The use of cork as a production tool during the production of bottle-fermented sparkling wine

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Introduction

Production of bottle fermented sparkling wine

Ivit NN, Kemp B. 2018. The Impact of Non-Saccharomyces Yeast on Traditional Method Sparkling Wine. Fermentation 4, 73; doi:10.3390/fermentation4030073
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Introduction

- Second fermentation - standard practice is a crown cap.
- Ease of automation on bottling and disgorgement line.
- The first crown caps were used commercially in 1960.
- Previously bottles were closed with a cork held in place with a metal clip/staple (agrafe).
- Some producers, e.g. some Champagne Houses never switched for premium products – continued use of the traditional method (cork).
- Perceived favourable sensory outcome, despite the risk of cork-taint (2,4,6-trichloroanisole).
- Some Champagnes e.g. Dom Perignon Plénitude contact with cork for 15 years.
- Methode Cap Classique (MCC) industry is an important sector:
  - Competitive market - increase quality and produce niche products.
  - One of the tools: cork closure instead of a crown cap during the second fermentation.
Cork?

- Cork’s beneficial role in the maturation of still wines well-researched.
- Compounds such as phenolics migrate from the cork into the still wine.
- Phenolic compounds have the ability to bind with both proteins and peptides.
- The potential effect of the phenolic/protein interaction in the sparkling wine could theoretically impact the sensory attributes of the wine, but......
- Sparkling wine bottle: high pressure; thin layer of natural cork (one/two-disc cork) as a closure, as opposed to the traditional still wine cork.
- Will the result be the same?
- Anecdotal evidence noted by MCC producers using cork closure:
  - Stylistic changes in the wines.
  - Improved foam stability/bubble retention time (slower loss of CO₂ from the glass).
  - Improved bubble texture (smaller bubbles).
  - Increase in the wine complexity.
  - Beneficial ‘cork effect’ becomes more noticeable the longer the wine is in contact with the cork.
Aim

• Limited published literature available to guide South African producers.
• A selection of bottle fermented experimental and commercial sparkling wines closed with corks (two-disc) and crown caps were investigated for physical, chemical and sensory differences.
Experimental design

- Limited published literature available to guide South African producers
- A selection of bottle fermented experimental and commercial sparkling wines closed with corks (two-disc) and crown caps were investigated for physical, chemical and sensory differences.
- Six wine pairs, five vintages, three producers, different times on lees.

<table>
<thead>
<tr>
<th>Vintage</th>
<th>Wine code</th>
<th>Closure</th>
<th>Number of months on lees</th>
<th>Producer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>LL12 Co</td>
<td>Cork</td>
<td>72</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>LL12 Cr</td>
<td>Crown</td>
<td>72</td>
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<tr>
<td>2013</td>
<td>LL13 Co</td>
<td>Cork</td>
<td>60</td>
<td>1</td>
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<tr>
<td></td>
<td>LL13 Cr</td>
<td>Crown</td>
<td>60</td>
<td>1</td>
</tr>
<tr>
<td>2014</td>
<td>LL14 Co</td>
<td>Cork</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>LL14 Cr</td>
<td>Crown</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>2014</td>
<td>GB14 Co</td>
<td>Cork</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>GB14 Cr</td>
<td>Crown</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>2015</td>
<td>LO15 Co</td>
<td>Cork</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>LO15 Cr</td>
<td>Crown</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>2018</td>
<td>GB18 Co</td>
<td>Cork</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>GB18 Cr</td>
<td>Crown</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>


- Cork closures from three different cork suppliers.

Cork and Crown wine analyses

- Pressure kPa at 20°C, Dissolved CO₂ (g/L), O₂ (mg/L).
- Wine clarified (remove lees) by centrifugation before chemical analyses.
- pH, malic acid, total acidity.
- Total yeast count (cells/mL), Sugar (°Balling), Alcohol (%), YAN (mg/L), Total extract (g/L).
- Phenolic classes: Phenolic acids; Flavonols; Flavanols.
- Phenolic acids: Gallic acid, Caftaric acid, Caffeic acid, p-Coumaric acid.
- Three to five bottles analysed.
pH, malic and total acidity
### Pressure, CO₂, O₂

<table>
<thead>
<tr>
<th>Parameter measured</th>
<th>Wine investigated n = 5 ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LL12 Co</td>
</tr>
<tr>
<td>Pressure kPa at 20°C</td>
<td>264.60b ± 24.20</td>
</tr>
<tr>
<td>Dissolved CO₂ (g/L)</td>
<td>7.71b ± 0.34</td>
</tr>
<tr>
<td>O₂ (mg/L)</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>LL13 Co</td>
</tr>
<tr>
<td>Pressure kPa at 20°C</td>
<td>461.70b ± 32.80</td>
</tr>
<tr>
<td>Dissolved CO₂ (g/L)</td>
<td>9.20b ± 0.72</td>
</tr>
<tr>
<td>O₂ (mg/L)</td>
<td>0.020a ± 0.030</td>
</tr>
<tr>
<td></td>
<td>LL14 Co</td>
</tr>
<tr>
<td>Pressure kPa at 20°C</td>
<td>521.30a ± 9.10</td>
</tr>
<tr>
<td>Dissolved CO₂ (g/L)</td>
<td>11.15b ± 0.24</td>
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<tr>
<td>O₂ (mg/L)</td>
<td>0.035a ± 0.032</td>
</tr>
<tr>
<td></td>
<td>GB14 Co</td>
</tr>
<tr>
<td>Pressure kPa at 20°C</td>
<td>480.10a ± 32.60</td>
</tr>
<tr>
<td>Dissolved CO₂ (g/L)</td>
<td>8.95b ± 0.05</td>
</tr>
<tr>
<td>O₂ (mg/L)</td>
<td>0.057a ± 0.029</td>
</tr>
<tr>
<td></td>
<td>LO15 Co</td>
</tr>
<tr>
<td>Pressure kPa at 20°C</td>
<td>621.20a ± 16.80</td>
</tr>
<tr>
<td>Dissolved CO₂ (g/L)</td>
<td>10.94a ± 0.07</td>
</tr>
<tr>
<td>O₂ (mg/L)</td>
<td>0.108a ± 0.095</td>
</tr>
<tr>
<td></td>
<td>GB18 Co</td>
</tr>
<tr>
<td>Pressure kPa at 20°C</td>
<td>450.80b ± 10.70</td>
</tr>
<tr>
<td>Dissolved CO₂ (g/L)</td>
<td>9.55b ± 0.16</td>
</tr>
<tr>
<td>O₂ (mg/L)</td>
<td>0.052a ± 0.009</td>
</tr>
</tbody>
</table>

- Pressures within limit.
- Crown capped had higher pressure, but only significant for some.
- Crown cap a better barrier.
- No differences in oxygen.
Mid infra-red spectroscopy – spectral fingerprints
Mid infra-red spectroscopy – spectral fingerprints

Older wines
Mid infra-red spectroscopy – spectral fingerprints

Younger wines
Total yeast cell count, alcohol, residual sugar, YAN, total extract

- Total cells, alcohol and residual sugar - some significant differences, but no pattern.
- Bottle variation?
- YAN and total extract – broad indication of degree of yeast autolyses.
- Overall:
  - Older crown capped wines (60-72 months on lees): yeast autolyses more advanced than cork counterparts.
  - 39 to 48 months on lees: yeast autolyses the same.
  - Younger wines (< 4 months): faster in the cork closed wines.
Phenolic content

• Main source of phenolics – grapes.
• Corks – secondary source.
• Still wines – phenolic compounds migrate into wine.
• Measure phenolic classes (total phenolic acids, flavanols, flavonols).
• Phenolic acids (gallic, caffeic, caftaric and $p$-coumaric) - useful marker compounds.
• Results:
  – Phenolic classes – differences, sometime significant, no consistent pattern.
  – Phenolic acids…
Phenolic acids: gallic, caffeic, caftaric and p-coumaric

• Clear distinction, but no pattern linked to the individual marker compounds.
• Possibly due to polymerisation of monomeric phenolic compounds.
Phenolic acids: gallic, caffeic, caftaric and p-coumaric

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- Possibly due to polymerisation of monomeric phenolic compounds.
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- 2018 wines - least time on lees (4 months).
  - Migration and polymerisation faster than originally surmised.
  - Area of cork related to cork roughness and porosity.
25 descriptors for CATA (Check All That Apply).

- No cork taint.
- Phenolic compounds contribute sensorially astringency, bitterness, mouthfeel/structure and flavour.
- Affected by pH, sweetness and alcohol.
- Different sensory profiles, but some overlaps.

2018 not tasted due to not being on lees the required months.
• Differences more pronounced in older wines (2012-2014) less in younger wine (2015).
• Overall cork associated with:
  – visually smaller bubbles, less autolytic character, longer aftertaste and for older wines yeasty/toasty.
• Crown capped associated with:
  – visually larger bubbles, more pronounced autolytic character shorter aftertaste.
  – Smaller bubbles and longer aftertaste; perception of more complexity.

2018 not tasted due to not being on lees the required months.
**CO₂ kinetics: loss from the glass (20 minutes)**

- 10 to 20 minutes?
- Overall tendency for slower release from cork wines.
- Cork wines had lower pressures.
CO$_2$ kinetics: bubble count

**CO₂ kinetics: bubble count**

**CO₂ kinetics – Number of bubbles**

10 minutes after pouring

- Wines pairs differed.
- Average:
  - 10 min: Cork closed wines had more bubbles compared to crown.
  - 20 min: Number of bubbles the same for cork and crown.
Past research: Use of cork during ageing on lees - agrafe

**CO₂ kinetics – Number of bubbles**

10 minutes after pouring

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20 minutes after pouring
Different corks?

- Changes in the phenolic profile of the wine: phenolic classes and acids.
- Gallic acid was significantly highest in Cork A wines.
- Cork R wines were strongly associated with caffeic, gallic and caftaric acids and total flavanols.
- Cork origin (cork supplier) can bring about subtle differences.
- Cork is a natural product.
Conclusions - use of cork vs. crown cap during ageing on lees

- **Infra-red spectroscopy** a powerful and inexpensive tool to illustrate differences between the pairs of cork-crown wines.
- **Cork-closed wines** can have **lower pressure** (within legal requirements).
- Contact with the cork results in changes in the wine’s phenolic acid profile. Gallic, caftaric, caffeic and p-coumaric acids can be used collectively as marker compounds to differentiate between cork and crown-capped wines.
- **Sensorial changes** to the wines. Cork-closed wines have less autolytic character but are more complex and have a longer aftertaste.
- An effect on the CO$_2$ kinetics can also occur. After pouring cork-closed wines lost CO$_2$ slower than the crown-capped wines with visually more and smaller bubbles. Lower pressure?
- Effect of cork on foam stability, bubble texture and stylistic changes in MCC wine is supported.
Future: Cork and crown post degorgement

Schematic layout

Crown 2018
- DEGORE
  - Top Up and Crown
    - 12 bt
    - 12 bt
  - Time 4 month
  - Lab Analysis
    - 6 bt
- NO DEGORE
  - No Change - Crown
    - 12 bt
    - 12 bt
- Lab Analysis
  - 6 bt
- Sensorial Analysis
  - 6 bt

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  - 6 bt

2018 wines – one year on lees
2014 wines – five year on lees
Thank you / Dankie