Untargeted metabolomics as a tool to study grapevine biosynthetic behaviour in the relation with purposely-induced and monitored microclimate modifications in 'Pinot noir' vineyards

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Leaf removal is an important viticulture technique that can lead to substantial improvements in crop quality. Depending on the timing of leaf removal, grapes can develop under conditions varying from shaded to fully sun-exposed, thus different fruit-zone microclimate within different phases of grape berry development is achieved, known to significantly affect grapevine biosynthetic behaviour. Whereas earlier research efforts to reveal the effects of microclimate manipulation on grape quality parameters were mainly focused on just a few targeted compounds, newer analytical approaches, such as metabolomics, offer lot wider possibilities to study plant responses to different environmental factors. A completely randomised experimental design with three treatments (18 plots of 5 vines/plot) was thus introduced in two 'Pinot noir' vineyards (Vipava, Slovenia; Trentino, Italy). A sample of 500-600g berries (6 biological replicates per each treatment) were randomly collected at commercial harvest, immediately frozen at -80°C and later subjected to untargeted metabolomics analytical approach, aiming to compare the performance of a novel (early) pre-flowering leaf removal and more widely adopted (late) veraison leaf removal with the performance of untreated vines. The results revealed plentiful microclimate-related alterations in berry composition. Numerous biomarker candidates for different leaf removal timing were indicated based on similar behaviour in both vineyards. In positive ionisation mode there were 209 significant features found for pre-flowering treatment, 64 for veraison treatment and 27 for shaded, untreated vines, whereas in negative ionisation mode 147, 49 and 15 features (pre-flowering, veraison and untreated respectively) were significant overall. Metabolomics was shown to be a useful tool to support research efforts toward better understanding of grapevine biosynthetic behaviour and its biochemical pathways; however, it also represents a new way to gather important applicable data for knowledge-based improvements in a modern, quality-oriented vineyard management.

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