higher polymerization degree (including A-type dimers). On the other hand, all compounds underwent oxidative degradation, especially in the absence of ethanol, identifying quinone species as well as degradation products such as hydroxybenzoic acids and aldehydes, catechol derivatives and chalcones. Furthermore, oxidation-related pigments appeared in the oxygenated solutions containing anthocyanins (vitisins, direct and acetaldehyde-mediated condensates in the presence of ethanol) and flavanols (xanthylium cations and related compounds). Overall, the results show that matrix composition, particularly ethanol content and phenolic profile, fundamentally dictates the oxidative evolutionary pathways of the compounds. Thus, the characterization of these oxidation-derived species could serve as a valuable tool to monitor oxidation in different wine matrices, from traditional white, red or rosé wines to the emerging category of low alcohol or dealcoholized wines.

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P009 — Poster

Wine bottle overcapping wax: Is it an effective barrier to oxygen or just an aesthetic element?

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Keywords: Overcapping wax, Cork stoppers, Oxygen transfer, Aging

The use of waxes and resins to seal wine bottles dates back several millennia, as shown by archaeological evidence. In modern winemaking, wax overcapping is still practiced for aesthetic, branding, or perceived bottle sealing benefits. However, the effectiveness of wax overcapping as an oxygen barrier has received limited scientific attention. This study aimed to evaluate the oxygen barrier performance of wax overcapping, alone and in combination with cork-based stoppers, under controlled storage conditions (25 °C, 50% RH). The first part of the study focused on processing conditions, particularly bottleneck temperature during wax application. Glass–wax adhesion was assessed via extraction force measurements, while oxygen barrier performance was evaluated through one-year oxygen permeation analysis using a chemiluminescence method. Preheating bottlenecks to 60 °C or 70 °C before applying wax at 120 °C significantly increased maximum extraction forces, indicating improved wax–glass adhesion. This enhanced adhesion was associated to low oxygen transmission rates (OTRs), comparable to those of the wax material itself. These results demonstrate that higher bottleneck temperatures during application improve adhesion and further limit oxygen transfer at the wax–glass interface. After optimizing wax deposition, oxygen transfer was monitored over one year in bottles sealed with natural and microagglomerated cork stoppers, with and without wax overcapping. Some stoppers were left without surface treatment to simulate leakage with high oxygen transfer occurring at the glass–cork interface. Corks were inserted 3.5 mm below the bottleneck, and wax was applied forming a solidified layer. For surface-treated corks, wax application was delayed by one month to avoid deformation due to cork outgassing. Untreated corks were waxed immediately after insertion. Results showed that wax effectiveness depends on the intrinsic oxygen barrier properties of both the wax and the stopper. For the low-permeability blend wax studied, barrier performance was similar to that of microagglomerated stoppers, indicating a mainly aesthetic role. For natural corks, material variability made it difficult to assess the wax contribution. In worst-case conditions, with untreated corks, wax could prevent gas leakage at the glass–cork interface, but only when applied immediately after insertion, a condition practically achievable only after pressure equilibration, typically after at least one month.

P010 — Poster

Molecular insights to sorption of aroma compounds by insoluble fractions of specific yeast derivatives.

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Keywords: yeast derivatives, adsorption isotherm models, wine chemistry modelling, aroma interactions, wines

Aroma compounds are critical for wine sensory quality, yet their concentration and expression can be altered during winemaking and aging by sorption onto solid surfaces such as oak wood, yeast lees, or yeast derivatives (1-3). While sorption by yeast cell walls is well documented, comparative quantitative studies on different yeast derivative products (SYD) insoluble fractions remain scarce, particularly regarding the influence of surface properties and the sorption reversibility (2; 4-5). This study characterized the sorption of various aroma families by three insoluble fractions of SYDs in a model wine system. Sorption kinetics and isotherms were established and modeled using classical approaches to gain insight into potential interaction mechanisms. The effects of polyphenols and ethanol were also investigated, alongside correlations between aroma physicochemical parameters and surface properties of the SYDs. Finally, desorption experiments evaluated the reversibility of these interactions under varying matrix conditions. For the first time, the sorption capacities of different insoluble fractions of SYDs were quantified and compared, following the order: protein extract (ifPE)> inactivated yeast (ifIY) > cell walls (ifCW). These differences were linked to surface properties, particularly electron donor and acceptor characteristics. Aroma adsorption by insoluble fractions was successfully described using different isotherm models. The Henry model provided the best fit for ifPE indicating linear, non saturable interactions governed by non covalent forces while the Freundlich model adequately described adsorption, particularly for ifIY and ifCW, suggesting heterogeneous adsorption sites and potential interactions between aroma molecules. Although hydrophobicity generally correlated with adsorption, we showed that additional physicochemical parameters played significant roles and boiling point emerged as the most influential factor. Polyphenols were also shown to reduce aroma adsorption, either by directly interacting with aroma compounds or by competing for adsorption sites. Overall, modelling proved valuable for understanding adsorption mechanisms and the results highlight the importance of selecting appropriate SYDs according to the wine matrix and the targeted aroma compounds.

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P011 — Poster

Beyond single-marker analysis: Integrating FTIR fingerprinting for the pre-bottling assessment of light-strike susceptibility

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Keywords: Light-strike, Methanethiol, Rosé wine, FTIR, Predictive model

Light-strike susceptibility varies widely among rosé wines, yet predictive tools for pre-bottling risk assessment remain inadequate. While the photo-sensitizing role of riboflavin and the precursor function of methionine are well-established, quantification of individual markers often fails to capture the complexity of wine matrix interactions. This study aimed to develop robust models to estimate methanethiol (MetSH) formation by integrating routine enological parameters with FTIR spectroscopy. Thirty-six commercial Chiaretto di Bardolino wines (2023 vintage) were collected at the bottling line. Initial composition was characterized by routine assays, HPLC (riboflavin), LC-MS (methionine), and SPME-GC-MS (VSCs). FTIR spectra (900–3000 cm^{-1}) were acquired to provide a holistic fingerprint of the wine matrix. After anoxic stabilization, aliquots were exposed to LED light (400–500 nm) for 30 days at 20 °C. To mitigate the risk of overfitting inherent to high-dimensional spectral data, predictive modeling was performed using Ridge regression coupled with bootstrap selection (2000 iterations), ensuring the identification of stable and generalizable predictors. All wines accumulated MetSH upon exposure, but with a striking 5-fold range in net production (1.9-10.6 µg/L). A chemistry-only model R2=0.65 (LOOCV) identified key drivers including riboflavin, methionine, and total acidity (positive coefficients), and free/total SO2 (negative). Integrating FTIR second-derivative features significantly improved the prediction R2 = 0.72 (LOOCV), with selected regions (O-H/N-H stretching, C-O vibrations) likely capturing the "compositional buffering capacity" and antioxidant network of the wine. Notably, a simplified model, independent of HPLC/LC-MS data, maintained similar performances R2 = 0.67 (LOOCV) using only routine winery parameters and FTIR spectra. These results demonstrate that light-strike risk is a matrix-dependent property that can be effectively modeled. This approach provides a practical, non-destructive screening tool for immediate winery implementation, enabling producers to make evidence-based decisions on glass color, SO2 management, and shelf-life strategies before the wine leaves the cellar.

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P012 — Poster

Rapid prediction of free SO_2 loss in white wines using portable cyclic voltammetry

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Keywords: Cyclic voltammetry, SO2 management, white wine oxidation, predictive model

Sulfur dioxide management in white wines remains largely empirical, often relying on uniform dosing rather than the actual oxidative requirements of the matrix. The key challenge for winemakers is predicting how much SO_2 will be depleted following oxygen exposure, as this consumption is highly wine-specific. Currently, quantifying this "antioxidant demand" requires time-consuming oxidation trials that are incompatible with fast-paced winery workflows. This study presents a rapid, data-driven approach to predict SO_2 depletion using electrochemical fingerprints. A calibration set of 31 commercial Lugana white wines was subjected to a standardized oxidative challenge (5.0 ± 0.5 mg/L O_2 uptake at 20°C). Cyclic voltammetry on disposable carbon electrodes (reference electrode Ag/AgCl, 0–1200 mV) was used to capture the redox profile of each wine. These voltammetric signals were integrated with integrated with readily available enological parameters into a non-linear model designed to estimate the final free SO_2 concentration after oxidation. The results confirmed high variability in SO_2 consumption among wines, even at identical oxygen uptake levels. The developed model effectively translated the electrochemical fingerprint into actionable estimates of SO_2 loss. Model robustness was verified by leave-one-out cross-validation (RMSE = 3.23 mg/L) and confirmed on an independent set of 40 wines, including samples from a different variety (RMSE = 3.26 mg/L) providing a fast and easy to use tool for quality control. This methodology converts a rapid measurement into a quantitative assessment of SO_2 resilience. By enabling lot-specific antioxidant additions, the tool supports the reduction of unnecessary SO_2 inputs while helping ensure that each wine retains sufficient protection. These results suggest that electrochemical profiling could complement traditional methods for SO_2 optimization.

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P013 — Poster

Wine Tartaric Stabilization Treatments: Impact on Wine Quality

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Keywords: Tartaric stability; Cold stabilization; Sodium carboxymethylcellulose; Metatartaric acid; Quality

During winemaking and aging, potassium hydrogen tartrate (KHT) and, to a lesser extent, calcium tartrate (CaT) crystals can precipitate, especially when grape must or wine is exposed to low temperatures [1]. However, these precipitations can also occur in bottled wines. Although, these precipitations are natural and harmless, there presence can negatively impact wine marketability, as consumers often associate these visible deposits with microbiological spoilage, sugar crystals, chemical additives, or even glass fragments, which may lead to purchase rejection [2–4]. To avoid this problem, several physical and chemical stabilization techniques have been developed. Current approaches include subtractive techniques, which remove potassium and calcium ions (cold stabilization, electrodialysis, and ion exchange resins), and additive methods, which involve adding protective colloids (metatartaric acid, sodium carboxymethylcellulose, mannoproteins, and potassium polyaspartate) to prevent or delay crystallization [5]. Cold stabilization remains the most widely used technique; it promotes tartrate precipitation at low-temperature, thereby eliminating the concentration of ions responsible for instability. Alternatively, oenological stabilizers with a protective colloidal effect can be used to inhibit nucleation and crystal growth. Among the stabilizers most used by the wine industry are sodium carboxymethylcellulose (CMC) and metatartaric acid. This study aimed to compare the effects of cold stabilization, CMC, and metatartaric acid on the chemical composition of white, rosé, and red wines. The results showed that cold stabilization significantly impacted the wine volatilome, especially in white and rosé wines, leading to a decrease in total alcohols and an increase in total esters. It also reduced the colour intensity of rosé and red wines by lowering the concentration of monomeric anthocyanins. In contrast, the oenological stabilizers had minimal impact on phenolic composition, chromatic characteristics, and the volatilome. The sensory impact of cold stabilization appears to be complex; while it can potentially enhance the aromatic profile of white and rosé wines by increasing ester volatile organic compounds (VOCs) and decreasing higher alcohols, it can negatively affect the color of rosé and red wines [6].
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P014 — Poster

Enzymatic and chemical degradation kinetics in wine model solution by tyrosinase of selected phenolic compounds involved in browning

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Keywords: tyrosinase, phenolic compounds, degradation, browning

Hydroxycinnamic and hydroxybenzoic acids are phenolic compounds that, upon oxidation, significantly contribute to browning, thereby impairing the organoleptic quality of musts and white wines [1]. This phenomenon is enhanced by the activity of tyrosinase, an endogenous phenol oxidase enzyme in grape berries [2]. The aim of the present study was to evaluate the kinetics of enzymatic and non-enzymatic degradation, as well as the development of browning, in a total of 17 phenolic compounds. Hydroxycinnamic acids exhibited a higher susceptibility to degradation and browning reactions, whereas hydroxybenzoic acids and phenol-derived compounds showed limited reactivity toward tyrosinase. The nature and number of substituents on the aromatic ring were key determinants of reaction rates; in particular, the simultaneous presence of hydroxyl and methoxy groups promoted enzymatic degradation. However, browning did not show a direct correlation with the degradation rate of phenolic compounds. Moreover, a decrease in browning was observed in all compounds one hour after the onset of the reaction, which was attributed to the precipitation of oxidation products, such as polymers or melanin-like compounds. Overall, the structural features of phenolic compounds proved to be reliable predictors of both browning intensity and degradation kinetics.

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P015 — Poster

Wine age and style effects on polymeric phenolic profiles of Pinot noir wines

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Keywords: pigments, Pinot noir, polymeric phenolics, wine ageing, wine style

This study investigated the relative influence of wine age and wine style on tannin composition and polymeric phenolic profiles in commercial Pinot noir wines from a major New Zealand producer. Building on our previous work on the same set of 22 wines, which primarily examined colour properties and their evolution during ageing [1], the present study extends this framework to focus on the structural composition of tannins and polymeric pigments. Polymeric phenolics are formed through reactions among tannins (T), anthocyanins (A), and flavan-3-ols (F), and their distributions are known to change substantially during wine ageing, with important implications for colour stability and mouthfeel development. Wine age exerted a dominant effect on polymeric phenolic composition. Progressive ageing was associated with substantial decreases in tannin yield (from 56% to 9.7%), mean degree of polymerisation (mDP, from 4.0 to 2.0), and the relative abundance of coloured T–A type pigments (from 73.6% to 17.5%) and colourless A–T type pigments (from 18.3% to 0.1%). In contrast, ageing led to marked increases in seed-derived epicatechin gallate subunits (from 0.12% to 3.72%), skin-derived epigallocatechin subunits (from 6.08% to 20.61%), and A-type polymeric pigments overall (from 17.73% to 82.42%). Notably, progressive accumulation of several A-type hybrid structures, including A–F (A type)–T, T–F–A–F (A type), and T–A–F (A type)–F adducts, was observed across wine age, providing new insights into polymeric pigment evolution in Pinot noir wines. By comparison, wine style showed a comparatively limited influence and significantly affected only T–A–F (A type)–F adducts, with Super Premium wines displaying the highest proportions. These results demonstrate that wine age is the primary driver of structural changes in polymeric phenolics in Pinot noir, while wine style plays a secondary role. The findings contribute to a more detailed understanding of phenolic evolution during Pinot noir wine ageing and have implications for managing long-term colour and mouthfeel development.

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P016 — Poster

Factors Affecting Strecker Aldehyde Levels in Alcoholic Fermentation

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Keywords: Strecker aldehydes, alcoholic fermentation, sulfur dioxide, yeast metabolism

Strecker aldehydes (SAs) are volatile compounds that significantly influence wine aroma and quality, contributing notes such as “cooked vegetable” (methional), “honey” (phenylacetaldehyde), and “malt” (2-methylpropanal, 2-methylbutanal, 3methylbutanal). Although traditionally linked to oxidative faults, recent evidence suggests that alcoholic fermentation itself can be a relevant source of SAs [1]. During fermentation, amino acids are metabolized via the Ehrlich pathway, generating aldehyde intermediates that are usually reduced to alcohols. However, incomplete reduction can occur [2-3], particularly in the presence of sulfite or polyphenols [4], leading to residual SAs that may bind SO_2 as reversible adducts, potentially affecting aroma during aging [5]. This study evaluates the formation and accumulation of SAs under different fermentation conditions through five independent experiments. Three experiments used synthetic musts to investigate the effects of yeast strain, Zn^{2+} concentration, and SO_2 levels. A fourth experiment examined SO_2 interactions in polyphenol-enriched media, while the fifth monitored SAs in industrial fermentations. Results confirm that SAs are naturally produced during alcoholic fermentation and are predominantly present as SO_2-bound adducts. Their accumulation strongly depends on yeast-mediated sulfite metabolism and the availability of SO_2 during the Ehrlich pathway. Temporal formation patterns varied by compound and batch: 2-methylbutanal was produced in parallel with SO_2 and hence acetaldehyde, whereas phenylacetaldehyde and methional formed earlier. Methional accumulation also showed strain-specific differences. Although yeast strain strongly influenced SO_2 metabolism and aldehyde quenching, final concentrations of most SAs were only weakly strain-dependent, and the impact of added SO_2 varied by compound, being negligible for methional. These findings demonstrate that wine shelf life may already be compromised during alcoholic fermentation, as shown by analyses in real musts and wines, and highlight the need to restructure fermentation practices to minimize Strecker aldehyde formation.

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P017 — Poster

Targeted and untargeted UHPLC-MS metabolomic approaches for the study of the stability of monovarietal wine samples over time.

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Keywords: Stability, Temperature, UHPLC-HRMS/MS, wine

Metabolomics approaches are highly suitable for studying complex topics in wine traceability, the effects of global warming on wine components, the development of new resistant grape varieties, and the relationships between composition and wine quality traits. However, because the wine matrix is constantly evolving, a major concern in wine metabolomics studies is how to preserve samples before analysis [1]. This concern is particularly important in collaborative metabolomics studies using different platforms. For two years, our laboratory has been analysing the effects of storing wine samples at different temperatures. We selected 38 commercial monovarietal French wines, mainly from the Pays d'Oc region, including Cabernet Sauvignon, Merlot, Gamay, and Pinot Noir. Wine samples were stored in Eppendorf tubes at four temperatures: room temperature, 4°C, -20°C & -80°C. Analyses were performed after 6 months, 1 year, 1.5 years and 2 years of storage using a UHPLC-HRMS/MS system comprising a QExactive Orbitrap Mass Spectrometer. A targeted analysis of polyphenols was conducted using a calibration curve covering over 50 polyphenols (including flavanols, flavonols, phenolic acids and stilbenes), while an untargeted approach using Full-Scan HRMS with data-dependent fragmentation acquisition in both positive and negative modes was also performed [2]. Preliminary targeted tests at 2 months already showed a significant difference between samples stored at 4°C and those stored at room temperature, which became striking at 6 months, primarily affecting flavanols and phenolic acids. By comparison, the targeted analysis showed no significant differences at 12 or 18 months for most polyphenols stored at -20°C or -80°C. When comparing these samples with those kept at 4°C, we observed stability of phenolic acids (gallic, caftaric, caffeic) at these temperatures throughout the experiment, variable responses in flavonols and stilbenes (i. e., the expected loss in quercetin but stability of its glycosides), and a marked loss of all flavanols at 4°C by 6 months (catechin, gallocatechin, procyanidin B 1). The untargeted approaches are providing similar results, with even stronger discrimination between room temperature, 4°C and -20/-80°C. Further research will be conducted to identify additional biomarkers specifically involved in these discriminations.

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P018 — Poster

Prié blanc sparkling wines from Mont Blanc: Altitude effects on the physical-chemical characteristics during second fermentation and ageing

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Keywords: sparkling wine, Prié blanc, Mont Blanc, chemical composition, perlage pattern

Prié blanc is an ancient white grape variety (Vitis vinifera L.), native to the Aosta Valley alpine region in North-West Italy, growing own-rooted in heroic viticulture at altitudes between 900 and 1200 m asl where it can ripe properly with short growing seasons. This linkage between grape variety and terroir gives a strong identity to the wines produced. To date, no study has been published on the characterization of sparkling wines produced from Prié blanc grapes. Therefore, the first aim of this research was to determine physical-chemical characteristics of this unique sparkling wine. During second fermentation and ageing, the altitude impact was also evaluated. The effect of atmospheric pressure with increasing altitude can influence the fermentation process in bottle, yeast autolysis, and therefore volatile organic compounds. The base wine was submitted to second fermentation at two different altitudes on the glacier of Mont Blanc (923 and 2173 m asl), and then aged also at 3462 m. The sparkling wines were analyzed at 6, 12, and 24 months from the end of second fermentation for technological parameters, color traits, phenolic composition, volatile compounds, and bubble pattern. Sensory differences were evaluated at each sampling point using a duo-trio test. The results showed that the performance of Saccharomyces cerevisiae starter culture and fermentation kinetics were not influenced by altitude. During ageing, Prié blanc sparkling wines exhibited a reduction in total polyphenols and an increase in b* color component. After 24 months, significantly higher b* values were observed for the wines aged at 2173 m. Wines aged at 3462 m showed a better preservation of (+)-catechin, (–)-epicatechin, and resveratrol. Volatile compounds were influenced by both altitude and ageing time. Fruity fermentation esters were higher at lower altitude, whereas ageing-related compounds accumulated more at higher altitude. Norisoprenoids and volatile phenols achieved the highest values after 24 months, particularly at 2173 and 3462 m. The greatest altitude gave wines with the lowest concentrations of ketones, confirming their better preservation against oxidation. Regarding the bubble pattern, the only observed effect concerned the reduction in foam thickness over time, which decreased with increasing altitude. Sensory significant differences were found at 6 months of ageing between the wines produced at different altitudes, but the effect decreased with extended ageing.

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P019 — Poster

Determination of Chardonnay oxidative susceptibility through Strecker Aldehyde quantification and Spin-Trap/EPR spectroscopy

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Keywords: EPR, 1-HER, Strecker aldehydes, oxidative stability

Oxidative susceptibility of Chardonnay wines (CW) governs aging potential and quality. Consequently, the wine industry seeks robust strategies to predict it. During bottle aging, upstream of white wine oxidation involves Fenton-type chemistry along with the formation of hydroxyl radicals (•OH) and the 1-hydroxyethyl radical (1-HER). Such oxidation is also associated with the formation of Strecker aldehydes (SA) (Escudero et al., 2000), notably methional (MET) and phenylacetaldehyde (PHE). Additionally, SA could be released during oxidation from bound forms [1]. Based on current knowledge, this work combines 1-HER kinetic (K-1HER) study using Spin Trap/EPR technique with quantification of SA to evaluate the oxidative susceptibility of CW. We selected fifty CW spanning largely oxidative status from 1998 to 2022 vintages. Free and total SA were quantified by GC-MS, while K-1HER were monitored using Spin Trap/EPR methods to calculate the index a, which integrates the peak area and peak width of the kinetic profile (Han and Pons, 2025). On average, total (free + bound) MET and PHE varied widely across wines (22.1 ± 14.2 µg/L and 24.6 ± 13.8 µg/L, respectively). In oxidized wines, we showed that total MET correlated with free MET level ($r = 0.77$) and index a correlated with free MET ($r = 0.58$). These observations were then confirmed in 38 additional CW under controlled accelerated aging (AAg). Higher initial bound MET levels were associated with higher free MET levels after AAg. Indicating that the bound fraction can serve as a potential predictive indicator. Moreover, we demonstrate for the first time that the increase in MET is consistent with the rise in index a (49.8%), confirm that K-1HER reflect oxidation progress. Furthermore, using two complementary spin traps (POBN and DMPO) selective to radicals, we confirmed that both 1-HER and •OH contribute to MET formation, providing mechanistic support for this aspect. We propose, combining EPR signatures along with free bisulfite content, as a potential indicator to estimate shelf life in CW under AAg conditions. Overall, this work outlines an integrative strategy to predict oxidative susceptibility in CW. Of course, additional investigations and validations under different bottle aging conditions are required.

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P020 — Poster

Mucoadhesive properties of typical wine phenolic compounds and their capacity to modulate oral aroma retention under simulated wine tasting conditions

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Keywords: Wine phenolics, mucoadhesion, aroma retention, oral model, fluorescence.

Phenolic compounds play a key role in wine sensory properties, traditionally associated with colour, taste attributes (e.g., bitterness) and trigeminal sensations such as astringency. Beyond these well-established effects, phenolics may also interact with aroma compounds through different types of non-covalent interactions [1]. Moreover, phenolic compounds can bind to salivary glycoproteins (mucins) covering the oral epithelium (2), a mechanism that has been suggested to influence prolonged retronasal aroma release during wine tasting (3). However, considering the structural diversity of wine phenolics, it remains unclear to what extent different phenolic families exhibit mucoadhesive behaviour and whether such interactions could indirectly modulate aroma perception through their oral retention. The aim of this study is to evaluate the mucoadhesive properties of representative wine phenolic compounds added to a synthetic wine matrix at concentrations relevant to wine, using simulated wine tasting conditions. An in vitro oral mucosa model based on mucin immobilised in calcium alginate beads was employed to mimic oral exposure during wine consumption. Fluorescence spectroscopy was used to assess the mucoadhesion of each phenolic compound by comparing fluorescence intensity in the wine before and after simulated oral exposure. In addition, the potential of phenolic-mucin interactions to promote aroma retention was investigated using an auto-fluorescent aroma compound (methyl vanillin) as a model molecule. The results are expected to provide new insights into the oral behaviour of wine phenolics and their potential role in modulating retronasal aroma perception and persistence. A better understanding of these mechanisms may contribute to the development of winemaking strategies aimed at tailoring aroma-related sensory properties.

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P021 — Poster

Commercial red wines under the lens: a snapshot of colloidal diversity

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Keywords: red wines, colloidal variability, wine quality

Red wine is a complex product whose sensory properties depend on the balance and interactions of its chemical components. Among these, colloids, organized assemblies of proteins, polyphenols, and polysaccharides, play a central role in shaping key qualitative attributes such as color, clarity, texture, stability, and overall quality [1]. Although research has shown that these structures are organized rather than random aggregates, their formation, evolution, and variability in commercial red wines remain insufficiently characterized, limiting a comprehensive understanding of their contribution to wine diversity and stability. This study investigates the hypothesis that chemical composition and winemaking practices drive colloidal variability in red wine. To test this, twenty-three commercial monovarietal wines, comprising fifteen varieties from ten countries, were subjected to comprehensive physicochemical profiling. The analytical framework included assessment of pH, organic acids, sugars, alcohols, and chromatic attributes, together with colloidal characteristics and stability-related parameters. Specifically, Nanoparticle Tracking Analysis (NTA) was used to determine particle size and concentration, while phenolic and polysaccharide quantification, combined with SDS-PAGE, elucidated the role of proteins and protein-tannin aggregates. The results reveal substantial compositional variability, with an average colloidal particle size of ~220 nm and limited differences among samples, suggesting a potential upper stability limit for red wine colloids. Particle concentration varied widely and was positively correlated with wine turbidity ($p = 0.49$), while a significant negative correlation was observed between lactic acid and particle size ($p = -0.45$). This relationship likely reflects the effect of malolactic fermentation on pH, a parameter that should govern interaction among colloid-forming macromolecules. SDS-PAGE profiling identified bands of 20-40 kDa, corresponding to free heat-unstable proteins in specific samples, whereas wines with higher phenolic content exhibited larger protein-tannin aggregates. By clarifying these macromolecular relationships, this work identifies drivers of colloidal organization in red wine and establishes a framework for future research to elucidate the influence of variables such as pH and environmental factors on long-term colloidal evolution and stability.

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P022 — Poster

Impact of Closure System and Sulfur Dioxide Management on the Oxidative Evolution of Timorasso Wine

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Keywords: closure, SO2, aroma compounds

When a winemaker considers which closure to use for a specific wine, they must evaluate several factors, including the wine's expected longevity and its shelf life after leaving the cellar. However, the choice isn't limited to whether the closure can preserve the wine's aroma from oxidation over time, but also influences oxygen permeation, with consequences for the need for exogenous antioxidants, particularly sulfur dioxide. This study investigated the influence of bottle closure type and sulfur dioxide (SO_2) concentration on the chemical and sensory evolution of Timorasso (Derthona 2022) during bottle aging. Eight closure systems with different oxygen transmission rates (OTR) were evaluated, including four screw caps with differentiated OTRs, beeswax, Nomacorc Reserva, DIAM 10, and natural cork. Wines were bottled at three initial free SO_2 levels (15, 25, and 35 mg/L). Bottle evolution was monitored after 1 year through routine chemical analyses, colorimetric measurements, and targeted quantification of 37 carbonyl compounds using HS-SPME-GC-MS/MS, following the method described by Piergiovanni et al. [1], and was complemented by a technical sensory evaluation. Results showed that both closure oxygen permeability and initial SO_2 concentration significantly influenced the kinetics of sulfur dioxide depletion and the formation of oxidation markers such as aldehydes and ketones associated with oxidative processes. The differences between closure types were most pronounced at the lowest SO_2 level (15 mg/L). At these low levels of free sulfur dioxide, it is more evident that some closures are more suitable to limit the formation of oxidative markers and preserve the wine's freshness. Colorimetric parameters and carbonyl profiles were consistent with the observed chemical trends. Sensory evaluation supported the analytical findings, revealing clear relationships between chemical stability and aromatic expression, particularly regarding freshness, fruit character, and overall aromatic intensity. Overall, the results confirm the critical role of closure selection and SO_2 management in modulating oxidative evolution in bottled white wines. Appropriate combinations of closure type and sulfur dioxide level can enhance the longevity and quality of Timorasso wines, providing practical guidance for precision enology and bottle-aging strategies.

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P023 — Poster

Metal-mediated reduction as a tool for estimating hydrogen sulfide (H2S) and methanethiol (MeSH) precursor pools in wines

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Keywords: Metal reducing agents, off-odors, sulfur compounds

Hydrogen sulfide (H2S) and methanethiol (MeSH) are the primary compounds responsible for the reduction fault in wine. These molecules exist in various oxidized forms, creating a complex "pool" of precursors1,2. In anoxic environments, such as those found after bottling, this pool can trigger the release of H2S and MeSH. Recent studies indicate that these precursors can reach levels between 1 and 3 mg/L3; however, the industry lacks a rapid analytical method to quantify this risk before the wine is released. The objective of this study was to evaluate whether metallic reductants, such as Fe and Al, could serve as an effective alternative to assess the pool of H_2S and MeSH precursors. Real and synthetic wines were incubated in containers holding vials with CuCl-based trapping solutions for H_2S and MeSH. Throughout the incubation period, the traps were analyzed by HS-GC-SCD and replaced by fresh ones. The effects of pH, SO_2, temperature, metal dose (8 and 40 cm of Fe wire per 80 mL of wine), acetaldehyde concentration to prevent the reduction of SO_2 to H_2S, and dilution of the wine with different acids at various concentrations for Fe were evaluated. A strong interference from SO_2 was observed, as both metals reduced it to H_2S, which could only be partially limited. Al was inefficient in reducing H_2S precursors and was therefore unsuitable for this assay. In contrast, Fe was significantly more effective. At room temperature, pH 4.5, and with 2 g/L acetaldehyde, the amount of SO_2 reduced to H_2S was marginal. However, under these conditions, the precursor pool could not be effectively reduced. At 50°C, the addition of 4 g/L acetaldehyde was necessary to limit the reduction of SO_2 to H_2S (<2 µg/L/day for every 10 mg/L of SO_2 present in synthetic wine). Under these conditions, and through dilution with acetic acid, complete reduction of the precursor pool was achieved in some wines within 10 days, allowing a reasonable estimation of the H_2S precursor pool. However, in another set of wines, full reduction of the pool was not achieved due to the massive reduction of SO_2 to H_2S. In conclusion, while iron-mediated reduction offers a potential pathway to estimate H2S precursor pools, the interference from SO2 remains the limiting factor. Our results suggest that SO2 removal appears necessary to develop a truly reproducible and effective method for predicting the reduction potential of wine.

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P135 — Poster

Rapid Assessment of Wine Oxidative Stability Combining Climatic Chamber Stress Tests and EPR Spectroscopy

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Keywords: oxidative stability, white wine, accelerated test, EPR (Electron Paramagnetic Resonance)

Accurate prediction of wine shelf life is crucial for quality and economic value. Since real ageing studies are time-consuming, accelerated tests simulate long-term chemical and sensory changes in shorter times, enabling rapid evaluation of oxidative stability, aroma loss, and phenolic evolution through kinetic models. Beyond colour metrics, the innovative Electron Paramagnetic Resonance (EPR) spectroscopy can offer complementary mode-of-action insight by tracking radicals and antioxidant capacity, correlating with oxidation markers and being possibly combined with accelerated tests.

In the present study, 22 white wines from different grape varieties (Grechetto, Trebbiano, Vermentino, Fiano) were subjected to accelerated ageing tests in climatic chambers to evaluate oxidative and colour stability. Real storage trials lasted up to 12 months at 15 and/or 23 °C. In parallel, micro-vinifications from Grechetto, Trebbiano and Vermentino grapes were conducted under controlled conditions to investigate the effects of different oenological strategies on wine stability. EPR spectroscopy was also applied for the prediction of the shelf life.

A strong and statistically significant correlation was observed between the colour variation (ΔE) measured under accelerated and real storage conditions. Linear regression analysis yielded a high coefficient of determination (R^2 = 0.851), indicating that a substantial proportion of the colour changes occurring during real ageing can be explained by accelerated approaches. The regression slope (≈1.07), close to unity, suggests a comparable extent of colour evolution under accelerated and real storage conditions, while the low intercept value indicates minimal systematic bias. Wines exhibiting higher EPR-derived oxidative stability indices showed greater resistance to oxidative changes under both accelerated and real ageing conditions, indicating consistency between instrumental oxidative stability measurements and stress test outcomes.

These results support the suitability of climatic chamber as an effective accelerated shelf life methodology for predicting medium-term colour stability of white wines. The statistically significant correlation ($p<0.01$) between climatic chamber ΔE data and EPR-based oxidative stability markers not only further validates the use of climatic chambers as accelerated shelf life tests, but also supports the suitability of EPR spectroscopy as a rapid method for evaluating oxidative stability in white wines.

This work was supported by the Italian Ministry of Universities and Research (MUR) and the European Union – NextGenerationEU under the PRIN-PNRR framework, through Project P2022LXY3A (WiSSaTech; Mission 4, Component 2, Investment 1.1 – D.D. 1409/2022) and the project *White Wine Identity* (PRIN-PNRR "Supply Chain and District Contracts" – MASAF 5th call; PNRR M2C1-I 3.4; CUP B79I21001220001; IRIS ID: PRJ-1058).

Session II

Chemical analysis of grapes, wines, spirits and by-products

KS2 — Keynote

Understanding Wine Flavor: Complex Interactions, Analytical Advances, Future Opportunities

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Keywords: aroma, analytical chemistry, aroma interactions

The complexities of grape and wine flavor have been extensively studied, and advances have been informed by developments in analytical chemistry, sensory science, genetic and multi-omic approaches, and statistical tools that relate information from multiple data sets. In this presentation we will discuss applications of these approaches to improve our understanding of the impacts of aroma-aroma and aroma-matrix interactions (e.g., masking, enhancement effects) and their future applications, for example, in studying blends with novel cultivars. Analytical tools for measuring aroma precursors (e.g., glycosides) are also providing new opportunities to better understand relationships between grapevine genetics and wine flavor and to understand impacts of climate change (e.g., extreme heat events and drought) on grape and wine flavor composition and quality. Continued development of advanced statistical tools will provide opportunities for future advancements in understanding and predicting wine flavor.

O7 — Oral communication 7

Identification and sensory properties of novel 3-sulfanylhexan-1-ol esters in wine

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Keywords: aroma, volatile thiols, esters, Sauvignon blanc

Polyfunctional thiols are among the most potent aroma compounds in wine and play an important role in the varietal character of a wide range of white and red wines, especially Sauvignon blanc wines.1 While 3-sulfanylhexan-1-ol (3SH) and its acetate 3-sulfanylhexyl acetate (3SHA) are well established, the occurrence of further esters of 3SH has not been investigated. In our study, we report the first identification of two previously undescribed wine thiols: 3-sulfanylhexyl propionate (3SHP) and 3-sulfanylhexyl butyrate (3SHB).2 Targeted fermentation trials demonstrated that both compounds are formed during alcoholic fermentation in the presence of 3SH and short-chain fatty acids. Reference standards were synthesized to enable the identification and quantification of 3SHP and 3SHB in commercial Sauvignon blanc, Scheurebe and Verdejo wines at ng/L levels with GC-MS after derivatization.3 3SHP was detected more frequently and at higher concentrations than 3SHB, consistent with the higher abundance of propionic acid relative to butyric acid in wine. To evaluate their sensory relevance, odor detection and recognition thresholds were determined. Both 3SHP and 3SHB exhibited grapefruit-, passionfruit-, and tropical fruit-like odor qualities, but with higher thresholds than 3SH and 3SHA. Although concentrations measured in commercial wines were generally below perception thresholds, these esters may contribute to wine aroma through additive or synergistic effects at subthreshold levels.

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O8 — Oral communication 8

Identification and quantification of furaneol-β-glucoside by LC-MS/MS in berries and wine during ripening and winemaking

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Keywords: Glucoside; Aroma precursors; Wine aroma balance; LC-MS/MS; Climate change

Furaneol® (2,5-dimethyl-4-hydroxy-3(2H)-furanone) is a key wine aroma compound reminiscent of strawberry and caramel notes and, together with other furanones and lactones, contribute to overwhelming dried fruit aromas. Under climate change, high temperatures and accelerated ripening are expected to increase furaneol amount in wines. In this context, understanding the pathway responsible for its formation is essential. A glycosylated form (Furaneol-β-glucoside; Fur-β-Glu) has already been reported in aromatic cultivar Muscat Bailey. However, its identification in non-aromatic Vitis vinifera cultivars remains elusive and the link between Fur-β-Glu and Furaneol in wine has never been demonstrated. This study aimed to quantify Fur-β-Glu in grapes, must and wine, assessing variables like variety (Vitis vinifera cultivars), maturity level, vintage effect, as well as the contribution of yeast metabolism to the formation of furaneol in wine. Fur-β-Glu (commercial standard) was identified by LC-HRMS and quantified using a validated LC-MS/MS method. The method was applied to analyze musts and wines from a wide range of white and red cultivars collected in France (Bordeaux, n=9) and southern Italy (Campania, n=5) across multiple vintages (2019, 2022, and 2025). Fur-β-Glu was quantified in Merlot grape berries at different maturity stages. We confirmed that more than 90% of Fur-β-Glu is localized in berry skin regardless of the maturity stage. In terms of concentration, it was found at levels of up to 15 µg/L in musts and from 10 to 55 µg/L in the resulting red wines obtained from different cultivars harvested at different maturity levels. Fur-β-Glu concentration in must, in the most part of the variety under our analysis, decreased during over-ripening, whereas significant increase was detected in wine made with these overripe grapes. Among the 14 cultivars analyzed, highest Fur-β-Glu levels were detected in Merlot wines (35-55 µg/L), and lowest levels in Cabernet Sauvignon, Touriga Nacional and Carmenere wines (2-12 µg/L). AF trials on musts spiked or not with known precursor concentrations led us to validate for the first time Fur-β-Glu as precursor of furaneol in red wine through putative enzymatic hydrolysis. These findings may help, in a near future, to improve the varietal selection, harvest timing, and maceration strategies to preserve wine aroma balance.

From Grapes to Data: Rapid Must Characterization Using Benchtop NMR Spectroscopy

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Keywords: Benchtop NMR; Must analysis; Rot indicators; Process analytics; Wine quality

Fast and reliable compositional analysis of grape must is essential for process control and quality assurance in winemaking. Fourier-transform infrared (FTIR) spectroscopy is widely used in routine analysis but relies on calibration models and can show reduced accuracy for individual compound quantification in highly variable sample matrices. These limitations are particularly relevant for quality markers associated with grape rot, such as gluconic acid, glycerol and acetic acid, where sensitivity and robustness may be limited. Nuclear magnetic resonance (NMR) spectroscopy enables direct molecular detection and quantification without matrix-dependent calibration. While high-field NMR systems are restricted to specialized laboratories due to cost and infrastructure requirements, recent technological and methodological advances in benchtop NMR have improved performance and robustness, enabling broader application in routine must and wine analysis. In this study, ^{1}H benchtop NMR spectroscopy was applied for quantitative analysis of relevant must components across a wide compositional range. Must samples from different grape quality levels, including rot-affected material, were analyzed. Optimized measurement protocols combined with an advanced spectral evaluation algorithm [1] were used to enhance signal quality, spectral resolution and quantification reliability. Results were compared with FTIR measurements and validated using established reference methods, including enzymatic and titrimetric analyses. Benchtop NMR enabled simultaneous quantification of multiple compound classes relevant for must quality assessment, including organic acids and selected rot-associated markers. Results showed strong agreement with reference methods and, for selected parameters, improved analytical performance together with robustness against matrix effects and turbidity. Sample preparation was minimal, enabling fast analytical workflows. Limitations occurred at very low analyte concentrations due to signal overlap and baseline variability, highlighting the need for further spectral optimization. Benchtop NMR represents a versatile platform for comprehensive must characterization, enabling rapid, calibration-independent quantification and showing strong potential for routine quality monitoring, including early detection of rot-related deviations. With further validation, benchtop NMR can support data-driven decision-making in grape processing and fermentation management.

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O10 — Oral communication 10

Multi-isotopic dilution QQQ-ICP/MS for high geographical discrimination of origin and quality assessment in wine: developing a world database and demonstration of its potential of applications

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Keywords: Elemental profile, Traceability, Quality assessment

Trace elements in wine are primarily markers of the soil in which the vine grew (e.g. Rb, Sr, Ba, ...), other elements are markers of agricultural practices (e.g. Cu, B, ...) and others are markers of anthropogenic contaminations (e.g. Pb, As, ...). The multi-elemental signature can therefore be used for traceability purposes in wines. We have selected a set of 23 elements, highlighting the combination of these different types of signatures to establish the elemental profile of the wines with a high analytical resolution. A new method based on multi-isotopic dilution has been optimized in order to improve the precision of the measurement. This approach allows us to have the best traceability of measurements with reference to the SI system. This new method was then applied to generate an original database of more than 500 wines collected worldwide, that could be treated by combined advanced statistics and artificial intelligence. The presentation will demonstrate that we can discriminate with high precision the origin of these wines at different spatial scales, from the national down to small plots of land covering a few square kilometers. These results demonstrate their exceptional potential for addressing traceability issues such as counterfeiting but also elemental content variation in wine linked to climate changes. We will also highlight the first approaches that we are developing for combining trace elements' content in the wine and its taste properties. The comparative results obtained between the elemental profile and the wine classification (Grand Cru versus traditional) will be presented. Particularly, the results of a blind study aiming at attributing the wine classification will be shown. All these examples have been extracted from the global database, with examples selected in different countries and highlighting the potential of information of this world data bank (still in dynamic development).

O11 — Oral communication 11

Expanding white wine peptide coverage through an integrated LC-MS workflow

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Keywords: peptides, antioxidant, SPE, RP/HILIC-MS

Peptides are attracting growing interest as contributors to the main qualitative characteristics of wine, including oxidative stability, aromatic development, and mouthfeel impact (1,2). Their composition results from grape and yeast proteins and evolves throughout fermentation and aging (3). While glutathione remains the most studied peptide, growing evidence suggests that other short peptides may also influence wine quality (2,4). However, their low abundance and the complexity of the wine matrix have often complicated their purification and detection, thereby limiting our understanding of their potential oenological roles. Recent advances achieved in our laboratory has led to the development of an integrated analytical method combining cation exchange solid-phase extraction (SPE) for peptide enrichment, with complementary reverse-phase (RP) and hydrophilic interaction (HILIC) chromatography and high-resolution mass spectrometry (UHPLC-MS) (5). A preliminary application on a single wine sample revealed a rich diversity of low molecular weight potential peptides covering a wide range of polarity. These results confirmed the sensitivity and robustness of the method and supported its use for a broader comparative study across multiple wines. Building on this validated approach, the present study aims to explore peptide diversity in wines from different grape varieties and regions from Southwest France to Burgundy, with the objective to establish characteristic peptide signatures from national to plot scales. This exhaustive sampling, covering more than sixty wines, provides a large and diverse dataset, allowing robust discrimination and enriching the peptides database. In parallel, antioxidant capacity assessed by the DPPH assay is used to explore potential correlations between specific peptides features and the antioxidant properties of wines. This approach should better characterize peptide-linked antioxidant patterns and thereby improve the assessment of wine oxidative stability across diverse wines. The study is expected to uncover low-abundance, low-molecular-weight peptides that may serve as new markers of oxidative stability.

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O12 — Oral communication 12

Optimization of Sorbent Sheet Geometry for High-Throughput Targeted Odorant Analysis

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Keywords: Mass Spectrometry, Volatiles, Odorant, Rapid Analysis, Quantitation

Targeted trace level (< mg/kg) quantitative analysis of volatiles in wines, grape, and other matrices is time consuming and expensive. Solid phase microextraction-gas chromatography-mass spectrometry (SPME-GC-MS) is the gold standard for such analyses but is limited to around three samples per hour in typical configuration. Sorbent sheet extraction from headspace direct analysis in real time mass spectrometry (SPMESH-DART-MS) has been put forward as a possible high-throughput alternative. By cutting out chromatography, SPMESH-DART reaches potential throughput of around 120 samples per hour, a 40-fold increase. However, poor sensitivity is reported for some compound classes. SPMESH uses an etched sorbent mesh to facilitate parallel extraction and desorption of headspace volatiles, but thorough optimization of SPMESH mesh pattern geometry to enhance sensitivity is not reported. New SPMESH geometries were designed with varying mesh aperture and surface area. Using a turnkey DART-MS/MS system, performance of these geometries were evaluated using two odorants of particular interest to the wine and grape industry: 3-isobutyl-2-methoxypyrazine (IBMP; “green bell pepper”) and methyl anthranilate (MA; “grape candy”). Improvements in sensitivity were observed for mesh patterns with circular mesh apertures in place of square, and for larger mesh apertures. Increasing surface area did not enhance sensitivity. These results are likely because SPMESH-DART-MS sensitivity is limited by transmission of absorbed volatiles from SPMESH to the MS as opposed to limitations in volatile extraction and desorption. The best performing design improved detection limits by 24-fold for IBMP (LOD decreased to 4.1 ng/kg from 100 ng/kg) and by 6-fold for MA (20.9 µg/kg from 135 µg/kg) as compared to the original SPMESH design.

Decoding Antioxidant Mechanisms in specific inactivated yeast

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Keywords: Non-Saccharomyces, yeast derivatives, enology, glutathione, analytical chemistry

Inactivated yeasts, like many other enological biotechnologies, are routinely characterized by producers to assess their functional performance. Glutathione content, in particular, is commonly used to classify products as "Inactivated yeast with guaranteed glutathione level, implying enhanced protection against oxidation. But, as already shown, its concentration alone cannot fully predict the antioxidant capacity of a yeast biomass1. Antioxidant activity is in fact multifactorial, involving a combination of redox active molecules, nucleophiles, and other reactive compounds. In this study, we combined advances in biotechnology and analytical chemistry to investigate how yeast strain selection and production processes influence the antioxidant potential and mechanisms of inactivated yeasts. One Saccharomyces (ISY) and one non-Saccharomyces (INSY) inactivated yeast both from selected strains and both produce to improve their antioxidant properties, were evaluated for their capability to consume oxygen, to trap reactive species (DPPH scavenging capacity, radical species trapping by electron paramagnetic resonance (EPR), as well as their ability to release nucleophilic compounds and thus having a quinone-trapping activity estimated by UHPLC-MS. Despite a fivefold difference in glutathione content, the two products showed similar DPPH indices, indicating that additional compounds contribute significantly to radical scavenging. Both studied inactivated yeasts consumed oxygen efficiently, with slightly higher rates observed for ISY. The most striking difference emerged from nucleophilic fingerprinting. ISY displayed a broad and diverse nucleophilic profile, while INSY exhibited a much narrower chemical signature. This limited diversity was directly reflected in a weaker quinone trapping capacity, highlighting a distinct mode of antioxidant action. Overall, ISY appears to rely mainly on nucleophile mediated quinone trapping, whereas INSY seems to act predominantly through redox active compounds. By integrating complementary assays, this work provides a clearer understanding of how different yeast biotechnologies express antioxidant potential and offers a robust framework for their rational selection. Beyond fundamental insight, this multidimensional approach opens new perspectives for the wine sector, where oxidative challenges are increasing and demand more precise, mechanism-oriented tools to guide the development of next-generation enological solutions.

SO7 — Short oral communication 7

Understanding the Occurrence and Evolution of Thiophenols in Wine

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Keywords: thiophenols; derivatization; UHPLC-HRMS; baseline; evolution

Volatile thiols are key contributors to wine aroma due to their odor properties and high potency. While tropical-smelling varietal thiols have been researched extensively in wine, thiophenols were only discovered recently and remain understudied. Baseline data on these ultra-trace thiols in wine are scarce and little is known about the impact of grape varieties, winemaking processes, and particularly smoke exposure on thiophenols. In this study, we developed and validated an UHPLC–HRMS method to quantify 11 thiophenols, including 7 previously unreported thiophenols in three wine matrices. This method was applied to screen a wide selection of Californian wines, establishing an initial baseline of their occurrence. In a subset of wines made with wildfire smoke impacted grapes, volatile phenols were measured and compared with thiophenols in these wines. The evolution and stability of thiophenols were investigated in control and smoke exposure wines. Concentrations of volatile phenols and added thiophenols were tracked over time under varying conditions. By combining method adaptation, baseline screening, and targeted stability trials, this work provides new insight into the distribution and evolution of thiophenols in wine. Acknowledgements: This work was supported by California wine industry gift funds to the UC Davis Department of Viticulture and Enology in memory of Professor Anita Oberholster and her dedication to wildfire smoke research.

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SO8 — Short oral communication 8

Peptide profiling and antioxidant capacity of white grape juice using LC-MS approach

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Keywords: oxidative stability, Liquid-chromatography, DPPH, peptides, mass spectrometry

The oxidative stability of white wine is governed by a complex network of native metabolites collectively described as the wine antioxidant metabolome1. Beyond polyphenols and glutathione, this metabolome includes diverse nitrogen- and sulfur-containing compounds that buffer oxidation reactions and influence white wine ageing. Peptides have recently emerged as a potentially important, yet largely unexplored, fraction of this antioxidant metabolome. Their expected variability with vintage, grape variety and pre-fermentation practices, particularly for thiol-containing (thiolated) peptides, highlights the need for dedicated analytical workflows to investigate the peptidic composition of grapes and its link to wine oxidative stability. We hypothesize that part of the peptide pool is established during grape ripening and extracted into must during pressing. Because grape proteins occur at low levels in must and are progressively degraded during winemaking, peptide characterization requires enrichment of protein precursors followed by controlled peptide generation. After building the workflow to get a pool of peptides extracted from the must (protein concentration via dedicated purification steps, enzymatic digestion, and qualitative controls of recovery/digestion efficiency), we now focus on comprehensive peptide profiling using LC-QTOF-MS metabolomics. To expand chemical coverage, we compared two complementary chromatographic modes: reverse-phase HSS T3 (favoring less polar features) and HILIC (optimized for polar compounds). After digestion, extracts were evaporated and reconstituted in an acidic buffer (pH 3.0) at 2-10 mg mL^{-1}, then injected in triplicate to ensure reproducible feature detection. This approach allows evaluation of peptide separation efficiency across both columns and assessment of shared versus complementary peptide-related mass features between systems. In parallel, the antioxidant capacity of peptide-rich fractions was screened using a DPPH assay to evaluate radical-scavenging activity. Overall, this work validates an analytical pipeline to profile grape/must-derived peptides and explore their antioxidant potential, opening new perspectives for managing white-wine oxidative stability from the vineyard and early winemaking stages.

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Influence of Berry Skin Cuticular Wax on Smoke-Derived Volatile Phenol Uptake in Grapes

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Keywords: Smoke Taint, Cuticular wax, volatile phenols

Wildfire smoke exposure is known to alter grape composition and cause “smoke taint” in the resulting wines, causing significant economic losses (USD 3.7B in the US in 2020). Moreover, rising fire intensity and duration due to climate change are increasing the relevance of smoke exposure across viticultural regions worldwide, including Portugal, Spain, and Chile. While the chemical nature and sensory implications of smoke-derived volatile phenols (VPs) have been widely reported in the literature, comparatively less attention has been given to the role of grape berry skin properties in modulating smoke compound uptake. This study examined the role of cuticular wax quantity and composition in influencing the uptake of smoke-derived compounds by grapes. Seven grape genotypes characterized by differing berry skin wax were selected for controlled smoke exposure experiments. Grape clusters and individual berries were separated into four treatments in a factorial design defined by cuticular wax status (intact or removed using chloroform) and smoke exposure (present or absent). Berries and clusters were exposed to artificial smoke under controlled conditions at two phenological stages of maturity. Volatile phenols (VPs) in grapes were quantified by GC–MS/MS. Cuticular wax was determined gravimetrically and chemically characterized, after derivatization, by GC–MS/MS. Grape berry skin and tissue morphology and thickness were also evaluated using scanning electron microscopy (SEM) and light microscopy (LM). Smoke exposure increased VPs concentrations across all genotypes and sample types (WAX or NO WAX). In particular, smoke-exposed berries differentiated according to wax presence, abundance and composition, clearly highlighting the protective role of cuticular wax against volatile phenols (VPs) uptake. These findings identify cuticular wax influencing grape response to smoke exposure and provide new insights into genetic variability in smoke taint susceptibility, with implications for vineyard risk assessment and mitigation strategies under increasing wildfire pressure.

SO10 — Short oral communication 10

Phenolic compounds evolution of still dry Chenin blanc wines during oak barrel aging on lees

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Keywords: phenolic compounds, barrel aging on lees, vintage, vineyard, evolution

Oak barrel aging is a traditional practice used in winemaking to produce high quality white wines. The impact of this practice over the evolution of volatile compounds in white wines is well documented. Yet the evolution of non-volatile compounds, such as phenolic compounds, remains poorly explored. The evolution of phenolic compounds in still dry Chenin blanc wine was studied during oak barrel aging on lees. Wine samples were collected over three vintages (2021, 2022 and 2023) after alcoholic and malolactic fermentation from three different vineyards at three or four sampling periods during aging in new and used oak barrels. The phenolic compound contents of various families were determined using a LC-MS-DAD. The data analyses consisted in assessing the temporal evolution of the phenolic composition between the sampling periods and the potential impact of the different factors of the experimental design (vintage, parcel, type of barrel and the sampling period) using linear mixed models. The results showed that the vintage factor had the main effect in the global phenolic composition considering all periods ($p = 0.001$), followed by vineyard effect ($p = 0.008$), while the barrel effect was nonsignificant ($p = 0.075$). However, data showed an heterogenous dispersion, which could represent higher variability in each vintage. To go further, the effect of the different factors assembled was considered for each phenolic compound during aging for the three vintages. Phenolic compounds concentrations were significantly affected by the period and its interactions with the other factors: vintage, vineyard and barrel. For example, ferulic acid concentration was significantly impacted by the period and vintage interaction ($p = 8.45.10\text{-}12$). Period and vineyard interaction had a significant effect over ethyl caffeate ($p = 7.15.10\text{-}08$), while period and barrel interaction had a significant effect over gallic acid level ($p = 9.55.10\text{-}3$). Phenolic concentration of these three compounds increased during oak barrel aging. We propose to present the evolution of the phenolic compounds of the wines during aging and offer tentative explanations for these variations. These results showed however the complexity of understanding molecular interactions during wine aging on lees in oak barrel and may suggest further study on the temporal evolution of other non-volatile compounds such as amino acids.

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AF4 – UHPLC: Two-dimensional separation of macromolecules in monovarietal white wines from South-Western France

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Keywords: proteins, mannoproteins, white wine, AF4, UHPLC

The French south-west region is unique in having over 300 grape varieties for wine production, 120 of which being indigenous. In this area, Gers (20,362 hectares, 2022) and Tarn (6,274 hectares, 2022) produce dry white wines from typical grape varieties among which Colombard, Gros Manseng, Mauzac and Len de l'el. Wines from each of these varieties have their own sensory identity. To differentiate them at macromolecular level, asymmetrical flow field flow fractionation (AF4) was used. This method can only separate wine macromolecular populations by size. The aim of this work was to identify the composition of each population in white wines by developing an on-line system combining AF4 and high-resolution liquid chromatography (UHPLC). For this purpose, 69 wines were collected and first analyzed by Fourier Transform Infrared Spectroscopy (FTIR) to determine the conventional enological parameters (alcohol content, titratable acidity, pH…) [1]. After statistical processing by hierarchical ascending classification, 3 wines were selected for each variety. A sensory "Flash Profile" test was first set up using an expert panel to differentiate the 12 white wines according to their specific mouthfeel [2]. These wines were injected into AF4 coupled with ultra UHPLC. To validate the system, two standards (thaumatin and mannoproteins) naturally present in the wines were injected. The results showed that each variety had its own 2D mapping. Colombard and Gros Manseng grape varieties showed different types of proteins, with varying degrees of affinity with the column. On the other hand, Len de l'el and Mauzac varieties stood out for their total absence of proteins but their presence of mannoproteins [3]. This innovative technique can be of considerable interest for the separation of complex mixtures, such as wine but also milk or beer, offering the advantage of differentiating compounds of distinct sizes but with the same hydrophobicity: it could provide an accurate representation of the macromolecular profile of various matrices. Understanding the contribution of these macromolecules in white wines mouthfeel perception is another perspective of this study.

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P024 — Poster

Studying the Redox State of Wines under Oxidative Processes with a Multi-Parametric Analysis

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Keywords: Redox state, wine oxidation, electrochemistry

Wine oxidation phenomena are becoming a strong issue in the context of climate change. The detection of wine reducing compounds such as phenolic acids, tannins, thiols, etc. is thus essential to better understand the antioxidant capacity, ageing behaviour and premature oxidation of wines. Conventional spectrophotometric methods (ABTS, DPPH) are widely used as reference methods, but they suffer from significant limitations due to their lack of selectivity and interference from other reducing compounds naturally present in wine matrices.1 In this context, electrochemical approaches offer major advantages, as they are rapid, easy to implement and highly selective towards redox-active reducing species. The research conducted within the RedoxWine joint laboratory (CBMN – Biolaffort) primarily focuses on the development of electrochemical analytical protocols to monitor key redox-active molecules in all types of wines allowing to define in real-time their redox signature.2 In this study, the proposed methodologies are applied to the monitoring of oxidative processes in white wines. Several electrochemical sensors are developed to investigate the relationships between reducing species, including sulfites, flavonoids, polyphenols, and oxidizing agents - dissolved oxygen, free metals and reactive oxygen species (H_2O_2, $O_2^{\bullet -}$) - generated or introduced under controlled conditions. The evolution of the wine redox chemistry during oxidation is finally assessed through a combination of electrochemical and spectroscopic measurements, including redox signatures, sulfite content, dissolved oxygen, pH, color parameters (CIELab) and thiol concentrations.

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P025 — Poster

A Chemical Survey of Commercial Chilean Chardonnay Wines: Vintage-Related Variability in Phenolic, Polysaccharide and Color Composition

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Keywords: Tipicity; wine chemistry; polysaccharides; phenolic compounds; commercial wines

Chardonnay is the most widely planted international white grape variety, covering approximately 210,000 hectares worldwide and about 10,205 hectares in Chile (≈7.9% of the national vineyard). Despite its relevance, integrated chemical surveys describing the compositional variability of commercial Chardonnay wines remain limited, particularly regarding the combined contribution of phenolic compounds, polysaccharides, and color parameters. This study presents a chemical survey of thirty commercial Chilean Chardonnay wines from two consecutive vintages (2023 and 2024) produced across contrasting wine regions. Wines were characterized through integrated physicochemical analyses including pH, total acidity, color intensity, CIELAB coordinates, total phenols, total tannins, four polysaccharide fractions according to molecular weight, total polysaccharides, and selected low-molecular-weight phenolic compounds. Global parameters were evaluated by spectrophotometric methods, while individual phenolics were quantified chromatographically. Results revealed pronounced compositional variability among wines and vintages. Total phenolic content ranged from approximately 200 to 460 mg gallic acid equivalents L^{-1}, while total polysaccharides showed wide dispersion, suggesting strong influences of regional origin and winemaking practices. Chromatic parameters were consistent with white wine matrices, displaying low color intensity and negative a* values; however, differences in b* and hue indicated variable oxidative evolution. Phenolic acids and flavan-3-ol derivatives contributed to chemical differentiation, whereas intermediate molecular weight polysaccharide fractions represented a major source of variability. Overall, the combined evaluation of phenolic composition, polysaccharide distribution, and color chemistry provides a robust analytical framework for assessing commercial Chardonnay wines and highlights the chemical heterogeneity associated with vintage and regional origin.

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P026 — Poster

Targeted and untargeted analytical approaches to distinguish barrel-aged from wines aged with alternative woods

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Keywords: GC-MS, NIR, quality control, alternative wood aging, barrel-aged wine

The widespread use of alternative wood products (e.g., chips, staves, and cubes) as oenological aging practices poses new significant challenges for quality control, traceability, and authenticity assessment, with relevance to regulatory oversight. Gas chromatography-mass detection (GC–MS) and near infrared spectroscopy (NIR) are powerful techniques for targeted and untargeted characterization of complex matrices such as wine. When combined with multivariate statistical analyses (PCA, DFA, PLS-DA), they enable quality control and discrimination of wine aging methods, helping to protect wine quality, typicity, and consumer interests. Model solutions and experimental wines were appropriately treated with alternative wood products, while a significant number of commercial wines stored in barrels (barriques, tonneaux) were collected. Wood-derived aroma compounds (xylovolatiles) were accurately described by GC–MS analysis. NIR spectroscopy coupled with chemometric models was applied too, for a rapid, non-destructive, and low-cost monitoring of wine composition. Finally, multivariate statistical methods used on both spectroscopic and spectrometric data allowed wine classification and description. GC–MS analysis revealed clear differences as regards xylovolatile profiles of wines and a clear separation by PCA among wines aged with different wood formats. Barrel-aged wines were clearly separated from those treated with alternative woods. More specifically, wines with chips clustered together and were associated with vanillin, acetophenone, acetovanillone, and trans-whiskey lactone; wines with staves were correlated with furanic compounds and wines with cubes with methyl-2-furoate and several phenolic compounds, including guaiacol and syringol. By contrast, traditionally aged wines showed a strong correlation with ethylphenols, sotolon, cis-whisky lactone, and cyclotene. Multivariate analysis on NIR spectra showed no matrix effect, but clearly distinguished wines aged with alternative formats from barrel-aged ones while no separation was observed between barrel- and barrique-aged wines. The discrimination of specific wood aging practices requires the integration of targeted analytical techniques, that provide detailed chemical information, and complementary NIR spectroscopy coupled with supervised chemometric models aiming at the rapid classification of wines and the development of predictive models to safeguard product quality, origin, and authenticity.

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P027 — Poster

Fate of Fresh Mushroom Off-Flavor Markers during Alcoholic Fermentation: Formation of Novel Acetylated Derivatives.

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Keywords: Fresh Mushroom Off-Flavor ; Aroma ; LC-MS/MS ; Must ; Wine

Since the 2000's, the occurrence of fresh mushroom off-flavor (FMOff) in wines has become a recurrent issue, linked to fungal alteration of grapes. Among the mushroom-related compounds identified in altered musts and wines, two analytical markers, 1-hydroxyoctan-3-one and octan-1,3-diol, clearly discriminate contaminated from healthy matrices(1,2). However, their fate during alcoholic fermentation has not yet been investigated. We hypothesized that these compounds could be acetylated by wine yeasts to form the corresponding esters. This study aimed (i) to develop an LC–MS/MS analytical method to quantify these compounds and (ii) to apply it to investigate their evolution during fermentation. Meunier musts contaminated with Crustomyces subabruptus under laboratory conditions were fermented under standardized conditions, and FMOff biomarkers were monitored throughout alcoholic and malolactic fermentations. The analytical method was validated in enological matrices and showed very satisfactory performance, with high repeatability and reproducibility (RSD < 10%), good linearity (R^2 > 0.99), and high accuracy (analytical bias < 20%). During alcoholic and malolactic fermentations, concentrations of 1-hydroxyoctan-3-one decreased while those of octan-1,3-diol increased, supporting the existence of a biochemical reaction. In addition, acetylated derivatives of octan-1,3-diol were identified for the first time, corresponding to two new compounds potentially involved in FMOff metabolism. These results open new avenues to better understanding the role of yeast strains in modulating these compounds, as well as the potential masking effect of their esters on wine aroma.

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P028 — Poster

Leveraging Volatile Sensing for Rapid Detection of Smoke-Derived Signatures in Grapes and Wines

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Keywords: nanotubes, smoke-taint, screening, risk assessment

Smoke-exposed grapes accumulate volatile organic compounds (VOCs) and their glycoconjugate precursors that can be released during fermentation and impart unpleasant, smoky, and ashy flavors to wines, complicating harvest decisions and potentially compromising wine quality. Current diagnostic methods rely on GC-MS/LC-MS analyses and small-scale fermentations that are time-consuming and costly. As smoke events continue to impact the California wine industry, there is a growing need for rapid, cost-effective methods to assess smoke impact risk in grapes and wine. This study explores the use of a novel, commercially available Signature Analysis Machine (SAM) that leverages differential sensing and data models to classify samples based on VOC signatures rapidly. Using wines across various cultivars from the 2020 and 2021 vintages, the SAM was able to differentiate smoke-impacted wines from non-impacted wines with classification driven by smoke exposure rather than variety or vintage. GC-MS and LC-MS chemical analyses were performed as validation for all samples to quantify smoke-derived volatile phenols and their glycoconjugates, respectively. Application of the SAM for the detection of smoke impact is currently being extended to grape samples collected from Napa Valley appellations affected by the Pickett Fire in 2025. Results suggest that rapid VOC fingerprinting may enable detection and classification of smoke-derived signatures. Continued integration of VOC signals with chemical and sensory data to construct a library of validated smoke exposure signatures may enable rapid screening of grape samples and risk assessment. Similar approaches are also being explored for the detection of Fresh Mushroom Aroma (FMA) in France, supporting the broader applicability of this strategy to vineyard-derived sensory risks.

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P029 — Poster

Impact of spontaneous versus inoculated fermentation on the colour and phenolic profile of Nebbiolo wines from 32 vineyards

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Keywords: fermentation inoculum, anthocyanins, Nebbiolo, LC-MS/MS

Red wine production relies on the alcoholic fermentation of grape must, conducted either through the inoculation of selected yeast cultures, or spontaneously with a complex microbial ecosystem comprising indigenous Saccharomyces and non-Saccharomyces strains. Crucially, the combined effect of maceration and yeast activity impacts the extraction of phenolic compounds, including anthocyanins, and the formation of derived stable polymeric pigments [1]. This behaviour is particularly important for monovarietal, like Nebbiolo wines, characterized by a low colour intensity. The study aimed to assess the potential impact of spontaneous fermentation on the general parameters, colour traits, and detailed anthocyanin and pigment composition by LC-MS/MS for the wines obtained from Vitis vinifera L. cv. Nebbiolo grapes (vintage 2024) from 32 vineyards. A multi-zone and vineyard approach was designed to minimize the confounding effects of regional variability. Each parcel was separately subjected to micro-scale winemaking, either with spontaneous fermentation or inoculation with Saccharomyces cerevisiae BRL97 strain, and the wines were analysed after 6 months. Partial Least Squares Discriminant Analysis (PLS-DA) was performed to generate Variable Importance in Projection (VIP) scores, identifying the key metabolic drivers distinguishing the fermentation modalities. On general parameters, glycerol was the most significantly affected, showing higher concentrations for spontaneous fermentation with a VIP score of 3.69. Specific monomeric anthocyanins were also found in higher quantities, including delphinidin (VIP 1.87) and cyanidin (VIP 1.76). Derived pigments were present in higher concentrations in spontaneously fermented wines. These included anthocyanin-flavanol adducts like malvidin-catechin (VIP 1.69), peonidin-catechin (VIP 1.35), peonidin-vinylcatechol (VIP 1.59), petunidin-vinylphenol (VIP 1.40), peonidin-vitisin B (VIP 1.28), and malvidin-vitisin A (VIP 1.19). These compounds potentially impacted the resulting colour intensity (VIP 1.56) and total anthocyanins (VIP 1.20). These results help to quantify the impact of spontaneous fermentation on derived pigments and their possible role in stabilizing colour. Acknowledgments: this study was carried out within the Agritech National Research Center and was funded by the European Union Next-GenerationEU under the PNRR - Missione 4 Componente 2, Investimento 1.4 - D.D. 1032 17/06/2022, CN00000022.

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P030 — Poster

Modulating the chemical and sensory profile of Avgoustiatis grapes (Vitis Vinifera L.) and wines: The impact of irrigation and post-harvest dehydration under extreme Mediterranean thermal conditions

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Keywords: grape dehydration, irrigation, sensory analysis, volatiles

The application of irrigation and post-harvest dehydration on the indigenous red variety Augoustiatis proved pivotal for managing the extreme thermal stress of the 2024 vintage. Analysis of the berries revealed that dehydration induced significant water loss, concentrating soluble solids and acids, whereas irrigation maintained hydration and prevented the physiological degradation of acidity typically caused by heat stress. These trends were closely mirrored in the finished wines. Irrigated treatments resulted in enhanced color intensity and higher total phenolic content, achieving superior sensory scores for visual and aromatic clarity. In contrast, wines from sun-dried grapes showed the highest phenolic indices and astringent tannins, characterized by a mature plum aroma and a tile hue. Volatile analysis further differentiated the two treatments, with irrigation favoring compounds such as 1-hexanol and isoamyl acetate, while dehydration correlated with butyric acid derivatives and nerol. As irrigation becomes increasingly restricted by limited water resources under climate change, post-harvest dehydration serves as an effective alternative for producing robust red wines with increased structural depth.

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P031 — Poster

Oenological potential of PIWI grape varieties assessed through volatile composition analysis by GC×GC-ToFMS

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Keywords: Sustainable viticulture, PIWI varieties, volatile compounds, GC×GC–ToFMS

Viticulture currently faces major environmental challenges, mainly due to the intensive use of plant protection products to control downy and powdery mildew diseases, which are being intensified by climate change. To promote more sustainable production, disease-tolerant grapevine varieties or PIWI (Pilzwiderstandsfähige Rebsorten), have been developed through crosses between fungus-resistant varieties and high-quality Vitis vinifera varieties. These varieties can reduce the use of plant protection products by up to 80%, lowering both the carbon footprint and environmental impact.1 Nevertheless, knowledge on their oenological potential, especially in terms of volatile composition, remains limited. This study aims to characterize and compare the volatile composition of PIWI grape varieties and their parental varieties from the 2024 and 2025 vintages, using headspace solid-phase microextraction coupled with comprehensive two-dimensional gas chromatography and time-of-flight mass spectrometry (HS-SPME–GC×GC–ToFMS). The results show that PIWI varieties showed a volatile composition, which is more closely aligned with that of Vitis vinifera varieties than with that of fungus-resistant varieties. Additionally, PIWI grapes contain a large amount of compounds known to give wines high-quality aromas. Overall, this research supports winegrowers in making informed choices that promote a more sustainable and climate-resilient viticulture, with the potential to increase productivity while lowering production costs.

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P032 — Poster

From amino acids to aroma: evaluation of grape aroma potential

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Keywords: aroma precursors, volatile compounds, aroma potential index, fermentation

Wine aroma is a major determinant of quality and typicality and originates from the interaction between grape-derived precursors and fermentation-related metabolites. While the aromatic potential of grapes and must has traditionally been evaluated through well-known classes of aroma precursors, growing evidence highlights the central role of free amino acids in shaping fermentative aroma. Amino acids act as direct precursors of key volatile compounds, including higher alcohols and esters. The amino acid profile of must is highly variable and depends on cultivar, vineyard practices, climate conditions, and fruit maturity, contributing significantly to differences in volatile composition and aroma expression. However, correlations between amino acid composition and aroma formation requires further investigations with the purpose to integrate amino acids into models for the assessment of the grape aromatic potential. Sixteen musts from different grape varieties (Riesling, Pinot noir, Nero d'Avola) were characterised in terms of general chemical parameters, amino acid profile and aroma precursors. These musts were fermented under controlled conditions without performing any correction. Moreover, the content of nitrogen was adjusted for the two nitrogen-poorer musts by adding different nitrogen sources, including diammonium phosphate, pool of amino acids, 9 essential amino acids and yeast extract. Once the fermentations were completed, the wines were analysed for general chemical parameters, amino acid profile, aroma precursors and volatile compounds. Fermentative vigour and power were lower for musts poorer in nitrogen with an additive decrease in case of more acidic pH. The addition of the selected nitrogen sources led to increased fermentative vigour and power being more relevant when the yeast extract was used. In any case, all the fermentations were completed. Negligible differences were found for lactic acid, while larger variation was observed for acetic acid. The volatile composition was affected by the nitrogen source in particular for certain higher alcohols and esters, the former being higher with inorganic nitrogen. Organic nitrogen led to major content of esters, in particular of acetate esters when yeast extract was supplemented. This study advanced the evaluation of grape aromatic potential and can support the development of predictive tools applicable to vineyard management and valorisation of varietal and terroir-specific aromatic expression.

P033 — Poster

Impact of Ethanol Removal on Wine Composition: Nero d'Avola as Case Study

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Keywords: dealcoholisation, reverse osmosis, Nero d'Avola wine, phenolics, aroma compounds

Over the past twenty years, climate change has increased the sugar content of grape must, leading to higher ethanol concentrations in wines. This trend contrasts with the rising consumer demand for low- or no-alcohol wines, a market segment that continues to grow. Several technologies exist to partially or fully remove ethanol from wine, including distillation, vacuum evaporation, and membrane-based methods. The impact of these techniques on wine composition, however, depends on the method employed, the extent of ethanol removal, and the intrinsic characteristics of the wine (1,2). Further research is needed to better understand how dealcoholisation affects different wine profiles as well as to clarify the evolution of wine that occur during wine storage. Nero d'Avola wines were collected from four different wineries after malolactic fermentation. These wines underwent dealcoholisation using a combined nanofiltration-reverse osmosis technology with ethanol reduction of -2% and -4% (v/v). The treated wines were bottled and stored at 15±1°C up to 12 months. The wines were analysed for general chemical parameters, phenolic and volatile compounds. The results showed that a -2% (v/v) ethanol removal caused moderate decreases in titratable acidity (up to -14%) and tartaric acid (up to -6%) after 12 months of storage. Likewise, a -4% (v/v) removal led to losses up to -38% and -67% for titratable acidity and tartaric acid, respectively. A decrease of acetaldehyde was observed in most partly-dealcoholised wines after 12 months (up to -52%) suggesting the limited occurrence of oxidation. With regards to phenolics, a lower content of both flavonoids and anthocyanins was observed in partly-dealcoholised wines, up to around -50%. Nevertheless, two wines showed only minimal losses (up to -5% for flavonoids and -24% for anthocyanins), suggesting that the response to dealcoholisation may depend on wine-related characteristics. A decrease of these phenolics occurred during storage, even if to a lower extent. An overall decrease of the most sensitive aromatic compounds (e.g., β-ionone, linalool, geraniol) was observed because of ethanol removal even thought a wine-specific impact was observed on sensory profile. This research provides new insights into the effects of membrane-based dealcoholisation on Nero d'Avola wine, a grape variety not previously studied in this context, the best of our knowledge, and will serve to expand the dealcoholisation for white wine.

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P034 — Poster

Beyond Oak: Impacts of Juniper versus Oak on Red-Wine Colour, Phenolic Composition, and Volatiles

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Keywords: Wood ageing, colour, volatile compounds, polyphenols, mass spectrometry

Wood ageing remains one of the most fascinating processes in winemaking. Wood can act as a catalyst for wine quality through the release of volatile and non-volatile constituents. Historically, a range of species has been employed according to local availability, most notably oak, but also chestnut and walnut. In recent years, novel woods have entered practice together with diversified formats and toasting regimes. While the medium-toast barrique endures as the gold standard, modular formats (e.g., staves, chips, shavings) allow more practical, scalable and, in many cases, more sustainable solutions. Untoasted or lightly toasted woods are also increasingly adopted to better preserve the wine matrix, especially its aroma profile. In parallel, new botanical species (e.g., acacia, mulberry) are gaining attention for their distinctive impacts on wine attributes, enabling trials with woods unsuited to cooperage and opening new oenological possibilities. This study evaluated juniper (Juniperus communis) for the treatment of red wines, a Mediterranean species never previously applied to wine, though traditional in the ageing of Italian balsamic vinegar. Juniperus species are among the greatest accumulators of terpenoids in the plant kingdom. Two formats (cubes and shavings) at the same 4 g/L dose were added to Pinot Noir and Merlot for 1, 2, 4, 6, 10, and 14 weeks. In parallel, the same wines were treated with untoasted French oak or no wood, providing positive and negative controls. Conventional spectrophotometric assays for polyphenols and colour (CIELab and anthocyanin classes per Boulton) were coupled by UHPLC–qTOF–IMS for non-volatiles (ca. 350 identified compounds) and GC×GC–MS for volatiles (ca. 140 identified molecules); identical analyses were performed on wood extracts to test effects in the absence of the wine matrix. The most pronounced effects concerned wine pigments and volatiles. Despite pigments being present in juniper wood, no direct transfer to wines was detected; nevertheless, wood contact consistently promoted chromatic evolution and stabilisation of the colour compounds. Volatile composition exhibited species-specific and format-dependent signatures, with relevant release of sesquiterpenes and terpenes in juniper samples, differentiating juniper from oak and cubes from chips. Overall, juniper additions modulated colour development as for oak, but conferred a distinctive volatile fingerprint, expanding the array of woods available to oenology

P035 — Poster

Influence of terroir on the physicochemical and sensory composition of wines from the minority grape variety "Cenicienta" (Vitis vinifera L.) in Castilla y León (Spain)

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Keywords: Homeland, vintage, native variety, sensory analysis

The Spanish minority varieties, such as the red Cenicienta recovered in Castilla y León, are raising greater interest due to its potential to diversify viticulture, although data on how terroir and vintage modulate their oenological expression are scarce1. This study evaluated the impact of 3 locations (Zamadueñas/Rueda/Toro) and 2 vintages (2023-24) on Cenicienta musts and single-varietal wines (standard winemaking conditions). The following physicochemical parameters were measured in musts: sugar concentration (ºBrix), pH, total acidity (g/L), malic acid (g/L), potassium (mg/L) and TPI. Parameters measured in wines: alcohol content (% vol), dry extract (g/L), pH, total acidity (g/L), TPI, tannins (g/L) and anthocyanins (mg/L). Wines were sensorially described by a panel of 8 experts (OIV sheet) and 26 consumer tasters using attribute ranking tasting. Musts grown in Rueda showed greater maturity (24.5-26.0°B) and total acidity (5.3-5.6 g/L), with high potassium amount (1560-1800 mg/L). Toro spotlight TPI (27-37) and high potassium. Musts from Zamadueñas showed lower sugar (214-223 g/L) but higher malic acidity (1.1-1.8 g/L). Zamadueñas wines showed low alcohol (13.0-13.4%) and more acidic pH (3.25-3.57); Rueda had more tannins (4.7 g/L) and high anthocyanins (421-654 mg/L) and Toro showed balance with medium extract (28-30 g/L) and intense colour. From the sensory point of view, 2023 vintage in Zamadueñas led the overall score (81.53/100) due to its clarity (8.5), intense colour (8.5) and balanced aromatic intensity (8.3). Rueda (80.88) stood out for aromatic frankness (8.44) and overall appreciation (8.52), while Toro (78.22) compensated for less frankness with greater persistence (8.28). In 2024, Toro reached 82.98/100 with high aromatic intensity/quality (8.6/8.1), volume (8.6) and persistence (8.6). Zamadueñas (80.28) maximized clarity (9.0) but had a light palate. Rueda (80.21) had an intermediate aromatic intensity (8.1). The ranking of attributes 2023 positioned Toro in terms of color/violet hues (T≥R≥Z) and aromatic intensity (R>T>Z). In 2024, Toro dominated in volume (T=R>Z), balance and overall quality. Zamadueñas led in red/black fruit (Z=T>R), acidity and astringency. Cenicienta variety demonstrates its versatility in Castilla y León: Toro is ideal for structured premium wines (volume/colour), Rueda for fresh aromatic wines (acidity/intensity) and Zamadueñas for light, fruity wines (acidity/fruit), validating its recovery and marketing

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P036 — Poster

Discovering Erbamat: characterization and oenological potential

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Keywords: Erbamat variety, must composition, base wine, sparkling wine

In the context of climate change, increasing grape ripeness and sugar accumulation are associated with a loss of acidity, posing a significant challenge for sparkling wine production. A possible response to mitigate the climate change is represented by 'Erbamat' variety (Vitis vinifera L.), an autochthonous cultivar cultivated in Brescia area (Lombardy, Italy). This variety has received attention from both the scientific community and the wine industry due to its distinctive agronomic and compositional traits, including high titratable acidity, moderate sugar content, and late ripening. Due to these characteristics, 'Erbamat' grape was recently admitted for the production of Franciacorta DOCG. However, the current knowledge of this grape variety is limited in terms of both composition and its impact on sparkling wine. The study aimed to the characterization of 'Erbamat' variety and the evaluation of its oenological potential addressed to the sparkling wine production. Erbamat grape were collected in harvests 2023 and 2024. Experimental musts were produced by pressing whole bunches and after destemming. These musts were used for the production of base wines. Triplicate fermentations with and without maceration were carried out in harvest 2023. Instead, in harvest 2024, musts from whole bunches and destemmed berries were divided in 2 aliquots and a cryomaceration step was performed for one aliquot of each must. Must and base wine samples were characterized in terms of general chemical parameters and phenolic indexes. Pressing methods had a negligible impact on must composition. However, significant vintage-dependent differences were observed in must samples: grapes harvested in the 2024 vintage led to musts with lower sugar content and pH, and higher titratable acidity. Cryomaceration resulted in a negligible increase in pH and in a marked decrease in titratable acidity (of approximately 1 g/L tartaric acid). The base wines showed a relevant titratable acidity in particular for harvest 2024. The destemming seemed to affect the acidity that resulted lower in those base wines. However, Chardonnay base wines produced in the same conditions in harvest 2024 had a much lower titratable acidity (6.7±1.7 [n=6] vs. 11.3±1.2 g/L tartaric acid for Chardonnay and Erbamat wines, respectively). These results demonstrate the suitability of the 'Erbamat' grape variety as an acidity regulator, with its impact on sparkling wine during aging on yeast lees being evaluated.

P037 — Poster

Microwave and Submerged Cap Maceration Highlight Cultivar-Dependent Responses in Red Wine Phenolic Composition and Color

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Keywords: Microwave-assisted maceration, Submerged cap maceration, Red wines, Polyphenols

Polyphenols play a central role in wine quality by contributing to color, astringency, and chemical stability. Their extraction during maceration depends on processing conditions and grape characteristics. This study evaluated cultivar-dependent effects of alternative maceration techniques on color and phenolic composition in red wines from Tannat, Marselan, and Arinarnoa (Vitis vinifera). Experimental vinifications were performed with grapes harvested in 2024. Four maceration techniques were tested in triplicate: traditional maceration (TM), microwave-assisted maceration (MW), short microwave-assisted maceration (SMW), and submerged cap maceration (SC). Macerations lasted 7 days, except SMW (3 days). Phenolic evolution during maceration and final wine composition were monitored by spectrophotometry and HPLC-DAD. Alternative maceration techniques modified phenolic composition relative to TM, but the effect depended on grape cultivar. Total HPLC pigments increased most in Tannat, with SC and SMW reaching roughly +33 % and +58 % vs TM, respectively. In Marselan and Arinarnoa, SMW produced the largest increases (+30 % and +39 %, respectively), whereas MW caused minor changes in Marselan, suggesting that pigment re adsorption during later maceration stages may be greater in this cultivar. Pigment profiles revealed cultivar treatment interactions. In Tannat, SMW wines showed lower relative malvidin derivatives than TM (about 85 % to 74 %) and higher delphinidin derivatives. In Marselan, SMW specifically increased acylated pigments, with p-coumaroylated anthocyanins rising from 15.3 to 30.0 mg/L. In all cultivars, alternative maceration increased color intensity more than total pigments relative to TM, consistent with stronger copigmentation. Consistently, flavonol contents also increased and were significantly higher in Marselan, whose grapes contained about threefold more flavonols than Tannat and Arinarnoa. Flavan-3-ol extraction kinetics also showed cultivar-specific patterns. In Marselan and Arinarnoa, the largest differences appeared within the first three days, mainly under MW and especially SMW (typically +10 to +60 % vs TM, and in some cases >80 % in Marselan), whereas in Tannat they became more evident at later stages (days 5 to 7), particularly under SC (+30 to +40 % vs TM). Sensory differences were clear, but alternative techniques were not always preferred. Statistically significant cultivar by treatment interactions ($p < 0.05$) were confirmed.

P038 — Poster

Development and Validation of a Spectrophotometric Method to Quantify Low-Molecular-Mass Flavan-3-ols in Grapes and Wines

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Keywords: dimethylaminocinnamaldehyde; methylcellulose tannin precipitation assay; proanthocyanidins; condensed tannins; grape and wine polyphenols

Low-molecular-mass (LMM) flavan-3-ols (monomers and small oligomers) are typically minor constituents of wines, yet they may provide information on their tissue origin (seed vs. skin), cultivar, and winemaking practices. Spectrophotometric quantification is difficult due to interference from oligomeric and polymeric proanthocyanidins and the complex wine-matrix. Dimethylaminocinnamaldehyde (DMAC) shows high selectivity towards flavan-3-ols, but its reactivity strongly depends on tannin degree of polymerization, limiting the interpretability of direct measurements. A selective analytical workflow is presented, coupling the methylcellulose precipitation assay (MCP) to remove condensed tannins with subsequent DMAC determination of the MCP supernatant (SUP) to quantify the remaining LMM fraction (DMAC_SUP). The SUP matrix provides a stable and homogeneous reaction medium. For reliable paired-well correction at 640 nm, both the DMAC reagent and the methanolic control were acidified (1.2 M HCl), preventing ammonium sulfate precipitation. A Small Flavanol Index (SFI, %) is proposed as (DMAC_SUP/MCP)×100 to express the LMM fraction relative to MCP-precipitable tannins. Calibration in SUP (reported as (−)-epicatechin equivalents) was linear from 0 to 6 mg L^{-1} (R^2 = 0.995), with a limit of detection of 0.52 mg L^{-1} and a limit of quantification of 1.58 mg L^{-1} (≈36 mg L^{-1} in the original sample at DF = 23). Between 2 and 6 mg L^{-1}, precision ranged from 2 to 5% RSD, with absolute bias ≤4.4%. Comparison of direct DMAC and DMAC_SUP measurements indicated that a substantial fraction of the direct signal originates from MCP-precipitable material, supporting the cleanup step to improve quantitative interpretability across matrices. Spike-recovery experiments (3–75 mg L^{-1} added prior to MCP) showed quantitative recovery in seed and skin extracts and a small positive offset in wines near the LOQ that became negligible at mid-to-high concentrations; results were cross-validated by HPLC. Applicability was demonstrated in Marselan and Tannat (Vitis vinifera) seed and skin extracts and in wines produced under enzyme-assisted and extended maceration, resolving compositional differences by tissue, cultivar, and maceration strategy. Compatible with microplate formats and simple instrumentation, the workflow enables tandem determination of LMM flavan-3-ols and condensed tannins, while the SFI provides a simple descriptor of the relative contribution of low-versus high-molecular-mass flavanols.

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P039 — Poster

Grape pomaces from Spanish minority Vitis vinifera L. varieties as a valuable source of phenolic compounds

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Keywords: wine by-product; minority grape varieties; phenolic composition; CIELAB; antioxidant capacity.

The recovery and characterization of Spanish minority Vitis vinifera L. varieties has gained increasing relevance in enology, since it can contribute to wine diversity and typicity and may enhance resilience to climate change through differences in phenology, adaptability, and stress tolerance. On the other hand, grape pomace represents the main solid by-product of winemaking and constitutes an abundant source of bioactive compounds with technological and functional potential. Its valorization is essential within current circular economy strategies in the wine sector and key to reduce the environmental impact of wine production [1]. In this context, this work aimed at characterizing, by HPLC-DAD-MSn [2], the detailed phenolic composition (including phenolic acids, flavanol, flavonol and anthocyanins) of grape pomaces obtained as by-products in the winemaking of 8 different red and white V. vinifera grape varieties (Tempranillo, Rufete, Juan García, Mandón, Gajo Arroba, Bruñal, Verdejo and Puesta en Cruz). In addition, color intensity (I), shade (N), total polyphenol index (IPT), and Folin–Ciocalteu index were determined using the OIV methodologies but optimized for their application to grape pomaces. The technofunctional potential of the grape pomace extracts was also assessed through tristimulus colorimetry in the CIELAB space and by evaluating antioxidant capacity using FRAP and ABTS assays. The results revealed marked varietal differences in the phenolic composition among the studied varieties. Moreover, the proportions of coumaroyl-derived anthocyanins detected in grape pomaces were significantly higher than those usually observed in fresh grapes. This feature could be of special interest due to the enhanced chemical stability and distinctive chromatic properties associated with this type of pigments. Indeed, the extracts exhibited differentiated color characteristics, pointing out their potential as natural colorants that could be used, for instance, in the food industry. Furthermore, significant variability in antioxidant capacity was observed among varieties, closely related to the differences observed in their phenolic profiles. Overall, grape pomaces from Spanish minority varieties emerge as valuable sources of phenolic extracts with diverse technofunctional properties depending on varietal origin. Thus, their potential use as natural colorants or antioxidant additives may revalorize this important enological by-product.

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P040 — Poster

Sustainable Strategies to Ensure Reliable Alcoholic Fermentation under Climate Change–Driven Alterations of Grape Must Composition

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Keywords: climate change, yeast-assimilable nitrogen, yeast stress, fermentation reliability, Alcoholic fermentation

Reliable alcoholic fermentation is essential for the production of high-quality wine and sparkling wine. Small and medium-sized wineries are increasingly affected by fermentation problems, which can lead to substantial economic losses. In addition to insufficient yeast viability and vitality, climate change–induced alterations in grape and must composition represent major risk factors. Elevated sugar concentrations, reduced yeast-assimilable nitrogen, altered pH values, and increased ethanol levels impose stress on yeast cells, significantly increasing the risk of sluggish or stuck fermentations. Against this background, the EFMoST project adopts an integrated approach to improve fermentation reliability by combining optimised rehydration and propagation strategies for active dry yeasts with adaptation measures addressing climate-related changes in must composition [1]. A central focus is the development of simple, scalable, and OIV-compliant methods for controlled aerobic yeast propagation to obtain highly vital and metabolically active yeast cultures [3]. In parallel, practical and cost-effective methods for assessing yeast viability and vitality are being developed to enable fermentation fitness to be evaluated directly in the winery [3]. Complementary to this, the VINO-KLIM project systematically investigates the effects of climate change on grape must and base wine composition, with particular emphasis on yeast-assimilable nutrients and their impact on fermentation performance [4]. Based on these analyses, the fermentation behaviour of different wine yeast strains is studied under nutrient-limited and ethanol-stressed conditions to identify robust strains and critical nutrient thresholds [5]. In addition, photometric rapid tests are being developed to support the rapid assessment of key must parameters and targeted nutrient supplementation [6]. By integrating optimised yeast preparation, adapted analytical tools, and a deeper understanding of climate change–induced changes in must composition, these projects aim to establish practical strategies to prevent fermentation failures and to support more resilient and sustainable wine and sparkling wine production. The EFMoST project is funded by the Landwirtschaftliche Rentenbank within its research programme for innovation in agriculture (Funding code: 1 012 183). The VINO-KLIM project is co-funded by the European Commission and the State of Rhineland-Palatinate (Funding code: P1-SZ1-9 InnoProm – MWG).

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P041 — Poster

Developing a Green Sensory Approach to Taste Oak Ellagitannins

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Keywords: Ellagitannins; Barrel aging; Oxidation monitoring; HPLC-MS; Wine maturation

Oak barrels release a complex mixture of compounds into wine that shape organoleptic properties, such as its aroma, structure and colour. Among these compounds, ellagitannins are non-volatile hydrolysable tannins and are key contributors to astringency and bitterness1. However, their individual sensory properties remain difficult to assess. Ellagitannins are naturally abundant in oak wood, whereas their concentrations in wine remain relatively low due to partial extraction and chemical transformations during aging. In practice, these compounds are highly reactive and interact with wine components such as condensed tannins and anthocyanins, leading to an underestimation of their individual sensory contribution. The aim of this work was to develop a sensory-oriented approach to study C-glucosidic ellagitannins using extraction methods compatible with tasting. Several extraction strategies were tested, including aqueous and hydroalcoholic approaches, to obtain ellagitannin-rich fractions from oak wood using food-grade, environmentally friendly solvents. These "green" extracts were designed to preserve the integrity of the compounds while ensuring safety and acceptability for sensory evaluation. The extracts were analysed using liquid chromatography coupled with time-of-flight mass spectrometry (HPLC–TOF–MS). They contained the major C-glucosidic ellagitannins (castalagin, vescalagin, grandinin and roburins A, B, C, D and E) along with other naturally co-extracted compounds, providing a simplified yet realistic representation of oak composition. By comparing extracts obtained with different extraction conditions, it was possible to highlight differences in ellagitannin concentration and identify the most ellagitannin-rich fractions. The extraction yields indicated that hydroalcoholic solutions produced higher ellagitannin concentrations (5.9%) compared to hot aqueous solutions (2.9%). Based on these results, food-grade separation strategies are now being considered to further isolate and purify these compounds and enable more direct tasting. This approach makes it possible to taste and compare the main ellagitannins under controlled conditions, outside of the wine matrix. By combining green extraction techniques with sensory analysis, this work contributes to a better understanding of ellagitannins' sensory properties and their relationship with wood composition, extraction methods, and wine aging.

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P042 — Poster

Updated insights into esterified Flavan-3-ols in grapevine and wine: Origin, transformation, and taste response of epicatechin-3-O-vanillate and -3-O-gallate

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Keywords: Flavan-3-ols; Epicatechin-3-O-vanillate; Epicatechin-3-O-gallate; Wine; Tannin; Vinification; Taste response

Esterified flavan-3-ols, prevalent in grapes and wine as monomers or subunits within condensed tannins, significantly influence the mouthfeel of wine. However, comprehensive knowledge of their molecular structures and transformations during vinification is still limited. This study investigated tannin derivatives, specifically vanillate and gallate forms, using UHPLC-Q-TOF to elucidate their distribution across four Vitis vinifera L. cultivars, their transformations during vinification, and their metabolic fate mediated by Oenococcus oeni and β-glucosidase activity. The taste responses of epicatechin-3-O-vanillate (ECV) and -3-O-gallate (ECG) were evaluated using an electronic tongue. The results indicated that ECV was predominantly found as monomers and terminal units within the condensed tannins across all examined grape varieties. During early malolactic fermentation (MLF), ECV and ECG are hydrolyzed into epicatechin (EC), vanillic acid (VA), and gallic acid (GA) by O. oeni and β-glucosidase enzymes. This enzymatic cleavage is potentially correlated with reduction of esterified flavan-3-ols contentand perceptible bitterness in wine.

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P043 — Poster

Advanced characterization of oxidation markers in grape seeds condensed tannins using AcquireX™ data acquisition and Feature-Based Molecular Networking

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Keywords: Polyphenols, Condensed tannins, Depolymerization, Molecular networking, Oxidation markers

Condensed tannins (CTs) play a crucial role in various domains, from food quality to health benefits. They significantly contribute to the sensory profiles and stability of fruit-derived beverages, such as wines and are increasingly studied for their impact on preventing chronic diseases such as cancer and neurodegenerative disorders. However, despite their importance, understanding the structural evolution of CTs, particularly their oxidation processes, remains a significant analytical challenge. To date, oxidation markers of CTs have been identified by Liquid Chromatography coupled to Mass Spectrometry (LC-MS) after chemical depolymerization1,2. However, this process is time-consuming and largely manual. Automating data processing is crucial to maximize the value of the results. In this study, to efficiently accelerate identification of oxidation markers and overcome the challenges of finely characterizing CTs and their chemical evolution, thioglycolysis was combined with advanced analytical techniques. This includes AcquireX™ deep scan, an intelligent MS/MS data acquisition strategy and Feature-Based Molecular Networking, a powerful tool for organizing and visualizing MS/MS data, which facilitates the investigation of complex chemical matrices. This combined approach was applied to grape seeds, a well-known and rich source of CTs, to identify specific oxidation markers. Our study successfully highlighted 104 oxidation markers, including 49 previously unreported. These findings rapidly highlighted connections between structurally similar markers and enabled differentiating isomers across molecular network clusters, which might be missed by traditional methods. Detailed MS/MS analyses revealed dimers and trimers, indicating linkages between extension and terminal units, or both, classified according to their oxidation levels, from 1 to 8, revealing structural rearrangements that affect the quality and the stability of products containing them. Moreover, this innovative analytical approach, applied here for the first time, offers a new framework for studying the oxidation mechanisms of CTs in complex matrices. Beyond grape seeds, this methodology is being applied in an ongoing study to investigate broader aspects of aged wine chemistry. It focuses on both the oxidative and non-oxidative evolution of condensed tannins and their interactions, such as tannin-tannin, tannin-anthocyanin and aroma-tannin interactions during the aging process.

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P044 — Poster

The efficacy of barrier sprays to reduce the update of volatile phenols in a smoke event and the resulting sensory analysis of these wines

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Keywords: e taint, Descriptive analysis, Analytical Chemistry, Barrier spray

Wildfires release volatile phenols (VPs) through the thermal degradation of wood lignin, and these compounds can be absorbed by grape berries, leading to smoke taint in wine. As wildfire events increase in frequency and severity, the wine industry faces growing challenges, with few effective vineyard strategies available to prevent uptake or reduce sensory impacts. This study evaluated the efficacy of two potential barrier sprays, a clay-based kaolin treatment and a polymer based film forming product (EMP), previously identified as promising in vineyard trials. Four purpose-built greenhouses over two rows of Cabernet Sauvignon (Vitis vinifera) vines were used for controlled smoke exposure treatments. Each greenhouse contained two rows of six vines. Barrier sprays were applied 21 days before smoke exposure using a tractor-mounted sprayer at 60 g/L for kaolin and 10 g/L for EMP. Both were applied at a rate of 935 L/ha at a speed of 4 km/h. Corresponding control vines received water applications. Non-smoked control fruit was sourced from vines outside the greenhouses. Smoke exposure was conducted overnight for 10 hours using a pellet smoker with hickory pellets. Grapes were harvested 27 days later at 25 °Brix. Half of each treatment lot was washed at the winery using tap water sprayed over the grapes and a mechanical agitation prior to processing. Wines were produced using standard winemaking protocols. Sensory properties were evaluated using modified descriptive analysis, and free and total VPs in grapes and wines were quantified using gas chromatography-mass spectrometry (GC-MS). Chemical results showed that postharvest washing reduced VP concentrations in both grapes and finished wines compared to unwashed counterparts. Among treatments, kaolin combined with washing yielded the lowest VP levels. Sensory analysis supported these findings: washed kaolin-treated wines were rated closest to non-smoked controls and showed the least smoke-related attributes, while EMP and unwashed treatments retained noticeable smoky, ashy, and medicinal notes.

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P045 — Poster

Modulation of the aromatic and polysaccharide composition of white wines by varying the Kluyveromyces marxianus / Saccharomyces cerevisiae co-inoculation ratio

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Keywords: Kluyveromyces marxianus, co-inoculation, aroma, polysaccharides, white wine

In recent years, interest in non-Saccharomyces (NS) yeasts has grown significantly due to their distinctive metabolic characteristics and their impact on the sensory properties of wines. Driven by this, the present study investigated the influence of the Km L2009 Kluyveromyces marxianus strain on the volatile composition and polysaccharide profile of wines co-fermented with Saccharomyces cerevisiae. A Gewürztraminer must was inoculated with 2×10^6 CFU/mL, testing five different cell ratios of K. marxianus and a commercial S. cerevisiae: 80%, 90%, 95%, 99%, 99.9%. A pure S. cerevisiae and a sequential K. marxianus - S. cerevisiae fermentations were also included as controls. At the end of fermentation, samples were collected and the aromatic and polysaccharide composition of the wines were analyzed by GC–MS/MS[1] and HRSEC–RI, respectively[2]. Results indicate that K. marxianus increased short- and medium-chain fatty acids and their corresponding ethyl esters, while acetate esters were reduced. Although no difference in ethyl ester production was observed among K. marxianus protocols, the inoculation ratio was correlated with fatty acids and acetate esters content, with significant Person correlation coefficients (R = 0,74 and R = -0,55, respectively). Regarding grape-derived volatile compounds, protocols were not clearly differentiated. However, a positive trend ($p < 0.05$) was observed for increasing K. marxianus ratio and terpenes, which are typicity markers for Gewürztraminer. Moreover, differences were found in the polymerization degree of the polysaccharides released by the yeasts, which was again strongly correlated with the abundance of K. marxianus (R = -0.77). Thus, the choice of the K. marxianus to S. cerevisiae co-inoculation ratio emerges as an effective strategy for winemakers, allowing for the precise modulation of both the aromatic and polysaccharide profiles of wine.

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P046 — Poster

Onsite testing for Brettanomyces Bruxellensis contaminations during winemaking

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Keywords: Brettanomyces bruxellensis ; contaminations ; rapid tests ; LAMP ; ribosomal RNA

World wine production is estimated at 262 million hectolitres in 2022. Long spared from the constraints of the agri-food industry due to the absence of pathogens, the oenological sector is now facing the yeast Brettanomyces bruxellensis, which has a high potential for organoleptic deviation due to the production of volatile phenols that make wines unmarketable. This problem is currently the most concerning regarding wine quality. It poses significant challenges in the current context of reduced inputs (sulfites) and climate change, which raises the pH of wines and, as a result, increases their sensitivity. One of the main difficulties is the lack of efficient tools to detect and quantify the presence of this yeast. Current tests only partially meet the criteria to enable effective prevention and management of contamination. Indeed, the assay should be fast, inexpensive, easy to use, and usable on-site while quantifying only living cells. Here, a new approach was developed based on quantifying a specific ribosomal RNA (rRNA) sequence of Brettanomyces Bruxellensis. Thanks to loop-mediated isothermal amplification (LAMP), the assay was highly sensitive and specific, allowed easy detection, exhibited a large dynamic range, and was compatible with inexpensive commercially available readers. Furthermore, using rRNA as a target allowed for the quantification of living cells only. An analytical workflow was developed to simplify the isolation of rRNA using simple laboratory tools and commercial kits. The analysis of wines took less than 2h for a small cost per test. We will describe our latest results in this project.

P047 — Poster

Contribution of alcoholic fermentation and post-fermentation maceration to red wine sweetness: new insights on N6-succinyladenosine release

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Keywords: Sweetness, post-fermentation maceration, yeast autolysis

Recently, we identified in wine N6-succinyladenosine (NSA), a sapid molecule that contributes to the sweetness of red wines [1]. To gain insight on the biogenesis of this new impacting molecule, the kinetics release of NSA during alcoholic fermentation and post-fermentation maceration (PFM) was monitored by a LC-MS quantitative method. The impact of different enological parameters on NSA release were investigated, including the grape juice origin, the Saccharomyces cerevisiae strain used for alcoholic fermentation and the temperature during PFM. Our findings reveal that NSA, present in low amounts in grape juice and ranging from 10 to 200 µg/L, steadily increases during alcoholic fermentation, reaching final level of 500 to 1000 µg/L. Likewise, it appears that the post-fermentation maceration has a strong impact on NSA release, achieving concentrations higher that its perception threshold (>5000 µg/L). Both the duration and the temperature of PFM affect the kinetics of NSA release. By using flow cytometry, we demonstrated that NSA release is linked to yeast mortality occurring during the PFM, hence suggesting a positive effect of yeast autolysis. However, the biochemical origin of NSA remains to be more precisely determined. Finaly, this work reveals that the concentration of yeast cells at the end of alcoholic fermentation is a key factor influencing the final NSA concentration in wines. Besides, significant differences are observed in wines after MPF when different commercial wine yeast strains were used to perform alcoholic fermentation, paving the way for the selection of new yeast strains.

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P048 — Poster

A comparative study of sulfite quantification methods in wine

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Keywords: Sulfites, Reference methods, Innovative methods, Green analytical chemistry, Wine

Abstract *(maximum 2500 characters including spaces)*

Sulfites remain essential preservatives in winemaking due to their antioxidant, anti-oxidasic, and antimicrobial properties. The international Organization of Vine and Wine (OIV) defines maximum permitted levels through the OENO 09/1998 Resolution and requires sulfite labelling above 10 mg L^{-1}, a threshold associated with potential adverse effects in sensitive consumers.

In a context where reducing chemical inputs is a growing priority, a robust understanding of sulfite and accurate analytical tools become crucial. Currently, only two methods are officially recommended by the OIV: iodometric, so-called Ripper method, and aeration-oxidation, also known as Monier-Williams or Frantz-Paul method, while colorimetric, and FTIR based methods may also be used upon previous accurate calibration.

Beyond these approaches, numerous alternative methods have been proposed in the literature. However the question remains: is there a method capable of replacing the current ones? Ideally, such a method would be accurate, or even more accurate than existing techniques, while being simple to use, fast, cost-effective, and in line with the principles of green analytical chemistry. Moreover, the complexity of the wine matrix makes it difficult to fully understand how sulfites behave in wine. This highlights the need to develop alternative methods to better explain aspects of sulfite chemistry that are not yet understood.

This study provides a comprehensive overview of most of the analytical methods for sulfite quantification with a comparison based on their analytical performance and their compliance with green analytical chemistry. It includes the methods reported in the literature and the commercial instruments used by professionals. By combining a range of emerging technologies and methodological innovations, this work highlights the current opportunities to improve sulfite analysis and supports the development of more efficient approaches in the future.

P049 — Poster

Phenolic Profiles of Red Straw Wines: Impact of Grape Variety and Ripeness on Postharvest Dehydration

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Keywords: postharvest dehydration, wine phenols, Corvina, Moscato di Scanzo, Nebbiolo

Postharvest dehydration is applied as a winemaking strategy to increase sugar concentration and secondary metabolites in grapes, resulting in wines with peculiar compositional and sensory attributes. The process is influenced by temperature, relative humidity (RH), ventilation and duration, which determine water and weight loss (WL), and varies according to grape variety and ripeness [1]. The aim of this research was to evaluate the combined influence of ripeness level and grape variety on the phenolic profile of grape and resulting straw wines. 'Corvina', 'Moscato di Scanzo' and 'Nebbiolo' red grapes were harvested at three maturity levels (18, 21, 23 Brix) and subjected to dehydration (14–15 °C, 40–50% RH) until 20% WL. Total anthocyanins (ACNs) and flavonoids (TFs) were assessed in grape samples. After standardized micro scale winemaking, the resulting wines were characterized in terms of proanthocyanidin (PAC) profile. Mean degree of polymerization (mDP), conversion yield (CY) and galloylation (%G) were estimated. The investigated varieties showed distinct phenolic compound dynamics over the ripening and dehydration duration. Specifically, in terms of ACNs, negligible changes were observed for the increasing grape ripeness for all the varieties. In contrast, an increased concentration of FVs was found on wines processed from 'Corvina' harvested at 23 °Bx and 'Moscato di Scanzo' at 21 °Bx, while no change was shown for 'Nebbiolo'. A distinct pattern was evidenced for wine PACs which composition substantially unchanged in Corvina and Moscato di Scanzo wines. A relevant decrease of catechin and epicatechin, both constitutive and terminal units, was observed for Nebbiolo wines from more ripen grapes. Overall, the increased ripeness of grapes led to a lower concentration of PACs detected in wines. Nonetheless, the variation of mDP was limited, and CY and %G remained constant despite greater maturity. This study contributes to a deeper understanding of varietal-specific responses to postharvest grape dehydration, focusing on red grape varieties traditionally employed in this technique.

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P050 — Poster

Compositional and structural characterization of mannoprotein extracts obtained from non-Saccharomyces wine yeasts

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Keywords: mannoproteins, non-Saccharomyces yeasts, wine, polysaccharides, structure

Mannoproteins (MPs) constitute one of the most abundant classes of wine polysaccharides. They are proteoglycans located in the yeast cell wall that are composed by a major polysaccharide moiety (formed mainly by mannose) linked to a minor protein part. MPs are naturally released by yeast into the wine during alcoholic fermentation and during wine ageing on lees. Moreover, in winemaking, MP extracts can be added to the wine to improve some technological and sensory properties, such as protein and tartaric stability, astringency, color stability and aroma persistence, among others. However, some inconsistencies regarding the use of MPs in winemaking can be found in the literature, which can be explained by the high structural diversity of MPs conditioning their techno-functional properties in wine [1]. Moreover, most of the studies up to date have focused on MPs from Saccharomyces cerevisiae, while few information is available about MPs originating from non-Saccharomyces species. In this context, a more detailed characterization of MP structural diversity is needed in order to clarify structure-activity relationships, which would allow an effective use of these biopolymers in the wineries. Therefore, the objective of this work was to perform an in-depth characterization of MP extracts obtained from S. cerevisiae and from non-Saccharomyces yeasts. Ten MP extracts were obtained from five commercial enological yeasts (S. cerevisiae, Lachancea thermotolerans, Metschnikowia pulcherrima, Pichia kluyveri and Torulaspora delbrueckii) through induced autolysis and enzymatic hydrolysis with a -1,3-glucanase. The monosaccharide composition, determined by GC-FID, varied among the extracts, indicating different degrees of MPs purity. Moreover, the glycosyl-linkage composition, determined by GC-MS, also showed substantial variation, suggesting differences in the structure of the polysaccharide moiety of MPs belonging to different wine yeast species. Characterization of the net charge of MPs showed that almost all extracts obtained would display a net negative charge at wine pH. Finally, HPSEC-MALLS-QELS analysis allowed the identification, within each MP extract, of several MP populations likely exhibiting different macromolecular conformations, which highlighted the structural complexity of the MP extracts. Overall, these results offer valuable information regarding the impact of the extraction method and the yeast species on MP extract characteristics.

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P051 — Poster

Aromatic Fingerprint and Sensory Profile of Baratuciat, a Minor Autochthonous Cultivar from North-Western Italy

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Keywords: Baratuciat, Piedmont, aroma precursors, sensory analysis, polyfunctional thiols

The investigation of minor grapevine cultivars contributes to biodiversity preservation and supports more sustainable viticulture. Baratuciat is a white grape variety from north-western Italy, traditionally cultivated in marginal areas and recently re-evaluated for its enological potential. However, information on the aromatic composition of both the grapes and wines produced from this variety remains limited. The present study investigates the varietal aroma profile of Baratuciat characterizing grape aroma precursors through GC–MS analysis over two consecutive vintages (2023–2024). Indipendently, wines produced from the same variety were analyzed for their free volatile composition and polyfunctional thiols were determined by targeted LC–HRMS analysis in order to assess the contribution of these aroma compounds to the overall sensory profile. Finally, a sensory evaluation of commercial Baratuciat wines from different vintages was performed to characterize their sensory expression across years. Aroma precursors determined in grapes were grouped into major chemical families1. In both vintages, Baratuciat exhibited a terpene-dominated profile, with total terpene concentrations of 1547 µg/kg in 2023 and 1603 µg/kg in 2024, suggesting terpenes as key-role molecules in varietal aroma definition. Oxygenated monoterpenes were particularly abundant and consistent across the years. Cis-8-hydroxylinalool was the predominant compound, followed by trans-8-hydroxylinalool, linalool, and geraniol, which together define the floral–citrus notes of the varietal aroma. Secondary contributions were provided by norisoprenoids and benzenoid precursors, which may release aroma-active compounds during bottle aging, potentially contributing to balsamic and fruity nuances of the wine. Despite quantitative vintage-related fluctuations, the dominance of hydroxylated linalool derivatives and other major monoterpenes across years supports the classification of Baratuciat as a semi-aromatic variety, characterized by a terpene-rich profile and appreciable levels of norisoprenoid and benzenoid compounds. These results, together with the chemical and sensory evaluation of the wines, provide valuable insights for optimizing vinification practices and bottle-aging strategies aimed at enhancing the expression and enological valorization of this rare variety.

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P052 — Poster

NMR-based metabolomic tools for quality control and authenticity assessment of wines aged with alternative wood products

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Keywords: wine authenticity, quality control, NMR metabolomics, alternative wood aging, chemometrics

The increasing use of alternative wood products (e.g. chips, staves and large oak vessels) in enological aging practices raises relevant issues related to quality control, traceability and authenticity assessment, particularly in the context of regulatory monitoring. Analytical approaches capable of providing robust and reproducible compositional fingerprints of wines are therefore required. Nuclear Magnetic Resonance (NMR) spectroscopy represents a powerful, non-destructive technique for untargeted metabolomic characterization of complex matrices such as wine. This work evaluates the potential of an NMR-based metabolomic approach combined with multivariate statistical analysis for the assessment of alternative wood aging practices, with a specific focus on applications related to quality control and authenticity. Preliminary trials involved the characterization of French oak chip extracts with different toasting levels, obtained through optimized Soxhlet extraction protocols and supported by the analysis of reference standards of key wood-derived compounds. Subsequently, hydroalcoholic model solutions (12% v/v ethanol, pH 3.2) and experimental monovarietal wines were treated with alternative wood products under controlled conditions (3 g/L; 45 days). The experimental wines included four grape varieties (Nebbiolo, Barbera, Pinot Noir and Merlot) subjected to different aging modalities, namely chips, barrique, large oak vessels, staves and untreated controls. 1H NMR spectra were acquired at 600 MHz following standardized sample preparation procedures, and spectral data were processed using bucket integration and principal component analysis (PCA). Multivariate analysis highlighted a clear discrimination among grape varieties, confirming the dominant influence of varietal composition on the global NMR metabolomic profile. In contrast, separation among different wood aging treatments was less pronounced, although partial trends were observed for barrique-aged wines. These results indicate that, under the applied conditions, varietal effects outweigh the impact of alternative wood aging in untargeted NMR-PCA models. Overall, NMR metabolomic fingerprints appear suitable as a screening tool for wine authenticity and quality control, while the discrimination of specific wood aging practices requires the integration of supervised chemometric models and complementary targeted analytical techniques.

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P053 — Poster

VOLATILE COMPOSITION AND SENSORY PROFILE OF ARMENIAN APRICOT DISTILATE (eau-de-vie)

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Keywords: apricot distillate; production technology; volatile compounds; HS-SPME/GC-MS; sensory profile

Apricot (Prunus armeniaca L.) has been cultivated in the territory of Armenia for millennia and remains a national symbol and a key fruit crop. It plays a central role in rural agriculture and supports both the canning and spirits industries. Apricot distillates represent a distinctive category of Armenian fruit spirits. In this study, the technological production process of apricot eau-de-vie was documented together with HS-SPME/GC-MS profiling of volatile compounds. Fresh apricots harvested in the Ararat Valley were fermented without the addition of sugar using SafSpirit™ FD 3 (S.cerevisiae) yeast and double-distilled in copper alembics. The spirit was blended with pure water (reverse osmosis) to obtained 45% ABV and bottled. Analytical profiling identified 64 volatile compounds, mainly esters (ethyl decanoate, ethyl octanoate and ethyl laurate) and terpenes (linalool, geraniol). Studies on other apricot brandies confirm that ethyl decanoate emerges as the principal ester and that cultivar influences terpenic expression, particularly linalool content. Technological interventions (cold stabilization and chill membrane filtration) have been shown to selectively reduce ester fractions, improving clarity but potentially affecting aroma retention. Previous investigations of raw apricot distillates highlighted norisoprenoids, including β-damascenone and theaspiranes, together with terpenes, as key sensory markers, in agreement with the present results. Studies on fresh apricot fruit further demonstrate that γ-decalactone, β-damascenone, and linalool are contributors to apricot aroma, many of which persist after distillation. A sensory analysis was conducted using a trained panel of 12 assessors to correlate analytical data with organoleptic perception. The aromatic profile was expressive and balanced, clearly fruity with distinct apricot and peach notes. Floral nuances of orange blossom were integrated with fresh herbaceous hints and subtle aromatic herbs, enhancing complexity without masking other components. Secondary impressions of apricot stone and honey added depth. On the palate, alcohol warmth was pronounced, giving a full-bodied and warming character. Sweetness was moderate and bitterness low, resulting in a smooth and approachable mouthfeel. Overall, the combination of Armenian terroir, traditional distillation technology, and volatile composition rich in esters and terpenes defines the unique sensory identity of Armenian apricot eau-de-vie.

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P054 — Poster

Comparative analytical and sensory profiling of Armenian orange wines from widely cultivated grape varieties under low-intervention skin-contact vinification

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Keywords: orange wine, skin-contact vinification, natural wine, spontaneous fermentation, sensory profiling.

Orange (skin-contact) wines are experiencing renewed global interest, yet published data remain scarce for Armenian white varieties and local low-intervention practices. This study presents a comparative analytical and sensory characterization of Armenian white grape variety Mskhali and the Georgian variety Rkatsiteli, widely spread in Armenia, vinified using natural wine production requirements and skin contact: orange wine technology in stainless steel tanks and of their blended vin d'assemblage bottled as Yerevak Orange Natural wine. Grapes were collected from Norabats village Rkatsiteli was harvested in early September 2022 and Mskhali in October 2022; fermentations were spontaneous (wild yeast) with cap management performed 2 to 3 times daily. Wines matured for approximately one year before bottling. No additives or preservatives were applied, including no sulfur dioxide addition. Wines were bottled on 09 May 2023 after sheet filtration and without stabilization treatment, allowing possible natural sediment. Following vinification, the monovarietal wines and the blended wine (vin d'assemblage) were analyzed for physicochemical parameters in EVN Wine Academy laboratory. The analyses shows that alcohol ranged from 10.7 to 11.9% (v/v), titratable acidity from 4.20 to 5.83 g/L and pH from 3.52 to 4.07. Total phenolics varied markedly and Rkatsiteli showed high phenolic contents. The wines were evaluated by 2 panels (in Armenia and in Italy) which consistently identified dried fruit, cooked apple, apricot, walnut, honey, vegetal notes, orange blossom, moderate bitterness and a tea-like astringency as the main shared descriptors. Descriptive sensory profiling indicated that the blend expressed a stronger dried-fruit character and a more structured, tea-like tannin perception than the monovarietal Mskhali orange wine. From an aromatic point of view, Yerevak Orange Natural wine is dominated by fermentation-derived volatiles, particularly higher alcohols, ethyl lactate, and succinate-related esters, while fruity ethyl esters are quantitatively secondary. Among varietal compounds, norisoprenoids derived from carotenoids and vinylphenols originating from hydroxycinnamic acids represent the main components extracted during skin maceration. These results provide baseline compositional and sensory data for Armenian orange wines and suggest that blending can be used to balance acidity, phenolic structure and aromatic expression in low-intervention skin-contact wines

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P055 — Poster

Long-term study on Phenolic Compounds in Austrian Red- and White Wine Varieties from 20 Vintages

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Keywords: Vintages; Terroir; Chemometrics, Autochthonous

Phenolic compounds have a significant influence on the quality, taste, and aging potential of wines. The aim of this study was to conduct a long-term investigation of autochthonous Austrian red and white wine varieties based on phenolic compounds. The data set comprised 437 red wines from six grape varieties and 792 white wines from eight grape varieties from the 2002 to 2023 vintages, which were vinified as part of the Austrian wine database. All wines were produced under standardized conditions. Phenolic compounds were determined using HPLC-DAD. Statistical analysis included variance, discriminant, and principal component analysis, with the factors of grape variety, vintage, and origin. For both red and white wines, the grape variety proved to be the dominant factor influencing the phenolic profile, followed by vintage and location. Red wines showed a more pronounced differentiation between grape varieties, mainly due to flavan-3-ols and anthocyanins. The Blauer Wildbacher variety also showed increased concentrations of several flavanols. The Blaufränkisch variety showed significant location-related effects, indicating terroir sensitivity. This location-related discrimination based on phenolic compounds was not observed in any other variety. A comparison of the discriminant models showed that wines made from the Zweigelt grape variety had a higher correct classification rate by vintage compared to the other varieties. The phenolic composition of the white wines, on the other hand, was predominantly characterized by hydroxycinnamic acid esters. The Rheinriesling variety showed significantly increased concentrations of selected compounds across all vintages and locations. Over the study period, both red and white wines showed a steady increase in certain phenolic compounds, with differences in the individual parameters. While the increase in red wines was mainly observed in flavan- and tannin-associated compounds, in white wines it was primarily caused by hydroxycinnamic acid esters. Overall, the results highlight both fundamental differences and common trends in the phenolic profiles of red and white wines and provide a basis for evaluating varietal and vintage-related quality characteristics under long-term conditions.

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P056 — Poster

Effects of Oenological Practices and Site Factors on Benzenemethanethiol and Rotundone Concentrations in Blaufränkisch

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Keywords: Blaufränkisch, Benzenemethanethiol, Rotundone, Oenology, Terroir

While several important Austrian red grape varieties, most notably Zweigelt, are increasingly affected by the consequences of climate change – such as berry shrivel, which leads to substantial qualitative and quantitative yield losses and remains largely uncontrollable – the variety Blaufränkisch has so far proven comparatively resilient to these developments. Against this background, Blaufränkisch was re-evaluated in recent investigations, with particular emphasis on two highly potent aroma compounds: benzenemethanethiol (BMT; odour detection threshold 0.3 ng/L; sensory descriptors “gunpowder”, “flint”) and rotundone (odour detection threshold 16 ng/L; “spicy”, “peppery”). Both compounds were quantified using specific GC–TQMS analytical methods. In a controlled maceration experiment, a homogeneous Blaufränkisch must was subjected to different treatment regimes involving the alternating addition of reduced glutathione (GSH-IDY), oak wood chips and oxygen. The results demonstrated that the application of oak chips led to a significant reduction in benzenemethanethiol concentrations (−18%), whereas GSH-IDY and oxygen had no significant effect on BMT levels under moderate yeast-assimilable nitrogen (YAN) conditions. In addition, a field study investigated the effects of yield regulation and leaf removal on rotundone concentrations in Blaufränkisch. Site-related factors emerged as the dominant drivers of rotundone expression. Although a significant increase in rotundone concentration (+56%) was observed at one site in the non-defoliated and non-yield-reduced (control) treatment, this effect could not be reproduced consistently across other locations. Furthermore, at one site, a mild infection with powdery mildew resulted in more than a tenfold increase in rotundone concentration across all treatments. Overall, the findings highlight a continued need for further research, particularly with regard to the formation pathways and modulation mechanisms of benzenemethanethiol. A deeper understanding of these processes may enable winegrowers to purposefully manage distinctive aroma profiles, thereby enhancing both sensory differentiation and market positioning in an international context.

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P057 — Poster

Process Optimization of Subcritical Water Extraction for the Recovery of Antioxidant Compounds from White Wine Lees

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Keywords: White wine lees, Subcritical water extraction, Antioxidants, Response Surface Methodology

Subcritical water extraction (SWE) represents a highly efficient green alternative to conventional organic solvents such as methanol, ethanol, or acetonitrile for the recovery of bioactive compounds from white wine lees, leading to more than a threefold increase in the antiradical activity of the extracts [1]. Using a Doehlert experimental design combined with response surface methodology (RSM), the extraction process was optimized by varying temperature, extraction time, and stirring speed [1]. Temperature was identified as the key parameter driving the enhancement of antioxidant capacity as evaluated by DPPH (antiradical activity), FRAP (ferric reducing antioxidant power), and oxygen consumption rate (OCR) assays. Optimal conditions were achieved at 240 °C for 15 min and 550 rpm, yielding extracts with high antioxidant activity [1]. Chemical analysis by LC-HRMS of the extracts obtained under optimal conditions revealed a high total sulfhydryl (TSH) content. A strong positive correlation was observed between TSH levels and antioxidant capacity, whereas glutathione (GSH) showed no such correlation [1, 2]. These results suggest that the antioxidant activity mainly originates from sulfhydryl-containing compounds derived from the protein and lipid fractions of wine lees. High SWE temperatures promote hydrolysis and the release of these compounds from yeast cell walls, resulting in extracts in which elevated sulfhydryl content is directly associated with enhanced antioxidant capacity [1, 2]. The antioxidant capacity of extracts was further evaluated in wine, where they exhibited a strong ability to reduce oxygen consumption through their antiradical activity, thereby slowing chain oxidation reactions [1].

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P058 — Poster

Determination of major aroma compounds in wine by HS-SPME-Arrow GC-FID

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Keywords: SPME Arrow, wine, aroma, headspace

Wine is a complex matrix in which a diverse array of volatile compounds, ranging from major components to trace compounds, collectively define its quality. Among these are compounds produced during alcoholic fermentation, typically found in concentrations exceeding their odor thresholds (ranging from 0.1 mg/L to several hundred mg/L). Specifically, ethyl esters, acetates, higher alcohols, volatile acids, acetaldehyde, and 2,3-butanedione are critical to the interpretation of wine aroma. While numerous analytical methods exist for these compounds [1], this study presents the development and validation of a method based on SPME Arrow extraction. This approach provides a robust, cost-effective, eco-friendly, and highly automated procedure for analyzing major wine aroma compounds. The proposed method utilizes headspace (HS) SPME Arrow GC-FID on highly diluted wine samples. This dilution effectively eliminates matrix effects and standardizes alcohol content, that are usually the drawbacks of original SPME, allowing for the simultaneous analysis of 29 compounds. The figures of merit confirm that the method's reproducibility, linearity, detection limits, and accuracy are comparable to the liquid microextraction techniques used in our laboratory for years. Furthermore, this new method significantly reduces analysis time and sample manipulation while eliminating the use of organic solvents.

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P059 — Poster

New insights into wine polysaccharides quantification: Evaluation of acidic methanolysis challenges and different two-step sequential precipitation strategies

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Keywords: Polysaccharides, Precipitation, Quantification, Acidic methanolysis, GC-MS

Among the macromolecules present in wine, polysaccharides represent one of the most complex and abundant classes. Commonly classified as grape- or yeast-derived polymers, they play a crucial role in wine quality and colloidal stability1,2. Despite their importance, polysaccharide analysis remains challenging and requires a prior isolation step, most often achieved by ethanolic precipitation3. While several methodological improvements have been proposed to increase precipitation repeatability, only a limited number of studies have investigated how sample preparation and precipitation conditions influence the recovery of the different polysaccharide families4,5. As a result, a strong need for analytical approaches that combine efficient extraction with reliable qualitative and quantitative measurements still exist3. Recently, the influence of sample preparation and precipitation steps on wine polysaccharides recovery and detection by HRSEC-RI and GC–MS, following acidic methanolysis and derivatization, was re-evaluated by our group through the application of design of experiments (DoE) techniques6. This work highlighted the possibility of selectively recovering yeast-derived polysaccharides or both yeast- and most grape-derived polymers depending on precipitation conditions. However, the results also suggested that acidic methanolysis efficiency may depend on the nature of the precipitate obtained and that a single precipitation step may be insufficient to recover the full diversity of wine polysaccharides6. In the present study, the challenges and limitations of acidic methanolysis are investigated in detail, with particular attention to the water content of solvents and to the dehydration of polysaccharide extracts. Several strategies aimed at minimizing water content were evaluated, and a modified acidic methanolysis protocol is proposed to improve polysaccharide conversion into TMS methyl glycosyl derivatives while limiting their secondary hydrolysis into free monosaccharides. Moreover, a two-step sequential precipitation scheme was systematically applied under different conditions across various wines to identify conditions leading to maximal polysaccharides quantification and to examine how polysaccharides are distributed between the two precipitation steps. Overall, this work provides a refined methodological framework for wine polysaccharides quantification and offers new perspectives for studying their role in wine colloidal systems.

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P060 — Poster

Aroma Trajectories Under Climate Pressure: How Must pH Shifts Reshape Alcoholic Fermentation (AF) VOCs Pathways and Final Wine Sensory Profiles

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Keywords: acidity, volatiles, fermentation dynamics, chemical analysis, sensory analysis

Climate change (CC) is altering grapes and must by affecting technological performance and wine quality[1], including VOCs and sensory features(2). Under the current CC, the increased pH(3) may modulate VOCs formation during AF and impact their evolution over time with consequences on wine aroma quality and typicality. This study investigates how pH variations influence formation kinetics of VOCs during AF of a must and sensory quality of the final wine. A Falanghina white grape must was adjusted at increasing 3 pHs (3.2-3.5-3.8) representative of the current CC-related pH-shift and fermented at 16°C in batch micro-vinifications (3 replicates per pH). During AF, 64 VOCs were isolated by LLE at 7 sampling times (Days:D0-3-7-10-14-22-25) and quantified (calibration curves) by GC/MS (triplicate). At D25, 15 trained subjects evaluated olfactory and taste attributes of the final wines by RATA sensory method (duplicate). Preliminary results suggest that, across all pHs, total VOCs rise sharply after AF onset, peak at D7-10, then decline, remaining consistently higher at pH3.8, with compound-specific kinetics and pH effects. Isoamyl acetate peaks at D7 and remains stable, with highest concentrations at pH3.8 (significant at D7). Phenethyl acetate increases early, reaches a maximum at D10, and declines during the late stages, showing consistently higher levels at pH3.8 from D7 onward. Ethyl hexanoate follows a temporal trend like phenethyl acetate without significant pH effects, whereas ethyl octanoate exhibits an evolution comparable to isoamyl acetate. 1-Butanol peaks at D10 and then declines, with significant pH differences observed only at D25 (pH3.8>3.5>3.2). 1-Hexanol and cis-3-hexenol show early increases (D3) with the highest concentrations at pH3.2 and a decrease at increasing pH, a trend also observed for linalool and α-terpineol, which rise the maximum concentration at D7 that is maintained till the end. PCA on chemical and sensory data of the final wines discriminates samples by pH. pH3.8 clusters with a fruity/banana–mango profile, driven mainly by acetate and ethyl esters. pH3.2 aligns with vegetal/mineral/dried-fruit notes, associated with C6 alcohols, terpenes, and a few lactones. pH3.5 forms a distinct group linked to tropical/balsamic notes, showing fewer VOCs correlations (guaiacol, ethyl valerate). The study provides useful insights for wine fermentation aimed at managing VOCs composition and sensory expression under CC–related pH conditions.

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P061 — Poster

Is the shelf-life of wines spirits influenced by their ageing technology?

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Keywords: Shelf-life, Wine Spirit, Ageing technology, Physicochemical characteristics

Wine Spirit (WS) is a spirit beverage that is usually consumed after ageing. In the production process, this stage is essential to achieve the desired sensory properties, depending on several factors, including the wood botanical species and the technology applied1. However, it is a time-consuming and expensive stage2. In this context, the research project Centro-04-3928-FEDER-000001was developed, aiming to study aged WS resulting from different ageing technologies (traditional technology using wooden barrels and alternative technology combining wood staves with micro-oxygenation - MOX), together with different botanical species (Q. robur L. and C. sativa Mill.). To this end, the same "Lourinhã" wine distillate was distributed by 250 L barrels made from Limousin oak or chestnut, and by 1000 L stainless steel tanks with wood staves inside (Limousin oak or chestnut) combined with MOX (flow rate 2 mL/L/month), in duplicate, and it was aged for 18 months1. To deeply assess the implications of the ageing stage, it is important to study the shelf life (SL) of aged spirits, which reflects the effect of opening the bottle on the characteristics of the product. By definition, the SL of a food or beverage is the period during which the product maintains its microbiological safety and sensory characteristics under certain storage conditions3. As aged wine spirit is an alcoholic beverage with a high ethanol content and low pH, it is considered to be microbiologically stable and, as far as we know, does not have a determined SL. The objective of this study was to verify whether the SL of WS is influenced or not by the ageing technology used. Thus, some physicochemical characteristics - acidity (total-TA, fixed-FA and volatile-VA), total dry extract (DE) - were analysed by the OIV methods, and total polyphenol index (TPI)1, in duplicate, 11 months after opening of the bottle. The results showed that the WSs produced by alternative technology with chestnut wood had a longer SL than those produced by the traditional one, based on non- significant differences between sampling times for variables highly correlated with the product's quality: DE (t0 – 1.70 ± 0.08; t11 – 1.73 ± 0.05; p-value – 0.6070) and TPI (t0 - 46.08 ± 2.94; t11 – 45.66 ± 3.88; p-value – 0.8256). In summary, these first results suggest that SL is influenced by the ageing technology and the kind of wood used.

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P062 — Poster

Comprehensive Analytical Workflow for Fermented and Non-Fermented Grape-Based Beverages Volatile Profiling: Higher Resolution and Reliability for a Wide Range of Molecular Structures

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Keywords: Grape-based beverages, No/Low alcohol beverages, GC×GC-ToFMS, HS-SPME, VOCs

The increasing demand for no/low-alcohol beverages (<5% v/v) has intensified the need for technological innovation in grape-based products within this category. Such innovation must be supported by robust analytical data to guide process monitoring. Although advanced analytical techniques, such as Headspace Solid-Phase Microextraction (HS-SPME) combined with Comprehensive Two-Dimensional Gas Chromatography (GC×GC), are already well stablished for the study of beverages volatile composition, studies are usually focused on one type of beverage and not on comparative studies involving fermented and non-fermented beverages with different ethanol contents and compositional complexity. Chemical complexity arises from compounds generated during fermentation, such as esters and higher alcohols that become major compounds in beverages and difficult analysis[1], while rising ethanol concentrations alter the partitioning behaviour of volatile compounds in the headspace. Therefore, optimizing sample preparation parameters and selecting an appropriate gas chromatographic method are fundamental steps in the development of a workflow for the characterization of volatile composition of grape-based beverages with different chemical complexity and ethanol content. This research aimed to develop a solvent-free and high throughput approach based on HS-SPME/GC×GC that enables a comparative profiling of grape-based beverages with and without ethanol (from 0% to ca. 10%). To fulfil this objective three main aspects were considered: a) HS-SPME parameters, namely fiber coating and extraction time, to ensure balanced sensitivity and selectivity across a wide range of volatile compounds, b) chromatographic conditions, namely columns configuration and secondary-oven temperature offset, to enhance resolution and peak capacity, and c) chromatographic data normalization to reduce variability and enhance results reliability. A reverse column configuration combined with a triple-phase fiber coating combined with selected extraction time (5 pre-equilibrium followed by 15 min of extraction) and internal standard normalization provided improved compound coverage, enhanced separation of structurally diverse volatiles, and reduced analytical variability across matrices with different ethanol contents. These findings establish an analytical workflow for comprehensive volatilome characterization of grape-based beverages, supporting innovation in no- and low-alcohol product development.

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P063 — Poster

Phenolic composition and antioxidant activity of seeds and stems of hybrid grapes

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Keywords: Hybrid grapes; UPLC–DAD; DPPH; Winemaking; Grape composition

Winemaking in France dates more than 400 BCE and it has evolved a lot through the ages. Today, it faces two major problems: the over usage of pesticides and rapid progress of climate change. One of the strategies to overcome these issues is the employment of hybrid varieties. Such varieties can however present an unusual characteristic phenolic profile. In red grapes, phenolics are the main components responsible for the flavor profile and they also are associated with health benefits, however their concentration and exact composition varies depending on the year and compartment of the grape that is considered. The main aim of this research was to broaden the knowledge on the phenolic composition of hybrid grapes by gathering the phenolic profile of seeds and stems of four new hybrid grapes: Vidoc, Artaban, Coliris and Chamburcin, over three vintages (2022-2024). Phenolic compounds were extracted from seeds and stems using solid/liquid extraction. The obtained phenolic extracts underwent chemical analysis including Total Phenol Concentration (TPC), Total Tannin Concentration (TTC), Total Anthocyanin Concentration (TAC). To determine the phenolic profile of the extracts, two methods for UPLC - DAD were used, one for phenols present in red wine and one specifically targeting anthocyanins. Antioxidant activity was also assessed through DPPH assay. Notable differences were observed both among the different hybrids, as well as between seeds and stems within the same hybrid variety over the different vintages taken into consideration. Vintage variation seems to affect stems more than seeds, which may indicate the higher sensibility of stems to climate parameters. Regarding UPLC-DAD results, 16 compounds were identified and quantified in grape stems, while only 9 compounds were successfully identified and quantified in seeds. Nevertheless, some of the compounds identified in seeds were present in only one of the varieties studied, showing their potential to be used as chemical markers for variety identification. For instance, Coliris contains caffeic and caftaric acids, and it is the only hybrid with those components. These results give us a first insight of the concentration and specific phenolic profile in these four new hybrids, showing their variability over the different vintages.

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P064 — Poster

Biochemical markers of grape berry textural maturity and their implications for compound extractability and wine physico-chemical stability

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Keywords: textural maturity, cell wall degradation, polysaccharide extractability, phenolic compounds, wine stability

In the context of climate change, grape ripening is increasingly suffering a decoupling between technological, phenolic, and textural maturity. Textural maturity is closely associated with the structural and biochemical evolution of skin cell walls, whose composition and macromolecular organization determine the extractability of oenologically relevant compounds during winemaking(1,2). The aim of this study is to investigate the evolution of grape skin cell wall composition throughout ripening and to identify biochemical markers capable of predicting the extractability of polysaccharides and phenolic compounds in wine, with direct consequences for wine quality and physicochemical stability over time. Cabernet Sauvignon grapes were harvested at different stages of technological maturity from véraison onwards within a selected vineyard plot over two consecutive vintages. Skin degradation was assessed through mechanical measurements (penetrometry) and by monitoring pectolytic enzymatic activities involved in cell wall remodeling. Cell wall composition was first characterized in isolated grape skins using chemical approaches, including polysaccharide analysis by size-exclusion chromatography (SEC) and phenolic profiling by high-performance liquid chromatography coupled with mass spectrometry (HPLC–MS). The extractability of polysaccharides and phenolic compounds of oenological interest was subsequently assessed in wines produced by controlled microvinifications performed on the same grape batches. Wine samples were analysed using SEC for polysaccharide profiling and HPLC–MS for phenolic characterization. Results demonstrate that ripening-related modifications in skin cell wall composition and organization significantly modulate the extractability of macromolecules and phenolic compounds into wine, thereby influencing its structural balance and stability. These preliminary studies must be confirmed to identify robust indicators of textural maturity as predictive tools to guide harvest decisions and optimize vinification strategies according to targeted wine styles, while offering opportunities to reduce oenological inputs.

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P065 — Poster

Evaluating the Greenness of Wine Analytical Chemistry: A New Metric Approach

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Keywords: Greenness metric, environmental impact, sustainability, wine analysis

Wine is a complex matrix influenced by climatic, agricultural, and winemaking factors, making quality control and authenticity assessment essential. Alongside analytical performance, sustainability has become a priority. Although tools such as the Analytical Eco-Scale, GAPI, and AGREE assess the greenness of analytical methods, they present limitations when applied to wine analysis. To address these gaps, this study introduces the Green Wine Analytical Procedure Evaluation (GWAPE), a dedicated framework for assessing the environmental impact of wine analytical methods. GWAPE integrates and refines existing green metrics, excludes non-relevant criteria, and introduces new principles tailored to enological analysis. The metric is structured around 10 principles and is supported by a Python-based software tool. GWAPE was applied to three common wine analytical procedures: enzymatic determination of glucose and fructose, determination of reducing substances, and FTIR-based determination of glucose and fructose. The results highlighted clear differences in environmental performance, with FTIR being the most eco-friendly method (3.5/5), followed by enzymatic analysis (2.5/5), while the determination of reducing substances showed the highest environmental impact (1.8/5). GWAPE provides a practical and quantitative tool for comparing analytical procedures, supporting greener decision-making in wine analysis and promoting sustainable practices within the sector.

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P066 — Poster

Higher Alcohols and Other Volatiles in Non or Low Alcoholic (NOLO) Wines: Insights from GC-FID and NMR Analysis

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Keywords: Non- and low alcoholic wines, Dealcoholization, Nuclear Magnetic Resonance (NMR), Higher alcohols, Wine aroma

Climate change and changing consumer preferences are driving the growth of no- and low-alcohol (NOLO) wines, increasing the use of dealcoholization technologies such as reverse osmosis. However, ethanol reduction presents analytical and sensory challenges, particularly regarding accurate alcohol quantification and aroma preservation. This study evaluates the chemical profile of dealcoholized wines, with emphasis on higher alcohols and volatile compounds. Nuclear Magnetic Resonance (NMR) spectroscopy and Gas Chromatography–Flame Ionization Detection (GC-FID) were applied as complementary techniques to assess compositional changes in dealcoholized wines. Dealcoholization led to significant reductions in key aroma compounds, including ethyl acetate, alongside increased acetaldehyde levels, particularly in white wines, suggesting oxidation effects or altered yeast metabolism. Higher alcohols such as 3-methylbutan-1-ol and isobutanol also decreased, potentially affecting aroma and mouthfeel. NMR demonstrated strong performance for ethanol quantification at low concentrations, providing reliable results in complex wine matrices with minimal interference. These results highlight the need for robust analytical approaches and support NMR as a promising alternative for alcohol determination and quality control in NOLO wines.

P067 — Poster

Phenolic Composition and Wine Potential of Grapes at High Altitude Regions in Yunnan, China

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Keywords: Grape, wines, phenolic compounds, high-altitude

Yunnan is a southwestern province in China characterized by a low-latitude, high-altitude plateau climate, which is considered suitable for producing high-quality red wines. The vineyard areas are located at around 2000 m above sea level, extending from the river's alluvial plains to the mountain slopes. Phenolic compounds, particularly anthocyanins and tannins, are strongly influenced by environmental conditions and are key determinants of wine quality. To investigate the phenolic characteristics of grapes and the resulting wine quality in this region, as well as to identify potential high-altitude markers, Cabernet Sauvignon, Petit Verdot, and Merlot grapes were collected from 12 vineyard sites across three representative villages, ranging in altitude from 2117 m to 2391 m. Grape skins and seeds were separated from berries and immersed in a wine model solution to simulate a 7-day maceration. In parallel, lab-scale alcoholic fermentations were conducted to obtain wine samples. The extracts and wines were analyzed for both general and phenolic parameters, including IPT, total phenols, total anthocyanins, and total tannins. Additionally, molecular tannins, molecular anthocyanins, and the mean degree of polymerization were examined to better assess the enological potential of grapes at different altitudes. This study provides a deeper understanding of the relationship between altitude and grape phenolic composition in Yunnan, offering insights into the unique quality potential of high-altitude vineyards in China.

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P068 — Poster

Chemical Composition of Sauvignon Blanc Wines with Varying Alcohol Levels

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Keywords: Sauvignon Blanc, Chemical composition, Alcohol level, Sensory profile

Non-alcohol or low alcohol wines have become more popular due to the rising trend towards a healthier lifestyle1. Moreover, the growing value of the non-alcohol wine market is remarkable, and in 2021 the total worth of the non-alcoholic wine market exceeded USD1.6 billion, and it is projected to reach approximately to USD 4.5 billion by 2031. A market analysis indicates that the non-alcohol wine market in the USA, Australia, France, Italy, and Germany is projected to grow at compound annual growth rates of 9.6%, 12.2%, 11.0%, 9.9%, and 9.0%, respectively, between 2021 and 2031 2. This study investigates the chemical composition of the most popular exported wine from New Zealand, Sauvignon Blanc, with three alcohol levels, full, lighter and zero. Volatile aroma compounds and major polyphenols were quantified using gas chromatography–mass spectrometry (GC-MS) and high-performance liquid chromatography (HPLC-UV). Sensory evaluation was also conducted by a trained Descriptive Analysis panel to assess the aroma and palate characteristics of the commercial wines. The results showed that reduced-alcohol wines, especially zero alcohol wines, consist of lower levels of key aroma compounds and higher levels of polyphenols. The variations were mainly influenced by dealcoholization processes and differences in base wine composition. Correlation analysis between chemical profile and sensory data revealed how flavor perception changed with alcohol level. Overall, the findings improve the understanding of how alcohol reduction influences both the chemical composition and sensory characteristics of commercial Sauvignon Blanc wines. The results may support the development of low- and no-alcohol wines in response to growing market demand.

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P069 — Poster

Integrated Chemical Markers of Regional Typicity in Chilean Cool-Climate Pinot Noir Wines

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Keywords: Pinot Noir; cool-climate wines; phenolic compounds; polysaccharides; regional typicity

Pinot Noir wines produced under cool-climate conditions often display subtle phenolic expression and high sensitivity to environmental variation, making the identification of regional typicity particularly challenging. In Chile, the recent expansion of Pinot Noir into diverse cool-climate areas has increased the need for robust analytical approaches capable of distinguishing regional characteristics based on objective chemical parameters. In this work, forty-three commercial Vitis vinifera L. cv. Pinot Noir wines from five Chilean cool-climate regions (Limarí, Casablanca, Leyda–San Antonio, Southern, and Austral), corresponding to the 2021 and 2022 vintages, were characterized through an integrated analytical strategy combining phenolic composition, polysaccharide fractions, and color chemistry. Low-molecular-weight phenolics and individual anthocyanins were quantified by HPLC–DAD, polysaccharides were analyzed according to molecular weight distribution using HPSEC–RID, and color parameters were determined by UV–visible spectrophotometry together with CIELAB coordinates. The results revealed significant regional differences mainly associated with anthocyanin composition, chromatic expression, and specific polysaccharide fractions, whereas total phenolic content and total tannins showed limited discriminatory capacity. These findings highlight the usefulness of combining targeted chemical analyses to define regional signatures and improve the understanding of terroir expression in Chilean cool-climate Pinot Noir wines.

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P137 — Poster

Unravelling the nitrogen profile of the new descendant varieties of Monastrell. Preliminary study

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Keywords: aminoacids, hybrids, grape, wine, fermentation

The amino acid composition of grape must is a critical factor influencing both fermentation dynamics and the sensory attributes of wine. Amino acids act as essential nitrogen sources for yeast metabolism, directly affecting fermentation performance and the production of secondary metabolites. Beyond their nutritional role, amino acids serve as precursors for a wide range of volatile compounds, including higher alcohols, esters, and aldehydes, which are key contributors to wine aroma.

This is a preliminary study on the amino acid content of the new red grape varieties descendants of Monastrell (Calnegre, Carmolí, Gebas, MS104, Myrtia and Quípar) developed at IMIDA and its parental varieties (Monastrell, Cabernet Sauvignon and Syrah). The analysis were carried out by HPLC over two vintages (2024 and 2025), following the methodology proposed by Gómez-Alonso[1] with some modifications.
The results showed a lower synthesis of aminoacids in 2024 due to meteorological conditions. Even so, MS104 reached higher aminoacids amount in 2024 and Monastrell was not affected. Quípar, Myrtia, MS104, Carmolí, Monastrell, Cabernet and Syrah shown a particular aminoacids profile over the two studied seasons in contrast to Gebas and Calnegre in which there is no consistency over the two seasons. Concerning the fermentation performance, it was observed that Cabernet Sauvignon and Quípar were great proline accumulators, Gebas, Calnegre y Myrtia were medium proline accumulators and finally Monastrell, Syrah, Carmolí and MS 104 were low proline accumulators. About proline/arginine ratio, Cabernet Sauvignon reached the highest ratio, over 100, in contrast to Monastrell, MS 104, Myrtia and Syrah that were between 4.6 and 1.5.

In conclusion, the different grape varieties showed different characteristic aminoacids profile, which could affect the development of diverse aromatic characteristics in wines. Relate to the fermentation performance, Cabernet Sauvignon may require additional nitrogen due to its high proline-to-arginine ratio, whereas Monastrell, MS 104, Myrtia, and Syrah exhibited more favourable ratios that generally supported proper alcoholic fermentation. Even with this results, it is necessary to extend these studies over more years to establish stronger conclusions.

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Session III

Nontargeted analysis and chemometrics

KS3 — Keynote

Bridging the Gap: Integrating Advanced Data Science with Untargeted Grape Metabolomics

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Keywords: metabolomics, multivariate analysis, data science

The unbiased characterization of grape and wine matrices through metabolomics generates vast and high-dimensional datasets which potentially represent strong foundations to expand our understanding of complex chemical and biological interactions.

The complexity and the size of these datasets challenge traditional interpretation and new tools are needed to visualize and decipher this complexity. These approaches are often developed in seemingly far domains like computer science and big data analytics, and it is important to share them with the analytical and biological community to fully profit from the information content of metabolomics investigations.

In the presentation we will focus on non-linear visualization strategies like Uniform Manifold Approximation and Projection (UMAP), showing how they can be used to reveal specific compositional patterns inside a large-scale untargeted metabolomics dataset collected for the characterization of the “grape metabolome”. In contrast to established untargeted linear visualization approaches like PCA, the UMAP representation is designed to preserve both local and global data structures offering a more “global” representation of the compositional diversity of the dataset.

O13 — Oral communication 13

How closure oxygen permeability impacts tannin evolution in long-term aged red wines: breaking analytical barriers using UHPLC–UHRMS metabolomics and MS/MS-based molecular networking

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Keywords: Condensed tannins, Depolymerization, UHPLC–UHRMS, Molecular networking, Evolution markers

The significant role played by condensed tannins (CTs) in oenology has encouraged extensive research on these compounds. Indeed, this class of polyphenolic compounds, composed of flavan-3-ol polymers, contributes to the modulation of colour, astringency and bitterness perception of red wine, key sensory attributes that shape wine quality and consumer acceptance. CTs are highly reactive compounds, and during bottle aging, oxygen is a key factor governing their molecular reactivity. In this closed system, oxygen transfer mainly occurs through the closure, and promotes molecular reactions, including oxidation, driving CT structural rearrangement that ultimately affects wine quality. However, despite their importance, understanding the structural evolution of CTs during bottle aging remains a significant analytical challenge, and the impact of closure oxygen permeability on CT structural evolution has yet to be explored. This study explores how closure oxygen permeability influences CT structural evolution over 17 years of bottle aging and which molecular markers define and differentiate these changes according to closure type. For the first time, thioglycolysis1 of isolated tannins from wines was combined with powerful analytical approaches including untargeted UHPLC–UHRMS Orbitrap metabolomics, which compares CT evolution profiles, and MS/MS-based molecular networking2 (MN) to characterize discriminant markers. Wines (70% Cabernet Sauvignon, 30% Merlot) were produced under identical winemaking conditions, aged in oak barrels, and stored under the same conditions, differing only in closures type, which varied in oxygen permeability. Statistical analyses revealed a clear separation of tannin profiles according to closure type (45.5% of the variance), highlighting groups of discriminant variables significantly related to closure permeability. Molecular networks identified 136 oxidative and non-oxidative markers, including 69 previously unreported. MS/MS analyses revealed dimers and trimers, indicating linkage between tannins and other compounds, including anthocyanins and pyranoanthocyanins. Furthermore, MN revealed closure-dependent quantitative differences in marker distributions. Overall, this work improves characterization of CT evolution in complex wines, provides scientific validation of the importance of closure choice, and supports high-throughput tools for understanding complex enological processes.

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O14 — Oral communication 14

Redox-dependent metabolomic signatures of red wine aging

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Keywords: Metabolomics, Wine aging, Oxygen, Redox chemistry, Proteomics

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Keywords: Metabolomics, Wine aging, Oxygen, Redox chemistry, Proteomics

Oxygen is a central factor in wine evolution, driving a network of redox-mediated chemical and biochemical processes that shape wine quality, stability, and sensory perception. While controlled oxygen exposure can enhance color stability and mouthfeel, excessive oxidation or strongly reductive conditions may lead to chemical imbalance and sensory deterioration. These outcomes result from global shifts in the wine redox environment, affecting multiple molecular families beyond conventional targeted markers.

The aim of this study was to evaluate the impact of oxygen availability on the metabolomic and proteomic space of red wines stored under oxidative and reductive conditions.

Twelve red wines were selected, including six young wines intended for early consumption and six aged wines with a longer expected shelf life. Samples were stored under three conditions: control (anoxic, 6 °C, 10 weeks), thermal stress (anoxic, 35 °C, 10 weeks), and oxidation (35 mg L^{-1} dissolved oxygen, 35 °C, 10 weeks). Redox potential was measured in all samples to confirm the coherence of the experimental design. Untargeted metabolomic profiling was performed using UPLC–HRMS–QTOF to obtain metabolic fingerprints, complemented by targeted analyses. Preliminary proteomic analyses (HPLC-MS/MS Orbitrap) were conducted in control and thermally stressed samples. Data processing followed an in-house workflow for quality control, feature selection, and tentative biomarker annotation.

Untargeted LC–MS analysis generated over 10,000 features, from which approximately 600 statistically relevant markers were selected and grouped according to their response to oxygen. Putative annotation indicated the involvement of phenolic compounds, anthocyanin-related species, and sulfonated derivatives. Several anthocyanin-related signals decreased markedly under oxidative conditions, while others showed slower decreases under anoxic storage. Sulfonated flavanol- and indole-related features were predominantly associated with anoxic conditions, particularly under thermal stress. Preliminary untargeted proteomic analysis led to the tentative identification of 64 proteins and peptides (FDR<1%) whose abundance differed between control and thermally stressed samples.

Overall, this study highlights the potential of untargeted metabolomics to capture redox driven molecular signatures in red wine aging, enabling discrimination of oxidative and reductive aging trajectories beyond targeted chemical markers.

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O15 — Oral communication 15

Exploring the Relationship Between Wine Chemical Composition and Its Permissiveness to Brettanomyces bruxellensis via Untargeted Metabolomics

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Keywords: B. bruxellensis, wine, permissiveness, metabolomics, UHPLC-HRMSn

Brettanomyces bruxellensis remains a major challenge for the wine industry. Its development is typically revealed by "horse sweat" or "burnt plastic" off flavours in red wines, aromas that are not aligned with today's consumer expectations. Despite extensive efforts to control and/or eliminate this yeast, its remarkable genetic diversity contributes to its strong adaptation to the harsh wine matrix (high level of alcohol, low pH, SO2). However, some wines seem "resistant" to a contamination by B. bruxellensis. The vulnerability of a wine seems to be due to its own chemical composition, in which alcohol appears as an important element but not the sole1. In this study, the link between chemical composition and wine vulnerability was studied, thanks to the analysis of 69 Bordeaux red wines from 3 grape varieties (Cabernet Sauvignon, Merlot, and Cabernet franc) and sampled over 4 consecutive vintages (2020, 2021, 2022, and 2023). A prediction model based on UHPLC-HRMS data was created and achieved an accuracy of 98%. Several variables of interest were identified as flavonols, anthocyanins, and hydroxybenzoic acids. Each wine vulnerability to B. bruxellensis seems to result from a specific balance between growth inhibitors and activators.

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O16 — Oral communication 16

Do wine lees derived biomolecule mixtures lead to enhancing the grapevine innate immunity? A metabolomic study on Vitis vinifera leaves

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Keywords: Wine lees, Plasmopara viticola, grapevine, metabolomics, by-products

Downy mildew (Plasmopara viticola) is one of the most devastating diseases of Vitis vinifera. The use of products containing compounds that rapidly enhance the self-defense of Vitis vinifera, is a promising strategy for crop protection, as pathogens are prone to developing resistance to chemical pesticides. In this context, this work aimed to evaluate the effects of products derived from wine lees, by-products of the winemaking industry [1], on P. viticola inoculated detached leaves of the Agiorgitiko cv. (Vitis vinifera). We investigated metabolic profile of leaves treated with wine lees derived biomolecule mixtures, upon infection with P. viticola after 24 and 48 hours post inoculation (hpi), by applying an untargeted metabolomics approach (using an HPLC-TIMS-QTOF) [2]. By utilizing Data-Dependent Acquisition (DDA) to obtain MS/MS fragmentation patterns, we successfully annotated 125 metabolites. Among these, 10 tentative biomarkers were significantly modulated during the defense response to pathogen infection, and all the immune system-related pathways were up-regulated by the treatment with wine lees derived biomolecule mixture. This work highlights the relevance of wine lees-derived biomolecule mixtures in metabolomic perturbations that alter metabolic pathways related to grapevine innate immunity, thereby reducing symptoms and compromising pathogen angiospore production. The research project is implemented in the framework of the H.F.R.I. call “Basic research Financing (Horizontal support of all Sciences)” under the National Recovery and Resilience Plan “Greece 2.0” funded by the European Union—NextGenerationEU (Hellenic Foundation for Research and Innovation Project Number: 15100).

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O17 — Oral communication 17

Comprehensive profiling of glycosidic aroma precursors in grapes via semi-preparative LC fractionation, GC-MS and UHPLC-MS analysis

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Keywords: Aroma precursors, acid hydrolysis, phenolic aromatic fraction, glycosides

Glycosidically bound aroma compounds are the most abundant non-volatile precursors and play a key role in wine aroma formation [1]. Early methodologies for studying these molecules relied on aglycone release through acid or enzymatic hydrolysis, followed by GC-MS analysis. Although such approaches effectively assess the overall aromatic potential of winemaking grapes, they are not suitable for elucidating the structures of the intact glycosides. Advances in UHPLC-MS have enabled the direct determination of aroma precursors [2]; however, analysis remains challenging due to the lack of commercial standards, the structural diversity of precursors linked to the same aroma, and their typically low concentrations. This study aims to identify as many aroma precursors as possible using a fractionation approach involving a sequence of semi-preparative chromatographies, first by size exclusion and then by normal phase. This method is designed to reduce the high complexity of grape samples prior to UHPLC-MS analysis, thereby facilitating precursor identification. For this purpose, 27 phenolic aromatic fractions (PAFs) from Garnacha grapes were prepared [3] (15 from D.O. Campo de Borja and 12 from D.O.Ca. Rioja). An equal mixture of these PAFs was subjected to the fractionation strategy, yielding 96 fractions, 92 of which released aroma upon hydrolysis. These fractions were analysed using SPME-GC-MS to identify the location of the precursors of some relevant varietal aromas, including terpenes, norisoprenoids, phenols, vanillins, and cinnamates. Aromatic molecules of interest were found in hydrolysates from 55 of these fractions; therefore, the corresponding non-hydrolysed fractions were analysed using UHPLC-MS to detect potential precursors. Identification was based on three criteria: a) the expected molecular mass of the precursor, b) the presence of MS/MS fragments consistent with its proposed structure, and c) the correlation between the precursor signal in UHPLC-MS and the corresponding aroma signal in GC-MS. A total of 185 precursors were identified, 98 of which had not been previously reported. Of these, 75 precursors were confirmed based on all three identification criteria. Most of the precursors were disaccharides (94) and trisaccharides (57), with a smaller proportion of monosaccharides (34). These included precursors of 83 terpenes, 30 phenols, 22 cinnamic acid derivatives, 21 norisoprenoids, 19 vanillin-related compounds, 6 ethyl leucate and 4 furaneol.

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O18 — Oral communication 18

Untargeted GC-MS metabolomics to evaluate how red grape varieties and synthetic must impact volatile profiles of grape-associated fungi

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Keywords: fresh mushroom aroma, growth modelling, untargeted GC-MS, volatilomics

Mycobiota from vine-to-wine is highly diverse and can affect grape quality at harvest as well as wine sensory properties, sometimes leading to off-flavors. Fresh mushroom aroma (FMA) is an off-flavor caused by some molds on grapes or in wines that produce specific volatile compounds (VOCs), the most well-known being 1-octen-3-ol and 1-octen-3-one, although many other VOCs are likely involved [1, 2, 3]. To better understand the FMA defect, a multidisciplinary approach combining predictive and classical mycology, sensorial and biochemical analyses, was used. We determined growth patterns and VOCs profiles for 18 grape-associated fungi, individually or in co-inoculation, on must media or grapes. Fastest growth rates on must media were observed for Botrytis cinerea and Penicillium crocicola although most fungi thrived in a wide range of conditions. We also determined how pH and temperature affected the growth of these grape-associated molds and some inter- and intra-specific variations were observed. Untargeted GC-MS strategy was used to identify VOCs, with a focus on FMA defect [4]. One of the originalities was to determine to what extent fungal co-inoculations modified VOC profiles and if an increase in FMA off-odors was perceived by sensorial analyses. FMA was primarily linked to Penicillium species as Penicillium crocicola. On grapes, Botrytis cinerea co-inoculated with Penicillium bialowiezense or Penicllium citreonigrum induced detectable FMA off-odors and an increase in 3-octanol and 3-octanone. We detected multiple unknown VOCs. Finally, all datasets were combined in a global analysis to identify how the matrix impacted fungal isolate VOCs profiles. A higher number of fungal VOCs were shared between Pinot Noir and Meunier grapes datasets than with must medium. VOCs profiles for B. cinerea and P. crocicola were clearly distinguished. Overall, this study provides new knowledge about changes in fungal growth kinetics and VOC profiles in musts and on grapes, with the studied fungal species thriving in a wide range of conditions. Based on the data generated, better vineyard management practices to anticipate conditions leading to FMA emergence but also related to annual climate variations favouring fungal growth could be put in place. Indeed, our results suggest there may be a need for more intensive fungal community surveillance in the vineyards. Predictive tools could also be developed for early detection.

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Spectrofluorometric fingerprinting to track the evolution of red wine and model the relationship with compositional aspects

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Keywords: Fluorescence spectroscopy, red wine evolution, phenolic profile, chemometrics

Red wine contains an abundance of phenolic constituents that crucially contribute to sensory appeal. These compounds undergo dynamic reactions that evolve the wine's phenolic profile, finally shaping its quality and sensory attributes. Given the importance, this work aimed to apply a rapid spectral method and machine learning to investigate red wine compositional modifications over time. Various red wines were studied under different evolution conditions using spectrofluorometric fingerprinting. Specifically, Mataro and Grenache wines treated after fermentation with seven common additives at three levels were analysed immediately after addition and after a period of storage. In addition, four Grenache, two Shiraz, and two Cabernet Sauvignon wines produced commercially were analysed at three successive time points during maturation. Pinot Noir and Petite Sirah wines with five cap management treatments were tracked during natural and accelerated bottle ageing. Phenolic and chromatic parameters were measured periodically for the wines under maturation or bottle ageing, along with determining tannin composition and molecular size for bottle-aged wines. Machine learning was used for spectral data analysis to classify different additives in Mataro and Grenache and to explore the traceability of additive treatments based on their spectrofluorometric fingerprint. Moreover, the relationship between spectral data and phenolic and chromatic compositions was established via extreme gradient boosting regression (XGBR), enabling the simultaneous prediction of these parameters. Spectral fingerprints of the bottle-aged wines and their isolated tannins were also compared to provide further insights into the compositional changes of red wines during ageing. XGBR models were validated to predict the molecular size and composition (according to subunit composition) of tannins based on fluorescence data of wines. The Train models reached near-perfect accuracy (R^2 = 0.9999), with Cross-validation and Test models maintaining robust performance based on R^2 values of 0.9271–0.9891. This study illustrates the ability of fluorescence spectroscopy to rapidly detect differences and changes in red wine phenolic profile induced by additives, short-term storage, maturation, and bottle ageing. It offers a powerful and simple spectroscopic approach for efficient monitoring and classifying of red wines, and enables the prediction of multiple phenolic-related parameters in a single method.

Metabolic plasticity of Oenococcus oeni driven by strain diversity and wine matrix composition

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Keywords: Malolactic fermentation, Untargeted metabolomic, Metabolism plasticity, Oenococcus oeni

Oenococcus oeni is an essential microorganism in winemaking due to its role in malolactic fermentation (MLF). Genetic variability among strains within this species leads to marked differences in metabolic capacities and adaptive potential, which strongly influence MLF performance. The metabolic behavior of O. oeni is therefore of particular interest, as these diverse strains must operate within the complex wine matrix. Investigating how different strains express these metabolic traits provides valuable insight into the mechanisms that shape wine evolution during MLF. To investigate how this diversity translates into distinct metabolic outputs, eight strains were inoculated into four red wine matrices differing in variety (Pinot Noir, Merlot) and in their adjusted or unadjusted pH and L-malic acid levels. L-malic acid degradation kinetics were monitored and integrated with high resolution mass spectrometry (HRMS) exometabolomic profiling. This combined approach allows a comprehensive characterization of strain-dependent metabolic signatures. Multivariate analyses revealed that, beyond a shared metabolic foundation associated with stress adaptation, strains deployed divergent metabolic programs. Differences have been observed in central carbon fluxes, membrane-associated responses and the transformation of phenolic compounds. These contrasted behaviors highlight the capacity of O. oeni to modulate its metabolic activity depending on both intrinsic genetic traits and extrinsic environmental factors. These differences reflect the modulation of metabolic activity driven by both genetic background and wine matrix composition, with polyphenols and their derivatives emerging as major discriminant features and potential markers of malolactic fermentation outcomes. Overall, the results demonstrate that the interplay between microbial genotype and wine composition governs the metabolic trajectories of O. oeni during malolactic fermentation, highlighting the strain-dependent plasticity that can influence red wine chemical profiles. These findings reinforce the value of untargeted metabolomics for capturing the complexity of microbial activity in wine and open perspectives for selecting strains according to desired enological outcomes.

From vine to wine: integrating conventional and advanced analytical techniques to support breeding. A Barbera, Croatina, and Ervi pivotal study

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Keywords: Phenotyping, HRMS, polyphenols, grapes, wine

The introduction of new grapevine varieties has long accompanied viticulture and enology, enabling the emergence of new wine styles and ensuring the continuity of oenological practice. If the 19th century's challenge was to preserve viticulture through the deployment of new hybrids, the subsequent century sought to obtain varieties capable of producing high quality wines. It was in this context that Ervi was selected and introduced as a variety born from the cross between Barbera and Croatina (Vitis vinifera), two of the major cultivars in northern Italy by Prof. Mario Fregoni, capturing the essence of the typical northwestern blend and thereby mimicking the canonical Gutturnio DOC, traditionally obtained blending these two varieties. Ervi was selected in late '70 and granted full authorization only in 1999. Previous studies have underscored its excellent viticultural and oenological aptitude in comparison to its parentals. To further investigate the new breed's traits, this study was performed. We analysed in-plant productive traits, grapes and wine characteristics, using conventional techniques (UV-Vis, LC-UV) alongside advanced approaches (UHPLC-HRMS). In detail, productive parameters and quality traits were assessed in planta, on grapes, and on wines; finally, we performed a complete UHPLC–HRMS profiling on skins, seeds, and wines. The study pursued multiple aims: first, to confirm the oenological aptitude of the new Ervi breed; second, to evaluate whether HRMS tools can support the breeding process. In this respect, Ervi's excellent oenological aptitude was confirmed, both with respect to its parental cultivars and to its commercial counterpart: Gutturnio. Moreover, the large HRMS datasets from skins/seeds (on Barbera, Croatina and Ervi) and from wines (Barbera, Croatina, Ervi and Gutturnio) were analysed trough metabolomic tools (OPLS and PLS DA), corroborating the findings of conventional analyses: namely, solid oenological aptitude and the integration of the parental cultivars' main positive traits within a single new variety, with an higher closeness to Croatina respect to Barbera, and a pronounced accumulation of anthocyanins. In conclusion, the combined use of conventional and advanced analytical techniques, applied to this phenotyping case proved to be an excellent support tool, confirming prior indications in the literature for Ervi, and positioning UHPLC-HRMS as a valuable resource for supporting the breeding of new grapevine varieties.

Towards AI-guided process metrics with the rapid prediction of red wine mouthfeel

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Keywords: prediction model, A-TEEM, machine learning, mouthfeel qualities, winemaking

Mouthfeel is a key component of red wine sensory perceptions and impacts consumer preference for certain wine styles. Sensory evaluation of wine mouthfeel with experts or trained panellists is necessary for production decisions and research, but is time-intensive and costly. This study aimed to develop machine learning models to predict wine mouthfeel attributes using absorbance-transmittance and excitation-emission matrix (A-TEEM) spectroscopy as a rapid analysis technique. A-TEEM combines fluorescence and UV-Vis measurements, generating thousands of spectral variables per sample. These capture signals from chromophores and fluorophores (primarily phenolics that contribute to wine mouthfeel) and the modulating components that influence fluorescence through matrix effects. An A-TEEM dataset is thus of high dimensionality and capable of capturing wine spectral fingerprints incorporating mouthfeel-related compounds. In combination with the wine's corresponding sensory data, the application of machine learning modelling makes the prediction of wine mouthfeel attributes feasible. Twelve commercial red wines differing in variety were evaluated using descriptive analysis by nine trained panellists. Eleven out of twelve in-mouth descriptors showed significant differences among samples: acidity, bitterness, pucker, dry, grippy, coating, adhesive, graininess, heat, fullness, and sweetness. A-TEEM spectra collected for the wines were pre-processed and modelled against the sensory scores using machine learning regression algorithms, with strong predictive performance obtained from cross-validation. For example, using extreme gradient boosting, the model for fullness achieved an R2 of 0.986 and root mean square error (RMSE) of 0.71 (for a score range of 0-100), coating afforded an R2 of 0.888 and RMSE of 2.76, and graininess gave an R2 of 0.925 and RMSE of 1.57. These results demonstrate the capacity of combining A-TEEM spectroscopy and machine learning techniques to predict wine mouthfeel attributes. With only minutes required for spectral data acquisition, the developed approach appears viable for the rapid prediction of wine mouthfeel sub-qualities. Ultimately, A-TEEM spectroscopy with machine learning prediction of sensory traits could potentially be used in real time to guide the winemaking process and achieve targeted mouthfeel outcomes that meet consumer expectations.

P070 — Poster

Characterization of oenological tannins rich in gallotannins by multimodal mass spectrometry

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Keywords: Oenological tannins, Gallotannins, HRMS, Ion mobility spectrometry, Molecular networking

Oenological tannins are widely used in winemaking to stabilize wine color, improve must and wine clarification, prevent protein haze formation, and enhance antioxidant protection. They are extracted from different botanical sources, and comprise condensed tannins or hydrolysable tannins. Gallotannins, extracted from gallnuts, are a class of hydrolysable tannins composed of gallic acid units esterified to a polyol core, most commonly glucose. They exhibit high structural diversity, with varying degrees of polymerization. Previous studies based on nuclear magnetic resonance and liquid chromatography–mass spectrometry (LC-MS) have highlighted significant compositional variability among commercial gallotannin extracts. However, their chemical composition remains insufficiently characterized due to their high structural complexity, including extensive isomerism. The aim of this study was to improve the characterization of gallotannin-rich oenological extracts using complementary, untargeted, multimodal MS approaches. Analyses were performed on gallotannin extracts from our internal collection using two high-resolution mass spectrometers (Orbitrap Exploris 480 and timsTOF Pro2), providing orthogonal and complementary information. Three analytical strategies were combined: (1) Kendrick mass defect (KMD) analysis to visualize homologous galloyl series, (2) ion mobility spectrometry (IMS) to resolve and characterize isomeric species, and (3) molecular networking (MN) to explore structural relationships among detected compounds. These approaches enabled the establishment of a comprehensive chemical fingerprint of gallotannin extracts, revealing a high level of molecular complexity. Several previously unreported compounds and isomeric forms were detected and partially characterized, with molecular weights ranging from approximately 330 to 3000 Da. This study also revealed chemical differences and diversity among the samples, demonstrating the strong potential of multidimensional MS for the in-depth analysis of complex polyphenolic mixtures. This multimodal MS approach can be useful for the selection of oenological gallotannin extracts.

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P071 — Poster

Authentication of grape varieties in wines using 1H-NRM spectra and convolutional neural networks: first results using a database containing more than 3000 observations

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Keywords: wine, 1H-NMR, CNN, grape varieties, authentication

Authentication in the wine industry aims to prevent fraud and strengthen confidence in trade. A previous study proposed 1H NMR as a solution for authenticating several characteristics such as grape variety, origin, and vintage [1]. However, a database of 600 observations could be considered significant for a publication, but not robust enough for an application. The same approach was adopted, on a much larger scale. Wines and their metadata were provided by oenological laboratories. Samples were prepared as in Leleu et al, 2025. NMR spectra were acquired on a Bruker 400 MHz spectrometer, after water suppression (zgpr) or after water and ethanol suppression (noesy). An observation was a set of 10 to 40 metadata plus a zgpr and noesy NMR spectrum. More than 4,000 observations were collected in 2024 and 2025. The calibration dataset was a subset of 2,683 observations. Predictions were focused on grape variety, three of them were selected for model construction using one-dimensional convolutional neural networks (1D-CNN). Models were then applied to a series of test datasets, completely independent of the calibration dataset, used only once and representing hundreds of observations. Results showed that predictions for wines of the same origin and vintage as the model were fairly good, around 80%. Performance dropped to 50% when the models were applied to wines from the new vintage (2025) and to 35% when they were applied to wines from the new vintage and another French region, Aquitaine. In such conditions, out of the calibration scope, models were strongly challenged, but despite this, they retained a certain prediction ability. These results were therefore considered very encouraging. New observations to be collected in 2026 and 2027 at different locations will improve the models robustness. An application could be available when the number of observations reach an estimated 10,000 or more. Acknowledgments PRRI EWAP-NMR project (Occitanie region) funded the 400 MHz NMR device and support staff, thereby providing an analytical taskforce. ANR WAP-NMR project provided the standard operating procedure (SOP) for acquiring NMR spectra and metadata tables. ANR AIOLY laboratory provided CNN assistance and Python notebooks. FFLŒI association provided test samples. Calculations were performed on the CoLab.IA INRAE web application.

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P072 — Poster

Beyond tannins, exploring the complexity of grape seed using non targeted analysis and molecular network

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Keywords: Non-targeted metabolomics, Molecular networks, Grape seed

Grape seeds are an important part of grape, especially in the context of red wine. They are also frequently used as markers of grape maturity and as contributors to wine quality. The aim of this study is to explore the diversity of grape seeds compounds and to partially characterize their evolution during ripening. Data for this study were collected from bunches sampled at different stages of maturity (from bunch closure to 2 weeks after harvest) in 2024. Whole grape bunch were frozen, and the seeds were then extracted from the berries. For three key sampling dates (bunch closure, end of veraison and harvest), the grape seeds were dissected into the three main layer, external layer (cuticle, epidermis, outer integument), middle layer (middle and inner integument) and endosperm. Samples were ground and extracted for 24 h in methanol, then filtered and dried under vacuum. They were the re-dissolved to the same concentration (1 mg/mL), filtered and analyzed by HPLC MS/MS. All results were used to build a molecular network using the fragmentation pattern and retention time of the molecules [1], using the software MetGem (2). MetGem database and manual interpretation of fragmentation pattern recognition were used to annotate compounds of interest within the molecular networks. Two molecular networks were built separately: one including seed, skin and pulp, to identify compound specific to seed or shared with other berry tissues, and a second one using only data from the dissected seed to locate compounds of interest in the different seed layers. Thanks to the molecular networking approach, cluster (group of related compounds) are formed on the basis of MS2 spectrum similarity, which make it easier to annotate molecules grouped together if at least one appears in a database. For example, epicatechin gallate, a well-known grape seeds compound, is grouped with epicatechin vanillate (recently described in grape seeds) and other potential epicatechin derivatives that have not previously been reported in grape seed before. This cluster found in our second molecular network also provides information on the localization on these compounds. The same process was applied to all compound detected in grape seed to obtain a comprehensive list of annotated (database hits) and putative (good fragmentation pattern and consistent molecular formula) grape seed compound.

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P073 — Poster

Unravel grape volatiles using HS-SPME-GC×GC-ToFMS

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Keywords: : GC×GC-ToFMS, grapes, terpenes, norisoprenoids

Varietal volatile compounds in grapes are influenced by multiple factors, including grape variety and clone, cultural practices, and climatic conditions. Both free and glycosidically bound volatile compounds can be used for varietal fingerprinting and profiling, and they also provide valuable insights into the effects of agronomic and climatic factors on grape aroma development. In this context, a robust analytical methodology for the analysis of free and bound volatile compounds in grapes using HS-SPME-GC×GC-ToFMS, equipped with a flow modulator. The method, applied with or without enzymatic hydrolysis using the AR2000 enzyme, was employed in the analysis of several several batches of grapes.1,2 The aim of this work is to give an overview of the GC×GC with a flow modulator and show how HS-SPME combined with GC×GC-ToFMS provides a suitable and sustainable approach for determining the volatile signature of grapes. The results will demonstrate the usefulness of this approach for characterizing and comparing grape samples from different varieties and clones, hydric regimes, and viticultural practices, including biological viticulture.

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P074 — Poster

Prediction of Fresh Mushroom Aroma (FMA) taint in must via volatile organic compound analysis

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Keywords: Fresh mushroom aroma, must, electronic nose

Fresh Mushroom Aroma (FMA) is an undesirable off-flavor in wine, characterized by a button mushroom–like aroma. Reported in several French wine regions around 2000, FMA is associated with specific fungal consortia present on grapes. The defect is typically detected only at the end of alcoholic fermentation by sensory analysis. Early identification of FMA-risked musts would prevent economic losses associated with producing tainted wines and further prevent spoilage of wines via blending. Here, we report for the first time a technological approach enabling detection of FMA risk directly from grape must. The Signature Analysis Machine (SAM) is a tabletop electronic nose designed to analyze complex mixtures of volatile organic compounds (VOCs). VOC detection is achieved using a high-dimensional array of highly orthogonal sensors integrated into a vial cap, generating a distinctive multidimensional “signature” for each sample. Following supervised training on labeled datasets, SAM learns characteristic signatures associated with predefined classes and can subsequently classify unknown samples, with performance improving as additional data are acquired. SAM was trained using 26 FMA-tainted and 8 non-tainted Meunier musts, as well as 8 non-tainted pinot noir musts. Sensory evaluations and chemical analyses of the wines produced from these musts were used for validation. The model achieved 100% specificity and greater than 90% sensitivity in detecting FMA taint directly from the original musts. Moreover, preliminary results indicate that SAM can predict the severity of FMA as later rated by trained sensory panels, weeks after fermentation, based solely on analysis of the initial must. These results demonstrate the potential of electronic-nose technology for early prediction of FMA in musts. Similar approaches are also being explored for smoke-taint detection in California, supporting the broader applicability of this strategy to vineyard-derived sensory risks.

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P075 — Poster

Integrating shotgun metagenomics and wine metabolomics links terroir-driven microbiome functions to nucleotide, amino acid, fatty acid, and carbohydrate pathways

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Keywords: Muscat; untargeted metabolomics; microbiome, Saccharomyces cerevisiae; alcoholic fermentation

Microbial terroir is increasingly linked to wine typicity, yet the chemical mechanisms connecting regional microbiomes to the wine phenotype remain incompletely defined. This stud focused on untargeted metabolomics to track terroir expression during alcoholic fermentation, supported by shotgun mycobiome profiling. Muscat (Vitis vinifera L.) grapes from two terroirs (Piedmont, Italy and Limnos Island, Greece) were vinified under comparable white-winemaking conditions and inoculated with the same Saccharomyces cerevisiae starter. Samples were collected before inoculation, after 72 h, and at end of fermentation, having three biological replicates per each time point/region. The samples were analysed by shotgun metagenomics and LC-MS based metabolomics. Shotgun metagenomics showed clear terroir separation of fungal communities in musts, followed by a marked reduction in diversity during fermentation consistent with starter dominance. Differential abundance analyses highlighted Torulaspora delbrueckii enrichment in Greek samples and Kluyveromyces spp. enrichment in Italian samples. Functional profiling revealed terroir- and time-dependent shifts across core metabolic categories, including significant variation in amino acid, carbohydrate and energy metabolism. In parallel, UHPLC–QTOF-MS untargeted metabolomics generated broad chemical fingerprints, with unsupervised models separating samples primarily by terroir and secondarily by fermentation stage and showing larger divergence between terroirs in wines than in musts. Discriminant metabolite classes included oligosaccharides, glycosylated phenolics that decreased during fermentation but remained overall higher in Greek samples, and nitrogen-containing metabolites reflecting amino acid/peptide turnover and redox-related trajectories1. Overall, the multi-omics integration links terroir-driven microbiome functions to coherent pathway-level shifts in the wine metabolome, providing new tools that could be used to ensure wine authenticity and quality control.

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P076 — Poster

Characterisation of pinking precursors in Muscat and their dose-dependent accumulation in a Roditis skin-contact model

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Keywords: Roditis, Muscat, pinking, untargeted

Pinking in white wines occurs unpredictably due to PPO-mediated oxidation of skin-derived flavan-3-ols and hydroxycinnamic acids into quinones that form chromophores [1,2]. Conventional remedies, such as PVPP, bentonite, and SO_2, are limited by their non-selectivity, allergen concerns, and significant volume losses [3,4,5]. Although GSH can effectively trap quinones as the colourless Grape Reaction Product (GRP), its protective ability is limited, depends on concentration, and is gradually depleted during winemaking, reducing its reliability as a standalone solution [6,7,8]. The natural presence of GSH in oenological nitrogen supplements used during fermentation [9,10] indicates these preparations may provide an additional, readily available form of protection against oxidation without requiring special treatment steps. We characterised the metabolic signature of a natural pinking event in commercial Muscat (Control, Pink, Pink+P1, Pink+P2; where P1 and P2 are oenological supplements) and validated marker origins using a controlled skin-contact model in Roditis Alepou (Control; G1: 1×; G2: 2×; G3: 4× native skin w/w). All samples were analysed utilising an untargeted metabolomics approach with an HPLC-TIMS-QTOF system [11], employing Data-Dependent Acquisition (DDA) to acquire MS/MS fragmentation spectra. Among the 100 most abundant features, five were identified as pinking biomarkers: 4-Hydroxycoumarin (absent in control; +5,521 at G3), the predominant (4S,5Z,6S)-4-(2-methoxy-2-oxoethyl) derivative (Pink vs control: +36,234%; G3 vs Roditis control: +3,909%), (−)-epicatechin (+2,441%; +521%) [12,13], sinapaldehyde (+2,096%; +147%), and an unidentified compound at m/z 259.12891 (+576%; +1,977%). The monotonic accumulation from G1 to G3 confirmed their skin-derived origin [14,15]. Both P1 and P2 reduced all five markers by −9% to −32%, with the dominant precursor exhibiting the most robust response (P1: −32%; P2: −23%), in alignment with downstream GSH-mediated quinone trapping mechanisms [16,10]. The m/z 259.12891 feature is identified as the most skin-sensitive compound within the dataset. Together, these findings extend the known pinking-precursor space beyond classical flavan-3-ols and position oenological supplements as an effective, winery-compatible preventive strategy that does not necessitate additional treatment steps. Future research should aim to validate the conduct of longitudinal ageing studies to verify sustained post-bottling protection.

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P077 — Poster

A Chemometrics Approach to Characterise Albariño Wines from New Zealand and Spain

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Keywords: Albariño, aroma-sensory mapping, chemometrics, New Zealand, Rías Baixas DO

In New Zealand (NZ), wines made from the white grape variety Albariño, traditionally grown in Spain and Portugal, are becoming increasingly popular, with producers actively working to discover a grape variety with potential to diversify their portfolios beyond Sauvignon blanc. As yet, no scientific research has been published on NZ Albariño wines and their chemical or sensory properties. This project investigated chemical and sensorial differences between NZ Albariño wines from North Island (NI) and South Island (SI) regions, compared to Rías Baixas DO (RB) wines from Spain. Aroma compound quantitation for 24 wines, eight per region, was conducted using headspace solid phase microextraction gas chromatography mass spectrometry (HS-SPME-GC-MS) and liquid chromatography-triple quadrupole mass spectrometry (LC-QQQ-MS). Sensory evaluation was performed via a trained panel using qualitative descriptive analysis (QDA). Chemical and sensory data were linked to regional differences and production methods using multivariate analyses. Albariño wines showed clear separation based on their sensory attributes, with one cluster of unoaked wines demonstrating high levels of fruity and floral attributes. Acetate esters and terpenoids were associated with this grouping. Wine chemical data and sensory attributes showed wide diversity within each region, with NI and RB Albariño wines showing broad overlap in their chemical and sensory profiles. SI Albariño appeared to be more distinct, characterised by high acidity and flavour intensity, and associated with chemical drivers including ethyl esters, fatty acids, and the varietal thiol 3-sulfanyl-1-hexanol (3SH). These results provide key insights into the influence of growing region, wine production methods, and chemical profiles on the sensory qualities of Albariño wines. This information will be very valuable in helping to characterise Albariño styles and demonstrates the viability of a new and burgeoning style from the SI of NZ.

P134 — Poster

A-TEEM and Machine Learning for Rapid Assessment of Grape Anthocyanins and Wine Smoke Taint

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Keywords: A-TEEM, Chemometrics, Wine Smoke taint, Anthocyanins, Rapid Analysis

Anthocyanin profiling remains essential for assessing red grape quality and predicting wine color stability. However, traditional HPLC-based methods are time-consuming and impractical for routine vineyard maturity monitoring. Hybrid grapes present additional challenges due to their distinct anthocyanin composition, including diglucoside forms for which reference standards are difficult to obtain and costly. A-TEEM spectroscopy, which simultaneously captures absorbance and three-dimensional fluorescence excitation-emission matrices, presents a promising alternative for rapid phenolic characterization without requiring expensive standards. Wildfire smoke exposure poses an escalating threat to wine quality globally, yet rapid analytical methods for identifying affected fruit and wine remain unavailable. Current smoke taint detection relies on GC-MS and LC-MS/MS approaches requiring 24–48 hours and extensive sample preparation, making real-time assessment impractical. This work develops A-TEEM-based methods coupled with machine learning for rapid assessment of both hybrid grape anthocyanins and smoke taint in wine. For anthocyanin profiling, grape samples were analyzed by HPLC-DAD to establish reference anthocyanin compositions. A-TEEM spectral data combined with HPLC reference measurements were used to build machine learning models for quantitative prediction of anthocyanins. For smoke taint assessment, wine samples from smoke-impacted 2025 vintage fruit were analyzed by LC-MS/MS to determine volatile phenol glucoconjugates reference chemistry. A-TEEM spectral data combined with LC-MS/MS reference measurements were used to build machine learning models for quantitative prediction of smoke taint markers. Results demonstrate that A-TEEM combined with machine learning provides rapid quantification of both hybrid grape anthocyanins and smoke taint compounds, reducing analysis time from conventional analytical methods to minutes. This approach enables timely vineyard and winery decisions and addresses analytical challenges in hybrid viticulture and wildfire impact assessment.

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P136 — Poster

Enhancing wine traceability through data fusion strategies combining ^{1}H-NMR and IR analysis

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Keywords: Authenticity, Metabolomics, Data fusion, Grape variety, Geographical origin

Wine authentication is a major challenge in the context of an expanding global market and increasing fraudulent practices. Protecting designations of origin is essential to sustain the wine sector and maintain consumer confidence. Among the available analytical tools in the wine industry, infrared (IR) spectroscopy is widespread, while ^{1}H-NMR spectroscopy has demonstrated its effectiveness to assess wine authenticity. To enhance the discriminative capacity of analytical classification, a data fusion strategy combining ^{1}H-NMR and IR spectroscopic data was implemented. This approach leverages the complementary strengths of both techniques. IR spectroscopy provides information related to hydrogen bonding and asymmetric polar groups, whereas ^{1}H-NMR spectroscopy offers highly resolved insights into specific proton environments.

The complementary spectral features obtained from these methods enable the construction of fused datasets containing richer and more comprehensive chemical information. By exploiting this complementarity, data fusion enhances classification robustness and reliability. This strategy has been applied to discriminate 44 wines according to grape variety, geographical origin, and vintage. The results demonstrate the effectiveness of combining data from multiple analytical techniques to enhance wine traceability and authenticity assessment.

Session IV

Biotechnology, microbiology and genetic approaches towards better grape and wine quality

KS4 — Keynote

Wine Microbiology in a Changing Environment: Leveraging Microbial Biodiversity for Biotechnological innovation

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Keywords: microorganisms, biodiversity, biocontrol, bioprotection, bioacidification

From the vineyard to the cellar, microorganisms influence soil health, vine growth, fermentation processes, and the chemical and sensory characteristics of wine. Climate change poses unprecedented challenges to the wine industry, especially by altering grape composition. Other challenges include developing sustainable vineyard and winemaking practices and adapting to changing consumer preferences. In this shifting landscape, microbial biodiversity is essential for designing innovative, sustainable biotechnological solutions. Over the past two decades, our understanding of microbial diversity has advanced significantly thanks to integrated "omics" approaches, such as high-throughput sequencing, culturomics, and metabolomics, as well as strategies that leverage synthetic communities and synthetic biology. A holistic approach to studying, promoting, and harnessing microbial biodiversity involves collecting samples, establishing microbial culture collections, analyzing taxonomic and functional diversity, and ultimately developing new protocols and selecting strains. This plenary session will present examples of recent research showing how microbial diversity can lead to innovations in winemaking biotechnology. Biocontrol and bioprotection have emerged as sustainable alternatives to synthetic pesticides for managing pests and diseases in vineyards, as well as for reducing sulfur dioxide use in must and wine. Additionally, recent yeast-based strategies for managing wine acidity, such as bioacidification, have been proposed to mitigate the impact of climate change on must and wine composition. Finally, advances in decoding the genetic and phenotypic diversity of the spoilage yeast *Brettanomyces bruxellensis* have resulted in new diagnostic tools and promising preventive treatments for spoilage. To fully benefit from the range of ecosystem services provided by microorganisms, more research is needed to understand and preserve microbial biodiversity in the long term.

O19 — Oral communication 19

Origin of Fresh mushroom Off-Flavor in grape must and wine: from linoleic acid breakdown to glycosylated compounds biosynthesis

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Keywords: Fresh mushroom off-flavor, glycosidic precursors, linoleic acid, 1-hydroxyoctan-3-one, octane-1,3-diol

Fresh-Mushroom Off-Flavour (FMOff) is a recurrent wine defect associated with fungal alteration of grapes 1-3. Recent studies have identified 1-hydroxyoctan-3-one (HDY) and octane-1,3-diol as analytical markers of this taint 4, 5, with HDY also being confirmed as a sensory marker in wines 5. Its content appeared to be modulated by fermentation 6. These compounds are detected in free form in grape must and in wines but their origin and biosynthetic pathways remain poorly understood. This study aimed to elucidate the origin of these FMOff markers by (i) investigating the role of linoleic acid and glycosylated precursors and (ii) assessing the influence of environmental parameters on their biosynthesis. The catalytic breakdown of linoleic acid into C8 compounds was studied in synthetic must at two stages: the pre-fermentative stage, involving grapevine fungi and alcoholic fermentation (AF), involving yeast. A full factorial design was used to evaluate environmental effects on the production of free and glycosylated compounds. Both Penicillium crocicola and Botrytis cinerea were able to synthetize HDY and octane-1,3-diol but they secreted these compounds into the growing medium only under hypoxic conditions. These compounds were produced from linoleic acid with significant genus-specific differences. B. cinerea was also able to glycosylate these compounds, and glycosylated forms were detected for the first time in must from grapes naturally infected with grey mold. Linoleic acid concentration and pH significantly affected FMOff compounds biosynthesis, with contrasting responses between the two fungi. In contrast, the yeast studied did not produce these compounds from linoleic acid during AF, suggesting that fermentation is not a critical step for FMOff formation under our conditions. Overall, this work highlights two potential reservoirs of FMOff markers in contaminated matrices: free linoleic acid and its glycosylated derivatives.

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O20 — Oral communication 20

Unlocking the Lipid Potential of Yeast Derivatives

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Keywords: lipids; oleaginous yeasts; wine; fermentation; aromas

Climate change brings about various challenges to the wine industry, including higher sugar content, lower acidity, and imbalances in yeast nutrients. Winemaking practices such as low fermentation temperature and excessive clarification of white grape must – that may lead to the partial loss of lipids - to produce fruitier wines in response to consumer demand may create conditions leading to sluggish or stuck fermentations. The latter conditions are typically overcome by the yeast Saccharomyces cerevisiae that can alter its membrane composition in fatty acids and ergosterol. Nevertheless, in the absence of oxygen, the yeast cannot produce the necessary lipids and therefore relies on those occurring in grape must. Without lipids, fermentation ceases prematurely due to early cell death. Subsequently, winemakers must account for the lack of lipids by supplementing the grape must with nutrients. In this work, a wide selection of non-Saccharomyces yeasts isolated from the broader wine environment was screened for their lipid content, after which six strains were selected based on the amount of lipids produced and diversity of lipid composition. Inactivated dry yeasts were produced from these strains and tested as lipid supplements in over-clarified Chenin Blanc juice. The addition of the inactivated yeasts enhanced fermentation performance compared to the reintroduction of fine lees and no addition. Furthermore, experiments with the addition of pure analytical standard lipids in the same concentrations yielded similar results, correlating the change in fermentation kinetics to lipid addition. Nevertheless, differences in fermentation performance were observed, largely due to the variation in lipid composition, as the supplementation of some inactivated yeast derivatives led to better fermentation performance than others. Differences in the production of a selection of aroma compounds linked with lipid metabolism were also observed between the addition of pure lipids and inactivated yeasts. Overall, the data showed that the wine yeast microbiota may serve as a sustainable source of lipids to improve fermentation under challenging environmental conditions and pave the way for further research on the availability and utilisation of lipids for wine yeasts.

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Uncovering metabolic interactions between yeasts during wine alcoholic fermentation by non-targeted extracellular metabolomics

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Keywords: Yeast, interactions, metabolites, biomarkers and metabolic pathways

During wine fermentation, different yeast species coexist and interact, shaping metabolomic profiles through species-specific metabolism, thereby influencing wine quality1. These effects are driven by metabolic exchanges that remodel their surroundings2,3. Characterizing these extracellular metabolite profiles is essential for elucidating the physicochemical mechanisms behind interspecies interactions. In this study, it was introduced an experimental framework that enables systematic characterization of the extracellular metabolome at the end of alcoholic fermentation, moving beyond traditional pairwise co-culture designs to investigate complex tri-species yeast interactions involving Saccharomyces cerevisiae, Torulaspora delbrueckii, and Hanseniaspora uvarum. Combined approach was employed (LC-MS and GC-MS) to obtain comprehensive metabolic fingerprints of extracellular cultures. These techniques enabled the analysis of both non-volatile and volatile compounds, facilitating the detection of condition-specific and interaction-driven changes in secreted metabolites4,5. This strategy provides deeper insight into the metabolic mechanisms of microbial interactions. Comparison of the exometabolomic footprints of monoculture and their corresponding two and three species co-cultures allowed the identification of 527 significant biomarkers out of 2,857 detected features. Of these, 336 were associated with monoculture, while 115 and 76 were enriched in two and three species co-culture, respectively. These differences reveal distinct exometabolomic profiles characterized by pronounced shifts in metabolite composition, resulting from the differential regulation of 36 common and 27 unique metabolic pathways across conditions. The most affected pathways were related to ABC transporters, byosinthesis of amino acids and carbon metabolism, demonstrating the impact of yeast interspecies interactions during alcoholic fermentation. Furthermore, this metabolomic remodeling was reflected in the volatilome profile. A total of 23 volatile compounds were significantly affected across culture conditions, with esters, alcohols and monoterpenes being the most impacted chemical families. These findings demonstrate that yeast interspecies interactions extensively remodel the extracellular metabolome and affect volatile compound production. The metabolic signatures observed in co-cultures highlight the key role of microbial interactions in modulating biochemical pathways.

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Membrane vesicles of Oenococcus oeni: A tool for adaptation to wine-related stresses?

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Keywords: Oenococcus oeni; membrane vesicles; stress response

Membrane vesicles (MVs) are nanoscale structures derived from the cytoplasmic membrane that are involved in a wide range of biological functions, including cell–cell communication, molecular transport and biofilm formation [1]. In Gram-positive bacteria, MVs are now recognized as key players in stress responses, although their precise roles remain insufficiently characterized [2]. The lactic acid bacterium Oenococcus oeni represents a relevant model for investigating stress adaptation mechanisms, as this species is able to survive and maintain metabolic activity in wine, a highly constraining environment characterized by low pH, presence of ethanol and limited nutrient availability [3]. In this context, the aim of this work was to investigate the impact of different environmental stresses on MV production and properties in O. oeni, and to evaluate their potential role in bacterial survival under adverse conditions. MVs were isolated by ultracentrifugation from a standard O. oeni culture and from cultures subjected to different stresses, including ethanol stress (13%), acid stress (pH 3) and mitomycin C–induced stress (1µg/mL). The resulting vesicular fractions were characterized using complementary approaches, including particle size and concentration analysis by MA-DLS, protein quantification, protein profile analysis by SDS-PAGE, and morphological observation by transmission electron microscopy (TEM). TEM observations confirmed the presence of structures morphologically compatible with MVs. While no major differences in particle size or concentration were observed between the experimental conditions, clear variations were detected in MV protein concentrations and protein profiles, suggesting stress-dependent modulation of vesicular cargo. From a functional perspective, assays performed under ethanol stress conditions showed that the addition of MVs derived from control or stressed cultures improved bacterial survival in a dose-dependent manner. To further investigate the molecular mechanisms underlying this protective effect, the fluorescent probe Laurdan is being used to assess the impact of MVs on membrane fluidity. Overall, the study of membrane vesicles provides new insights into how O. oeni withstands environmental stresses and adjusts its membrane properties to preserve survival and metabolic activity.

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AROMATIC ELEGANCE IN A CHANGING CLIMATE: A THREE-YEAR STUDY ON OENOCOCCUS OENI VARIABILITY AND ORGANIC ACID MODULATION IN SPARKLING WINE BASES.

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Keywords: Citric acid, climate change, malolactic fermentation, Oenococcus oeni, diacetyl, HS-GC-IMS, HS-SPME-GC-MS.

This study explores the dynamics of maintaining aromatic elegance in a challenging oenological landscape by investigating the intraspecific variability of O. oeni in response to OIV-approved organic acid additions. Conducted over a 3-year period across both laboratory and cellar scales, specifically using sparkling wine bases, the research integrates microbiology with advanced chemical analysis via HS-GC-IMS and HS-SPME-GC-MS/MS. The volatile profile of the obtained wines was characterized to evaluate the evolution of key compounds throughout the fermentation process. Among the primary constituents identified, the analysis highlighted significant concentrations of isoamyl alcohol, 2-methyl-1-butanol, phenylethyl alcohol, and hexanoic and octanoic acids. Results demonstrate that supplementing the native acidic profile with tartaric, malic, or citric acid significantly alters microbial growth, malolactic fermentation (MLF) rates, and aromatic production. Crucially, the acids induced distinct behaviours: at equivalent addition levels, tartaric and malic acids tended to repress microbial activity and delay MLF evolution. Conversely, citric acid stimulated both fermentation kinetics and diacetyl production. The quantitative analysis of the wine samples analyzed revealed distinct profiles for vicinal diketones and their reduction products. Diacetyl concentrations ranged from 0.35 to 0.02 mg/L. Notably, sample made by strain PN4 exhibited the highest levels within this group, suggesting a specific metabolic peak or a lower rate of subsequent reduction during the winemaking process. The detected levels of acetoin were significantly lower than those of diacetyl, with values spanning a narrow range between 0.008 and 0.001 mg/L. 2,3-Butanediol showed the highest overall concentrations, ranging from 8.0 to 0.5 mg/L. In contrast to the diacetyl trends, sample made form strain IB6 emerged as the one with the most prominent values. Sensory analysis indicated that citric acid treatments enhanced freshness and varietal adherence while preventing defects associated with uncontrolled bacterial activity. This work provides a strategic roadmap for winemakers: by leveraging specific O. oeni responses to acidification, producers can better navigate modern vinification complexities to safeguard quality and achieve sensory balance.

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Unravelling the killer activity of Lachancea species against the wine spoilage yeast Brettanomyces bruxellensis

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Keywords: killer phenotype, Brettanomyces bruxellensis, Lachancea species, wine.

The wine industry faces many challenges including spoilage, mostly attributed to Brettanomyces bruxellensis as the main spoilage yeast. Its genetic diversity, persistence during vinification, and tolerance to various chemical preservatives (including sulfur dioxide), make it difficult to control. Killer toxins secreted by other yeast species could represent a promising biological alternative to chemical preservatives. Killer phenotype against B. bruxellensis has been described in various yeasts, but their application in industry remains limited. Such killer activity was recently reported in Lachancea thermotolerans but not fully investigated1. This study aimed to further explore and characterise killer phenotypes in the Lachancea genus against B. bruxellensis and other wine spoilage and beneficial yeasts. The killer phenotype of 17 Lachancea isolates was assessed against several target isolates: 29 B. bruxellensis strains representative of the six main genetic groups of this yeast species, as well as 25 strains belonging to beneficial or spoilage wine yeast species. The killer phenotype was assessed using a standard plate assay at pH 3.5. The zones of inhibition were measured in mm after 3-7 days incubation at 24 °C. Additionally, the impact of lactic acid (3 - 18 g/L) on the growth of spoilage yeasts was also assessed. Ten of the 17 Lachancea isolates screened displayed variable growth inhibition phenotypes against spoilage yeasts. Of these, L. thermotolerans A, L. thermotolerans B and L. waltii consistently displayed high permanent growth inhibitory effect against B. bruxellensis strains across the six genetic groups. Remarkably, these strains had no killer effect against all the nine commercial wine yeasts tested, highlighting them as promising biocontrol yeasts. All lactic acid concentration were ineffective at inhibiting the growth of target isolates suggesting that lactic acid was not involved in the killer phenotype. Although these results highlighted the three killer strains as potential biocontrol yeast in real winemaking, they pave a way to further exploring their efficacy under a wine-like liquid medium.

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Exploring copper's role in metabolic modulation of Lachancea thermotolerans in winemaking conditions

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Keywords: Lachancea thermotolerans, Copper fungicides, Winemaking acidification, Microbiology, Transcriptomic approach

The phenomenon of global warming has been demonstrated to induce the premature ripening of grapes, resulting in a concomitant increase in sugar and a decrease in acidity. This can result in the production of wines that are characterised by an imbalance in terms of alcohol content and acidity. The utilisation of lactic acid-producing Lachancea thermotolerans yeast in fermentation represents a promising strategy for reducing the pH of must without the need for chemical acidification. However, it is important to note that the fermentation rate and lactic acid production can be influenced by several factors present in the must. The present study focused on the effect of copper, utilised in organic vineyards to limit mildew, on biomass and lactic acid production by two L. thermotolerans oenological strains in laboratory-scale fermentations. The results obtained demonstrated that the addition of copper resulted in increased lactic acid production in comparison with the control condition and this effect was strain-dependent. The results of the microbiological follow-up, which was carried out using classical microbiological methods in conjunction with flow cytometry, demonstrate discrepancies in the fermentation kinetics in conditions exhibiting varying concentrations of copper. Furthermore, the analysis of the samples using flow cytometry revealed the oxidative status of the two strains throughout the fermentation process. Transcriptomic data indicates that certain metabolic pathways of L. thermotolerans are induced by the presence of copper, with hypothesises about ribosomal and parietal activities in addition to cell communication. The findings of this study demonstrate strain-specific effects of copper on L. thermotolerans, which may be of interest to winemakers, particularly those engaged in organic viticulture who intend to utilise acidifying yeasts during warm vintages.

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IMPACT OF FERMENTATION REDOX MANAGEMENT ON POLYFUNCTIONAL THIOLS IN MODEL WINE

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Keywords: Redox, ORP control, polyfunctional thiols

An enzyme encoded by IRC7 gene of S. cerevisiae releases 4-Mercapto-4-methylpentan-2-on (4MMP) and 3-Mercaptohexan-1-ol (3MH) from their cysteinylated precursors (Santiago and Gardner, 2015). The expression of this gene is influenced by the yeast's intracellular oxidation-reduction potential (ORP), which is linked to extracellular ORP during fermentation and can be modified by technical intervention [1]. The aim of this study was to enhance thiol production by adjusting ORP via adding air during fermentation. Synthetic grape must, enriched with thiol precursors was fermented using SAUVY yeast (Lallemand, Canada) in 1 L bioreactors. ORP of the must was monitored continuously throughout fermentation. Once a defined ORP setpoint was reached, a solenoid valve was opened to introduce air at 100 mL/s for 4 s. Three different setpoints of -30, -90, -120 mV were applied and compared to reference fermentation. Analyses of reduced and oxidized thiols, as well as thiol precursors, were performed every 24 hours. We show that by actively controlling the ORP during alcoholic fermentation, the efficiency of sugar degradation by the yeast was enhanced. Fermentations with higher ORP setpoint were completed faster. Significant differences in the concentrations of reduced 4MMP and 3MH concentrations were observed and are discussed with regards to ORP setpoints.

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Mitigating smoke taint in wine using microbes: a sustainable solution?

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Keywords: Smoke taint, glycosidase activity, wine microbes

With climate change, the frequency of wildfires has increased in wine-producing regions across the world. Wildfires pose a double threat to an industry already under pressure: the direct burning of vineyards, and the indirect smoke exposure. Indeed, upon smoke exposure, the volatile phenols (VPs) arising from the burning of lignin within the surrounding vegetation, are absorbed by ripening grape berries where they are glycosylated to non-volatile precursors. During wine fermentation, microorganisms release the VPs, which impart an unpleasant smoky/burnt off-flavour to the wines. The most efficient solution implemented in wineries is the addition of activated charcoal that reduces the odorous fault but also diminishes the overall quality of the wine because of its lack of selectivity. Furthermore, while effective at removing free VPs, charcoal poorly removes glycosylated VPs, which can be slowly released chemically during wine ageing. In this study, a collection of diverse wine yeasts and lactic acid bacteria was screened and characterised for their ability to enhance the release of free VPs during fermentation, thereby facilitating their downstream removal with activated charcoal. The data demonstrated that all yeast and bacterial species displayed glycosidase activity but to varying degrees. Surprisingly, strains of the main wine yeast Saccharomyces cerevisiae, which reputedly display low glycosidase activity in wine, released more free VPs than initially expected. The glycosidase enzyme activities of the most promising yeasts were then characterised and showed properties compatible with winemaking conditions. Finally, combinations of the most promising yeasts and bacteria were evaluated as a possible biological solution to smoke taint. This study confirms that the microbial diversity occurring in the broader grape and wine environment constitutes a reservoir of biochemical activities of great industrial interest that can be tapped into to find targeted sustainable solutions to environmental challenges.

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Metschnikowia pulcherrima as a biocontrol tool for grapevine protection

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Keywords: Bioprotection; Metschnikowia pulcherrima; Vineyard application

Bioprotection is emerging as an innovative technique for preserving grape health contrary to traditional approaches based on the addition of external chemical agents [1]. The presence of fungicide residues in grapes and musts may interfere in alcoholic fermentation kinetics, leading to fermentation delays and negative sensory impacts on the final wine (2). Metschnikowia pulcherrima is a non-Saccharomyces yeast that has demonstrated remarkable antagonistic capacity against various phytopathogenic fungi, mainly associated with its high affinity for iron (3,4). This property makes M. pulcherrima an ideal candidate for preventive applications in vineyards, thus constituting a sustainable agricultural strategy by supporting natural biocontrol and reducing reliance on chemical inputs. The aim of this study was to explore a bioprotective strategy through the application of M. pulcherrima in grapevine. A native strain exhibiting the highest antimicrobial activity was first selected following established procedures (5). Subsequently, a field trial was conducted in a white-grape vineyard using a randomized complete block design comprising three vine rows. Within each row, three blocks of 30 vines were assigned to one of the following treatments, applied by spraying two weeks before harvest: 800 mL of water (WT), a commercial yeast suspension containing 2–3 × 10^7 CFU/mL (CY), or the selected M. pulcherrima strain at the same concentration (208T). For microbiological analyses, 100 berries were aseptically collected from each treatment 30 minutes after spraying (time 0) and again at harvest (after 2 weeks). Quantification of molds, yeasts, lactic and acetic acid bacteria was performed on selective media following OIV recommendations (6) and implantation of both strains was confirmed at the two sampling times by PCR-RAPD. Finally, each vine block was vinified independently to assess the impact of this in-field application on the final wine quality. Results obtained showed that 208T treatments resulted in a higher reduction in Aspergillus niger counts (72%) compared to control plots, together with a complete inhibition of Gluconobacter spp. Although CY treatments also reduced both microorganisms, this effect was less pronounced (6% and 54%, respectively), indicating a higher bioprotective capacity of 208T. RAPD-PCR analysis confirmed the correct implantation of each strain in their corresponding blocks, being both strains quantified at 10^3–10^4 CFU/mL after racking.

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Rapid Flow Cytometry Profiling of Yeast Cell-Wall Mannoproteins Across Wine Strains

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Keywords: mannoproteins; flow cytometry; Saccharomyces; non-Saccharomyces yeasts; monosaccharide composition

Background: Mannoproteins (MP) from the outer yeast cell wall (30–50% of yeast dry weight) contribute to wine stability, colour, mouthfeel, and aroma retention via interactions with phenolics and volatiles. MP levels vary across species/strains and are influenced by external factors such as pH and carbon source. Conventional MP assessment commonly relies on extraction and compositional characterisation, limiting throughput. Methods: A concanavalin (Con) A-fluorescein isothiocyanate (FITC) flow cytometry (FC) assay was developed to quantify relative MP levels on intact cells and benchmarked against polysaccharide extraction followed by monosaccharide analysis. Staining was optimised by ConA-FITC titration, standardising cell concentration and event number and evaluating buffer conditions to achieve reproducible saturation. Ten strains (selected from 48 Saccharomyces cerevisiae and non-Saccharomyces spp.) spanning a range of cell sizes were cultured under matched conditions, with growth curves used to standardise stationary-phase sampling. FC readouts were then benchmarked against traditional polysaccharide extraction followed by monosaccharide analysis. Results: The optimised FC protocol achieved reproducible saturation staining and robust fluorescence intensity measurements. Extraction-based analyses similarly revealed inter-strain differences in polysaccharide yield and monosaccharide profiles. Conclusion: FC provides a faster and practical approach to screen yeast MP levels while extraction-based composition data add complementary chemical insight.

P078 — Poster

Malolactic fermentation promoters obtained from post-distillation wine lees using Natural Deep Eutectic Solvents

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Keywords: Wine lees, Natural Deep Eutectic Solvents (NaDES), Yeast extracts, Malolactic fermentation, Upcycling

Despite being the second winemaking by-product in terms of volume, wine lees remains mostly undervalued1. This is especially true after distillation, when the removal of ethanol results in an unstable product difficult to transport or valorize, leaving distilleries in charge for its disposal2. This study aims to propose a sustainable strategy for the stabilization and valorization of post-distillation wine lees (PDWL) as a source of high-value enological additives. PDWL from a local distillery were dried through a thermal treatment (135°C to 90°C, 6 h) that reduced moisture to 7.5%, yielding a stable powder containing exhausted yeasts and wine sediments. The powder was extracted using three food-grade Natural Deep Eutectic Solvents (NADES) formulations (betaine mixed with citric, malic, or lactic acid)3 with a pH 3.4 McIlvaine buffer (MC) taken as a benchmark solvent. Extracts were combined with autoclave treatment (121 °C, 20 min) and ethanol precipitation to recover and concentrate proteins and polysaccharides. Although the use of NADES did not lead to an improvement of the extraction yield, citric acid/betaine and malic acid/betaine formulations allowed to obtain extracts with a higher polysaccharide content (39.2–45.4%) compared to MC (25.2%). The higher glucose-to-mannose ratio in these former samples suggests a higher amount of yeast β-glucans; conversely, yeast mannoproteins appeared to be more concentrated in both the lactic acid/betaine NADES and MC. The extracts' impact on malolactic fermentation (MLF) was evaluated in model wine. Two O. oeni strains were inoculated at $1x10^6$ cells/mL and monitored for 144 h at 25 °C in the presence of the four extracts (0.4 and 1.0 g/L). Almost all trials significantly enhanced MLF speed in a dose dependent manner, enabling complete conversion of 2 g/L malic acid to lactic acid within 30–50 h. An increase in growth rate and population size was observed, rising from 1.68×10^7 cells/mL (control) up to 2.33×10^8 cells/mL. These findings suggest that PDWL extracts can enhance the tolerance of O. oeni strains to the stressful conditions of synthetic wine indicating their potential application as functional aids in winemaking.

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P079 — Poster

Managing the conditions of the pied de cuve offers wine with different organoleptic profiles

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Keywords: pied de cuve, fermentation, Saccharomyces, aromatics profiles

Saccharomyces cerevisiae is responsible for alcoholic fermentation (AF) and is widely distributed as active dry yeast (ADY). While optimal ADY rehydration conditions are well established, the management of yeast biomass propagation ("pied de cuve") remains poorly documented with respect to its impact on fermentation performance and wine quality. This study evaluated the influence of propagation medium and growth duration on AF kinetics and on the chemical and sensory profiles of wines. Yeast biomass was propagated either in YEPD or in a low-cost beet molasses-based medium (50 g/L beet molasses supplemented with 1% yeast extract), for 24 or 96 h. Fermentations were conducted in Chasselas must using the four resulting inocula (Y_24h, Y_96h, M_24h, M_96h), with directly rehydrated ADY used as a control. Yeast viability and vitality were assessed on days 3 and 14 of AF, and final wine composition was analyzed by HPLC and GC. Sensory differences were evaluated using Napping and Newman–Keuls tests. All propagation conditions resulted in high yeast viability (>99%). The M_24h inoculum exhibited a slightly higher maximum specific growth rate (μmax). While cell viability remained similar among treatments on days 3 and 14 of AF, yeast vitality differed at the beginning of fermentation, with higher vitality observed for inocula propagated for 24 h. While viability remained similar throughout AF, yeast vitality differed at the beginning of fermentation, with higher vitality observed for inocula propagated for 24 h. No significant differences were detected in the chemical composition of the wines. However, distinct aromatic profiles were perceived in both mouth and nose. Although the sensory analysis was exploratory, the consistent discrimination observed across replicates suggests that yeast propagation conditions induced robust and perceivable sensory differences. These results indicate that yeast propagation can be used as a practical and economical tool to modulate wine sensory profiles without negatively affecting fermentation kinetics or chemical composition.

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P080 — Poster

Impact of must oxidation on β-lyase coding genes of Saccharomyces cerevisiae and the release of polyfunctional thiols in Sauvignon Blanc

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Keywords: Key words: polyfunctional thiols, qPCR, oxidation-reduction potential

Polyfunctional thiols represent a potent class of aroma compounds that shape the wine aroma due to their low odor detection thresholds [1]. The uptake of thiol precursors in yeast cells, their enzymatic cleavage and the release of volatile thiols has been found to be related to the intracellular oxidation-reduction potential (ORP) influencing the expression of β-lyase coding genes involved in thiol metabolism (Gallo et al., 2026). Must oxidation prior to inoculation is thought to increase the ORP and therefore enhancing the expression of β-lyase coding genes. However, must oxidation may also reduce the concentration of thiol precursors in must causing a decrease of volatile thiol yields in wine (Roland et al., 2010). Consequently, it remains unclear if an optimal balance between these opposing effects exists and if it can be controlled through monitoring ORP during must processing and wine fermentation. Clarified Sauvignon Blanc grape must was subjected to different pre-fermentation treatments: [1] addition of 60 mg/L SO_2, (2) protection with dry ice and (3) active air addition. The batches were inoculated with Saccharomyces cerevisiae to start fermentation. ORP was monitored during pre-fermentation treatments until the end of fermentation. Total RNA was isolated from yeast cells, collected at 24, 48, 72, and 96 h after inoculation. After generating complementary DNA (cDNA), quantitative real-time PCR (qPCR) was performed in order to analyze the expression of genes STR3 and IRC7 associated with β-lyase activity. ORP was found to be significantly enhanced by must oxidation. Gene expression during the onset of fermentation was positively correlated to the ORP suggesting the ORP as a potent parameter to control aroma formation. The liberation of polyfunctional thiols can be increased in the wine by controlling the ORP during must processing and wine fermentation in the right corridor.

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P081 — Poster

Oxygen consumption and CO_2 production rates as selection criteria for Metschnikowia pulcherrima strains in must bioprotection

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Keywords: M. pulcherrima, bioprotection, tyrosinase inhibition, browning

Enzyme-catalysed oxidation of polyphenols in grape must triggers enzymatic browning, a biochemical process that adversely affects must and wine quality [1]. The resulting increase in brown coloration often leads to reduced consumer acceptance [2]. Therefore, winemakers need to prevent enzymatic browning reactions to guarantee the quality of their products. The main strategy currently employed in the wine industry is to use sulphur dioxide (E220) due to its inhibitory effect of both tyrosinase and laccase, as well as its antimicrobial properties [3]. However, given that sulphur dioxide can provoke adverse reactions in sensitive individuals, there is increasing interest in the development of effective alternative strategies to replace it. Bioprotection is a biotechnological strategy that serves as an alternative for minimizing or even eliminating the use of sulphur dioxide in winemaking. This approach involves using specific non-Saccharomyces yeasts. Among the different species of non-Saccharomyces yeasts, Metschnikowia pulcherrima seems to be the most promising thanks to its respiratory metabolism that enables it to quickly consume the dissolved molecular oxygen. In addition, its inoculation seems to prevent the development of some spoilage microorganisms. Consequently, M. pulcherrima emerges as a potential strategy for protecting musts and wines from enzymatic browning and microbiological spoilage [4]. This study proposes the use of two novel selection criteria for M. pulcherrima strains: the oxygen consumption and CO_2 production rates. An optimal strain would exhibit the highest possible oxygen consumption rate, thereby limiting oxidative processes, together with a moderate CO_2 production rate to ensure that must clarification (settling) proceeds without problems

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P082 — Poster

From sensory quality and aroma chemistry to novel traits in MAS grape vine breeding – the case of polyfunctional thiols

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Keywords: grape vine breeding, sensory quality, marker-assisted selection (MAS), QTL, polyfunctional thiols

In the context of global crises such as climate change, biodiversity loss and pollution, it is necessary to reconsider current agricultural practices. Breeding new grape varieties that are resistant to pests can make viticulture more sustainable by reducing the need for pesticides and their impact on biodiversity and pollution. As a traditional product with well-established styles, acceptance of new wine varieties depends heavily on sensory quality. Including wine sensory quality as a trait for marker-assisted selection (MAS) in a grapevine breeding programme would make grapevine breeding faster and more efficient. [1]. In the current multidisciplinary project, two segregating F1 populations of 'Calardis Musqué' x 'Villard Blanc' crosses, including a total of 150 selected individual genotypes, were characterised by a high-density genetic map using a 'genotyping by sequencing' approach [2]. Individual wines were vinified over multiple vintages and extensively characterised by sensory and chemical analysis. Sensory analysis shows a high overall reproducibility of a measure called Total Quality Score (TQS) for the whole system "Growing - Harvesting - Winemaking - Sensory Analysis" over all vintages. TQS was strongly positively correlated with the descriptive sensory attributes 'floral', 'fruity' and 'tropical fruit'. To understand the underlying molecular basis, the concentration of highly aroma-active varietal volatile thiols in the experimental wines was analysed by means of HPLC-MS-MS using a modified method according to Capone et al. (2015) [3]. When the results of aroma compound analysis in the wines were linked to sensory data, the varietal thiol 4-sulfanyl-4-methyl-pentan-2-one (4-MSP) showed significantly higher values for the group of best wines. At the same time, 3-sulfanylhexanol (3-SH) and its actetate ester 3-sulfanylhexanol acetate (3-SHA) did not directly correlate significantly with sensory quality. The concentration of three polyfunctional thiols (3-SH, 3-SHA and 4-MSP) in wines was used as phenotypic data, which was then combined with genetic information to identify stable quantitative trait loci (QTLs) associated with variation in wine quality. This approach revealed six stable QTL’s for these compounds (2 for 3-SH, 1 for 3-SHA, and 3 for 4-MSP) throughout the genome. The results of this study will help to enable the selection of thiol producing genotypes by MAS in future breeding programs.

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P083 — Poster

Brettanomyces in Switzerland: isolation, characterization, and impact of wine matrix on deviations

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Keywords: Brettanomyces, Genetic diversity, Wine matrix, Switzerland

Yeasts of the genus Brettanomyces are known for their ability to alter wine aroma profiles, primarily through the production of specific phenolic compounds that are now well characterized (1). Understanding their diversity and behavior in cellars is essential to anticipate and prevent these sensory deviations. In this study, we isolated and analyzed strains from 15 Swiss wineries to evaluate their potential for aroma deviation and their genetic diversity (2). Each strain was phenotypically characterized, focusing on volatile phenolic compound production, but also on a broad range of metabolites to identify distinctive traits between strains (3). Genetic analyses are expected to establish links between the molecular identity of the yeasts and their functional traits. This combined approach aims to map, for the first time, the diversity of Brettanomyces in Switzerland and to identify the most active or problematic strains affecting wine quality. In parallel, we monitored the evolution of wines exposed to these strains to assess their susceptibility to spoilage. Results reveal significant variations depending on the grape variety and initial wine characteristics, with some wines being particularly prone to deviations (4). These observations provide precise guidance to anticipate risks and adapt cellar management strategies, taking into account the metabolic and genetic profiles of the strains present. These findings contribute to a better understanding of the risks associated with Brettanomyces in the Swiss wine context and provide a solid basis for developing targeted oenological practices aimed at preserving sensory quality while minimizing corrective interventions. This study paves the way for systematic monitoring of undesirable yeasts and a proactive approach to managing aromatic alterations in wine.

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P084 — Poster

Effects of vineyard biological control agents on fermentation and wine quality

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Keywords: Botrytis cinerea, Biological Control Agents, Alcoholic fermentation, Wine quality

The reduction of synthetic fungicide use in viticulture has promoted the development of alternative strategies such as Biological Control Agents (BCAs) for the control of Botrytis cinerea. Although several BCAs have proven effective in limiting disease incidence in vineyards, their potential impact on the evolution of the alcoholic fermentation and the final wine quality requires further evaluation. In this study, the potential effect of four different BCAs (Bacillus velezensis, Aureobasidium pullulans, Hanseniaspora uvarum and Pichia kudriavzevii) on the winemaking process was investigated using two grape varieties (Nebbiolo and Trebbiano). Grapes were inoculated with each BCA prior to vinification, followed by alcoholic fermentation initiated by inoculation with Saccharomyces cerevisiae. Fermentation kinetics and microbial population dynamics were monitored to evaluate S. cerevisiae performance and changes in the associated microbial communities during alcoholic fermentation. Must and wine samples were collected at different fermentation stages for subsequent chemical analysis, including organic acids and volatile compound profiles. Additionally, sensory analysis was conducted to evaluate possible effects of the treatments on wine sensory attributes. The results showed that although some BCAs initially affected fermentative vigor, all fermentations reached dryness (residual sugars < 0.5 g/L), indicating that yeast activity was not adversely affected. Notably, the use of certain BCAs led to favorable analytical changes: A. pullulans increased glycerol content, a compound associated with enhanced wine body, while several treatments significantly reduced volatile acidity in Trebbiano wines compared to the untreated control. Furthermore, grape treatment with H. uvarum resulted in a decrease in malic acid concentration in Nebbiolo wines. In summary, these findings suggest that the evaluated BCAs are compatible with the winemaking process and can modulate specific chemical and sensory parameters, supporting their use as sustainable tools for the control of B. cinerea in viticulture without compromising, and potentially enhancing, wine quality.

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P085 — Poster

How does the inoculation mode of selected oenological yeasts influence wine profiles?

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Keywords: Saccharomyces cerevisiae, yeast preparation, metabolomic, volatilome, alcoholic fermentation

Yeasts profoundly influence winemaking outcomes, not only by driving alcoholic fermentation but also by shaping the chemical and aromatic diversity of wines. Beyond the standard rehydration of Active Dry Yeasts (ADY), alternative preparation methods such as pre culturing—akin to a pied de cuve—have regained interest, as they involve a phase of yeast multiplication prior to must inoculation and are known to modify fermentation dynamics. In this work, we investigated how these two inoculation strategies affect the metabolism of three commercial Saccharomyces cerevisiae strains and the resulting composition of Chardonnay wines by combining high resolution, targeted and untargeted metabolomics. Although classical oenological parameters remained unchanged between inoculation modes, deep metabolic profiling revealed marked differences in both the volatilome and exometabolome. HRMS analysis showed that yeast preparation prior to inoculation profoundly affects metabolic activity, with over a thousand biomarkers modulated depending on the method used. Wines fermented from rehydrated ADY displayed signatures enriched in polyphenol related compounds and higher levels of esters, whereas pre cultured yeasts produced wines characterized by metabolites associated mainly with nitrogen metabolism. Interestingly, the metabolic fingerprints of wines produced with multiplied yeast converged across strains, while those from directly rehydrated ADY retained strain specific profiles. Altogether, these results demonstrate that the physiological state imposed by the inoculation method leads to a substantial reprogramming of yeast metabolism, determining both the non volatile and volatile chemical compositions of the finished wines.

P086 — Poster

Limiting Brettanomyces bruxellensis by early inoculations of Metschnikowia pulcherrima and Oenococcus oeni

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Keywords: Interactions, Brettanomyces bruxellensis, Metschnikowia pulcherrima, Oenococcus oeni

Metschnikowia pulcherrima (Mp) species has been proposed for several years to wine makers as a bioprotective agent against spoilage organisms (Berbegal et al. 2017). This work studies the association of Mp and Oenococcus oeni strains as an interesting way to limit microbiological alterations associated with Brettanomyces bruxellensis (Bb). In the first part of this study, strains were selected based on their performances. Thus, fast growth, fast consumption of dioxygen and vitamins and strong pulcherriminic acid production were key factors for Mp strains. Selection of O. Oeni was focused on the rate of inoculation, survival and malolactic fermentation (MLF). Finally, B. bruxellensis strains with different sensibility of SO2 were chosen. The second part of the study aim to monitor the growth of B.bruxellensis during bioprotection phase, alcoholic fermentation (AF), MLF and during post fermentations phase (up to 70 days after inoculations). The impact of the association of one selected Mp strain and 2 selected O. oeni strains on Bb populations is presented here. These fermentations were performed in 1.2 L bioreactors in Cabernet Sauvignon grape must, at 24°C. AF and MLF kinetics were monitored by weight loss and L-malic acid concentrations respectively. Bb growth was assessed using plating onto WL agar medium. Moreover, two inoculation times were tested: early co-inoculation (24 hours after Saccharomyces cerevisiae) and late co-inoculation (3/4 of AF). Wines analyses were performed at the end of post fermentation phase: volatile acidity, pH, ethanol, vinylphenols and ethylphenols. AF and FML were completed in 8 and 5 days respectively. The best results in controlling Bb growth were achieved with the early co-inoculation of Mp and one of the selected O.oeni This association allowed reducing both Bb maximum population and the viable population after 70 days (<10 CFU/mL). In addition, this resulted in a lower concentration of ethylphenols (10.5 µg/l) compared to control modalities: Bb with only S. cerevisiae (226 µg/L) and Bb with only Mp (169 µg/L). This indicates that mixed cultures of yeasts and lactic acid bacteria could be a new innovative way to control spoilage during the early stage of Bb implantation.

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P087 — Poster

Understanding early yeast lipid consumption in wine fermentation through lipidomics: new perspectives for fermentation management

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Keywords: Lipidomics, Saccharomyces cerevisiae, Nutrient uptake, Fermentation kinetics, Adsorption

Lipids play a pivotal role in yeast stress resistance, fermentation kinetics, and aroma production. However, while nitrogen nutrition is well characterized, the consumption of the diverse lipid fraction present in grape musts during fermentation remains poorly understood. This study applies a comprehensive targeted lipidomics approach, combining GC-MS and LC-MS/MS, to investigate the consumption kinetics of 94 lipid species in two grape musts (Chardonnay and Gewurztraminer) by three commercial yeast strains. We demonstrate that yeasts consume a much broader range of exogenous lipids than previously reported. Significant concentration changes were observed for 66 lipids during fermentation. In addition to the previously reported consumption of Free Fatty Acids (FFAs) and phytosterols, we demonstrate that yeasts also actively consume Sterol Esters (SE) and Diglycerides (DG). Adsorption tests confirmed that these decreases during fermentation are primarily driven by metabolic consumption rather than cell wall binding, although minor phytosterol adsorption was observed. Lipid uptake occurred principally during the yeast exponential growth phase. We quantified functional requirements for specific consumption: phytosterol uptake (4.5 ± 1.6 mg/L/10^8 cells) and DG consumption were constant across strains and musts. Conversely, FFA and SE requirements were matrix-dependent. Notably, strong linear correlations were found between initial concentrations and specific consumption for FFAs ($R^2=0.91$), phytosterols ($R^2=0.81$), SE ($R^2=0.94$), and DG ($R^2=0.93$). This indicates a dose-response effect where uptake is largely proportional to initial abundance. These results highlight that yeast lipid demand is significantly greater than previously thought. The established quantitative data and linear models offer new opportunities for optimizing nutrient supplementation and developing predictive models for precision oenology.

P088 — Poster

A tale from 30 French vineyards: how shifts in bacterial and fungal species shape microbial communities from vine to wine and impact fresh mushroom aroma off-odors

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Keywords: microbial communities, metagenetic, volatile organic compounds, grape and wine quality

Grape berry quality is highly influenced by the pedoclimatic conditions in vineyards and specific microbial communities colonizing the berry surface during ripening. Yet, microbial community shifts from vine to wine have not been fully explored, especially mycobiota. Fungi are well-known producers of volatile organic compounds (VOCs) that may impact wine quality. Some fungi as well as their interactions may contribute to wine defects such as fresh mushroom aroma (FMA). To decipher the microbial succession from vine to wine, we monitored bacterial and fungal communities in 30 vineyards at five different stages from vine to wine during three successive years (2021-23). Climatic conditions, vine data and growing practices were recorded. The cultural and metabarcoding data generated were compared with sensorial analyses of still wines resulting from 30 grape must micro-vinifications to determine to what extent fungal composition and microbial interactions led to the FMA defect in wines. We observed distinct shifts in microbial communities, mainly influenced by climatic data and berry ripening stage. In the early stages, yeasts dominated followed by a progressive increase in mold diversity. Climatic conditions not only shaped mycobiota but also played a crucial role in FMA detection in wines. Wines exhibiting FMA off odors were linked to vineyards with higher precipitation and lower temperatures during the 2021 and 2023 growing seasons. FMA was primarily linked to higher fungal counts and Penicillium species, especially Penicillium crocicola among the fifteen Penicillium species identified. On Meunier or Pinot noir grapes, Botrytis cinerea co-inoculated with Penicillium bialowiezense or Penicillium citreonigrum also led to detectable FMA off-odors and an increase in known FMA markers. Untargeted head space GC-MS identified known FMA-associated VOCs (8 carbon VOCs) but also unidentified VOCs suggesting the FMA defect is most likely linked to combinations of multiple fungal derived compounds. Overall, our results advance the understanding of how microbial communities evolve from vine to wine. We showed how specific individual and co-cultured grape-associated fungi thrived on berries and induced FMA off odors. This research provides the groundwork to put in place better vineyard and wine management practices including the possible use of the identified repressive species to control fungal populations on berries.

P089 — Poster

Sensory, what does malolactic fermentation highlight?

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Keywords: Malolactic fermentation, lactic acid bacteria, Oenococcus oeni, sensory, aromas

Lactic acid bacteria (LAB) drive malolactic fermentation (MLF) which modulates the sensorial profile of wines through the decarboxylation of malic acid into lactic acid. Beyond deacidification and the associated softer flavors, LAB also synthesize secondary metabolites, including diacetyl, esters and sulphur compounds, that contribute to wine bouquet. However, the organoleptic role of MLF remains controversial, as it depends on the wine matrix, winemaking processes and LAB strains. This study evaluated the impact of various Oenococcus oeni strains through two pilot scale assays in winery. First, seven commercial strains and indigenous LAB conducted sequential MLF in merlot. Results demonstrated that MLF influenced color, aromatic composition and sensory profiles of wines. After MLF, the wines were perceived brighter with ruby shades and higher concentrations of diacetyl and ethyl lactate, while preserving the ester content. Comparisons between strains revealed that indigenous bacteria produced significantly higher levels of diacetyl, ethyl lactate and high-alcohol acetates in accordance with the sensory profiling. These wines were characterized by amylic and buttery notes, which masked fruity notes. While differences between commercial strains were more subtle, variabilities in ester and diacetyl production led to distinct wines though their fruit intensity. The second assay compared two O. oeni strains along with two inoculation strategies in merlot: co-inoculation (24h after yeast addition) and sequential inoculation (post-alcoholic fermentation). Inoculation timing proved to be a dominant factor after two months of aging. Sequential inoculation favoured the synthesis of substituted or hydroxylated ethyl esters, acting as fruit enhancers and resulting in wines with jammy and pastry notes. Conversely, co-inoculated wines were associated with brightness, fresh fruit, floral and vegetal notes. In this inoculation modality, a strain-specific effect was more pronounced, differentiating wines based on their concentrations of C13-norisoprenoids and floral aromas versus fatty acid ethyl esters, diacetyl, ethyl lactate and toasted notes. Ours studies show that LAB are not just tools for malic acid degradation but are essential for sensory modulation and complement the action of yeasts. The diversity of selected strains and the strategic timing of inoculation offer winemakers precise levers to fine-tune the analytical and organoleptic profiles of their red wines.

P090 — Poster

Enhancing Wine Acidity Through Lactic and Succinic Acid-Producing Yeast Strains

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Keywords: Lachancea thermotolerans, Saccharomyces cerevisiae, Lactic acid, Succinic acid, Climate change

Climate change presents a major challenge for the wine industry because of anticipated changes in grape composition at harvest, which include higher sugar levels (i.e., increased alcohol in wine) and decreased acidity [1]. However, many consumers continue to prefer fresh and vibrant white wine styles (Bucher et al., 2018), which can be achieved by using novel yeasts that offer a biological solution. For example, Lachancea thermotolerans metabolism produces lactic acid with an associated reduction in alcohol levels. Selected Saccharomyces cerevisiae strains also have metabolic outputs that include increased amounts of succinic acid (Vicente et al., 2022). In this study, a Riesling must (pH 3.5, 22.3 °Brix, titratable acidity 4.69 g/L) was fermented with selected strains of L. thermotolerans and S. cerevisiae, chosen for their enhanced production of lactic and succinic acids, respectively. A commercial S. cerevisiae strain (Lalvin DV10) was used as a control. The experimental fermentations resulted in an increase in titratable acidity by 1.4 to 5.5 g/L and a reduction in pH of 0.04 to 0.28 units, depending on the yeast strain. Additionally, alcohol content decreased by 0.13% to 0.67% (v/v) across treatments. The L. thermotolerans strains produced lactic acid concentrations of up to 7 g/L, while one S. cerevisiae strain generated 1.4 g/L succinic acid. Sensory evaluation indicated that none of the yeast treatments led to the development of off-flavors, and significant differences in perceived sourness, bitterness, and sweetness were observed. These findings highlight the potential of bioacidification as a viable alternative to chemical acidification, particularly for producing wines with elevated freshness. Such wines may be used as blending components or as base wines for sparkling wine production where higher acidity is desirable. This strategy offers a practical tool for mitigating the enological impacts of climate change, and future research should explore optimal conditions, methodologies, and yeast selection to expand its applicability.

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P091 — Poster

GRAPEVINE VIRUSES: FRIEND OR FOE FOR QUALITY VITICULTURE? A CASE STUDY FROM TRENTINO

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Keywords: Grapevine viruses, Grapevine Pinot Gris Virus, viral associations, grape quality, alcoholic fermentation

Grapevine viruses represent a critical challenge in many viticultural districts, significantly undermining vine productivity and longevity. Despite this, it is still debated whether such infections might paradoxically enhance quality. To verify this hypothesis, this study investigated the impact of GPGV, GFLV, GLRaV-1, and GLRaV-3 mixed infections on Pinot Gris performance in Trentino (Italian Alps). Molecular tests (ELISA, RT-PCR) highlighted widespread mixed infections, likely resulting from infected nursery material and vectors. Comparing healthy and infected plants revealed significant differences: infections caused a drastic reduction in cluster weight (mean 198 g vs 49 g, -80%). Chemical analyses confirmed a qualitative shift, with generally higher total acidity and lower sugars. However, the impact depended on the viral mix: GPGV/GFLV/GLRaV-3 was the most detrimental, whereas the GPGV/GFLV/GLRaV-1 combination remained surprisingly similar to healthy grapes. Micro-fermentations (by selected S. cerevisiae strain and controlled environmental condition, without grape must modification) showed significantly higher viable yeast counts in healthy musts. While CO_2 production rates (estimated by Gompertz model) were similar, infected samples showed a delayed lag phase. Finished wines mirrored the musts: GFLV/GLRaV-3 trials resulted in lower alcohol and elevated acidity, confirming that specific co-infections compromise oenological suitability. GC-MS/MS analysis also verified distinct aromatic profiles from virus affected and safe samples. In conclusion, viral associations not only reduce productivity and lifespan but also deteriorate grape quality, debunking the myth of qualitative improvement. While targeted nutrition is advisable, strict sanitary control of nursery material remains the primary defence.

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P092 — Poster

Evolution of copper tolerance in Hanseniaspora uvarum under climate driven selective pressures: analysis of strains isolated over twenty years

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Keywords: Hanseniaspora uvarum; copper tolerance; climate change; adaptation

Climate change is reshaping viticultural ecosystems through rising temperatures, altered rainfall patterns and adjustments in plant protection strategies. The ClimHans project investigates the evolution and adaptation of different species of the genus Hanseniaspora in response to these environmental shifts. Among this genus, Hanseniaspora uvarum species plays a dual role in fermented beverages: it is described as a spoilage yeast in winemaking due to acetic acid and ethyl acetate production (Ciani and Picciotti, 1995; Ciani and Maccarelli, 1997), while certain strains are technologically valued (Aponte and Blaiotta, 2016; Testa et al., 2021). Environmental changes may therefore influence diversity of this species as well as tolerance to technological stresses, like the copper widely applied as a vineyard fungicide and present also during the winemaking process (Wand et al., 2023). This work tests the hypothesis that environmental and climatic changes may affect copper stress tolerance within H. uvarum populations. This study evaluated intra-specific variability in copper tolerance within a collection of H. uvarum strains originating from diverse French viticultural regions and spanning several decades. Two complementary experimental approaches were implemented based on the study of Grangeteau et al. (2017). Solid medium assays were conducted using copper concentrations mimicking those encountered on grape berries following phytosanitary treatments. Growth was monitored through colony development on solid plates by colony diameter estimation. In parallel, liquid culture assays were done with different copper concentrations representative of those potentially present in must during vinification. Growth-related fitness parameters were calculated. Finally, tolerance was defined relative to copper-free controls, allowing determination of maximum tolerated concentration. Preliminary results reveal intra-specific heterogeneity in copper sensitivity, suggesting that environmental pressures contribute to functional diversification and may ultimately impact wine quality in future production systems.

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P093 — Poster

Hydroxycinnamic acids - as an early biomarker of Brett in Georgian red wines

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Keywords: Wine, Brettanomyces, Brett, Hydroxycinnamic acids.

In Georgian red wines, we studied the formation of hydroxycinnamic acids, which are precursors of volatile phenols, the prerequisite for Brett disease. Wines were produced from Georgian red wine grape varieties using classical technology. From the 2025 harvest season, grapes of the Saperavi, Cabernet Sauvignon, Aleksandrouli, Mujuretuli, Ojaleshi, Tavkveri, and Shavkapito varieties were harvested at technological maturity, processed, and alcoholic fermentation of the destemmed pomace was carried out at 25°C in three options for each variety: (1) control – spontaneous fermentation; (2) fermentation with the Italian strain CBS2499 of Brettanomyces/Bruxellensis; (3)fermentation with the Georgian strain AUG01 of Brettanomyces/Bruxellensis. These yeast strains were isolated in September 2025 at the University of Milan (Microbiology Laboratory) from Italian and Georgian red wines affected by Brett disease. Yeast strains were identified based on DNA analysis.In the wine materials produced according to these variants, para-coumaric, ferulic and caffeic acids were determined using the HPLC method. In all control wine materials, p-coumaric acid was found to be dominant. Changes in the concentrations of all three acids were observed in the presence of Brettanomyces/Bruxellensis yeasts, with the Italian strain showing a more intense effect compared to the Georgian strain. After completion of the formation process of the experimental wine materials, analysis of hydroxycinnamic acids and volatile phenols in the resulting wines will allow us to confirm our hypothesis—whether hydroxycinnamic acids can be considered an early biomarker of Brett in Georgian red wines.

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P094 — Poster

Characterization of Torulaspora delbrueckii Isolates from Patagonia for Apple Must Fermentation and Mixed Cider Fermentations

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Keywords: Torulaspora delbrueckii; ArgentinNorpatagonia; non-Saccharomyces yeasts; mixed fermentation; cider production.

Cider production in Argentina is concentrated in the Norpatagonian region, which accounts for approximately 85% of the country's total production due to the availability of pome fruits such as apples and pears. Torulaspora delbrueckii (Td) was the first non-Saccharomyces species commercialized as a starter culture because of its favorable enological properties. It is characterized by low acetic acid production, low ethanol yield, increased glycerol synthesis, and mannoprotein release. It also improves the aromatic profile and phenolic composition of wines. However, its use in apple must fermentation remains underexplored. This study analyzed eleven Td isolates obtained from different fermentative environments in Argentine Patagonia. Their response to stress parameters relevant to the fermented beverage industry was evaluated, and microfermentations were conducted in sterile apple must. The chemical composition of the fermentation products was subsequently analyzed. Based on these results, mixed fermentations were performed with a commercial strain of Saccharomyces cerevisiae (Sc). During physiological characterization, all isolates grew between 13 and 35 °C and exhibited intraspecific differences in thermotolerance. All isolates grew in the presence of 1 mM sodium metabisulfite, a concentration above typical industrial levels, whereas only some grew at 4 mM. Microfermentations were conducted in 35 mL of sterile apple must (12.5 °Bx). All isolates completed fermentation in 18 days and reached an average ethanol concentration of 5.5 ± 0.5% v/v. A commercial Sc strain was used as control. Compared with Sc, Td isolates produced higher concentrations of glycerol, sorbitol, and erythritol, compounds of enological interest. Two Td strains were selected, based on physiological characterization and microfermentation performance, for mixed fermentations in 350 mL of sterile Granny Smith apple must (13.1 °Bx). These fermentations were carried out with a commercial Sc strain. Fermentation was completed after 19 days, and Td coexisted with Sc. HPLC analysis showed higher concentrations of glycerol, sorbitol, and erythritol in fermentations involving Td compared with the commercial Sc strain. This study explores the fermentative potential of Td strains. The results provide insight into their application as biotechnological resources for premium cider production and contribute to the valorization of non-Saccharomyces yeasts in the cider industry.

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P095 — Poster

Non-Saccharomyces yeasts as bio-tools for modulating wine aroma and acidity in warm-climate regions

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Keywords: non-Saccharomyces yeast, wine aroma modulation, biological acidification, warm-aride climatte winemaking, microbial consortia.

Climate change is increasingly disrupting the compositional balance of Mediterranean wines. Rising temperatures accelerate grape ripening, resulting in excessive sugar accumulation, lower total acidity, and diminished aromatic expression. Conventional corrective practices often face technological limitations and may compromise sensory quality. In this context, non-Saccharomyces yeasts represent a sustainable strategy to modulate fermentation under warm and arid environments. This study applied an integrated experimental approach to assess the technological, metabolic and volatilome contribution of Starmerella lactis-condensi MN412 and 4 strains of Lachancea thermotolerans (coded as LT-A, LT-B, LT-C, LT-D) inoculated with Oenococcus oeni and Saccharomyces cerevisiae in Catarratto and Syrah winemaking. The MN412 strain rapidly colonised the must (6.74–6.88 Log CFU/mL), reached a peak of 7.34 Log CFU/mL on day three, and maintained activity until day six. The MN412 fermentations showed increased glycerol production (up to +2.4 g/L vs control), reaching 9.2 g/L, alongside a reduction in ethanol content (up to −0.55% v/v), indicating partial carbon flux redirection.. Volatilome analysis revealed enhanced ester formation modulated by microbial consortia: ethyl esters increased by 38% in St. lactis-condensi MN412-O. oeni-S. cerevisiae fermentation while acetate esters increased by 81% in St. lactis-condensi MN412-S. cerevisiae trials. 3D-plot surface highlighted synergistic volatile interactions associated with pear and lavender perceptions. Non-target metabolomic showed that MN412 strain preserved bioactive compounds. In Syrah fermentations, L. thermotolerans exhibited strong bioacidifying potential. The LT-D strain achieved a pH reduction of 0.68, higher than chemical acidification, accompanied by L-lactic acid production ranging from 5.96 to 12.10 g/L. The LT-B strain stood out for its increase in fruity esters synthesis, while LT-A strain promoted increased shikimic acid levels, suggesting the release of floral aroma precursors into the medium. Overall, St. lactis-condensi MN412 emerges as a highly effective aromatic bio-tool,

while L. thermotolerans LT-D strain confirmed its role as a precision biological acidification modulator. Their combined application outlines an advanced microbial strategy to enhance oenological resilience and maintain wine quality under warm-arid climatic conditions.

P096 — Poster

Acidification-deacidification strategies driven by wine fermentations performed throughout selected yeasts: impact on the final wine quality evaluated by multi-analytical approach

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Global warming is a phenomenon with far-reaching consequences affecting the environment, society, and the economy, impacting several sectors, including the wine industry [1].

One of the main effects of rising temperatures associated with climate change is the acceleration of grapevine vegetative and reproductive cycles, which influences both berry composition and wine quality. In addition to affecting primary metabolites such as organic acids, particularly, malic acid, sugars, and amino acids, elevated temperatures also impact secondary metabolites responsible for key sensory attributes [2]. Modern winemaking aims to limit the use of additives; therefore, biological approaches for managing wine acidity are increasingly preferred. Recent studies have focused on malic acid metabolism by the oenological yeast *Saccharomyces cerevisiae* [3], leading to the identification of quantitative trait loci (QTLs) involved in malic acid modulation in *S. cerevisiae* [4]. These findings have enabled the development, through genetic selection programs, of strains capable of either consuming malic acid or preserving/producing it [5,6].

This study, carried out in collaboration with the French company BioLaffort, aims to evaluate the use of four yeast strains selected for their malic/demalic activity. One microvinification trial was carried out by testing the fermentative performances of the four yeast strains into the same vinification protocols. The objective was to assess the ability of the inoculated microorganisms to modulate and correct the overall acid balance of the wine and to better understand the mechanisms underlying these variations. Investigations were performed using Nuclear Magnetic Resonance (NMR), HPLC-MS, and GC-MS technologies, which enabled the acquisition of detailed insights into the metabolic fluxes involved in the modulation of malic acid, as well as other organic acids and the biosynthesized secondary metabolites, and to explain how these compounds impact wine pH and total acidity.

Finally, the study was complemented by the application of non-destructive analytical technologies (e.g. NIR and E-nose), supporting conventional analytical methods, for fermentation monitoring, wine quality control, and the development of predictive models.

Key Words: *yeast strains, acidification-deacidification, fermentation protocols, multi-analytical approach, wine quality.*

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P097 — Poster

Chemical, Genetic and Sensory Determinants of Free and Bound Terpenoids in Viognier Fermentations with Single and Mixed *Saccharomyces cerevisiae* Strains

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Keywords: Saccharomyces cerevisiae, Viognier, terpenoids, mixed-strain fermentation, β-Glucosidase

Terpenoids are central to the varietal aroma of Viognier wines, yet a large proportion of these compounds occur in grapes as glycosidically bound, non-volatile precursors. During alcoholic fermentation, yeast *β*-glucosidase activity has been suggested to influence the balance between free and bound monoterpenoids, with potential consequences for aroma expression. However, the extent to which differences in yeast enzymatic activity, strain interactions, and genetic factors contribute to these effects remains unclear. Here, *β*-glucosidase activity was screened across 102 *Saccharomyces cerevisiae* strains, allowing strains to be grouped according to relative activity levels. Twenty strains with relatively high or low *β*-glucosidase activity were subsequently selected for more detailed enzymatic characterisation. From these, two high-activity strains (H1, H2) and two low-activity strains (L1, L2) were chosen for fermentation trials. Viognier fermentations were carried out using a structured inoculation scheme that included single-strain fermentations, pairwise combinations, three-strain consortia, and a four-strain consortium, enabling a systematic assessment of yeast interactions under increasing inoculation complexity. The resulting wines were analysed for free and glycosidically bound monoterpenoids to examine how different inoculation strategies influenced their distribution. In parallel, a small set of candidate genes potentially linked to *β*-glucosidase activity was examined across the four selected strains to explore genetic contributions to the observed enzymatic differences. Sensory analysis was conducted to determine whether changes in monoterpenoid profiles were reflected in perceptible differences in Viognier aroma. This study combines chemical, genetic, and sensory perspectives to better understand how yeast *β*-glucosidase activity and mixed-strain fermentations shape terpenoid-related aroma expression in Viognier wines, and to inform aroma-driven yeast selection and fermentation design.

Session V

Sensory analysis, wine styles and consumer preferences

KS5 — Keynote

From wine styles to complexity: decoding the multisensory perception of wine through sensory diversity

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Keywords: wine aroma, taste, mouthfeel, sensory interactions, sensory configurations

Wine is one of the most complex food sensory systems. Considerable progress has been made in identifying wine flavor compounds and understanding their role and behavior [1], but the mechanisms through which chemical composition is translated into wine perception, wine styles and sensory complexity remain only partially understood.

Most studies investigating sensory interactions in wine have traditionally adopted a top-down approach, focusing on the effects of specific compounds or simplified mixtures on selected sensory attributes. The approach presented here explores wine diversity itself as an experimental model to investigate how multisensory perception is structured in real wines. By combining sensory analysis with chemical and compositional data across diverse wines, stable perceptual configurations emerge from recurring patterns of co-presence and systematic absence among sensory dimensions. These configurations suggest that wine styles are not defined by descriptors, but by organized multisensory structures resulting from interactions among aroma, taste and mouthfeel stimuli.

Studies conducted on both white and red wines indicate that sensory diversity can reveal higher-order perceptual organizations linked to wine identity, style differentiation and complexity [2-5]. Cross-modal interactions between olfactory and oral sensations appear to play a key role in shaping these perceptual structures. Recent investigations on new potential flavor compounds in wine [6] further suggest that some dimensions of wine complexity may arise from system-level perceptual effects that cannot be fully explained by individual sensory descriptors alone.

Overall, it will be discussed how a bottom-up exploration of wine sensory diversity may contribute to bridging molecular interaction studies with the emergence of perceptual meaning, wine styles and sensory complexity.

Acknowledgements

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O23 — Oral communication 23

Why wine aromas linger differently: a salivary proteome perspective on oral aroma retention

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Keywords: Wine, aroma persistence, mucoadhesion, mucin, in-vivo methodology.

Aroma persistence is a key determinant of wine sensory quality, driven by the prolonged perception of volatile compounds retained in the oropharyngeal mucosa and gradually released during saliva swallowing and exhalation. This oral-phase phenomenon strongly influences overall aroma perception and therefore plays a central role in consumer acceptance. Oral aroma persistence depends on the ability of volatile compounds to remain in the oral cavity, a process modulated by interactions with salivary proteins—particularly mucins through mucoadhesion—as well as by individual physiological factors such as saliva composition (low molecular weight proteins) and enzymatic activity. However, whether interindividual differences in the salivary proteome, and specifically in mucin profiles, can explain variability in oral aroma retention remains largely unexplored. The objective of this study was twofold: first, to characterize the oral retention behaviour of a mixture of representative wine aroma compounds added to synthetic wine matrices using an in vivo Spit-Off Odorant Measurement (SOOM)–GC–MS approach in a panel of 11 volunteers; and second, to explore the relationship between aroma retention patterns and individual differences in high-molecular-weight salivary fraction using a proteomic RP–LC–MS/MS strategy. Preliminary results revealed marked interindividual variability in aroma retention, largely driven by the chemical nature of the aroma compounds and by differences in salivary protein composition. These findings support the hypothesis that saliva composition—and particularly salivary mucins—plays a key role in modulating oral aroma persistence and may underlie consumer heterogeneity in aroma perception. Ongoing proteomic analyses aim to further elucidate the specific salivary protein features associated with differential aroma retention. Overall, this work provides novel mechanistic insights into matrix–saliva–aroma interactions and opens new perspectives for personalized sensory strategies and targeted wine formulation to enhance aromatic performance.

O24 — Oral communication 24

Biotechnological tools to preserve the complexity and the fruity quality of Bordeaux red wines

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Keywords: S. cerevisiae, biotechnological tools, red wine, aromatic complexity, fruity expression

The production of wine is closely linked to complexity and quality[1]. In the context of climate change, changing consumer habits and economic pressure on the wine industry, identifying the factors that influence aromatic complexity is crucial for improving wine quality. There is concern within the wine industry that the widespread use of single commercial yeast strains may reduce wine complexity and lead to standardization. The literature reports that interactions among multiple yeast species can produce wines with distinct chemical profiles(2). However, are such wines truly more complex in terms of their sensory properties? In this context, the olfactory and molecular profile of Merlot red wines from Bordeaux produced using different oenological techniques were studied. An original sensory analysis approach, focusing on the concept of complexity(3) and evaluating the fruity expression, was conducted alongside GC/MS analysis of targeted volatile compounds. To assess the link between microbiological diversity and aromatic complexity, alcoholic fermentations were carried out using several S. cerevisiae strains, either alone or in combination, and their molecular and sensory impact on the wines was analysed. Initial results show that, while each yeast strain contributes to a unique aromatic and sensory profile, using a mixed culture of S. cerevisiae strains for fermentation does not necessarily result in an increased perceived complexity or fruity notes. These observations put into perspective the commonly held belief that microbiological diversity leads to sensory complexity. In addition to this main study, the use of β-glucosidase-based enzyme preparation in Bordeaux white and red wines was studied in order to evaluate its impact on the olfactory complexity and fruity expression. Recently, scientists revealed that adding certain monoterpenic and C13-norisoprenoid compounds to a red wine, initially described as having cooked fruit aromas, increases the fresh fruity notes(4). Numerous studies have been conducted on the use of enzymes to release these compounds in white wine, but very little attention has been paid to red wines. These results will enable a critical discussion of the oenological levers that can be used to modulate the aromatic complexity and the fruity expression of Bordeaux red wines in the context of climate change.

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O25 — Oral communication 25

Evolution of Grenache wine sensory profiles across distinct climatic zones and ripening stages throughout two consecutive vintages.

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Keywords: Grenache, Climate Change, Grape Ripening, Sensory Analysis, Aroma.

Climate change is introducing high variability in grape ripening, leading to aromatic challenges associated with both overripeness and persistent greenness. These effects are particularly evident in Grenache, a variety widely grown in France and Spain. This study explores the influence of climatic zones and maturity stages on the sensory identity of Grenache wines over two consecutive vintages (2024-2025) in the Pyrenean foothills. Three distinct climatic areas (A, B, and C) were identified using k-means clustering of bioclimatic indices from historical data (1981–2010). Twenty-eight vineyards (20 in Spain, 8 in France) were selected across these zones. Grapes were harvested at two stages: P1 (21.0 ± 2.0 °Brix) and P2 (10-14 days later). All samples underwent standardized microvinification. To characterize the sensory space, multiple Sorting Task sessions were conducted, followed by MultiDimensional Scaling (MDS), Agglomerative Hierarchical Clustering (AHC), and Correspondence Analysis (CA). Representative wines were further characterized by Descriptive Analysis (DA) and Gas Chromatography-Olfactometry (GC-O) to identify key aroma compounds. Results from the two-year study indicate that climatic origin strongly dictates the sensory profile at earlier ripening stages (P1), where cooler zones exhibit vegetal notes, potentially linked to phenolic immaturity [1]. However, as ripening progresses (P2), a sensory convergence is observed across all climatic zones, characterized by a shift towards ripe fruit and overripe descriptors. The inclusion of a second vintage confirms the consistency of these trends under varying seasonal conditions. These findings provide crucial insights for optimizing harvest timing and mitigating climate change effects on wine typicity. This work is part of the EFA102/01 CLIMAROMA project, 65% co-financed by the European Union through the Interreg VI-A Spain-France-Andorra Programme (POCTEFA 2021-2027).

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O26 — Oral communication 26

Effects of Oak Aging on Quality and Sensory Attributes of Wines Produced from Smoke-Exposed Grapes

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Keywords: Smoke taint, Descriptive analysis, Analytical Chemistry, Quality

Wildfires are becoming increasingly prevalent due to climate change. During wildfire events, volatile phenols (VPs) are released in fresh smoke from the combustion of wood lignin. These compounds are absorbed through grape berry skins and are rapidly glycosylated. Wines produced from smoke-impacted grapes can display medicinal, smoky, and retro-nasal ashtray-like characters. Once grapes are exposed, few effective mitigation strategies exist to remediate these sensory defects. In addition, matrix differences among grape varieties and winemaking styles influence smoke expression, as well as potential synergistic effects among VPs. In this study, serial dilutions of non-impacted and impacted wines (intentionally smoked post-harvest) were used to create wines with varying smoke levels in Cabernet Sauvignon and Chardonnay. Oak barrel aging (12 months in new French or American oak) was evaluated as a mitigation strategy, with stainless steel-aged wines serving as controls. Free and total VPs, along with individual bound glycosides, were quantified using GC-MS and LC-QqQ-MS, respectively. Descriptive analysis assessed sensory attributes, and Wine CualityTM was used to evaluate overall quality. A linear relationship was observed between VP and glycoside concentrations and the proportion of smoke-impacted wine in each blend. Wines with higher VP levels also received higher smoke intensity ratings from the sensory panel. Overall, barrel-aged wines showed reduced ashy aftertaste and lower intensities of smoke-related attributes in both varieties. Stainless steel wines were fruitier but expressed stronger smoke characters. Oak-aged wines received higher quality ratings and fewer smoke-related off-flavors than stainless steel counterparts. At very low dilutions of smoke-impacted wine, quality ratings increased in both aging treatments despite measurable increases in VP markers. Oak-aged Cabernet Sauvignon containing low levels of smoke-impacted wine was rated higher in quality than the non-impacted control, a trend less evident in Chardonnay. These findings enhance our understanding of how varying levels of grape smoke exposure influence wine sensory properties and demonstrate that oak barrel aging may serve as a viable strategy to mitigate the overall perception of smoke-related attributes across different wine matrices and taint levels. It also shows the potential use of Wine CualityTM as an alternative method for quality assessment.

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Diving into a Glass of Non-Added Sulphite Wine: How Information Shapes Consumer and Professional Acceptance?

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Keywords: non-added sulphite wine; liking; blind and informed tasting; consumer; expertise

Non-added sulphite (NAS) wines have gained increasing popularity in recent years, driven by consumer demand for healthier, more environmentally friendly products, where reduced chemical inputs are particularly valued. Previous studies have shown contrasting representations of NAS wines among wine consumers and professionals: consumers mainly associate them with naturalness, organic certification and health benefits, whereas professionals focus on the potential risk of sensory defects. From these results, the present study investigates how consumers and professionals evaluate NAS wines during informed or non-informed tastings, and how they react to wines presenting sensory defects. An overall liking test using a 9-point hedonic scale was conducted with 552 consumers from three French wine-producing regions (Angers, Lyon and Marseille) and 37 wine professionals from the Touraine and Bordeaux vineyards. Participants evaluated either three NAS white (PDO Touraine Sauvignon) or red (PDO Bordeaux) wines, presented either under blind or with NAS information. One wine from each PDO was intentionally selected to present an oxidative character for the white wine and a phenolic one for the red. For each wine, consumers were asked to describe what they liked and/or disliked, while professionals were asked to describe the sensory qualities and/or defects they perceived. The results revealed marked differences between the two panels. While the consumer panel did not reject oxidized and phenolic wines under any condition, the professionals systematically rejected the defective wines. Interestingly, the professionals were more critical of the defective wines when they were informed. Finally, these results highlight the difficulty of ensuring both consumer acceptance and oenological quality standards in the growing NAS wine market. The question of defects remains a key point of discord among professionals, with some valuing them as authentic markers of non-interventionist winemaking. This divergence makes arbitration increasingly complex, particularly as consumers appreciate, and sometimes even value, such profiles. This issue should be resolved to establish a clearer identity and quality expectations for NAS wines.

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O28 — Oral communication 28

Sensory–chemical integration of perceived aging potential in red Old Vintage wines: a cross-cultural expert study

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Keywords: aging potential, wine longevity, cross-cultural experts, free description, volatile markers

Today, the consumption of high quality wines with significant ageing potential has become widespread well beyond the countries that have historically produced them. Perceived wine aging potential is widely used in professional evaluation, across origins and cultures, yet it is rarely linked to measurable chemical drivers in commercial old-vintage wines. We investigated how cross-cultural expert judgments of aging potential relate to sensory language and to targeted volatile markers associated with freshness, oxidation, and wine longevity. Nine Argentine commercial red wines (Cabernet Sauvignon/Malbec) spanning 1990–2022 were evaluated blind in 2025 by 140 wine experts across five locations (São Paulo, London, Bordeaux, Davis, Chengdu). For each wine, local experts rated acceptability, estimated perceived aging potential using an ordinal categorical scale and provided free sensory descriptions. Data were analyzed using mixed-effects and multivariate approaches. In parallel, sensory impact compounds (polyfunctional thiols, sulfur compounds, lactones and oxidation related compounds, volatile phenols) specific to both red and white wines were analyzed by different workflows (SPE GC–MS/MS; SPME GC–MS). We showed that most of the red wines were rated above the neutral acceptability anchor. Although perception of aging potential decreased with bottle age but did not collapse to zero for decades-old wines, supporting a gradual, sensory-driven view of aging in which perceived potential evolves rather than abruptly disappearing with bottle age. The liking score of young red wines was similar whatever the country when older wines tended to be more appreciated by the São Paulo panel compared with London. The rejection of oxidation was consistent, regardless of the panel's origin and strongly linked with a loss in their aging potential. Multivariate chemistry (PCA) separated younger samples (high thiols levels) from older vintages characterized by higher maturation/bouquet markers (including lactones and DMS). These sensory lexical patterns were consistent with analytical trends in freshness- and aging-related volatiles, providing an integrated sensory–chemical framework to interpret cross-cultural expert evaluations of old-vintage red wines.

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Sensory differentiation among rosé wine styles using Merlot, Pinot Noir and Dornfelder grapes sustained well the dealcoholization process

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Keywords: Rosé, Sensory, dealcoholization, style vs cultivar, non vs. alcoholic

According to the OIV, consumption of rosé wines exceeded worldwide production by 6% [1]. These figures stimulated the experimental vinification of 3 different rosé styles for each of the cultivar Merlot, Pinot Noir and Dornfelder. The “Provence” style, aiming for pale color and light body applied whole cluster pressing, no use of SO2 in grape processing and flotation with air. The equally processed “Fumé” style fermented with an early autolyzing yeast in presence of 0.5 g/L oak chips, followed by weekly bâtonnage. For the “Thiol” style, crushed grapes were processed in presence of SO2/ascorbic acid and fermented by a thiol releasing strain. All wines passed malolactic fermentation by a lactobacillus plantarum strain and were bottled with 1.9 g/L CO2 (2). Descriptive sensory analysis and PCA revealed a clear distinction among colorful Dornfelder rosé wines, while paler Merlot and Pinot noir plotted in proximity being more sour and mineral. Hierarchal cluster analysis (HCA) classified the rosé style as the dominating factor for Merlot and Pinot Noir, while all 3 styles clustered together for Dornfelder. Thus, Merlot and Pinot Noir are well suited for the pale “Provence" style, while Merlot and Dornfelder yield more pronounced “Thiol” rosé wines with higher grapefruit intensities. The impact of oak and yeast autolysis was stronger perceived in Pinot Noir and Merlot, while Dornfelder yielded a more colorful version. All 9 rosé wines were dealcoholized by vacuum distillation in January of the following year. Sweetness was equally adjusted to 30 g/L, using neutral rectified grape concentrate to avoid color changes. Although sensory intensities declined due to ethanol removal, the specific characters of each rosé style were well resembled in the dealcoholized versions. HCA grouped first rosé styles of varying alcohol levels together, followed by the three cultivars. Pinot Noir rosé wines showed the smallest differences among alcoholic vs. non-alcoholic wines, followed by Merlot, while Dornfelder yielded the largest differentiation. Regarding wine styles, the smallest deviation was observed for the “Provence” style, followed by “Thiol” and “Fumé”. Volatiles, including thiols, are currently analyzed in non- and alcoholic wines and will be presented as well. In conclusion, all grape varieties were highly sensitive to oenological measures to differentiate three distinct rosé styles. Differences among styles and cultivars were well preserved after alcohol removal.

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SO24 — Short oral communication 24

The influence of wine label visual codes on perceived quality

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Keywords: Perceived wine quality, categorical visual cues, wine label design, label semiotics

Wine is an experience good whose quality can't be directly assessed prior to consumption. Consumers therefore rely on extrinsic cues to form quality judgments. In mass retail environments characterized by a dense and visually standardized offer, wine labels play a central role in shaping sensory expectations and perceived quality. Rather than reflecting objective quality, perceived quality emerges as a cognitive construction based on the interpretation of accessible visual signals. This study investigates the influence of categorical visual codes on wine quality perception and explores the existence of consumer segments receptive to visual innovation, even within traditionally conservative appellations. Focusing on the Burgundy appellation Nuits-Saint-Georges, the research follows a multi-stage methodological approach. First, a brand awareness study identifies Nuits-Saint-Georges as the most recognized Burgundy appellation. Second, a semiotic analysis of the corpus of 120 labels reveals the dominant visual codes structuring this category. Third, a choice-based conjoint (CBC) analysis conducted with 206 consumers assesses the relative impact of these visual attributes on perceived quality in a moderate-risk consumption context. Results indicate that visual attributes do not contribute equally to perceived quality. Illustration and label color emerge as the most influential determinants, followed by label shape, whereas typography and typographic color play a secondary role. Consumer segmentation further reveals a distinct segment—approximately one quarter of the sample—that is receptive to visual innovation. This finding is particularly noteworthy given the traditionally conservative image of the appellation. Overall, the study highlights the strategic importance of aligning label design with wine positioning, perceived consumption risk, and target audience diversity. Beyond the case of Nuits-Saint-Georges, the findings contribute to a broader understanding of visual perception mechanisms in wine markets and offer insights applicable to other contexts facing challenges of visual standardization and differentiation, while acknowledging the role of consumer culture in shaping categorical visual codes.

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Chemosensory Insights Into Perceived Regional Chardonnay Typicity and Its Oenological and Terroir Drivers

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Keywords: chardonnay, typicity, projective mapping, DA, soil types, aroma compounds

The Chardonnay grape variety has only been permitted for the production of quality wines for 30 years, but it is gaining increasing attention in Germany's main grape-growing regions due to its ability to adapt to current climatic conditions. The question to be answered is whether a regional Chardonnay wine style exists yet and, if it is mainly impacted by viticultural or oenological factors.This study demonstrates how research can support the wine industry in developing new regional wine styles for the future. The sensory characteristics of 21 German Chardonnay wines from the 2023 vintage were examined. One trained panel characterised the set of wines using projective mapping, followed descriptive analysis (DA). A second panel of wine experts then rated the wines based on their regional typicity and origin. They also linked the wines to a specific soil type and assessed the impact of viticulture and oenology on them. Furthermore, they evaluated the wines' quality. Applying agglomerative hierarchical clustering (AHC) to DA data revealed two main clusters, one of which was subdivided. One cluster was clearly defined by mineral-woody descriptors, while the second cluster was defined by fresh-fruity descriptors. Its subset was defined by palate-driven descriptors. Interestingly, perceived typicity did not correlate significantly with any of these wine styles, showing only a slight tendency towards the mineral-woody Chardonnay style. Moreover perceived typicity of regional Chardonnay wines was highly correlated with overall quality ratings. The expert panel associated high-quality, typical wines with shell-bearing limestone soils (Muschelkalk), regardless of the actual soil type. We then analysed the sensory data using additional metadata obtained from the wineries' questionnaires on soil types, oenological practices and the instrumental analysis of various aroma compound classes (esters, monoterpenes, C13-norisoprenoids and polyfunctional thiols). Analytical data revealed the significant impact of the aroma compounds 2-methylfurane-3-thiol and benzenemethane thiol, which show odour activity values (OAVs) of up to 50 and 100, respectively. Furthermore, understanding the role of different ester species, especially branched and hydroxylated esters, in the perception of fruity descriptors — presumably modulated by oenological factors — is important for precisely producing defined Chardonnay wine styles in future.

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[1] not required - see: only if required and not encouraged

EEG and fNIRS Evidence for Brain Responses to Three Tannins: Implications for Astringency Surface Sub-quality in Red Wine

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Keywords: wine; Tannin; Astringency surface sub-quality; EEG; fNIRS

The astringency surface sub-quality is pivotal to red wine perception, yet its neural bases remain unclear. The approaches of non-invasive neurophysiological techniques, sensory analysis, LC-MS analysis, and molecular docking were applied to examine the astringency surface sub-quality responses to three tannins—tannic acid, grape tannin and wine tannin—standardized to equivalent astringency intensity. The results showed that the three tannins at iso-intensity evoked distinct brain activity and sensory responses. The EEG (electroencephalography) results showed that differential frontal delta-band power, while fNIRS (functional near-infrared spectroscopy) revealed corresponding changes in oxygenated hemoglobin within the ventromedial prefrontal cortex, most prominently at channel 6 (wine tannin > tannic acid > grape tannin; $p < 0.05$). LC-MS analysis of tannins indicated that higher levels of polymeric pigments and free anthocyanins were associated with finer astringency sub-quality and stronger neurophysiological responses. This investigation suggested a rapid, objective of non-invasive neurophysiological approach to complement sensory evaluation of wine.

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SO27 — Short oral communication 27

Pairing red wine and closure: a multimodal decoding of ortho and retronasal perception

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Keywords: wine closures; ortho and retronasal perception; aroma compounds; phenolic compounds, multimodal approach

The sensory expression of wine emerges from dynamic interactions between volatile and non-volatile compounds and is perceived through two distinct yet complementary olfactory pathways: via ortho and retronasal. Orthonasal perception arises from the direct inhalation of volatile compounds through the nasal cavity, whereas retronasal perception occurs during consumption and results from the release of aroma in the oral cavity, modulated by physicochemical interactions with saliva and oral surfaces (1,2). Although closures are known to affect oxidative-reductive balance during bottle storage, their impact on ortho and retronasal perceptions remains largely unexplored. Thus, in this study, a red wine from Burgenland region (Austria) sealed with natural cork, microagglomerated cork, and screw cap was evaluated as case-study, after 5 and 30 months of storage. Various techniques were employed to investigate changes during bottle storage, including the determination of volatile components by GC×GC-ToFMS, phenolic profile by UHPLC-DAD-MSn, general physicochemical parameters, and sensorial analysis performed by a trained panel. Also, oxygen transfer rate of cork stoppers was evaluated. Chemometric tools were used to explore the data sets, select relevant features, and decoding of ortho and retronasal aroma perception. Wines sealed with natural cork exhibited a more balanced oxidative–reductive profile and higher aromatic complexity, reflected by the relative contribution of ethyl esters, norisoprenoids, Strecker aldehydes, and terpenic oxides. In contrast, wines sealed with a screw cap showed a tendency toward reductive characteristics, associated with a higher content of sulphur compounds. The Friedman test revealed significant differences only for longer storage time and in retronasal perception, with wines bottled with screw cap tending toward a reductive profile. This reflects the distinct nature of the two sensory pathways: retronasal perception is more sensitive to closure-induced changes during oral processing, whereas orthonasal perception largely reflects the headspace volatile composition. Data fusion analysis emphasized the contribution of closures to shaping long-term sensory expression and revealed correlative networks linking volatile and non-volatile compounds. Additionally, this study emphasizes that differences modulated by the wine–closure pairing can serve as an oenological tool in the construction of a wine's identity.

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P098 — Poster

Linking volatile compounds and aroma perception in macerated white wines: an integrated GC-MS and sensory approach

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Keywords: macerated white wine, sensory analysis, VOCs, HS-SPME/GC-MS

Fermentative and post-fermentative maceration applied to white grapes has been traditionally used in Georgian winemaking and recently gained wider international interest. Scientific data on the chemical and sensory characteristics of these wines remain limited. This study focuses on the volatile composition of macerated white wines in relation to sensory perception. A total of 36 commercial Italian monovarietal white wines were selected from five cultivars (‘Arneis’, ‘Catarratto’, ‘Erbaluce’, ‘Malvasia Istriana’, ‘Vermentino’), produced with different maceration regimes: non-macerated controls, short (≤3 days), medium (4-7 days), long (8-30 days) skin contact, and “orange” (>1 month). Volatile organic compounds (VOCs) were identified and quantified by HS-SPME/GC-MS. Aroma sensory evaluation was performed by a trained expert panel using the Rate-All-That-Apply (RATA) method with 20 pre-selected descriptors. A similar behaviour was observed in all wines, independently of grape variety, for certain VOCs. Most medium-chain fatty acids (hexanoic, octanoic, decanoic, and dodecanoic acids) and their corresponding ethyl esters decreased even after short maceration. In contrast, ethyl lactate and ethyl acetate were higher in macerated wines (approximately 3-fold and 1.5-fold, respectively) compared to controls. Methyl salicylate concentrations rose with increasing maceration duration, with maximum values observed in “orange” wines. For volatile phenols, 4-vinylguaiacol showed a decrease in wines macerated for more than 4 days, whereas 4-ethylphenol and 4-ethylguaiacol exhibited an increasing trend even after short maceration, although not consistently across all samples. Sensory analysis showed that Citrus, Pineapple, and White flowers descriptors were more pronounced in control wines, while macerated wines were characterized by Prune, Dried fig, Clove, and Liqueur notes. White pepper was a distinctive attribute of “orange” wines. PCA clearly separated “orange”, controls, and short-macerated samples. Short-macerated wines were associated with terpenes, esters, phenylethyl alcohol, and β-damascenone, which are known to contribute to fruity and floral aromas, confirming the role of 1-3 days of maceration in intensifying varietal and fermentative aroma. Prolonged maceration was associated with spicy and dried-fruit aroma, possibly linked to ethyl phenols, ethyl lactate, ethyl acetate, and methyl salicylate.

References

[1] not required

P099 — Poster

From Descriptive Analysis to Rapid Sorting: Sensory Approaches for the Identification of Smoke-Affected Cabernet Sauvignon Wines

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Keywords: Cabernet Sauvignon, smoke-taint, threshold levels, sensory methods

The increasing incidence of wildfires in the United States has raised the risk of vineyard smoke exposure, consequently possibly changed grape composition and the development of negative sensory attributes, commonly referred to as smoke taint (1.). During smoke exposure, grapes absorb volatile phenols that are subsequently glycosylated into odorless bound precursors capable of releasing aroma-active compounds during winemaking and aging (2.). The objectives of this study were to establish threshold levels of free and bound volatile phenols associated with undesirable sensory impacts in wine and to evaluate efficient sensory approaches for differentiating smoke-affected wines. A proof-of-concept design was implemented in which harvested grapes were exposed to smoke generated from various fuel sources, such as wood and grass, at defined intensities. Experiments conducted in 2023 and 2024 focused on Vitis vinifera L. cv. Cabernet Sauvignon is a cultivar of significant importance to premium wine production. Grapes were smoked in a chamber to achieve three exposure levels (low, medium, high) in addition to a non-smoked control. Wines were produced following a standardized UC Davis winemaking protocol and analyzed for volatile phenols and their glycoconjugates using GC–MS/MS and LC–MS/MS, respectively (4.,5.). Sensory evaluation comprised descriptive analysis with a trained panel and a rapid sorting task performed by experienced wine assessors utilizing a targeted smoke-related lexicon (3.). In 2023, Cabernet Sauvignon (CS) wines subjected to high smoke exposure were consistently distinguished through descriptive analysis, while separation among the different treatments improved in 2024. Given the substantial time and resource requirements of descriptive analysis, rapid sorting was evaluated as an alternative. The results from the CS wines suggest that sorting may offer a “quick and dirty” method for identifying sensory differences among smoke-affected wines and may serve as an efficient screening tool in conjunction with chemical analysis.

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P100 — Poster

Sensory Profiling of Commercial Dealcoholized Red Wines and Correlation with Chemical Markers: Evidence from Two Trained Panels- Greece and France

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Keywords: Dealcoholized red wines, Sensory characterization, Polarized Projective Mapping, Chemical markers

Dealcoholized wines represent a rapidly expanding product category, yet their sensory properties remain insufficiently documented. Ethanol removal is known to alter aroma, taste, and mouthfeel perception, often leading to sometimes atypical sensory profiles that challenge traditional wine categorization. A clearer understanding of how these products are sensorially perceived is therefore essential. The present study explores the sensory space of a large and diverse set of commercially available dealcoholized red wines, evaluated by two trained sensory panels based in Greece and France. Using Polarized Projective Mapping combined with Ultra Flash Profiling, the study aimed to describe the main sensory dimensions characterizing this category, as profiled by two different panels and observe how it relates to standard chemical markers of the products. Results revealed clear sensory differentiation among the wines, with products organizing along a limited number of dominant sensory directions rather than according to grape variety or geographical origin. Associations between sensory profiles and product composition, reflected by certain chemical parameters are explored.

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P101 — Poster

The taste of white wines : is there a specific Chardonnay taste?

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Keywords: sensory analysis; white wine; taste; Chardonnay; gustatory profile

The quality of white wine is closely linked to its sensory profile, including colour, odour, and taste. Chardonnay, the most widely planted white grape variety worldwide, covers approximately 210,000 hectares across more than 40 countries [1-4]. Originating from Burgundy [5], this cultivar exhibits strong phenotypic plasticity and terroir-driven variability [2]. Despite a well-documented aromatic fingerprint [6,7], little is known about its gustatory profile. This study focuses specifically on taste attributes, aiming to determine whether gustatory profile alone can contribute to the discrimination of Chardonnay wines from other white grape varieties through controlled sensory experiments. Our research hypothesis was that taste-related attributes, integrating sapidity and trigeminal sensations while excluding olfactory input, could enable varietal discrimination. To test this hypothesis, a trained sensory panel of 16 panelists evaluated commercial single-variety white wines under strictly controlled conditions, using black glasses and nose clips to eliminate visual and retronasal olfactory biases [8,9]. The study comprised two phases: first, preliminary sensory tests assessed the feasibility of discriminating Chardonnay wines by taste alone; second, Rate All That Apply experiments were conducted to identify the specific taste descriptors involved in the differentiation between Chardonnay, Viognier and Sauvignon Blanc wines [10]. Initial results showed that some Chardonnay wines could be identified by taste alone, but olfactory cues significantly improved discrimination, partially confirming the hypothesis. The RATA analysis highlighted that descriptors such as “fat,” “salt,” “bitter,” and “acid” were key to distinguishing Chardonnay from non-Chardonnay wines, especially Sauvignon Blanc. Some Chardonnay wines were very well identified by taste alone by the majority (up to 71%) of the tasters [11]. This study demonstrates that taste attributes alone can sometime be very powerful for wine variety discrimination although olfaction remains very powerful. The identification of specific taste descriptors associated with Chardonnay offers valuable insights for winemakers, sommeliers, and consumers, enhancing both the production and appreciation of this renowned grape variety. Ongoing work will extend this approach to a larger and more diverse set of Chardonnay wines from Occitanie and Burgundy regions to confirm these results.

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P102 — Poster

Decoding Hidden Wine Patterns: How Mineral Profiles and Machine Learning Reveal Identity Clues for Recognising Grape Varieties Beyond Sensory Perception

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Keywords: expertise; grape variety, machine learning, sensory perception, mineral wine profile

Previous sensory studies have consistently shown that both professionals and consumers encounter difficulties distinguishing wines consistently according to expected categories, such as grape variety or appellation. This raises the question of whether specific sensory characteristics can be used to discriminate between close grape varieties and appellations[MD1.1]. In this exploratory study, we analyzed the Mineral Wine Profiles [1] (40 elements through inductively coupled plasma mass spectrometry (ICP-MS)) of twelve red wines (six Gamay and six Pinot Noir from the 2011 vintage) that had previously been evaluated in a sensory categorization task. We then submitted these mineral profiles to a machine learning model trained exclusively on several thousand wines from recent vintages. The model had learned to recognize varietal signatures from multi-element combinations and to capture complex relationships among elements rather than relying on a single marker. This approach makes it possible to objectively assess whether elemental composition alone contains sufficient information to classify wines according to grape variety. While wine professionals showed inconsistent varietal grouping between the 12 wines, the model achieved a perfect grape varietal prediction, showing a clear and robust separation between Gamay and Pinot noir, relying on multi-element combinations (especially Sr, Ba, S, Cu, Mn) rather than a single discriminant element. Together, these findings suggest the existence of robust, multi-element signatures that underline wine identity. They also demonstrate the potential of combining mineral profiling with machine learning to discriminate grape varieties, thus opening new perspectives on the potential relationships between chemical markers and perceptual expertise in wine evaluation.

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P103 — Poster

Perceived minerality in Greek monovarietal white wines by experts and a trained sensory panel: correlation with chemical markers

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Keywords: Minerality; Perception; Greek white wines

Minerality is one of the most discussed and least clearly defined descriptors in modern wine science. Despite growing scientific interest, research on minerality has focused predominantly on international cool climate varieties, particularly Chardonnay and Sauvignon Blanc from Burgundy, Chablis, and New Zealand (Ballester et al., 2013; Parr et al., 2016; Rodrigues et al., 2017). In contrast, Greek white wines remain mainly unexplored, despite their longstanding reputation for mineral expression. The present study aimed to investigate the perception of minerality in Greek monovarietal white wines by combining sensory data from both a trained sensory panel and wine professionals with standard markers reflecting their chemical composition. Results indicated, clear differences across wines in perceived minerality by both experts and trained panel assessors, influenced by grape variety and region of origin. Moreover, results indicated an influence by the sensory modality used by the experts (aroma vs. holistic impression) on the categorization of the wines on minerality. Correlation was observed with few chemical markers.

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P104 — Poster

Contribution of thiols and new thiophenols to the ageing bouquet of red wines by using the polarised sensory positioning approach

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Keywords: Ageing bouquet, sulphur compounds, empyreumatic, polarised sensory positioning

The bouquet of aged wines is a complex sensory concept that is strongly associated with a balance of fresh fruit notes, complemented by empyreumatic notes, toast, mint, and truffle. In more recent studies, the presence of sulphur compounds associated with empyreumatic, grilled meat or smoky aromas has been described in old red wines.1 The objective of this work was to determine the sensory contribution of these empyreumatic sulphur compounds to the ageing bouquet perception of red wines. The first step was to quantify these thiols in wines and to calculate their odour activity based on individual perception thresholds. The concentration levels were ranged from some ng/L to few hundreds ng/L. Some of them (5-methyl-2-furfurylthiol, 2,5-dimethylfuran-3-thiol, 1-phenylethanethiol, o-thiocresol and thioguaiacol) can be found in old red wines at higher concentrations than their perception threshold with OAV > 1 (from 1.9 to 61.4). To further determine their sensory impact on the aroma of old red wines, we applied a polarised sensory positioning (PSP).2 This approach is interesting for comparing complex samples with small differences. The pivotal step in this approach is the selection of references, termed "poles". In the context of our study, we selected three poles (P) corresponding to: P1, a young wine developing fresh fruity aromas; P2, an old red wine (2006) without bouquet and without oxidation; and P3, an old red wine (2006) characterised by the empyreumatic notes of an ageing bouquet. The sulphur compounds: thioguaiacol, o-thiocresol, 5-methylfurfurylthiol and 2,5-dimethyl-2-furanthiol associated with these empyreumatic notes were quantified. Highest levels were detected in the wine P3, but remaining below their perception threshold. To evaluate whether these compounds contribute to the expression of empyreumatic notes in the ageing bouquet, their concentrations in P1 and P2 were adjusted to the levels measured in P3. Sensory analysis reveals a change in their aromatic profile, bringing it closer to the reference wine characterized by an ageing bouquet, P3. The supplementation of these compounds at low (infraliminar) concentrations modifies the aromatic balance, likely through perceptual interactions that contribute to the perception and complexity of the bouquet of aged Cabernet Sauvignon red wines. Finally, this new sensory approach helped to validate the contribution of new sulphur compounds to the ageing bouquet.

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P105 — Poster

Sensory and colorimetric profiling of Armenian brandy: influence of aging on aroma, taste and visual characteristics

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Keywords: Armenian brandy, sensory analysis, aroma, aging, geographical indication

Armenian brandy is a culturally and economically significant distilled spirit, characterized by a complex sensory profile shaped by autochthonous grapevine varieties, distillation, and barrel aging and blending. In this study, 62 Armenian brandy samples, aged 3, 5, 7, 10, 15 and 20 years, were evaluated by a trained panel. Brandy samples were collected from 13 Armenian brandy producers within the framework of the EU-funded project: "Technical Assistance for the Development of the Geographical Indication Armenian Brandy" (Contract No.2024/454-624). All studies were conducted with the aim of defining the general and common characteristics of Armenian brandy as a future Geographical Indication (GI) Armenian Brandy. Sensory descriptors related to color, aroma and taste were used in the evaluation. For color, the proposed descriptors included amber yellow and orange highlights. The olfactory descriptors comprised notes of orange blossom and rose, licorice, nutmeg and ginger, fruity nuances (apricot, pear, cherry and plum). Sweet and complex aromatic notes (caramel, chocolate, candied fruits, honey-milk candies, raisins, dried apricot, smoked roasting, vanilla and oak wood) were also proposed. The gustatory aspect focused on taste and mouthfeel attributes, particularly softness and persistence. Also colorimetric analysis was performed. Results showed a progressive increase in sensory complexity and color depth with aging. Young samples (3 years) presented light fruit and floral notes (plum, cherry, orange blossom), a low intensity of oak, vanilla and sweetness. Medium-aged products (5–10 years) displayed enhanced floral and fruity complexity, spicy and dried fruit notes and increased smoothness and persistence. Long-aged samples (15–20 years) showed dominant oak, vanilla, caramel, chocolate and dried fruit notes. Visual assessment confirmed progressive darkening and increased orange hues with aging. Hierarchical Cluster Analysis (HCA) revealed two macro-clusters: 15–20 years and 3–10 years brandies, with finer subdivisions reflecting intermediate aging stages. Principal Component Analysis (PCA) explained 94.85 % of sensory variance, with aging-related descriptors strongly associated with the first component and caramelized/evoluted versus floral notes separated along the second. Correlation analysis indicated significant associations between color indexes and sensory attributes supporting the role of oak maturation in shaping both visual and gustatory properties

P106 — Poster

Experimental and Numerical Study of Ethanol Vapor Distribution in the headspace of a Champagne Glass

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Keywords: Glass Headspace, Gaseous Ethanol, Interband Cascade Laser, Numerical Simulation

During wine tasting, volatile organic compounds progressively invade the headspace of the glass and strongly influence aroma perception. Gaseous ethanol, in particular, plays a key role by modulating aroma release and activating the trigeminal system at high concentrations [1,2]. Yet, its spatio-temporal distribution remains poorly characterized due to the lack of fast, non-intrusive measurement techniques and dedicated physical models. In this work, we combine real-time laser spectroscopy with numerical simulation to investigate ethanol vapor transport above the surface of champagne. A dedicated sensor based on Tunable Diode Laser Absorption Spectroscopy integrating an interband cascade laser at 3.35 µm was developed and validated using certified gas standards [3]. Coupled with galvanometric mirrors, the system enables two-dimensional multipoint mapping of ethanol concentration in the glass headspace with sub-second temporal resolution [4]. Experiments were performed on champagne served in standard INAO tasting glasses. Immediately after pouring, ethanol rapidly reaches saturation levels governed by vapor–liquid equilibrium. This initial regime is followed by the establishment of a steady-state vertical stratification, whose amplitude strongly depends on serving temperature [3]. To interpret these observations, a three-dimensional diffusion model was implemented in COMSOL Multiphysics, solving Fick's second law with appropriate initial and boundary conditions derived from experimental data. The simulation quantitatively reproduces both the temporal evolution and the vertical concentration gradients measured experimentally. The strong agreement between model and measurements highlights the predominance of molecular diffusion in controlling ethanol transport in the glass headspace [3]. This combined experimental–numerical approach provides new insights into volatile compound transport above wine and opens perspectives for linking physical mechanisms to sensory perception.

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P107 — Poster

Decoding the visual aesthetics of bubble trains in sparkling wines

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Keywords: Sparkling wines; Carbon dioxide; Bubble trains; Effervescence

Since Leonardo da Vinci's first sketches depicting air bubbles rising in water [1], researchers worldwide have investigated the dynamics of bubbles of varying sizes ascending through liquids with a broad range of surface tensions, viscosities, and densities. This long-standing interest has thus generated an extensive body of literature over the past century. However, only in recent decades have sparkling beverages (particularly champagne and other sparkling wines) become subjects of academic inquiry, driven by their increasing popularity [2]. Under tasting conditions, a consumer's first visual encounter with a sparkling wine is typically the characteristic columns, or trains, of bubbles rising along the inner surface of the glass. Nevertheless, many misconceptions still persist regarding the relationship between the visual attributes of these bubble trains and the sensory qualities of the wine. A widespread belief, for example, is that smaller bubbles are indicative of higher-quality sparkling wines. To what extent do the macroscopic visual features of bubble trains reflect the physicochemical properties of the wine, and beyond their aesthetic appeal, can they provide insights into its sensory characteristics? Over the past three decades, multidisciplinary research combining fluid mechanics, physical chemistry of interface, and soft matter with the carbonated beverage industry has progressively identified the key parameters governing bubble formation and dynamics in sparkling drinks. The universality of models developed in recent years (and presented here) made it possible to investigate how various physicochemical properties of both the beverage and the glass shape the appearance of bubble trains, regardless of the sparkling drink considered [3]. This work has dispelled many misconceptions about the visual role of bubbles, particularly in the field of sparkling wines, where confusion has long prevailed. In this overview, we highlighted the influence of several parameters on the visual appearance of bubble trains rising in a glass of sparkling wine: (i) the size of gaseous nuclei acting as bubble nucleation sites; (ii) the level of dissolved CO_2 in the wine; (iii) ambient pressure; (iv) gravitational acceleration; and (v) a comparison of the visual characteristics of bubble trains in glasses filled with either standard alcoholic or non-alcoholic sparkling wine.

P108 — Poster

Characterization and evaluation of Tannat wines : cross sensory studies between experts and consumers

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Keywords: Red wine, Astringency, Consumer preference, TCATA, CATA-Liking

In recent years, red wine consumption has declined in France, particularly among younger consumers, raising new challenges for traditionally structured and highly tannic wines. Understanding and adapting sensory properties such as astringency has therefore become a key issue for the wine sector in order to maintain the attractiveness of these wines [1]. The aim of this study was to explore the preferences of different consumer profiles for red wines produced in the Madiran denomination from Tannat, a typical grape variety known for its high tannin content. The mouthfeel characteristics of these wines, particularly their astringency, were then investigated to better understand the link between astringency and consumer preference [2]. First, four wines exhibiting contrasting sensory profiles were evaluated by consumers through focus groups to identify relevant descriptors related to sensory sensations and moments of consumption. This qualitative phase allowed the identification of key perception drivers and the refinement of the sensory assessment framework. Two large-scale sensory studies were then conducted with young consumers and regular Madiran wine drinkers using the Check-All-That-Apply (CATA) method, followed by a hedonic evaluation [3]. A detailed sensory characterization of ten Tannat-based wines was then performed by an expert panel specifically trained in astringency perception. Ten astringency descriptors were selected using standards, allowing both qualitative and quantitative characterization using Temporal-Check-All-That-Apply (TCATA) method [4]. Additional sensory attributes related to mouthfeel, including viscosity, bitterness, acidity, and sweetness, were also assessed using the conventional profile method. Citation frequencies of sensory attributes were explored using multivariate statistical analyses, and differences between products were assessed using non-parametric tests. Consumers' and experts' results were combined to investigate relationships between sensory perception and overall acceptability. This work seeks to better understand the sensory drivers of astringency perception in Tannat wines and to contribute to the rethinking of Madiran red wine profiles in response to evolving consumer expectations by combining consumer preference data with an expert sensory analysis of wine astringency.

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P109 — Poster

Impact of different dealcoholisation technologies on the volatile composition, sensory profiles and consumer preference of Riesling and Pinot Noir wines

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Keywords: dealcoholisation technologies, consumer preference, volatile aroma compounds

The increasing consumer demand for high-quality alcohol-free wines has necessitated a deeper understanding of how dealcoholisation affects the complex matrix of wine. This study investigates the influence of three distinct technologies—vacuum distillation (VD), spinning cone column (SCC), and vacuum distillation with aroma recovery (VD-AR)—on the aromatic composition and sensory perception of Riesling, Pinot Noir rosé, and Pinot Noir red wine. To evaluate the chemical impact, volatile compounds were analysed using targeted headspace solid-phase microextraction gas chromatography-mass spectrometry (HS-SPME-GC-MS). Sensory evaluation was conducted through a consumer preference test, complemented by descriptive analysis from a panel of wine experts. The analytical results revealed that both VD and SCC significantly reduced the concentrations of secondary aromas, such as fermentation-derived esters and alcohols. However, wines processed via VD-AR retained significantly higher levels of fruity esters. Notably, grape-derived compounds, including 3-mercapto-1-hexanol and beta-damascenone, remained above their respective odor thresholds across all treatments, preserving a degree of varietal character. Sensory findings indicated that consumer preference is not dictated by a single superior technology but is highly dependent on the wine type and grape variety. For Riesling, VD-AR was significantly preferred. Expert descriptions and analysis of volatile aroma compounds suggested that the preservation of fruity attributes in VD-AR successfully masked off-flavors from higher alcohols that were more prominent in the wines dealcoholised by VD. For Pinot Noir rosé, both SCC and VD-AR were favored by experts and consumers alike. In contrast, no significant differences in preference or quality ratings were observed for the Pinot Noir red wines, indicating that the red wine matrix may be more resilient to changes in wine compounds during processing. Overall, these results yield to a better understanding of consumer and expert evaluations of dealcoholised wines produced using different dealcoholisation methods.

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P110 — Poster

Astringency subqualities and the sensory-chemical drivers of wine typicality: a study on Nebbiolo wines

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Keywords: typicity, tannins, astringency, modelling

Typicality is a multidimensional concept resulting from the interplay of intrinsic and extrinsic characteristics. Among intrinsic factors, grape variety and its associated varietal traits is central in shaping aroma, flavour, basic taste, and mouthfeel, although winemaking practices and ageing influence the final wine profile. 'Nebbiolo' is a grape variety native to north-western Italy and is the basis of several DOCG (Denominazione di Origine Controllata e Garantita) wines, the highest level in the Italian designation of origin system. The Piedmont region represents the core of 'Nebbiolo' production, with renowned DOCG such as Barbaresco, Barolo, Gattinara, Ghemme, and Roero. In this study, 65 Nebbiolo wines (aged 3-8 years at the time of analysis) from these DOCGs were collected and then chemically and sensorially analysed with a specific focus on tannin traits and mouthfeel. Tannin content was assessed using methylcellulose precipitation assay, flavanols reactive to vanillin, bovine serum albumin assay, together with total polyphenols and flavonoids by spectrophotometric methods. Tannin composition was determined by phloroglucinolysis. Two sensory evaluations were conducted: a trained panel performed a mixed descriptive analysis and Check-All-That-Apply (CATA) methodology to investigate astringency subqualities, while an expert panel evaluated oxidation, balance, and in-mouth typicality. Wine differences were explored by multivariate analysis and ANOVA. Relationships between expert-rated typicality and both sensory and chemical parameters were investigated using Pearson correlation and partial least squares regression (PLSR). The analysed Nebbiolo wines were characterised by Powdery particulate, Fine grain surface smoothness, and a Dry mouthfeel. Powdery and Dry were positively correlated with tannin content. The Fine grain descriptor was positively correlated with in-mouth typicality, that was also positively linked to a higher degree of tannin galloylation and epicatechin subunits (%) and negatively with the chain length (mDP). PLSR model revealed limited predictive ability of tannin instrumental data alone for in-mouth typicality. Improved power was achieved using sensory descriptors. These results suggest that tannin instrumental analysis can partially explain in-mouth typicality and pave the way towards additional parameters evaluation or an increased sample number to improve the performance of these predictive models.

P111 — Poster

Can Chemical and Sensory Profiles Distinguish Typicity in Aged Chasselas Wines?

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Keywords: Chasselas, aging, wine quality, sensory analysis, chemical markers

Chasselas is best known for its finesse and terroir-driven character. Typically consumed young for its soft acidity and floral-fruity nuances, certain expressions, particularly from regions like Dézaley and under controlled aging conditions, reveal unexpected complexity, including honeyed and dried fruit aromas. However, scientific inquiry into these aged profiles remains limited, with most insights still rooted in tradition rather than data. The objective of this work is to assess whether sensory profiling and targeted chemical analyses can effectively differentiate high-quality aged Chasselas from poorly aged examples, thereby identifying potential markers of aging quality. To evaluate whether sensory profiling and targeted chemical analyses can reliably distinguish the typicity of aged Chasselas, 13 wines estates were selected from across the Vaud wine region (with the exception of northern Vaud due to limited availability of aged samples). For each estate, three vintages were considered (2003, 2009, and 2012). Due to availability constraints, some estates provided wines from only two vintages (2009 and 2012). In total, 36 wines were analysed. Chemical characterization included gas chromatography mass spectrometry (GC-MS), phenolic acids, amino acid profile, and standard oenological parameters. Sensory evaluation was conducted via an exemplarity test, performed by a panel of 37 professionals recognised as Chasselas specialists and experts in aged vintages, to classify each wine as a "good" or "poor" example of aged Chasselas. Vineyard and winemaking data were also integrated to support classification and identify potential quality predictors. The panel successfully classified each wine as either a "good" or "poor" example of aged Chasselas, assigning an exemplarity score to reflect its perceived typicity. While chemical analyses failed to identify specific compounds correlating with sensory ratings, unsurprising given both wine aging and diversity of analysed wines. Certain oenological factors emerged as significant predictors of quality: wines sealed with screw caps consistently received higher exemplarity scores, and nitrogen supplementation in the must prior to fermentation also appeared associated with better aging outcomes.

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P112 — Poster

Sensory evolution of minerality in Chasselas wines

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Keywords: minerality, aging potential, exemplarity, sensory

The term 'minerality' is one which is still widely employed to describe wines. Mineral wines have sensory characteristics such as gunflint aromas, sometimes extending to reduction odours. These wines are distinguished by their aromatic and gustatory freshness, which is frequently associated with acidity. Whilst the majority of studies on minerality have been conducted on young wines, minerality is frequently associated with the ageing potential of wines. Nevertheless, the sensory evolution of minerality over time remains not studied, and it is this gap that this work aims to address. A total of 80 Chasselas wines (vintage 2012) were evaluated on an “exemplary scale” by 62 Swiss professionals, to select contrasting pairs of wines. The selected wines are composed of seven mineral wines (good examples) opposed to seven non-mineral wines (poor examples). An expert panel then described these 14 wines using the sensory profile method over three different years (2015, 2016 and 2018) in order to study the impact of ageing between the two categories of wines. The findings demonstrate that specific characteristics associated with minerality, including freshness, acidity and tension, are sustained or amplified in mineral wines during the ageing process. The gunflint aromas persist in the early years, subsequently fading and disappearing after six years (tasting conducted in 2018). Similarly, young mineral wines do not exhibit any indications of evolution or milky odours (lactic, milk), nor even slight oxidation, in contrast to non-mineral wines. Beyond the minerality criteria sought, mineral wines seem to benefit from superior ageing potential.

P113 — Poster

Selection of Saccharomyces cerevisiae strains for traditional Sicilian sparkling wines: effects on secondary fermentation kinetics and sensory profile

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Keywords: traditional sparkling wine; traditional method; secondary fermentation; Saccharomyces cerevisiae; yeast strain selection; fermentation kinetics; sensory analysis.

Sparkling wine is defined as a wine containing carbon dioxide in solution, produced exclusively through a secondary fermentation process. According to European EC Regulation No. 1308/2013, sparkling wines must exhibit a natural pressure of at least 3 bar at 20 °C. The objective of this thesis was to select and evaluate Saccharomyces cerevisiae yeast strains suitable for the production of Sicilian sparkling wines using the traditional or “Champenoise” method. This work classifies sparkling wines based on internal pressure, sweetness level, and production method. Secondary fermentation was carried out in 14 experimental trials at a constant temperature of 15 °C. Fermentation kinetics were monitored usingan afrometer (Tecnobolle group srl), which recorded pressure increase inside the bottles. Pressure values were measured at multiple time points (0, 7, 15, 30, 60, 90,180, and 270 days), then standardized to 15 °C using Henry's law constant (Henry, 1803). Results were expressed as pressure (bar) at 15 °C. The sensory analysis of the experimental sparkling wines aimed to identify organoleptic differences among the samples. Tasting was conducted under controlled conditions using ISO-standard glasses, with 50 mL aliquots served at 6 – 8 °C. The judges assessed the intensity of eighteen sensory attributes covering visual, olfactory, and gustatory perception, enabling the definition of detailed organoleptic profiles for each wine. Six experimental trials showed optimal secondary fermentation kinetics, comparable to the two controls used. Sensory evaluations confirmed the significant role of yeast strain selection in shaping the overall quality of traditional-method sparkling wines. Three trials stood out for their superior perlage quality, visual brilliance, and aromatic intensity, and were therefore identified as the most promising candidates for high-quality sparkling wine production. All fermented samples were free from organoleptic defects and exhibited a richer and more complex sensory profile than the base wine. Overall, the findings demonstrate that the targeted selection of Saccharomyces cerevisiae strains is a key element in modulating the kinetics of secondary fermentation and optimizing the sensory profile of sparkling wines produced with the traditional method.

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P114 — Poster

From lexicon to molecular: Decoding Vegetal Aroma of Ningxia Cabernet wines through the approaches of survey, sensory and GC-MS analysis

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Keywords: vegetal aroma, Cabernet wines, Ningxia, GC-MS

Vegetal aroma constitutes an important sensory classification for wine. However, its precise terminology and corresponding molecular basis remain poorly defined. This study aimed to refine the differentiation of vegetal aroma descriptors and identify their chemical correlates, with a specific focus on characterizing the profile of Cabernet wines from Ningxia. The vegetal aroma profile was established as a typical aromatic descriptor for Ningxia Cabernet wines through survey, napping, and Quantitative Descriptive Analysis (QDA). A Check-All-That-Apply (CATA) task defined a specific vegetal lexicon for Ningxia Cabernet Gernischt wines, comprising green pepper, Chinese medicinal herbs, and stemmy notes, thereby distinguishing dried from fresh vegetal characters. Furthermore, vegetal aroma was found to differ significantly in wines produced from GLRaV-3-infected vines; these wines were uniquely characterized by a Chinese medicinal herbs note, as identified through triangle tests and Free Choice Profiling (FCP). Overall, this study provides new insights into vegetal aroma classification, identifies a novel aroma descriptor associated with GLRaV-3 infection, and establishes a framework for investigating the molecular mechanism underlying the Chinese medicinal herbs attribute.

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P115 — Poster

Nanostructured Potentiometric Biosensor Arrays for Chemical Fingerprinting of Complex Liquid Matrices: Application to Minority Wine Varieties

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Keywords: WINE, SENSORS, ELECTRONIC TONGUE, POTENTIOMETRIC SENSORS

The development of advanced multisensor platforms capable of rapidly analyzing complex chemical matrices remains a key challenge in analytical sensing. In this work, a high- performance potentiometric bioelectronic tongue (bio-ET) is presented as an innovative multisensor system integrating enzyme-functionalized polymeric membranes and nanostructured electron mediators for enhanced analytical performance. The sensing platform is based on arrays of potentiometric biosensors fabricated using carboxylated polyvinyl chloride membranes that enable covalent immobilization of selective enzymes, including glucose oxidase, tyrosinase, laccase, and lyase. To improve electron transfer and signal stability, membranes were modified with gold nanoparticles, generating highly reproducible and sensitive responses.
Individual biosensors displayed linear behavior toward representative analytes such as glucose, catechol, cysteine, and tartaric acid, with detection limits in the order of 10^{-4} mol L^{-1} and coefficients of variation below 5%. When combined into a multisensor array, the bio-ET produced cross-selective potentiometric signals suitable for chemometric processing. Principal component analysis demonstrated effective discrimination among minority wines and musts varieties from Castilla y Leon (Spain), highlighting the ability of the system to detect subtle compositional differences in complex hydroalcoholic matrices. Furthermore, partial least squares regression established robust correlations between sensor outputs and conventional physicochemical parameters, including total acidity, pH, sulfur dioxide, anthocyanins, polyphenols, and glucose, with determination coefficients up to 0.98.
The results confirm that enzyme-functionalized potentiometric biosensor arrays enhanced with nanostructured mediators provide a versatile platform for rapid chemical fingerprinting and multicomponent analysis. This approach represents a promising strategy for the development of next-generation multisensor systems targeting complex liquid matrices, combining specificity, cross-selectivity, and advanced data processing within a single analytical tool.

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P116 — Poster

Valorisation of by-product-derived polysaccharides as a sustainable strategy to improve the sensory profile of wine

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Keywords: Astringency, By-products; Oral interactions; Polysaccharides

The agri-food industry generates large amounts of coproducts and by-products that represent valuable resources for developing sustainable and innovative solutions[1]. Among these, plant-derived polysaccharides have attracted attention due to their ability to interact with polyphenols and modulate sensory perception[2]. Astringency, a key mouthfeel attribute in wine, is mainly associated with interactions between polyphenols and oral components such as salivary proteins and oral epithelial cells[3]. This work aimed to evaluate the potential of polysaccharides derived from agri-food by-products as modulators of wine astringency through different molecular mechanisms.

Two complementary approaches were used. First, a highly astringent red wine from northern Portugal was supplemented with grape skin polysaccharides and aged for nine months, with effects assessed via physicochemical analysis and polyphenol–salivary protein interactions. Second, a red wine extract model was combined with citrus-derived pectic polysaccharides. Their influence on interactions between polyphenols and oral components was evaluated using *in vitro* oral models containing salivary proteins, oral epithelial cells (HSC-3 cell line), mucin and mucosal pellicle. Polyphenol adsorption and changes in salivary protein family interactions were analysed to better understand the mechanisms involved.

Polysaccharides reduce wine astringency by limiting interactions between polyphenols and salivary proteins. In an oral model, all fractions decreased polyphenol adsorption, especially at higher concentrations. They also modulated binding with key salivary proteins (proline-rich proteins, statherin/P-B peptide, cystatins). Their effectiveness depends on structural traits like molecular weight and uronic acid content, likely enhancing hydrogen bonding with phenolics and reducing interactions with oral surfaces.

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P117 — Poster

Ancient Sicilian Grapevines for Modern Wines: Linking Metabolomics, Sensory Profiles and Consumer Preference

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Keywords: Low Alcohol Wines, Ancient Grapes, Consumer Perception, Liking Drivers, CATA

Climate change is accelerating grape ripening, increasing sugar accumulation and leading to higher alcohol wines, potentially compromising balance and freshness. In this context, heritage cultivars from warm regions such as Sicily (Italy) represent a valuable resource, as they tend to accumulate less sugar and retain higher acidity, enabling the production of more balanced wines [2]. Low-alcohol wines from ancient varieties offer a promising alternative to conventional styles, aligning with consumer demand while preserving aromatic complexity and regional identity, and supporting more sustainable viticulture [1]. Ten wines from minor Sicilian red and white cultivars were investigated, including varieties registered in 2018 (*Lucignola*, *Vitrarolo*, *Catanese Nera*) and relic ones (*Dunnuni*, *Rucignola*, *Anonima*, *Bracau*) which are potential candidates for future registration. *Vitrarolo* was also evaluated across different environments. Metabolite profiles (*Vitis vinifera* L.) were assessed over two vintages through physicochemical analyses, phenolics (HPLC, LC–MS), volatile compounds (GC–MS), and astringency (SDS-PAGE). Sensory evaluation was conducted using the CATA method to explore consumer perception and liking drivers. Wines showed distinct profiles depending on cultivar and vintage. Metabolite analyses revealed variability in phenolic and volatile composition, with notable environmental effects for *Vitrarolo*. Sensory results highlighted fruity intensity, acidity, and persistence as key attributes. Consumer liking was mainly driven by complexity and persistence, while bitterness and astringency reduced acceptance. *Vitrarolo* wines achieved the highest overall liking, confirming the potential of these ancient cultivars for contemporary wine production.

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P138 — Poster

The Professional Concept of Press Wines

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Keywords: Press wines; Blending; Professional representation

Press wines form a distinct technical category of wines. However, the vision remained by the literature is partial and did not fully capture how professionals understand and use press wines in practice. This study explores how wine professionals perceive, define and use press wines, based on an online survey conducted among 59 experienced practitioners, involved in wine production [1]. Their level of expertise and frequent tasting practice provide a solid basis for understanding the professional concept of press wines. The results clearly show that press wines are widely used. Importantly, press wines are not considered for their standalone quality, but for their functional role within the blend. Professionals consistently describe them as tools used to build, adjust and balance the final wine rather than as independent wines. Four key dimension's structure the concept of press wines: structure (for their contribution to tannic backbone, volume, density and length on the palate); sensory (involving color, mouthfeel and aromatic complexity); technical flexibility; volume in the blend. Professionals also emphasize the strong variability of press wines, depending on vintage and grape variety, which requires their use to be reconsidered each year. This variability reinforces the need to anticipate and manage press wines early in the winemaking process. Overall, this study confirms that press wines are not perceived as a simple by-product of winemaking. Instead, they are recognized as key oenological tools, essential for shaping structure, balance, style and ageing potential, especially in high-quality red wines. Their successful use relies on expertise, anticipation and precise sensory judgement, making them a central element in professional blending strategies.

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Session VI

Wine and health

KS6 — Keynote

Dietary bioactive compounds, healthy ageing, and cognition – A focus on polyphenols and the brain

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Keywords: Polyphenols; cognition; flavonoids; gut–brain axis; neuroprotection; diet; brain health

Dietary polyphenols are bioactive plant-derived compounds increasingly recognised for their potential to support cognitive health across the lifespan. These compounds, including flavonoids, phenolic acids, stilbenes, and lignans, exert antioxidant, anti-inflammatory, and cell-signalling effects that influence key processes underlying cognition[1]. Emerging evidence suggests that polyphenols contribute to enhanced neurovascular function, modulation of neuronal signalling, and reduction of neuroinflammation, as well as interacting with the gut microbiota via the microbiota–gut–brain axis[2].

Observational studies indicate that higher consumption of polyphenol-rich foods is associated with improved memory and executive function, alongside a reduced risk of cognitive decline and dementia[3,4]. Complementary evidence from the MRC National Survey of Health and Development (NSHD) further demonstrates that adherence to healthy and plant-based dietary patterns is positively associated with cognitive reserve[5]. Additionally, findings from randomised controlled trials and meta-analyses further support modest but significant cognitive benefits, particularly in ageing populations[6].

Despite these promising findings, important challenges remain, including variability in polyphenol bioavailability, inter-individual differences, and limitations in the current evidence base. Well-designed, long-term randomised controlled trials are needed. Overall, dietary polyphenols represent a potentially important modifiable factor for cognitive health, while highlighting key priorities for future research, policy, and public health nutrition.

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How to communicate about wine in France ?

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Keywords: Wine, Wine, Communication, alcoholic beverage, addiction,

Since 25 years in France, communication about wine has too often been considered solely as an incitement to consume an alcoholic beverage. The ban on communication about wine and, indirectly, about vineyards was relaxed by two legislative reforms in 2005 and 2016 at the request of winegrowers and professionals in the wine industry to address an economic crisis in the wine sector. The French courts took these developments into account. However, we are now seeing a reversal of this trend and a desire on the part of health officials to apply the current legal standards very strictly. The current issue is as follows: How can wines with a GI be communicated and promoted without risking censorship by the French agency for the fight against addiction ? To answer this question, this paper proposes to list the administrative, professional, and judicial bodies involved in the field of wine communication, specifying their respective competences and powers. It then goes on to indicate which statements and which images or photographs are authorised, offering a critical opinion on the interpretation made by the agency responsible for combating addiction, in order to avoid a return to the prohibition principle of 1991, with the Evin law.

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O30 — Oral communication 30

Oenological Tannins as Sulfur Dioxide Alternatives in White and Red Winemaking: Chemical, Sensory, and Health Implications

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Keywords: Wine; Sulfur dioxide; Grape tannin; Oak tannin; Wine quality

Sulfur dioxide (SO2) has long been an effective additive in winemaking, yet its use raises health concerns for sensitive individuals. While oenological tannins are increasingly recognized for their color-stabilizing and antioxidant effects, their potential to replace SO_2 throughout the winemaking process and their broader impacts on wine quality and safety have not been systematically studied. In this work, we present the first comprehensive evaluation of grape and oak tannins as SO_2 alternatives at multiple stages of both white and red wine production. By adding specific doses of tannins before alcoholic fermentation (0.3 g/L), after alcoholic fermentation(0.4 g/L), and after malolactic fermentation (0.4 g/L), we assessed their effects on wine chemistry, sensory attributes, and health-related parameters. Our findings demonstrated that tannin addition effectively reduced the need for SO2, supported a smooth fermentation process, and significantly decreased the production of volatile acidity ($p < 0.05$). Wines treated with tannins showed no significant differences in redox potential compared to those treated with SO2 ($p > 0.05$). Notably, the addition of grape tannins to pre-alcoholic fermentation in red wines significantly enhanced the aroma profile (ethyl esters and higher alcohols) and reduced the formation of methionol. Sensory analysis revealed no significant differences in palate attributes between the tannin and SO2-treated wines ($p > 0.05$). Importantly, the concentration of methanol, a health-related byproduct, was not significantly affected by tannin treatment ($p > 0.05$). Overall, these results highlighted the potential of oenological tannins as a viable alternative to SO2 in winemaking. And it was the first time to establish the feasibility and benefits of using 0.3 g/L grape tannins as practical SO_2 substitutes, with pre-fermentation grape tannin addition emerging as the most promising strategy for further development.

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O31 — Oral communication 31

A grape-derived ally: how resveratrol disarms lipid-driven resistance to anticancer agents in colorectal cancer

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Keywords: polyphenol; resveratrol; cancer; lipids, metabolism

Resveratrol (RSV), a stilbene polyphenol naturally concentrated in the grapevine and present in red wine, has long been recognized for its bioactive potential. Beyond its well known antioxidant properties, increasing evidence supports its relevance in oncology, particularly in colorectal cancer (CRC), where metabolic rewiring contributes to therapeutic resistance. Among these adaptations, cancer cells frequently amplify lipid metabolism, especially phosphatidylcholine (PC) synthesis through the Kennedy pathway and the Lands cycle, with LPCAT2 emerging as a pivotal enzyme linking membrane remodeling, lipid droplet (LD) accumulation, and chemoresistance. In this context, we investigated the capacity of RSV to interfere with PC metabolism and restore therapeutic sensitivity. In chemoresistant CRC models overexpressing LPCAT2 (HT29 and SW620 LPCAT2), RSV induced apoptosis and significantly impaired cell survival. Mechanistically, RSV decreased key Kennedy pathway enzymes while leaving LPCAT2 levels and LD abundance unchanged, suggesting that its pro apoptotic activity arises from a selective disruption of PC remodeling. Drug combination assays further revealed that RSV acts as a potent chemosensitizer. When combined with anticancer agents (5 fluorouracil, oxaliplatin and the combination of the two) in CRC management, RSV produced robust synergistic effects. These interactions translated into increased cytotoxicity at lower drug doses, highlighting a clinically relevant strategy to mitigate toxicity while maintaining efficacy. Altogether, our findings position RSV, a signature molecule of grapevine and wine, as a promising metabolic adjuvant capable of targeting vulnerabilities in PC biosynthesis and enhancing the therapeutic response to chemotherapeutic drug. This work underscores the translational potential of wine derived polyphenols as modulators of cancer cell metabolism and as valuable allies in overcoming chemoresistance in CRC.

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O32 — Oral communication 32

Antioxidant Components of Wines Acting on Human Phagocytes and the Proliferation of Lactobacillus plantarum

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Keywords: antioxidant components of wines, human phagocytes, ploriferation of Lactobacillus plantarum

The health-promoting effects of wine consumption have frequently been attributed to their antioxidant constituents; however, the direct biological actions of these components on immune cells and gut microbiota remain incompletely understood. In this study, we investigated the in vitro effects of four well-known Hungarian wines on (i) the oxidative activity of human peripheral blood phagocytes and (ii) the proliferation of the catalase-negative gut bacterium Lactobacillus plantarum. Reactive oxygen species production by phagocytes was assessed by luminol-enhanced chemiluminescence following zymosan stimulation. Experiments were performed using cells obtained from three healthy donors aged 35, 54, and 79 years. Bacterial proliferation was evaluated after a three-day standardized cultivation period. All tested wines inhibited zymosan-induced chemiluminescence, with increasing antioxidant potency observed in the following order: Tokaj Furmint <Eger red wine <Tokaj Aszú <Tokaj Essence. The extent of inhibition showed a direct correlation with the concentrations of plant peroxidase III, catalase, and glutathione present in the wines, whereas taxifolin (dihydroflavonol) levels did not correlate with the antioxidant effect. Tokaj Aszú elevated significantly the proliferation of Lactobacillus plantarum, indicating that wine-derived antioxidants can influence both immune cell function and gut-associated microorganisms. These results provide evidence that specific enzymatic and non-enzymatic antioxidant components of wines can exert direct biological effects in human organism. We propose that plant peroxidase III, catalase, and glutathione play a central role in mediating the antioxidant health effects of wines, primarily within the gastrointestinal environment, while taxifolin may contribute indirectly as an electron donor supporting peroxidase activity.

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[1] Not required.

O33 — Oral communication 33

Generation Z's attraction to sweetened red wines: CATA, penalty analyses and health aspects

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The wine industry is experiencing a significant global decline in wine consumption. This decline is particularly marked for red wine and the industry is seeking innovations to enhance the appeal of wine. The addition of sugars is known to improve the palatability of red wine, particularly for young adults, but the risk of in-bottle fermentation requires the use of stabilizers. Thus, the use of non-fermentable sweeteners, with a lower caloric content than sugars, would offer several advantages.

A series of experiments (Geffroy et al., 2024; Chervin et al. 2026) was carried out using various red wines and various sweeteners (erythritol, xylitol, rebaudioside A). The panellists were approximately 22 years old, representative of Generation Z. Check-All-That-Apply (CATA) was used as a descriptive method and penalty analysis was developed combining CATA and liking analyses, using freely available R scripts.

The results showed a consistent preference among panels of young adults for the sweetened red wines. This should prompt industry and regulatory bodies to consider authorizing the use of non-sugar sweeteners in wines, at least for marketing tests, as these additives are already authorized in beer production and various food processes. Health aspects will be commented.

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O34 — Oral communication 34

The issue of sulfites in France at the beginning of the 20th century. Economic, political, and scientific origins of a unique situation between tradition and innovation.

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Keywords: sulfites, standards, appellation of origin, expertise, wine science

At the end of the 19th century, with the development of the chemical industry and the arrival of sulfite products that were easy to add throughout the winemaking process, SO2 volumes tended to increase in wines. However, sulfites were quickly singled out in the context of defining wine quality standards with a view to cleaning up the markets and protecting consumer health. In a debate that was taking place on the national stage and, even more so, on the international stage, French producers, particularly those of sweet wines from Bordeaux, attempted to counter the attempts of the protagonists, led by the Americans, to introduce drastic legislation on the issue. For producers of sweet wines, beverages with a long and distinguished reputation, the fight is almost existential, as the specific characteristics of these wines depend on certain doses of SO2, which are capable, among other things, of blocking fermentation. Using unpublished private collections, publications, old scientific reports, and political archives, we will show how an alliance of convenience between producers, oenologists, and the medical world is taking shape. At a time when the rapidly expanding science of wine is entering the economic arena, the industry needs to draw on expertise capable of countering the arguments of sulfite opponents with irrefutable evidence. With the additional support of local and national elected officials and politicians, and at a time when intense discussions are underway on future appellation of origin regulations, this study examines how Bordeaux producers managed to preserve the “analytical” uniqueness of their wines and impose their views on the world. This episode thus set French standards, policies, and discourse on the use of sulfites in wine for almost sixty years. This issue, which spanned the entire 20th century, clearly raised the dialectic between tradition and innovation during a period of intense upheaval for viticulture

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P118 — Poster

Recovery of polyphenols and mannoproteins from enological by-products: evaluation of their potential application for glycemic control

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Keywords: grape pomace, lees, mannoproteins, phenolic compounds, salivary -amylase

Starch is the main carbohydrate in the human diet and its digestion is one of the primary sources of increasing post-prandial blood glucose. Starch digestion begins in the oral cavity with the action of the salivary -amylase, which releases maltose by producing the hydrolysis of -1,4 glycosidic bonds. Starch is further hydrolyzed along the digestive tract, releasing glucose that enters the bloodstream. Blood glucose levels need to be balanced, since high glucose levels have been associated with a wide range of health risks, such as oxidative stress, insulin resistance and type II diabetes, obesity and cardiovascular diseases. Intake of dietary polyphenols has shown potential to modulate post-prandial glucose index due to their ability to inhibit digestive enzymes such as -amylases and -glucosidases, among other effects [1, 2]. Therefore, fortification of foods with polyphenols could help control the glycemic response. The winemaking industry produces large amounts of by-products, like grape pomace and wine lees, which can be revalorized as sources of grape-derived polyphenols and mannoproteins (MPs), contributing to the environmental sustainability of the wine industry. Polyphenols are known for producing unpleasant sensations for the consumer, such as bitter taste and astringency. MPs are yeast polysaccharides that can act as flavor modulators, so their combination with polyphenols may help overcome this issue by reducing polyphenol-induced bitterness and astringency. In view of this, the objective of this work was to obtain a polyphenol-rich extract and MPs from white grape pomace and lees, respectively, and analyze their effects on the activity of human salivary -amylase. The results obtained showed that the polyphenol-rich extract was able to reduce -amylase activity, probably by forming soluble enzyme-phenolic compound complexes. MPs partially decreased the inhibitory effect of polyphenols by decreasing enzyme-phenolic compound interactions. The combined addition of polyphenols and MPs still caused an important inhibition of -amylase activity, indicating that MPs could be used as potential flavor modulators. Furthermore, MP characteristics played a role in their ability to counteract the enzymatic inhibition caused by polyphenols. These results open the possibility to the valorization of winemaking by-products as sources of useful compounds with potential applications for developing glycemic-modulating functional foods.

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P119 — Poster

A formulation combining resveratrol, derived from grapes and wine, and omega-3 fatty acids exerts anti-cancer activity by blocking neoangiogenesis, damaging the DNA of tumor cells, causing their death, and modulating the immune system

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Keywords: Colorectal Cancer, Therapeutic Adjuvants, Resveratrol, Fatty Acids

Resveratrol, a key polyphenol from grapes and red wine, and omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), abundant in Mediterranean dietary patterns, provide complementary antioxidant, anti inflammatory, and anti tumor properties. Beyond their nutritional relevance, these bioactive food derived molecules represent a powerful and underexplored reservoir for developing novel cancer modulating strategies. We evaluated Resvega (RGA), a formulation combining resveratrol with EPA/DHA and clinically used in ocular diseases, as a diet inspired therapeutic candidate for colorectal cancer (CRC). Anti cancer effects of RGA were examined in vivo, using murine CRC xenografts and the chicken embryo chorioallantoic membrane (CAM) model, with daily RGA administration (15 or 30 mg/kg), and in vitro, using human and murine CRC cell lines, immune competent 3D tumor spheroids, and human umbilical vein endothelial cells (HUVEC). Angiogenesis (VEGF A secretion, pseudotube formation), tumor growth, oxidative stress, DNA damage, apoptosis, ferroptosis, and immune modulation were evaluated with microscopy, immunoblotting, flow cytometry, and immunostaining. Toxicity was assessed in healthy human cells and in vivo. RGA markedly inhibited angiogenesis by reducing VEGF A secretion of cancer cells and impairing HUVEC pseudotube formation, consistent with its known retinal anti angiogenic effects. Tumor growth was significantly reduced in CRC bearing mice and in CAM tumor model. Mechanistic analyses showed that RGA increased ROS production and induced DNA damage, leading to apoptosis and ferroptosis. In immune inclusive models, RGA modulated components of the tumor microenvironment relevant to anti tumor responses. No toxicity was detected in normal cells or animals. These findings highlight that combining resveratrol with EPA/DHA, two emblematic bioactive compounds from Mediterranean diet, yields multi target anti tumor effects with an excellent safety profile. This work reinforces the concept that food derived molecules constitute a valuable and still largely untapped source for oncology innovation. RGA appears as a promising adjuvant candidate, warranting evaluation in combination with radiotherapy, chemotherapy, or immunotherapy to enhance efficacy without increasing toxicity.

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P120 — Poster

SOD Activity of Wine: It’s all in the mix

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Keywords: reactive oxygen species, superoxide dismutase, antioxidants, alcohol-free wine, polyphenols

Wine is widely known for its antioxidative characteristics. However, assessment of these properties is mostly indirect and lacks standardization. The most common methods, such as DPPH, ORAC, ABTS, or DMPD assays, yield results that are difficult to compare due to differences in methodology and in the underlying chemical reactions.[1] In our previous work, we established a direct and comparative method by combining stopped-flow measurements with time-resolved UV/vis spectroscopy, allowing precise monitoring of the decay of superoxide under physiological conditions.[2] This approach enables determination of catalytic superoxide-dismutase (SOD) activity, i.e. true turnover-based superoxide conversion, in contrast to the purely stoichiometric radical scavenging behavior typically observed for individual antioxidants, including polyphenols. Therefore, we can determine the catalytic superoxide-dismutase (SOD) activity of substances which mimic the function of native SOD in vitro. Our research shows that certain wines exhibit such catalytic properties. This behavior is unique to wine as a mixed formulation and is not observed when its polyphenolic constituents are examined individually, despite their well-documented antioxidant capacity.[3–5] Moreover, alcohol-free wine possesses higher SOD activity than traditional wine. Our method provides a new standard for quantifying wine’s antioxidant behavior beyond classical scavenging assays and suggests alcohol-free wine as a particularly relevant model system for further investigation, especially from a public health perspective.[6,7]

P121 — Poster

Phenolic Compounds as Natural Alternatives to Sulfur Dioxide in Winemaking

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Keywords: wine, polyphenols, antioxidants, low-sulfite

Winemaking involves a complex series of biochemical transformations where the use of additives is a standard practice to ensure product quality, safety, and stability. Among these, sulfur dioxide (SO2) constitutes the primary additive used in oenology due to its potent antioxidant and antimicrobial properties. However, increasing clinical evidence regarding sulfite hypersensitivity, ranging from respiratory distress to allergic reactions1, has shifted consumer preference toward "clean-label" and bio-based alternatives. In response to this demand, the addition of phenolic extracts or individual compounds is being explored as a novel wine-protection strategy. The increasing employment of these molecules in the food industry as substitutes for conventional antioxidants has drawn particular interest, as they not only provide functional preservation through their high radical-scavenging capacity, but could also offer potential nutraceutical benefits. Furthermore, since polyphenols are naturally occurring in Vitis vinifera, they might represent inherently compatible candidates for oenological applications, enriching the wine's existing polyphenolic matrix2,3. This study evaluates the potential of key phenolic compounds, such as catechin and resveratrol, as partial or total substitutes for SO2. The research focuses on their efficacy in maintaining the oxidative stability of red and rosé wines while assessing their impact on the organoleptic profile. Treated wines were monitored over time and compared against SO2-treated controls. Analytical methods included spectrophotometric techniques for color and total polyphenol content and HPLC-UV-Vis/Fluorescence for quantifying major markers (anthocyanins, flavan-3-ols, procyanidins). Molecular interactions were monitored via LC-DAD-QQQ, while overall antioxidant capacity was determined through DPPH, FRAP, ORAC, and ABTS assays. Finally, sensory profiles were evaluated and correlated with the chemical data. Initial results highlight the promising role of catechin and resveratrol, showing antioxidant capacities comparable to SO2 within the wine matrix. However, technical challenges remain regarding the dissolution and homogenization of resveratrol. This preliminary work contributes to the development of sustainable strategies for producing high-quality, low-sulfite wines that align with contemporary health-conscious market trends without compromising sensory characteristics.

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Session VII

Innovations in viticulture and enology facing societal, environmental and economic challenges

KS7 — Closing Keynote

Viticultural practice innovation in the light of history: novelties, heritages and blending of knowledge

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Keywords: skill, expertise,

Innovating means introducing a change in a process, from mistakes, a curiosity or the desire to do better. Concerning winegrowers, ancestral skills remain at the heart of the relationship between them and the vines they cultivate. However, the work at each stage changes according to social, economic and technical contexts. If a new practice gives satisfaction, first it can become part of a regional professional knowledge. What is new somewhere can be useful somewhere else. However, even the smallest change leads with time to a global transformation of the way of working. Innovating has to be understood in the way novelties are becoming part of a practice. Constantly, old skills remain sources of inspiration. Nowadays, experimental science and fundamental science interfere more than ever with winegrowers' practices. From a historian point of view, it seems quite sure that what we name "novelties" are more often the development or the reappropriation of oldest knowledges or skills than a real transformation of a practice.

Acknowledgements

O35 — Oral communication 35

Enological impact of vineyard application of methyl jasmonate–loaded chitosan nanoparticles on ethanol reduction and wine quality preservation

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Keywords: nanotechnology, grapes, phenolic composition, Monastrell

Viticultural practices aimed at producing lower alcohol wines have traditionally focused on reducing sugar accumulation in grapes through canopy management techniques—such as early leaf removal or shading—which limit photosynthetic activity and delay ripening (Palliotti et al., 2014). Other approaches, including regulated deficit irrigation and the selection of late ripening cultivars or specific rootstocks, have been used to moderate berry sugar concentration under warm conditions (Intrigliolo & Castel, 2010). More recently, the application of metabolic elicitors has gained attention for their ability to influence grape composition and fermentative outcomes [1].Within this emerging field, the use of chitosan based nanoparticles loaded with bioactive compounds represents a novel strategy to modulate berry metabolism and ultimately achieve wines with reduced ethanol content while maintaining enological quality In this study, we evaluated the impact of 3 foliar treatments on the phenolic composition of Monastrell wines during the 2025 season. Treatments were applied at veraison and at one- and two-week intervals (200 mL/plant): (i) Control (water), (ii) methyl jasmonate (MeJ, 7.5 mM), (iii) ChNPs (chitosan naoparticles), and (iv) MeJ-ChNPs (chitosan nanoparticles loaded with methyl jasmonate) (7.5 mM). Chemical parameters were evaluated according to OIV procedures (OIV, 2021), and the phenolic composition was analyzed and quantified by liquid chromatography following the methodology described by Pérez Porras et al. (2022). A sensory analysis was performed after the completion of malolactic fermentation. All treatments resulted in wines with reduced ethanol content, with the largest decreases observed in those involving methyl jasmonate, both in its conventional form and encapsulated in chitosan nanoparticles. Although no statistically significant differences in phenolic composition were detected relative to the control, wines produced from MeJ ChNP–treated grapes showed the highest phenolic concentrations. These wines also obtained the highest sensory scores showing a high quality. These findings indicate that nanotechnology-based elicitors can modulate grape metabolism, positioning them as a promising tool for obtaining wines with lower alcohol content while preserving enological quality. This approach aligns with current consumer preferences for fresher, more balanced, and lower-alcohol wine styles

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O36 — Oral communication 36

DISINHIBITION OF GRAPEVINE IMMUNE RESPONSES: AN INNOVATIVE STRATEGY TO IMPROVE PLANT DEFENSE INDUCERS EFFICIENCY

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Keywords: Biocontrol – Plant Defense Inducers - Type 2 HDACs – Disinhibition – Downy mildew

Among the approaches aiming to reduce our reliance on usual phytosanitary products, stimulating plant immune responses is a promising strategy. However, the protection induced by plant defense inducers (PDI) remains often insufficient or inconsistent. In previous fundamental studies carried out on tobacco, we demonstrated that type 2 histone deacetylases (HD2), a family of HDACs specific to plants, act as negative regulators of immune response intensity. We identified a natural, non-toxic molecule (thereafter called « disinhibitor ») that inhibits HD2s, thereby lifting their repressive effect. This led us to develop a "disinhibition" strategy, combining the disinhibitor with a PDI to enhance the level of induced protection against diseases. Under controlled conditions, using grapevine and downy mildew/powdery mildew pathosystems, we showed a synergistic effect between the disinhibitor and the PDI used at reduced doses, achieving full protection. This increased efficacy is notably characterized by stronger and longer-lasting activation of defense genes, such as those involved in the stilbene phytoalexin synthesis. As part of the DEREBIO project (ANR Ecophyto Maturation), in collaboration with Cérience and the BC2Grape platform of UMR SAVE in Bordeaux, we tested this disinhibition strategy together with reduced doses of copper. Experiments were carried in experimental plots and with lead winegrowers across diverse soil and climate contexts during the 2024 and 2025 vintages, marked by a severe and moderate downy mildew pressure, respectively. On cv Chardonnay, the combined use of a reduced copper dose (50% below the approved rate), the disinhibitor, and a half-dose of PDI provided a level protection similar to that obtained with the standard copper treatment, without significantly increasing treatment costs. Importantly, we showed that the application of disinhibition strategy does not alter the biochemical characteristics of the berries or the physiology of the plant. This innovative biocontrol strategy, for which an international patent has been filed, holds promise for effective disease management against grapevine fungal pathogens under field conditions.

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O37 — Oral communication 37

Evaluating the Potential for Particulate Matter Sensors to Predict Smoke Taint Risk in the Vineyard

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Keywords: climate change, smoke taint, sensors, volatile phenols, fires

Vineyard exposure to wildfire smoke can contaminate grapes due to the uptake of smoke-derived volatile phenols.1 Smoke density, the duration of smoke exposure, and winemaking decisions influence the concentration of free and glycosylated volatile phenols in wine, and consequently, the perception of undesirable 'smoky' characters.2,3 Climate change is expected to increase the frequency and severity of fires; thus, it is likely the issue of 'smoke taint' will continue. As such, the (global) wine industry would benefit from the development of real-time methods for assessing vineyard smoke exposure. This project evaluated the potential for particulate matter (PM) sensors to monitor smoke exposure in the vineyard, and thus, smoke taint risk. PurpleAir PM sensors were deployed alongside excised bunches of grapes during prescribed burns conducted by the Department for Environment and Water in several South Australian national parks. Smoke emissions were monitored as particulate matter (PM2.5) concentrations (at different distances upwind and downwind of the burn site), while the uptake and glycosylation of smoke-derived volatile phenols by grapes determined the extent of smoke contamination. The sensors enabled temporal changes in smoke density to be monitored during each burn, and demonstrated the rapid dispersion of smoke. Higher free and glycosylated volatile phenol concentrations were observed in grapes positioned closer to the burn, attributable to exposure to higher density smoke. Model smoke experiments were subsequently undertaken to further evaluate sensor performance. While the density of smoke generated within a purpose-built smoke chamber (specifically designed for smoke taint research) saturated the sensors, smoke emissions were successfully monitored during a field trial simulating vineyard smoke exposure. The density of smoke was monitored over 5 hours and grapes exposed to higher PM yielded wines with increased smoke taint marker concentrations and perceivable smoke characters. By deploying PM sensors in vineyards, grape and wine producers would have access to real-time data regarding both the duration of smoke exposure, and the density of smoke. Where no or low PM measures are returned, industry can confidently proceed with harvest. Where PM data suggests prolonged exposure to smoke, especially dense smoke, informed decisions regarding the need for further testing and/or implementation of remediation strategies can be made, prior to harvest.

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O38 — Oral communication 38

Effect of common oenological treatments on grape must vitamin content and final wine volatile composition

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Keywords: Vitamin, Grape, Must, Fining, Fermentation

Yeast nutrition is a key factor in the control of alcoholic fermentation, although the role of vitamins received limited attention for decades. Recent studies have shown that several B-group vitamins strongly influence fermentation kinetics, yeast growth and volatile compounds production [1,2]. This study focuses on the impact of oenological treatments with fining agents or nutrients on vitamins in grape must and the following fermentation process. An LC-MS method was used and demonstrates that bentonites can severely deplete the must of some vitamins: up to -92% and -72 % for vitamins B1 and B6, respectively, and -38% for B2. Carbons presented similar trends on B1 and B6, and a stronger impact on B2 and B3 compared to bentonites (up to -99% and -60%, respectively). Such reductions in vitamin content could lead to deficiencies with adverse effects on Saccharomyces cerevisiae, especially in the case of vitamin B1 (thiamine) which is deemed as essential for yeasts. On the other hand, we showed that some yeast-derived compounds can release significant amounts of B1, B2 and B3 (up to +48%, +151% and +65%, respectively), which could overcome such deficiencies. Those first results opened the possibility to adjust thiamine levels in grape must by using bentonite, to assess effects on fermentability and volatile composition directly on a real matrix instead of a synthetic medium. After fermentation monitoring, GC-FID and GC-MS were used on wine samples for the quantification of 13 higher alcohols and esters. 9 compounds were significantly impacted by initial thiamine, with an overall increase of the 5 alcohols from 356 to 386 mg/L (+8%) and the 4 esters from 307 to 423 µg/L (+38%) under normal B1 conditions compared to the deficient must. Among the most impacted compounds were 2-phenylethanol and its acetate ester (both described as floral aromas), with an increase from 35 to 53 mg/L (+51%) for the alcohol and from 217 to 323 µg/L (+49%) for the ester. Globally, B1 addition to the bentonite treated must restored the volatile profile observed in the untreated control, proving the effects on volatiles are mainly due to thiamine and not to other depleted compounds. Overall, this study provides new insights on the impact of pre-fermentative treatments on nutrient availability while confirming the importance of vitamins for wine's volatiles. It suggests that the vitaminic status of musts could be a new parameter to consider for fermentation control.

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O39 — Oral communication 39

Development of a new process for wine dealcoholisation using supercritical CO_2 extraction-distillation coupling

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Keywords: wine dealcoholisation, aroma extraction, supercritical CO2, distillation, simulation

The global wine sector is currently facing a significant crisis driven by declining consumption and changing consumer preferences. In this context, fully dealcoholised wines emerge as a promising diversification strategy to adapt to new markets and consumption patterns. Current processes, such as membrane separation or vacuum distillation, do not generate a finished product with good olfactory qualities because there is a lack of selectivity between alcohol and aromas and the use of exogenous aromas became a common practice. The purpose of our work is to develop a process that combines distillation and supercritical CO2 (scCO2) extraction to produce a dealcoholised wine with an alcohol by volume content below 0.1% v/v. Studies showed that the aroma extraction by scCO2 extraction enabled the obtention of high-quality aromatic extract. Thanks to this selective process, the aroma fraction recovered could be reintroduced into the dealcoholised wine, significantly reducing the aroma loss occurring during other processes [1]. Various process couplings are being studied (distillation-distillation, distillation-scCO2 extraction, scCO2 extraction-distillation, scCO2 extraction-scCO2 extraction) using numerical simulation with ProSimPlus software (v3.7.10, Fives ProSim, Toulouse). Simulations are conducted on model wine composed with nine volatile molecules representative of the main aromatic chemical families present in wine (alcohols, carbonyl compounds, acetates, ethyl esters, volatile phenols, monoterpenes and sesquiterpenes). The first results of process simulation for the distillation-distillation coupling, based on the thermodynamic behaviour of the mixture, showed that the alcohol could be completely removed from wine while preserving most of the aroma compounds. However, specific aromas like acetates or carbonyl compounds could not be effectively separated from ethanol and therefore preserved. Although no sensory studies have been conducted, this loss is likely to directly influence the sensory profile of the product and highlights the obstacles associated with current processes. Therefore, the combination of distillation and scCO2 extraction whose study is still under progress could improve the preservation of these missing aromas and improve overall quality. The optimal operating conditions for this innovative combined process are being identified through simulations and will be subsequently validated and refined based on additional experimental results.

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O40 — Oral communication 40

Microalgae extract in winemaking: a bio-based alternative to sulfites to fight Brettanomyces bruxellensis

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Keywords: Brettanomyces bruxellensis, algae extract, amphidinols, antifungal, sulfite reduction

Research on microalgae as a reservoir of metabolites with antifungal potential for innovative oenological applications remains unexplored. This study demonstrated, under oenological conditions, the efficacy of a novel treatment based on an algal extract from Amphidinium carterae to inhibit Brettanomyces bruxellensis growth in red wines over 150 days. Throughout the experiment, viable and culturable cell concentrations were monitored. To determine the impact of the treatment on volatile phenol production by B. bruxellensis, concentrations of 4-ethylphenol and 4-ethylguaiacol were quantified. The contribution of amphidinols (AMs) to the extract's biocidal activity was also demonstrated under oenological conditions. In addition, the degradation of amphidinol 18 in the wine matrix was tracked by HPLC to evaluate the persistence of the active compound. The extract completely suppressed both B. bruxellensis growth and volatile phenol production throughout the monitoring period, regardless of the strain tested, including strains resistant to conventional treatments. Treatment performance depended on the initial contamination level. Finally, amphidinol 18 progressively degraded in red wine and became undetectable after 30 days. Overall, these findings underscore the potential of amphidinols as a promising alternative to sulfites for controlling B. bruxellensis in oenology.

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O41 — Oral communication 41

Beyond the Bottle: Consumer Perceptions and Systemic Challenges in Reusable Wine Packaging

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Keywords: reuse glass bottle, glass carbon footprint, consumer perception, environmental challenge, packaging

The post-war industrialization led to the dominance of single-use packaging and the decline of bottle reuse systems. Today, glass bottles account for 30–40% of the carbon footprint of wine and exert high pressure on sand resources. The manufacturing process is also subject to a multitude of systemic risks, which have the potential to result in supply disruptions that would exert a significant impact. Reuse systems offer a significant environmental benefit, yet their adoption remains limited in the wine sector. Wine professionals often cite a consumer resistance as a key barrier. This study investigates consumer perceptions of reusable wine bottles in Switzerland. Based on previous collective intelligence workshops information, an online survey was designed and completed by 442 participants. This survey assessed mental representations of reuse bottles, reverse logistics, positive and constraints arguments and the knowledge of environmental footprint. Cluster analysis indicates that two groups can be identified among consumers. The first cluster expressed strong acceptance of reuse. Those respondents associate reusable bottles with innovation and sustainability. The main barrier identified is the underdeveloped return infrastructure. This group is mainly composed by women and consumers with higher education levels. In contrast, the second cluster expressed more doubts. This group is made of wine lovers, closer to wine producers. This study suggests that consumer attitudes are not the main barrier. Reluctance come from logistics constraints and professional resistance that has spread to some consumers. Once logistic problems will be solved, wine professionals can adopt the reuse system confident.

SO28 — Short oral communication 28

Transcriptome and metabolite profiling reveals correlation of smoke taint compounds accumulation in Vitis Vinifera L. berries with phenylpropanoid pathway – the impact of plant growth regulators

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Keywords: glycosylated phenols (Gly-VPs), glycotransferases, monomeric phenolics, abscisic acid (ABA)

Wildfire smoke exposure has continued to be a threat for the wine industry, causing smoke tainted wines, reminiscent of medicinal, smoky smell and ashy aftertaste. The major tainted compounds in the smoke have been identified as volatile phenols (VPs) such as guaiacol, cresols, and syringol. Grape berries exposed to smoke can uptake these compounds and metabolize them into glycosylated volatile phenols (Gly-VPs). The glycosides can be hydrolyzed during fermentation, through wine storage, and upon consumption, releasing the tainted flavor. The biosynthetic pathway of Gly-VPs is ill defined, albeit studies have identified several smoke-responsive glycotransferases that contribute to their accumulation. The identified glycotransferases function in the phenylpropanoid pathway and are responsible for other secondary metabolites biosynthesis. Therefore, this study aims to investigate the correlation of Gly-VPs accumulation with monomeric phenolics biosynthesis in Cabernet Sauvignon berries following simulated smoke exposure. Plant growth regulators that are reported to regulate the phenylpropanoid pathway were applied to amplify the potential correlation and to provide insights on possible mitigation practice in the vineyard under smoke exposure risk. Abscisic acid (ABA) and methyl jasmonate (MeJA) were applied to the fruit zone of the vine one week prior to the simulated smoke exposure. The grapes were at E-L stage 36, one-week post-veraison. Grapes were sampled 1-, 5-day post smoke exposure and at harvest (33-day post exposure). There was a positive correlation between the concentration of Gly-VPs and monomeric phenolics in grapes collected at harvest, regardless of the ABA, MeJA application. The ABA treated grapes had significant higher amounts of Gly-VPs than the control without ABA treatment 5-day post exposure. The stimulating impact of ABA on Gly-VPs accumulation diminished for some of the measured Gly-VPs at harvest. The results suggested that either the application of ABA might promote further metabolism of the measured Gly-VPs into new metabolites or it impacted the rate of the glycosylation process rather than the amount. The effect of MeJA on Gly-VPs accumulation was arbitrary. More analyses including transcriptome profiling will be performed to elucidate the observations.

Evaluation of a Novel Chitosan-Based Defense Elicitor for the Reduction of Fungicide and Copper Inputs While Preserving Yield, Grape, and Wine Quality

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Keywords: Chitosan, Downy mildew, Fungicid/ Copper reduction

The use of fungicides and copper-based products to control grapevine diseases has raised concerns regarding their environmental impact and potential risks to human health. To reduce reliance on these inputs, new biostimulants and defense inducers have emerged, among which chitosan is one of the most widely studied due to its versatile properties as both an antimicrobial agent and an elicitor of plant defense mechanisms. In this study, we evaluated the efficacy of an innovative chitosan-based product (hereafter ICBP), a complex preparation developed using a patented technology (patent FR3145668), in reducing copper or fungicide inputs for the control of downy mildew (Plasmopara viticola) incidence and severity in vineyards. In addition, we assessed the biostimulant effects of chitosan on grape quality and potential wine quality. The experiment was conducted in a vineyard (Toulouges, 66300 France) between April and August 2025. Twenty plots (~20 m²; 10 plants: Vitis vinifera cv. Chardonnay) were assigned to five experimental groups in a randomized complete block design: [1] untreated control; (2) full recommended dose of copper (BB Protect); (3) half-dose copper (BB Protect) combined with 2 L ha^{-1} ICBP; (4) full recommended dose of fungicides (Polyram, Redelli, Tebaide); and (5) half-dose fungicides combined with 2 L ha^{-1} ICBP. In total, eight applications were performed according to standard viticultural practices. Disease severity, as well as grape physiological and biochemical parameters, were measured at harvest. Downy mildew pressure was ensured by four controlled inoculations with Plasmopara viticola to promote uniform disease development across experimental groups. Grape quality parameters included pH, total acidity, malic acid content, amino nitrogen, ammonium, yeast-assimilable nitrogen (YAN), sugar content (°Brix), and potential alcohol. Our study shows that eight applications of ICBP allowed a 50% reduction in copper or fungicide doses while maintaining 100% plant protection, equivalent to that achieved with full-dose treatments. The results indicate that combining ICBP with half of the conventional dose provides the same technical performance as the full treatment, while slightly improving grape balance. Sugar content, potential alcohol, YAN, and amino nitrogen levels remained essentially unchanged, indicating that dose reduction does not compromise ripeness or fermentation security.

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Selective Adsorption of Free Volatile Phenols in Smoke-Tainted Wines

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Keywords: Smoke-taint, Remediation, Adsorption, and Free Volatile Phenols

Wine grapes exposed to smoke from wildfires pose a significant threat to the wine industry because smoke exposure can cause severe decreases in grape and wine quality. During the 2020 wildfire season alone, Californian wine losses were estimated at up to $USD3.7 billion, due to smoke-taint concerns. When grape skins absorb volatile phenols from smoke, these compounds and those that bind to sugars, produce wines with unpleasant smoky, ashy, or medicinal characteristics—commonly referred to as smoke-taint. Effective remediation of smoke-tainted wines is critical to prevent the economic losses associated with the disposal of tainted grapes and wine. An opportunity exists to further improve cost and efficiency of remediation strategies, which are often limited by insufficient removal of smoke-derived volatile phenols or unintended removal desirable components that define a wine's natural color, aroma, flavor, and mouthfeel. This work highlights advanced materials treatment, which can be regenerated and reused, that has been developed to address the removal of smoke-taint molecules while preserving the wine's original composition. Batch treatment of highly smoke-tainted California Cabernet sauvignon resulted in an average 63% reduction in smoke-related free volatile phenols (FVPs), with all phenolic compounds measured—except phenol—being reduced below reported sensory detection thresholds. Importantly, the treatment material exhibited negligible impact on wine color, with a CIE Lab* ΔE value of 0.76 ($\Delta E < 1$ indicates no perceptible color difference). This preservation of color aligns with the minimal changes observed in anthocyanin content following treatment. Continued evaluation of the treatment material across varietals will further define its potential as a scalable platform for maintaining wine composition and quality.

Effects of Membrane Alcohol Reduction on Key Aroma Compounds, Including Rotundone, in Austrian Grüner Veltliner

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Keywords: membrane technology; alcohol reduction; Grüner Veltliner; aroma compounds; sensory analysis

This study examines how stepwise alcohol reduction using membrane-based processes affects the composition, aroma, and sensory properties of an Austrian Grüner Veltliner wine. Alcohol was removed with a reverse osmosis system combined with a membrane contactor, and the resulting wines were compared with blends prepared from the dealcoholised and the original wine. The analytical work included standard chemical and physical measurements, sensory evaluation, and an extensive aroma analysis. In total, around 100 volatile compounds were quantified using six complementary GC–MS or GC-MS/MS methods, covering all aroma-relevant compound classes known for Grüner Veltliner [1] Ethanol removal led to changes that stem mainly from the reduction in total volume, which resulted in higher concentrations of non-volatile constituents and, to some extent, also of individual volatile compounds such as certain monoterpenes. At the same time, thiols, esters, higher alcohols and fatty acids decreased noticeably. Rotundone—the compound responsible for the typical pepper note of Grüner Veltliner—was not affected by the treatment and remained stable throughout the process. These analytical findings were reflected in the sensory assessment. Wines with lower alcohol were described more frequently with fresher attributes, while riper notes became less prominent. The blending approach produced comparatively small differences in aroma and showed no clear preference in the ranking test. Overall, the results indicate that membrane-based alcohol reduction can be applied without compromising key aroma characteristics, including the varietal pepper note, and may therefore represent a viable option for future wine production.

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Preliminary Study on Valorizing Fermentation CO_2 for Ethanol Removal by Gas-Liquid Stripping

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Keywords: Sustainability, alcohol reduction, valorization, carbon dioxide, stripping

Reducing the alcohol content of wine has become a technological and sensory challenge. As consumer demand shifts toward lighter wines, current dealcoholization methods including vacuum distillation, reverse osmosis and spinning cone columns remain energy-intensive, expensive and result in aromatic profiles alteration. In a sector that is fighting to reduce its carbon footprint, the need for low-impact alternatives is necessary. Fermentation-derived CO_2, usually released into the atmosphere, represents a largely resource with significant potential for valorization. This study explores a novel CO_2 based gas-liquid stripping process designed for partial ethanol removal. By recycling fermentation CO_2 as the stripping gas, the method includes alcohol adjustment within a circular and climate conscious framework. The work integrates (i) theoretical modeling of gas-liquid mass transfer, (ii) laboratory scale optimization using hydroalcoholic solutions, and (iii) validation on wines to assess chemical and aromatic impacts. Two reduction targets, 0.5% and 1% (v/v), were evaluated, compared with vacuum distillation serving as the industrial standard. Optimization of the volumetric mass transfer coefficient (kLa) focused on gas flow, pressure and diffuser pore size. Modeling and experiments demonstrated that smaller bubbles offer higher surface to volume ratios, which improve transfer surface and thus efficiency. Under optimized conditions, a 0.7% ethanol reduction was achieved within three hours in 4 L of hydroalcoholic solution. When applied to wines, ethanol reductions of 0.5-0.8% v/v were obtained depending on initial composition. Analytical results indicated moderate but measurable modifications in tannins, anthocyanins, color intensity and total polyphenols, suggesting interactions between CO_2 stripping and wine macromolecules. GC MS analyses revealed a 10-20% decrease in higher alcohols and a 70-100% loss of key esters such as ethyl acetate and isoamyl acetate. Although further optimization is needed, CO_2 based stripping emerges as a promising solution for alcohol adjustment. Its integration during fermentation could enable real time ethanol control, aroma management and significant reduction in the carbon footprint of winemaking. This preliminary work demonstrates the feasibility of this technology and outlines future directions for enhancing aroma recovery and improving selectivity and scaling up to industrial applications.

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A Novel Lab-Scale Carbonation Method for studying Sparkling Wines and Oenological Additives

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Keywords: Sparkling wines, Foaming properties, Carbonation, CO_2, Oenological products

Bubbles and foam are key visual attributes of sparkling wines, as they are often the first features noticed by consumers [1]. In the absence of a fine foam collar (or mousse ring), the product is commonly perceived as unsatisfactory by sparkling wine aficionados [2]. Several approaches are currently available to assess the factors influencing foam. Among them, standardized instrumental methods based on gas injection are the most widely used [3,4]. Other techniques, mainly based on image analysis, aim to assess foam properties under conditions closer to real tasting [5,6]. While some studies were conducted directly on wine, isolating the effect of a single factor remains difficult. Other studies have used model solutions [6–8], although these generally did not contain CO_2 at levels comparable to those in real sparkling wines. To investigate the effect of a single variable on foam, the ideal approach is to use a champagne-like model solution with dissolved CO_2 at concentrations comparable to those in sparkling wine and to evaluate its foaming properties under tasting conditions. To this end, we developed a small-scale laboratory carbonation method for model solutions. The setup consists of a CO_2 cylinder connected to a flowmeter, which is then linked via tubing to the bottle containing the solution to be carbonated. Standard champagne bottles sealed with a pierced crown cap were used. We first validated our carbonation system by carbonating four distinct model solutions—water, sweetened water, a hydroalcoholic solution, and a sweetened hydroalcoholic solution—to target dissolved CO_2 concentrations of 6, 8, and 10 g L^{-1}. Dissolved CO_2 concentrations were measured using a laser aphrometer and the standard OIV acid–base titration method. We then examined the impact of ethanol and pH on foaming properties by photographing the foam collar and performing image analysis under standard tasting conditions. This approach revealed that increases in ethanol and pH (conditions often associated with climate change), reduce foam quantity and stability while increasing bubble size, two factors negatively correlated with consumer-perceived wine quality. We also assessed the effects of various oenological additives, including tannins, gums, and yeast-derived products, on both foam characteristics and CO_2 retention in the solutions. This analysis allowed us to identify certain additives that enhance CO_2-related properties, while others have a detrimental effect.

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P122 — Poster

New approach to reduce energy consumption in alcoholic fermentation

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Keywords: Alcoholic fermentation, Energy consumption, Optimization, Modeling

The wine industry is undergoing major changes in response to global climate change and societal concerns. In particular, it needs to reduce its energy footprint while preserving the organoleptic quality of wines. The aromatic profile of wines is closely linked to the grape varieties and the practices used during the winemaking process, particularly during alcoholic fermentation. The nutrients present in the must, the yeast strain used and the fermentation temperature all have a direct impact on the production of aroma compounds. Temperature has both a physiological and physical effect on the production and preservation of these volatile molecules in wine [1]. Firstly, fermentation temperature affects the regulation of metabolic pathways that enable the synthesis of different classes of aromas (higher alcohols, ethyl esters and acetate esters). Secondly, it has an impact on the loss of aroma compounds resulting from their evaporation during the process. These compounds have a low molecular mass, and their vapour pressure at atmospheric pressure and room temperature is sufficient to cause them to volatilise and thus be lost through evaporation. Furthermore, this phenomenon is amplified by the release of CO2 during the fermentation process [2]. Thus, to minimise aroma loss through evaporation, the fermentation stage in white and rosé wine production is generally carried out at low temperatures (12-20 °C) [3]. However, the main reaction in alcoholic fermentation is exothermic. In fact, the heat production yield is 98.23 kJ/mol of sugars [4],[5]. Therefore, a lot of energy is required to maintain low temperatures. Increasing the fermentation temperature can certainly reduce the energy cost of the fermentation process, but it risks promoting the loss of volatile compounds of interest. However, these losses can be partially controlled by carefully selecting the yeast/nutrient combination used in the fermentation process. As wine quality is a highly multidimensional criterion, reducing the energy footprint of the winemaking process without compromising quality is a complex problem. It requires the development of disruptive strategies to find a suitable compromise between these two key factors.

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P123 — Poster

Application of protective agents in Nebbiolo vines and effects on Grape Secondary Metabolites

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Keywords: anti-stress agents, grape aroma precursors, grape polyphenols

Within a context marked by climate change–related abiotic stresses, grapes are more exposed to excessive heat and solar radiation causing sunburn damage with visual and organoleptic alterations in the berries and resulting wines. Sustainable approaches, including the application of foliar protective products in the vineyard, represent potential options for preserving grape quality and protecting wine quality and typicity. This research evaluated the impact of foliar application of anti-stress agents (kaolin 3%, 6% and zeolite) on the polyphenolic and aromatic composition of Nebbiolo grapes for Barolo production, across two consecutive seasons marked by different ripening meteorological conditions. Kaolin and zeolite were applied at different time points after veraison following a two- or three application protocol during two consecutive vintages (2024, 2025). Quantitative determination of grape aroma precursors was carried out using GC-MS, whereas polyphenols in skins and seeds were analysed by spectrophotometric and HPLC methods. In mild ripening conditions (2024), the 6% kaolin treatment reduced polyphenol levels, especially anthocyanins in Nebbiolo skins and total polyphenols and flavonoids in seeds, compared to the control. Under stress conditions (2025), no significant differences were observed in skins, but seeds of kaolin and especially zeolite treatments showed higher polyphenol and flavonoid content. Although the similar sugar contents were observed across treatments, zeolite treatments resulted in higher total acidity while kaolin 3% showed higher malic acid levels. Aroma precursors (norisoprenoids) were highest in the 3% kaolin treatment, though differences were not significant. Climatic and meteorological conditions play a critical role in determining the effectiveness of protective product applications designed to mitigate climate change impacts. Further research including vinification and sensory evaluation of the resulting wines must be conducted. Such studies will help determine the practical relevance of these protective applications under varying climatic conditions and guide their optimal use in vineyard management.

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P124 — Poster

Effects of must settling and pre-bottling filtration in the ancestral sparkling wine production

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Keywords: Ancestral method, Sparkling wine, Settling, Filtration

The ancestral method, based on a single fermentation completed in bottle without sugar addition, has gained renewed interest among both conventional and alternative wine producers. However, limited information is available regarding the impact of key oenological practices on wine quality [1,2]. This study evaluated the effects of must settling and pre-bottling filtration on the physicochemical composition, volatile profile, foam properties, colloidal characteristics, and sensory quality of ancestral sparkling wines. Macabeo grapes (2023 vintage) were vinified under four conditions combining the presence or absence of must settling and pre-bottling filtration. After eighteen months of bottle ageing on lees, wines were disgorged and analyzed. While ethanol and pH were unaffected, significant differences were observed in total polyphenol index, titratable acidity, protein and polysaccharide content, and colloidal particle concentration. Non-settled wines showed higher colloidal loads and lower foamability, whereas both settling and filtration improved maximum and stable foam height. Volatile analysis revealed higher fruity and floral esters in settled wines, while non-settled/non-filtered wines presented increased levels of volatile phenols and fatty acids associated with less desirable aromas. Sensory evaluation confirmed perceptible differences, particularly in phenolic, fruity/floral, and Maillard-related notes. Overall, must settling and pre-bottling filtration significantly influence the compositional and sensory profile of ancestral sparkling wines, providing practical guidance for quality optimization in this emerging production style.

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P125 — Poster

Rethinking mixed fermentations : why yeast–yeast interactions matter in wine

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Keywords: Yeast interaction, metabolomic profiling, mixed fermentation, intra-specific variability

Yeast interactions during microbial fermentations represent a central topic in understanding the dynamics of microbial populations including their metabolic exchanges and the consequences for the final composition of wine. Recent studies have shown that metabolomes produced in co-cultures do not simply reflect the addition of individual metabolisms, they exhibit interaction-specific metabolic signatures. High-resolution metabolomic analyses have revealed non volatiles compounds that are absent in pure cultures, providing direct evidence of emergent metabolic responses resulting from yeast coexistence1-4. Additionally, through their metabolic interactions, yeast coexistence leads to a significant diversification of the aromatic profile of wines, characterized by both quantitative and qualitative changes in fermentative volatile compounds, resulting in perceivable sensory differences and increased wine complexity4. Esters, fatty acids and phenol families were identified as affected. One of the yeast interactions revealed through metabolomic analysis is the compeition for nutrient. Indeed, the redistribution of fluxes through the central nitrogen metabolism occurring as part of interactions between yeast have been shown2. Our investigations further demonstrate that parameters often considered secondary, such as the initial physiological state of the yeasts, the mode and timing of inoculation, and the requirement for physical cell contact, actually play a major role in interaction expression1–6. Importantly, the impact of yeast interactions varies not only between species but also within a single species, including both Saccharomyces and non-Saccharomyces yeasts4–7. The divergent metabolic responses and fermentation trajectories observed highlight a previously underappreciated level of intra-specific variability challenging current strain selection strategies in mixed fermentations. Together these findings demonstrate that yeast interactions cannot be predicted from species identity alone. Overall, these results demonstrate that yeast interactions strongly influence microbial dynamics and the final composition of wines including non volatile, volatile and sensory profiles. They open new perspectives for optimizing mixed fermentations according to technological or sensory objectives and underscore the need for integrative, systems-level approaches to fully understand microbial interactions.

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P126 — Poster

Valorization of Minority Red Grape Residues for Sustainable Gold Nanoparticle Synthesis: A Matrix-Dependent Approach

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Keywords: minority grapes, gold nanoparticles, circular bioeconomy, green synthesis, AFM.

This research investigates the potential of four minority red grape varieties from Northwest Spain—Bruñal, Cenicienta, Mouraz, and Puesto Mayor—as sustainable bio-templates for the green synthesis of gold nanoparticles (AuNPs). In the framework of a circular bioeconomy, the study evaluates how the specific chemical "fingerprint" of different winery residues (musts, skins, and seeds) regulates the final properties of the nanomaterials. The results establish a clear functional specialization based on the tissue-specific phytochemical profile. Skin extracts, characterized by high anthocyanin concentrations (up to 388 mg/L in Cenicienta), acted as superior stabilizing media, yielding the smallest nanoparticles. Specifically, Puesto Mayor skin extracts produced ultra-small primary nuclei of 3.16 nm. In contrast, seed extracts, rich in condensed tannins (TPI ~28), served as powerful reducing engines. However, the massive production of nuclei in seeds often leads to vertical stacking phenomena upon dehydration, as evidenced by Atomic Force Microscopy (AFM). Analysis of must-derived AuNPs revealed inhomogeneous matrices where gold nuclei are embedded in voluminous organic "rafts" of sugars and polysaccharides, explaining the large hydrodynamic diameters (>400 nm) detected by DLS. Morphological characterization via AFM provided definitive validation of this matrix-dependent growth. While seed-derived AuNPs were predominantly spherical, skin extracts from Cenicienta and Mouraz promoted the formation of triangular nanoprisms. This anisotropic growth is attributed to the high total acidity and specific phenolic hydroxyl groups acting as shape-directing agents. The high colloidal stability achieved, with Zeta potential values reaching –39.00 mV in Mouraz seeds, highlights the efficiency of grape-derived phenolics as robust surface protectors. Ultimately, this work valorizes the unique chemical profiles of underutilized viticultural biodiversity, demonstrating that winery by-products can be transformed into high-added-value technological resources for strategic applications in food science and biomedicine.

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P127 — Poster

Can roasted grape seed infusions act as a sustainable aging-like strategy to enhance complexity while preserving fruitiness in young red wines?

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Keywords: wine aging, sensory profiling, aroma compounds, grape seeds, valorization

Traditional oak aging enhances wine flavor but faces growing economic and environmental challenges, often conflicting with modern market trends favoring fresher, fruit-forward styles [1-3]. This study explores the valorization of grape seeds—an abundant winemaking by-product [4]—as a natural, grape-derived alternative to impart desirable aromatic and structural qualities while reducing reliance on natural or synthetic aging materials. Specifically, the present work evaluated the impact of roasted grape seed infusions on the chemical and sensory profiles of red wine during aging, with this innovative approach recently filed with the INPI as a provisional patent [5]. Seeds from a 2022 Bordeaux Merlot were dried and roasted following five reproducible protocols (T1-T5), ranging from light to intense heat treatment. A control wine (no infusion) and experimental wines infused with roasted seeds (1 g/L, 14 days) were prepared. The resulting wines were analyzed for phenolic content and underwent extended chemical profiling, including targeted analysis of volatile compounds, specifically terpenes, norisoprenoids, C6 compounds, esters, and oak-derived compounds (lactones, phenolic aldehydes, volatile phenols, furanic compounds) [6]. Sensory evaluation was conducted using the Check-All-That-Apply (CATA) methodology by 62 tasters, assessing 9 aroma and mouthfeel descriptors [7]. Roasting significantly altered the volatile profiles of wines. Treated wines exhibited substantially increased levels of key wood-derived compounds, particularly those typically associated with oak aging, such as vanillin and guaiacol, with concentrations depending on the toasting level, highlighting the strong compositional impact of these wood components. Slight variations were also observed in some varietal, pre-fermentation, and fermentation-derived compounds. Sensory results revealed clear differences in aroma perception between the seed-aged wines and the control, which was primarily characterized by fresh-fruit aromas. Wines infused with highly roasted seeds (T4-T5) developed a complex aromatic profile with prominent grilled, coffee, and popcorn notes, whereas those from lower thermal treatments (T1-T2) were distinguished by enhanced fruitiness, often described as jammy. Overall, these findings highlight roasted grape seed infusions as a promising and sustainable approach to redefine red wine aging, promoting aromatic complexity while fostering innovation and circularity in winemaking.

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P128 — Poster

Zeolites: A Selective Alternative for Managing Volatile Phenols in Wine

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Keywords: volatile phenols, zeolite, adsorption

The wine industry is undergoing profound changes. Climate change, evolving pest pressure, and shifting oenological practices - notably the reduction of SO2 and increasing pH levels - are creating an environment conducive to the emergence of contaminating molecules and organoleptic defects. While current winemaking tools can treat some of these deviations, they often lack specificity, impacting the structure or aromatic profile of the wine. In response to the demand for environmentally friendly processes, zeolites offer innovative prospects. These crystalline aluminosilicates, already authorized by the OIV for TCA removal, possess adjustable porosity and modulable physicochemical properties that enable high-precision adsorption. Recent works have validated their effectiveness in reducing pesticide residues (patented results). Current research is diversifying targets toward the mitigation of heavy metals and molecules responsible for premature oxidation or volatile phenol spoilage. This study focuses on the adsorption capacity of various zeolite structures regarding phenolic ring molecules, such as ethyl phenols (4-EP, 4-EG) derived from Brettanomyces bruxellensis and molecules from wildfire smoke. Adsorption kinetics and isotherms of 4-EP and 4-EG were determined in model solutions, including competition tests and studies on medium complexity. The performance of the best-performing zeolites was assessed on numerous wines and compared to classical adsorbers like activated carbons. The study showed that specific zeolites could adsorb large quantities of volatile phenols. This effectiveness is linked to zeolite topology, chemical composition, and concentration. Furthermore, unlike activated carbon—which has high gross efficiency but is non-specific—zeolite preserves the integrity of the wine. While carbon causes a loss of color and aromatic complexity, zeolite treatment maintains analytical and sensory balance. These results confirm the significant superiority of selected zeolites for the adsorption of target compounds. Selecting the right zeolite can drastically reduce volatile phenol levels without the drawbacks associated with activated carbons. This work highlights the importance of understanding adsorption mechanisms and molecular selectivity to adapt the material to the specific winemaking challenge.

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P129 — Poster

Effect of flavonoids and a citrus-derived biostimulant on grape ripening: from cell cultures to field trials

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Keywords: Anthocyanins, naringenin, cell cultures, biostimulant, climate change

Climate change is disrupting grape ripening kinetics, causing a critical decoupling between technological and phenolic maturity in Vitis vinifera L. This shift often leads to wines with excessive alcohol and poor color, a major hurdle for the industry. While elicitors like methyl jasmonate1,2 have been studied, their field adoption remains low. We hypothesized that naringenin—a key intermediate in the phenylpropanoid pathway found abundantly in citrus waste—could bridge this gap, offering a sustainable solution within a circular economy framework. This study evaluates the potential of naringenin and naringin to stimulate anthocyanin biosynthesis in cell cultures and tests the field efficacy of a citrus-derived biostimulant on the composition of Garnacha and Tempranillo grapes and wines. Initially, Vitis vinifera L. cv. Gamay cell cultures were treated with 1.5 mM naringenin and naringin, both individually and combined. We monitored cell viability to ensure no toxicity and quantified anthocyanin accumulation, followed by a preliminary RNA-seq analysis to detect shifts in global gene expression. Subsequently, a biostimulant was extracted from grapefruit peels using Subcritical Water Extraction (SWE) and applied to field plots of cv. Garnacha and cv. Tempranillo. All replicates were harvested when control grapes reached 21 °Brix and analyzed individually via the Cromoenos method. Finally, we performed microvinifications and assessed the resulting wines through standard oenological analysis and sensory triangle tests. Cell culture trials proved that these flavonoids are non-toxic and result in a synergistic increase in anthocyanins, accompanied by clear changes in the global transcriptomic profile. In the vineyard, however, the biostimulant did not significantly increase anthocyanin levels or the Total Polyphenolic Index (TPI) in grapes or wine. Interestingly, a consistent and significant reduction in ethanol content was observed in the treated wines compared to controls. While naringenin effectively modulates the flavonoid pathway in vitro, its field application did not enhance color under our study conditions. However, the observed reduction in ethanol suggests that citrus-derived biostimulants are a promising, eco-friendly tool for managing grape ripening and wine balance in a warming climate.

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P130 — Poster

Vine Water Status Modulates Aroma Composition and Sensory Quality of White Wines cv. Pinela (Vitis vinifera L.)

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Keywords: Deficit irrigation, vine water status, aroma composition, phenolic compounds, sensory quality

Vine water status affects grape ripening, metabolite accumulation, and wine quality. In the sub-Mediterranean climate of western Slovenia, terraced vineyards are increasingly exposed to summer droughts. This study evaluated the impact of regulated deficit irrigation on yield, aroma composition, phenolic profile, and sensory properties of autochthonous Pinela (Vitis vinifera L.) white wines produced in 2024 in a terraced vineyard in the Vipava Valley. A decision support system (DSS; Vintel®) was used to maintain three levels of predawn leaf water potential (ΨPD) from flowering to harvest: well-watered control (–0.10 to –0.30 MPa), mild-to-moderate deficit (–0.25 to –0.45 MPa), and moderate-to-severe deficit (–0.45 to –0.65 MPa). Vine water status was monitored using a Scholander pressure chamber. Grapes were harvested at technological maturity and microvinified in triplicate with commercial S.cerevisiae. Varietal and fermentative volatile compounds and phenolic compounds were analysed in five-month-old wines. At the same time wines were sensorially evaluated by a panel of experts using ranking test. Deficit irrigation reduced yield by 19% (mild-to-moderate) and 34% (moderate-to-severe) compared to the well-watered control. Mild-to-moderate deficit increased varietal thiols, esters, and higher alcohols, whereas moderate-to-severe deficit enhanced terpenes, fatty acids, C6 compounds, and volatile phenols. Flavan-3-ols were more abundant in well-watered wines. Sensory analysis revealed a preference for wines produced under mild-to-moderate deficit, which were rated highest in fullness and overall quality. Wines from the moderate-to-severe deficit exhibited greater bitterness, fruitiness and tropical and green apple notes. Well-watered wines received the lowest scores for most parameters but were characterized by higher perceived acidity. Vine water status modulates both chemical and sensory attributes of Pinela wines. Mild-to-moderate deficit irrigation proved to be the most sustainable water management strategy for producing Pinela wines in terraced vineyards, as the yield was not substantially affected while the quality was improved.

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P131 — Poster

From wine tourism to eco-cultural tourism. The Atlas of the Wonders of Latin America

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Keywords: Wine Tourism; Eco-Cultural Tourism; Atlas of Wonders

The Atlas of Latin American Wonders—eco-cultural tourism—is examined as a new strategy for wineries in the Southern Cone of South America to address the market crisis. It represents a qualitative leap in the concept of wine tourism, moving from a proposal focused exclusively on wine (vineyard visits and tastings) to a more ambitious one that extends to natural and cultural heritage, and partnerships with gastronomy, local products, and anthropological festivals.

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P132 — Poster

Polysaccharides from grape pomace: Extraction and fractionation strategies and aroma modulation in Sauvignon blanc wines

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Keywords: Grape pomace; polysaccharides extraction; fractionation; wine aroma

Grape pomace is a rich source of polysaccharides (PS) with potential aroma-enhancing effects in wine. The molecular weight (Mw) of PS plays a key role in determining their physicochemical and functional properties. In this study, three extraction methods: acid-assisted extraction with sonication, hot water extraction and ethanol pretreatment followed by hot water extraction, were compared for recovering PS from Sauvignon blanc (SB) and Syrah (SYR) pomace. Three fractionation techniques were evaluated to separate PS into high Mw (HM) and low Mw (LM) fractions: gradient ethanol precipitation, ultrafiltration, and ion-exchange chromatography. Both hot water-based extraction methods with 80% and 40% ethanol precipitation gave higher PS yields (~10 mg/g for SB and ~5 mg/g for SYR). Gradient ethanol precipitation gave lower yields but increased PS purity and different Mw distributions. SB-derived PS showed higher proportions of low Mw PS than PS from SYR and were more suitable for separation. Ultrafiltration resulted in a low yield of LM PS (1.49%), while the yield for ion-exchange chromatography recovered LM PS was ten-fold higher (15.10%). Given these findings, two SB PS fractions were collected using ion-exchange chromatography and have been utilised in fermentation experiments. Ongoing analyses will evaluate their impact on aroma and wine stability during 12-months aging, with implications for PS application in SB wines.

P133 — Poster

Influence of adjuvants used in viticulture on the final quality of wines

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Keywords: global warming, kaolin, anthocyanins, red wine.

The effect of global warming and water stress on Mediterranean vineyards has prompted the search for strategies to counteract the damage associated with sunburn of grapes and leaf dehydration of vines. Exposure promotes biochemical changes in the phytochemical composition of grapes affecting the final quality of wines. Also, the vine may exhibit physiological changes caused by heat-induced stress. To decrease the surface area exposed to the sun, the use of inert materials - like kaolin- applied to leaves, grape steams and berries has become a viable strategy. Kaolin can reflect solar radiation preventing sunburn and reducing the surface temperature of the vine structures. This effect results in less water loss in the plant and avoiding negative changes in the grape's composition that could affect the desirable qualities of the wine. The amount of kaolin applied is usually between 1 and 5% and is carried out after flowering when temperatures rises. During the harvest, mainly through mechanical collection, the grapes are often accompanied by other parts of the vine (leaves, stems), so the residual presence of kaolin is possible during subsequent winemaking stages. Its impact on the phenolic profile during fermentation could affect the organoleptic qualities of wine – like color, which is provided by anthocyanins in red wines-. This research explores the influence of added kaolin on the anthocyanins profile of experimental young Malbec red wine. Degradation parameters of anthocyanins from experimental red wine stored with 3 different kaolin percentages (3,5 and 10% w/v) over 130 days were determined. Total anthocyanins (T-ACN) were quantified by UV-Vis at 520 nm. Degradation of T-ACN followed first-order kinetics. The reaction rate constant (k value) showed that the degradation rate was highest in the experimental red wine with 10% kaolin ($6.263 \cdot 10^{-3}$ d^{-1}), followed by the wine with 5% ($6.064 \cdot 10^{-3}$ d^{-1}), 3% ($4.509 \cdot 10^{-3}$ d^{-1}) and finally, the wine without additive ($1.849 \cdot 10^{-3}$ d^{-1}). Half-time of T-ACN was highest in the control red wine (374.8 d), followed by wine with 3% kaolin (153.7 d), 5% (114.3 d) and finally, the wine with 10% of additive (110.6 d). In addition, the malvidin-3-glucoside/malvidin 3-O-(6-O-p-coumaroyl) glucoside ratio in experimental red wines was monitored using HPLC-DAD.