Wine storage temperature – investigating the impact of small differences

By Eric Wilkes, Bryan Newell and Dan Johnson, The Australian Wine Research Institute,
PO Box 197, Glen Osmond, South Australia 5064

What is the ideal temperature to store your wine? Do you need an underground cellar or a dedicated airconditioned space, or will the dining room cupboard do the trick? In the past some have thought that it is extremes of temperature that are the greatest enemy of wine longevity; however, a recent study suggests that even relatively minor differences in storage temperature may have a significant impact over time.

AT A GLANCE

- Samples of Cabernet Sauvignon wine stored in an office environment (~21°C) were compared with samples of the same wine stored in a temperature-controlled cellar (~15°C) over 12 months.
- Free and total SO_2 levels dropped at different rates in the two sets of samples, leading to differences between the two sets of 5 mg/L free SO_2 and 9 mg/L total SO_2 after 12 months.
- The loss of free and total SO_2 was not linear in either environment.
- After 12 months of storage, some colour and phenolic measures also differed between the two sets.
- Even small differences in storage temperature appear likely to have an impact on wine shelf life over time.

INTRODUCTION

There is no doubt that storage temperature has an influence on the development of wine and its potential shelf life. Wine ageing and development, however, involve a complex interplay of different chemical processes. This makes the impact of storage temperature difficult to quantify simply, other than via the generalisation that higher temperatures make things happen faster.

It has also become apparent that wine ageing processes are not linear with time and can vary significantly as different components in wine are depleted or formed and new equilibria are established. A classic example of this is the preservative sulfur dioxide (SO_2), which plays important roles as both a sacrificial antioxidant and an anti-microbial agent. The SO_2 concentration of a wine is often used as a proxy to understand the wine's development, because SO_2 reacts with components formed when wine is oxidised, being consumed in the process, and therefore its loss can reflect the degree of oxidation a wine has undergone.

The NATA-accredited AWRI Commercial Services laboratory, like many wine laboratories in and outside Australia, is an active participant in the Interwinery Analysis Group wine testing proficiency program. In this program, samples of wine are tested six times a year and the results compared across more than 150 laboratories to provide an indication of analytical performance.

In recent years it was noted that the AWRI results for SO_2 shifted higher compared to the group mean over the course of the year by a small but measurable amount. The effect was not enough to be an issue for reporting of SO_2 results, but was worthy of investigation. One theory put forward to explain the difference was that the AWRI samples were stored in a 15°C cellar, whereas the majority of samples in other laboratories were stored at typical laboratory temperatures around 20°C. It was decided to conduct a trial to test this and at the same time gain an understanding of the impact of such relatively small difference in temperature on SO_2 values.

SETTING UP THE TRIAL

Six cases were acquired of a recently bottled 2016 vintage Cabernet Sauvignon sealed with screwcaps with saran/tin liners. Three of these cases were stored in the AWRI's temperature-controlled cellar (15.1°C, standard deviation 0.3°C) and three cases in the laboratory office (21.5°C, standard deviation 1.8°C) for a period of 12 months. Each month, three bottles were opened from each set and tested for free and total SO_2 using the AWRI's discrete analyser (Porter *et al*. 2017).

The final samples from both locations (analysed after 12 months' storage) were also tested for differences in general wine chemistry attributes (pH/TA, alcohol, glucose + fructose, malic and acetic acids) and modified Somers colour and phenolic measures. All testing was done with appropriate controls and calibrations as per the AWRI's NATA-accredited methods.

CHANGES IN FREE AND TOTAL SO_2

The results for free and total SO_2 are shown in Figures 1 and 2 (see page 28). After 12 months the difference in mean free SO_2 between the two sets of samples was 5.1mg/L (22% lower in the samples stored in the warmer office conditions). For total SO_2 the difference was 9mg/L (16% lower in the office-stored samples).

Both of these results represent a significant difference in SO_2 content and if extrapolated to a longer timeframe would suggest that wine stored at around 21.5°C would be likely to have a significantly shorter shelf life than that stored at around 15.1°C.

EXAMINING THE TRENDS

There are some further factors that need to be considered when looking at this data. The changes observed in both free and total SO_2 concentrations were

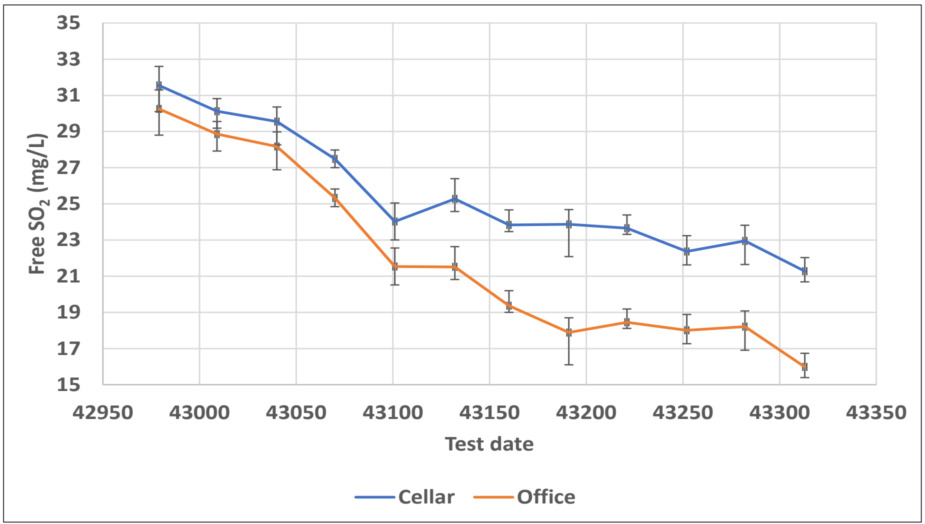

Figure 1. Differences in free SO_2 in wines stored in cellar (15.1° C) and office (21.5 °C) conditions. Error bars represent maximum and minimum values for samples tested at each timepoint.

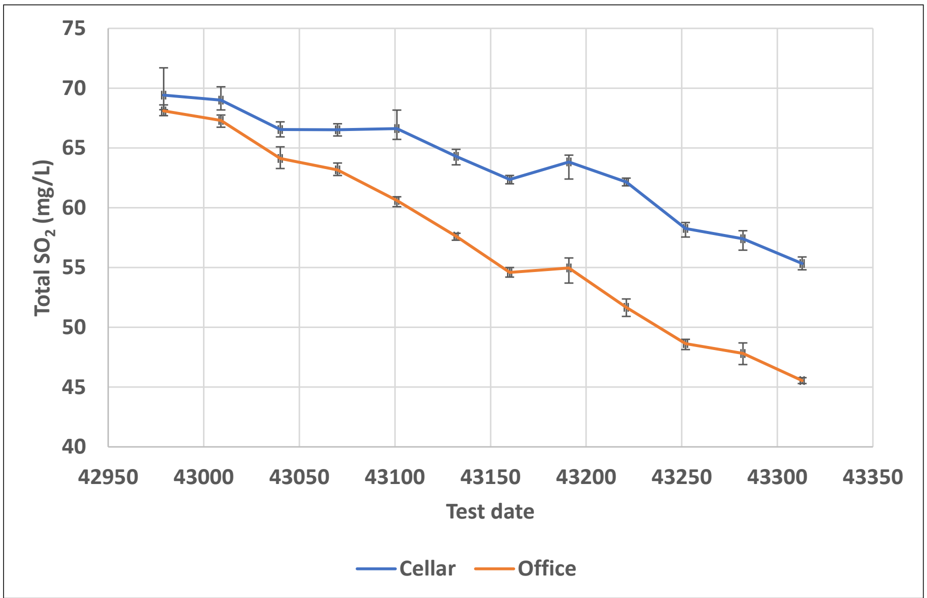

Figure 2. Differences in total SO_2 in wines stored in cellar (15.1 °C) and office (21.5 °C) conditions. Error bars represent maximum and minimum values for samples tested at each timepoint.

not linear over the life of the trial. The trial itself started roughly two months after the wine had been packaged, which means that the oxygen entrained in the wine during packaging is unlikely to have significantly influenced the rate of free SO_2 loss observed. It should also be noted that even though the samples were sealed under screw cap this does not represent anoxic conditions, as even saran tin lined screw caps allow a small amount of oxygen into the package.

For both sets of samples, over the first two months of the trial changes in free SO_2 were relatively modest, followed by a much more rapid drop over the next two to three months. After five months the rate of SO_2 loss reduced substantially. The pattern for total SO_2 is somewhat similar but delayed by around a month, most likely due to some of the bound SO_2 moving into the free form as the free SO_2 is consumed.

The overall pattern observed is not simply related to changes in temperature across the year, as temperature conditions in the cellar varied by less than a degree across the entire trial. Rather, the pattern seen, at least for the cellar-stored samples, reflects changes in chemical reactions occurring as various wine components are consumed. These observations suggest that care needs to be taken in extrapolating the results to any further timepoints. Interestingly the rate of loss for total SO_2 after the first two months seems relatively more consistent than that seen for free SO_2.

A more useful way of observing the impact of changing temperature is seen in Figure 3, which shows the differences in free and total SO_2 for the two sample sets against the differences in temperature that they experienced. The middle of the trial occurred during the warmest part of the year, with a maximum temperature difference of approximately 8°C, corresponding to a storage temperature of around 23°C in the office environment. It was during this time that the greatest difference in SO_2 loss was observed.

In the latter part of the trial (during cooler months) the temperature differences between the two sets of samples dropped to as low as 3.5°C, with the office storage temperature around 19°C. Once the temperature difference dropped to these lower levels the differences between the sample sets remained relatively constant, while the actual SO_2 levels for wines under both sets of storage conditions continued to drop. This clearly demonstrates the impact of temperature on the SO_2 content of wines, with the elevated temperatures leading to a significantly more rapid loss of SO_2.

HOW DO THE FREE AND TOTAL SO_2 NUMBERS RELATE TO OTHER WINE COMPONENTS?

Free and total SO_2 levels in wine are really only proxies for wine quality or development and rarely have a direct impact on consumer perceptions. Instead, they give an indication of the level of chemical change happening in the wine as oxidation and maturation processes progress. To look for direct evidence of consumer-relevant changes in the wine at the conclusion of the 12-month trial, a range of additional chemical analyses were undertaken. The values for alcohol, pH/TA, glucose + fructose, acetic acid and malic acid showed no significant differences between the sample sets. This is not particularly surprising given the relatively small differences in temperature experienced during the trial. Some of the colour and phenolic

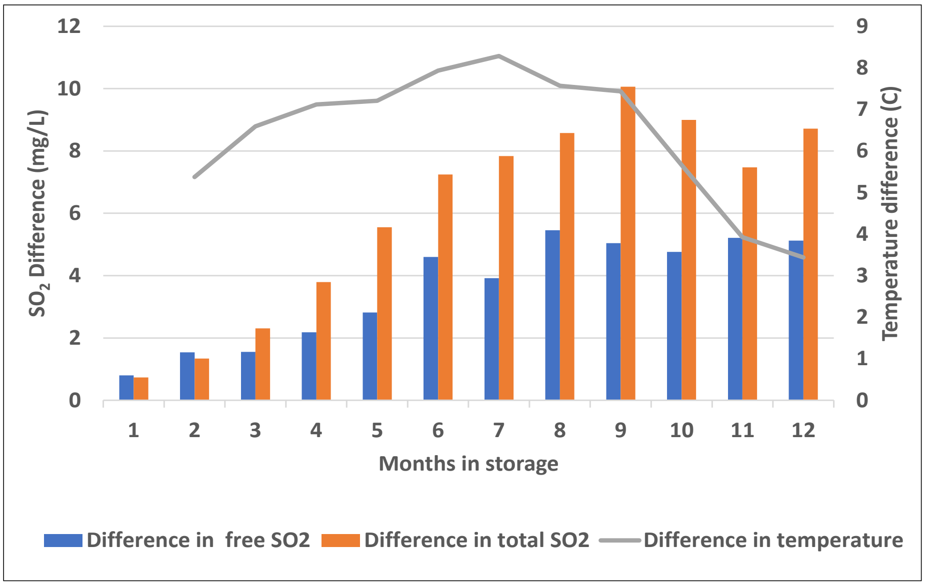

Figure 3. Differences in free and total SO_2 between the office-stored and cellar-stored samples and the differences in the mean storage temperature for each month.

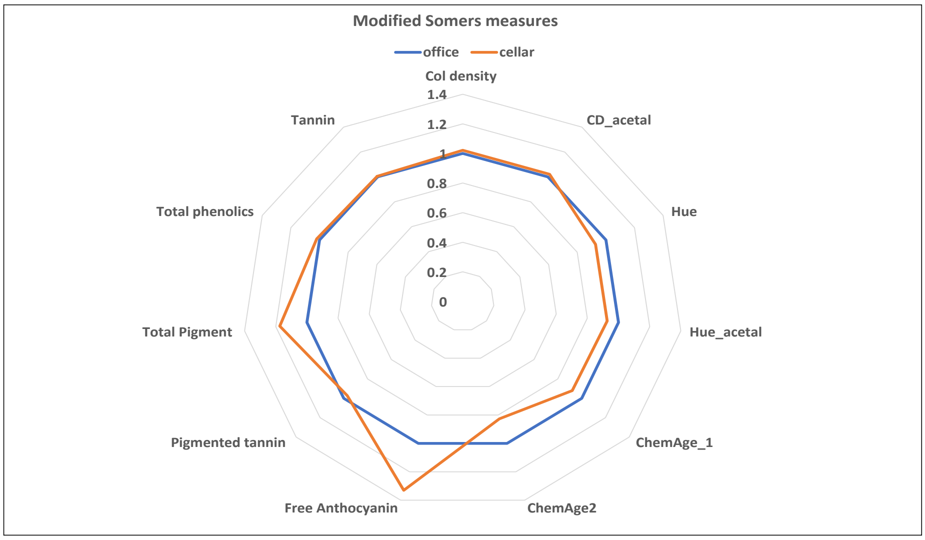

Figure 4. A spider plot comparing the relative differences between the two sample sets for the colour and phenolic parameters that make up the modified Somers measures (Somers and Evans 1977).

measures did, however, show significant differences between the sample sets, as can be seen in Figure 4.

Total phenolics, tannin, colour density, colour density-acetaldehyde and pigmented tannin measures did not show any significant differences between the sets. Hue, hue-acetaldehyde and chemical age 1 were slightly lower (7%, 7% and 8% respectively) for the samples stored in the cellar, but only by amounts marginally greater than the uncertainty of the measurement.

The value for chemical age 2 was significantly lower (17%) and the values for total pigment and free anthocyanins were significantly higher (17% and 33%) in the cellar-stored samples. (These colour and phenolic measures, collectively known as the modified Somers measures, are explained in Somers and Evans 1977.)

While these results do not necessarily demonstrate that the cellar-stored wine is in better condition than the office stored samples, they are consistent with the office-stored wine being more advanced in its ageing process and most likely to have a reduced shelf life.

CONCLUSIONS

The results from this trial demonstrate that even modest differences in temperature can have a measurable impact on the development of a wine in bottle. The maximum temperature reached in the warmer storage conditions of 23°C would not be considered extreme for wine storage, and no sudden changes in temperature were experienced.

It should be noted that the wine used in this study was a typical mainstream commercial Cabernet Sauvignon and while it would be reasonable to expect a degree of cellaring potential, it is unlikely to have the innate capacity to sustain longer-term ageing that more premium wines may have. It is highly likely that if a different wine was chosen the magnitude of changes observed in a similar trial could be quite different, even if the trends were similar.

It's also important to note that the wine stored at the higher temperature was still in a very sound condition and the remaining SO_2 levels were more than adequate to protect the wine for a period beyond the length of the trial, especially given the relatively slower rate of free SO_2 loss seen in the latter half of the trial. As such, it would be incorrect to suggest that all wine must be stored at lower temperatures if quality is to be preserved.

Given the extended period of the trial and relatively constant temperatures it would also be incorrect to extrapolate the results to other situations where short-term increases in temperature may occur, for example in bulk wine shipment where wine may spend a week or more at moderately elevated temperatures.

Rather, this trial demonstrates that relatively modest differences in storage temperature for packaged wine over an extended period can lead to quantifiable differences in wine chemistry and most likely significant changes in product shelf life. It also demonstrates clearly that when comparing analytical results between facilities that factors such as storage conditions must be considered.

REFERENCES

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