



## Malolactic fermentation before or during wine aging in barrels



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### ABSTRACT

Malolactic fermentation (MLF) and aging in oak barrels are two oenological processes which modify the composition and sensory characteristics of the wines. However, there are few studies on the MLF in barrels.

This work compares wines in which MLF is carried out in steel tanks and then aged in oak barrels, with wines in which MLF has been carried out in barrels.

MLF occurs faster in barrels and while the fundamental structure of the wine is virtually identical, there is less color loss.

Some groups of volatile compounds vary significantly depending on whether MLF takes place in tanks prior to aging or in the oak barrels themselves. It was shown that in this latter case, wines were obtained with slightly higher concentrations of methoxy-phenols and approximately double amount of whisky-lactones and furanic compounds.

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### 1. Introduction

In addition to alcoholic fermentation, red winemaking also requires malolactic fermentation (MLF) and aging in barrels and/or in bottles. The main purpose of MLF is to reduce wine acidity by transforming the malic acid, into lactic acid (Moreno-Arribas, Gómez-Cordovés, & Martín-Alvarez, 2008).

Moreover, volatile compounds are also formed during this process that enrich the wine's aromatic quality while also modifying color and phenolic composition (Izquierdo-Cañas, García, Gómez, & Palop, 2008; Martínez-Pinilla, Martínez-Lapiente, Guadalupe, & Ayestarán, 2012).

When MLF is complete, the wine is subjected to different clarification and stabilization treatments and/or is stored in oak barrels for aging for a variable period of time. This practice modifies wine composition due to the compounds extracted from the wood and to the chemical reactions that take place when oxygen passes through wood pores or staves (Gómez García-Carpintero, Gómez Gallego, Sánchez-Palomo, & González Viñas, 2012).

In an attempt to obtain more complex quality wines from an

organoleptic point of view with their own distinguishing personality, another production method employed consists of carrying out the MLF process in the oak barrels where the wine is stored to age (Hernández-Orte, Peña, Pardo, Cacho, & Ferreira, 2012).

Traditional red wine production, in which MLF is carried out in tanks and aging in barrels, has been widely studied (Castro-Vázquez et al. 2011; Jarauta, Cacho, & Ferreira, 2005). However, less research has been done on MLF in barrels in which there is less control over the process and therefore entails greater risks.

Barrel MLF modifies the aromatic sensory profile of wine in varying degrees depending differences in the design of the studies performed (De Revel, Bloem, Augustin, Lonvaud-Funel, & Bertrand, 2005; Gómez García-Carpintero, Sánchez-Palomo, & González Viñas, 2014), the general consensus showing a preference for barrel MLF wines over the tank MLF variety (Vivas, Lonvaud-Funel, & Glories, 1995). However, few articles have taken a close look at the changes occurring in the concentration of the different volatile compounds when MLF takes place in barrels.

The objective of this study is to compare the chemical composition, color, volatile composition and sensory qualities of two groups of red wines aged in French oak barrels: one in which MLF was carried out in tanks and the other in barrels.

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## 2. Material and methods

### 2.1. Fermentation assays

Cabernet Franc grape variety was fermented in our experimental winery, vintage 2013. The chemical composition of the must was: ° Brix 23.00; total acidity 6.89 g/L; pH 3.24; L-malic acid 1.83 g/L. Alcoholic fermentation was carried out at  $25 \pm 2$  °C using the commercial yeast Uvaferm VN<sup>®</sup> (Lallemand Inc.) at 20 g/HL. The fermentation was monitored daily by measuring density and the wine was pressed upon reaching a density of 995 g/L marking the completion of alcoholic fermentation at room temperature.

After alcoholic fermentation, the wine was divided into two batches to carry out MLF in tanks and in barrels, by triplicate. Fifty-liter stainless-steel tanks were used for one batch and 32-L French oak barrels for the other. Upon completion of the MLF process, the wine held in the tanks was transferred to barrels for 45 days so that it would have the same contact time with the oakwood as the other batch.

A commercial Alpha strain (MBR<sup>®</sup>) at 1 g/HL was used for MLF according to the manufacturer's instructions (Lallemand Inc.) at a temperature of 22 °C.

MLF development was controlled by monitoring the L-malic acid content of the wines. When malic acid content reached values  $\leq 0.2$  g/L, the wines were sulphited until a final free SO<sub>2</sub> concentration of 30.0 mg/L.

When MLF was finished, the wines were left for a total of 45 days in barrels and were then stabilized, filtered through 0.2 μm filters and bottled.

### 2.2. Chemical analysis

The wines were analytically characterized following the official analytical methods (OIV, 2014).

Anthocyanins were determined by decoloring with sulfur dioxide (Ribereau-Gayon & Stronestreet, 1965) and total polyphenols by measuring the absorbance at 280 nm (Somers & Evans, 1976). Total flavan-3-ols were determined by reaction with dimethylaminocinnamaldehyde and measurement of the absorbance at 640 nm (Vivas, Glories, Lagune, Sancier, & Augustin, 1994), and tannins by precipitation with methylcellulose (Smith, 2005).

### 2.3. Volatile compound analysis

Volatile compounds were analyzed by GC–MS with quadrupole analyzer. A BP21 column (SGE) 50 m–0.32 mm internal diameter and 0.25 mm thick of Free Fatty Acid Phase (FFAP) (polyethylene glycol treated with nitroterephthalic acid) was used.

For the major volatile compounds, 1 μL of the samples was directly injected with 4-methyl-2-pentanol as internal standard (final concentration 20 mg/L). The chromatographic conditions were as follows: carrier helium gas (1.7 mL/min, split 1/25); injector temperature, 220 °C and oven temperature, 43 °C for 5 min, 4 °C/min to 100 °C, 20 °C/min to 190 °C, and 45 min at 190 °C.

Minor volatile compounds were extracted using the method developed by Ibarz, Ferreira, Hernández-Orte, Loscos, and Cacho (2006). Extracts were concentrated by distillation in a Vigreux column and under nitrogen stream to 100 μL and then kept at –20 °C until analysis.

Separated compounds were identified by their mass spectra and their chromatographic retention times, using commercial products as a standard. Quantification was performed by analyzing the characteristic *m/z* fragment for each compound using the internal standard method. Results for non-available compounds was expressed in concentration units (μg/L or mg/L) as internal

standard equivalents obtained by normalizing the compound peak area to that of the internal standard and multiplying by the concentration of the internal standard.

### 2.4. Sensory analysis

Sensory analyses were performed to identify the differences among the two different MLF procedures. Both triangle and descriptive tests were carried out. Wines were analyzed by a panel of expert assessors (between 25 and 50 years age) who were staff members from Institute of Wine and Vin of Castilla-La Mancha, Spain, with experience in sensory analysis. Previously, assessors were trained in descriptive sensory analysis over several sessions, using discriminative tests.

A triangular test to evaluate differences in color, aroma and taste was performed. Sets of three samples each were analyzed by 14 panelists in three sessions carried out on different days in accordance with ISO Standard 4120 (ISO, 1983).

Descriptive sensory analysis was performed by 10 selected panelists following the Sensory Profile method according to ISO Standard 11035 (ISO, 1994). The descriptors were scored on a scale of 0–5 (0 absence of the descriptor and 5 maximum intensity of the descriptor).

### 2.5. Statistical analysis

The paired Student *t* test was used to identify any significant differences between chemical analysis results and volatile compounds. SPSS 12.0 software was used for both analyses.

## 3. Result and discussion

### 3.1. Evolution of L-malic acid

Fig. 1 shows the evolution of L-malic acid from tank MLF and barrel MLF assays. The figure shows that malic acid degradation began on day 5 in the oak trials but on day 11 in the steel tank trials. MLF was completed after 18 and 21 days respectively. De Revel et al. (2005) showed that the LAB population was higher in samples containing oak heated shavings than in the controls, which would explain the quicker fermentation.

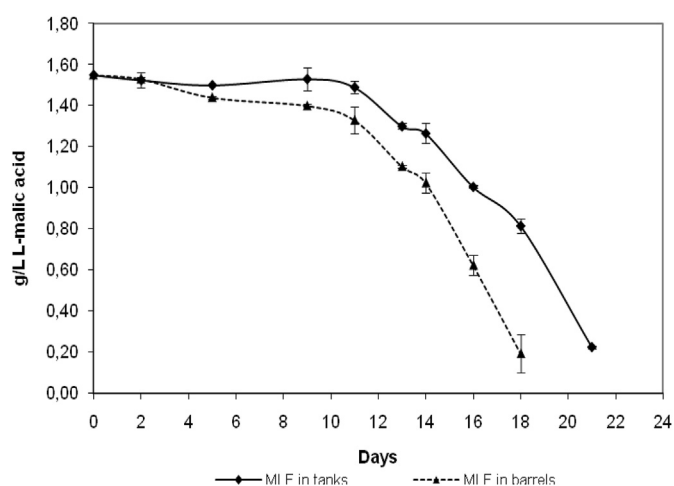


Fig. 1. Evolution of MLF.

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