

## **Micro-oxygenation in South Africa: part 2. Effect on the sensorial and microbial aspects of wine**

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This is the second article on micro-oxygenation. The first article focussed on the effect of micro-oxygenation on the phenolic and colour composition of red wine. The addition of oxygen will however also influence other characteristics of the wine. These include the sensorial properties and microbial composition and will be discussed in this article. Some guidelines regarding the use of micro-oxygenation will also be given.

### **Experimental observations**

#### **Materials and Methods**

Micro-oxygenation is supposed to induce different positive sensorial characteristics to the wine according to the suppliers of micro-oxygenation equipment. These include an increase in colour, softening of tannins and the removal of unwanted aromas such as certain vegetative and sulphur like aromas. We decided to investigate some of these claims by conducting sensorial analyses of two different red wines, which had undergone micro-oxygenation. These wines were a 2002 Cabernet Sauvignon (wine A) and a 2004 Pinotage. Wine A was treated with 0 mg O<sub>2</sub>/L/month, 1.5 mg O<sub>2</sub>/L/month and 3 mg O<sub>2</sub>/L/month. Wine B was treated with 0 mg O<sub>2</sub>/L/month, 1.5 mg O<sub>2</sub>/L/month and 3 mg O<sub>2</sub>/L/month in contact with American oak staves which had 50% of the internal surface of an oak barrel. The same wine was also stored in a new American oak barrel from the same cooperage as a reference.

At the tastings expert wine tasters were used, consisting mostly of enologists from the Pinotage association and a major cooperage. Tastings was done blind in a temperature controlled tasting room in standard ISO wine tasting glasses. Triangular tastings were held to distinguish between different treatments in wines A and B and an unstructured line scale to indicate intensities of certain flavours in wine B. The relevant statistics were applied to all the data.

Acetic acid bacteria and *Brettanomyces* counts were performed on selective media in wine B during the treatments.

## Results and Discussion

In wine A, a very full bodied high phenol wine, the tasters were able to distinguish between the control (no O<sub>2</sub> added) and the 3 O<sub>2</sub> mg/L/month eight weeks after the treatment started, but not between the control (0 mg O<sub>2</sub>/L/month) and 1.5 mg O<sub>2</sub>/L/month treatment at this stage. After 12 weeks, however, they could distinguish all three wines from each other.

Wine B was tasted twice. In the first tasting (after three months) the panel could not statistically distinguish between the control, the 1.5 and 3 mg O<sub>2</sub>/L/month treatments, and the barrel wine on an intensity tasting for bitterness and astringency (results not shown). The wine matured in the barrel was however rated much higher for oak wood character and lower for fruitiness.

After six months of micro-oxygenation the same tendencies were observed, with the barrel matured wines having higher oak associated flavours (Figure 1). This indicates that the oak used for the barrels were not of the same treatment and/or composition as those used to produce the staves, although both were American oak from the same supplier. Winemakers should thus also note the quality of staves when using micro-oxygenation.

Oxidised/aged and barnyard/medicinal flavours were higher in the 3 mg O<sub>2</sub>/L/month treatment after 6 months in wine B. The panel however did not statistically prefer the barrel, 0 mg O<sub>2</sub>/L/month and 1.5 mg O<sub>2</sub>/L/month wines over each other. They did however prefer the 3 mg O<sub>2</sub>/L/month treatment the least at this stage, due to the above mentioned negative flavours being formed. This was probably due to the micro-oxygenation being applied for too long a period of time, with free SO<sub>2</sub> levels dropping to lower than 20 mg/L. Nikfardjam & Dykes (2003) also found that when micro-oxygenation is applied for too long that the wine becomes too astringent. This correlates with a mean degree of polymerisation of procyanidins that is too high.

We are currently busy investigating the effect of using barrels and oak staves made from the wood destined for producing barrels with micro-oxygenation. Preliminary results indicate that a panel found it much more difficult to distinguish between the barrelled and micro-oxygenated treated wines using these staves if the oak stave concentration was correct.

It is also true that when micro-oxygenation is applied for too long the wine can become over-aged/developed, with a decrease in quality. The barnyard/medicinal aromas normally associated with *Brettanomyces* spoilage, also correlated with the

increase in *Brettanomyces* counts after 14 and 20 weeks in the 1.5 mg O<sub>2</sub>/L/month and 3 mg O<sub>2</sub>/L/month treatments (Figure 2). Acetic acid bacteria counts were also higher in the micro-oxygenation wines, although growth was not observed from the beginning of the treatment. No increase in volatile acidity was observed. It is thus also doubtful whether micro-oxygenation is effective in an older red wine because the panel did not have a clear preference for the O<sub>2</sub> treated wines over the control. Micro-oxygenation has also been shown to lead to a decrease in unwanted sulfur compounds, even at low concentrations when applied in red wine.

## **Recommendations**

When applying micro-oxygenation a few guidelines should be adhered to. The first step is to decide on a dosage. This is quite a difficult decision, due to red wines differing so much in terms of their phenolic composition. When the wine has a high phenolic content, such as 40-60 at 280 nm 3-4 mg O<sub>2</sub>/L/month can be supplied, especially if phenolic development and colour change is required. Total tannins should also be higher than 1 g/L and that of anthocyanins preferably more than 500 mg/L. For the removal of sulfur compounds lower dosages can probably be used.

We also noted that often winemakers in SA will use micro-oxygenation only for 2-3 weeks at a dosage of 0.5-1 mg O<sub>2</sub>/L/month. It is very doubtful if this low dosage for such a short period of time will lead to any changes in the wine. Red wine can actually accommodate more O<sub>2</sub> than one normally think, if applied in a controlled manner.

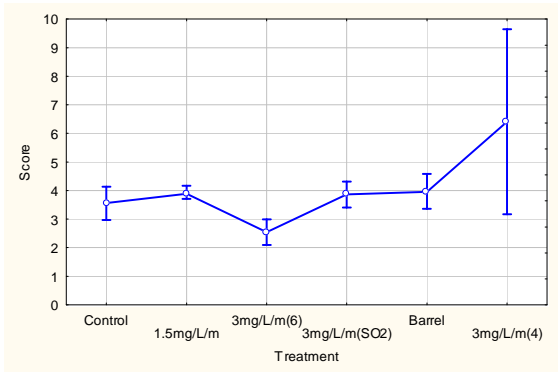
It is also better to induce the O<sub>2</sub> to the wine as soon as possible, either in the form of macro-oxygenation (2-4 mg O<sub>2</sub>/L/day) just before malolactic fermentation or micro-oxygenation just after malolactic fermentation (2-4 mg O<sub>2</sub>/L/month). Currently computer programs exist which take into account the HCl index (level of polymerization of tannins), colour density, total phenolics, etc to decide on a micro-oxygenation dosage. This program however determine the dosage to a large extend on the phenolic maturity of the wine, which is determined by taste. The HCl index also does not always seem to work efficiently in young SA red wines.

The best way to monitor the progression of micro-oxygenation is still by taste. Wine undergoing micro-oxygenation should be assed at least once every one to two weeks when undergoing micro-oxygenation. There is a perception that red wines first become

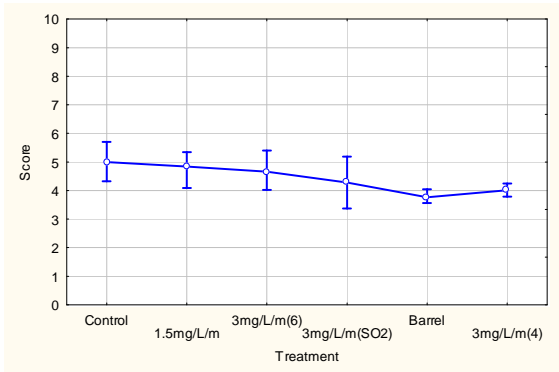
more astringent when undergoing micro-oxygenation and then later softer, but this has not been proven conclusively. It is however true that if the process is applied for a too long period of time the wine's tannins can become dry and harsh. The wine's nose would also be assessed for the typical oxidation aromas, as well as a loss of fruit. When this happens the micro-oxygenation should be terminated.

Sulfur dioxide levels should also be checked at least once a month and kept at around 25 mg/L free. Higher levels than this will probably inhibit the positive effect of adding small amounts of O<sub>2</sub> to the wine, while free levels lower than 20 mg/L seems to increase the risk of *Brettanomyces* infection. When *Brettanomyces* infection is suspected in a red wine micro-oxygenating should not be applied at all. *Brettanomyces* numbers can also be monitored with selective plating, but it can happen that volatile phenols already forms in the wine when the winemaker is waiting for the results, which might take up to two weeks. Hopefully new quicker DNA based techniques to detect *Brettanomyces* in wine might rectify this situation in future. Micro-oxygenation does not seem to lead to an increase in VA due to acetic acid bacterial growth (if tanks are filled completely), but this can also be assessed regularly. The wine's temperature should also be around 18-20 °C, much lower temperatures than this can lead to O<sub>2</sub> accumulation in the wine and much higher temperatures to not sufficient O<sub>2</sub> dissolving in the wine. Also refer to the first article regarding more practical recommendations.

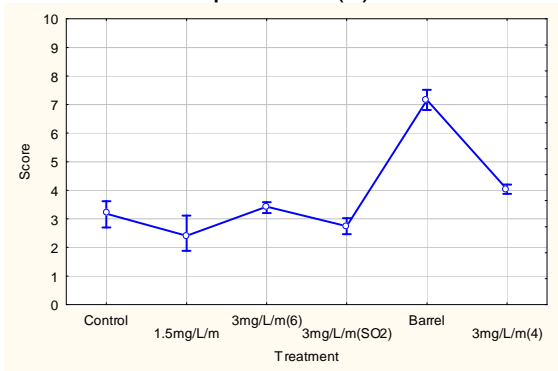
Micro-oxygenation is a technique that can be used efficiently by winemakers to bring about certain positive changes to the wine if used correctly. Many questions still remain regarding micro-oxygenation, such as if used with oak staves a barrel can be simulated and its effect on aroma compounds in wine. We are continuing with our research on micro-oxygenation and will publish new data regarding these aspects in future.



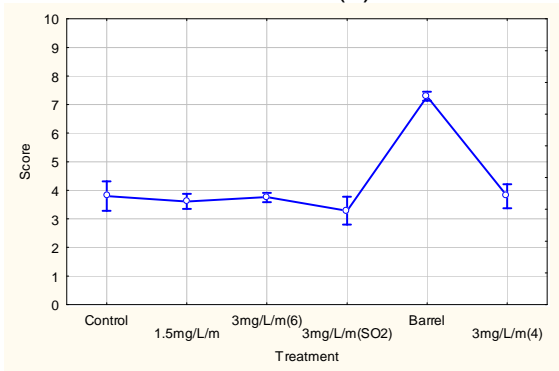
Spiciness (a)



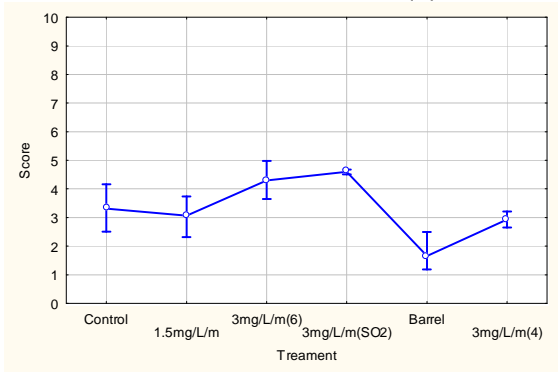
Fruitiness (b)



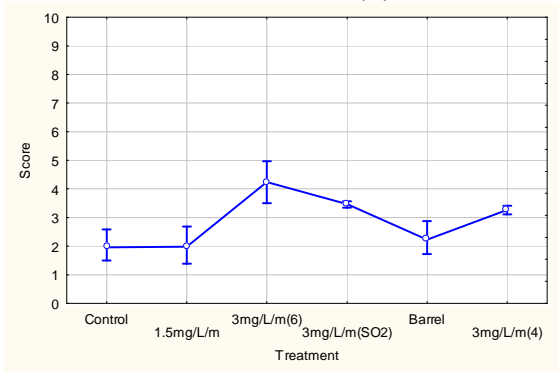
Vanilla/butterscotch (c)



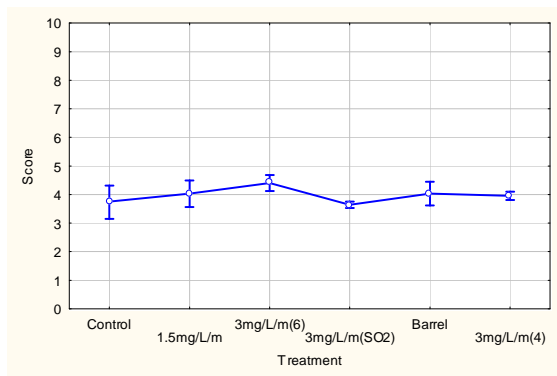
Oak/coconut (d)



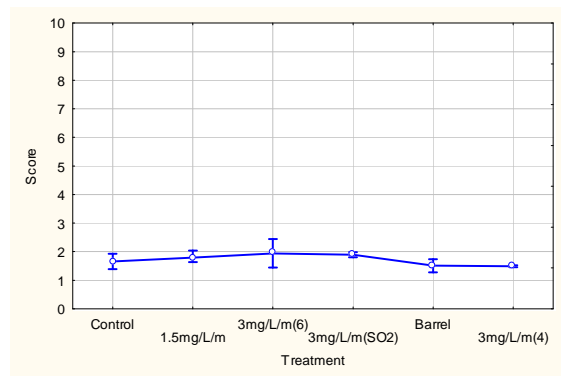
Barnyard/medicinal (e)



Oxidized/aged (f)



Astringency (g)



Bitterness (h)

FIGURE 1

Different sensory attributes of wine B after 6 months of micro-oxygenation (6). In the 3 mg O<sub>2</sub>/L/month treatment wines, were also evaluated after 4 months (4), as well as to which SO<sub>2</sub> was added prior to the tasting (SO<sub>2</sub>). Vertical bars denote 0.95 bootstrap confidence interval.

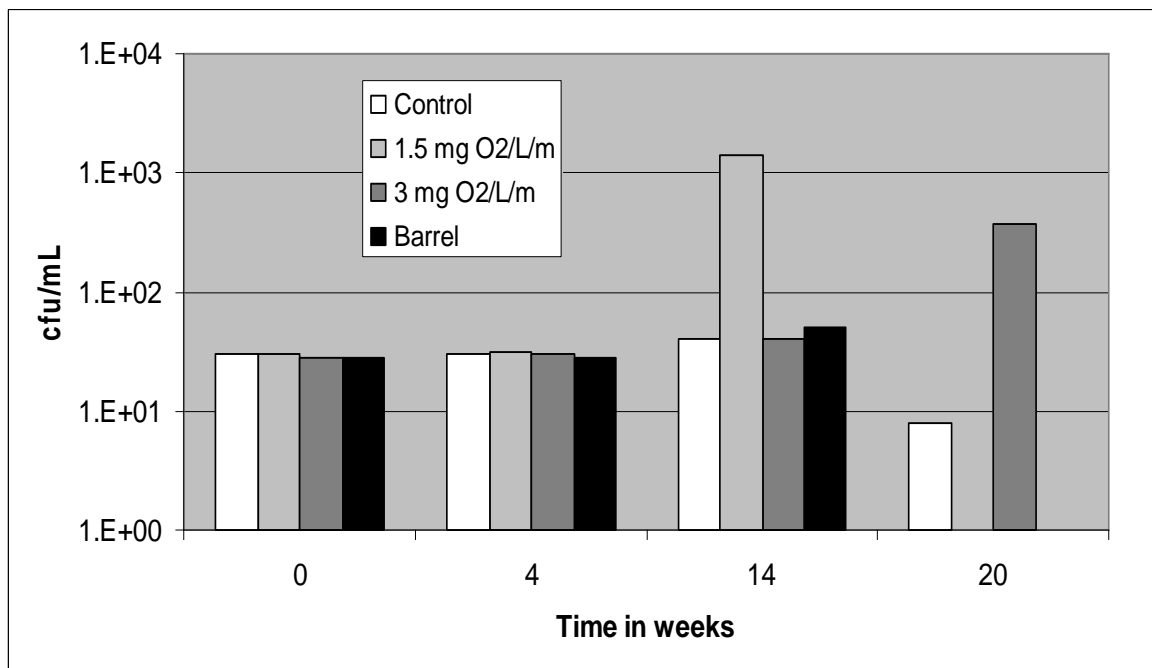


FIGURE 2

*Brettanomyces* numbers in wine B during micro-oxygenation treatment

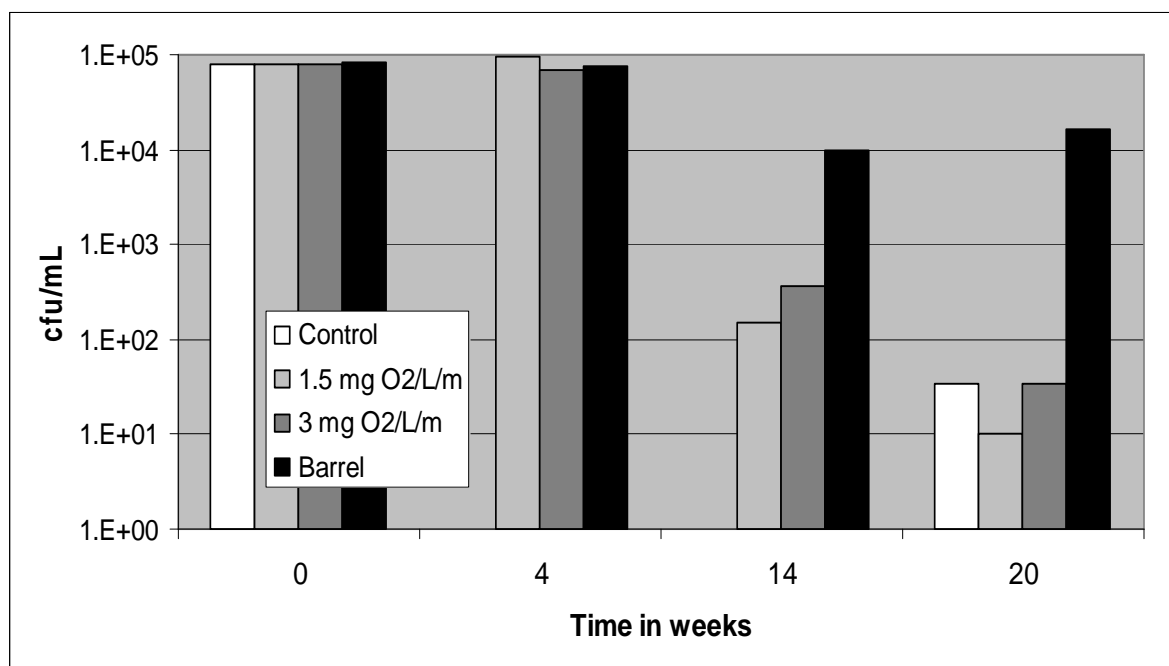


FIGURE 3

Acetic acid bacterial numbers in wine B during micro-oxygenation treatment

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