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Sensory drivers of intrinsic quality of red wines. Effect of culture and level of expertise

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Abstract

The present study aims at evaluating the effect of culture and level of expertise on the perception of wine intrinsic quality. Therefore, regular consumers (108) and experts (119) from La Rioja (RJ-Spain) and Côtes du Rhône (CdR-France) evaluated the intrinsic quality of 12 red wines from both regions. Participants had to categorise the wines according to four levels of quality going from very low to very high quality.

Results show no significant correlation between the quality scores given by experts and regular consumers whereas judgments given by French and Spanish experts are significantly correlated as are consumers’ quality judgments. This demonstrates that perceived intrinsic quality is dependent on consumers’ level of expertise. Consumers associate quality exemplars to woody-related aromas and experts to red fruity aromas. Animal and vegetal attributes are negatively correlated to wine quality, regardless consumer’s culture and level of expertise, while astringency negatively influences quality evaluated by Spanish consumers.

It is also observed that Spanish consumers (who report to drink mostly RJ wines) find domestic wines (RJ) of higher quality than foreign wines (CdR). However, French consumers (who drink RJ and CdR with the same frequency) do not differentiate foreign and domestic wines in terms of intrinsic quality. This suggests that intrinsic quality perceived by both groups of regular wine consumers is related to consumers’ exposure to wine, and thus to wine familiarity.

Keywords: wine; quality; cross-cultural; expertise
1. Introduction

Wine quality perception has aroused special interest in the last years as it seems to be an important factor involved in the decision-making process developed at the purchase stage (Marin & Durham, 2007; Marin, Jorgensen, Kennedy, & Ferrier, 2007). The concept of quality has been demonstrated to be the combination of product-related (sensory properties, origin, vintage...) and consumer-related (level of involvement, country of origin, expectation...) factors (Charters & Pettigrew, 2007; Prescott, Young, O’Neill, Yau, & Stevens, 2002).

1.1. Product-related factors

Product-related factors have been classified into two main categories: intrinsic and extrinsic cues (Charters & Pettigrew, 2007; Jover, Montes, & Fuentes, 2004). Intrinsic cues refer to sensory properties of the wine itself. Extrinsic cues refer to properties which are not physically part of the wine such as region, year, label structure, winemaker, etc. While consumers rely on both types of cues when selecting a wine (D’Alessandro & Pecotich, 2013; Mueller, Osidacz, Francis, & Lockshin, 2010), past research has focused mostly on understanding the impact of extrinsic cues on quality perception. Among them, bottle weight, bottling place, type of wine or appellation, back label information, label design or the presence/absence of awards have come forth as important factors influencing consumers’ quality perception (Piquerás-Fiszman & Spence, 2012; Sáenz-Navajas, Campo, Sutan, Ballester, & Valentin, 2013). However, much less is known about the intrinsic quality cues. To this concern, intrinsic quality assessments carried out by experts (Lathey, Bramley, & Francis, 2010; Machado, Graça, Hirson, & Heymann, 2011; Sáenz-Navajas, Fernandez-Zurbano, Martin-Lopez, & Ferreira, 2011; Sáenz-Navajas, González-Hernández, Campo, Fernandez-Zurbano, & Ferreira, 2012) or highly-involved wine consumers (Varela & Gambaro, 2006) have been correlated to aroma, taste and in-mouth sensory profiles obtained from trained panels. Results emerging from these studies coincide in positively correlating fruity (berry or dried fruit depending on the type of wine) and woody aromas as well as astringency to the quality scores given by experts (or high involved wine consumers) whereas they differ in the negative drivers of quality. This divergence on intrinsic drivers of quality could be
due to the association of different quality concepts to different grape varieties, winemaking processes or to participants with different culture or level of expertise.

1.2. Consumers-related factors: culture and level of expertise

Consumer-related factors have also been shown to be important drivers of quality perception. These factors are indirectly related to the product itself but relate to consumers’ “drinking histories” (Melo, Delahunty, & Cox, 2011), gender or age (Bruwer, Saliba, & Miller, 2011) and are determinant in the cognitive construction of consumer’s quality concepts (Parr, 2000). For example, many studies in the food domain report the importance of consumer culture on the evaluation of food products such as salad dressings (L. Chung et al., 2012), soy products (L. Chung & Chung, 2007; Tu, Valentin, Husson, & Daclanmont, 2010), jellies (Blancher, Le, Sieffermann, & Chollet, 2008), apples (Jaeger, 2000; Jaeger, Andani, Wakeling, & MacFie, 1998) or ham (Fischer et al., 2005a). Studies exploring cultural effects have been mainly focused on comparing: (1) chemosensory perception of flavours (Prescott et al., 1998; Yoo, Saliba, Prenzler, & Ryan, 2012), (2) hedonic ratings (L. Chung et al., 2012; S. J. Chung, McDaniel, & Lundahl, 2010) or (3) food profiling (Antmann et al., 2011a, 2011b) between different cultures. The consumer’s familiarity with the product was shown to be the most prominent factor explaining flavour perception or product liking level between different cultures (Fischer et al., 2005a; Laing et al., 1993; Prescott et al., 1998). This cross-cultural effect is especially true when consumer preferences from very different cultures such as European or Asian countries are compared (Tu et al., 2010).

Although there is an important part of research tackling cross-cultural influences on product perception, the lack of literature related to wine is evident. To our knowledge, no cross-cultural research dealing with wine intrinsic quality perception has been carried out until now. Only few investigations have focused on the variations in wine preference depending on culture between consumers from different countries such as: Germany and France (Fischer et al., 2005a), China and Australia (Williamson, Robichaud, & Francis, 2012) or America and Italy (Torri, Noble, & Heymann, 2012). These studies have shown differences in acceptance of foreign and domestic red wines being strongly influenced by how long consumers have been drinking wine and by their familiarity with
wine. To this concern, Melo et al. (2011) suggest that wine consumption and exposure are important drivers which are able to shape wine sensory preference. Most cross-cultural studies converge in concluding that an increase in familiarity leads to an increase in preference and quality perception (Schnettler, Ruiz, Sepulveda, & Sepulveda, 2008). This effect has been attributed to pronounced differences in diet habits and practices, even among culturally close countries such as countries within the European Union (Sachet, Askegaard, & Madsen, 1995). However, some studies failed to show an effect of culture on quality perception (Verbeke & Ward, 2006). This absence of cultural differences might be due to either the consumers’ difficulty in understanding wine quality (Charters & Pettigrew, 2006) or even the lack of knowledge about origin cues (Grunert, 2005). According to Bruwer and Buller (2012) only consumers with high objective knowledge seem to be able to interpret intrinsic origin cues. Thus, Famularo, Bruwer and Li (2010) suggest that an increase in wine knowledge (and involvement) can lead to a greater understanding of wine’s region of origin, influencing consumer’s wine decision-making.

Another important consumer-related factor is consumer’s level of expertise (Frost & Noble, 2002; Lattey et al., 2010). Wine expertise has been demonstrated to be the combination of both wine knowledge and sensory expertise (Johnson & Bastian, 2007). Hughson and Boakes (2001, 2009) have linked the level of expertise to notions of domain specific, experience, speed of acquisition of knowledge, organisation and processing, and memory. The superior performance of experts in comparison with consumers when describing wines has been attributed more to a cognitive than a perceptual process (Hughson & Boakes, 2002). The memory representations of novices seem to be episodic since they are mainly based on a few exemplars of each type of wine and it is more associated to the situation in which the wines were tasted than the taste of the wines by itself. As a consequence novice responses tend to be related to their personal experience of consuming resulting in personalised and subjective responses (Parr, Mouret, Blackmore, Pelquest-Hunt, & Urdapilleta, 2011). On the contrary, experts regularly attend formal wine tasting sessions, in which they often have information about the wines they taste, what leads to a lower variability and higher consistency in responses compared to novices (Urdapilleta, Parr, Dacremont, & Green, 2011). This higher consistency is
attributed to the building of shared semantic sensory memory representations of wine knowledge (Urdapilleta et al., 2011) especially for experts belonging to the same wine culture (Ballester, Patris, Symoneaux, & Valentin, 2008).

Furthermore, there is evidence in the literature suggesting that the level of expertise of consumers is an important factor determining wine perception. Jover et al. (2004) highlighted its importance on wine quality judgements, stating that there are two different viewpoints: one expressed by wine professionals and the other by consumers. In line with these results Blackman, Saliba, and Schmidtke (2010) and Parr et al. (2011) demonstrated the importance of the level of expertise, based in wine consumption habits and exposure, in both sweet taste preference and the construction of the concept of wine complexity, respectively.

1.3. Research aims

Although both product-related properties (extrinsic and intrinsic) and consumer-related properties (such as culture and level of expertise) have been shown to be important factors in the building of consumers’ wine concepts, there is a lack of research evaluating the influence of consumer-related factors on intrinsic wine quality perception. More specifically, the effect of the level of expertise and the origin/culture of consumers on intrinsic quality perception has received little research to date. Thus, in the present study both consumer-related variables were studied. To accomplish such goal, a set of Spanish Rioja wines and French red wines from AOC Côtes du Rhône were evaluated in terms of intrinsic quality by Spanish and French participants with different levels of expertise: regular consumers and experts. Both wine regions have a wide tradition in producing and drinking quality red wines.

1.4. Hypothesis

The main research question is whether consumer culture (or consumers’ region of origin) and level of expertise lead to different intrinsic quality perception. More specifically, the present work ought to answer the following hypotheses:

H1: The effect of the level of expertise of consumers on the construction of different mental representations is hypothesised to lead to differences in the quality concept generated by experts and
regular consumers within a given wine region. This could further lead to different intrinsic wine quality drivers depending on the level of consumers’ expertise.

H2: The fact that wine experts usually construct similar sensory memory representations of different wine styles and quality concepts through frequent formal wine tastings lead to hypothesise that Spanish and French experts could share the same quality concept regardless their region of origin.

H3: Based on the fact that domestic products are perceived higher in quality than foreign ones, it is hypothesised that regular consumers would attach higher quality to wines of their own region.

H4: Cognitive and perceptual differences developed in different cultures could lead to certain differences in the description of wines carried out by both trained panels (Spanish and French).

2. Pilot study

2.1. Objective

A pilot study was carried out to select a set of 12 wine samples (six Spanish from DOCa Rioja and six French from AOC Côtes du Rhône) with a priori different intrinsic quality.

2.2. Material and Methods

2.2.1. Participants

Thirty-eight students of the first year of Viticulture and Oenology (19 French and 19 Spanish participants) from the Universities of Burgundy (France) and La Rioja (Spain) participated in the study. They had no relevant professional experience with wine (e.g. had never participated in winemaking processes; had never attended wine-tasting classes) and they have an intermediate level of expertise between the two groups of participants worked the main study (regular consumers vs experts).

The Spanish panel ranged from 19 to 32 years old (average = 22.4) and was composed of eight men and 11 women, and the French panel was formed by 14 women and five men with ages ranging from 20 to 26 years old (average = 22.8).

2.2.2. Stimuli

Firstly, a list of red wines (price range between 2€ and 12€) available in December 2011 in the supermarkets of Logroño (DOCa Rioja) and Avignon (AOC Côtes du Rhône) for Spanish and French
wines, respectively, was elaborated. Around one hundred wines from each wine region were classified according to extrinsic factors accessible to consumers when purchasing wine such as appellation, area of origin, vintage and label information on expected aroma and wine production (see supplementary material: SM1). On the basis of expected intrinsic quality based on extrinsic cues and in consultation with wine experts in both production regions, twenty-two red wines from both production regions (11 from DOCa Rioja and 11 from AOC Côtes du Rhône) with different expected intrinsic quality levels were selected. The detailed list of wines and their main extrinsic factors are shown in Table 1.

2.2.3. Experimental conditions

Both groups of Spanish and French participants were randomly divided in two; each group evaluated 11 wines (out of twenty-two). Twenty-mL wine samples were presented in trays of eleven samples in a different random order specific to each participant. Each participant attended one forty-minute session. Fifteen minutes before formal tasting, wines were served at room temperature in clear ISO glasses coded with three digit numbers and covered with plastic Petri dishes. All assessments were conducted in individual tasting booths under the same instructions for the two panels.

2.2.4. Method

A categorisation task at four quality levels (very low, low, high and very high quality) was carried out with wine samples in Table 1. These quality categories are easily interpretable by not experienced consumers and avoid centring biases (tendency to use the middle category) that could have appeared if an “average quality” group would have been provided. The instructions given to participants were as follows:

“Eleven glasses of wines are presented on the table. Each glass is coded by a three-digit number. You are asked to taste the wines from left to right and to classify them in any of the four quality groups: very high, high, low and very low.

Before tasting the following wine you are asked to eat a bit of cracker and to rinse your mouth with water”.

2.2.5. Data analysis
For each wine and participant, an individual quality score was calculated by assigning a value of 1, 2, 3 or 4 to wine samples classified in “very low”, “low”, “high” or “very high” categories, respectively. A one-way ANOVA with wine as within subject factor was performed on quality scores followed by a Student–Newman–Keuls post-hoc pairwise comparison (95%) test.

2.3. Results

Quality mean scores for the 22 wines range from 1.96 to 2.81, 1 and 4 being the maximum and minimum possible scores, respectively.

The ANOVA showed a significant effect of wine ($F = 2.717; P < 0.05$) on quality scores. Fig. 1 shows that five main quality groups of wines according to Student–Newman–Keuls post-hoc pairwise comparison analysis can be distinguished (a, ab, be, cd, de). Twelve wines (six Spanish from the DOCa Rioja and six French from Côtes du Rhône, France) with different intrinsic quality were selected for the main study. These samples are marked with a star in Fig. 1.

3. Main Study

3.1. Objective

The main goal was to evaluate the effects of both culture (or region of origin of consumers) and level of expertise on the intrinsic quality of the twelve red wines selected in the aforementioned pilot study as well as disclosing the main sensory intrinsic cues driving quality.

3.2. Material and methods

3.2.1. Sensory evaluation of intrinsic quality

3.2.1.1. Consumer recruitment. Participants were recruited through advertisements in public areas and internet, radio and newspaper advertisements on the basis of their interest. To qualify participants were required: i) to be regular consumers of red wine (drink red wine at least once every fortnight), ii) to have no experience in the wine industry, iii) to live either in La Rioja (for the Spanish recruitment) or Avignon (for the French recruitment) areas for at least the last 10 years in order to guarantee their immersion in the wine culture/habits of the region and iv) to be of legal drinking age (18 years). The screening and selection process ensured similar age and gender distribution of consumers between
both countries/regions. The final criterion for selecting participants was their interest and their availability during one 20-min session.

Fifty-six Spanish consumers (51.8% men and 48.2% women from 19 to 67 years, median = 39.5) living in La Rioja area and fifty-two French consumers (48.1% men and 51.9% women from 19 to 67 years, median = 42.5) living in Avignon area took part in the study. An attempt was made to match the Spanish and French consumers for age and gender. Although exact matching proved difficult, chi-square for gender rate and one-way ANOVA test (with country-of-origin of consumers as fix factor) for age distribution showed no significant difference between both groups of consumers.

3.2.1.2. Expert recruitment. The panels of experts included established winemakers and other wine professionals. Following Melcher and Schoeler (1996), Parr, Heatherbell, and White (2002), and Ballester et al. (2008) participants were considered as experts if they fitted at least one of the following categories:

- Established winemakers
- Wine-science researchers and teaching staff who were regularly involved in wine-making and/or wine evaluation
- Wine professionals (e.g., Master of Wine; wine judges; wine writers; wine retailers)
- Persons with an extensive (>10 years) history of wine involvement (e.g., family history; extensive wine cellar; regular involvement in formal wine tastings).
- Graduate students in Viticulture and Oenology who had relevant professional experience (e.g., had participated in more than one vintage; had run wine-tasting classes).

To qualify participants had to be of legal drinking age (18 years). The Spanish panel was composed of fifty-nine wine professionals of the DOCa Rioja area (51% men and 49% women, from 24 to 56 years, median = 35) and the French one of sixty wine experts of the Côtes du Rhône area (67% men and 33% women, from 72 to 22 years, median = 45). One-way ANOVA calculated on the age of participants and their country of origin as independent variable showed that French experts were significantly older than Spanish experts (F = 9.15; P < 0.05). Gender distribution was not significantly different according to chi-tests (P > 0.05) between French and Spanish experts.
3.2.1.3. **Method.** The twelve red wines marked in bold in Table 1 were evaluated in terms of quality by four different panels (Spanish consumers –Sp-C– and experts –Sp-E– and French consumers –Fr-C– and experts –Fr-E–). Each participant evaluated the intrinsic quality of a series of six wine samples in one session by sorting them in four different quality categories (1 = very low quality, 2 = low quality, 3 = high quality and 4 = very high quality). Participants were asked to taste the wine samples once in the proposed order. Then, they had to sort the samples according to their global quality perception (visual, olfactory and in-mouth cues were available as in a regular wine tasting). During the categorisation task, participants were allowed to taste the wines as many times as they wanted and in any order. Each quality group could contain as many wines as the participants wished. Participants were free to add comments next to the groups. However, this information was not systematically analysed. Participants worked in their own native language. The proposed instructions were as follows:

"Six glasses of wines are presented on the table. Each glass is coded by a three-digit number. You are asked to taste the wines from left to right and to classify the samples in any of the following four quality groups: very high, high, low and very low.

Before tasting the following wine you are asked to eat a bit of cracker and to rinse your mouth with water".

Quality assessments were carried out in March 2012 in Logroño (Spain) at La Rioja University and in April 2012 in Avignon area (France) at Inter Rhône for consumers and experts.

3.2.1.4. **Experimental conditions**

Fifteen minutes before formal tasting, wines were served at room temperature in clear ISO glasses coded with three digit numbers and covered with plastic Petri dishes. Twenty-mL wine samples were presented in trays of six samples according to a circular incomplete balanced experimental design in a different order specific to each participant following a Latin square arrangement. All assessments were conducted in individual tasting booths by the same leader under the same instructions for the four panels. Each participant attended only one session of about 20 min.

3.2.1.5. **Data analysis**
The number of times each wine was classified by participants in each of the four quality groups was counted. Chi-Square ($\chi^2$) tests were used to evaluate if significant differences ($P \leq 0.05$) were observed between Spanish and French wines. Further Marascuilo’s post-hoc pairwise comparisons (95%) were carried out for significant effects (Marascuilo & Busk, 1987). The Bonferroni’s correction was applied to adjust for the effects of multiple testing.

For each panellist and wine, individual quality scores were first calculated as indicated in section 2.2.3. Then, an overall quality score (Q) was calculated for each panel (Sp-C, Fr-C, Sp-E and Fr-E) and each wine by averaging individual scores.

Pearson’s correlation coefficients were calculated between the overall quality scores given by the four panels for evaluating similarities in quality concepts.

3.2.2. Sensory descriptive analysis

3.2.2.1. Participants. Two trained panels participated in the descriptive analysis: a French and a Spanish panel. The panels included mostly staff and students of Burgundy and La Rioja Universities, respectively. In both cases, the panels were composed of 29 participants recruited on the basis of their interest and their availability during 9 months between September 2011 and June 2012. Panellists were not paid for their participation. Both panels worked in their own native language.

3.2.2.2. Panel training. Participants of both panels followed 21 training sessions (one 60-min session per week). The frequency of citation method was used for orthonasal aroma description and continuous intensity scales for in-mouth description as described elsewhere (Campo, Ballester, Langlois, Dacremont, & Valentín, 2010). Panellists worked in subgroups and following the same guidelines. The detailed information for the panel training is presented in the supplementary material (SM2).

3.2.2.3. Sample description. Both French and Spanish panels evaluated the 12 wine samples (marked in bold in Table 1). Fifteen minutes before formal tasting, 20 mL of wine per sample were served at room temperature in dark ISO glasses coded with three-digit numbers and covered with plastic Petri
Each panellist completed two sessions (30 min each). For control of global panel reproducibility, one wine was evaluated in duplicate (7 wines were presented in each session). Panellists started by smelling the first presented wine and described its odour by choosing a maximum of five attributes from the list of 116 descriptors arranged in odour families as described in Campo et al. (2010). Then, they were asked to rate in mouth: sweetness, sourness, bitterness, astringency, balance, complexity, global intensity and persistence using structured scales for each wine (see SM2).

3.2.2.4. Data Analysis. The performance of panellists was evaluated by calculating the reproducibility index (Ri) proposed by Campo, Do, Ferreira, and Valentin (2008). Responses from the panellists showing a Ri < 0.2 were left out from the study as proposed Campo et al. (2008). With this criterion, the data of 27 French (19 women and 10 men from 20 to 56 years; average = 34; SD = 10) and 26 Spanish (11 women and 15 men from 20 to 56 years; average = 30; SD = 7) panellists were kept for further analysis.

A two-way analysis of variance (ANOVA) in which wine was the fix factor and judges random factor was performed on each in-mouth description derived from each panel for assessing the discrimination ability of attributes.

Orthonasal aroma and in-mouth data were analysed by Correspondence analysis (CA) and Principal component analysis (PCA), respectively. CA was performed on the contingency table containing the citation frequency of terms cited by more than 15% for both Spanish and French trained panels. Standardised PCA was performed on the mean ratings among the panellists for the eight attributes evaluated in-mouth and for each wine. The number of factors or principal components with an eigenvalue higher than the mean eigenvalue (Kaiser law) were retained in either CA and PCA spaces. The quality scores given by either consumers or experts were projected as illustrative quantitative variables in the CA maps.

Hierarchical Cluster Analysis (HCA) with the Ward criteria was finally applied. The attributes best defining the resulting clusters were identified by computing their probability of characterising a cluster (Lebart, Morineau, & Piron, 1995). All analyses were carried out with SPAD software (version 5.5, CISIA-CESRESTA, Montreuil, France).
Similarities between the two wine spaces (description carried out by both trained panels) were further assessed by computing Spearman correlations between the main factors of the two CAs and between the principal components of the two PCAs obtained from the two panels.

3.3. Results

3.3.1. Sensory evaluation of intrinsic quality

The proportion of Spanish (RJ) and French (CdR) wines placed in each of the four quality groups by Spanish and French consumers and experts is shown in Fig. 2. The Chi-square tests show significant differences between the quality perception of Spanish and French wines only for Spanish consumers. They have categorised the Spanish wines significantly ($P < 0.01$) more often in the “very high” quality group and less often ($P < 0.05$) in the “very low” category than French wines.

Significant Pearson’s correlations are observed for the scores given by Spanish and French experts ($r = 0.616; P < 0.05$) and consumers ($r = 0.590; P < 0.05$). No significant correlations are observed between experts and consumers within and between regions.

3.3.2. Sensory descriptive analysis and its correlation with quality

3.3.2.1. Orthonasal aroma description. Thirty-two attributes were considered for the French panel and 27 for the Spanish one. A first CA analysis shows that, in both countries, wine CdR-102, mainly described by “unpleasant” attributes from the vegetal and animal families, is isolated from the other wine samples on the first factor, indicating a very different wine in terms of odour characteristics. Thus, further CAs were performed without this wine. The first four factors, explaining 70% of the total variance, were considered for further analysis for both panels. The description of wines by the Spanish panel can be seen in Fig. 3. The CA map was zoomed in to have a more readable plot. The term apricot had a coordinate of 1.7 on factor 1, thus this term cannot be seen in Fig 3. Results show a clear opposition on the first factor of fruity terms (mainly apricot and to a lesser extent red fruits and raspberry), “sulphur” or “menthol/fresh” to unpleasant terms from the undergrowth (humus/earthy or mouldy), vegetable (olive) and animal (cat urine and leather) families. The second factor mainly opposes “dried apricot” and “mouldy”. Furthermore, the plot shows that samples are mainly classified in the first dimension according to their country of origin: Spanish samples on the left and French
wines on the right, except for CdR-333, which is plotted on the left part of the plot close to Spanish wine samples.

The description of wines by the French panel can be seen in Fig. 4. This map shows a clear opposition on the first factor of “wet cloth”, “cardboard”, “smoky” or “humus/earthy” to “solvent” and “red fruits”. The second factor mainly opposes two dried fruits: “dried fig” and “prune” to animal-related attributes (“transpiration” and “musk/civet”), the vegetal term “blackcurrant bud” and “cardboard/dust”. Again, as was observed on Fig. 3, the CA plot shows that samples are mainly classified in the first dimension according to their country of origin: Spanish wines on the left and French wines on the right part of the plot. This suggests that French and Spanish wines are different in terms of aroma properties.

The HCA applied to the factorial coordinates of the 12 wines in the spaces defined by the CAs calculated with Spanish and French data yielded three clusters in both cases. Table 3 and 4 present the terms characterising best the wines in each HCA cluster and their correlation to quality perception (projected as illustrative variable). In general, a relatively good agreement is found for cluster arrangements as they share nine out of twelve wine samples. Samples RJ-005, CdR-888 and CdR-333 are the three samples that do not coincide. Likewise, Spearman correlation coefficients showed a significant correlation between the firsts factors ($r = 0.688, P < 0.05$) as well as a tendency ($r = 0.526, P < 0.1$) between the thirds factors (explaining almost 14% of total variance in both CAs) of the CA maps obtained for the two panels.

The first cluster (Cluster 1) shares five Spanish wines (RJ-058, RJ-381, RJ-690, RJ-774, RJ-917) and is mainly characterised by barrel aging related terms such as roasted woody, leather and toasted bread by the Spanish panel and smoky, fresh wood, cardboard/dust or wet cloth by the French panel. This cluster is positively characterised especially by Spanish and French consumer illustrative quality variables and to a lesser extent by French expert quality. On the contrary, this cluster is negatively characterised by the Spanish expert quality variable.

Three French wines are common to the second cluster (CdR-081, CdR-903, CdR-936), which is described with terms from the red fruit family (raspberry, strawberry or cherry) and alcohol. This
cluster is also characterised by the Spanish panel with attributes such as apricot or menthol/fresh, while the term solvent is also significant for the French panel. This cluster is negatively related to Spanish and French consumers’ quality judgement, but is positively related to experts’ quality judgements from both countries (see Tables 3 and 4). The third cluster is formed by only one wine in both Spanish and French panels: CdR-102. This sample is described with animal/transpiration nuances (also cat urine by the Spanish panel) and vegetal (vegetables for Spanish panel and blackcurrant bud for French panel) related attributes. Remarkable is also the fact that the four panels evaluating quality perception score this wine either with the lowest (Spanish and French consumers) or the second lowest (Spanish and French experts) quality score. Besides, this third cluster is largely negatively characterised by the quality variable \( (P < 0.001) \), regardless the origin or level of expertise of assessors as it is shown in Tables 3 and 4.

The relationship between the aroma attributes describing wine samples and the quality perception evaluated by the four panels was further investigated by simple correlation analysis. Results show that significant positive correlations were found between quality scores and woody-related terms such as roasted wood \( (r = 0.627; \ P < 0.05) \) and fresh wood \( (r = 0.658; \ P < 0.05) \), respectively for Spanish and French consumers. For Spanish consumers sulphur \( (r = -0.643; \ P < 0.05) \) and animal \( (r = -0.584 \) for cat urine and \( r = -0.680 \) for transpiration; \( P < 0.05 \) ) related aromas are negatively correlated to quality perception. The quality scores of Spanish and French experts are positively correlated with the terms vanilla \( (r = 0.609; \ P < 0.05 \) and \( r = 0.615; \ P < 0.05 \), respectively) and red fruits \( (r = 0.613; \ P < 0.05 \) and \( r = 0.576; \ P < 0.05 \), respectively), more specifically with “cherry” in the case of French experts. On the contrary, attributes related to the vegetal family such as olive for Sp-E \( (r = -0.631; \ P < 0.05) \) and blackcurrant bud for Fr-E \( (r = -0.647; \ P < 0.05) \) are negatively correlated with quality perception. Similarly, animal nuances such as cat urine \( (r = -0.640; \ P < 0.05) \) for Spanish experts and perspiration \( (r = -0.609; \ P < 0.05) \) or musk/civet \( (r = -0.596; \ P < 0.05) \) for French experts are negatively correlated with “quality”. Dried fruits attribute also correlates negatively with the quality perceived by Spanish experts.

3.3.2.2. In-mouth sensory description
Fig. 5 and 6 show the projections of wines on the first two principal components obtained from the PCAs calculated with the average scores of the eight in-mouth sensory properties evaluated by the Spanish and French trained panels, respectively. Further HCA calculated on all the PCA coordinates yielded four main clusters. For the Spanish panel the four clusters are formed by nine, one (CdR-936), one (RJ-381) and one (CdR-102) wines, respectively. Only Cluster 1 is significantly characterised by the terms: balance (test-value = 2.54; P < 0.01) and complexity (test-value = 1.68; P < 0.05).

For the French panel, Cluster 1 (RJ-005, RJ-690, CdR-888 and CdR-903) is significantly characterised by “balance” (test-value = 1.95; P = 0.026), Cluster 2 (CdR-102, CdR-333 and RJ-917) by “bitterness” (test-value = 2.22; P = 0.013) and “sourness” (test-value = 2.04; P = 0.021), Cluster 3 (RJ-058, RJ-381 and RJ-774) by “complexity” (test-value = 2.03; P = 0.021) and “persistence” (test-value = 1.80; P = 0.036) and finally Cluster 4 (CdR-936 and CdR-081) by “astringency” (test-value = 2.13; P = 0.016).

Further Pearson correlation coefficients were calculated to analyse whether linear relationships exist between the in-mouth attributes used by the Spanish and French panels. Results showed that only the term astringency was significantly correlated in both panels (r = 0.90; P < 0.001). No significant correlations were found for the remaining seven attributes.

According to ANOVAs, the effect of wine was significant for “balance” for the French panel (F = 2.404; P < 0.01) and for “astringency” for Spanish (F = 2.731; P < 0.05) and French (F = 5.386; P < 0.001) panels and a tendency was observed for “sourness” evaluated by the Spanish panel (F = 2.334; P < 0.1). This indicates that only these attributes (for the indicated panels) were useful in characterising in-mouth differences among the 12 wines. Further PCAs run on each in-mouth attribute revealed judges’ projections were grouped on the loading plots for “sourness” and “balance” in Spanish and French panels, respectively, as well as for “astringency” in both panels. On the contrary for the rest of attributes, judges were spread over a large part of the plots, indicating differences in the interpretation of these attributes within panels.

It is important to highlight the result obtained for the term balance, which seems to be contrary understood by both panels. In the Spanish panel, it shows a significant and positive correlation with
global intensity ($r = 0.50; P < 0.05$), while in the French panel the correlation is negative ($r = -0.55; P < 0.05$).

The coordinates of the wines on the second PC (19% of the original variance) of the Spanish panel show significant correlation with the first ($r = -0.51, P < 0.05$) and the second ($r = 0.58, P < 0.05$) dimension of the French panel, which explain 29% and 16% of variance, respectively. The third dimension explaining 16% of the total variance of the Spanish panel is also significantly correlated ($r = 0.51, P < 0.05$) with the first PC of the French panel. These results show a moderate agreement between the two configurations obtained from the in-mouth descriptions in both countries.

Table 5 shows the correlation matrix obtained from the PCA analysis performed on the in-mouth descriptors given by the Spanish trained panel together with the quality perceived by both Spanish consumers and experts. According to results, the quality perceived by Spanish experts is positively correlated to “balance”, while Spanish consumers find less astringent wines higher in quality. Both consumers and experts coincide in relating quality to complex wines.

Table 6 shows the correlation matrix obtained from the PCA analysis performed on the in-mouth descriptors given by the French trained panel together with the quality perceived by both Spanish consumers and experts. This table shows that for French experts quality is negatively correlated with “bitterness” ($r = -0.51; P < 0.05$) whereas for French consumers it is positively correlated with “sweetness” ($r = 0.84; P < 0.01$) and “complexity” ($r = -0.51; P < 0.05$).

4. Discussion

4.1. Effect of culture and level of expertise on quality perception

The present work aimed to evaluate the effects of culture (region of origin of participants) and level of expertise on participants’ representation of wine intrinsic quality. The effect of expertise or familiarity on wine perception has been studied by segmenting consumers according to their pre-supposed knowledge of wine based on their previous experience and according to the frequency of wine consumption as has been done in other studies with beer (Lelièvre, 2010) or wine (Langlois, Daclermont, Peyron, Valentin, & Dubois, 2011). Based on these criteria, consumers are segmented in experts (professionally involved in the field), connoisseurs (regular consumers who live in a region
with important and traditional production of the studied product), sensory panellists (trained to describe the product) and novices (occasional consumers). Attending to this classification, in the present work, experts and regular consumers/connoisseurs were studied. Results confirm our first hypothesis showing that quality perception of both groups of regular consumers and experts are not correlated in any of the two studied regions. These results show that perceived quality is dependent on consumers’ level of expertise and varies between regular consumers and wine experts, which are well in line with other works tackling wine preference (Lawless et al., 1997, Charters & Pettigrew, 2007). The importance of the level of expertise of wine consumers in intrinsic quality perception is further supported by the significant correlations observed between the quality scores given by experts from both countries. This confirms our second hypothesis that suggested that experts would have aligned quality concepts even if they come from different cultures/regions. This could be explained by the fact that wine experts base their judgements on oenological processes and viticulture variables that are similar in both regions (Parr et al., 2011). These shared mental representations of experts have been also observed for different concepts such as wine complexity (Parr et al., 2011), wine variety (Ballester et al., 2008) or type of wine (Hughson & Boakes, 2001).

Contrary to wine experts, consumers tend to base their judgements on their personal experience with wine (Parr et al., 2011), yielding personalised and subjective (e.g., about their own enjoyment and pleasure) mental representations. To this concern, a wide range of works dealing with cross-cultural perception of food (L. Chung & Chung, 2007; Hong et al., 2011; Jaeger et al., 1998) agree in finding that the fact of coming from different cultures or regions results in different consumers’ perception of foods. In these studies, domestic products are usually given higher hedonic ratings than unfamiliar foreign products (Fischer et al., 2005a, 2005b). This together with the fact that quality perceived by consumers is correlated to hedonic ratings (Cardello, 1995; Delgado & Guinard, 2011; Lawless, Liu, & Goldwyn, 1997), we hypothesised that regular consumers would perceive domestic wines higher in quality that foreign ones as has been already demonstrated for ham intrinsic preferences (Fischer et al., 2005a). This hypothesis could only be confirmed for Spanish consumers, who found Spanish wines of higher quality than French wines. These results could be explained by the results obtained from an
independent study (carried out in the same regions with almost 200 wine consumers) showing that consumers from the Rioja area are more used to consuming Spanish Rioja wines than French wines, and thus they are more familiar to them. This increase in the familiarity with wines of their own region could have led to an enhancement in quality perception. The results observed for French consumers were unexpected. Contrary to what is observed for Spanish consumers, they did not show a differentiation between Spanish and French wines in terms of quality. This result should be carefully interpreted because it was firstly assumed that consumers are more familiar with the wines from their own country/region. However, a survey (data not shown) carried out in parallel in the same regions (with almost 200 wine consumers) has shown that a wide range of red wine consumers from AOC Côtes du Rhône (74% out of 95 consumers) are more used to drinking and purchasing wines from Italy than from their own region, they even declared not to have preferences when consuming wines produced in France or Spain. This fact suggests that the difference in familiarity (and exposure) between Spanish and French wines for French consumers is not enough for inducing quality differences between them. On the contrary, most consumers from DOCa Rioja (71% out of 93 consumers) declared to drink mostly Spanish Rioja wines. This could explain why familiarity with the product could only be demonstrated for the group of Spanish consumers and thus wine exposure emerges as a key factor in quality perception. This wine exposure effect could be explained in terms of wine knowledge (and thus wine involvement) as suggested Fanularo, Bruwer and Li (2010). These authors showed that an increase in wine knowledge (probably gained through wine exposure) can lead to a greater understanding of wine region of origin, what could explain the results observed for Spanish consumers.

Consumers’ knowledge, and involvement level, with wine has been demonstrated to be an important factor determining wine preference (Bruwer & Buller, 2013) or purchase behaviour (L. Lockshin, Quester, & Spawton, 2001). The notion of involvement encompasses interest, exposure, ritual in the preparation of wine for drinking, pleasure provided and risk (Bruwer & Huang, 2012). Given the importance of consumer’s exposure in the concept of consumer’s involvement (and knowledge) further work combining sensory approaches and involvement questionnaires (Bruwer & Huang, 2012;
L. S. Lockshin, Spawton, & Macintosh, 1997) is necessary to gain deeper knowledge in the intrinsic quality concept developed by consumers.

4.2. Sensory description by French and Spanish trained panels

Perceptual or cognitive differences were expected to appear in the description of wines carried out by trained panels from different cultures (Prescott et al., 1998). Thus, the characterization of wines was performed by two panels (a French and a Spanish panel) and the two characterisations compared. Results show that in spite of the differences found in the verbalisation of aroma properties attributed to differences between both cultures in their familiarity with the corresponding aromas, wine positioning is relatively similar in both CA maps. Thus, there is a cross-cultural agreement in segmenting and differentiating wine samples according to the aroma properties employed by both Spanish and French trained panels. However, this cross-cultural agreement in wine aroma characterisation could not be confirmed for the in-mouth description given by both panels, except for the attribute astringency. According to Prescott et al. (1998), familiarity with the overall product can lead to different sensitivities in individual sensory characteristics, what could explain why the sourness (significant differences only for the Spanish panel) and balance (only for the French panel) discrimination power were different between the two panels.

Important to remark are the differences observed in the verbalisation of aroma properties carried out by both panels. It is observed that panellists used different descriptors depending on their cultural backgrounds. For instance, the Spanish panel used the general descriptors “vegetal” or “black fruits” when the French panel used more specific terms such as “blackcurrant buds” or “blackcurrant”, respectively. Similarly, the Spanish panel uses quite often the term “apricot” contrary to the French panel. These differences may be attributed to differences in fruit availability in the two countries and thus to differences in familiarity with the corresponding aromas. Indeed, French assessors, living in Burgundy, are much familiarised with blackcurrant-related aromas based on their prior experiences, contrary to the Spanish panel, for which more than 90% of panellists did not know this fruit before participating in the panel. Likewise, Spain produces 30% of apricots in Europe (second position) while
France produces 4% (last position) (Iglesias & Casals, 2011). Similar results have been reported in cross-cultural studies carried out with cheese (Drake et al., 2005), fermented soybean (L. Chung & Chung, 2007) or soy yogurts (Tu et al., 2010). These results highlight the difference in the verbalisation of sensory attributes in the description of wine properties depending on the culture. This suggests that the translation of wine descriptions usually employed either in back labels of export or in wine guides should be carefully conducted, because the use of the wrong attributes may lead to pre-consumption expectations that may not match consumer’s experience. This could finally drive post-consumption dissatisfaction as expectations based on information about a food’s taste or other attributes have been demonstrated to play a profound role in consumers’ responses to sensory properties of foods (Cardello, 1994; Deliza & MacFie, 1996; Prescott, 1998).

4.3. Sensory properties driving quality perception

By combining the sensory descriptions given by the trained panels and the quality judgements of Spanish and French consumers and experts, the sensory properties involved in either the enhancement or detriment of wine quality are revealed. Results show that experts from both countries score wines rich in “red fruits” (such as cherry) with high quality scores, contrary to low quality exemplars that are mainly described with terms from the vegetal (olive or blackcurrant bud) and animal (cat urine, perspiration or musk/civet) families as well as dried fruit notes for Spanish experts. These results are well in accordance with previous works (Varela et al., 2006, Lattey et al., 2010, Sáenz-Navajas et al., 2012). One important observation is that concerning the fruity note, different studies have already shown that these aromas are highly appreciated by experts and lead to higher quality scores in Uruguayan (Varela & Gambaro, 2006), Spanish (Sáenz-Navajas et al., 2012) and Australian (Lattey et al., 2010) wines. However, it is important to remark the role played by the different fruity aroma nuances such as dried or fresh/red fruit. While this fruity note holds a positive relationship with quality, the role played by the dried fruit note seems to be dependent on the different wine categories (mainly linked to the segment of price to which wines belong). For example, in Spanish Premium (Sáenz-Navajas et al., 2012) and Uruguayan Tannat (Varela & Gambaro, 2006) wines the dried fruit attribute positively correlates with quality, while in high- and low-standard Spanish (Sáenz-Navajas et
wines it holds a negative correlation as observed in the present work. The dried fruit character has been related in part to oxidation related compounds such as methional (potato-smelling compound), which is able to transform the berry fruit note into dried fruit note (San-Juan, Ferreira, Cacho, & Escudero, 2011). -nonalactone, β-damascenone or 3-methyl-2,4-nonanedione described to be responsible for the dried prune aroma in prematurely aged red wines (Pons, Lavigne, Eric, Darriet, & Dubourdieu, 2008). Thus, this oxidation process can generate dried fruit notes contributing to an increase in quality perception in some wines, but to a decrease in quality in some others. This suggests the existence of different attributes evoking either positive or negative expert quality judgements depending on the different wine categories, belonging to different price segments.

Consumers associate quality exemplars to woody-related (such as roasted or fresh wood) aroma attributes and experts to red fruity nuances, while animal nuances correlate negatively for both consumers and experts. Thus, the sensory pairs woody/animal or red fruit/animal are confirmed as the most relevant and influential for the construction of the wine quality concept for consumers and experts, respectively.

As far as in-mouth properties are concerned, Spanish consumers associate “astringency” to lower quality exemplars, contrary to what has been found for Spanish (Sáenz-Navajas et al., 2011) and Australian (Lattey et al., 2010) experts and high-involved Uruguayan consumers evaluating Tannat wines (Varela and Gambaro, 2006).

Complexity evaluated in-mouth has shown to be linked to quality judgements of Spanish and French experts as well as of French consumers. This result is in accordance with previous works (Guillot, Medel, Viala, Schlich, & Garrel, 2012), where Premium wines (high quality samples) are perceived as the most complex by consumers. Besides, the term complexity is significantly correlated to global intensity and persistence ($P < 0.05$) for the Spanish trained panel as was already reported (Guillot et al., 2012; Paulsen, Segman, & Hersleth, 2012). However, these results should be interpreted with caution and further conclusions cannot be drawn for the correlation between quality and in-mouth properties (except for astringency), given the absence of discrimination ability among the studied wines of most attributes for both panels.
In general, the agreement between the general quality scores given by experts from both countries as well as by consumers can be explained by the aroma properties. This suggests that wine aromas play a primary role in quality evaluation carried out by both consumers and experts, while in-mouth sensory properties may be playing a secondary role. However, further research should be carried out to determine the exact role played by the different sensory stages (visual, olfactory or gustatory) in quality judgements for understanding the construction of the concept of quality.

The present international and multidisciplinary approach has evidenced the difference that exists between wine quality perception of consumers and experts. Moreover, the importance of carrying out consumers’ tests for disclosing the main drivers of quality rather than to exclusively base research on experts’ judgements is suggested.

Acknowledgements

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San-Juan, F., Ferreira, V., Cacho, J., & Escudero, A. (2011). Quality and Aromatic Sensory Descriptors (Mainly Fresh and Dry Fruit Character) of Spanish Red Wines can be Predicted from their Aroma-Active Chemical Composition. *Journal of Agricultural and Food Chemistry*, 59 (14), 7916-7924.


Figure captions

Figure 1. Average quality scores given to the 22 red wines (half from Spain and half from France) in the pilot study. Wines marked with an asterisk were selected for the main study. Different letters indicate significant differences (P < 0.05) in wine quality scores according to Student–Newman–Keuls post-hoc test.

Figure 2. Frequency (expressed in %) French and Spanish wines were classified in “very low”, “low”, “high” or “very high” quality groups by Spanish experts (Sp-E), French experts (Fr-E), Spanish consumers (Sp-C) or French consumers (Fr-C). Different letters indicate the existence of a significant difference between French and Spanish wines (chi-square test followed by the Marascuilo post-hoc procedure P ≤ 0.05).

Figure 3. Projection of aroma descriptors and wines in the CA space by the Spanish trained panel. The arrows (illustrative variables) show wine with quality according to the categorisation task carried out by both Spanish consumer and expert panel.

Figure 4. Projection of aroma descriptors and wines in the CA space by the French trained panel. The arrows (illustrative variables) show wine with quality according to the categorisation task carried out by both French consumer and expert panel.

Figure 5. Projection of wines in the PCA space by the Spanish trained panel. The dots represent the barycentre of each cluster and their size the quality of representation of the clusters (cos²) yielded by the HCA.

Figure 6. Projection of wines in the PCA space by the French trained panel. The dots represent the barycentre of each cluster and their size the quality of representation of the clusters (cos²) yielded by the HCA.
Figure 2.
Figure 3

[Diagram showing a factor analysis with labeled factors and variables for quality Spanish consumers and experts.]
Figure 4
Figure 6
Table 1. The red wines used for the study with their code, region of origin, vintage, appellation and area of origin variety. Wines marked in bold were selected for the main study.

<table>
<thead>
<tr>
<th>Code</th>
<th>Region of origin</th>
<th>Vintage</th>
<th>Appellation</th>
<th>Area of origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>CdR-081</td>
<td></td>
<td>2010</td>
<td>AOC Regional</td>
<td>Regional</td>
</tr>
<tr>
<td>CdR-102</td>
<td></td>
<td>2010</td>
<td>AOC Village</td>
<td>Valrêas</td>
</tr>
<tr>
<td>CdR-176</td>
<td></td>
<td>2009</td>
<td>AOC Regional</td>
<td>Regional</td>
</tr>
<tr>
<td>CdR-196</td>
<td></td>
<td>2009</td>
<td>AOC Regional</td>
<td>Regional</td>
</tr>
<tr>
<td>CdR-308</td>
<td></td>
<td>2007</td>
<td>AOC Regional</td>
<td>Regional</td>
</tr>
<tr>
<td>CdR-333</td>
<td>France (AOC Côtes du Rhône)</td>
<td>2007</td>
<td>AOC Regional</td>
<td>Regional</td>
</tr>
<tr>
<td>CdR-419</td>
<td></td>
<td>2010</td>
<td>AOC Village</td>
<td>Plan de Dieu</td>
</tr>
<tr>
<td>CdR-888</td>
<td></td>
<td>2009</td>
<td>AOC Village</td>
<td>Plan de Dieu</td>
</tr>
<tr>
<td>CdR-903</td>
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<td>AOC Regional</td>
<td>Regional</td>
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<td>CdR-936</td>
<td></td>
<td>2009</td>
<td>AOC Village</td>
<td>Plan de Dieu</td>
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<td>CdR-055</td>
<td></td>
<td>2009</td>
<td>AOC Village</td>
<td>Saint-Maurice</td>
</tr>
<tr>
<td>RJ-005</td>
<td></td>
<td>2005</td>
<td>Reserva</td>
<td>Rioja alavesa</td>
</tr>
<tr>
<td>RJ-058</td>
<td></td>
<td>2009</td>
<td>Cosecha</td>
<td>Rioja alavesa</td>
</tr>
<tr>
<td>RJ-231</td>
<td></td>
<td>2005</td>
<td>Reserva</td>
<td>Rioja baja</td>
</tr>
<tr>
<td>RJ-381</td>
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<td>2010</td>
<td>Cosecha</td>
<td>Rioja alta</td>
</tr>
<tr>
<td>RJ-595</td>
<td></td>
<td>2008</td>
<td>Crianza</td>
<td>Rioja alavesa</td>
</tr>
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<td>RJ-631</td>
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<td>RJ-774</td>
<td></td>
<td>2005</td>
<td>Reserva</td>
<td>Rioja alta</td>
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<td>RJ-841</td>
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<td>2008</td>
<td>Crianza</td>
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<td>RJ-904</td>
<td></td>
<td>2008</td>
<td>Crianza</td>
<td>Rioja baja</td>
</tr>
<tr>
<td>RJ-917</td>
<td></td>
<td>2007</td>
<td>Crianza</td>
<td>Rioja baja</td>
</tr>
<tr>
<td>RJ-690</td>
<td></td>
<td>2005</td>
<td>Reserva</td>
<td>Rioja alavesa</td>
</tr>
</tbody>
</table>

Spain (DOCa Rioja)
Table 2. Aroma attributes cited at least by 15% of the assessors belonging to either French or

<table>
<thead>
<tr>
<th>French panel</th>
<th>Spanish panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ------</td>
<td>1. Apricot</td>
</tr>
<tr>
<td>2. Red fruits (cherry, strawberry, raspberry)</td>
<td>2. Red fruits (cherry, strawberry, raspberry)</td>
</tr>
<tr>
<td>4. Dried fruit (prune)</td>
<td>4. Dried fruit (apricot)</td>
</tr>
<tr>
<td>5. Candied/cooked fruits</td>
<td>5. Candied/cooked fruits</td>
</tr>
<tr>
<td>6. Cherry in alcohol</td>
<td>6. ------</td>
</tr>
<tr>
<td>7. Floral</td>
<td>7. ------</td>
</tr>
<tr>
<td>8. Cabbage</td>
<td>8. Vegetables (olive)</td>
</tr>
<tr>
<td>9. Cassis bud</td>
<td>9. ------</td>
</tr>
<tr>
<td>10. Black pepper, vanilla</td>
<td>10. Spicy (black pepper, vanilla, liquorice, menthol)</td>
</tr>
<tr>
<td>15. Alcohol</td>
<td>15. Alcohol</td>
</tr>
<tr>
<td>16. ------</td>
<td>16. Sulphur</td>
</tr>
<tr>
<td>17. Carton/dust</td>
<td>17. ------</td>
</tr>
<tr>
<td>18. Wet cloth</td>
<td>18. ------</td>
</tr>
<tr>
<td>19. Dissolvent</td>
<td>19. ------</td>
</tr>
</tbody>
</table>

Spanish panel
Table 3. Clusters yielded by HCA for orthonasal aroma description carried out by the Spanish trained panel and their correlation to the illustrative variables: quality evaluated by Spanish experts (Sp-E) and consumers (Sp-C) (positive correlations are marked in bold). Descriptors contributing most to the building of the clusters (P < 0.05) and wines belonging to each cluster. Wines with asterisk are those closest to the centre of gravity of the cluster. Underlined wines are those common to the same cluster in both Spanish and French panels.

<table>
<thead>
<tr>
<th>CLUSTER</th>
<th>Wines</th>
<th>Attributes</th>
<th>Correlation with quality</th>
</tr>
</thead>
</table>
| 1       | RJ-005*, RJ-058, CdR-333, RJ-381, RJ-690, RJ-774, CdR-888, RJ-917 | Roasted wood, leather, toasted bread | Sp-E (t-value= -4.45; P < 0.001)  
Sp-C (t-value= +25.86; P < 0.001) |
| 2       | CdR-081, CdR-903, CdR-936* | Red fruits, raspberry, strawberry, apricot, alcohol, menthol/fresh | Sp-E (t-value= +12.52; P < 0.001)  
Sp-C (t-value= -16.23; P < 0.038) |
| 3       | CdR-102* | Animal, transpiration, cat urine, vegetables | Sp-E (t-value= -12.37; P < 0.001)  
Sp-C (t-value= -19.13; P < 0.001) |
Table 4. Clusters yielded by HCA for orthonasal aroma description carried out by the French trained panel and their correlation to the illustrative variables: quality evaluated by French experts (Fr-E) and consumers (Fr-C) (positive correlations are marked in bold). Descriptors contributing most to the building of the clusters (P < 0.05) and wines belonging to each cluster. Wines with asterisk are those closest to the centre of gravity of the cluster. Underlined wines are those common to the same cluster in both Spanish and French panels.

<table>
<thead>
<tr>
<th>CLUSTER</th>
<th>Wines</th>
<th>Attributes</th>
<th>Correlation with quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RJ-058, RJ-381, RJ-690, RJ-774*, RJ-917</td>
<td>Smoky, fresh wood, cardboard/dust, wet cloth</td>
<td>Fr-E (t-value= +1.68; P &lt; 0.001) Fr-C (t-value= +8.85; P &lt; 0.05)</td>
</tr>
<tr>
<td>2</td>
<td>RJ-005, CdR-081*, CdR-333, CdR-888, CdR-905, CdR-936</td>
<td>Strawberry, cherry, alcohol, solvent</td>
<td>Fr-E (t-value= +5.17; P &lt; 0.001) Fr-C (t-value= -1.77; P &lt; 0.038)</td>
</tr>
<tr>
<td>3</td>
<td>CdR-102*</td>
<td>Transpiration, blackcurrant bud</td>
<td>Fr-E (t-value= -12.89; P &lt; 0.001) Fr-C (t-value= -13.18; P &lt; 0.001)</td>
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Table 5. Correlation matrix obtained from the PCA calculated with the in-mouth sensory properties and the quality evaluated by the Spanish trained panel and consumers or experts, respectively, evaluated on the 12 red wine samples. Significant correlations (P < 0.05) are marked in bold and underlined

<table>
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<th>sourness</th>
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<th>balance</th>
<th>complexity</th>
<th>global intensity</th>
<th>persistence</th>
<th>quality experts</th>
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Table 6. Correlation matrix obtained from the PCA calculated with the in-mouth sensory properties and the quality evaluated by the French trained panel and consumers or experts, respectively, evaluated on the 12 red wine samples. Significant correlations (P < 0.05) are marked in bold and underlined.

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<th>astringency</th>
<th>balance</th>
<th>complexity</th>
<th>global intensity</th>
<th>persistence</th>
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Highlights

Intrinsic quality perception is dependent on the level of expertise of consumers

Experts from DOCa Rioja and AOC Côtes du Rhône as well as consumers have aligned intrinsic quality concepts

Consumers associate quality exemplars to woody-related aromas and experts to red fruit aromas

Wine intrinsic quality perceived by two groups of regular consumers is related to wine exposure