Introduction and aims

The residual elemental profiles of wines play an important role in modulating the sensory attributes of wines. The use of oxygen ($O_2$) during winemaking is an important tool in managing fermentation efficiency, wine style, and wine aroma. Oxygen exposure during winemaking may have considerable effects on the residual elemental concentration in finished wine by affecting the oxidation states and reactivity of the elements as well as the available binding sites and reactivity of compounds present in the fermenting must, lees, and wine.

$O_2 + \text{metals} = \text{metals?}$

This study aimed to investigate the role of $O_2$ in modulating the elemental composition in a Chardonnay wine throughout vinification, and to determine whether certain elements preferentially accumulate in specific wine fractions (i.e. grape solids post pressing, wine lees, or in the finished wine supernatant).

Results

(a) During pressing

- $Cr$ was the only element affected during pressing.
- Only at the start of press was $Cr$ present in higher concentrations in inertly pressed samples.

(b) Juice solids

- $Cu$ concentration decreased with increased $O_2$ exposure: $IR > IO > AR > AO$
- Largest amount of $Cu$ was removed from samples protected from $O_2$.

(c) Early fermentation

- $Cu$ concentration higher in samples exposed to $O_2$.
- Due to increased removal of $Cu$ bound to juice solids (b) in wines protected from $O_2$.

(d) Pre- and post-bentonite fining

- $Al$, $As$, and $Fe$ increased post-bentonite addition.
- These elements were introduced into the wine through extraction from bentonite.

(e) Wine lees

- $Al$, $Cu$, and $Zn$ concentrations in wine lees were significantly affected by $O_2$ exposure during vinification.
- $O_2$ exposure during vinification modulated $Al$ concentration in wine lees: $↑O_2 = ↑Al$
- $O_2$ exposure during pressing modulated $Cu$ and $Zn$ concentrations in wine lees: $↑O_2 = ↑Cu$ and $↑Zn$

(f) Finished wine

- $Cu$ concentrations in finished wines were significantly affected by $O_2$ exposure.
- All wines exposed to $O_2$ had lowest residual $Cu$ concentrations.

Conclusions

Oxygen management during winemaking had a significant impact on residual elemental concentrations in lees and wine. Elements such as $As$, $Ca$, $Cr$, $K$, and $Zn$ were impacted by $O_2$ exposure only at certain stages of vinification; however, $Cu$ was significantly affected by $O_2$ exposure throughout vinification. $O_2$ exposure significantly affected the amount of $Cu$ bound and subsequently removed by juice solids (b) and wine lees (e), and this was reflected in the $Cu$ concentration in wines after the removal of the solid material.

The effects of $O_2$ exposure on residual elemental concentrations in wine have important implications for wine authenticity studies, as well as for organoleptic qualities of wine, given that the elements most affected by $O_2$ exposure are known to be important for aroma development and wine oxidation.