Method development for sensory quality control of products with certified quality labels: a case study on wine

Iñaki Etaio Alonso
LASEHU (Laboratorio de Análisis Sensorial Euskal Herriko Unibertsitatea)
UPV/EHU (University of the Basque Country)
INTRODUCTION
Sensory quality evaluation of PDO products

Sensory characteristics linked to the region, raw materials, elaboration procedure or cultural aspects (Bertozzi, 1995; Ballester et al., 2005; Cayot, 2007; Parr et al., 2007)

Necessary to consider the “typicity”

Evaluation often focused on avoiding commercializing product with serious defects

Very few reports about methods categorizing the sensory quality:

- Idiazabal cheese (Pérez Elortondo et al., 2007)
- Extra virgin olive oil (IOOC, 2005)
- Asparagus from Navarra (Torre, 2002)
Sensory quality evaluation of wine

**Introduction**

Necessary to describe the "principal organoleptic characteristics" of PDO wines according to European legislation (OJEU, 2008).

Specifications of many PDOs mention to "characteristic" properties.

**What is “characteristic”... ????**
DOC Rioja regulations (BOE, 2004):

- Production zone
- Viticulture and enological practices
- Harvest conditions
- Grape yields
- Physico-chemical characteristics

... and organoleptic characteristics

Wines must present the characteristic organoleptic properties of color, odour and taste

... what are these characteristic organoleptic properties ???
Sensory quality evaluation of wine

Score cards to measure the sensory quality:

Davis 20-point scale
(Ough & Baker, 1961; Amerine & Roessler, 1983)

Score card for international wine competitions of the International Organisation of Vine and Wine
(OIV, 1994)

Score card of the Union Internationale des Oenologues
(reproduced in OIV, 1994)

Hedonic wine tasting sheet for quality assessment
(Jackson, 2000)

Score card of the Faculté d’oenologie de Bordeaux
(reproduced in Peynaud & Blouin, 2002)

Score card of the Unión Española de Catadores
(reproduced in Del Castillo, 2005)

…
Introduction

Sensory quality evaluation of wine

Some problems related to these score cards:

Usually, parameters not defined enough

what is “balance”?  
what is “harmony”?  
What is “genuineness”?  
...

Scoring criteria not specified enough

Scoring very influenced by opinion, formation and experience of each expert

Lack of specificity

Wide range of wines: “Still wines”, “sparkling wines”...

Particularities not considered
Sensory quality evaluation of PDO products

Together with specific method development

Qualified panels necessary to apply them

How to train, qualificate and supervise the panel?

How to check the reliability of the panel?

Accreditation according to ISO 17025 (2005)

Guarantee of technical competence
Rioja Alavesa (RA)

66,842,000 L red wine (2009)
275 wineries
Introduction

Rioja Alavesa (RA)

Sensory characteristics of RA wines influenced by some particularities:

- **Climate**: Atlantic climate + Mediterranean climate
- **Orography**: slope from mountains to Ebro river
- **Soil composition**: 95% chalky-clayey
- **Grape varieties**: Tempranillo predominant
- **Many little wineries**: traditional practices

Young red wine (unoaked) → the most traditional one

Winemaking process: **carbonic maceration** and **destemming**

Main variety: **Tempranillo**
METHOD DEVELOPMENT
Sensory quality: a controversial concept

First question:

Who defines the sensory quality?

Consumers?  Experts?  Both?
Method development

Participants

12 wine experts: enologists, winemakers and restaurateurs
15 meetings of 2 hours and half

Wine samples

90 samples of young red wine from different villages of RA

Preparation and service of samples

Storage and serving at 17 2°C
Standardized glasses (ISO, 1977) covered with Petri dishes

Tasting room

Discussion room
Sensory booths
T°F: 21 2°C / RH (60±20%)
1- Attribute generation

First 3 sessions: wine pair comparison with 18 wines

Terms of:
- odour
- aroma
- taste and mouth-feel
- appearance
2- Selection of parameters determining the sensory quality

By consensus, considering:
- Term citation frequency
- Parameters usually cited in the bibliography
- Knowledge of the experts

2 questions to lead the discussion:

*Does this parameter really influence the sensory quality of the wine?*

*Does this parameter differentiate among wines?*
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odour intensity</td>
<td>Global intensity of odour</td>
</tr>
<tr>
<td>Odour complexity</td>
<td>Amount and type of odour attributes, and how they are integrated</td>
</tr>
<tr>
<td>Aroma intensity</td>
<td>Global intensity of aroma (retronasal perception)</td>
</tr>
<tr>
<td>Aroma complexity</td>
<td>Amount and type of aroma attributes (retronasal perception), and how they are integrated</td>
</tr>
<tr>
<td>Balance and body</td>
<td>Balance: situation when acidity, astringency, and bitterness (if present) are compensated by sweetness. Body: intensity of taste and, specially, mouth-feel sensations. Consistency, density, “volume” in mouth</td>
</tr>
<tr>
<td>Global aroma persistence</td>
<td>Duration of overall aroma (no taste or mouth-feel sensations) that remains after the wine has been spitted out</td>
</tr>
<tr>
<td>Colour hue</td>
<td>Colour shade of the border layer of the wine in the glass</td>
</tr>
<tr>
<td>Colour intensity</td>
<td>How easily the light goes through the wine in the glass; colour “deepness”</td>
</tr>
</tbody>
</table>
3- Definition of the top situation, quality grading and scoring criteria for each parameter

“Top situation” definition:

What are the characteristics that a typical young red wine from RA must present to be considered the ideal one?

Consideration of typicity !!

Linking score - quality grading - sensory description:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Null quality</td>
<td>Very low quality</td>
<td>Low quality</td>
<td>Medium quality</td>
<td>High quality</td>
<td>Very high quality</td>
<td>Top quality</td>
</tr>
</tbody>
</table>

Scoring criteria determined by presence / absence of particular attributes intensities

Decision trees to make easier the scoring
Scoring criteria

How is the aroma / flavour intensity?

- Lower than the reference
  - Null (almost no intensity) → 1
  - Very low → 2
  - Low → 3

- Like the reference (medium) → 4

- Higher than the reference
  - High → 5
  - Very high → 6
  - Extremely high → 7

* If an odour/aroma defect is perceived do not consider it for intensity evaluation. Just consider non-defect odour/aroma intensity. Thus, if a defect predominates the score will be in the low part of the scale.
Scoring criteria

Do you perceive any defects in the wine?
- NO
- YES

Do you perceive any key attributes* in the wine?
- One or more key attributes are perceived
  - (according to how the wine fits the definition of the ideal one)
  - The 3 key attributes perceived and well combined

* Odour/aroma key attributes for the ideal young red wine from RA: ripe fruit, liquorice, floral
Scoring criteria

Has the wine any imbalance causes?

NO

One but slight

What is the body like?

YES

Several of importance or one very important

Several but slights or one but important

and medium or low body

and high or very high body

Low

Medium

High

Very high

1 (Completely imbalanced)

2 (Quite imbalanced)

3 (A bit imbalanced)

Method development

Balance and body
Scoring criteria

Does any aroma defect remain after having spitted the wine out?

YES

NO

How long is the global aroma persistence?

< 5 s → 1
5 - 7 s → 2
8 - 10 s → 3
11 - 13 s → 4
> 14 s → 5

Important 1
Slight 2
Very slight 3
Slight 4

Global aroma persistence
What colour hue and what colour intensity of the reference is more similar to the colour hue / intensity of the wine?

<table>
<thead>
<tr>
<th>Point in the scale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality score</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
4- Definition of the evaluation procedure

By **consensus**, throughout the first 4 sessions

**Homogenization** of tasting procedure

all the assessors evaluate the wine **in the same manner**

Detailed procedure in a **evaluation handbook** provided to each assessor
Evaluation procedure

Method development

**Odour intensity**
Without moving the glass remove the Petri-dish, wait 5 seconds and evaluate global odour intensity without considering the attributes. Score odour intensity by comparison with the intensity reference.

**Odour complexity**
Swirl the glass and smell the wine several times. Indicate all the attributes perceived and give a score by using the decision tree.

**Aroma intensity and aroma complexity**
Take a sip of wine, maintain it 5 seconds in the mouth (to increase a bit the temperature), swirl it three times by sipping air and expelling this volatile enriched air through the nose. Score the aroma intensity by comparison with the reference. Simultaneously indicate all the attributes perceived and score aroma complexity by using the decision tree.

Clean the mouth with water and crackers

**Balance and body**
Take a sip of wine and move it to wet all the surface of the tongue. If you perceive any imbalance causes point it. Score the balance and body by using the decision tree.

**Global aroma persistence**
Expectorate the sip of wine and count the time that the overall aroma maintains. Score global aroma persistence by using the decision tree and, in case of perceiving any aroma defect, indicate it.

**Colour hue**
Incline the glass 45° against a white background and look at the rim of the wine. Score colour hue by comparison with the reference.

**Colour intensity**
With the glass in the same position look at the center of the sample. Score colour intensity by comparison with the reference.
**5- Definition of the score card**

**Nose parameters**

**Odour intensity**
- 1- Null
- 2- Very low
- 3- Low
- 4- Medium
- 5- High
- 6- Very high
- 7- Top

**Odour complexity**

**Attributes:**
- Ripe fruit
- Licorice
- Floral
- Un-ripe or un-determined fruit
- Over-ripe fruit
- Forest berries
- Tropical fruit
- Raisin
- Smoky
- Herbaceous
- Lactic
- Others

**Defects:**
- Lactic (exc.)
- Herbaceous (exc.)
- Rotten egg/peel
- Overheated
- Oxidized
- Pricked (acetic+glue)
- Sulfurous
- Moldy
- Others

**Mouth parameters**

**Aroma intensity**
- 1- Null
- 2- Very low
- 3- Low
- 4- Medium
- 5- High
- 6- Very high
- 7- Top

**Aroma complexity**

**Attributes:**
- Ripe fruit
- Licorice
- Floral
- Un-ripe or un-determined fruit
- Over-ripe fruit
- Forest berries
- Tropical fruit
- Raisin
- Smoky
- Herbaceous
- Lactic
- Others

**Defects:**
- Lactic (exc.)
- Herbaceous (exc.)
- Rotten egg/peel
- Overheated
- Oxidized
- Pricked (acetic+glue)
- Sulfurous
- Moldy
- Others

**Balance and body**

**Attributes:**
- 1- Null
- 2- Very low
- 3- Low
- 4- Medium
- 5- High
- 6- Very high
- 7- Top

**Causes of imbalance:**
- Exc. astringency
- Exc. acidity
- Exc. bitterness
- Lack of acidity
- Other causes of imbalance

**Global aroma persistence**

**Attributes:**
- 1- Null
- 2- Very low
- 3- Low
- 4- Medium
- 5- High
- 6- Very high
- 7- Top

**Defects:**
- Lactic (exc.)
- Herbaceous (exc.)
- Rotten egg/peel
- Overheated
- Oxidized
- Pricked (acetic+glue)
- Sulfurous
- Moldy
- Others

**Appearance parameters**

**Colour hue**

**Attributes:**
- 1- Null
- 2- Very low
- 3- Low
- 4- Medium
- 5- High
- 6- Very high
- 7- Top

**Colour intensity**

**Attributes:**
- 1- Null
- 2- Very low
- 3- Low
- 4- Medium
- 5- High
- 6- Very high
- 7- Top

**Other comments:**

**Numerical scales of 7 points**

**List of attributes and defects most frequent**
6- Definition of the contribution of each parameter to the overall quality

All the parameters do **not** have the same importance…

- **Weighting factor** for each parameter defined by discussion
  - Integration of **partial qualities** from sensory parameters
  - Overall sensory quality of the wine
## Contribution of each parameter to the overall quality

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Weight in the overall quality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“By nose” parameters</td>
<td>30</td>
</tr>
<tr>
<td>Odour intensity</td>
<td>12</td>
</tr>
<tr>
<td>Odour complexity</td>
<td>18</td>
</tr>
<tr>
<td>“In mouth” parameters</td>
<td>60</td>
</tr>
<tr>
<td>Aroma intensity</td>
<td>10</td>
</tr>
<tr>
<td>Aroma complexity</td>
<td>15</td>
</tr>
<tr>
<td>Balance-Body</td>
<td>25</td>
</tr>
<tr>
<td>Global aroma persistence</td>
<td>10</td>
</tr>
<tr>
<td>Appearance parameters</td>
<td>10</td>
</tr>
<tr>
<td>Colour hue</td>
<td>6</td>
</tr>
<tr>
<td>Colour intensity</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>
7- Sensory reference development

To **homogenize the concepts** among the participants

To **train de panel**

<table>
<thead>
<tr>
<th>Attribute / defect</th>
<th>Mother-solution (MS)</th>
<th>Reference preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odour intensity/ aroma intensity / global aroma persistence</td>
<td>300 μL of <strong>butyl acetate</strong> and 300 μL of <strong>ethyl valerate</strong> in a final volume of 30 mL of absolute ethanol.</td>
<td>Add 150 μL of MS to 400 mL of a mix of commercial wines (100 mL oaked red table wine + 300 mL unoaked red table wine) and 300 μL of butyl acetate in a final volume of 30 mL of absolute ethanol.</td>
</tr>
<tr>
<td>Ripe fruit</td>
<td>300 μL of <strong>butyl acetate</strong> in a final volume of 30 mL of absolute ethanol.</td>
<td>Add 250 μL of MS to 50 mL of BW</td>
</tr>
<tr>
<td>Forest berries</td>
<td>300 μL of <strong>“raspberry” flavour</strong> (International Flavours and Fragrances) and 250 μL of <strong>“blueberry” flavour</strong> (Givaudan) in a final volume of 30 mL of absolute ethanol.</td>
<td>Add 200 μL of MS to 50 mL of BW</td>
</tr>
<tr>
<td>Tropical fruit</td>
<td>300 μL of <strong>isoamyl acetate</strong> in a final volume of 30 mL of absolute ethanol.</td>
<td>Add 150 μL of MS to 50 mL of BW</td>
</tr>
<tr>
<td>Raisin</td>
<td></td>
<td>Add 10 mL of Pedro Ximenez raisin wine to 40 mL of BW</td>
</tr>
<tr>
<td>Floral</td>
<td>300 μL of <strong>linalool</strong> and 300 μL of <strong>geraniol</strong> in a final volume of 30 mL of absolute ethanol.</td>
<td>Add 25 μL of MS to 50 mL of BW</td>
</tr>
<tr>
<td>Liquorice</td>
<td>10 g of <strong>liquorice paste</strong> dissolved in 100 mL of distilled water</td>
<td>Add 2,5 mL of MS to 50 mL of BW</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Analysis report
Report number: 5-S08-08

Analysis report

Method identification: “PNTM-03 Sensory evaluation of young red wine from Rioja Alavesa”

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Defects and imbalance causes</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroma: Ripe fruit, Forest berry, Tropical fruit</td>
<td>Aroma: Ripe fruit, Forest berry, Tropical fruit</td>
<td></td>
</tr>
<tr>
<td>Flavour: Ripe fruit, Tropical fruit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean score of the 7 assessors

- Aroma intensity: 4.3
- Aroma complexity: 4.4
- Flavour intensity: 4.4
- Flavour complexity: 4.7
- Balance and body: 4.3
- Global flavour persistence: 4.6
- Colour hue: 4.9
- Colour intensity: 3.3

Winery:

Analyzed wine: 

Reception date: 09/05/2008
Analysis date: 28/05/2008

Uncertainty levels of the analysis are at client disposal. Results of this analysis refer only to the wine analyzed. This report cannot be reproduced without laboratory approval.

Signature of the laboratory manager:

Report sending date: 30/05/2008
The next graphics show the citation frequency of attributes, defects and imbalance causes. When they are out from the discontinuous line (citation frequency ≥5) they are considered to be present in the wine.

**Aroma attributes**

**Aroma defects**
FORMATION OF AN EXPERT PANEL AND PERFORMANCE MONITORING

- Assessor selection
- Basic training
- Specific training
- Assessor qualification
- Method validation
- Monitoring
Objective: To detect problems in sensory perception
To assure enough sensibility

Procedure and criteria described by Pérez Elortondo et al. (2007):
10 ISO tests in duplicate
Overcoming 75% of the test required

<table>
<thead>
<tr>
<th>Test</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour vision test</td>
<td>Ishihara test</td>
</tr>
<tr>
<td>Taste identification test</td>
<td>ISO 3972, 1991</td>
</tr>
<tr>
<td>Duo-trio test with sapid substances</td>
<td>ISO 10399, 2004</td>
</tr>
<tr>
<td>Triangle test with sapid substances</td>
<td>ISO 4120, 2004</td>
</tr>
<tr>
<td>Ranking test</td>
<td>ISO 8587, 1988</td>
</tr>
<tr>
<td>colour / aroma / taste / texture</td>
<td>ISO 8586-1, 1993</td>
</tr>
<tr>
<td>Description test</td>
<td></td>
</tr>
<tr>
<td>aroma / texture</td>
<td></td>
</tr>
</tbody>
</table>
Objective: To provide some basic knowledges and abilities in sensory evaluation of foods

Procedure and criteria described by Pérez Elortondo et al. (2007):

- **12 ISO tests**
- **Overcoming 75% of the test required**

<table>
<thead>
<tr>
<th>Test</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroma pairing test</td>
<td>ISO 8586-1, 1993</td>
</tr>
<tr>
<td>Paired comparison test</td>
<td>ISO 5495, 1983</td>
</tr>
<tr>
<td>aroma / taste</td>
<td></td>
</tr>
<tr>
<td>Duo-trio test</td>
<td>ISO 10399, 2004</td>
</tr>
<tr>
<td>Use of scales - one-dimensional parameters</td>
<td>ISO 4121, 2003</td>
</tr>
<tr>
<td>aroma / taste</td>
<td></td>
</tr>
<tr>
<td>Use of scales - multidimensional parameters</td>
<td>ISO 4121, 2003</td>
</tr>
<tr>
<td>aroma / flavour-taste / texture</td>
<td></td>
</tr>
<tr>
<td>Food product profiling</td>
<td>ISO 6564, 1985</td>
</tr>
<tr>
<td>aroma / flavour-taste</td>
<td></td>
</tr>
<tr>
<td>Texture profiling of food products</td>
<td>ISO 11036, 1994</td>
</tr>
</tbody>
</table>
Objective: To train the assessors to apply the method

15 sessions of 90-120 min

Reference evaluation
+ wine evaluation
+ discussion

1 ➔ 9 wine samples per session
Objective: To check if each assessor is ready to make up the expert panel

1- Repeatability in scores
Standard deviation in repeatability (SDR) ≤ 0.6 in ≥ 50% of parameters

2- Reproducibility in scores
Standard deviation in reproducibility (SDRr) ≤ 0.6 in ≥ 50% of parameters

3- Discrimination ability in scores
Discriminate the wines (A-B) by ≥ 50% of parameters discriminative with the panel

Besides checking assessor scoring ...

**Necessary to check the ability to identify attributes !!!**
4- Reference identification
Correct identification of $\geq 50\%$ of references in each block
Correct identification of $\geq 65\%$ of all the references

Session 1
- 20 references of **odour**
- 20 references of **aroma**
- 10 references of **imbalance causes**

5- Attribute identification in wine
Citation of $\geq 50\%$ attributes cited by the panel

Sessions 2 and 3
Objective: To check the reliability of the method applied by the expert panel

Parameters relative to scores:

1- **Repeatability in scores**
   \[ SDR \leq 0.5 \text{ for each parameter} \]

2- **Reproducibility in scores**
   \[ SDR_r \leq 0.8 \text{ for each parameter} \]

3- **Reproducibility in discrimination ability in scores**
   Discriminative parameters in session 2 between 50% and 150% of discriminative parameters in session 1
How to deal with attribute citation ????

... no references available

Parameters relative to attribute citation:

4- Repeatability in attribute identification
Citation difference among replications $\leq 2$ for $\geq 80\%$ of attributes with Citation Frequency (CF) $\geq 50\%$.

5- Reproducibility in attribute identification
Citation difference between sessions 1 and 2 $\leq 6$ for $\geq 80\%$ of attributes with CF $\geq 50\%$.

6- Reproducibility in discrimination ability in attribute identification
Discriminative attributes in session 2 between 50% and 150% of the number of discriminative attributes in session 1.
Monitoring

Objective: To check the performance of the panel and each assessor
To check periodically the reliability of the method

- **Annually**
  - Assessor requalification
    - Same tests and criteria as in qualification

- **Each 150 samples**
  - Quality control
    - Same tests and criteria as in method validation

- **At each session**
  - Panel monitoring
  - Individual assessor monitoring
At each session:

Panel monitoring

Score dispersion
SD ≤ 1 at least for 6 of the 8 parameters for each wine

Individual assessor monitoring

1- Score agreement with the panel
Assessor scores within rounded panel score ±1 in at least 85% of the cases

2- Attribute agreement with the panel
   2.a- Citation ≥ 50% of the attributes identified by the panel
   2.b- Number of attributes cited only by the assessor < 3 x number of samples
CONCLUSIONS
Conclusions

FIRST – The method developed in this work applied by a panel of expert assessors makes possible to evaluate the sensory quality of the young red wines from Rioja Alavesa in a rigorous and reliable way. The procedures and criteria about attribute citation developed for assessor qualification, method validation and control of assessor performance can be very useful for other laboratories and accreditation bodies.

SECOND – Working with a group of people with great knowledge of the product, use of decision trees and development of sensory references are very important aspects when developing methods to evaluate the sensory quality of specific products, especially when typicity is considered.

THIRD – The consideration of attribute citation frequency by the panel is an effective tool to determine the perception degree of an attribute in the product. This information complements the numerical scores, so providing a more detailed description of the product quality.
Vino tinto joven Rioja Alavesa

Análisis sensorial:
- Mediante pruebas escalares
  - Intensidad de color
  - Matiz
  - Intensidad de olor
  - Complejidad de olor
  - Intensidad de aroma
  - Complejidad de aroma
  - Equilibrio - cuerpo
  - Persistencia aromática global
- Identificación de descriptores y defectos por mayoría

Procedimiento interno PNTM-03
Sensory quality control for food certification: A case study on wine. Method development

I. Etaio, M. Albisu, M. Ojeda, P.F. Gil, J. Salmerón, F.J. Pérez Elortondo *

Sensory quality control for food certification: A case study on wine. Panel training and qualification, method validation and monitoring

I. Etaio, M. Albisu, M. Ojeda, P.F. Gil, J. Salmerón, F.J. Pérez Elortondo *
THANK YOU FOR YOUR ATTENTION!