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## Research Note

**Resveratrol content of two Californian table grape cultivars**

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**Introduction:** Phytoalexins are biologically active compounds that are produced by plants in response to fungal infection or abiotic stress such as heavy metal ions or UV light. In grapevines, the stress response mainly includes the synthesis of a simple stilbene, resveratrol. This compound has provoked an intense interest due to its antifungal properties (HOOS and BLAICH 1990). In addition to the resveratrol association with reduced *Botrytis cinerea* infection in grapes, previous studies have also found resveratrol to be very beneficial to human health: due to its particular solubility in the lipid phases of low density lipoproteins (LDLs) (FRANKEL *et al.* 1995), resveratrol may reduce human LDL oxidation (FRANKEL *et al.* 1993) and platelet aggregation (PACE-ASCIAC *et al.* 1995), two major parameters implicated in atherothrombogenesis. The so-called French paradox could thus be attributable in part to the presence of this compound in wines. In addition to its antioxidant properties, very recent studies have shown resveratrol to have anti-cancer capabilities as well (JANG *et al.* 1997).

Since the pioneering work of SIEMANN and CREASY (1992), much attention has been paid to resveratrol concentrations in wine. In contrast, very few research reports, except the study of ECTOR *et al.* (1996) have focused on the concentration of resveratrol in fruit of table grape cultivars. The aim of this preliminary study was thus to analyze the resveratrol content of grapes produced under conditions found in a commercial vineyard.

**Material and Methods:** Plant material: One black grape cultivar, Black Corinth, and one pink red cultivar, Flame Seedless, were obtained from vineyards managed by Corrin Produce in Fresno, CA, USA. These cultivars arrived in three

shipments (approximately corresponding to the dates of harvest), July 7, July 23 and August 8, 1997. Fruit within the three shipments was edible. Upon arrival of each of the three shipments, two separate samplings of grape berries were prepared. The first sample (10-20 grape berries of each cultivar) was extracted directly to determine the resveratrol content under natural conditions. At the same time, the maximal resveratrol production potential of grapes was determined by using an abiotic elicitor of stilbene synthesis, *i.e.* UV irradiance. 10-20 grape berries from each cultivar were irradiated on their abaxial surfaces under UV irradiance (TLC inspection lamp, 254 nm, 10 min; distance from the lamp: 15 cm) as previously described (JEANDET *et al.* 1995 b). All experiments were done in quadruplicate, so the analytical results are representative of the resveratrol content of both varieties.

**Sample preparation and resveratrol analysis:** Since resveratrol is mainly produced by grape skin cells and is absent or produced at a very low level in the fruit flesh, grape skins were carefully peeled from irradiated and non-irradiated berries. Grape skins were extracted as previously described (JEANDET *et al.* 1995 b). Samples (dissolved in 80 % methanol) were then injected directly to a HPLC system (Waters, Milford, MA) (JEANDET *et al.* 1997).

**Anthocyanin quantitation:** The anthocyanin content of grape berries was determined as previously described by SOMERS and EVANS (1977).

**Results and Discussion:** The anthocyanin concentration was approximately the same for the last two shipments (Tab. 1).

Table 1

Anthocyanin content of grapes (mg·kg<sup>-1</sup> fresh weight)<sup>a</sup>

	1 <sup>st</sup> shipment (July 07)	2 <sup>nd</sup> shipment (July 23)	3 <sup>rd</sup> shipment (August 08)
Black Corinth	670 <sup>b</sup>	880	850
Flame Seedless	350	450	470

<sup>a</sup> Total anthocyanins in the fruits were expressed as mg of a mixture of acylated and non-acylated anthocyanins ( $E_{1\%}^{1\text{cm}}=500$ ).

<sup>b</sup> Each value corresponds to the mean for a sample obtained by pooling 100 berries.

Tab. 2 presents the resveratrol concentrations determined in grape berries of the two varieties. Concentrations varied considerably in both cultivars depending on the time of harvest. The highest resveratrol concentration was found in the first shipment (July 07). During ripening (as determined by the anthocyanin content; Tab. 1), resveratrol concentration steadily decreased in both cultivars (second and third shipments, July 23 and August 8; Tab. 2). This confirms the negative relationship between resveratrol synthesis and anthocyanin concentration (JEANDET *et al.* 1995 b).

In order to determine the maximum phytoalexin production of grape berries within the three shipments, resveratrol

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Table 2

Resveratrol ( $\mu\text{g}\cdot\text{g}^{-1}$  fresh skin) in irradiated and non-irradiated grapes

	1 <sup>st</sup> shipment (July 07)	2 <sup>nd</sup> shipment (July 23)	3 <sup>rd</sup> shipment (August 08)
<b>Flame Seedless</b>			
Non-irradiated fruits	13.2 ± 7.6	4.0 ± 0.6	1.0 ± 0.3
Irradiated fruits	57.3 ± 20.8	4.8 ± 1.2	1.8 ± 0.7
<b>Black Corinth</b>			
Non-irradiated fruits	25.1 ± 14.5	0.8 ± 0.3	n.d. <sup>a</sup>
Irradiated fruits	33.2 ± 11.1	1.7 ± 0.2	0.9 ± 0.4

<sup>a</sup> Not detectable ( $\leq 0.1 \mu\text{g}\cdot\text{g}^{-1}$  fresh skin).

synthesis was induced by UV-irradiation. Results (Tab. 2) show that, for the first shipment cv. Flame Seedless experienced more than a 4-fold increase in resveratrol after UV irradiation. The resveratrol increase in cv. Black Corinth following UV irradiation was lower. It can be assumed that in both cases the values correspond to the potential maximum resveratrol production of the fruit. Two and 4 weeks after the first shipment, the phytoalexin production potential of grape berries drastically decreased at the end of maturation (Tab. 2).

The aim of the present work was to determine whether consumption of commercial Californian table grapes can constitute a significant dietary source of resveratrol. Results show that resveratrol can be found in relatively high amounts in table grapes under the growing conditions of California. The resveratrol content of Californian table grapes exceeds that in wine grapes from Northern France (*e.g.* Burgundy), which typically ranges from 5 to 20  $\mu\text{g}\cdot\text{g}^{-1}$  fresh skin (JEANDET *et al.* 1995 a).

The average values of *trans*-resveratrol of red wine (data from SIEMANN and CREASY 1992; FRANKEL *et al.* 1995) ranged from 1500 to 3000  $\mu\text{g}\cdot\text{l}^{-1}$ . According to our calculation, approximately 50 berries of cv. Black Corinth correspond to the amount of resveratrol found in a glass of red wine.

Since it has been shown that resveratrol concentration decreases during ripening, it would be beneficial to harvest and consume grapes as soon as they become edible.

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