A little dissolved CO_2 goes a long way in the wine glass

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Researchers from the Australian Wine Research Institute have measured the sensory interactions between dissolved carbon dioxide and acidity, ethanol and tannin concentration on the aroma, taste and mouthfeel of white and red wines. The assessment was conducted under conditions comparable to real-life consumption.

INTRODUCTION

Dissolved CO_2 (DCO_2) is an abundant and ubiquitous component of all still wines but its effect on their sensory properties has been overlooked for some time. The DCO_2 in bottled still wine comes primarily from the CO_2 produced during primary fermentation, with losses occurring during standard winery processing steps including transfers, filtration, centrifuging and bottling. DCO_2 concentration can also be dialled up or down prior to bottling by sparging with CO_2 or N_2, or more recently by using gas transfer membrane technologies (Nordestgaard 2017).

Measuring and tasting dissolved carbon dioxide in white wine.

DCO_2 creates a tactile sensation in the mouth commonly referred to as 'spritz'. Winemakers generally recognise that there is a 'sweet spot' for DCO_2 in still wines. Insufficient levels of DCO_2 can lead to 'flat' tasting wine that lacks the appearance of freshness, while excessive DCO_2 can result in the perception of a 'fizzy' character which is inconsistent with consumer expectations. However, the optimum level of DCO_2 depends on wine style, with desired levels in white wines higher than in red wines, and within both red and white wines, higher DCO_2 levels are more accepted in lighter-bodied styles.

To date, investigations into the role of DCO_2 on the sensory properties of alcoholic beverages have been confined to 'sparkling' products containing greater than 5g/L of DCO_2. However, the physiological basis underpinning the perception of sparkling products (i.e. those that release bubbles upon tasting) differs from that for still wine with its sub-saturated levels of DCO_2 (typically <2g/L). Furthermore, the composition of still table wines differs from that of sparkling alcoholic beverages in terms of their pH, alcohol content and tannin concentration.

This study quantified the sensory interactions between DCO_2 and important components of the matrix of still white and red wines — acidity, ethanol and tannin concentration — on their aroma, taste and mouthfeel properties. The assessment was conducted under conditions analogous to real-life consumption in terms of serving temperature and glass dimension.

METHODS

The DCO_2 concentrations of four commercially-bottled wines (Chardonnay, Viognier, Shiraz and Cabernet Sauvignon), each from the same bottling run and sealed under screwcap, were varied by blending N_2-sparged and carbonated versions of the same wine.

IN BRIEF

- **Winemakers generally recognise that there is a 'sweet spot' for dissolved carbon dioxide (DCO_2) in still wines — insufficient levels can lead to 'flat' tasting wine that lacks the appearance of freshness, while too much DCO_2 can result in the perception of a 'fizzy' character.**
- **The optimum level of DCO_2 depends on wine style, with desired levels in white wines being higher than in red wines.**
- **Studies so far into the role of DCO_2 on the sensory properties of alcoholic beverages have been confined to 'sparkling' products containing greater than 5g/L of DCO_2. But the perception of sparkling products differs from that for still wine and the composition of still table wines differs from that of sparkling alcoholic.**
- **Researchers measured the sensory interactions between DCO_2 and the acidity, ethanol and tannin concentration in four commercially bottled wines (Chardonnay, Viognier, Shiraz and Cabernet Sauvignon) on their aroma, taste and mouthfeel under conditions comparable to real-life consumption.**

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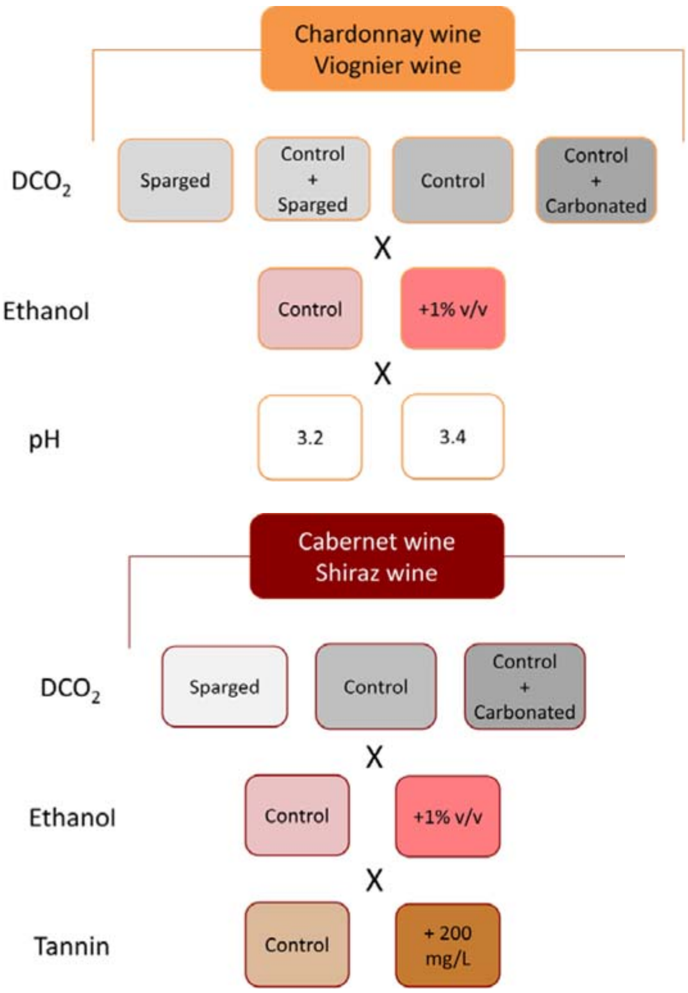

Figure 1. Experimental designs used to produce the white and red wines in this study.

The wines were then adjusted for pH (whites), alcohol (whites and reds) and tannin concentration (reds) (Figure 1). Adjustments to pH were made by adding tartaric acid and tannin concentrations were modified by adding a commercial oenotannin.

The wines were tasted in duplicate by nine trained tasters using standard descriptive analysis protocols. The tasters quantified the intensity of:

- the mouthfeel characteristics of spritz, astringency, hotness, and viscosity
- sweetness, acidity, and bitterness
- overall aroma and flavour.

To mimic 'real-life' wine consumption the tasters were presented with 150mL of wine in 'restaurant'-dimensioned (100mm height, 80mm bowl, 60mm opening) polycarbonate glasses at typical consumption temperatures (10°C for the white wines and 23°C for the red wines). To minimise variations in CO_2 dissipation from the glass after pouring, the wines were tasted within two minutes of pouring.

Preliminary work showed that the concentration of DCO_2 in the glass after pouring was 20-30% lower than the DCO_2 concentration of the wine when in the bottle (Gawel *et al*. 2020). For this reason, the DCO_2 concentrations in the glass were measured concurrently with the wines being tasted using an Orbisphere system adapted for in-glass measurement (Table 1).

Table 1. Mean concentrations of DCO_2 in glass at the time of tasting (g/L). (N/A denotes not applicable).

	Chardonnay	Viognier	Shiraz	Cabernet Sauvignon
Low	0.5	0.4	0.1	0.1
Control	1.1	0.9	0.6	0.4
Med-high	1.8	1.9	0.9	0.8
High	2.5	2.8	N/A	N/A

RESULTS: THE EFFECT OF DCO_2 ON WINE TASTE, TEXTURE, AROMA AND FLAVOUR

Few consistent interactions between DCO_2 and components of the wine matrix were observed across the four wines (Gawel *et al*. 2020), so this article will focus on the main effects of DCO_2 on the taste, texture and overall aroma and flavour of the wines (Figures 2 and 3).

Tastes

Higher DCO_2 concentration consistently resulted in reduced bitterness and increased sweetness in all wines. The increase in perceived sweetness is consistent with the reduction in bitterness (and vice versa) as the two tastes mutually suppress each other, but the reasons for this effect are unclear and warrant further investigation. DCO_2 concentration did not consistently affect the perceived acidity in the white wines, as their pH values were equalised after the DCO_2 levels were modified. In the red wines (where their pH was not adjusted), DCO_2 also did not affect the perception of acidity, which could be explained by the lower levels of DCO_2 used to represent the levels found in red wines.

Texture

The intensity of the 'spritz' sensation increased with DCO_2 concentration in all wines. While this result was expected, the strength of the effect of DCO_2 on spritz sensation compared with the other key sensory influences attributed to the wine matrix was notable.

Higher levels of DCO_2 decreased the perception of astringency in both the white and red wines; however, to understand this observation the likely mechanisms behind the concepts of astringency in the two wine types need to be defined. The white wines were unlikely to have contained enough polymeric flavanols (tannins) to elicit astringency in the classical sense of involving interactions between tannins and oral and salivary proteins. It is therefore more likely that the perception of astringency in the white wines resulted from their acidity (Gawel *et al*. 2014). However, in the case of the white wines where the pH was equalised after DCO_2 adjustment, it would be expected that their astringency should have been unaffected by DCO_2. In the case of the red wines which were not pH adjusted, it would be expected that astringency should increase with increasing DCO_2 due to enhanced tannin-oral protein interactions resulting from lower pH caused by carbonic acid formed by the dissociation of CO_2 in solution. However, contrary to expectations, astringency trended downward with increasing DCO_2 which could possibly be explained by competition for oral receptor sites common to both astringent substances and oral irritants including DCO_2 (Kurogi *et al*. 2015).

DCO_2 did not consistently influence other textural aspects including perceived viscosity and hotness.

Aroma and flavour

Altering the DCO_2 concentrations in both the white and red wines above that of the control wines did not consistently affect their overall aroma and flavour intensity (see Gawel *et al*. 2020). While other researchers have shown that CO_2 increases the availability of volatile compounds to the olfactory epithelium when presented nasally and retronasally (Pozo-Bayón *et al*. 2009, Saint-Eve *et al*. 2010), they, unlike in this study, applied saturated levels of DCO_2, which may have resulted in volatile stripping and convection in the nasal cavity by the action of gas bubbles.

SUMMARY

- The effects of dissolved carbon dioxide on the tastes, textures and overall aroma and flavour of still wines were quantified for the first time.
- When equalised for pH, higher DCO_2 concentration increased sweetness and decreased bitterness and dryness/astringency of the white wines.
- Increased DCO_2 also decreased the perception of bitterness and decreased the astringency of the red wines.

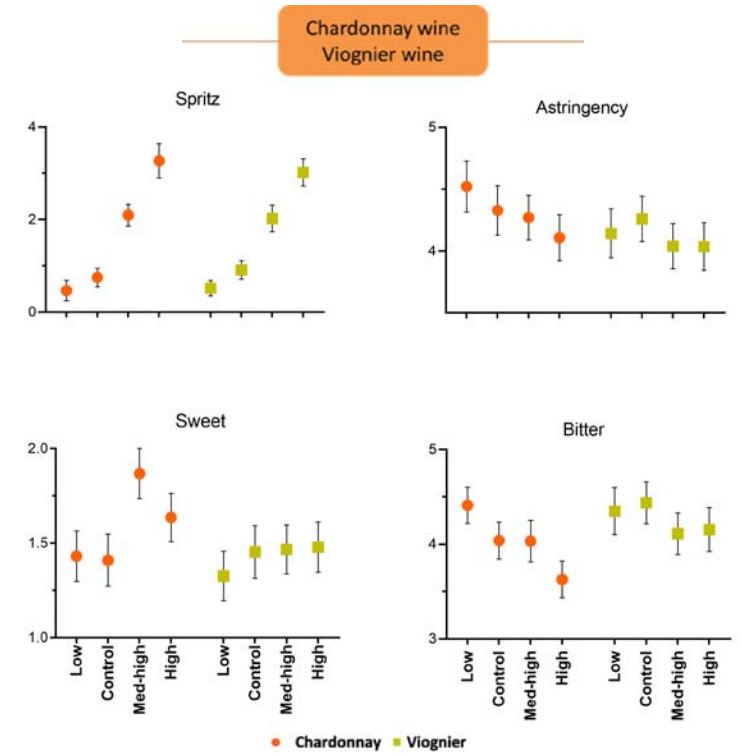

Figure 2. Effect of dissolved CO_2 on sensory attributes of the Chardonnay and Viognier wines in this study.

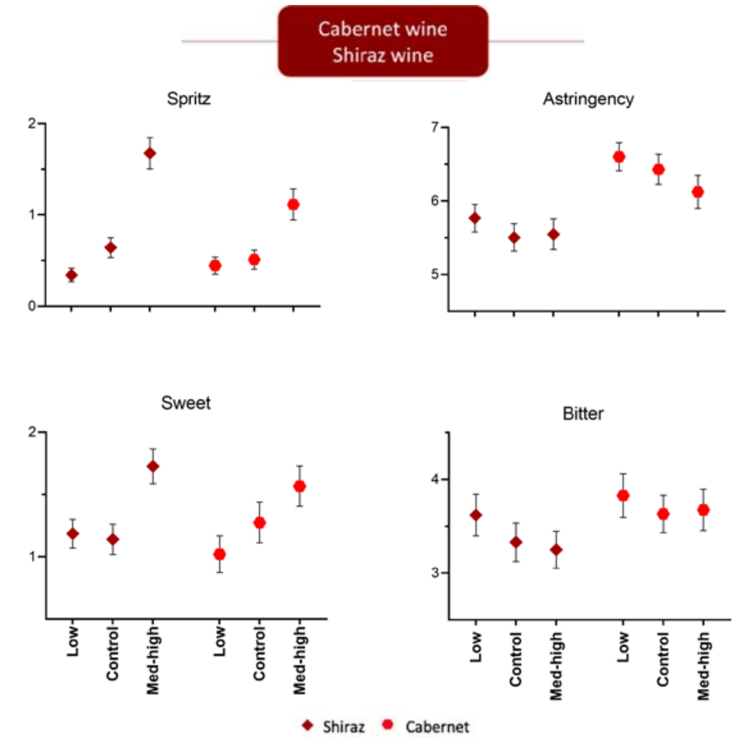

Figure 3. Effect of dissolved CO_2 on sensory attributes of the Shiraz and Cabernet Sauvignon wines in this study.

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