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Research Note

The phenolic composition of red grapes and wines as influenced by *Oidium tuckeri* development

Barbara Piermattei, A. Piva, M. Castellari, G. Arfelli and A. Amati

Summary: In two years the effect of *Oidium tuckeri* on the phenolic composition of red Sangiovese grapes and wines was evaluated. From veraison until ripeness the content of anthocyanins was reduced in infected grapes. The corresponding wines showed a lack of total phenols and anthocyanins; their colour density was reduced compared to wines obtained from healthy grapes. The content of *trans*-resveratrol, caftaric and coutaric acids was significantly higher in wines from infected grapes.

Key words: anthocyanins, polyphenols, Oidium tuckeri, trans-resveratrol.

Introduction: The degree of ripeness and the health condition are known to affect the phenolic composition of red grapes and subsequently the colour and sensorial properties of red wines (Jackson *et al.* 1978; Gunata *et al.* 1987; Bayonove 1989). Ough and Berg (1979) described sensory effects on wine caused by powdery mildew and more recently Amati *et al.* (1996) found that the grape and wine composition was significantly affected by *Oidium tuckeri*. In the present study the effects of *Oidium tuckeri* on the phenolic composition of red grapes and wines (cv. Sangiovese) were evaluated in two years.

Material and Methods: In 1995 and 1996 trials were carried out on a Sangiovese vineyard located in the "Chianti classico" area (Florence, Italy). In both years the ripening process of 100 bunches was monitored. In 1995 at commercial ripeness three randomised samples of 80 berries each were collected from both, infected grapes (infection >75 %) and healthy grapes. In 1996 the same number of bunches were sampled at veraison, 30 d after veraison and at commercial ripeness (46 d after veraison). Samples were immediately frozen and stored at -22 °C until analyses.

Each year three lots (20 kg each) of both, infected and healthy grapes, were harvested at commercial ripeness; grapes were destemmed, crushed, and 160 mg·kg^{-1} $K_2S_2O_5$ and dry, selected yeast were added. Fermentation was carried out at 25 °C for 7 d; the pressed and free run juices were assembled and completely fermented in stainless steel tanks.

Wines were racked, adjusted to 80 mg·l^{-1} total SO_2, filtered and stored under N_2 for 3 months at 15 °C and then analysed. Ethanol, pH, titratable acidity, colour density and hue were evaluated using the official UE methods (ECC Commission 1990). Extraction of anthocyanins from berries was carried out with a solution of cold (4 °C) methanol : water (75:25 v/v). Frozen berries were added to the cold methanol solution (1:1 w/v) and then homogenised for 5 min under N_2 using a Silverson laboratory mixer. The samples were centrifuged at 4 °C for 10 min at 3000 *g* and the precipitates were resuspended twice with the methanol solution and centrifuged as before. The three supernatant fractions were collected and diluted with methanol.

Methanol extracts and wines (diluted with water) were filtered (0.45 µm) and directly used for HPLC analyses. Anthocyanins were analysed as previously described (Amati *et al.* 1996) and quantified as malvidin 3,5-diglucoside (SERVA, Heidelberg, Germany). *Trans*-resveratrol in wines was determined after direct injection and a gradient elution at 308 nm (Castellari *et al.* 1998); the use of a MD-910 diode array detector (Jasco, Tokyo, Japan) allowed the simultaneous detection of *trans*-caffeoyl-(+)-tartaric (caftaric) acid and p-coumaroyl-(+)-tartaric (coutaric) acid at 320 nm; these substances were tentatively identified and quantified as caffeic and p-coumaric acids, respectively. Results of analyses were submitted to the ANOVA and Tukey tests by using "Statistica for Windows" (Statsoft Inc).

Results and Discussion: In 1995 and 1996 the concentration of anthocyanins in ripe, healthy berries was higher than in infected grapes (data not shown), confirming previous results of Amati *et al.* (1996). The Figure shows the evolution of the 5 anthocyanins during berry maturation in 1996. Immediately after veraison the differences between infected and healthy grapes were significant except for peonidin 3-glucoside which seemed not to be affected by the fungus. On the contrary, 30 and 46 d after veraison all anthocyanins were severely reduced in infected grapes. This effect was fairly similar for each compound, (average decrease: 25 % compared to healthy grapes).

The Table shows that the wine composition differed significantly between the years. The wines produced from infected grapes had a reduced colour density and a lower content of total phenols and single anthocyanins compared to healthy wines. On the contrary, the concentrations of *trans*-resveratrol, caftaric and coutaric acids in wines were increased due to the *Oidium tuckeri* infection of grapes. Titratable acidity and pH were not affected by the infection, while the ethanol content was slightly but significantly reduced, possibly due to a reduction of sugar in infected grapes (Piva *et al.* 1997).

The slight difference in the degree of ripeness does not explain the anthocyanin decrease in grapes and wines. This could be due to a strong modification of anthocyanin biosynthesis and accumulation (Darné 1993).

Conclusions: The negative relationship between *trans*-resveratrol and anthocyanin concentrations in wines from healthy and infected grapes seems to agree with the observation that the biosynthetic pathways of phytoalexins and flavonoids are competitive during grape ripening (Jeandet *et al.* 1995). The lower concentration of anthocyanins and the reduction of red colour in wines is extremely detrimental for red wine quality, especially if a long maturation or ageing phase are required.

Correspondence to: Dr. Barbara Piermattei, Università degli Studi di Bologna, Istituto di Industrie Agrarie, Via S. Giacomo, 7, I-40126 Bologna, Italy. Fax: +39-51-259911.
E-mail: bpiermat@agrsci.unibo.it

Table

Effect of fungus infection and year on wine composition

		Year 1995		Year 1996		p level of variables		
		Healthy	Infected	Healthy	Infected	year	health status	interaction
Ethanol	% (v/v)	11.45	10.62	12.70	12.30	0.001	0.05	0.01
pH at 20 °C		3.20	3.12	3.33	3.24	0.05	*ns*	*ns*
Titratable acidity	$g \cdot l^{-1}$	7.56	7.30	7.36	7.40	*ns*	*ns*	*ns*
Colour density	A.U.	4.452	2.795	3.560	2.925	0.001	0.05	0.001
Colour hue	A.U.	0.595	0.735	0.575	0.696	0.001	0.05	0.01
Total phenols	$mg \cdot l^{-1}$	1348	1120	1230	1094	0.001	0.05	0.01
Delphinidin 3-glucoside	$mg \cdot kg^{-1}$	25.1	9.2	19.8	10.9	0.001	0.01	0.01
Cyanidin 3-glucoside	$mg \cdot kg^{-1}$	9.5	5.7	6.7	5.9	0.001	0.01	0.001
Petunidin 3-glucoside	$mg \cdot kg^{-1}$	46.3	18.1	28.5	15.3	0.001	0.01	0.001
Peonidin 3-glucoside	$mg \cdot kg^{-1}$	21.7	13.1	13.5	10.6	0.001	0.01	0.001
Malvidin 3-glucoside	$mg \cdot kg^{-1}$	188.8	80.3	102.4	52.8	0.001	0.01	0.001
Caftaric acid	$mg \cdot kg^{-1}$	10.1	14.0	29.5	30.5	0.001	0.05	0.001
Coutaric acid	$mg \cdot kg^{-1}$	6.5	7.2	8.6	9.0	0.001	*ns*	*ns*
Trans-resveratrol	$mg \cdot kg^{-1}$	0.51	2.43	0.80	1.56	0.001	0.01	0.001

Each value is the average of three replicates. For each variable the level of significance (p) is indicated.

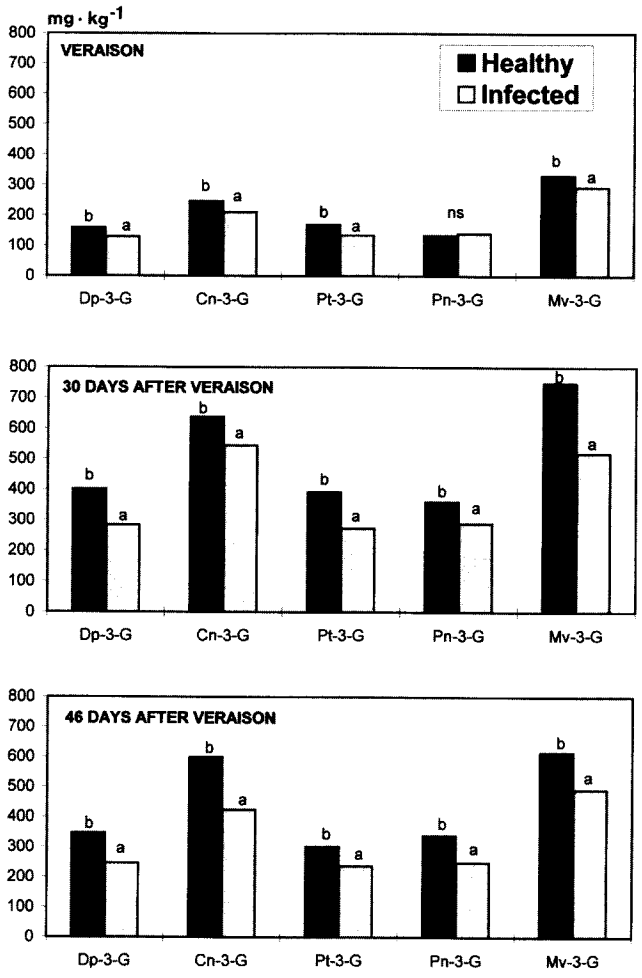

Figure: Evolution of the anthocyanin concentration in red grapes (cv. Sangiovese) during maturation in 1996 (each value is the average of three replicates). Columns marked by different indices are significantly different at the $p<0.05$ level.
Dp-3-G = delphinidin-3-glucoside; Cn-3-G = cyanidin-3-glucoside; Pt-3-G = petunidin-3-glucoside; Pn-3-G = peonidin-3-glucoside; Mv-3-G = malvidin-3-glucoside.

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