Biomarkers for UVB radiation in *Vitis vinifera* cv. Pinot noir: first results

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Introduction

Changing environmental conditions such as depletion of ozone create stressing conditions for plants [1] including damaging effects of UVB radiation, previously reported [2, 3].
The aim of the presented study is to investigate the interaction between UVB impact, physiological and chemical parameters in *Vitis vinifera* resulting in biomarkers which are qualified to serve as indicators for UVB stressed leaves.

Materials and Methods

Vitis vinifera cv. Pinot noir plants were used in the greenhouse experiment from September to October 2008, covering an experimental period of 15 days and UVB exposure for ten days. Three treatments were performed: the +UVB and the ++UVB treatments (filters absorbed radiation below 280 nm) and the –UVB treatment (filters absorbed radiation below 315 nm). Photosynthetic active radiation (PAR) was supplied from 0600 h until 2000 h resulting in 7263 mmol m^{-2} per day. UV radiation was programmed to be supplied in the middle of the PAR period. UVB dosages were calculated using a UV simulation tool [4]. Daily doses of UVB were corrected based on the generalized plant action spectrum [5], normalized to 300 nm and calculated using a model [6, 7].
Thirteen different candidate chemical biomarkers for UVB stress in leaves were searched within a set of polyphenolic compounds consisting of three phenolic acids (caffeic acid, coumaric acid, ferulic acid), one phenolic acid ester (caftaric acid methylester), two flavonols (quercetin, kaempferol) and their glucosides and glucuronides, respectively, three flavan-3-ols (catechin, epicatechin and epicatechin gallate), one stilbene (*trans*-resveratrol) and one anthocyanin (cyanidin-3-glucoside) using a LC-MS/MS method [8].

Results

Coumaric acid, caffeic acid and ferulic acid have been found in leaf samples of *Vitis vinifera* only in concentrations below the limit of detection (ca. 1 µg/g leaf each) or limit of quanitification (LOQ, 5, 4, 4 µg/g leaf, respectively), both limits were determined in leaf matrix. Median concentrations of the remaining compounds are shown in Fig. 1. Based on statistical differences between applied treatments kaempferol-3-*O*-glucoside, quercetin-3-*O*-glucopyranoside and quercetin-3-*O*-glucuronide have been used for applying a principal component analysis (PCA) with subsequent cluster analysis. Fig. 2 illustrates the suitability of these three compounds to distinguish between -UVB and +UVB/++UVB treated leaves. We propose a set of biomarkers rather than individual markers. Time course profiles of polyphenol concentrations are exemplified three compounds (Fig. 3).

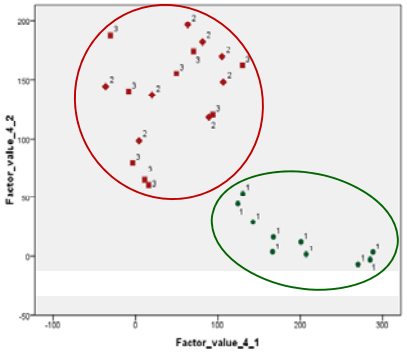

Fig. 2. Cluster Chart of rotated PCA factor values using three polyphenolic compounds after 10 days of radiation treatment.
1: -UVB samples
2: +UVB samples
3: ++UVB samples

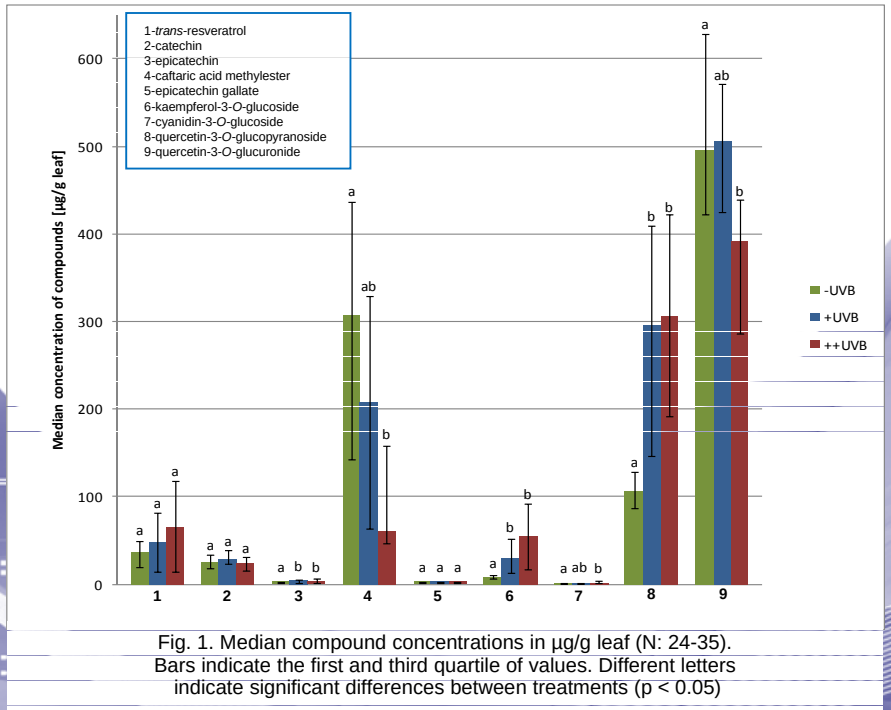

Fig. 1. Median compound concentrations in µg/g leaf (N: 24-35). Bars indicate the first and third quartile of values. Different letters indicate significant differences between treatments ($p < 0.05$)

Discussion

Nine out of 12 target compounds were detected above LOQs in *Vitis vinifera* L. cv. Pinot noir leaf samples. Highest concentrations have been found for quercetin-3-*O*-glucuronide and phenolc acids have shown to to be not detectable and quantificable, respectively. Not only the accumulation of certain substances indicates UVB application, degradation can serve as indicator as well as shown by caftaric acid methylester and quercetin-3-*O*-glucuronide.The resulting three compounds are tested for their ability as biomarkers for UVB radiation in following studies using additional cultivars under greenhouse and field conditions.

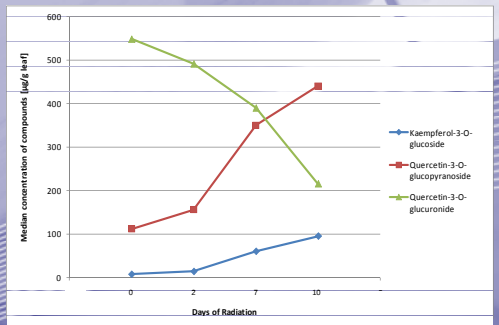

Fig. 3. Time course profile of polyphenol concentrations in ++UVB samples

References

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Acknowledgement

The project is supported by the Federal Ministry of Agriculture, Forestry, Environment and Water Management of Austria, the 'Niederösterreichischer Weinbauverband', the 'Raiffeisen Lagerhaus AG' and the 'Österreichischer Rebveredlerverband'. The presented work contributes in part to the PhD-thesis of Katharina Schoedl.

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