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Chemical, chromatic, and sensory attributes of 6 red wines produced with prefermentative cold soak

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ABSTRACT

Six red grape cultivars, Barbera D'Asti, Cabernet Sauvignon, Malbec, Merlot, Pinot Noir and Syrah, were produced with or without prefermentative cold soak (CS). Cold soak had no effect on the basic chemical composition of the wines. At pressing, CS wines were more saturated and with a higher red component than control wines. After 1 year of bottle aging, CS wines retained 22% more anthocyanins than control wines, but tannins and total phenolics remained unaffected. Both saturation and the red component of colour were slightly higher in CS wines. From a sensory standpoint, CS only enhanced colour intensity in Barbera D'Asti and Cabernet Sauvignon wines, whereas it diminished colour intensity in Pinot Noir. Cold soak had no effect on perceived aroma, bitterness, astringency, and body of the wines. Principal Component Analysis suggested that the outcome of CS is contingent upon the specific cultivar to which the CS technique is applied.

1. Introduction

In the past 20 years, the winemaking technique known as prefermentative cold soak (CS) has gained widespread use for the production of red wines and is nowadays applied in most wine-growing regions for many different grape cultivars. Prefermentative CS consists of the contact of fermentation solids (skins, seeds and occasionally stems) with the must in a non-alcoholic and low-temperature environment prior to the onset of alcoholic fermentation (Casassa & Sari, in press; Delteil, 2004). The absence of ethanol is ensured by keeping the must at low temperatures, typically in the range of 5–10 °C, for a variable period of time, ranging from 3 to 5 h up to 10 days (Álvarez, Aleixandre, García, & Lizama, 2006; Gil-Muñoz et al., 2009; Gordillo, López-Infante, Ramírez-Pérez, González-Miret, & Heredia, 2010; Marais, 2003; Ortega-Heras, Pérez-Magariño, & González-Sanjosé, 2012; Reynolds, Cliff, Girard, & Kopp, 2001). As both anthocyanins and tannins are water-soluble, CS should theoretically favour the extraction of both phenolic classes (Delteil, 2004; Hernández-Jiménez, Kennedy, Bautista-Ortín, & Gómez-Plaza, 2012), assuming that the increased solubility outweighs the decreased cellular permeability observed al lower temperatures (Sacchi, Bisson, & Adams, 2005).

The extent of extraction of anthocyanin and tannins as a result of the application of CS has been found to be cultivar-dependent, with conflicting results reported in the literature. For example, some reports indicate an increase in phenolics (Busse-Valverde et al., 2010; González-Neves et al., 2013), a decrease (Budic-Leto, Tomislav, & Vrhovsek, 2003; González-Neves, Gil, Favre, & Ferrer, 2012) or no effect (Ortega-Heras et al., 2012; Pérez-Lamela, García-Falcón, Simal-Gándara, & Orriols-Fernández, 2007) upon application of CS to red wines. Similarly, glycosylated bound-aroma compounds, also known as aroma precursors, are water-soluble and one of the claiming benefits of CS is to enhance the extraction of glycosylated bound aroma compounds thereby improving the aromatic potential of the wines during aging (Delteil, 2004). However, a specific look at the concentration of these compounds upon application of CS by two independent studies in Cabernet Sauvignon and Malbec wines have shown inconclusive results regarding this putative effect of CS on glycosylated aroma compounds (Casassa, 2007; McMahon, Zoecklein, & Jasinski, 1999).

Prefermentative CS has generated an intense debate over its sensory effects on red wines as well. Unfortunately, most of this ongoing debate is based on anecdotal reports from winemakers, with wines produced under variable and often unreported conditions (length and temperature of CS, yeast inoculation, use of CO_2 or external refrigeration). Indeed, these informal accounts are sometimes at odds with what formal research has reported. For

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example, the low temperatures at which the must is typically kept during CS (5–10 °C) are thought to favour the metabolism of non-*Saccharomyces* yeast over that of *Saccharomyces cerevisiae*, resulting in positive modifications of the flavor profile of the wines (Charpentier & Feuillat, 1998). While the viability of non-*Saccharomyces* yeast during CS have been established (Casassa & Sari, in press; Zott, Miot-Sertier, Claisse, Lonvaud-Funel, & Masneuf-Pomarede, 2008), their impact on the sensory profile of the wines is often negative. Published reports have found that CS increased the ethyl-acetate content (González-Neves et al., 2013) and the acetaldehyde character (Casassa & Sari, in press) of the finished wines, both compounds with negative sensory connotations. Likewise, the volatile composition of control and CS wines as determined by SPME GC–MS was statistically undistinguishable for 31 out of 33 volatiles in Cabernet Sauvignon wines (Gardner, Zoecklein, & Mallikarjunan, 2011), which casts doubt on a practical sensory impact of this technique.

The aim of the present study was to assess the chemical, chromatic and sensory effects of CS applied to 6 different grape cultivars grown in Mendoza, Argentina. Towards this end, experimental lots of Barbera D'Asti, Cabernet Sauvignon, Malbec, Merlot, Pinot Noir and Syrah were produced in triplicate by applying a control maceration of 14 days and also a CS treatment in the wines of each cultivar. The wines were analysed for basic and phenolic chemistry and chromatic parameters both at press and after 1 year of bottle aging. Complementarily, a formal sensory analysis of the wines was conducted.

2. Materials and methods

2.1. Grapes

Own-rooted Barbera D'Asti, Cabernet Sauvignon, Malbec, Merlot, Pinot Noir and Syrah grapes (*Vitis vinifera* L.) were obtained from a commercial vineyard property of INTA located in Luján de Cuyo, Mendoza, Argentina (33° 00′ S, 68° 51′ W). For Barbera D'Asti, Malbec and Merlot, the trellis system was vertical shoot positioning, whereas Cabernet Sauvignon, Pinot Noir and Syrah were trellised in overhead canopy positioning ("parral"); yields ranged from 7.4 to 18.5 th/ha (Table 1). For each cultivar, a total of 700 kg were manually harvested to 18-kg plastic boxes at selected dates depending on the cultivar (Table 1). Visual inspection of the grapes revealed variable, albeit fairly low degrees of *Botrytis cinerea* damage, with Barbera D'Asti and Pinot Noir having about 5% of affected clusters, and with Cabernet Sauvignon and Syrah showing about 2–3% of affected clusters. For the grape basic analysis, four independent samples of 30 berries each were taken at harvest for each cultivar and analysed independently for berry weight and volume, seeds/berry, Brix (Atago, Tokyo, Japan), pH (Orion model 701-A, Thermo Scientific, Waltham, MA, USA), titratable acidity, and laccase activity (Dubourdieu, Grassin, Deruche, & Ribereau-Gayon, 1984). The solid-to-juice ratio was computed as the percentage ratio between the weight of solids (skins and seeds) and the total liquid weight (i.e. pulp).

2.2. Winemaking

Grapes were transported upon harvest to the INTA Wine Research Center experimental winery. Grapes were crushed and destemmed (Metal Liniers model MTL 12, Mendoza, Argentina), and pumped into 100-L stainless steel tanks. Sulphur dioxide (SO_2) was dosed during crushing at a rate of 80 mg/L for all the experiments. The experimental design consisted of two maceration treatments for each of the 6 cultivars, replicated three times ($n = 3$). Initial must temperatures upon crushing were registered

Table 1
Harvest date, yields, physical and chemical composition of Barbera D'Asti, Cabernet Sauvignon, Malbec, Merlot, Pinot Noir and Syrah grapes used for the winemaking treatments. For berry data, values represent the mean (±SEM) of four independent sample replicates taken at harvest ($n = 30$ berries).

Cultivar	Harvest date	Yields (tn/ha)	Berry weight (g)	Berry volume (cm^3)	Seeds/berry	Solid-to-juice ratio (%)	Laccase activity (U/mL)	Brix	pH	Titratable acidity (g/L tartaric acid)
Barbera D'Asti	17-IV-2008	18.5	2.01 ± 0.04 d[a]	1.85 ± 0.03 e	1.76 ± 0.02 b	10.01 ± 0.09 b	4.96 ± 0.32 e	25.80 ± 0.21 b	2.96 ± 0.02 a	9.90 ± 0.21 d
Cabernet Sauvignon	17-III-2008	11.8	1.22 ± 0.06 a	1.15 ± 0.03 a	1.99 ± 0.02 cd	11.22 ± 0.45 c	3.16 ± 0.11 bc	24.15 ± 0.13 a	3.32 ± 0.04 b	6.60 ± 0.15 c
Malbec	13-III-2008	7.5	1.93 ± 0.04 d	1.73 ± 0.03 d	1.95 ± 0.02 c	8.11 ± 0.13 a	3.44 ± 0.15 c	26.10 ± 0.09 b	3.77 ± 0.01 de	4.42 ± 0.04 a
Merlot	7-III-2008	7.4	1.69 ± 0.02 c	1.56 ± 0.02 c	2.05 ± 0.03 d	10.02 ± 0.28 b	4.41 ± .015 d	24.10 ± 0.04 a	3.78 ± 0.02 e	4.42 ± 0.19 a
Pinot Noir	18-III-2008	12.8	1.43 ± 0.02 b	1.31 ± 0.02 b	2.67 ± 0.03 e	14.77 ± 0.03 d	1.62 ± 0.09 a	23.80 ± 0.15 a	3.72 ± 0.01 d	4.87 ± 0 .12 b
Syrah	15-III-2008	9.7	1.77 ± 0.03 c	1.61 ± 0.02 c	1.51 ± 0.02 a	9.33 ± 0.02 b	2.92 ± 0.08 b	24.00 ± 0.06 a	3.50 ± 0.02 c	6.47 ± 0.11 c

[a] Different letters within a column indicate significant differences for Fisher's LSD test and $p < 0.05$.