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 beQuality [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 sems to be a promising tool to better understand the sensoty 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 therfore 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 WineScanTM 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 an 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 proantocyanidins (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, coutaric 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, coutaric acid and quercetin-3-*O*-galacatoside.

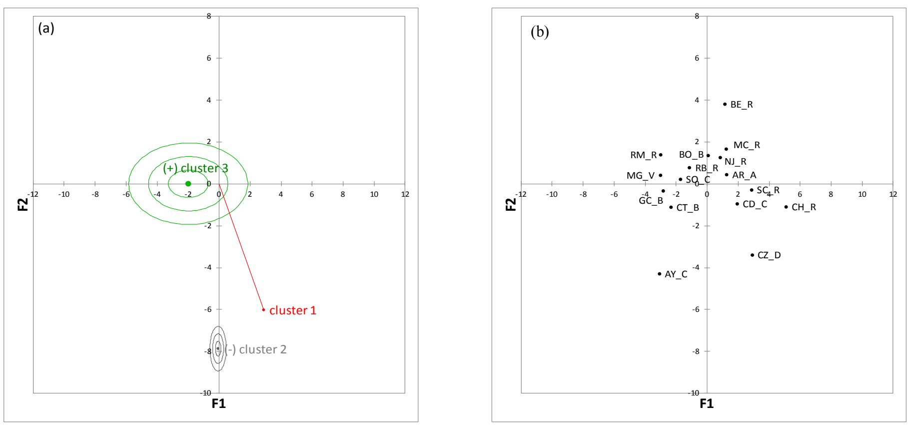

Figure 1. Projection of the three clusters on the external quality mapping on (a) factors 1 and 2. The vector of cluster 1 indicates a vector model. The plot of (-) and (+) show the location of the ideal and anti-ideal quality point for clusters 2 and 3, respectively. (b) Projection of the 16 wine samples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

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