# CHANGES IN PHENOLIC MATURITY AND TEXTURE CHARACTERISTICS OF THE GRAPE BERRY UNDER PRE-, AND POST-VERAISON WATER DEFICIT

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**Abstract:**

**Context and purpose of the study -** Kékfrankos (*Vitis vinifera* L.) grapevines grafted on Teleki-Kober 5BB rootstock were submitted to water deficit under greenhouse conditions. The aim of the experiment was to study the effect of pre-, and post-veraison water deficit on grape berry phenolic maturity and texture characteristics.

**Material and methods -** Plants were planted into 50L white plastic containers in a mixture of perlite (20%), loamy soil (30%) and peat (50%) (v/v). Three regimes of water supply were examined: (1) moderate water deficit from berry set until veraison (WD1), (2) moderate water deficit from veraison until harvest (WD2), (3) no water deficit (C). The water deficit treatments defined by the leaf daily stomatal conductance (between 50-150 $H_2O$ mmol $m^{-2}s^{-1}$). Anthocyanin glucosides and flavonols from berry skin were measured by Shimadzu HPLC system, berry texture characteristics were monitored by TA.XT Plus Texture Analyser. Cell and seed maturity indexes (CMI%, SMI%) and basic parameters (yield, sugar concentration, pH, must acidity) were also investigated.

**Results -** Pre-veraison treatment resulted in the lowest berry and cluster weight. The highest sugar concentration was found in control berries, and it was followed by the WD1 and WD2 treatments. Berries of the well-watered plants presented the lowest phenolic concentration. Pre-veraison water deficit resulted in a sllighty higher concentration of anthocyanin-glucosides compared to post-veraison water deficit. Water restriction during the ripening period induced higher flavonol (ie. quercetin, kaempferol etc.) concentration related to berry skin fresh weight as well as to the whole berry compared to WD1 treatment. Berry skin hardness ($F_{sk}$) was the highest in the case WD2 and the lowest was in WD1. Similar results were obtained in the case of berry skin thickness ($S_{psk}$). Seed (SMI%) maturity index presented higher values in the case of WD treatments compared to C. Cell maturity index (CMI%) of WD2 was significantly higher than C and WD1, however no differences were found between C and WD1.

**Keywords**: Water deficit, Anthocyanin extractability, Phenolic maturity, Berry texture

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## 1. Introduction.

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## Introduction & objectives

Grape berry maturity is strongly influenced by water deficit. Water restriction decreases berry size and in parallel increase skin thickness, and thus it resulted in higher skin/flesh ratio irrespective of berry size. Also, berry sugar concentration decreased as a result of drought stress, however moderate water deficit may lead increased berry sugar accumulation due to the modified sink-source relations and changes in assimilate partitioning. Phenolic maturity is also affected by mild to moderate water deficit; it has a positive effect on the concentration of skin phenolic components, such as anthocyanins and flavan-3-ols (Ojeda *et al.*, 2002; Ollé *et al.*, 2011). However, the extent, the timing and the duration of the water restriction can modify such effects on grape and wine phenolic concentration and composition. Anthocyanin extractability (EA%) of the grape berry have been studied intensively recently and the results have presented evidences that this aspect of phenolic maturity may influenced by many factors, including berry texture properties (Torchio *et al.* 2010; Segade *et al.* 2011). The aim of this present study is to describe the effect of pre-, and post veraison moderate water deficit on berry texture, skin phenolic concentration, seed (SMI) and cell maturity indexes (CMI, anthocyanin extractability).

## Materials & methods

**Experimental design:** Seven year old Kékfrankos (*Vitis vinifera* L.) grapevines grafted on Teleki-Kober 5BB rootstocks were submitted to pre-, and post-veraison water deficit in 2013 under greenhouse conditions. Three treatments were applied during the experiments: control (full irrigation during the whole vegetation period, nil stress, C), moderate water deficit from berry set to veraison (WD1) and moderate water deficit from veraison until harvest (WD2). The water regimes were defined by the leaf daily stomatal conductance ($g_s$). In situ gas-exchange parameters were measured with a CIRAS-1 infrared gas-analyser.

**Methods:** The analytical methods recommended by the OIV (2019) were used to determine titratable acidity and the pH of the grapes. Grape cell (CMI) and seed maturity indexes (SMI) were calculated according to Saint-Cricq *et al.* (1998). Grape skin phenolics were measured by HPLC according to Villangó *et al.* (2016). TA.XTplus Texture Analyser (Stable Micro System, Surrey, UK) was used to measure grape berry texture according to Letaief *et al.* (2008). Statistical analysis was conducted by Graph Pad Prism software 6 (GraphPad Software Inc., La Jolla, CA, USA).

## Results & Discussion

Moderate water deficit had a significant effect on grape quality. We found typical water stress phenomena with regard to yield and quality parameters, however the timing of water restriction have a great impact of these characteristics. Significant differences were found in average berry weight and sugar concentration among the treatments (**Table 1.**) Sugar concentration of the grape juice was the highest in the non-stressed treatments and the lowest in the WD2 berries; however there were significant differences between WD1 and C berries. The low sugar concentration of WD1 berries is due to the decreased photosynthesis as a result of low stomatal conductance after rewatering. Pre-veraison water deficit resulted in a slightly higher concentration of anthocyanin-glucosides compared to post-veraison water deficit as it was reported in previous studies (Ojeda *et al.* 2002; Ollé *et al.* 2011). Water restriction during the ripening period induced higher flavonol (ie. quercetin, kaempferol etc.) concentration compared to WD1 treatment (data not shown). Berry hardness (BH) of the water stressed grape was consistently lower than the control, however there were significantly higher values in the case of WD1 treatments than in WD2 (**Fig. 2**). Berry skin hardness ($F_{sk}$) was the highest in the case WD2 and the lowest was in WD1. Similar results were obtained in the case of berry skin thickness ($Sp_{sk}$) (data not shown). CMI indexes presented lower values in the C and WD1 berries and no differences were found between these treatments. In contrast the highest CMI indexes were measured in WD2 treatments (**Fig. 1**). Interestingly, in the case of seed maturity indexes, no differences were found between WD1 and WD2 and they were both higher compared to the control berries. No relationships were found between maturity indexes and berry texture parameters.

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| | Treatments | | |
|---|---|---|---|
| | C | WD1 | WD2 |
| Sugar (g/l) | 233.67a | 208.67b | 182.67c |
| Titratable acidity (g/L) | 8.07b | 6.57c | 10.03a |
| pH | 3.43b | 3.51a | 3.26c |
| Bunch weight (g) | 229.05a | 144.18c | 183.25b |
| Berry weight (g) | 1.77a | 1.13c | 1.33b |
| Berry skin weight (g) | 0.34a | 0.26b | 0.28b |

**Table 1. Basic yield and quality parameters. Different letters indicates significant differences between the treatments (P<0.05)**

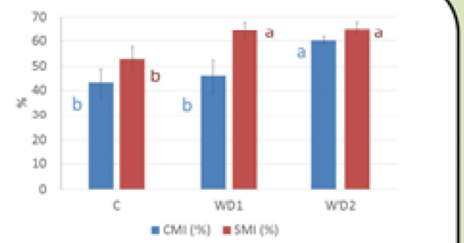


**Figure 1. Changes in cell (CMI %) and seed (SMI %) maturity indexes according to the treatments. Different letters indicate significant differences between the treatments (P<0.05)**

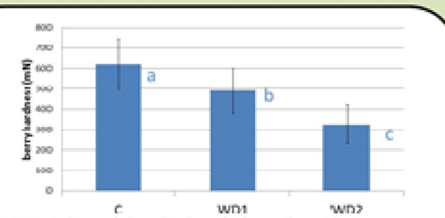


**Figure 2. Changes in berry hardness (BH) according to the treatments. Different letters indicate significant differences between the treatments (P<0.05)**

## Conclusion

In summary, timing of water deficit has a significant effect on grape yield and quality parameters. Berry physical behaviour and phenolic maturity has changed according to the treatments: however no relationship was found between texture parameters and anthocyanin extractability indices.

## References

**Letaief, H., Rolle, L., & Gerbi, V. (2008).** Mechanical behavior of winegrapes under compression tests. *American Journal of Enology and Viticulture*, 59(3), 323-329.

**Ojeda, H., Andary, C., Kraeva, E., Carbonneau, A. & Deloire, A.,** (2002). Influence of pre- and postveraison water deficit on synthesis and concentration of skin phenolic compounds during berry growth of Vitis vinifera cv. Shiraz. *American Journal of Enology and Viticulture* 53, 261-267.

**Ollé, D., Guiraud, J.L., Souquet, J.M., Terrier, N., Ageorges, A., Cheynier, V., & Verries, C.** (2011) Effect of pre- and post-veraison water deficit on proanthocyanidin and anthocyanin accumulation during Shiraz berry development. *Australian Journal of Grape and Wine Research* 17, 90-100.

**Saint-Cricq, N., Vivas, N. & Glories, Y.** (1998). Maturité phénolique: définition et contrôle. *Rev. Fr. Oenol.* 173, 22-25.

**Segade, S. R., Vázquez, E. S., Orriols, I., Giacosa, S., & Rolle, L.** (2011). Possible use of texture characteristics of winegrapes as markers for zoning and their relationship with anthocyanin extractability index. International journal of food science & technology, 46(2), 386-394.

**Torchio, F., Cagnasso, E., Gerbi, V., & Rolle, L. (2010).** Mechanical properties, phenolic composition and extractability indices of Barbera grapes of different soluble solids contents from several growing areas. *Analytica Chimica Acta*, 660(1-2), 183-189.

**Villangó, Sz., Szekeres, A., Bencsik, O., Láposi, R., Pálfi, Z., & Zsófi, Zs.** (2016). The effect of postveraison water deficit on the phenolic composition and concentration of the Kékfrankos (Vitis vinifera L.) berry. *Scientia Horticulturae*, 209, 113-116.