



The impact of closures, including screw cap with three different headspace volumes, on the composition, colour and sensory properties of a Cabernet Sauvignon wine during two years' storage

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- Screwcaps have sometimes been accused of being responsible for two problems in bottled wine: 1) lack of sufficient oxygen diffusion for proper in-the-bottle development, and 2) contributing an undesirable reduction aroma to the wine (“struck flint”, “rubbery”). Additionally, some controversy still exists regarding whether red wines require oxygen to continue “aging” in the bottle. Hoping to clarify these questions, the current authors decided to find out whether a red wine develops a more reduced aroma under a screwcap than if it had another type of closure, and whether the amount of headspace has any effect.
- The authors bottled a 2002 Cabernet Sauvignon from South-East Australia with 3 types of closures: natural cork, synthetic cork (Nomacorc), and screwcap (ROTE, or “roll-on-tamper-evident”). For the screwcap, they allowed 3 headspace volumes: 4, 16, 64 ml of air (16, 53, and 104 mm fill height), which we will call SC4, SC16, SC64. The corks had a headspace of 6 ml. All wines were stored for 2 years in a warehouse at 16°C constant temperature and 65% humidity. Then, at various intervals, the authors measured how closure type and headspace volume affected wine composition and sensory characteristics. The main compositional parameters affected were as follows.
 - **1) Microbial analysis.** Wines were bottled without sterile filtration, so the authors checked for any effect of closure/headspace on number of viable yeast or bacteria cells. At 6 months post-bottling, type of closure and/or amount of headspace had no effect on the number of yeast cells, bacteria cells. Likewise, they showed no effect on acetaldehyde levels, or volatile acidity. [Editor’s note: Microorganisms can still be active and consume oxygen in the headspace –thus impacting the study findings- even when they are not growing in number].
 - **2) SO₂.** By 24 hours following bottling, the bottles with the screwcap and the largest headspace (SC64) already showed the lowest levels of both free and total SO₂ (3 mg/l lower than the other wines). This difference was accentuated with time. On the opposite extreme, **the bottles that best preserved both free and total SO₂ were those with the screwcap and the smallest headspace (SC4)**. The bottles with screwcaps and intermediate headspace (SC16), as well as those with natural corks or synthetic corks, had intermediate SO₂ levels. Additionally, the large amount of SO₂ lost as storage time increased suggested to the authors that the mechanism involved was not only a combination of SO₂ with O₂ in the headspace, but SO₂ reacting with phenolic compounds in the wine as well.
 - **3) Color.** Color was measured by 2 methods: 1) spectrophotometrically, and 2) using the CIELAB coordinates: redness (a*), yellowness (b*), lightness (L*), chroma (C*), and hue angle (h). Spectrophotometrically, **the screwcap with the largest headspace (SC64) showed the highest color intensity**, and the screwcap with the smallest headspace (SC4) had the lowest color intensity. [May this partly due to higher SO₂ levels in these wines?] The CIELAB coordinates showed similar results. That is,

SC64 had the highest *redness*, the highest *chroma*, and the lowest *lightness* (darker color); whereas SC4 has the lowest redness, the lowest chroma, and the highest lightness (lighter color).

- **4) Phenolic compounds** . The wine with the screwcap and the largest headspace (SC64) had the lowest level of *total anthocyanins*, as well as the lowest level of malvidin-3-glucoside, the main anthocyanin in young wines. On the other hand, this wine had the highest level of *polymeric pigments* (or pigmented polymers). This is consistent with this wine having the highest color since, as we know, polymeric pigments are considered to contribute more to the stable color of a wine than monomeric anthocyanins. *Tannin concentrations* increased in all wines and then dropped after 1 year, with the highest levels still in the SC64 wine. In other words, **more headspace led to less anthocyanins, more polymeric pigments, and more tannins after the storage period.**

- **5) Sensory**. At 6 and 10 months post-bottling, a panel of 20-24 trained judges performed *duo-trio tests* to see if the wines could be distinguished based on their closure. The judges were asked to rate the wines based on aroma only. The result was that, at 10 months post-bottling, **tasters were able to differentiate the SC64 wine from the SC16 wine and from the natural cork wine** . [*If SC64 was significantly different from SC16, you would expect SC64 and SC4 to be even easier to tell apart, which was not the case*]. This panel was also asked to perform *descriptive analysis* of the wines (at 11, 18, and 24 months post-bottling). The result was that, at 11 months post-bottling, the attributes “reduced” (struck flint, rubber), and “oxidized” differed significantly in all the treatment involved. Specifically, “reduced” was highest in the SC4 wines, whereas “oxidized” was highest in the SC64 wines. [Editor’s note: Why are they looking for descriptive analysis differences if duo-trio tests did not declare these two wines different?] Still, the authors note these off-aromas were low in all wines studied (score 1 out of 0-9 scale) when compared to other descriptors.

- As the authors point out, they cannot conclude from this study whether oxygen is or is not required for red wine development because the trial did not include an anaerobic treatment (a zero-headspace or a vacuumed headspace). I would add that they cannot compare the effect of closures directly, because the headspaces in their experimental design were not the same.

In summary, the authors found that the most common commercial conditions –screwcap with 10 ml headspace, natural cork, and synthetic cork- all behaved very similarly in both composition and sensory characteristics. It seemed to be the amount of ullage under the screwcap closure that caused the most difference. In this particular case, wines bottled with 4 ml headspace were different from those with 64 ml headspace in the levels of *SO2*, *color*, *anthocyanins*, and *tannins*. The authors also conclude that these two wines were significantly higher in *reduced* (SC4) and *oxidized* aromas (SC64). But based on their sensory data, this conclusion seems inconsistent.

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