ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

INFLUENCE OF ENOLOGICAL TREATMENTS ON DISSOLVED OXYGEN CONTENT OF MOROCCAN RED WINE

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Manuscript Info

Manuscript History:

Received: 18 January 2016
Final Accepted: 19 February 2016
Published Online: March 2016

Key words:
Red wine, oxygen, enological treatments.

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Abstract

The aim of this study is to investigate the impact of different technological operations on dissolved oxygen amount. The concentration of oxygen is measured before and after different operations (ranking, earth filtration, tangential filtration, cadridgue filtration, and bottling) in cellar IQQDAR of company LES CELLIERES DE MEKNES, Morroco. It showed that all treatment increase significantly ($p<0, 05$) the dissolved oxygen amount in the red wine. The greatest increase has been observed during ranking (reception of wine) and bottling of wine, 1,81 and 2,7 mg/L,respectively.

Introduction:-

The oxygen plays a crucial role in enology. It is the major factor in the evolution of wine. The oxygen can be dissolved in wine at several stages during winemaking, bottling and aging. In recent years, oxygen is used during alcoholic fermentation to enhance the viability of yeast and is brought in infinitesimal quantities in the wine aging in tank or barrel (Pasteur, 1973). It plays a beneficial role during the winemaking process. The effect of oxidation phenomenan depends on the concentrations present and periods of enrichment. Oxygenation provided contributes to color stabilization and reduction of the astringency of red wines as during barrel aging (Glories, 1987), or micro-oxygenated tanks (Boulet and Moutounet, 1998). It is commonly accepted that inappropriate and uncontrolled oxygen dissolution induce oxidation mechanisms responsible for a negative change in the quality of wines. A large amount of oxygen is trapped in the bottle, Decreasing the levels of free and total SO_2, aromas and colors of white and pink wines (vidal *et al.*, 2001). The presence of oxygen in the wine, is not a stable state in time after it's dissolution,. The dissolved oxygen is gradually consumed by a variety of substrates, mainly the polyphenols (Singleton, 1987). The disappearance of floral aromas is faster as a result of oxygen supply even at 15 ° C and aromatic alterations arrive before the color changes (Silva *et al*., 2002). For a given operation (filtration, centrifugation ...), the quantities dissolved are dependent on operatory conditions. The level of dissolved oxygen at a given moment in wines, depends on the kinetics of dissolution and oxygen consumption. When applying a movement to a wine (pumping, decanting, filling, stirring, etc.) the kinetics of dissolution of the atmospheric oxygen in contact with wine is greater generally than that of the consumption by wine constituents. This study was conducted at the company LES CELLIERS DE MEKNES, wich is one of the biggest wineries in Morroco. The purpose of this study was to quantify the dissolved oxygen in red wine, during different enological treatments process such as racking, tartaric stabilization, filtering and bottling to identify the critical points (the unit operations) that contribute most to the integration of oxygen in wine and to establish preventive and corrective measures.

Material and Methods:-

Wine:-

The red wines analyzed were produced during 2014 vintage in winery IQQDAR of the society LES CELLIERS DE MEKNES Morocco from different varieties (*Syrah, Cabernet sauvignon, Merlot, and Marselan*).

Enological treatment of wine:-

Wine is treated with the enological equipment from the cellar of IQQDAR (table 1).

Measurement of Dissolved Oxygen:-

The concentration of dissolved oxygen of different wines is measured using a portable oximeter HACH HQ30D. The Increasing of the concentration of dissolved oxygen was determined by the calculated difference between the concentration of oxygen before (Q_{Bef}) and immediately after (Q_{Aft}) each treatment $\mathbf{Q_{dissolved} = (Q_{Aft}) - (Q_{Bef})}$

Statistical analysis:-

Data of dissolved oxygen are expressed as the average and standard deviation of measurements performed for the different wines. The influence of enological treatments was analyzed by non-parametric procedures using the paired-samples T-test (before and after treatment), the Wilcoxon signed ranks test, performed by the EXELSTAT software.

Results and Discussion:-

The measures of oxygen concentrations before and after the specific enological treatments provide variable data. The statistical analysis performed using non parametric paired samples revealed that the enrichment of dissolved oxygen is important for all the operations carried out (Table 2). The increase in dissolved oxygen for each treatment is shown in Figure 1.

Tanker- tank:-

Wine Pumping from the Tanker to the tank without inerting this later increased dissolved oxygen content to an average of 1,81 mg /L figure 1, in a time that overall enrichment in oxygen pumping with inerting reception tank is only 0,1 mg/L according to Vidal et al (2001)). However even the prior inerting circuit, the wine is eventhough enriched. The Oxygen enrichment essentially occur at the beginning and the end of the transfer, due to the dissolution of the air contained in the pipes and tanks. In our study the wine undergoes pumping in several situations, during loading or transfers within the cellar. The pump most commonly used for loading is the piston pump which increases the contact of wine with air after the end of the transfer (Catarino et al., 2014).

Earth filter:-

At the start of control, the average content of dissolved oxygen in the wine out of the starting tanks was 1,37 mg/L Table 2. At the end of the operation, the concentration in the receiving tanks achieved 1,78 mg/L Table 2. These results are consistent with data found by other authors (Vidal *et al.,* 2001). In addition to the above observations (Tanker- tank), Oxygen comes from the tray that feeds the filter where wine-kieselguhr mixture is saturated with oxygen (note that the stirring is performed at ambient air).

Flow filter:-

At the start of control, the average content of dissolved oxygen in the wine out of the starting tanks was 1,39 mg/L Table 2 and it is 1,99 mg/L at the end of the tangential filtration operation in the receiving tank Table 2. The overall enrichment was 0,60 mg/L, this result consists with data found by some authors (Vidal *et al.,* 2001) and exceeds results observed by Catarino *et al.,* (2014). The enrichment noted may be directly related to the design of the apparatus like the fed-batch and retrofiltration system with compressed air.

Finishing filtration (cartridge):-

At the start of control, the average content of dissolved oxygen in the wine out of the starting tanks was 0,76 mg/L Table 2. At the end of the membrane filtration operation, the concentration in the receiving tank is mounted to 1,18 mg/L Table 2. The overall enrichment is 0,42 mg/L figure 1. The dissolved oxygen in wine is higher than that reported in Refs. (Vidal, 2004, Castellari, 2004), these authors noted average values of 0,10 mg/L and 0,06 mg/L, respectively. The increase in dissolved oxygen in the wine during the filtration membrane cartridge mainly due to air vents in the circuit, in particular through the pipes, the pump body and the filter, the length and diameter of the tube as well as turbulent flow.

Bottling:-
This operation (bottling) has contributed to a greater enrichment of dissolved oxygen in the range of 2,07 mg/L figure 1. The filling of the bottles is the main critical point for the oxygen enrichment of wine. It is common to find conditioned wines with dissolved oxygen amounts of 2 to 4 mg / L. And if we add the oxygen present in the headspace after sealing, we can reach total amounts of trapped oxygen of 6 mg/L for several batches of bottles of 75 cL (Vidal et al., 2006).

Comparison between the three lines of finisher filtrations (cartridge):-
According to tests of Friedman, we note that there is no significant difference between the three lines of finishing filtration.

Comparison between the three lines of bottling:-
According to Friedman test, we note that there is a significant difference between bottling lines by oxygen enrichment. The greatest enrichment is showed in the bottling line number 3.

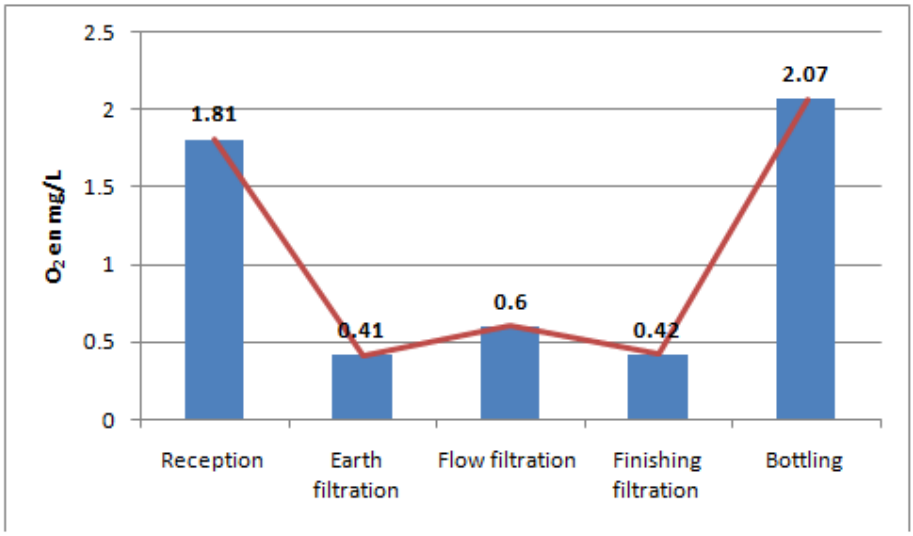

Figure 1: Average quantities of dissolved oxygen after each treatment

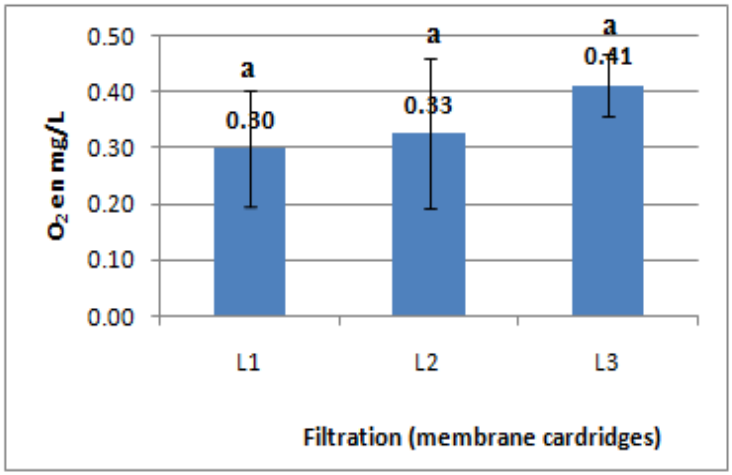

Figure 2: Increase of the amount of oxygen dissolved in the various lines of the finishing filter (cartridge)

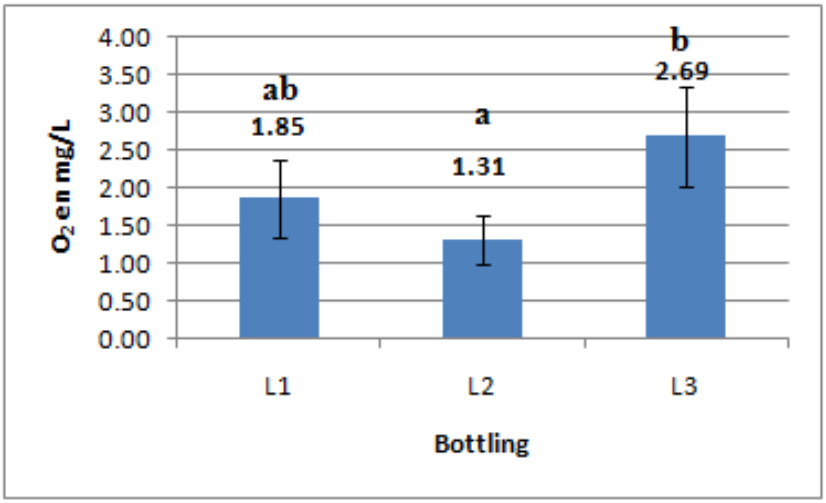

Figure 3: Increase of the amount of oxygen dissolved in the various lines of bottling.

Table 1: Description of oenological treatments at the winery IQQADAR.

Red wine	**Number of samples**
Reception (tank pump to tank)	8
Earth filtration	7
flow microfiltration	6
Finishing filtration (cartridge)	20
Bottling	16

Table 2: Amount of dissolved oxygen mg/L before treatment and bitter every enological and *p* value of the signed Wilcoxon test (comparison test two sets of paired measure)

Red wines	**Before treatment**	**After treatment**	**P value (Wilcoxon test)**
Reception (tank pump to tank)	2,04 ± 0,71	3,85 ± 0,77	0,014*
Earth filtration	1,37 ± 1,05	1,78 ± 1,08	0,022*
flow microfiltration	1,39 ± 1,21	1,99 ± 1,08	0,031*
Finishing filtration (membrane cartridge)	0,76 ± 0,53	1,18 ± 0,57	0,000*
Bottling	1,30 ± 0,57	3,37 ± 0,89	0,000*

*: Significant difference for P value <0,05

Conclusion:-

In this study the most enrichment of oxygen is shown during operation of ranking reception and bottling. The products of oxidation decrease the quality of the wine, the incorporation of oxygen into the wine during its handling is then to avoid. The chosen material must minimize this incorporation, we can then use vacuum pumps with a chamber that stores the wine and separates it from the air with a membrane, the latter prevents the wine contact with the air and therefore its oxidation.. In many studies, the factor related to all the wine processing operations that leads to an increase in dissolved oxygen in the wine is the manipulation at low temperature, example of tartaric stabilization which is considered as a critical point. Controlling dissolved oxygen is an important way permitting the improvement of the quality and the shelf-life of wine. To control and to decrease significantly the oxygen pick up in all the operations needs the using of neutral gases (as nitrogen gas) during operation treatment. But the operation of deoxygenating by the nitrogen is expensive, that's why it is made for higher quality wines in the company of study.

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