POLYPHENOL ACCUMULATION IN VITIS SPECIE LEAVES DURING THE VEGETATIVE SEASON

This is the author's manuscript

Original Citation:

Availability:
This version is available http://hdl.handle.net/2318/1670148 since 2018-06-29T14:04:50Z

Terms of use:
Open Access
Anyone can freely access the full text of works made available as "Open Access". Works made available under a Creative Commons license can be used according to the terms and conditions of said license. Use of all other works requires consent of the right holder (author or publisher) if not exempted from copyright protection by the applicable law.

(Article begins on next page)
POLYPHENOL ACCUMULATION IN VITIS SPECIE LEAVES DURING THE VEGETATIVE SEASON

Olga Kedrina1, Johannes Hadersdorfer2, Thomas Hoffmann2, Wilfried Schwab3, Vittorino Novello1, Alessandra Ferrandino4

1DISAFA, University of Turin, Largo Braccini 2, 10095 Grugliasco (TO), Italy
2Technical University of Munich, Associate Professorship of Fruit Science, Dürnast 2, 85345 Freising, Germany
3Technical University of Munich, Associate Professorship of Biotechnology of Natural Products, Liesel-Beckmann-Str. 1, 85345 Freising, Germany

*Corresponding author e-mail: alessandra.ferrandino@unito.it

INTRODUCTION

Grapevine has approximately 60 species; Vitis vinifera is the most known and widely cultivated species with high productivity and specific traits in berry characteristics that have favoured the spread of viticulture in the world. American and Asian Vitis species generally present low productivity and low berry quality, but they often possess good tolerance to environmental abiotic (for instance drought, to cite one) or biotic stressors (Li et al., 2014). Reasons of resistance or low susceptibility to biotic stressors have to be searched also in vegetative organs (leaves, stems, shoots) beyond that in berries. Moreover, vegetative organs are used in traditional medicine as a good source of bioactive polyphenolic compounds and they are known to display several health beneficial effect (Ali et al., 2010). Yet, knowledge of individual polyphenolic compounds and their accumulation trend during the season in different species is scarce. Therefore, we have undertook a study regarding the quantification and identification of main polyphenols in the healthy leaves of a number Vitis species during the vegetative season. In this work we report results of one Asian specie - Vitis amurensis (Fig. 1) and one American specie – Vitis berlandieri (Fig. 2). Vitis amurensis is highly cold and disease-resistant, displaying low susceptibility to downy mildew and powdery mildew (Liu et al., 2013); Vitis berlandieri is resistant to Phylloxera, tolerant to chlorosis (Ollat et al. 2016) and blood of many commercially used rootstocks.

EXPERIMENTAL OUTLINE

Healthy leaves were sampled in the collection vineyard of DISAFA, University of Turin located at Grugliasco (Piedmont, Italy) at five different time points: 1 - 28th of May (DOY 148), 2 – 22nd of June (DOY 173), 3 – 14th of July (DOY 195), 4 – 3rd of August (DOY 212), 5 - 28th of August (DOY 240) in 2015. Leaves were immediately transported to the laboratory, where blades and veins were separated and stored until further analysis at -20 °C. After the extraction of polyphenols with a suitable solvent, specifically optimized for leaf tissue, total polyphenols were measured spectrophotometrically. Quantification of individual polyphenolic compounds was performed by HPLC-ESI-MS.

RESULTS AND DISCUSSION

In leaf blades the concentration of total polyphenols ranged from 31.2 to 56.3 g/kg of fresh weight and it was significantly higher in V. amurensis during the whole season. Concentration of total polyphenols in leaf veins was similar between the two species and twice lower than in blades (Fig. 3A). Total flavonoids displayed even greater differences between the two species as to concentrations, trends (Fig. 3B) and profiles (Fig. 4). In V. amurensis the concentration of total flavonoids increased until DOY 215 (3rd of August), whereas in V. berlandieri total flavonoids decreased from the beginning of the season onwards (Fig. 3B). In V. amurensis, comparing to V. berlandieri, total flavonol concentration was significantly higher in blades during all the season and in veins at the first and at the last samplings. Moreover, at DOY 215 the concentration in V. berlandieri blades and V. amurensis veins was practically equal. Remarkably high concentration of flavan-3-ols was found in V. amurensis leaf blades, ranging from 530.6 to 1383.8 mg/kg of fresh weight; in V. amurensis veins flavan-3-ol concentration was important, sometimes significantly higher respect to V. berlandieri veins and blades (Fig. 3C).

GENOTYPIC AND SEASONAL PATTERN OF POLYPHENOLIC COMPOUNDS IN LEAVES

Two heatmaps were constructed for the visualization of phenolic compound changes during the vegetative season in blades and veins (Fig. 4). V. amurensis had higher concentration of the two prevalent flavonoids in leaves – quercetin 3-O-glucoside and quercetin 3-O-glucuronide. Instead, quercetin 3-O-rhamnoside was exclusively detected in V. berlandieri that also displayed a higher concentration of myricetin 3-O-glucoside.

Caffeic acid and trans-coumaric acid were prevalent in V. berlandieri and cis-coumaric and trans-ferric acids were prevalent in V. amurensis. Hydroxycinnamates showed a peak of maximum concentration at the first sampling date in veins of both species.

The accumulation of (+)-catechin, (-)-epicatechin and proanthocyanidin B1 decreased during the season. On the contrary concentration of (-)-epigallocatechin and (-)-epicatechin gallate increased.

In V. berlandieri leaves we found flavones, rarely detected in grapevine and to our knowledge, identified in leaves here for the first time. Vitisin and orientin were prevalent over their isoforms and their concentration progressively reduced during the season (Fig. 4).

Flavanonols were found exclusively in V. amurensis: dihydroquercetin-glucoside in blades and veins and dihydrokaempferol-glucoside in veins.

In V. amurensis high concentration of total polyphenols, flavonols and flavan-3-ols were detected; veins displayed a high concentration of flavonoids (Fig. 5). These peculiarities could contribute to explain the known specie low susceptibility to pathogens and its ability to cope with abiotic stressors.

GENOTYPIC AND SEASONAL PATTERN OF POLYPHENOLIC COMPOUNDS IN LEAVES

Two heatmaps were constructed for the visualization of phenolic compound changes during the vegetative season in blades and veins (Fig. 4).

- V. amurensis had higher concentration of the two prevalent flavonoids in leaves – quercetin 3-O-glucoside and quercetin 3-O-glucuronide. Instead, quercetin 3-O-rhamnoside was exclusively detected in V. berlandieri that also displayed a higher concentration of myricetin 3-O-glucoside.
- Caffeic acid and trans-coumaric acid were prevalent in V. berlandieri and cis-coumaric and trans-ferric acids were prevalent in V. amurensis. Hydroxycinnamates showed a peak of maximum concentration at the first sampling date in veins of both species.
- The accumulation of (+)-catechin, (-)-epicatechin and proanthocyanidin B1 decreased during the season. On the contrary concentration of (-)-epigallocatechin and (-)-epicatechin gallate increased.

In V. berlandieri leaves we found flavones, rarely detected in grapevine and to our knowledge, identified in leaves here for the first time. Vitisin and orientin were prevalent over their isoforms and their concentration progressively reduced during the season (Fig. 4).

Flavanonols were found exclusively in V. amurensis: dihydroquercetin-glucoside in blades and veins and dihydrokaempferol-glucoside in veins.

In V. amurensis high concentration of total polyphenols, flavonols and flavan-3-ols were detected; veins displayed a high concentration of flavonoids (Fig. 5). These peculiarities could contribute to explain the known specie low susceptibility to pathogens and its ability to cope with abiotic stressors.

GENOTYPIC AND SEASONAL PATTERN OF POLYPHENOLIC COMPOUNDS IN LEAVES

Two heatmaps were constructed for the visualization of phenolic compound changes during the vegetative season in blades and veins (Fig. 4). V. amurensis had higher concentration of the two prevalent flavonoids in leaves – quercetin 3-O-glucoside and quercetin 3-O-glucuronide. Instead, quercetin 3-O-rhamnoside was exclusively detected in V. berlandieri that also displayed a higher concentration of myricetin 3-O-glucoside.

Caffeic acid and trans-coumaric acid were prevalent in V. berlandieri and cis-coumaric and trans-ferric acids were prevalent in V. amurensis. Hydroxycinnamates showed a peak of maximum concentration at the first sampling date in veins of both species.

The accumulation of (+)-catechin, (-)-epicatechin and proanthocyanidin B1 decreased during the season. On the contrary concentration of (-)-epigallocatechin and (-)-epicatechin gallate increased.

In V. berlandieri leaves we found flavones, rarely detected in grapevine and to our knowledge, identified in leaves here for the first time. Vitisin and orientin were prevalent over their isoforms and their concentration progressively reduced during the season (Fig. 4).

Flavanonols were found exclusively in V. amurensis: dihydroquercetin-glucoside in blades and veins and dihydrokaempferol-glucoside in veins.

In V. amurensis high concentration of total polyphenols, flavonols and flavan-3-ols were detected; veins displayed a high concentration of flavonoids (Fig. 5). These peculiarities could contribute to explain the known specie low susceptibility to pathogens and its ability to cope with abiotic stressors.