Changes in wine ethanol content due to evaporation from wine glasses

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Introduction

The use of appropriate glassware for the consumption of wine is a prominent feature of wine culture. Besides the aesthetic appeal of wine glasses, knowledgeable consumers believe the shape, size, weight, clarity and/or colour of glasses can profoundly affect their appreciation of wine sensory properties\textsuperscript{1,2}. However, the relative proportion of water and ethanol present in alcoholic beverages can also significantly influence our perception of wine sensory attributes\textsuperscript{3,4}. This study investigated changes in wine ethanol concentration due to evaporation from a variety of wine glasses exposed to ambient conditions over time.

Trial 1: Loss of ethanol due to evaporation

In the first trial, the ethanol content of a 2014 Cabernet Sauvignon exposed to ambient conditions whilst in standard XL5 wine glasses was monitored over time (Figure 1). ‘Covered’ wine glasses had plastic lids placed over them immediately after pouring, whereas ’Uncovered’ A wines were located in a position that avoided direct exposure to airflow (from a ducted air conditioner vent in the ceiling) and ’Uncovered’ B wines received direct exposure to airflow. Ambient conditions were monitored throughout the evaporation trial: temperature and humidity remained relatively constant, at 23 ± 1°C and 35 ± 5% respectively, but air flow at positions A and B (being < 5.0 and 30.5 L/s, respectively) differed considerably; airflow at the air conditioner vent was 221 L/s. No change in wine ethanol content was observed where glasses were ‘covered’ with plastic lids, but where glasses were not covered, and exposed to differing room airflows, evaporation had a significant impact on wine ethanol content, with losses from 0.3 to 1.1% alcohol by volume (abv) observed over 2 hours, and more than 3% abv after 6 hours.

Trial 2: Influence of glass shape and wine volume

In the second trial, the influence of glass shape and sample volume (Figure 2) on the evaporation of ethanol from wine was investigated (Table 1). As expected, there was no change in the ethanol concentration of covered wines; nor was a significant change observed when uncovered A wine volume was doubled to 100 mL (in the XL5 glass). Relatively small (≤ 0.2% abv), but statistically significant changes in wine ethanol content were observed for uncovered A wines in XL5 and sparkling wine glasses. In contrast, the ethanol concentration of uncovered A wine decreased substantially (i.e. by 0.7% abv) in the Riedel glass, which likely reflects the increased opening diameter of this glass (Figure 2). The most significant changes in wine alcohol content again occurred for uncovered B wines, which can be attributed to direct exposure of wine glasses to airflow. XL5 and sparkling wine glasses had similar opening diameters and yielded wines with similar final ethanol concentrations despite differences in wine surface area; i.e. wine surface area did not affect ethanol evaporation. However, wine volume influenced the rate of ethanol evaporation, with ethanol losses occurring more quickly for 50 mL vs 100 mL of wine. The most notable evaporation of ethanol occurred in the uncovered B Riedel wine glass, with alcohol content decreasing from 15.1 to 13.2% abv. It is therefore worth considering whether the increasing use of Riedel glassware in wine shows might exacerbate the effects of ethanol evaporation, particularly under ambient conditions similar to those experienced in the current study.

Figure 1. Changes in ethanol concentration over time

Table 1. Changes in ethanol concentration of wines in covered and uncovered glasses exposed to ambient conditions over time (0 to 120 min).

<table>
<thead>
<tr>
<th>Wine Glass</th>
<th>Surface Area (cm(^2))</th>
<th>Surface Area:Volume</th>
<th>Opening Diameter:Volume</th>
<th>Ethanol Content (% abv)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Initial (t=0 min)</td>
</tr>
<tr>
<td>XL5 (100 mL)</td>
<td>31.7</td>
<td>0.32</td>
<td>0.44</td>
<td>15.0 a</td>
</tr>
<tr>
<td>XL5 (50 mL)</td>
<td>33.2</td>
<td>0.66</td>
<td>0.88</td>
<td>15.0 a</td>
</tr>
<tr>
<td>Sparkling</td>
<td>20.4</td>
<td>0.41</td>
<td>0.91</td>
<td>15.0 a</td>
</tr>
<tr>
<td>Riedel</td>
<td>40.7</td>
<td>0.81</td>
<td>1.36</td>
<td>15.1 a</td>
</tr>
</tbody>
</table>

Figure 2. Dimensions of wine glasses

Conclusion

The ethanol concentration of (uncovered) wine was found to decrease significantly over time as a consequence of evaporation; with the rate of ethanol loss being strongly influenced by exposure to airflow, together with glass shape and wine volume. However, ethanol evaporation was prevented simply placing covers over wine glasses. These findings have important implications for the technical evaluation of wine, since small changes in alcohol content (i.e. “~1% abv) can significantly influence our perception of wine sensory attributes. In some instances, e.g. sensory trials (including those employed for ‘alcohol sweet-spotting’) and wine show judging where the use of covers on wine glasses is not standard practice, there is the potential for significant sample variation as a consequence of evaporation. The extent to which evaporation occurs will be influenced by ambient conditions (temperature and airflow, in particular) and the glassware used.

References