Levels of *cis*- and *trans*-Resveratrol and Their Glucosides in White and Rosé *Vitis vinifera* Wines from Spain

Ana I. Romero-Pérez,[†] Rosa M. Lamuela-Raventós,*[,†] Andrew L. Waterhouse,[‡] and M. C. de la Torre-Boronat[†]

Nutrició i Bromatologia, Facultat de Farmàcia, Universitat de Barcelona, Av. Joan XXIII s/n, 08028-Barcelona, Spain, and Department of Viticulture and Enology, University of California, Davis, California 95616

The resveratrol monomers (*trans*-piceid, *cis*-piceid, *trans*-resveratrol, and *cis*-resveratrol) have been previously identified and quantified in red wines. Here, the levels of these compounds in Spanish white and rosé wines are described. For white wines, a concentration step was needed to quantify the four resveratrol isomers. The recovery and reproducibility of this procedure were very good. These white wines had levels between 0.051 and 1.801 mg/L. Rosé wines had an average level of 2.15 mg/L, in between those of red and white wines.

Keywords: *Resveratrol; piceid; glucosides; white wine; rosé wine*

INTRODUCTION

trans-Resveratrol is one of the compounds present in wines that could be responsible for the decrease in coronary heart disease observed among wine drinkers. This potential effect could be due to resveratrol's ability to inhibit LDL oxidation (Frankel *et al.*, 1993), block platelet aggregation (Bertelli *et al.*, 1995; Pace-Asciak *et al.*, 1995), and inhibit eicosanoid synthesis (Kimura *et al.*, 1985; Pace-Asciak *et al.*, 1995). Piceid, the 3-β-glucoside of *trans*-resveratrol, also shows antiplatelet aggregation properties (Kimura *et al.*, 1985; Shan *et al.*, 1990), and it may release *trans*-resveratrol by β-glucosidase hydrolysis in the intestine (Hackett,1986). Large differences in effective concentrations for anti-aggregation activity have been reported. Pace-Asciak *et al.* (1995) reported that 129.9 $\pm$ 64.4 μmol/L *trans*-resveratrol can inhibit platelet aggregation by 50% when ADP is used as the inducer or 164.7 $\pm$ 67.3 μmol/L is sufficient when thrombin is the inducer, while Bertelli *et al.* (1995) found that 0.016 μmol/L inhibited platelet aggregation by 50.3% when collagen was the inducer. Similar disparities are reported with the inhibition of eicosanoid synthesis; the levels that have physiological effects according to Pace-Asciak *et al.* (1995) are 10 times higher than those reported by Kimura *et al.* (1985). These differences may be due to the different mechanism used by each inducer (ADP, thrombin, collagen) in the hemostatic process; the effectiveness of the inhibitor depends on which step in the platelet aggregation process is affected. However, *in vivo* all three inducers are employed in the platelet aggregation process.

The *cis* isomers have potential anticancer activity, as do the *trans* isomers, by inhibiting protein-tyrosine kinase (Jayatilake *et al.*, 1993), and *cis*-resveratrol also shows antiaggregation properties (Bertelli *et al.*, 1996). However, the activity of the *cis* isomer in LDL oxidation has yet not been studied.

Since Siemann and Creasy (1992) described the presence of the phytoalexin *trans*-resveratrol in wines, many different methods have been developed to determine this compound, including those based on HPLC (Lamuela and Waterhouse, 1993; Mattivi, 1993a; Roggero and Archie, 1994; Pezet *et al.*, 1994; McMurtrey *et al.*, 1994) and GC/MS (Jeandet *et al.*, 1993; Soleas *et al.*, 1993; Goldberg *et al.*, 1994, 1995a). The quantification of the *cis* isomer of resveratrol in wines was achieved later by Jeandet *et al.* (1993, 1995), Soleas *et al.* (1995), and Goldberg *et al.* (1995a). Since the glycosides of these compounds are also present in red wines, HPLC methods that describe the separation of the four compounds have been published recently (Lamuela-Raventós *et al.*, 1995; Mattivi *et al.*, 1995).

In grape berries, resveratrol synthesis is mainly located in the skin cells and is absent or low in the fruit flesh. Resveratrol requires a relatively long maceration time on the skins to be extracted (Creasy and Coffee, 1988; Jeandet *et al.*, 1991, 1995). White wine is reported to have a much lower resveratrol content than red wine (Siemann and Creasy, 1992; Lamuela-Raventós and Waterhouse, 1993; McMurtrey *et al.*, 1994; Pezet *et al.*, 1994; Jeandet *et al.*, 1993, 1995; Goldberg *et al.*, 1995a,b), presumably due to minimal skin contact associated with white wine production.

The levels of resveratrol isomers in white wines found in the literature are described in Table 1. Goldberg *et al.* (1995a) analyzed 100 white wines with concentrations of *trans*-resveratrol lower than 0.1 mg/L; however, they do not describe the varieties tested. Jeandet *et al.* (1995) noted that "white wines macerated with skins had higher resveratrol content, than nonmacerated ones, but is *ca.* 3 fold lower than in those made with red grapes".

In the only study on rosé wines (Mattivi, 1993b), *trans*-resveratrol levels were between 0.005 and 1.19 mg/L, with the higher amounts than in white wines attributed to the longer maceration required to produce rosé wines.

Two reports have claimed that *trans*-resveratrol is unstable to rotary evaporation (Mattivi, 1993a; Pezet *et al.*, 1994). Since this technique was utilized here in the analysis of white wines, the stability of these compounds under rotary evaporation was confirmed.

Here, we describe the analysis of *trans*- and *cis*-piceid

* Author to whom correspondence should be addressed (e-mail lamuela@farmacia.far.ub.es).

[†] Universitat de Barcelona.

[‡] University of California.

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Table 1. Amounts of *trans*- and *cis*-Resveratrol in White Wines

		trans-resveratrol (mg/L)		*cis*-resveratrol (mg/L)	
author	variety	av	(min − max)	av	(min − max)
Siemann and Creasy (1992)	Chardonnay ($n = 13$)	0.029	(0.006−0.100)	−	−
	Cayuga white ($n = 1$)	0.4×10^{-3}	−	−	−
	white blend ($n = 1$)	0.2×10^{-3}	−	−	−
	white Bordeaux ($n = 2$)	0.003	(0.002−0.004)	−	−
	white Zinfandel ($n = 1$)	0.4×10^{-3}	−	−	−
Jeandet *et al.* (1993)	Aligoté ($n = 2$)	0.059	(0.036−0.083)	0.089	(0.046−0.125)
	Chardonnay ($n = 4$)	0.048	(0.019−0.062)	0.106	(0.088−0.124)
Lamuela-Raventós and Waterhouse (1993)	Chardonnay ($n = 1$)	not detected		−	−
	white Bordeaux ($n = 1$)	<0.05	−	−	−
Mattivi (1993a)	Chardonnay ($n = 3$)	0.041	(0.031−0.054)	−	−
	Müller Thurgau ($n = 1$)	0.111	−	−	−
	Nosiola ($n = 3$)	0.040	(0−0.122)	−	−
	Rhine Riesling ($n = 2$)	0.069	(0.064−0.074)	−	−
Pezet *et al.* (1994)	Chardonnay ($n = 1$)	0.032	−	−	−
	Chasselas ($n = 1$)	0.034	−	−	−
McMurtrey *et al.* (1994)	Chardonnay ($n = 6$)	≤0.02	−	−	−
	generic white ($n = 9$)	≤0.02	−	−	−
	Sauvignon blanc ($n = 10$)	≤0.02	−	−	−
Soleas *et al.* (1995)	Chardonnay ($n = 1$)	<0.01	−	0.06	−
	Muscat ($n = 1$)	<0.01	−	0.01	−
	Seyval blanc ($n = 1$)	0.02	−	0.04	−
	Vidal ($n = 1$)	0.11	−	0.03	−

[a] −, not described.

and *trans*- and *cis*-resveratrol in white and rosé wines produced in Spain.

MATERIALS AND METHODS

Standards. *trans*-Resveratrol was purchased from Sigma Chemical Co. *trans*-Piceid was obtained by the extraction of *Polygonum cuspidatum*, as described by Waterhouse and Lamuela-Raventós (1994). The *cis* forms of the aglycon and the glycoside standards were obtained by sunlight exposure of the *trans* isomers.

Samples. The levels of these four compounds were determined in 29 samples of varietal white wines (the white varietal samples were purchased from local markets or obtained from Spanish wineries), while the 10 rosé wines analyzed were all purchased in the market. The white wine grape varieties included Albariño, Chardonnay, Macabeo, Parellada, white Riesling, Sauvignon, Verdejo, and Xarel.lo, and the rosés included wines made from Cabernet Sauvignon, Grenache, and Pinot noir grapes.

Sample Preparation. All samples were protected from light to avoid light-induced isomerization during sample treatment. The rosé wines were analyzed by direct HPLC injection, after filtration, by the same procedure described for red wines by Lamuela-Raventós *et al.* (1995).

Quantitation of the low levels of the *cis* forms in some white wines required an additional sample concentration step; 10 mL was concentrated to 1 mL by rotary evaporation (30 °C, *in vacuo*), and the concentrate was filtered through Whatman inorganic Anopore membrane filters, with a prefilter of glass microfiber to avoid plugging the membrane filter (Anotop 10 Plus, 0.2 μm). The precision, recovery, and reproducibility of the method were established following *The U.S. Pharmacopoeia* (USP XXII).

To study the reproducibility, the same white wine sample (sauvignon blanc) was analyzed on six different days. For recovery, known amounts of the four standards were added to the same wine, and then the samples with the standards were concentrated, filtered, and analyzed.

HPLC Analysis. The analysis was carried out using a Hewlett-Packard (HP) 1050 instrument equipped with a Rheodyne injection valve (Model 7125) (100 μL fixed loop) and an HP 1040 M diode array UV−vis detector coupled to a Chem Station HP 79995A. The column used was a Tracer Nucleosil, C_{18} 120 (25 × 0.4 cm), 5 μm particle size, with a precolumn of the same material; the column heater was maintained at 40 °C. The HPLC conditions were described previously (Lamuela-Raventós *et al.,* 1995).

For the quantitation of *cis*-resveratrol, a standard curve of this compound was obtained after the exposure of *trans*-resveratrol to sunlight; after 10 min of exposure, 80−90% of *trans*-resveratrol was converted to *cis*-resveratrol. The quantitation of *trans*-piceid and *cis*-piceid was based the assumption of identical molar extinction coefficients of *trans*-resveratrol and *cis*-resveratrol at 306 and 285 nm, respectively.

RESULTS AND DISCUSSION

Method. All white wines were concentrated to assure that all four compounds could be quantified, since the limit of quantitation is 0.01 mg/L (Lamuela-Raventós *et al.*, 1995). However, in some white wines the levels were adequate to have been quantified by direct injection (see Table 2).

The instability of *trans*-resveratrol during rotary evaporation has been described by Mattivi (1993a) and Pezet *et al.* (1994). Mattivi (1993a) noticed variable recovery and reproducibility using a rotary evaporator, while Pezet *et al.* (1994) described extensive degradation of resveratrol at 40 °C and the appearance of oxidized products in the dried residue. McMurtrey *et al.* (1994) noted that *trans*-resveratrol was stable when dry, and the instability of *trans*-resveratrol observed during concentration by rotary evaporation may be caused by catalysis on the glass surface or by light-mediated reactions.

In our studies, the evaporating solutions were protected from light, and the bath temperature was maintained at 30 °C. The degradation of resveratrol during rotary evaporation, as decribed by Pezet *et al.* (1994), was not observed, and the amounts of the four compounds were the same before and after concentration. Our results were also different from those obtained by Mattivi (1993a); the recovery obtained with the concentration procedure was very high for the four compounds: 98.5% for *trans*-piceid (SD = ±2.29), 100.8% for *cis*-piceid (SD = ±0.63), 98.2% for *trans*-resveratrol (SD = ±1.21), and 98.7% for *cis*-resveratrol (SD = ±2.77). The reproducibility was also very good: the CV obtained on concentrated white wines, on six different days, was very low at 1.4% for *trans*-piceid, 1.2% for *cis*-piceid, 0.9% for *trans*-resveratrol, and 1.4% for *cis*-resveratrol. These values are better than those recom-

Table 2. Concentration of Resveratrol and Piceid Isomers in Spanish White Wines

winte variety (white)	vintage	apellation	*trans*-piceid[a] (mg/L)	*cis*-piceid[b] (mg/L)	*trans*-resveratrol (mg/L)	*cis*-resveratrol (mg/L)	total amount
Albariño	1993	Rias Baixas	0.080	0.071	0.080	0.021	0.252
Albariño	1993	Rias Baixas	0.119	0.161	0.233	0.121	0.634
Albariño	1993	Rias Baixas	0.063	0.100	0.082	0.044	0.289
Albariño	1993	Branco Portugese	0.212	0.025	0.396	0.021	0.654
Chardonnay	1992	Penedès	0.036	0.035	0.047	0.020	0.138
Chardonnay	1993	Penedès	0.030	0.033	0.031	0.021	0.115
Chardonnay	1993	Penedès	0.003	0.010	0.016	0.022	0.051
Macabeo	1991	Penedès	0.252	0.042	0.095	0.005	0.394
Macabeo	1992	Penedès	0.106	0.145	0.011	0.018	0.280
Macabeo	1992	Penedès	0.300	0.073	0.130	0.013	0.516
Macabeo	1993	Penedès	0.121	0.041	0.053	0.002	0.215
Macabeo	1993	Penedès	0.168	0.204	0.168	0.066	0.606
Parellada	1992	Penedès	0.425	0.196	0.174	0.030	0.825
Parellada	1992	Penedès	0.329	0.115	0.222	0.035	0.701
Parellada	1993	Penedès	0.305	0.146	0.183	0.022	0.656
Parellada	1993	Penedès	0.178	0.255	0.055	0.027	0.515
Riesling	1993	Penedès	0.143	0.100	0.041	0.013	0.297
Riesling	1993	Somontano	0.173	0.079	0.061	0.013	0.326
Riesling	1993	Penedès	0.086	0.036	0.059	0.006	0.187
Sauvignon blanc	1993	Penedès	0.040	0.027	0.081	0.029	0.177
Sauvignon blanc	1993	Rueda	0.166	0.145	0.284	0.084	0.679
Sauvignon blanc	1993	Rueda	0.064	0.092	0.051	0.063	0.270
Verdejo	1993	Valladolid	0.209	0.224	0.080	0.059	0.572
Verdejo	1993	Rueda	0.074	0.040	0.034	0.020	0.168
Verdejo	1993	Rueda	0.053	0.057	0.052	0.019	0.181
Xarel.lo	1992	Alella	0.422	0.217	0.353	0.062	1.054
Xarel.lo	1992	Penedès	0.153	0.393	0.547	0.708	1.801
Xarel.lo	1993	Penedès	0.380	0.447	0.166	0.076	1.069
Xarel.lo	1993	Penedès	0.448	0.225	0.342	0.040	1.055
Albariño av			0.118	0.089	0.198	0.052	0.457
Chardonnay av			0.023	0.026	0.031	0.021	0.101
Macabeo av			0.189	0.101	0.091	0.021	0.402
Parellada av			0.309	0.178	0.158	0.028	0.673
Riesling av			0.134	0.072	0.054	0.011	0.271
Sauvignon blanc av			0.090	0.088	0.139	0.059	0.376
Verdejo av			0.112	0.107	0.055	0.033	0.307
Xarel.lo av			0.351	0.320	0.352	0.221	1.244
total av			0.166	0.123	0.135	0.056	0.480

[a] Amount expressed as *trans*-resveratrol. [b] Amount expressed as *cis*-resveratrol.

mended by Horwitz (1982) to evaluate the intralaboratory precision of analytical methods.

Quantitation of *cis* Isomers. For the quantitation of the *cis* forms, we have obtained a standard curve with five known amounts of *trans*-resveratrol. These solutions were left in sunlight (10 min of exposure approximately) and reanalyzed. On the supposition that the isomerization of *trans*-resveratrol by irradiation is equal to the generation of *cis*-resveratrol, a calibration curve for the quantitation of *cis*-resveratrol at 285 nm was obtained. The coefficient of correlation for this curve was $r = 0.9997$ over the range 0.05−5.00 mg/L. With this method, the concentration of *cis* forms was approximately 2.3 times higher than when the *cis* concentration was calculated by assuming that the molar absorptivity of *cis* was the same as that of *trans*-resveratrol at the wavelength of maximum absorbance.

We also calculated the concentration of *cis*-resveratrol by using the method based on the *trans*-resveratrol standard curve and the differential molar absorptivities of both compounds at two wavelengths (Trela and Waterhouse, 1996), and the results were the same as those obtained with the *cis* standard curve.

Wines. *White Wines.* Table 2 shows the results obtained with the white wines.

trans-Piceid is the compound present at the highest level (0.166 mg/L) on average. This is the first report of the presence of this compound and its *cis* isomer in white and rosé wines. The values of *trans*-piceid in Spanish white wines are 10 times lower than the levels described in Spanish red wines, probably due to the limited maceration time for these wines. Xarel.lo wines have the highest amounts of this compound (0.351 mg/L), while Chardonnay has the lowest (0.023 mg/L).

The levels of *cis*-piceid for white wines were between 0.010 and 0.447 mg/L. The only two reports of the presence of this compound are in red wines (Lamuela *et al.*, 1995; Mattivi *et al.*, 1995). As for the *trans* isomer, Xarel.lo were the wines with the highest levels (0.320 mg/L), and Chardonnay had the lowest (0.026 mg/L).

trans-Resveratrol levels in white wines were between 0.011 and 0.547 mg/L. The variety again with the highest levels of *trans*-resveratrol was Xarel.lo (0.352 mg/L), while Chardonnay had the lowest levels (0.031 mg/L).

cis-Resveratrol was the compound present at the lowest concentration (0.056 mg/L). Jeandet *et al.* (1993) found higher levels for *cis*-resveratrol than for the *trans* isomer in white and red wines. Goldberg *et al.* (1995a) observed that *cis*-resveratrol is usually present in lower concentrations than *trans*, but on occasion it was the predominant form. *cis*-Resveratrol has not been detected in grapes (Jeandet *et al.*, 1993; Roggero and García-Parrilla, 1995; Soleas *et al.*, 1995), except in one study from Jeandet *et al.* (1995) in Pinot noir grapes, and it is thought to be produced during fermentation by the conversion of *trans*-resveratrol by isomerases, UV exposure (Jeandet *et al.*, 1995; Soleas *et al.*, 1995; Goldberg *et al.*, 1995a; Mattivi *et al.*, 1995), and/or hydrolysis of *cis*-piceid (Mattivi *et al.*, 1995; Goldberg *et al.*, 1995a). Xarel.lo was the variety with the highest

Table 3. Concentration of Resveratrol and Piceid Isomers in Spanish Rosé Wines

winte variety (rosé)	vintage	apellation	*trans*-piceid[a] (mg/L)	*cis*-piceid[b] (mg/L)	*trans*-resveratrol (mg/L)	*cis*-resveratrol (mg/L)	total amount
Cabernet Sauvignon	1992	Penedès	0.81	0.85	0.90	0.32	2.88
Cabernet Sauvignon	1993	Penedès	0.14	0.25	0.29	0.16	0.84
Cabernet Sauvignon	1993	Somontano	0.12	0.08	0.20	0.03	0.43
Grenache	1993	Priorat	0.66	1.20	0.23	0.20	2.29
Grenache	1993	Navarra	0.41	0.56	0.17	0.15	1.29
Grenache	1993	Navarra	0.71	0.56	0.07	0.02	1.36
Grenache	1993	Navarra	0.91	0.85	1.06	0.35	3.17
Grenache	1993	Rioja	0.69	0.55	0.93	0.43	2.60
Pinot noir	1992	Penedès	0.37	1.89	0.29	0.97	3.52
Pinot noir	1993	Penedès	0.24	1.14	0.28	0.72	2.38
Cabernet Sauvignon av			0.36	0.39	0.46	0.17	1.38
Grenache av			0.68	0.74	0.49	0.23	2.14
Pinot noir av			0.30	1.51	0.28	0.84	2.93
total av			0.45	0.88	0.41	0.41	2.15

[a] Amount expressed as *trans*-resveratrol. [b] Amount expressed as *cis*-resveratrol.

levels of this compound, as was noted for the *trans* isomer and piceid isomers. However, the variety with the lowest levels of *cis*-resveratrol was white Riesling.

On average, the amount of *trans*-piceid was greater than the amount of *trans*- resveratrol; however, this difference was not statistically significant. On the other hand, the concentration of *cis*-piceid was significantly greater than for its aglycon *cis*-resveratrol ($p < 0.01$). In Albariño, Chardonnay, and Sauvignon blanc wines, *trans*-resveratrol levels were higher than those of their glucosides, while in Macabeo, Parellada, white Riesling, Verdejo, and almost all Xarel.lo wines, *trans*-piceid was higher than *trans*-resveratrol. In all wines, the *trans* forms were found in higher concentrations than the *cis* isomers, especially in Albariño, Macabeo, Parellada, and white Riesling wines. The total amount of all derivatives was between 0.051 and 1.801 mg/L.

Rosé Wines. Table 3 summarizes the results obtained from analysis of rosé wines. In rosé wines, the levels of resveratrol monomers are between the levels of white and red wines.

The levels of *trans*-piceid were between 0.12 and 0.91 mg/L. The *trans*-piceid values were on average close to those measured for *trans*-resveratrol. Grenache wines had the highest amounts of this compound (0.68 mg/L), while Pinot noir had the lowest (0.30 mg/L).

The levels of *cis*-piceid were between 0.08 and 1.89 mg/L. On average, the levels of this compound (0.88 mg/L) were higher than those of *trans*-piceid (0.45 mg/L). In Pinot noir wines, *cis*-piceid was present at higher concentrations, more than the other compounds. The levels of *cis*-piceid in Pinot noir (1.51 mg/L) would be 5 times higher than those of *trans*-piceid or *trans*-resveratrol, while Cabernet Sauvignon had the lowest level (0.39 mg/L).

trans-Resveratrol levels were similar to those described in the only previous study done on rosé wines (Mattivi, 1993b). Mattivi reports a wide variability in the *trans*-resveratrol content, ranging from 0.05 to 1.19 mg/L. The levels of this compound in Spanish rosé wines were very similar, between 0.07 and 1.06 mg/L.

The levels of *cis*-resveratrol were between 0.17 and 0.84 mg/L. *cis*-Piceid was also statistically higher than *cis*-resveratrol ($p < 0.05$). This is the compound present at the lowest concentrations in Cabernet Sauvignon and Grenache varieties. In Pinot noir, the levels (0.84 mg/L) would be 3 times higher than that of *trans*-resveratrol. Goldberg *et al.* (1995a) note that certain grape varietals, at least Pinot noir, produced wines enriched in *cis*-resveratrol.

Among all wines analyzed in our laboratories, including the reds described by Lamuela-Raventós *et al.* (1995), the rosé Pinot noir wines were the only ones for which the *trans* to *cis* ratio was less than 1. This difference could also be related to a major isomerization of the *trans* form to *cis* during the wine-making process or storage in the bottle.

The total amount of all resveratrol-related compounds was between 0.84 and 3.52 mg/L. On average, the highest levels were found in Pinot noir variety wines (2.93 mg/L) followed by Grenache (2.14 mg/L), and the lowest were found in Cabernet Sauvignon (1.38 mg/L). This is the same decreasing order observed in red wines produced from these grape cultivars and analyzed previously by Lamuela-Raventós *et al.* (1995).

The amount of all derivatives consumed by a white wine drinker would be approximately 3.5 times greater than just the *trans*-resveratrol concentration, while for rosés wines the total would be 5.2 times greater. If all derivatives of resveratrol have similar physiological activities, the potential health benefit from white and rosé wine drinking could be greater than previously thought. Alternatively, these other derivatives may convert to *trans*-resveratrol via glycolysis and acid-catalyzed isomerization. Acid has been observed to catalyze the conversion of *cis*-resveratrol to the *trans* isomer (Trela and Waterhouse, 1996).

If resveratrol acts as an antioxidant in the vasculature, *in vitro* data by Frankel *et al.* (1993) suggest that a level near 2 mg/L would be required to obtain 80% inhibition of LDL oxidation. By measuring lipid peroxidation in liposomes and in rat liver microsomes, Blond *et al.* (1995) found that the same level of *trans*-resveratrol (2 mg/L) would inhibit 80% of lipid peroxidation in liposomes and in rat living microsomes, and only 0.79 mg/L assured 50% inhibition. On the other hand, Bertelli *et al.* (1995) found that *trans*-resveratrol at a concentration of 3.56 μg/L inhibited platelet aggregation *in vitro* on human platelet-rich plasma by 50.3%.

The absorption, volume of distribution, and metabolism of these compounds should be studied *in vivo* to evaluate any physiological effect from the resveratrol in wines. In addition, wines contain many other phenols that may have beneficial effects and also act as synergists, which could alter any effect of resveratrol, and constant moderate consumption of wine could provide a significant amount of these phenolic compounds in our diet.

Conclusions. Because of the low levels of resveratrol derivatives found in white wines, a concentration step must be used to ensure quantitation by HPLC with UV detection. The concentration step, carried out by rotary evaporation, did not cause degradation or loss of the

analytes. In rosé wines, analysis can be done without concentration. Since the absorbance of *cis*-resveratrol was lower than that of *trans*, the correct quantitation of *cis* forms shows that higher levels of *cis* are present than previously described. The total amount of resveratrol present in rosé and white wines may have an inhibitory effect on platelet aggregation. However, future studies will be needed to show whether or not the levels of resveratrol present in wine could have a physiological effect *in vivo*.

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