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Wine "bouquet": from sensory investigation to molecular analysis

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EVOLUTION DES COMPOSES VOLATILS DES RAISINS NOIRS AU COURS DE LEUR MATURATION ET SURMATURATION PAR GCXGC-TOFMS

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Mots clés : Arômes, GCxGC-TOFMS, Surmaturation, Raisin

Les arômes retrouvés dans les vins jeunes issus des appellations de la région de Bordeaux évoquent un mélange complexe d'odeurs évoquant les fruits rouges frais tels que le cassis, la mûre, ou encore la fraise. L'expression aromatique de ces vins est intimement liée à l'état de maturité des raisins.

Les modifications climatiques au cours de cette dernière décennie, sont un des facteurs à l'origine du changement des conditions de maturation des raisins. Au cours de la maturation le caractère végétal du raisin s'estompe puis disparaît lorsque celui-ci atteint sa maturité pour ensuite laisser place à des nuances de fruits cuits lorsque les raisins sont récoltés plus tardivement en état de surmaturation. En effet, à la faveur d'étés chauds et secs, il est empiriquement admis que les phénomènes de surmaturation des baies entraînent le développement de ces nuances caractéristiques retrouvées à la fois dans les moûts et les vins jeunes, et le plus souvent ceux élaborés à partir de raisins de Merlot.

Pour étudier l'évolution des composés volatils des raisins noirs au cours de leurs maturations et surmaturations, nous avons choisi d'utiliser la technique de GC-compréhensive couplée à un détecteur de masse de type TOF. Nous avons réalisé des extraits (liquide-liquide) de moûts issus de raisins récoltés à différents stades de leur maturation (de la maturation optimale à la surmaturation poussée) et les vins issus de leurs vinifications. Ces échantillons ont ensuite été analysés par GCxGC-TOFMS.

Les premiers résultats montrent que les profils chromatographiques des moûts obtenus par GCxGC-TOFMS sont spécifiques de chaque stade de maturation. A partir du choix judicieux du jeu de colonne, nous montrons que cette technique permet de « cartographier » l'état de maturation des raisins selon la distribution des composés volatils mais aussi d'identifier de nouveaux marqueurs moléculaires caractéristiques de l'état de surmaturation des raisins.

Relationship between the non-volatile composition and the in-mouth quality in red wines

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Keywords: quality, sensory properties, non-volatiles, sensory

1. INTRODUCTION

Understanding the factors that drive wine quality perception of experts is important as wine experts' influence consumers' final buying decisions [1,2]. Wine experts have been shown to have aligned quality concepts [3] which can be Quality [4, 5] correlated to aroma, taste and in-mouth sensory profiles obtained from trained panels. In this context, external preference mapping technic that has been used successively over the last two decade to describe the characteristics that contribute to the liking of consumers seems to be a promising tool to better understand the sensory drivers of quality [6]. The aim of the present work is to evaluate to potential of this tool to better understand experts' quality judgements. We first seek to establish the relationships between in-mouth sensory attributes and non-volatile composition of wines and then we use, quality mapping strategies to relate non-volatile chemical composition of red wines to experts' quality judgments.

2. MATERIALS AND METHODS

2.1 Wines

Sixteen Spanish red wines from different wine making areas, varieties, vintage and with different aging periods in both bottles and oak barrels were selected. A wide range of non-volatile chemical composition expected to induce different sensory properties and thus different quality perception are therefore expected.

2.2. Conventional analysis and analysis of polyphenols

The analyses of conventional parameters were determined by Infrared Spectrometry with Fourier Transformation (IRFT) with a WineScan™ FT 120 (FOSS®, Barcelona). UPLC analyses were performed using a Waters Acquity Ultra Performance LC system (Milford, MA, USA) by direct injection of wine samples.

2.2. Descriptive analysis by a trained panel

Fifty-two panelists were recruited to participate in the study during approximately 9 months. Trained panelists described wines following the procedure described in Sáenz-Navajas et al. [5]. They were asked to rate sweetness, acidity, bitterness, astringency, overall intensity and persistence of samples using structured scales as described in [5, 7].

2.3. Quality evaluation by experts

The panel of experts was composed of 21 established winemakers from DOCa Rioja (Spain). Each participant completed one session in individual booths. Experts evaluated the in-mouth wine quality of the 16 samples. They were asked to wear nose clips to avoid aroma interaction.

3. RESULTS AND DISCUSSION

3.1 Sensory activity

Results show that sour taste presents exponential relationships with tartaric ($R^2 = 0.36$; $P < 0.05$) and succinic ($R^2 = 0.35$ $P < 0.01$) acids. The present results demonstrate that the predictions are considerably improved by considering a quadratic rather than a linear trend as was recently suggested for volatile composition and aroma perception [8].

There are 15 bitter compounds analyzed that are not likely to contribute to bitterness in the studied set of wines since their content is well below their sensory threshold. Interestingly, both succinic acid ($R^2 = 0.62$; $P < 0.01$) and to a lesser extent the alcohol content ($R^2 = 0.55$;

$P < 0.01$) present exponential and linear relationships, respectively, with the perceived bitter taste.

As regards to astringency, a significant positive linear trend ($R^2 = 0.78$; $P < 0.001$) is observed between the total polyphenol index (TPI) and the astringency scores. Among this, total polyphenolic composition both protein-precipitable proanthocyanidins (PAs) ($R^2 = 0.62$; $P < 0.01$) and polymeric PAs (higher than trimmers) ($R^2 = 0.47$; $P < 0.05$) present exponential trends with astringency. Procyanidins B1 ($R^2 = 0.63$; $P < 0.01$) and B3 ($R^2 = 0.60$; $P < 0.01$) show a positive correlation with astringency. Among phenolic acids present at concentrations above their sensory threshold, a systematic relationship with astringency was not found, contrary to that observed for the organic acid, *t*-aconitic acid, which presents an exponential trend ($R^2 = 0.35$; $P < 0.05$) with astringency sensation evaluated by the trained panel.

3.2. Quality assessment by experts

A cluster analysis calculated on the 21 experts' scores has yielded three main clusters. The fact that expert quality judgments based on exclusively in-mouth properties derives in three main clusters demonstrates the heterogeneity among experts in the in-mouth quality construct. Previous research has shown that for experts in-mouth properties seem to be less relevant than aroma stimuli, when evaluating wine quality [4]. This could have led to develop dissimilar criteria when evaluating exclusively in-mouth sensations.

3.3. Correlation between chemical and quality variables: External quality mapping

A total of 22 chemical variables have been demonstrated to have a potential sensory impact in the studied set of wines and thus were submitted to a PCA. The quality scores of the three clusters were regressed onto the six PCs obtained from the PCA. Results show that quality evaluated by experts belonging to cluster 1 (33% of the panel) is adjusted to a vector model. This means that the chemical variables correlated with this vector have to be maximized for achieving high quality wines. The correlation matrix shows a significant and negative correlation between cluster 1 and PC5 ($R^2 = -0.60$). Hence, high contents in protein-precipitable PAs and *c*-aconitic acid result in high quality scores. Both compounds have been reported to be important drivers of astringency in wines [9]. Thus, this result is well in accordance with previous work carried out with Spanish [5] and Australian [4] experts showing that sensory astringency of wines is positively correlated with quality perception. The group of experts that constitute both cluster 2 (33% of the panel) and cluster 3 (34%) are significantly fitted by the elliptical model ($P < 0.05$) with an anti-ideal (-) and ideal (+) quality point, respectively. Thus, experts belonging to cluster 2 have an anti-ideal point on high negative values for PC1. This anti-ideal quality wine is found near the wine AY_C and is characterized by a higher concentration in reducing sugars, alcohol content, titratable acidity and gallic acid ethyl ester, while low in pH-values, *t*-aconitic, coumaric and lactic acids. Besides, the anti-ideal point is on the origin of the map for PC2 and PC3. This means

that the anti-ideal quality wine would have average concentrations in volatile acidity, glycerol, polymeric PAs, malic acid, IPTs, caftaric acid and quercetin-3-*O*-galactoside. For cluster 3 an ideal point is found near the wines SO_C and CT_B. Interestingly, both wines are among the most aged wines (vintage 2007). Both wines have in common that they present higher than the average content in reducing sugars and titratable acidity. On the contrary, these quality wines have lower than the average values for: alcohol content, pH, lactic acid, IPTs, polymeric PAs, procyanidin B1, coumaric acid and quercetin-3-*O*-galactoside.

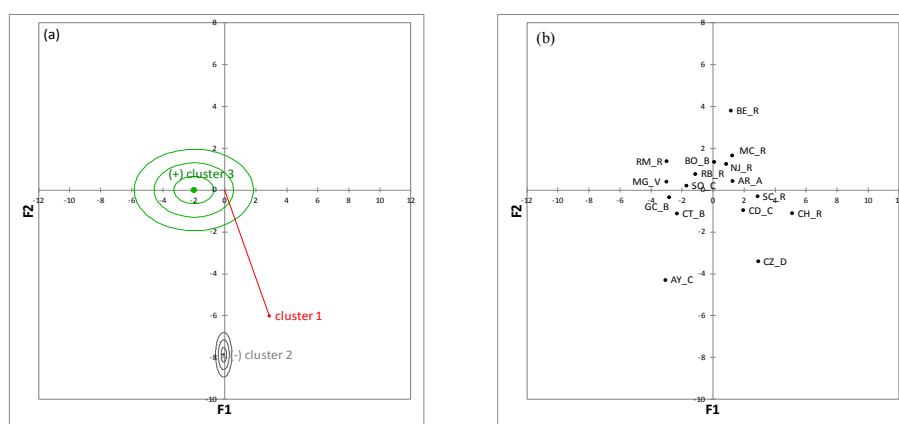


Figure 1. Projection of the three clusters on the external quality mapping on (a) factors 1 and 2. The vector of cluster 1 indicates a vector model. The plot of (-) and (+) show the location of the ideal and anti-ideal quality point for clusters 2 and 3, respectively. (b) Projection of the 16 wine samples on the external quality mapping on factors 1 and 2.

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EVALUATION OF THE CORRELATION BETWEEN THE CHEMICAL AND SENSORY COMPOUNDS IN RED WINES

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Key words: Polyphenols, organoleptic attribute, Cabernet franc, Blaufrankisch

The positive physiological effects of the bioactive compounds of red wines have been known for a long time. Besides that, the polyphenolic compounds of red wines represent one of the most important factors for oenology. With a special chemical analysis, we discover the relationship between the chemical and sensory compounds. This way, we explore which compounds influence sensory properties. The phenolic compounds are the quality attributes of the wine. They contribute to the forming of colour, clarity and the elaboration of the organoleptic properties, such as aroma and bitterness [1].

The aim of this study was to analyze the chemical and organoleptic characteristics of Cabernet franc (CF) and Blaufrankisch (BF) wines and to evaluate the connection between the two parameters in a cool climate wine district (Eger, Hungary) in the vintage of 2008. In addition, we also examined the influence of the polyphenolic content on sensory perception. We measured the wines in two states: first as a new wine (NW), and a year later, as an ageing wine (AW). Total phenolic compounds (TP), anthocyanins (A), leucoanthocyanins (LA), catechins (C), colour intensity (CI), the shade (S), were determined by spectrophotometer. Resveratrol concentrations (R), were identified and quantified by HPLC. The organoleptic analysis of the wines was carried out by a five-man expert jury, using a hundred point evaluation system. Within cultivars, the LA and C values, which impact the astringency and bitterness flavours, showed a growing trend in CF wines, as a result of ageing. These values were in good correlation with the profil analysis results. The variety effect doesn't apply. During ageing the R values became higher in both varieties. As an effect of ageing, the CI values decreased, while the S results increased. In AW wines in both varieties the anthocyanin concentration decreased, which caused policondensation. The results of the organoleptic analysis are in correlation with the chemical data.

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L'AROME VARIETAL DES VINS DE SAUVIGNON BLANC : IMPACT DES S-CONJUGUES SUR LA LIBERATION DES THIOLS VOLATILS

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Mots clés : thiols volatils, Sauvignon blanc, précurseurs d'arômes

Le 3-sulfanylhéxan-1-ol (3SH), composé clé de la typicité aromatique des vins de Sauvignon blanc, est libéré au cours de la fermentation alcoolique sous l'action de *Saccharomyces cerevisiae* et est retrouvé dans les moûts sous formes de S-conjugués (S-conjugué à la cystéine [1], et S-conjugué au glutathion [2]). Ces composés présentent un pourcentage de transformation en thiols volatils relativement faible.

Depuis quelques années, l'impact de ces composés sur la libération de 3SH est controversé. En effet, il semblerait que ces composés précurseurs ne contribuent pas de façon majoritaire à la libération des thiols [3,4]. Ainsi d'autres formes précurseurs seraient à ce jour encore inconnues. Ceci pourrait expliquer que la libération de 3SH ne soit pas directement corrélée à ces composés [5].

Il est donc nécessaire de mieux comprendre les déterminants moléculaires et les mécanismes impliqués dans la libération des thiols volatils dans les vins. Dans ce travail, nous démontrons grâce différentes techniques de fractionnement (chromatographie Flash et chromatographie de partage centrifuge), que d'une part l'origine des précurseurs peut fortement influencer leur biotransformation en thiols volatils au cours de la fermentation et d'autre part que d'autres composés pourraient participer à cette libération.

D'un point de vue technologique, l'identification de l'ensemble des composés précurseurs d'arômes pourrait alors permettre de quantifier le potentiel aromatique complet des raisins et ainsi d'optimiser certaines pratiques vitivinicoles.

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SENSORY IMPACT OF TWO VOLATILE THIOLS ON THE FRUITY CHARACTER OF GAMAY WINES

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Key words: Gamay, volatile thiols, blackcurrant, sensory analysis

Fruity aroma is one of the most valuable sensory characteristics of wine. In the case of Gamay from Beaujolais esters and acetates are mostly responsible of the fruity aroma . However thiols have recently been pointed out as important contributors to the fruity aroma of red wine in particular the blackcurrant note. The aim of the present study is to explore the sensory impact of two volatile thiols (3MH and ac3MH) on the fruity character of Gamay wines, in particular on the intensity of the blackcurrant note. All the samples belonged to the Beaujolais Nouveau appellation.

Shortly after the bottling, a pre-test consisting on a sensory profile was conducted on 25 Beaujolais Nouveau wines by 15 wine experts in transparent ISO glasses. Ten samples were then selected: the five wines presenting the most intense blackcurrant odor and the five presenting the lowest intensity of this attribute. The two thiols and isoamyl acetate (IAA) were quantified in the ten wines. As an external validation of the sensory impact of the thiols, a free sorting task followed by a description of the groups was carried out by a second panel of 28 enology students.

The averages of blackcurrant intensities given by the expert panel were significantly correlated to ac3MH but not to 3MH. As expected, isoamyl acetate was significantly correlated to the intensity of the amylic note. The first dimension of the MDS resulting from the sorting task carried out by the enology students was significantly correlated to wine experts' blackcurrant scores and to the ac3MH concentrations, which confirms the result obtained by wine experts. Moreover students' description also confirmed the link between ac3MH and thiol-related fruity aromas as blackcurrant and passion fruit. However as the correlation between blackcurrant and ac3MH is basically due to three of the samples, further studies are needed in order to validate this result.

Moreover, other thiols like 4MMP should be studied as possible contributors to the blackcurrant note in Beaujolais nouveau wines.

IMPACT OF A BIOGENE AMINE, AGMATINE, ON THE WOODY FLAVOUR PERCEPTION IN WINE

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Keywords: agmatine, vanillin, Schiff-base compounds, woody flavor

In wine biogenic amines are mainly produced by lactic acid bacteria through amino acids decarboxylation. Hence, one of the most present amino acid, arginine could be transformed into agmatine. A specific strain of *Oenococcus oeni* has been shown to produce in wine synthetic solution up to 120 mg.L⁻¹ of agmatine even if smaller values were detected in wine [1]. A recent study indicated that more than 50 % of consumers from a trained panel perceived a defect in wines containing amines compounds [2]. It is also well-known that red wine presents highest values of amines compared to white wine due to the malolactic fermentation [3]. Our study focus in the olfactive perception of agmatine spiked Chardonnay and Pinot Noir wines. This approach was combined to a chemical interpretation of interaction occurring between agmatine and vanillin, a well-known compound associated to woody flavor.

No difference was observed in the woody flavor perception of agmatine in red wine up to 120 mg.L⁻¹. Results were different in white wine, where an agmatine supplemented wine present a decrease in the woody flavor perception. Interestingly, this perception seems to be agmatine concentration dependant. Hence, we look for specific interactions between these two compounds by molecular spectroscopy (NMR, fluorescence). It was found that a Schiff base di-, tri- or tetramer formed between both compounds, emitting at 400 nm for an excitation set at 270 nm, was possible in our conditions.

By increasing the concentrations of agmatine, the emitting wavelength of the formed imine shifts down to 10 nm towards lower wavelengths. This traduces the lowest degree of condensation of the formation product, that could be associated to steric restriction. The presence of mannoproteins at the concentration of 100 mg.L⁻¹ in solution also stabilizes the dimer, even when agmatine is present at very low concentration. This implies that such imine compound should be stabilized by electrostatic interactions and could be the major form encountered in red wine where no sensorial difference was observed.

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Topic of the conference: Sensory related active compounds
Preference: oral (otherwise poster)

SCREENING FOR FLAVOUR DIVERSIFICATION DURING FERMENTATION WITH NON-CONVENTIONAL YEAST STRAINS AND MIXED CULTURES

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Key words: Micro-screening platform, flavour analytics, yeast, LAB, wine, beer, cheese, bread

High-throughput screening offers the opportunity for more rapid innovation in terms of selecting of strains, cultures or ingredients with novel functionalities. However, the predictive value of high-throughput screening is highly influenced by the environment under which the screening is carried out. Therefore a range of realistic screening models were developed to improve the predictive value of high-throughput screening for cheese [1], yogurt, beer[2], wine[3], bread [4] fermentation, a true Micro-Dinner.

In wine, the organoleptic properties such as mouthfeel, appearance, bouquet, aroma, and taste are determined significantly by hundreds of metabolites produced during fermentation. Next to flavour masking and enhancing strategies, the balance of flavours produced during alcoholic and malolactic fermentation can be controlled and influenced by the selection of the right starter strains (yeasts and lactic acid bacteria (LAB)).

Besides the development of the microvinification and flavour analytics (methodology comparison [5]), examples of the non-conventional yeast and LAB screening are given, displaying aroma characteristics in both pure and mixed cultures.

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THE MINERALITY OF WINE: WHICH STATUS FOR THE LEXEME IN WHICH SITUATIONS?

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Mis en forme : Police : (Par défaut)
Times New Roman, 10 pt,
Expositant

Key words: minerality, perception, discourse, semantics

Mis en forme : Police : (Par défaut)
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This paper aims at discussing the meaning, the relevance, and the status of the lexeme *minerality* in consumers' and wine professionals' discourses within the French-speaking world. It takes as a starting point the obvious role played by such a lexeme in wine tasting notes, in prescriptive texts, and in the marketing sector. Following previous studies [1]-[2] that have shown the instability of the notion for many speakers — including wine professionals— the discussion will focus on the status of this so-called term for each target group.

The study is based on the analysis of two sub-corpora collected through a questionnaire addressed on the one hand to consumers and on the other hand to experts working in the wine sector. The questionnaire was intended to generate metalinguistic data especially in terms of definition elements and of synonyms without any extralinguistic input (*i.e.* not in a wine tasting situation). The data are made of 50.253 words for the consumer corpus and 84.550 words for the expert one, distributed over all French regions and the French-speaking part of Switzerland. The study combines automatic text mining with lexical semantics approaches.

The analysis discusses the common definition strings, the way they are interrelated and the special role of exemplification in those two discourse spheres. It focuses on the status of the lexeme for the concerned speakers in order to produce a semantic map of the notion for further sensory and wine components analyses.

- (i) Consumers seem much more aware of the instability of the meaning of the lexeme when applied to wine as well as of the lack of specialized definition. Furthermore, some of them challenge the relevance of such a common word for a specialized notion.
- (ii) Experts seem to consider it as a term like any other wine descriptor, even if it lack any consensual definition. Professionals also don't seem to pay much attention to the induced semantic transfer from the common meaning of the adjective to the so-called term.

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SENSORY ATTRIBUTES OF RIOJA RED WINES AND THEIR RELATIONSHIP WITH QUALITY PERCEPTION OF CONSUMERS

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Key words: wine, clustering, sensory analysis, preference mapping

A complex problem in food product is to identify what are the parameters driving consumers' liking. The main goal of this study was to apply the technique classically used to understand consumer preference, internal preference mapping to the quality assessment of twenty-nine red wine by eighty-five regular consumers. The wines were subjected to a sensory descriptive analysis by trained panelist and to a categorization task by consumers' preference. Quality assessment was performed by means of a categorization task which was subsequently correlated to the aromatic wine sensory space obtained.

The PCA carried out on the wine*consumers matrix showed a wide dispersion in quality perception among consumers. The HCA indicates the presence of three well defined groups of consumers (QC1, QC2 and QC3) Pearson correlation coefficients show no significant correlations between the three groups of consumers indicating a quality concept different between them.

The concept of quality of the three groups of consumers when they evaluate wines aged in oak barrels is directly related to the presence of "toasted/wood" and the absence of the veggie/animal attributes. It is noteworthy that only the consumers QC2 considered positive the concept of fruity and floral aromas as quality in a wine barrel aged. Mouthfeel attributes described for these wines were considered in a different way for the quality assessment carried out by the three consumer groups.

RELATIONSHIP BETWEEN FOAMING PROPERTIES AND CHEMICAL COMPOSITION OF SPARKLING WINES

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Key words: sparkling wines; foaming properties; chemical composition

Sparkling wines elaborated following the champenoise method undergo a second fermentation in closed bottles of base wines, followed by aging of wines with lees for at least 9 months. The foam of sparkling wines is a key parameter of their quality. However, the compounds that are directly involved in foam quality are not yet completely established. Various studies have attempted to correlate specific family of compounds in sparkling wines with the quality of their foam properties. However, in complex mixtures such as sparkling wines, foaming behavior results from the balance of the different families of molecules. It would be necessary to evaluate the influence of the global sparkling wine chemical composition in the foam properties. Therefore, the aim of this work was to correlate the foaming properties with the chemical composition in different sparkling wines elaborated during three consecutive vintages.

Foaming properties were analysed by Mosalux method [1]. Monomeric phenols, proanthocyanidins amino acids and biogenic amines were analysed by HPLC-DAD [2-5]. Monosaccharides forming polysaccharide families were analysed by GC-MS [6].

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GLYCOCONJUGATES OF VOLATILE PHENOLS AND SMOKE RELATED OFF-FLAVOURS IN WINE

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Key words: smoke taint, volatile phenols, glycosides, grape metabolites

Glycosidically-bound volatile compounds are abundant in grapes and are important flavour precursors. Research conducted on smoke affected grapes and wine showed that volatile phenols from smoke are readily converted into glycoconjugates in grapes. These glycosides form a significant pool of smoke-related non-volatiles and we have recently demonstrated their potential as (a) biomarkers for detecting smoke exposure post-event and (b) role as flavour precursors: smoke taint in wine is caused by the presence of free volatile phenols and their glycoconjugates, and can be enhanced by gradual hydrolysis of the glycosides during winemaking, ageing and also tasting of wine.

In this presentation we summarise the metabolite profiling experiments that led to the identification of a broad range of phenolic glycosides [1, 2], discuss their contribution to smoke taint in wine [3], and outline analytical approaches for detecting smoke exposure in grapes and minimising the risk for wine to develop smoke taint [4].

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EXEMPLARITY JUDGEMENT: ESTIMATION OF THE LEVEL OF INTERJUDGE AGREEMENT FOR TWO CATEGORIES OF RED WINES

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Key words: exemplarity, typicality, interjudge agreement, Protected Designation of Origin

Evaluating the exemplarity of wines constitutes a holistic approach to supplement their description or sensory profile. Two families of French red wines are studied: Burgundy Pinot noir and Loire Valley Cabernet franc. For each family, short-listing criteria are used to collate 40 starting-price and middle-range wines differing a priori in olfactory terms. The judges are local wine professionals, respectively from Burgundy and the Loire Valley. They assess the wines first orthonasally and then, independently, by global evaluation. We concentrate here on the degree of interjudge agreement or disagreement as to the exemplarity of each of the two sets of wines. A pool of descriptive and inferential statistics (Principal Components Analysis, Kendall's coefficients of concordance, Analysis of variance, Intraclass Correlation Coefficients) indicates there is generally neither complete divergence nor real agreement among judges. Yet the two sets of wines give rise to two different situations. For Burgundy Pinot noir, the weak agreement observed and measured for orthonasal evaluation strengthens slightly for global evaluation. Contrariwise, for Loire Valley Cabernet franc wines, agreement is poorer for global evaluation than for nose-feel alone. With orthonasal evaluation, responses are more consistent for Cabernet franc than for Pinot noir, whereas for global evaluation, the levels of interjudge agreement are of the same order for both sets of wines. The subjectivity of sensory responses is interpreted for each situation. The personal judgment of exemplarity (or typicality) may therefore be defined as a demanding cognitive decision varying with the circumstances of the experiment and responding to a process of perceptual categorization based on previous knowledge and on an intuitive comparison between a sample and an abstract but conscious image of the category.

ETUDE DE LA COMPOSITION EN POLYSACCHARIDES ET OLIGOSACCHARIDES DU BOIS DE CHENE UTILISE EN TONNELLERIE

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Mots clés : Bois de chêne, polysaccharides, vin

Le bois de chêne est utilisé en tonnellerie pour ses propriétés mécaniques, sa porosité à l'air, favorisant les oxydations mais aussi pour ses composés extractibles.

Trois types de macromolécules sont présentes dans le bois de chêne : les ellagitannins qui apportent structure et astringence au vin, les lignines dont la dégradation par le brûlage du bois conduit à la formation de phénols volatils [1] ainsi que les polysaccharides (cellulose et hémicellulose) qui constituent la structure du bois. Des études ont montré l'importance de ce dernier type de composés provenant du raisin, des levures ou encore de *Botrytis* sur la qualité du vin, mais l'importance des polysaccharides du bois de chêne n'a, à ce jour, pas été mise en évidence [2].

L'étude s'est portée sur ces polysaccharides, susceptibles, via des hydrolyses et réactions chimiques de libérer des composés extractibles. Il s'agissait d'évaluer d'une part la teneur en saccharides extractibles par et au contact du vin ou d'une solution modèle, d'autre part la teneur en saccharides extraits. Ces derniers pouvant atteindre des teneurs allant de quelques mg/L à près de 500 mg/L dans les eaux-de-vie [3]. Il s'agit notamment de monosaccharides, principalement le glucose, le fructose, l'arabinose, le xylose et le mannose. Bien que les teneurs mesurées soient inférieures à leurs seuils de perceptions, des analyses sensorielles en solution modèle du vin (12% éthanol) ont mises en évidence l'impact de ce type de composés sur les perceptions gustatives, et ce, notamment sur les descripteurs astringence/amertume en bouche.

Ces composés ont été quantifiés grâce à une méthode HPLC couplée à un détecteur à indice réfractométrique suite à une extraction solide/liquide. Ces dosages ont concernés différents types de bois de chêne utilisés pour la fabrication de barriques et de produits dérivés (copeaux, staves, ...) en tonnellerie.

Ces résultats mettent en avant l'importance de la composition du bois de chêne en polysaccharides, pouvant être à l'origine de composés ayant un véritable intérêt sensoriel.

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LOSSES OF DISSOLVED CO₂ FROM CHAMPAGNE SERVED IN LASER-ETCHED INAO GLASSES

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Keywords : Champagne, carbon dioxide, tasting glass, effervescence, bubble nucleation

The concentration of dissolved CO₂ in champagne and sparkling wines is a parameter of importance since it directly influences bubbles' formation under standard tasting conditions, as well as the chemosensory excitation of nociceptors in the oral cavity (via the conversion of dissolved CO₂ to carbonic acid) [1].

Both losses of dissolved CO₂, and fluxes of gaseous CO₂ escaping from a Champagne wine served in laser-etched INAO glasses showing an increasing number of bubble nucleation sites, were examined, all along the first 10 minutes following pouring. Logically, the more intense the effervescence is into a glass, the more rapid its progressive loss of dissolved CO₂. Moreover, during the first minutes following pouring, the higher the number of laser beam's points of impact is in glasses, the higher the fluxes of gaseous CO₂ escaping from the champagne surface. Nevertheless, and quite counter intuitively, from approximately 3 min after pouring, the highest levels of gaseous CO₂ fluxes escaping champagne were not sustained from glasses with the highest number of bubble trains. This experimental observation was discussed on the basis of a theoretical bubbling model. It was finally demonstrated that the flux of gaseous CO₂ desorbing from the liquid phase is the result of a balance between the intensity of effervescence, and the dissolved CO₂ concentration found in champagne [2].

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CARACTERISATION AROMATIQUE DES VINS D'ALSACE DE RIESLING ET DE GEWURZTRAMINER

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Mots clés : analyse sensorielle, composés volatils aromatiques, riesling, gewurztraminer

Cette étude a pour objectif de mettre en relation les caractéristiques sensorielles des vins de Riesling et de Gewurztraminer avec leur composition en molécules d'arômes. La première étape consiste à réunir un jury de 12 personnes, à définir des descripteurs aromatiques représentatifs des deux cépages puis à entraîner le jury sur la reconnaissance de ces arômes à partir de préparations aromatiques du commerce. Parallèlement, 22 vins de l'AOC Alsace sont sélectionnés pour chacun des deux cépages. Les vins sont soumis à une analyse sensorielle par le jury entraîné sur les descripteurs sélectionnés ainsi que par un jury de professionnels non entraînés.

Les principaux composés aromatiques sont dosés : esters fermentaires, terpénols, thiols, C-13 norisoprénoides, diméthyl sulfure soit une vingtaine de molécules.

Les résultats de dégustation montrent une concordance des deux jurys pour le classement hédonique des vins mais seul le jury entraîné permet d'obtenir une description aromatique pertinente. Pour chaque cépage, le millésime intervient sur le profil aromatique des vins ainsi que sur les teneurs en composés volatils. Certains composés et famille de composés participent activement à l'expression aromatique des vins mais il n'est pas possible d'évaluer la qualité aromatique d'un vin donné sur la base des molécules analysées. Ainsi, l'un des meilleurs vins de gewurztraminer dégustés présente les teneurs les plus faibles pour la plupart des composés dosés.

Cette étude montre que les composés volatils dosés, en particulier les terpénols, tout en participant à leur expression aromatique ne suffisent pas à expliquer toute la complexité des vins d'Alsace de Riesling et de Gewurztraminer.

THE EVOCATIVE NOTION OF MINERALITY IN WINE: SENSORIAL REALITY OR SMART MARKETING?

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Key words: minerality; Sauvignon blanc; sensory; chemistry

Of the descriptors employed to characterise wine organoleptically, minerality is arguably the most enigmatic. Unlike wine descriptors such as “fruity” or “acidic”, sensorial characterisation of minerality is metaphorical, given that geologists have argued that we cannot literally be smelling or tasting minerals from the vineyard that have been transmitted through the vine and into the wine [1]. As well, percepts interpreted by tasters as “mineral” in character have ability to evoke via associative memory wider concepts including the powerful marketing tool of provenance or wine source-of-origin. The presentation will describe current research aimed at delineating the nature of perceived minerality in white wine, its sensorial reality for experienced wine professionals in France and New Zealand, and potential physico-chemical sources of perceived minerality. Data will be presented from sensory experiments conducted in Marlborough, New Zealand and in three regions of France, namely Bordeaux, Burgundy, and the Sancerre/Loire areas. The experiments involved sensory evaluation of 16 Sauvignon blanc wines (8 French; 8 New Zealand) by 63 wine professionals (31 New Zealanders and 32 French) under three conditions, bouquet only (ortho-nasal olfaction), palate only (Nose-clip condition), and full tasting (orthonasal olfaction, retronasal olfaction, taste, Trigeminal stimulation). The same wines were subjected to extensive physico-chemical analyses. Key results include (i) that minerality was perceived under all three modes of evaluation including via smell alone, (ii) that perceived mineral character associated significantly with other key wine descriptors, (iii) that there was substantial agreement conceptually between French and New Zealand participants in terms of the sensorial experience of minerality, and (iv) that several aspects of wine physico-chemical composition associated statistically with perception of mineral character in the wines. The results will be discussed in relation to potential sources of mineral character in wines including reductive phenomena and qualitative and quantitative aspects of wine acidity.

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Session : Sensorialité des molécules actives du vin et analyse des perceptions, acceptations, prescriptions et discours.

Présentation Orale

WINE “BOUQUET”: FROM SENSORY INVESTIGATION TO MOLECULAR ANALYSIS

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Keywords: Wine bouquet, sensory analysis, redox balance, roasted aroma compounds

One characteristic of fine wines is that their bouquet develops complexity during ageing. This is one of the most fascinating, but least known phenomena in oenology.

Our first investigation consisted of the sensory definition of the wine bouquet concept in the case of red Bordeaux wines. A panel of experienced wine tasters categorized 30 red wines (vintages from 1994 to 2005) according to their own concept of wine bouquet. Results highlighted the agreement between tasters and the most frequently cited descriptors were: truffle, licorice, mint, and toasted. These descriptors referred respectively to undergrowth, spicy, freshness, and empyreumatic notes.

The exact contribution of volatile compounds and their correlation with aromatic notes in the wine bouquet were explored from a chemical standpoint. It is well known that significant chemical changes in volatile composition occur during wine ageing. These reactions depend on the redox balance, which is strongly influenced by pH, temperature, and storage time. Our investigation focused on the formation of active odorous molecules, formed under reducing conditions and which make a positive contribution to the final wine bouquet.

Liquid-chromatography fractionation of the previous selected wines was performed. Analysis mainly focused on fractions with empyreumatic sensory notes, particularly roasted hazelnut flavor. The selected fractions were characterized by GC-MS. Specific attention was paid to heterocyclic compounds, such as thiazoles, pyrazines and furans, considered to be key "roasted" aroma compounds and formed through the Maillard reaction. Moreover, as their concentration increases during bottle ageing, the aromatic impact of weak sulfur compounds such as hydrogen sulfide and methanethiol was also considered.

Finally, the role of dimethyl sulfide as an enhancer of bottle aged bouquet was studied.

CLASSIFICATION DES VINS BIAIS D'EXPERIENCES ET CONTRADICTIONS THEORIQUES

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Mots clefs : agrégation ; classement ; dégustation ; notes hédoniques

La question de la classification des vins a donné lieu à une abondante littérature qui s'attache à (i) proposer des méthodes théoriques d'agrégation des préférences des évaluateurs et (ii) fournir des résultats empiriques d'évaluation en fonction d'un protocole de dégustation à l'aveugle. Les utilisations des résultats, notes et/ou classements, sont maintenant diffusés par des guides, des magazines, des blogs et des films diffusés sur internet et dans les réseaux sociaux. Cette médiatisation peut avoir des impacts économiques de grande ampleur sur les marchés. De fait, de plus en plus d'acheteurs et consommateurs, de producteurs, de financiers s'intéressent aux classements des vins, récents ou anciens, et les utilisent avant de décider pour les premiers de leurs stratégies économiques, financières, patrimoniales, pour les deuxièmes de leurs stratégies en matière de production, de management ou de développement sur le marché mondial, et pour les derniers dans leurs stratégies de la constitution de fonds d'investissement incluant le vin comme actif. De telles utilisations des résultats des dégustations suivies de classements révèlent l'intérêt de la crédibilité de la totalité des procédures retenues.

Nous montrons dans la présentation comment la mise en place de ces expérimentations ne tient généralement pas compte des biais élémentaires à éviter dans ce type d'analyse : biais liés au choix des vins, au choix des membres du jury, au protocole utilisé au cours de la dégustation, et enfin au choix de la méthode de traitement des données et des notes "hédoniques" fournies par les dégustateurs. Un tour d'horizon critique des méthodes d'agrégations utilisées est suivi d'une réflexion sur les incohérences présentes dans les procédures employées pour arriver à un classement. Une discussion de la philosophie et des principes anciens et récents appliqués par le Grand Jury Européen permet de mieux comprendre les conditions qui permettent de limiter les biais relevés ci-dessus.

ESTRATEGIES OF WINEMAKING IN CHARDONNAY TO IMPROVE SENSORY PROFILE

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Key Words: Chardonnay, sensory-analyses, mixed-culture-fermentation, cold-pre-fermentative-maceration.

Abstract:

In this work two winemaking strategies: mixed-culture-fermentation [1] and cold-pre-fermentative-maceration [2], have been evaluated to increase white wines quality, specifically its aromatic profile and terpenes content. These techniques were applied on Chardonnay grapes, during 2011 and 2012 harvest.

Chardonnay's wines showed different distribution for yeast's implantation percentages depending on the vintages. However, a similar trend for oenological parameters, organic acids and minor and major volatile compounds was found for mixed-culture-fermentation (MCF) wines versus control (CT) during both years. Main differences were reflected in sensorial analysis, being the MCF wines the best valued.

Regarding cold-pre-fermentative-maceration (CPFM) technique, 2011 vintage showed higher terpenes concentration versus CT and MCF wines. However this behavior was not observed in 2012.

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IMPLICATION OF VOLATILE THIOLS IN THE DEVELOPMENT OF BLACKCURRANT AROMA IN RED WINE.

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Mots clés: blackcurrant aroma, red wines, GC/MS, sensory analysis, varietal thiols

The accidental occurrence of strong blackcurrant aroma in certain wines has caused problems when consumers give particular care to the local flavor. Several studies reported that the red-berry aroma in red wines resulted from the additive and synergistic effects of compounds from a same chemical family such as ethyl esters or alkyl acetate [1,2,3,4]. But the direct impact of a particular volatile compound on the blackcurrant aroma development in wine could not be demonstrated. However, similar blackcurrant aroma was previously identified in white wine and attributed to the presence of thiol compounds which make them potential markers of the blackcurrant aroma in red wine.

Concentration of thiols such as 4-methyl mercaptopentanone (4MMP), 3 mercaptohexanol (3MH) and 3-mercaptohexyle acetate (3MHA) were quantified by GC/MS in ten wines that may have typical blackcurrant aroma using a well validated analytical method with standard isotopic dilution assay. Descriptive and quantitative sensory analyses of the blackcurrant aroma intensity were performed on the same wines by a trained panel. Data analyses by ANOVA revealed that 4MMP concentration was very well correlated to the blackcurrant aroma intensity and that 3MHA and 3MH present at high concentrations act as enhancers of the perception of this aroma. This correlation was further supported after performing a sensory comparison by classification test between a neutral wine and the same wine spiked with thiol compounds at different concentrations. To our knowledge, it is the first time that one compound is identified for playing a major role in the perception of blackcurrant aroma.

Wine making process conditions such as prolonged skin contact, high maceration temperature, and reductive conditions of wine conservation may explain the presence of thiols at very high concentration in certain red wine.

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PHENOLIC CHARACTERISTICS OF TANNINS MAINLY INVOLVED IN SALIVA PRECIPITATION AND RELATED TO ORAL ASTRINGENCY

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Key words: astringency, protein precipitation, commercial tannin, wine phenolics.

Astringency is an important sensory characteristic of food and beverages containing polyphenols. This mouthfeel is mainly due to the interactions of polyphenols with salivary proteins, causing complexes formation and their further precipitation, which leads to a reduction of the lubricating properties of saliva. As a consequence, sensations of dryness, hardness, and constriction are felt in the mouth. Therefore, protein precipitation is a phenomenon at the basis of the astringency sensation and it depends on the chemical features of wine phenolics.

In this work tannins of different origin such as grape (seeds and skins), wood and tannic acid were analysed by HPLC-MS in order to reveal their chemical composition. Tannins were dissolved in synthetic wine at a concentration of 1 g/L and were used for the binding reaction with human saliva (37°C; 5 min). After the interaction, supernatant was loaded on C18 cartridge and the eluted was analysed by HPLC. For each typology of tannin the phenolics mainly involved in the precipitation with human saliva were investigated, and the protein-bound phenolics quantified.

In the same way the reactivity of these tannins toward salivary proteins was analysed by the Saliva Precipitation Index (SPI). This method is based on the electrophoresis of human saliva after the binding reaction with tannin wine solutions, and the percentage of reduction of selected proteins after the interaction represents a way to chemically measure astringency. The SPI values, expressed as gallic acid equivalent, refer to the tannins capacity to confer astringency. Moreover, the SPI was performed to relate the phenolic characteristics with the astringency perception of tannin. In fact, the same tannin wine solutions were evaluated by sensory analysis for quantitative and qualitative astringency. The commercial tannins greatly differed not only for their composition and SPI but also for their perception in the subqualities of astringency.

REPRESENTATIONS DES VINS ROUGES DE BOURGOGNE CHEZ LES ACTEURS DE LA FILIERE : UN EFFET AMONT vs AVAL ?

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Mots clés : vins rouges, espace sensoriel, analyse conjointe, Bourgogne

Les différents segments de professionnels de la filière vitivinicole partagent-ils les mêmes représentations vis-à-vis des vins rouges de Bourgogne ? Telle est la question à laquelle nous avons souhaité répondre. Afin d'évaluer dans un premier temps le degré de convergence des réponses sensorielles, visuelles et olfacto-gustatives, deux familles d'acteurs de la filière bourguignonne ont été étudiées : celle des professionnels amont (viticulteurs, œnologues, techniciens) et celle des professionnels aval (restaurateurs, sommeliers, cavistes, commerciaux grande distribution). L'approche sensorielle convoquée ici reposait sur la mesure intrinsèque d'exemplarité. [1]

Pour ce faire, 40 vins rouges de Bourgogne d'entrée et de moyenne gamme, de cépage Pinot noir, du millésime 2010 illustrant la diversité de l'offre (appellations régionales et certaines communales, zones viticoles, type d'acteurs, prix, facteurs technologiques et humains,...) ont été présentés aux deux panels professionnels. Au total, 38 sujets ont été réunis : 20 professionnels amont et 18 professionnels aval. L'enjeu était double : (i) déterminer le degré d'accord ou de désaccord entre sujets, cela en fonction de la famille d'acteurs considérée, (ii) bipolariser les vins à l'issue des mesures d'exemplarité.

Les participants devaient également répondre à un questionnaire sur leurs pratiques et leurs représentations à l'égard des vins rouges de Bourgogne. Enfin, une analyse conjointe a été menée afin de déterminer les attributs extrinsèques (prix, nom de marque, appellation d'origine,...) les plus importants aux yeux des professionnels dans la discrimination et le positionnement commercial de tels vins.

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COMPLEXITY IN WINE

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Key words: complexity, blending, flavor, aroma, temporal perception

What makes a wine complex? And how do we recognize it? Complexity is a mark of quality in a wine and plays a role in people's comparative evaluation of different producers or vintages.. And yet, without knowing anything about the underlying chemistry, and often without being able perceptually to discriminate the component flavours of a wine, tasters are able to judge that one wine is more complex than another. How do they do it? What properties or qualities of a wine are they detecting when they judge a wine to be complex? Are judgements of complexity mostly olfactory judgements, or do we need contributions from taste and touch?

A challenge to our understanding of complexity is that many complex and satisfying wines have highly unified flavors, where the components are so well integrated that tasters cannot easily identify their constituent parts. The wine strikes us as having a single yet distinctive taste. Such harmonious combining of flavours is another mark of quality, but what signals to tasters that the wine they are drinking is complex? It requires more than balance since simple wines can be well balanced. It requires more than diversity of components. Blended wines are not necessarily more complex than single varietal wines.

To explain complexity we need to compare different explanations of complexity from complex relations between volatile compounds, to configurations of sapid, odorous and tactile stimuli, to ease of perceptual processing and the dynamic time course of tasting. We shall consider whether there must be perceptual contrasts between competing elements and if so, why we experience the flavours of wines as both complex and unified.

MISE EN EVIDENCE D'UN « ACCORD AROMATIQUE » IMPLIQUANT DES COMPOSES CLES DE L'AROME DES VINS LIQUEUREUX DE POURRITURE NOBLE

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Mots clés : accord aromatique, arôme, vins, pourriture noble.

Dans de travaux récents, un espace sensoriel caractéristique des vins liquoreux de pourriture noble a été mis en évidence [1] et des composés volatils appartenant à diverses familles chimiques (thiols, lactones, aldéhydes) ont pu être identifiés et corrélés avec le niveau de la typicité aromatique des vins.

L'objectif de ce travail est de progresser dans la connaissance des composés impliqués dans les notes d'« agrumes confits », typiques des vins liquoreux de pourriture noble. Ces travaux sont conduits grâce à des approches analytiques (identification de composés volatils par couplage chromatographie en phase gazeuse (GC) couplée à la spectrométrie de masse) et sensorielles (analyse par GC-olfactométrie, tests d'omission, de catégorisation et reconstitution aromatique) [2,3]. Ils visent à caractériser de nouveaux marqueurs de l'arôme des vins de pourriture noble. Compte tenu de la complexité de la construction des images sensorielles, l'accent a été mis sur l'étude des phénomènes d'interactions perceptives (phénomènes d'antagonisme, de synergie voire d'élaboration de nouveaux accords). La reconstitution aromatique a représenté, en particulier, une voie importante de recherche pour progresser dans la compréhension des phénomènes impliqués dans la construction de ces odeurs complexes. La contribution sensorielle de ces composés en mélange, en particulier une lactone nouvellement identifiée associée à la pourriture noble des raisins, a été menée dans le cadre d'expériences de reconstitution. Conduits à partir de fractions isolées du vin et supplémentées en composés volatils ou en solution synthétique, ces travaux conduisent à la mise en évidence d'un phénomène d'accord aromatique.

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CHARACTERIZATION OF SOME WINE DEFECTS MASKING EFFECTS

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Key words: wine defects, odor masking, psychophysiological test, perceptive interactions.

To date, most of the sensory studies about off-flavors focus on their detection or rejection thresholds. Supra-threshold as well as sub-threshold off-flavor components in odorous mixtures could change their perceptions [1] [2] [3].

In this context, the aim of the present study was to determine the impact of two wine defects, on the fruity note, namely “Bretty” character (ethylphenols) and cork taint (2,4,6-trichloroanisole) presented below and above threshold concentrations. The fruity aroma was modeled by ethyl heptanoate (EH - pineapple note) presented at a supra-limiar concentration. This study included sensory (triangular tests), psychophysical (detection threshold measurements, intensity and hedonic perception tests) and chemical (GC-MS) measurements.

The results showed that the infra- and supra-limiar off-flavors could interfere with the perception of the EH notes. Actually, the tests showed that a sub-threshold concentration of ethylphenols or 2,4,6-trichloroanisole decreases significantly the general perceived intensity of the mixtures and the ability to discriminate the variation of fruity note intensity.

At supra-limiar concentration of the two defects, asymmetric odor suppression was observed: both tested odorants had a masking effect on the fruity note.

The origin was not chemical (i.e. chemical interactions in the mixture). Complementary experiments examine whether these interactions have a peripheral or a central neurophysiological origin.

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Quantification and Kinetic of Evolution of Polymeric Pigment during Wine Aging

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Keywords: Red wine, phloroglucinolysis, pigments, tannins

Anthocyanins and condensed tannins are two important classes of polyphenolic compounds in wine. During wine aging, both anthocyanins and condensed tannins undergo chemical changes leading to the formation of polymeric pigments which modify wine color from purple-violet for young red wine to brick-orange in aged red wine. Generally, the high anthocyanin content is considered to be responsible for the color of young red wines, while the colors of older red wines are thought to be due to polymeric pigments which exhibit bathochromic or hypsochromic effect resulting in color modulation. Studies have showed that the anthocyanin content of wines decreases to very low level during aging and the aging process involves a slow, continuous interaction between anthocyanins and reactive tannin which transform pigments from the monomeric to a polymeric form [1]. Pigment deriving from their reaction between anthocyanins and monomeric or dimeric flavanol has been extensively studied in red wine as well as in wine model solution [2].

However, kinetic of formation and evolution of polymeric pigment resulting from the reaction between anthocyanins and polymeric tannins are poorly known during aging. Thus, to clarify the formation of these polymeric pigments, the acid catalyst depolymerisation (phloroglucinolysis) was carried out on wine fractions which results in the liberation of monomeric anthocyanins as well as the malvidin-3-*O*-glucoside-(epi)catechin adducts, both of which were detected and quantified by HPLC-UV-MS. Besides, a phloroglucinol adduct of the mentioned flavanol/anthocyanin dimer was also detected. Identification of the malvidin-3-*O*-glucoside-(epi)catechin adducts as flavanol-anthocyanin (F-A⁺) or anthocyanin-flavanol (A⁺-F) adduct has been realized by comparison with hemisynthesized model compounds. These polymeric pigments have been quantified on several red wines from the same winery of different vintages which results in characteristic kinetic pattern and composition according to the wine age.

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