Closure Quality Control at Southcorp Wines

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Introduction
This paper describes the quality assurance procedures for evaluating cork at delivery to the winery. The physical tests which are designed to evaluate closure efficiency are reviewed. These include grading and dimensions, moisture content and extraction force. The major focus, however, is the prevention of cork taint. The development of taint assessment procedures which culminated in the current method are outlined. These include the categorisation of cork taints, recognition of unacceptable taints, and the determination of the incidence of taint.

Sampling
Prior to any assessment, a representative sample must be taken. At Southcorp Wines, a fixed sampling frequency of 1000 corks for batches up to 500000 is used. This sampling regime complies with the 'normal' sampling format of the Military Standards 105D sampling protocol (Standards Australia 1988). Accordingly, sampling sensitivity is enhanced for those orders comprised of less than 500000 units. It is crucial that samples be taken randomly, in order to ensure that the samples are representative of the batch.

The 1000 corks are accumulated by the suppliers, who take samples from each surface treatment batch. These have been effectively mixed by the tumbling action of the de-dusting and treatment processes. The 1000 corks are further randomly sampled for the individual tests.

Physical testing

Dimensions
Physical dimensions are determined to ensure that the corks are actually cylindrical stoppers that meet purchase specifications. The average diameter and length of 25 corks are measured, and must meet the following standards:

- length: ±0.5 mm; and
deiameter: ±0.4 mm.

Growth rings
The number of growth rings of 25 corks are counted. The average must be at least 5.5 rings across the profile.

Grade
One hundred corks are categorised by grade, and all minor and major defects are noted. If the major grade does not correspond with that specified when the corks were ordered, and/or there are more than the specified number of major defects, the batch may be rejected.

Moisture content
Moisture content is a very important parameter, as effective sealing relies on the elasticity and ability of the cork to recover its shape after compression, which are both related to the moisture content of the cork. The moisture content of 50 corks is determined using a KPM Aquapam moisture meter. The standards applied are:

- natural cork: 6.5% ± 1.5%;
- agglomerate cork or sparkling wine plug: 6.0% ± 2%; and
- sparkling wine face/disc: 6.0% ± 2%.

Extraction
The extraction force is measured by a Chatillion force gauge on 25 corks previously inserted into CETIE bottles, filled with water at ambient temperature. After 48 hours, the corks are removed by a Macosin E1 force applicator at a constant removal rate of 50 cm/min.

The average extraction force required for all of the 25 corks is determined, and must fall between 220 and 350 N. The variation in force obtained for the aggregate sample is always high, and is usually in excess of 100 N. If the average force of the batch is within specifications, but individual corks have a high or low extraction force outside the specified range, the batch may be re-examined or rejected.

Organoleptic assessment
Development
Initial taint assessment involved filling 17 bottles, each holding 4 corks, with white wine. The filled bottles were incubated for 7 days at ambient temperature before organoleptic assessment. Approximately 4 years ago, a company merger introduced a radically different cork assessment procedure. This involved placing 100 corks into 2L white wine and organoleptically assessing the wine after 24 hours.

These two procedures were compared by examining 3 different batches of corks. The latter method indicated that none of the 3 batches were tainted, while the initial method resulted in the rejection of 2 of the batches. The test was therefore repeated with 4, 8 and 12 ng 2,4,6-trichloroanisole (TCA)/L added to each.

The wines spiked with TCA could not be clearly identified by tasters evaluating samples prepared by the latter procedure. In contrast, when evaluating the samples prepared using the initial protocol, all 4 tasters were able to detect the samples spiked with 8 and 12 ng TCA/L. This method was thus significantly more sensitive, and had the added advantage of providing statistically valid data, in contrast to the other method. It was decided to perform development work on the initial (4 cork/750mL) format.

The effect of time and temperature on taint expression
Two samples of corks were assessed in duplicate by 4 tasters after incubation for 0, 25, 1, 2, 3, 4, 5, 6 and 7 days. This protocol yielded 2304 results. In the cases of strongly tainted cork, TCA could be weakly detected after one day. Maximal TCA expression required incubation for 4-5 days.

The importance of temperature was realised when cork evaluation was transferred to a very cold environment in mid-winter. As a result, conditions of incubation time and temperature were standardised to ensure a cork/wine contact time of 48 hours at 25°C.
Choice of extraction medium
The 4 corks/500 mL format was evaluated with both mineral water (buffered with potassium bitartrate to wine pH) and 10% ethanol in water at wine pH. These media were found to be unsatisfactory because strong wood, cork, and ‘leather’ characters dominated the incubated samples. A study of the samples by gas chromatography/mass spectrometry showed that only a high concentration of TCA could be confidently identified. It was considered disturbing that, for the whole batch of corks, the concentration of TCA was 2 ng/L. White wine, considered to be an appropriate choice, was adopted as the extraction medium.

At this stage, the number of corks tested for taint was increased from 68 to 100 per batch. With this modification, the format for the assessment of natural cork was finalised. Its current format is summarised below:

• One hundred natural corks are randomly selected from the incoming sample. Twenty sets of 5 corks are put into 500 mL Schott bottles which are filled, under inert gas, with neutral (non-aromatic) dry white wine.

• A control, comprised of 500 mL wine, and a sample of the same wine spiked with 25 ng TCA/L, are prepared. All samples are incubated for 48 hours (96 hours for agglomerate corks) at 25°C, then assessed organoleptically for taint.

• The maximum accepted taint incidence is 2%.

• In order to evaluate sparkling wine corks, 5 face discs are cut from the agglomerate body of the cork, and placed in the wine. The incubation conditions are the same as for straight wine corks.

Statistical analysis
The format used does not indicate which of the 5 corks in each assessment lot has caused the taint, which precludes immediate determination of the precise frequency of taint. Experience indicates that over the range of taint incidence observed (0–8%), a taint resulting in rejection is normally caused by only 1 of the 5 corks. If only one cork is responsible for this taint, the incidence for the batch is 1%, because 100 corks are assessed.

Cork taint rejection criteria
Cork taint assessment is an acquired skill. Winemakers who are unfamiliar with cork assessment usually reject corks due to taints that may not be found in packaged wine. It is essential that panelists be able to recognise TCA and other types of taint which are routinely observed in cork taint assessment.

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TCA is perceived in 2–8% of samples at an intensity which would render the wine undrinkable. When it is positively identified, the sample is rejected. Fungal must is very infrequent, but can be present at an intensity which would render the wine undrinkable. It is often confused with TCA. At Southcorp Wines, cork batches are rejected only when this taint is strong. Petroleum, rubber and resinous characters are sometimes noted at unacceptable levels in packaged wines. Batches of corks which are affected by strong artificial taints are rejected.

In summary, TCA is the principal taint for which corks are rejected. Strong fungal must and artificial taints account for the remaining rejections. A shipment of corks comprising an order is rejected if 3 or more of the 20 sets assessed exhibit an unacceptable taint.

Acknowledgments
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Reference

Table 1. Nature and suspected origin of taints observed in natural and agglomerate wine corks by panel members at Southcorp Wines

<table>
<thead>
<tr>
<th>Taint</th>
<th>Suspected cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cork-derived aromas</td>
<td></td>
</tr>
<tr>
<td>Dust/wood/cardboard</td>
<td>inherent cork characters</td>
</tr>
<tr>
<td>Developed/oxidised</td>
<td>entrapped air (an artefact of the assay)</td>
</tr>
<tr>
<td>Pepper</td>
<td>residual oxidants</td>
</tr>
<tr>
<td>Fresh mushroom</td>
<td>1-octen-3-one (produced by a fungal tree pathogen)</td>
</tr>
<tr>
<td>‘Earthy’/’sulphidic’/infant faeces</td>
<td>unknown</td>
</tr>
<tr>
<td>Slate, musty/dark socks</td>
<td>TCA</td>
</tr>
<tr>
<td>Leather-like</td>
<td>(a fungal metabolite)</td>
</tr>
<tr>
<td>Fungal must/’aldehydic’/coffee/acid/musty</td>
<td>microbial metabolites?</td>
</tr>
<tr>
<td>Artificial taints</td>
<td>(associated with agglomerate and sparkling wine closures)</td>
</tr>
<tr>
<td>Plastic/petroleum</td>
<td>polyurethane?</td>
</tr>
<tr>
<td>Rubber</td>
<td>latex?</td>
</tr>
<tr>
<td>Dairy product</td>
<td>casein?</td>
</tr>
<tr>
<td>Resinous</td>
<td>pine resin adhesive additive</td>
</tr>
<tr>
<td>(associated with agglomerate and sparkling wine closures)</td>
<td>(albicatic acid)</td>
</tr>
</tbody>
</table>

1. This character is associated most often with untreated cork and is partially masked by the application of surface treatment materials.