Closure impact on post-bottling wine development

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Use of cork throughout the years

- V.A.C.
- 1680
- Grece
- Don Pérignon
- 1680 – 1980’s
- 100% cork
- 1990’s
- Alternatives
Synthetics 13%
Screw caps 20%
Others 1%
Cork stoppers 66%

17 à 18 milliards de bouteilles (0,75, 1 et 1,5 L)
Different types of wine closures

**ALUMINUM**
- **Source:** Environmentally destructive open pit mining
- Greenhouse Gas Emissions: 37g
- Non-Renewable Energy Consumption: 425 MJ
- Total Production of Solid Waste: 8.2 kg
- Water Consumption: 14 m³

**PLASTIC**
- **Source:** Non-renewable petroleum
- Greenhouse Gas Emissions: 16g
- Non-Renewable Energy Consumption: 625 MJ
- Total Production of Solid Waste: 5.8 kg
- Water Consumption: 41 m³

**CORK**
- **Source:** Bark from trees that are never cut down, the bark is simply harvested every 9 years
- Greenhouse Gas Emissions: 5g
- Non-Renewable Energy Consumption: 100 MJ
- Total Production of Solid Waste: 3.7 kg
- Water Consumption: 25 m³
Diferent types of wine closures

- **SARANEX 38.**
  From experience, Saranex 38 is used for right oxygen permeability values.

- **SARAN TIN.**
  From experience, Saran Tin is used for lower oxygen permeability values.

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Amcor - pioneer of Stelvin® aluminium screw caps and liners for wine - innovates by launching Stelvin Inside, a brand new range of four different liners.

All of the films used in the liners are produced by Amcor. The liners are manufactured exclusively by our development partner M3J.

- Targeted OTRs (Oxygen Transmission Rate) with low level of oxygen dispersion
- Low, medium and high barrier permeability
- PVDC-Free

Stelvin® Inside doubles OTR choice helping you to craft and perfect your wine.
Different types of wine closures

PLASTIC

SOURCE: NON-RENEWABLE PETROLEUM

- Greenhouse Gas Emissions
  - 16G
- Non-Renewable Energy Consumption
  - 625 MJ
- Total Production of Solid Waste
  - 5.8 KG

- Water Consumption
  - 41 m³

FOAMED CORE
The uniformity of cell size and density in Nomacorc products provides consistent and predictable oxygen permeation.

OUTER SKIN
The elastic outer skin on Nomacorc products ensures that no leakage occurs during bottling or storage. This flexible skin also provides support and protection during the bottling process. For the consumer, the Nomacorc skin replicates the look and feel of natural cork.

Automated Extrusion Lines

Skin Materials

Foam Materials

Co-extrusion Process

Water Cooling

Transfer to Printing & Packaging
Different types of wine closures
To understand closure impact on post-bottling wine development is important to know their gas barrier properties.
Main routes by which \( \text{O}_2 \) enters into bottles

Cork stoppers releases \( \text{O}_2 \) into wine = cork are not permeable to atm. \( \text{O}_2 \) while synthetic are clearly permeable to atm. \( \text{O}_2 \)
Oxygen Transmission Rates (OTR) of various closures

Oxygen transmission rates (OTR)*

\[
\text{OTR} = \frac{\text{Amount of } O_2 \text{ at 36 months} - \text{Amount of } O_2 \text{ at 1 month}}{\text{(number of days from 1 to 36) month}}
\]
Closure OTR is only one parameter. Other include: grape variety; winemaking; wine style; bottling and storage.

X : depends of the wine composition and particularly of the antioxidant components, naturally present or added.
Impact of closure on wine development during post-bottling

Impact on the antioxidant components

Wine (Sauvignon blanc) development with different closures

Closure impact on volatile sulfur compounds (VSC)

Good thiols = Varietal fruity characters of Sauvignon blanc

3-mercaptohexan-1-ol (3MH)
Passion fruit (R), Grapefruit (S)
Olfactory threshold: 50 / 60 ng/L

3-mercaptohexylacetate (3MHA)
Passion fruit (R), citrus (S)
Olfactory threshold: 9 / 2.5 ng/L

4-mercapto-4-methylpentan-2-one (4MMP)
Broom...cat’pee
Olfactory threshold: 0.8 ng/L
Fruity thiols = Good thiols...important to other varieties

<table>
<thead>
<tr>
<th>Cépages</th>
<th>4MMP</th>
<th>4MMPOH</th>
<th>3MMB</th>
<th>A3MH</th>
<th>3MH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gewurztraminer</td>
<td>0~15</td>
<td>5~10</td>
<td>900~1400</td>
<td>2~6</td>
<td>2000~3300</td>
</tr>
<tr>
<td>Riesling</td>
<td>0~8</td>
<td>0~4</td>
<td>45~110</td>
<td>0~3</td>
<td>550~1000</td>
</tr>
<tr>
<td>Muscat</td>
<td>30~100</td>
<td>4~30</td>
<td>20~140</td>
<td>0</td>
<td>260~600</td>
</tr>
<tr>
<td>Petit manseng</td>
<td>0</td>
<td>0</td>
<td>20~40</td>
<td>5~100</td>
<td>1000~5000</td>
</tr>
<tr>
<td>Colombard</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20~60</td>
<td>400~1000</td>
</tr>
</tbody>
</table>

These compounds are also present with other white varieties such as Chardonnay and red varieties; however, they do not have such a powerful impact on their varietal characters.
Impact of closure OTR on fruity aroma during post-bottling

Compounds responsible for the fruity character of wine are very oxygen sensitive!!!

VSC also responsible for wine reduction

“Bad thiols”

At subthreshold levels can contribute to the wine aromatic complexity
Development of reductive flavours during post-bottling

Most airtight closures conduct to reductive development of wine!!!
Compounds responsible for wine oxidation

**Acetaldehyde**
- Bruised apple, sherry, nutty
- Olfactory threshold: 40 mg/L

**Benzaldehyde**
- Nutty, sherry
- Olfactory threshold: 3 mg/L

**Phenylacetaldehyde**
- Honey, rose, “farm-feed”
- Olfactory threshold: 25 μg/L

**Methional**
- “Boiled-potato”
- Olfactory threshold: 0,5 μg/L

**Sotolon**
- Nutty, rancio, curry
- Olfactory threshold: 2 μg/L

**2-aminocetophenone**
- Rancio, “foxy”
- Olfactory threshold: 0,7 à 1 μg/L
Development of oxidative during post-bottling with different closures

Premature wine development is related with oxygen permeability of different closures!!!

Impact of closure on red wine development over post-bottling

Chemical development after 20 months of storage

Factor 1: 53.61%
Factor 2: 10.34%

Free anthocyanins
TA+
A-vinyl-T
Pyranoanthocyanins
% Polymerized anthocyanins
Phenolic acids
Flavanols
Flavonols
Tannins
DPm
Total SO₂
Free SO₂
Acetaldehyde
IC'
d420%
d520%
d620%
A-ethyl-T
Hue

T₀

6 months

12 months

20 months

wine development

Factor 1: 53.61%
Factor 2: 10.34%
Impact of closure on red wine development over post-bottling

Sensory assessment at 36 months of storage

Managing the risk of post-bottling reduction by bottle ullage

24 month sensory results for 2002 red wine *Cabernet Sauvignon*

Ullage volume and copper treatment do not prevent formation of reduced characters.
Metal catalysed wine oxidation mechanism

1. Oxygen solubilization

\[ \text{O}_2 \xrightarrow{\text{Temperature}} \text{O}_2 \xrightarrow{\text{Temperature}} \text{O}_2 \xrightarrow{\text{Temperature}} \text{O}_2 \]

Metal catalysed wine oxidation mechanism

2. Oxygen consumption

O₂

Temperature = Oxygen consumption

Possible post-bottling reduction mechanism

- Sulfites
- Pesticides
- Sulfate
- Sulfur containing amino acids
- SO$_2$
- Inorganic sulfur

Metal Catalyzed

- Sulfites
- Cuechol
- Quinone
- Semiquinone

- Ethanol (CH$_3$CH$_2$OH)
- Ethanethiol (CH$_3$CH$_2$SH)

- Rotten egg, sewage like aroma
- Onion, rubbery, burnt match aroma
Oxydo-reductive development of white wine

**During the first months of post-bottling**

**Wine aroma**

<table>
<thead>
<tr>
<th>Aroma Description</th>
<th>Taste: bitter and metallic</th>
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<tbody>
<tr>
<td>Sewage like aroma, rotten egg</td>
<td>Reduction</td>
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<tr>
<td>Cabbage, gunpowder, burnt match</td>
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<td>Oxydation</td>
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**Taste:**
- During the first months of post-bottling:
  - Taste: hollow, short and “dry”
**Oxydo-reductive development of white wine**

**During the first years of post-bottling**

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Taste: hollow, short and “dry”

- Screw cap saran-tin
- Screw cap saranex
- Technical cork
- Natural cork
- Synthetic
Oxydo-reductive development of white wine

During the long periods of storage

**Wine aroma**

- Sewage like aroma, rotten egg
- Cabbage, gunpowder, burnt match
- Mineral, silex, toasty
- Citrus
- Fresh white fruit (pear, lychee) or exotic fruits (pineapple, grapefruit, passion fruit)
- Cooked fruits, praliné, hazelnut
- Honey, bruised apple, Port, sherry
- Bee´s wax, rancio
- Acetaldehyde, nutts, curry

**Taste:** bitter and metallic

**Reduction**

**Optimum state**

**Oxydation**

**Taste:** hollow, short and “dry”

- Screw cap saran-tin
- Screw cap saranex
- Technical cork
- Natural cork
- Synthetic cork

**Taste:** bitter and metallic
Wine developments with closures are perceived by experts.
Closure impact the consumer wine linking

Closure influence wines development during post-bottling in a such way that will affect the liking and preference of consumers

Tasting exercise
Where you will classify this wine?

**Wine aroma**

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1 Control Sauvignon Blanc
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Where you will classify this wine?

**Control**

- **Acetaldehyde**
  - \( C_2H_4O \)
  - 10 mg/L
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Where you will classify this wine?

Control

Acetaldehyde

C₂H₄O

100 mg/L
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Control

Hydrogen sulfide

H₂S

2 µg/L
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**Where you will classify this wine?**

5
Control

+ Hydrogen sulfide

\( \text{H}_2\text{S} \)

20 \( \mu \text{g/L} \)
Thanks very much!!!!

Questions, critics, comments

Email: pdlopes.ai@amorim.com
LinkedIn: Paulo Lopes