A snapshot of SO_2 concentrations in Australian wines

Sulfur dioxide (SO_2) is a preservative widely used in foods and beverages. In winemaking, SO_2 is a very common additive, due to its antioxidant and antimicrobial functions. Even in wines where a conscious decision is made not to add SO_2, small amounts will be present because it is naturally produced by yeast. Maximum quantities of total SO_2 are regulated in Australian wines and in many of Australia's export markets. Understanding the levels of SO_2 found in Australian wine is important for monitoring regulatory compliance and also gives an indication of current trends in winemaking practices, especially when compared with historic data.

To gain an understanding of the current use of SO_2 in Australian wines, data were analysed for more than 3,000 wines from the 2016 and 2017 vintages which had been submitted to Wine Australia for export approval. As part of the export process each producer provides the pH, free SO_2 and total SO_2 levels (among other analytes) of the wine to be exported. These data, along with the major grape variety in each wine, were provided to the AWRI in an anonymised form by Wine Australia for analysis. In total, data from 3,167 wines (2,119 reds and 1,048 whites) were reviewed with 2,278 from the 2016 vintage and 889 from the 2017 vintage. When selecting the data, only varieties that had more than 24 entries in the dataset were chosen. In the case of blends, the variety that made up more than 50% of the blend was used to categorise the wine. Wines where no single variety constituted more than 50% were not included in the dataset. The statistical analysis of the data is summarised in Table 1.

Table 1. Statistical summary of SO_2 data for 3,167 Australian wines (2016 and 2017 vintages) submitted for export approval. All SO_2 results are in mg/L.

All wines		mean	SD	n	min	1st Qu	median	3rd Qu	max
	fSO_2	30.6	9.8	3167	0	27	32	37	126
	tSO_2	93.7	34.8	3167	0	72	92	117	233
Red									
	fSO_2	30.5	9.5	2119	0	27	32	36	89
	tSO_2	83.8	30.2	2119	0	66	82	101	219
White									
	fSO_2	31.0	10.4	1048	0	26	32	37	126
	tSO_2	113.9	34.6	1048	0	98	116	134	233
2016									
	fSO_2	30.4	9.6	2278	0	27	32	36	126
	tSO_2	94.0	34.2	2278	0	73	92	115	233
2017									
	fSO_2	31.1	10.3	889	0	27	32	37	61
	tSO_2	93.0	36.2	889	0	70	93	118	221

Free SO_2

When SO_2 is measured in wine, it is usually measured in two forms: free SO_2 and total SO_2. The free portion is responsible for the antioxidant and antimicrobial properties in wine. Figure 1 shows the distribution of free SO_2 results, broken down into red and white wines. It is interesting to note that there are no apparent differences in the distribution of SO_2 concentrations between red and white wines. Due to interactions with colour components in red wine the efficacy of free SO_2 varies between red and white wines, particularly in the amount needed to achieve equivalent antimicrobial activity. This difference does not appear to be reflected in Australian winemaking practices, based on this dataset. It is possible this result is due to a greater concern about management of oxidation in packaged wine rather than microbial spoilage.

Another interesting observation from the distribution in Figure 1 is the small grouping of wines at the extreme left of the histogram for both reds and whites. This grouping of low free SO_2 wines (<10 mg/L) most probably represents the increased occurrence of no preservative added wines in the marketplace. It can be seen that this is still a very small part of the overall population, with the vast majority of wines having free SO_2 levels above 20 mg/L and more than 95% having levels between 20 and 40 mg/L. Less than 1% of wines had free SO_2 levels over 50 mg/L, with one red wine (89 mg/L) and one white wine (126 mg/L) being extreme outliers.

This similarity between red and white wines is continued across vintages, as can be seen in Figure 2, which shows no significant differences between vintages and equivalent distributions for red and white wines. These results are consistent with the observations from 1986 to 2014 for white wines (Godden et al. 2015) that showed a general increase in free SO_2 results until 2012 and then a relatively constant value around 31 mg/L of free SO_2. The distribution of

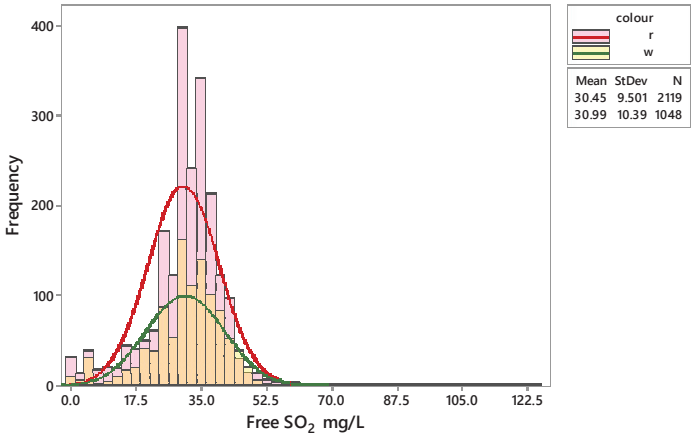

Figure 1. Distribution of free SO_2 values (mg/L) for red and white wines

results for white wines was also similar, with an average standard deviation for the free SO_2 for the last three years of that study being 9.7 mg/L compared to 10.4 mg/L in this dataset. For red wines the mean value found in this study (30.5 mg/L) was higher than the last three years in the Godden et al. (2015) study (27.1, 28.9 and 28 mg/L) but not by a large amount, suggesting that the general trend of increasing free SO_2 levels in red wines may also have peaked or plateaued. The standard deviations for recent values in the last three years of the Godden et al. (2015) study were also very close to those found in this dataset.

Figure 3 shows the free SO_2 concentrations broken down by grape variety. For the major varieties relatively little variation is evident. Once again this probably reflects winemaker decision-making being focused on post-packaging stability as well as a recognition that at

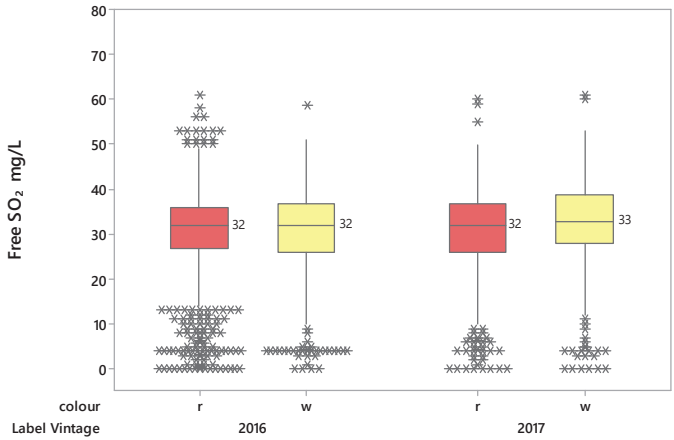

Figure 2. Box plot of free SO_2 levels (mg/L) for 2016 and 2017 vintage red and white wines, with outliers excluded

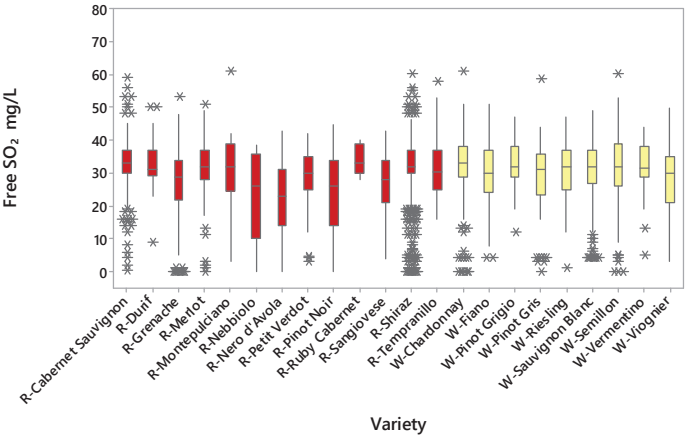

Figure 3. Boxplot of the free SO_2 values broken down by grape variety

these levels free SO_2 has little or no impact on wine's sensory properties. The mean free SO_2 concentrations for Pinot Noir and Grenache (23.7 and 27.3 mg/L) are significantly lower (based on a Tukey's means comparison test) than the major red varieties Cabernet Sauvignon (32.9 mg/L), Shiraz (31.9 mg/L) and Merlot (31.9 mg/L) which were not statistically different from each other. In the white wines no variety was found to be statistically different from all the other white varieties.

Total SO_2

Total SO_2 is a measure of all the forms of sulfur dioxide, bound and unbound, found in wine and as such is not as closely linked to the technical function of sulfur dioxide as free SO_2. It is an important measure, however, because in Australia and most of Australia's export markets the maximum allowed concentration of sulfur dioxide in wine is regulated as total SO_2. For this reason, it is important to have a picture of the levels found in Australian wines. Table 1 presents a summary of the statistical results from the survey for total SO_2 and Figure 4 shows the distribution of total SO_2 values for red and white wines. As is apparent from the histogram there is a significant difference in the mean total SO_2 values for red (83.8 mg/L) and white (113.9 mg/L) wine. The spread of results, however, is similar for whites and reds (standard deviations of 30.2 and 34.6 mg/L respectively). The higher level of total SO_2 in white wines is typical and is an artefact of white wine production where higher levels of acetaldehyde (which is a strong binder of SO_2) lead to a greater accumulation of bound SO_2 with consequently higher total SO_2 levels. The bound portion of the total SO_2 has relatively little impact on the antioxidant and antimicrobial function of SO_2 in wine.

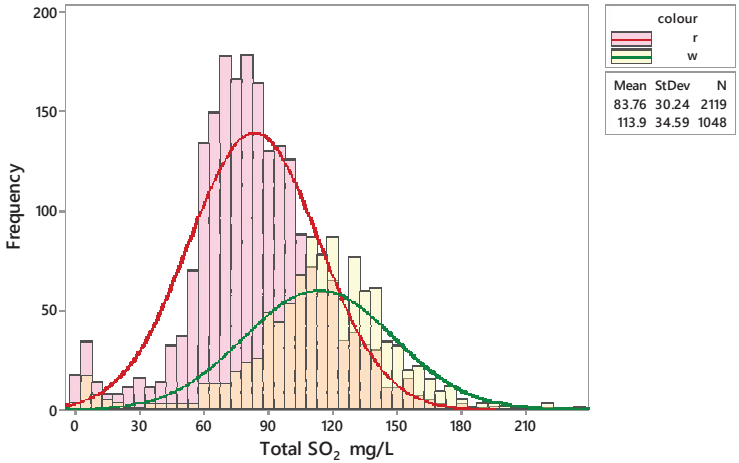

Figure 4. Distribution of total SO_2 values (mg/L) for red and white wines

The regulatory limit for total SO_2 in Australia for dry wines is 250 mg/L. All wines in the dataset fell below this figure, which is to be expected as they had all been submitted to the regulatory authority for export licence. The vast majority of wines were significantly below this figure (99% of red wines below 160 mg/L and 99% of white wines below 190 mg/L) and would easily meet the requirements of Australia's major export markets.

As with free SO_2, the differences in total SO_2 between vintage 2016 and 2017 wines were small and proved to be statistically insignificant, as shown in Figure 5. When compared to the historical data from Godden et al. (2015), the white wines continued the downwards trend observed from 2012–2014 (median values 129, 123 and 120 mg/L) with medians of 117 and 114.6 mg/L respectively. Interestingly the comparison for red wine total SO_2 is not so straightforward. In the Godden et al. (2015) paper, total SO_2 median values had declined significantly from 2011 to 2014 (84 to 67 mg/L) while the data in this study showed total SO_2 medians of 83 and 78 mg/L for 2016 and 2017 respectively. It was noted by the authors of the earlier study, however, that while the trend can be considered internally consistent, the results for total SO_2 may have been skewed as the time each sample had been in bottle when analysed was unknown and natural degradation of some samples may have lowered the overall values. The data in this study came from wines which were about to be exported so it can be assumed that the data was less affected by natural degradation of sulfur dioxide during bottle ageing. Since white wines generally spend much less time in bottle, the difference between the two studies is likely to be much less for white wines, giving more consistent comparisons for total SO_2.

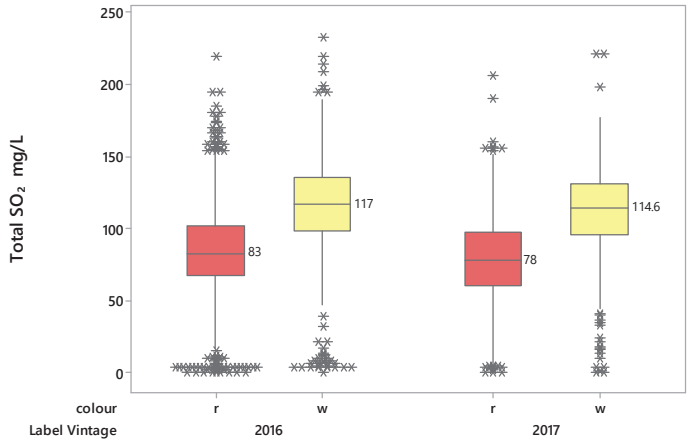

Figure 5. Box plot of total SO_2 (mg/L) levels for 2016 and 2017 vintage red and white wines, with outliers excluded

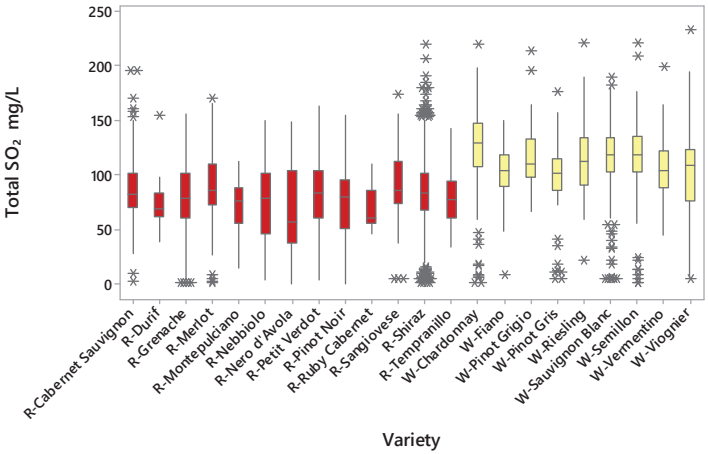

Figure 6. Boxplot of the total SO_2 values broken down by grape variety

The breakdown by variety of red wine total SO_2 (Figure 6) shows that with the exception of Pinot Noir, the differences in means for the red varieties were not statistically significant. Pinot Noir (with the lowest mean value of 70.9 mg/L) was statistically different from the other major red varieties. This may reflect concerns of winemakers about potential bleaching of colour by sulfur dioxide in this variety leading to more conservative additions. In white wines there was no statistically significant difference in means among the three major varieties of Chardonnay, Semillon and Sauvignon Blanc, which represented more than 65% of the white wines in the dataset.

Conclusion

This dataset of vintage 2016 and 2017 wines suggests that recent trends identified in the use of SO_2 in Australian wine have continued. All wines examined in study this easily comply with the regulatory limits in Australia's export markets.

Acknowledgements

The data for this study were kindly supplied by Wine Australia with special thanks to Steve Guy, Rachel Triggs and Belinda van Eyssen. This work was supported by Australia's grapegrowers and winemakers through their investment body, Wine Australia, with matching funds from the Australian Government. The AWRI is a member of the Wine Innovation Cluster in Adelaide, South Australia.

Reference

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