Application of two-dimensional chromatography and fast bench-top analysis for quality studies related to the wine supply chain

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INTRODUCTION

Assessing the authenticity of wines is a topical but difficult task that may be addressed with the appropriate profiling of the complex wine composition in terms of organic and inorganic constituents. Several methods and techniques are reported in the scientific literature describing the study of the wine characteristics; just to name a few, LC-MS, GC-MS and GCxGC-MS, ICP-MS, IR-MS, NMR, fast bench top analysis and sensory analysis have been applied, often coupled with multivariate statistical analysis for the data treatment (e.g., PCA, PLS). This PhD project will focus on the application of two-dimensional chromatography and fast bench-top analysis for quality assessment of processes and products of the wine supply chain.

STATE-OF-THE-ART

- Counterfeiting of high-quality wines is played at multiple levels (OLAF, 2020): it could involve the declared geographical, vintage and even varietal mislabeling; the assessment of such frauds is usually performed through the confrontation of analytical results between authentic and suspicious wines using various analytical and statistical approaches (Gougeon et al., 2019).

- The usefulness high-resolution multidimensional comprehensive techniques, such as two-dimensional chromatography, is often played out in its ability to provide a deeper understanding of the sample composition, hence its quality, allowing to obtain great amount of data. (Perestrelo, R., et al., 2010).

- In oenology, among the most employed of such rapid techniques, refractometry has been used extensively in wineries and in laboratories for its rapidity and non-destructiveness, e.g., for routine analyses or estimation of the quality of grapes (e.g., maturation), during wine fermentations and of the final wine (Son et al., 2009).

- Ultrasonic based devices can be used for rapid, non-destructive, non-invasive, automatic, inexpensive, accurate and on-line measurements and so to provide real-time information on the state of biochemical reactions (Resa et al., 2009).

RESEARCH OBJECTIVES

This PhD research project will focus on the following points:

- Carrying out a comprehensive mapping of volatile profiles by applying HS-SPME-GCxGC-ToF/MS in large and representative samples of different wines, in relation also to results from sensory analysis.

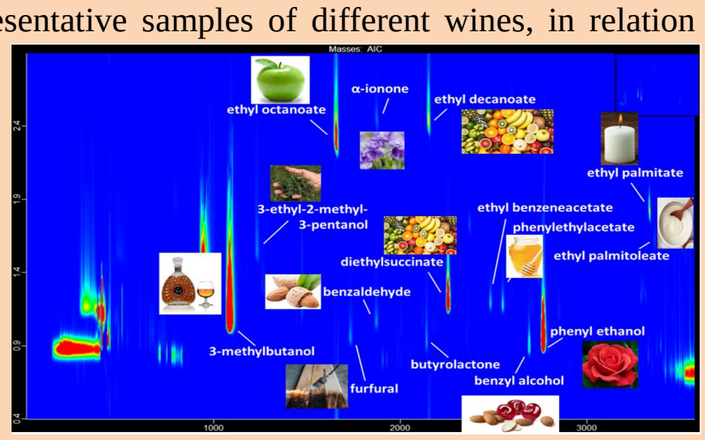

Figure 1. Example of Aroma map of Pinot noir obtained with GCxGC/TOF-MS

- Validating and applicating fast bench-top analysis such as refractometry and ultrasonic measurement investigating the analytical performance of instrumentation combining these two techniques in relation to the composition of grape musts, partially fermented musts and wines.

PHD THESIS MILESTONES

Activity / Months		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
A1)	Instrumental training																																				
A2)	Courses certifications																																				
A2)	Seminars and schools' certifications																																				
A3)	Validation of fast bench top analysis																																				
A4)	Construction of aroma maps on monovarietal wines																																				
A5)	Period abroad																																				
A6)	Oral/poster contributions to conferences																																				
A7)	Publishing scientific papers																																				
A8)	Writing PhD thesis																																				

MATERIALS AND METHODS

Fast bench top analysis

- Refractometric and sonic Brix values were determined using a **LP10 sensor** (Maselli Misure, Parma, Italy) working at controlled temperature
- The real enological samples were obtained during the 2020-2021 harvest in South Tyrol (Italy) with the collaboration of Laimburg Research Centre (Ulrich Pedri Research area Enology)

Figure 2. LP10 rapid analyzer

- The model solutions were prepared at different combinations of different levels of ethanol in water, glucose, tartaric acid, malic acid and gallic acid as major wine components
- The statistical analysis of the results has been performed on CAT (Leardi, R., Melzi C., Polotti G., Chemometric agile software) and XLStat (Addinsoft, France)

Application of two-dimensional chromatography

- Head space-solid phase microextraction (HS-SPME) followed by two dimensional GC coupled with time-of-flight mass spectrometry (GCxGC-ToF/MS) will be used to analyze enological samples in order to map the volatile compounds of these wines.

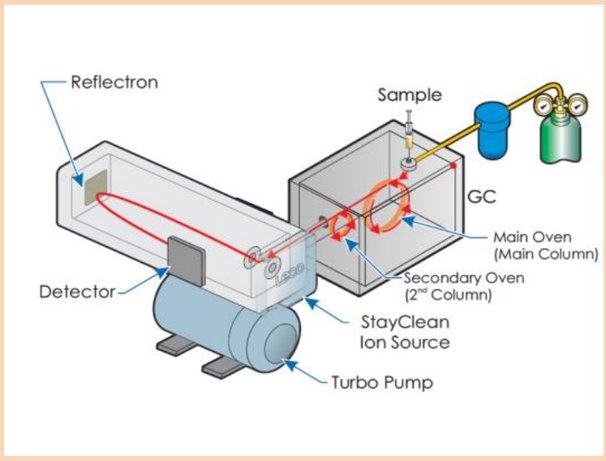

Figure 3. Two-dimensional gas chromatography in combination with mass spectrometry to create aroma maps for the wines.

EXPECTED OUTCOMES

- Validation of fast bench top ultra rapid analysis of unstable samples such as musts during fermentation (simultaneous determination of alcohol content, residual sugars and dry extract) using a combined refractometric and ultrasonic technique useful for technology transfer to wineries

- Collection of aroma maps on monovarietal wines of different geographical, regional, national and international origin and verification of the influence of winemaking practices on their profile for wine quality and authenticity assessment.

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