Oak aging influence on wine quality

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Introduction

— Oak Wood Extractible Composition
— Formation of Anthocyanos-Ellagitannins in wine after oak barrels aging
— Organoleptic impact of Ellagitannins
— Objectives
— Experimental design

RESULTS

Barrels

Chateau 01
— Aromatic compounds in wine after six and twelve months in contact with barrels.
— Sensory profile, ellagitannins perception and total ellagitannins concentration.
— Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.

Chateau 02
— Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.
— Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.

Chateau 03
— Aromatic compounds in wine after six and twelve months in contact with barrels.
— Sensory profile, ellagitannins perception and total ellagitannins concentration.
— Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.

Chateau 04
— Aromatic compounds in wine after six and twelve months in contact with barrels.
— Sensory profile, ellagitannins perception and total ellagitannins concentration.
— Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.

Conclusion

Barrels

RESULTS - Oak Chips (3 gr/L and 10 gr/L)

— OAK CHIPS aromatic profile (3 gr/L)
— OAK CHIPS aromatic profile (10 gr/L)
— Extraction kinetic of oak wood ellagitannins (3 and 10 gr/L)
— Sensory profile (oak 3 gr/L)
— Sensory profile (oak 10 gr/L)
— Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration in model wine solution (wood pieces concentration 3 gr/L).

RESULTS - Staves

— Extraction kinetic of staves aromas in wine during twelve months.
— Extraction kinetic of staves aromas in wine during twelve months.
— Extraction kinetic of staves ellagitannins.
— Sensory profile, ellagitannins perception of staves after six and twelve months.
— Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.

Conclusion

Oak Chips AND STAVES
**Introduction**

**Phenolic Compounds → Wine Quality Parameters**

- **Anthocyanins → Color (Glories, 1984)**
- **Tannins → Color Stabilization**
- **Condensed Tannins** (procyanidins, prodelphinidins)
- **Hydrosoluble Tannins** (ellagitannins and gallotannins)
- **Sensory Properties**
  - **Astringency**: Mouthfeel, Tactile Sensation (Bate-Smith, 1954, Breslin et al., 1993)
  - **Bitterness**: Taste (Noble, 1990)

**Oak Aging Influence on Wine Quality**

**Oak Wood Extractible Composition**

- **Phenolic compounds → Hydrosoluble tannins (gallotannins and ellagitannins)**
- **Volatile compounds + Phenolic compounds**

**Threshold perception for aromatic compounds in red wine**

<table>
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<tr>
<th></th>
<th>Almond/Grilled Almond</th>
<th>Smokey/Toasted bread</th>
<th>Coconut/whisky</th>
<th>Spicy</th>
<th>Vanilla</th>
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<td>45000</td>
<td>75</td>
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<td>500</td>
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<tr>
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<td>320</td>
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<td>Guaiacol</td>
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<tr>
<td>trans-Whisky lactone</td>
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<td>cis-Whisky</td>
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<td>Isoeugenol</td>
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<td>Vanillin</td>
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<td>Bitterness: Taste</td>
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</table>

**Volatile compounds**

- Oak lactone (cis/trans-Whisky lactone), coconut woody note
- Phenolic aldehydes (vanillin...), vanilla aroma
- Furanic compounds (furfural...), grilled flavor
- Phenols (Eugenol, Guaiacol...), spicy, smoky flavor

**Ellagitannins**

- Monomers
- Dimers
- Glucosidic Monomers
- Glucosidic Dimers

**Phenolic aldehydes**

- Vanillin, Eugenol, Guaiacol, 4-methyl Guaiacol, o-cresol, Syringol, Furfural, 5-Methylfurfural, Syringaldehyde and Ethyl-Vanillin

**Ellagic acid**

**Vescalagin**

**Castalagin**

- Grandinin: Lycose
- Roburin E: Xylose
- Roburin A: R1 = β-OH
- Roburin D: R1 = α-OH
- Dimers
- 60-70% of oak wood ellagitannins
Formation of Anthocyano-Ellagitannins in wine after oak barrels aging

Purple-colored anthocyano-ellagitannins, derived from the oak ellagitannins vescalagin and the red-colored grape pigments oenin and malvidin, are likely actors in wine color modulation during aging in oak barrels.

Glycosylated monomers are 5 times more astringent than monomers and 3 times more bitter. Monomers are astringents but very low bitterness. Dimers are less astringent than monomers but 2 times more bitter.

Half-mouth test in aqueous solution pH 4.5

Objectives

Extraction kinetic of aromas and tannins of oak chips, staves in wine/model solution and extraction kinetic of aromas and tannins of wines aging in barrels. Impact of toasting level on aromas and tannins.

Chemical analysis:
Aromatic compounds and hydrolysable tannins

Sensory analysis:
Aromatic descriptors and tannin perception

Impact of toasting level

Experimental design

Evaluation of descriptors in a point scale of 0 to 7

Aroma
(vanilla, grilled/smoky, spicy)

Perception
(sweet, astringency, bitterness)

20 judges
(10 training sessions, according to ISO 8586-2 2008)

Astringency
Bitterness

0 1 2 3 4 5 6 7

Absent Intensive

0 nil
1 very weak
2 weak
3 mean
4 barely strong
5 strong
6 very strong
7 depreciative
Results

1. Barrels
2. Oak Chips
3. Staves

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**Results**

1. Barrels

Château 1 Médoc
Château 2 Macau Médoc
Château 3 Graves
Château 4 Pessac Léognan

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**Sensory profile, ellagitannins perception and total ellagitannins concentration.**

Château 1

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**Aromatic compounds in wine after six and twelve months in contact with barrels.**

Château 1
Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.

GRILLED / SMOKEY AROMAS

VANILLA / SPICY AROMAS

Elagatannins, mg/L

Aromatic compounds in wine after six and twelve months in contact with barrels.
Sensory profile, ellagitannins perception and total ellagitannins concentration.

Aromatic compounds in wine after six and twelve months in contact with barrels.

15

16

GRILLED / SMOKEY AROMAS

VANILLA / SPICY AROMAS

9 months

12 months

6 months

12 months

17

18

Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.
Conclusion (barrels)

Aromas and tannins kinetics extractions varied according to wine, toasting method and forest origin.

Wines aged in «Colbert» and «Centre MT» present higher ellagitannins levels whereas wines aged in «Slavonia» MT present lower ellagitannins levels.

Wines aged in «AO MT TH» and in «Slavonia MT» presented the higher levels of whisky lactone and vanillin respectively, at the same time were perceived to dispose more vanilla flavor.

Independent of varietal, wines aged in barrels «Colbert MT» have the most important concentrations of furfural (grilled almond).

The vanillin (aromatic compound) as well as the vanilla flavor intensify during aging (≈ 30%-50% for vanillin, ≈ 10%-30% for vanilla flavor).

Regarding sensory evaluation, the sweetness perception increases during aging and tannins perceived softer and mellow.

Results

2. Oak Chips (3 gr/L and 10 gr/L)

UN (Untoasted)
MT (Medium Toast)
MT+ (Medium Plus Toast)
«Noisette»
**OAK CHIPS aromatic profile (3 gr/L)**

- Extraction kinetic of oak wood ellagitannins (3 and 10 gr/L)
  - Sensory profile (oak 3 gr/L)
  - Extraction Kinetic Of Ellagitannins In Model Wine Solution during three months.
  - Ellagitannins concentration estimated by acidic hydrolysis and expressed as mg equivalent of released ellagic acid per L.
  - Stabilization and maximum extraction after two months.
  - The size of the wood pieces as well as the type of heating influence ellagitannins concentrations.
  - The untoasted showed the highest concentrations of ellagitannins.

- Vanilla and spicy aromas were more intense for «Noisette» and MT.

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**OAK CHIPS aromatic profile (10 gr/L)**

- Extraction kinetic of oak wood ellagitannins (3 and 10 gr/L)
  - Sensory profile (oak 3 gr/L)
  - Extraction Kinetic Of Ellagitannins In Model Wine Solution during three months.
  - Ellagitannins concentration estimated by acidic hydrolysis and expressed as mg equivalent of released ellagic acid per L.
  - Stabilization and maximum extraction after two months.
  - The size of the wood pieces as well as the type of heating influence ellagitannins concentrations.
  - The untoasted showed the highest concentrations of ellagitannins.

- Vanilla and spicy aromas were more intense for «Noisette» and MT.
Sensory profile (oak 10 gr/L)

Vanilla and spicy aromas were more intense for “Noisette” and MT.

Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration in model wine solution (wood pieces concentration 3 gr/L).

Results

3. Staves

CONTROL
MT (Medium Toast)
MT+ (Medium Plus Toast)
“NOISSETTE”
SPECIAL

Wine 100% Merlot

The untoasted wood pieces showed the highest concentrations of ellagitannins and the highest intensities of bitterness and astringency.

The “Noisette” showed the higher concentrations of eugenol, vanillin and present more vanilla and spicy aromas.

The MT and MT+ showed higher concentrations of methyl-guaiacol and guaiacol and were perceived more smoky and grilled.
Extraction kinetic of staves aromas in wine during twelve months.

Extraction kinetic of staves ellagitannins in wine during twelve months.

Maximum extraction after two or three months. The MT showed the highest concentrations of ellagitannins after 3 months.

Sensory profile, ellagitannins perception of staves after six and twelve months.

All the aromas and the sweet flavor have a tendency to intensify during 12 months.
Aromatic and sensory profile, ellagitannins perception and total ellagitannins concentration.

Aromas and tannins kinetics extractions of wood pieces in model solution and wine as well as their organoleptic perception depend on their toasting level and maceration time.

- Aromas and ellagitannins extraction is maximum after 2 months (OAK CHIPS).
- Noisette Toast and Medium Toast were perceived more spicy and with more vanilla flavor (OAK CHIPS).
- The 10gr/L dosage in comparison with the dosage 3gr/L permit to extract the same aromatic compounds and ellagitannins but quicker and with highest concentrations (> 50%-70% for aromatic compounds and ~ 50% for ellagitannins).
- At sensory level the 10g/L dosage in comparison with the 3gr/L dosage permit to intensify the aromas (~10%-15%) (OAK CHIPS)
- Grilled almond/almond and vanilla flavors become maximum after 3 and 12 months respectively (STAVES).
- At sensory level the aromas like vanilla become more intense (~10%), tannins are perceived softer and the sweet flavor increases (~10%) during time (STAVES).
- The untoasted (OAK CHIPS) give highest concentrations of total ellagitannins.

Conclusion (Oak Chips and Staves)