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Research Note

Effects of the time of SO_2 addition on phenolic compounds in wine

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Introduction: Polyphenol compounds are very important for red wine colour and flavour. Most alterations in wine during aging are due to phenolic compounds, the most rapid changes in colour composition occurring during the first year. Oenological practices can affect the rate of extraction and final content of phenolic compounds in wines, *e.g.* by adding SO_2 at the onset of vinification. Among other positive effects SO_2 reduces the rate of browning of wines (Main and Morris 1991; Kontek *et al*. 1996) and enhances colour extraction (Dallas and Laureano 1994; Bakker *et al*. 1998). During vinification and conservation of wines, SO_2 reduces the rate of colour loss and phenolic polymerisation (Dallas and Laureano 1994; Picinelli *et al*. 1994). The moment of addition of SO_2 can be very important for the final quality of wine. In this paper we investigated the effect of a delayed SO_2 addition during the early stages of vinification and after one year of storage on phenolic compounds.

Material and Methods: Grapes from *Vitis vinifera* cv. Monastrell, cultivated in Jumilla (SE Spain) were harvested at optimum maturity. Two different lots (200 kg each) were prepared. The first lot (W1) was crushed, destemmed and sodium metabisulfite was immediately added (5 g SO_2 per 100 kg). The sulfited crushed berries were filled into a 120 l tank. The grapes of the second lot (W2) were treated the same way but sodium metabisulfite was added after 8 h. Total acidity was corrected to 5.5 g l^{-1} and selected yeasts were added to both tanks (10 g of dry yeast per 100 kg of grapes). During alcoholic fermentation temperature and must density were controlled twice a day and three rackings were made. Malolactic fermentation occurred in both wines; these wines were cold stabilized (-3° C). Thereafter, the wines were bottled and samples (three bottles of each wine) were taken at the moment of bottling, and again, after 12 months of storage.

Extraction, identification and quantification of phenolic compounds: All analyses were made in triplicate. Phenolic compounds were fractionated using a C_{18} Sep-pak cartridge (Waters Associates, Philadelphia) and analysed by means of HPLC according to Gómez-Plaza *et al.* (2000).

Spectrophotometric determinations: Absorbance measurements were made in a Hitachi 2000 spectrophotometer (Tokyo, Japan) with glass cells (0.2 cm path length). The samples were clean and free of CO_2 which had been eliminated by means of ultrasound and stirring. Colour density (CD) was calculated as the sum of absorbance at 620, 520 and 420 nm and tint as the ratio between absorbance at 420 and 520 nm. Total polyphenols, total colour of pigments (WCA), polymeric pigment color (PPC) and chemical age (CA) were calculated according to Gómez-Plaza *et al*. (2000).

Results and Discussion: The Table shows the concentration of phenolic compounds and spectral data of wines at the moment of bottling and after 12 months of storage. W2 showed more procyanidins, less hydroxycinnamic acid derivatives and less anthocyanins than W1. Total polyphenol levels and WCA were higher in W1, whereas PPC and CA were higher in W2. Previous studies have shown that the addition of SO_2 promotes extraction of total polyphenols (Bakker *et al*. 1998) and anthocyanins (Dallas and Laureano 1994) and increases the concentration of hydroxycinnamic acid derivatives due to the inhibition of the polyphenol oxidase enzyme (Main and Morris 1991; Mayen *et al*. 1996). At the same time, the level of procyanidins (Mayen *et al*. 1996) and the degree of polymerization decreased (Dallas and Laureano 1994). After 12 months of storage, in both wines WC, WCA and the concentration of anthocyanins decreased, confirming the spectrophotometric data. Two anthocyanins, delphinidin-3-monoglucoside and cyanidin-3-monoglucoside, could not be detected in the W2 samples after 12 months of storage; their o-diphenolic structure may have contributed to their faster degradation rate (Cheynier *et al*. 1994). Flavan-3-ols also diminished with time, probably due to oxidation and polymerisation. We found a slight increase in the procyanidin concentration during storage that could be attributed to the hydrolysis of other procyanidins, such as trimers and galloylated dimers; these reactions have previously been postulated by Timberlake and Bridle (1976) and Dallas *et al*. (1995). CA and PPC increased since these parameters are related to polymeric compounds.

Besides this expected evolution during storage in both wines, the results show that the differences which already existed between both wines at the moment of bottling still exist after 12 months of storage.

This experiment shows that if oxygen uptake is not restricted at the very beginning of vinification, oxidation and condensation reactions will lead to very reactive oxidation products. Delayed addition of SO_2 does not remove these oxidation products which will enter coupled oxidation reactions as well as condensation reactions, thereby changing the phenolic profile of wine.

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T a b l e

Phenolic compounds (mg l^{-1}) and colour characteristics of Monastrell wines

Compound	Duration of storage			
	0 months		12 months	
	W1	W2	W1	W2
Procyanidin B2	2.27*	2.49	2.71*	1.50
Procyanidin B4	1.05*	1.25	1.36*	1.55
Procyanidin B3	3.03*	3.84	3.33*	3.96
Procyanidin B5	1.07*	1.57	1.46*	1.94
Catechin	10.91	10.71	6.81*	6.09
Epicatechin	4.03*	3.87	2.21*	1.85
Caftaric acid	155.58*	105.18	92.71	82.57
Coutaric acid	88.77*	96.60	76.57*	64.54
Delphinidin-3-G	11.46*	10.10	8.51*	nd
Cyanidin-3-G	12.31*	8.30	7.44*	nd
Malvinidin-3-G	88.62*	63.15	31.87*	14.59
Peonidin-3-G	12.91*	10.75	8.62*	7.74
Petunidin-3-G	15.65*	14.49	11.62*	7.75
Colour density	5.00*	6.24	4.06*	5.21
Tint	0.82	0.82	0.87*	1.04
Total polyphenols (g l^{-1})	3.31*	3.53	1.13*	1.27
Ionized anthocyanins (WCA)	10.70*	7.10	7.40*	5.83
Polymeric compounds (PPC)	1.14*	1.79	1.20*	1.96
Chemical age (CA)	10.66*	25.21	15.28*	30.25

Asterisk denotes significant differences ($P<0.05$); nd: not detected.
W1: Vinification with immediate addition of SO_2;
W2: Vinification with delayed addition of SO_2.
0 months: Wines at the moment of bottling;
12 months: Wines after 12 months of storage.

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