# MODIFICATION ON GRAPE PHENOLIC AND AROMATIC COMPOSITION DUE TO DIFFERENT LEAFROLL VIRUS INFECTIONS•

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## 1. INTRODUCTION

Viral diseases are reported to cause several detrimental effects on grapevine (Walter, Martelli, 1996; Mannini, 2003). Among them, leafroll, due to single or mixed infection of GLRaV1 and GLRaV3, and rugose wood, associated to GVA, are considered the most widespread and dangerous. Although the negative effects on vegetative vigour and yield are clearly documented, the virus influence on grape qualitative (i.e enological) aspects is still controversial and the grapevine response may vary depending on the specific virus involved or on the environmental condition. The scarce literature available indicates that the grape phenolic compounds are involved in the vine/virus interaction, especially when leafroll viruses are present with possible important implications on winemaking and red wine quality (Guidoni *et al*., 1997; Mannini *et al*., 2009). In recent time also the grape aromatic compounds are regarded with great interest for their qualitative contribution to the evolution of red wine during aging (Mazza *et al*., 2006). Up to now however no investigation has been carried out on possible negative effect of viruses on this class of substances. The aim of the present study was to deeply investigate the alterations in berry phenolic and aromatic composition due to specific viruses.

## 2. MATERIAL AND METHODS

The healthy and the infected descendants of two clones of 'Nebbiolo' (*Vitis vinifera* L.) were compared in a vineyard planted in the area of Barbaresco DOCG wine (Neive, north-west Italy). The vineyard hosted the healthy and GLRaV1+GVA infected vines of the clone '308' and the healthy and GLRaV3+GVA infected vines of the clone '415'. During 2008 with the vineyard fully productive, pruning wood weight in winter time and yield at harvest were assessed on twenty vines each clone and sanitary status. In addition samples of around 300 berries each were collected from a three vines parcel replicated three times along the rows for each thesis. The berry samples were analyzed for qualitative and quantitative content of anthocyanins and flavonoids as well as for bound aromatic composition. The analysis of anthocyanins was performed by HPLC-DAD (Di Stefano, Cravero, 1991; Pomar *et al*., 2005; Rolle, Guidoni, 2007). The aromatic compounds were analyzed by gas

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chromatography-mass spectrometry (GC-MS) (Mazza *et al*., 2006). Data were elaborated by ANOVA followed by Tukey's test for statistical support.

## 3. RESULTS AND DISCUSSION

At the harvest 2008, yield was influenced in different way depending if leafroll was due to mixed infections of GLRaV1+GVA or of GLRaV3+GVA and consequently also grape soluble solids accumulation (tab. 1). In the first case the infected vines produced 15 % less than the healthy vines but sugars were practically unaffected, whereas in the second case the results were opposite: crop unaffected and soluble solids severely penalized. The results confirm previous reports (Mannini *et al*., 1998) which stated a different vine response according to the specific virus and not just to the disease (leafroll in the present case). Both the infections however basically reduced the amount of phenolic compounds with the exception of resveratrol, higher in the case of GLRaV1+GVA positive vines. Higher quantity of this compound in a virus stressed vine is expected being resveratrol a phenol produced by plants as a defense against infection by pathogenic microorganisms (Langcake, Pryce, 1977).

Tab. 1 - Grape phenolic potential and extractability of healthy or virus-infected plants of two 'Nebbiolo' clones. Neive (CN), 2008.

| Parameters | Clone 308 | | Clone 415 | |
|---|---|---|---|---|
| | healthy | GLRaV1+GVA | healthy | GLRaV3+GVA |
| **Yield** (kg vine$^{-1}$) | 3.06 ± 1.0 | 2.62 ± 1.0 | 3.09 ± 0.9 | 3.23 ± 0.9 |
| **Pruning wood wt** (g vine$^{-1}$) | 1423 ± 374 | 1273 ± 278 | 1488 ± 274 | 1325 ± 247 |
| **Soluble solids** (g L$^{-1}$) | 225 ± 1.5 | 229 ± 3.2 | 231 ± 5 | 225 ± 2.9 |
| **Titrable acidity** (g L$^{-1}$) | 8.6 ± 0.1 | 8.8 ± 0.10 | 8.3 ± 0.5 | 8.3 ± 0.5 |
| **pH** | 3.05 ± 0.02 | 3.07 ± 0.01 | 3.05 ± 0.03 | 3.08 ± 0.03 |
| **Total flavonoids** (skins) (mg kg$^{-1}$) | 2687 ± 275 | 2348 ± 314 | 2816 ± 265 | 2605 ± 302 |
| **Total anthocyanins** (skins) (mg kg$^{-1}$) | 556 ± 73 | 551± 40 | 604 ± 65 | 506 ± 90 |
| **Total flavonoids** (seeds) (mg kg$^{-1}$) | 2224 ±184 | 2331 ± 281 | 2246 ± 77 | 2136 ± 190 |
| **EA %** | 33 ± 8.5 | 38 ± 4 | 39.5 ± 10 | 39 ± 13 |
| **Mp %** | 46 ± 2 | 46 ± 2 | 41 ± 6 | 41 ± 10 |
| **Resveratrol** (mg kg$^{-1}$) | 0.25 ± 0.1 | 0.48 ± 0.2 | 0.33 ± 0.0 | 0.28 ± 0.0 |

In GLRaV1+GVA infected vines the amount of anthocyanins was not only quantitatively reduced but also qualitatively modified. The infection in fact seems to have interfered with the synthesis pathway of anthocyanins: the diseased vines showed an anthocyanin profile with an higher % of the less stable cyanidin-3-glucoside and peonidin-3-glucoside to detriment of tri-substituted malvidin-3-glucoside (fig. 1). These aspects are of particular relevance in winemaking because tri-substituted anthocyanins are more determinant for the intensity and the stability of future wine than di-substituted anthocyanins which rapidly undergo enzymatic degradation at the end of fermentation.

The modification of anthocyanic profile, *vice versa*, was not detected when the GLRaV3+GVA infection was present (clone 415). With regards to grape aromatic compounds, they resulted quite variable depending on the virus involved (fig. 2).

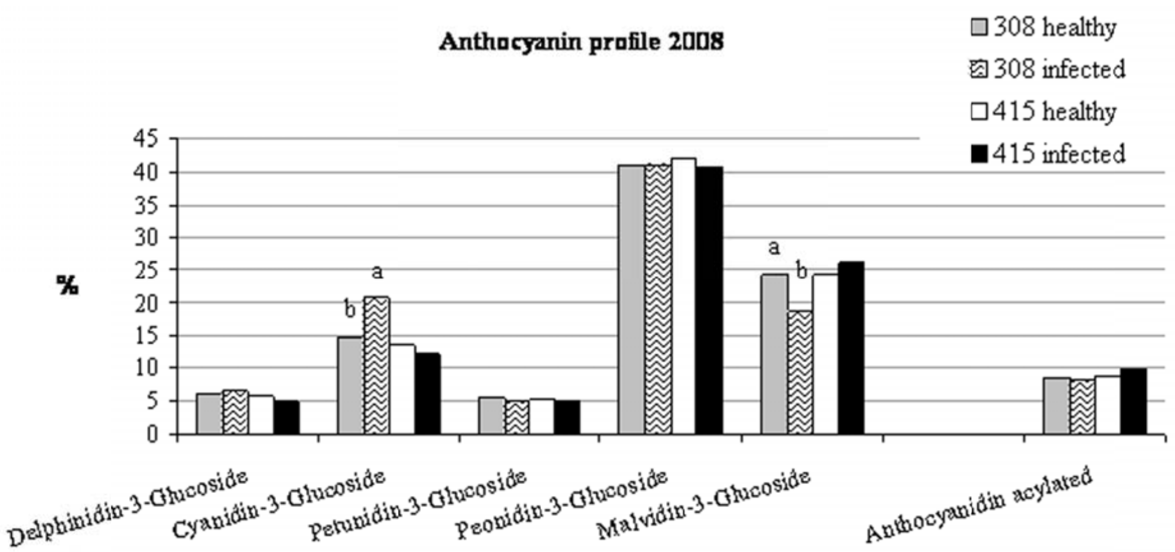


Fig. 1 – Grape anthocyanin profiles of healthy or leafroll-infected plants of two 'Nebbiolo' clones. Neive (CN). Different small or capital letters on histograms mean statistical significance at p≤ 0,05 and p≤ 0,01 respectively.

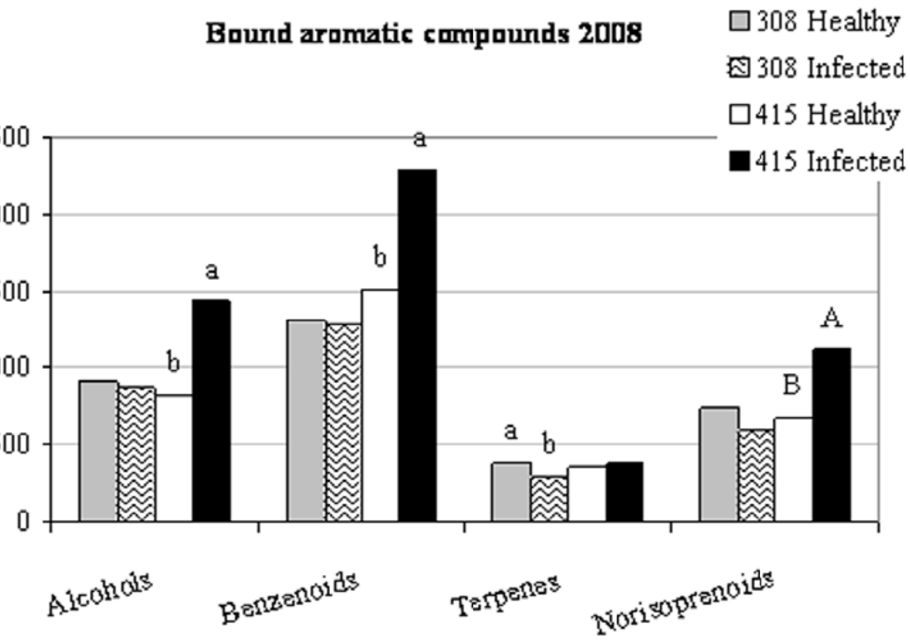


Fig. 2 - Content of grape aromatic compounds of healthy or leafroll-infected plants of two 'Nebbiolo' clones. Neive (CN). Different small or capital letters on histograms mean statistical significance at p≤ 0,05 and p≤ 0,01 respectively.

In 2008 the grape of the GLRaV3+GVA infected plants resulted significantly richer in aromatic compounds, namely alcohols, benzenoids and norisoprenoids, suggesting a possible effect of this specific virus. On the contrary the GLRaV1+GVA infection reduced the presence of terpenes (significantly) and norisoprenoids in the grapes confirming a different vine response due to a specific viral agent. So far, it is difficult to understand if these quantitative changes in the different grape aromatic compounds could be or not beneficial, being their role on wine quality and ageing still not perfectly clarified; however our results confirm that the presence of a virus infection may have a possible role in their evolution.

## 4. CONCLUSIONS

Despite GLRaV1 and GLRaV3 are both casual agents of grapevine leafroll disease the quantitative and qualitative response of infected vines changed depending on the specific virus involved. In presence of GLRaV1 (in this trial in mixed infection with GVA) the vines resulted penalized in terms of yield (but not in soluble solids) and berry phenols. In addition the berry anthocyanin profile was modified in favour of the less stable di-substituted anthocyanins. In presence of GLRaV3 (again + GVA) yield was unaffected but juice soluble solids decreased as well as berry phenolic compounds. In this case however the profile of anthocyanins was not modified. Regarding grape bound aromas, GLRaV3 was associated with a quantitative increase of several of these compounds. Further investigations are needed to confirm these results and to understand their consequence on wine quality; nevertheless the study showed leafroll viruses may negatively affect the behavior of 'Nebbiolo' vines thus potentially influencing wine quality and lasting.

**Abstract**

Viral diseases are reported to cause several detrimental effects on grapevine. Among them, leafroll, due to single or mixed infection of GLRaV1 and GLRaV3, and rugose wood, associated to GVA, are considered the most widespread and dangerous. The scarce literature available indicates the grape phenolic compounds are involved in the vine/virus interaction with possible important implications on red wine quality. In recent time also the grape aromatic compounds are regarded with great interest for their qualitative contribution to the evolution of red wine during aging. In order to investigate the alterations in berry phenolic and aromatic composition due to these viruses, in 2008 the healthy and the infected (GLRaV1+GVA or GLRaV3+GVA) descendants of two clones of 'Nebbiolo' (*Vitis vinifera* L.) were compared in a vineyard of north-west Italy. Despite GLRaV1 and GLRaV3 are both casual agents of leafroll the quantitative and qualitative response of the vines changed depending on the specific virus. GLRaV1+GVA infection basically reduced yield and berry phenols. In addition the profile of berry anthocyanins was modified in favour of less stable di-substituted anthocyanins. GLRaV3+GVA infection mainly penalized grape soluble solids but increased the amount of bound aromatic compounds. Further investigations are needed, nevertheless the results confirmed leafroll viruses may negatively affect the vine behaviors thus potentially influencing the quality of the wines.

**Literature cited**

Di Stefano R., Cravero M. C. – 1991 - Metodi per lo studio dei polifenoli dell'uva. *Riv. Vitic. Enol.*, 44, 2, 37-45.

Guidoni S., Mannini F., Ferrandino A., Argamante N., Di Stefano R. – 1997 - The effect of grapevine leafroll and rugose wood sanitation on agronomic performance and berry and leaf phenolic content of a Nebbiolo clone (*Vitis Vinifera* L.). *Am. J. Enol. Vitic.*, 48, 4, 438-442.

Langcake P., Pryce R.J. – 1977 - A new class of phytoalexins from grapevines. *Experientia*, 33, 151-152.

Mannini F., Gerbi V., Credi R. – 1998 - Heat-treated vs. virus-infected grapevine clones: agronomic and enological modifications. *Acta Hort. 473: 155-163.*

Mannini F. – 2003 - Virus elimination in grapevine and crop performance. *Proc. 14$^{th}$ Meeting ICVG,* Locorotondo, BA, I, 12-17 September 2003

Mannini F., Mollo A., Cuozzo D., Credi R. - 2009 - Field performances and wine quality modification in a clone of Dolcetto (*Vitis vinifera* L.) after GLRaV-3 elimination. *Progrès Agricole et Viticole, Hors Série, Ex. Abs. 16° ICVG,* 234-236.

Mazza G., Raifer W., Lanati D. – 2006 - Il quadro aromatico della cultivar Cabernet Sauvignon coltivata in Alto Adige. *L'Enologo*, 42, 4, 111-117.

Pomar F., Novo M., Masa A. - 2005 - Varietal differences among the anthocyanin profiles of 50 red table grape cultivars studied by high performance liquid chromatography. *J. Chromatogr. A,* 1094, 1-2, 34-41.

Rolle L., Guidoni S. - 2007 - Color and anthocyanin evaluation of red winegrapes by CIE L*, a*, b* parameters. *J. Int. Sci. Vigne Vin, 41, 4, 193-201.*

Walter B., Martelli G.P. – 1996 - Sélection clonale de la vigne: sélection sanitaire et sélection pomologique. Influence des viroses et qualité. *Bull. O.I.V., Paris, 69, 945-971.*