Unravelling the relationship between sugar accumulation and the aroma profile of single grape berries

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Sugars and aroma compounds are among the most important traits sought by grape growers and winemakers to produce wines of a desired style. At the end of the lag phase sugars are translocated from grapevine leaves into grape berries. Simultaneously, aroma compounds belonging to different chemical classes are either synthesised to be stored in the berries or degraded to be re-metabolised.

Objectives/aims

Although a large number of aroma compounds have already been characterised in grapes, little is known about the relationship between the synthesis of these specialised metabolites and the accumulation of sugars as they are transported into ripening grapes. Due to the high degree of variation in the ripening schedule of grape berries, it could be speculated that a relationship between the sugar level and the composition of aroma compounds exists at the level of individual berries, which is hidden by heterogeneity within the bunch when berries are pooled for winemaking purposes. To test this, we measured the sugar concentration and the level of some wine-related aroma compounds in single berries sampled over different stages of ripening (Figure 1). Five distinct classes of development were discriminated by visual and touch characteristics and berries were sorted into these classes at each week's sampling. Infrared (IR) spectroscopy was also used to investigate overall qualitative differences among the berries.

Key findings

The sugar concentration as Total Soluble Solids (TSS) and the content per berry of six C6 compounds were measured in individual berries belonging to five classes of development and collected on a weekly basis from veraison to commercial maturity (24°Brix). Berries were collected from each side of the canopy, from different in-bunch positions and with variable sunlight exposure to test how significantly the stage of development can determine berry composition compared to these other factors.

Chemical and IR data showed that there is a general correlation between the chemical composition of individual berries and the class of development that they were assigned.

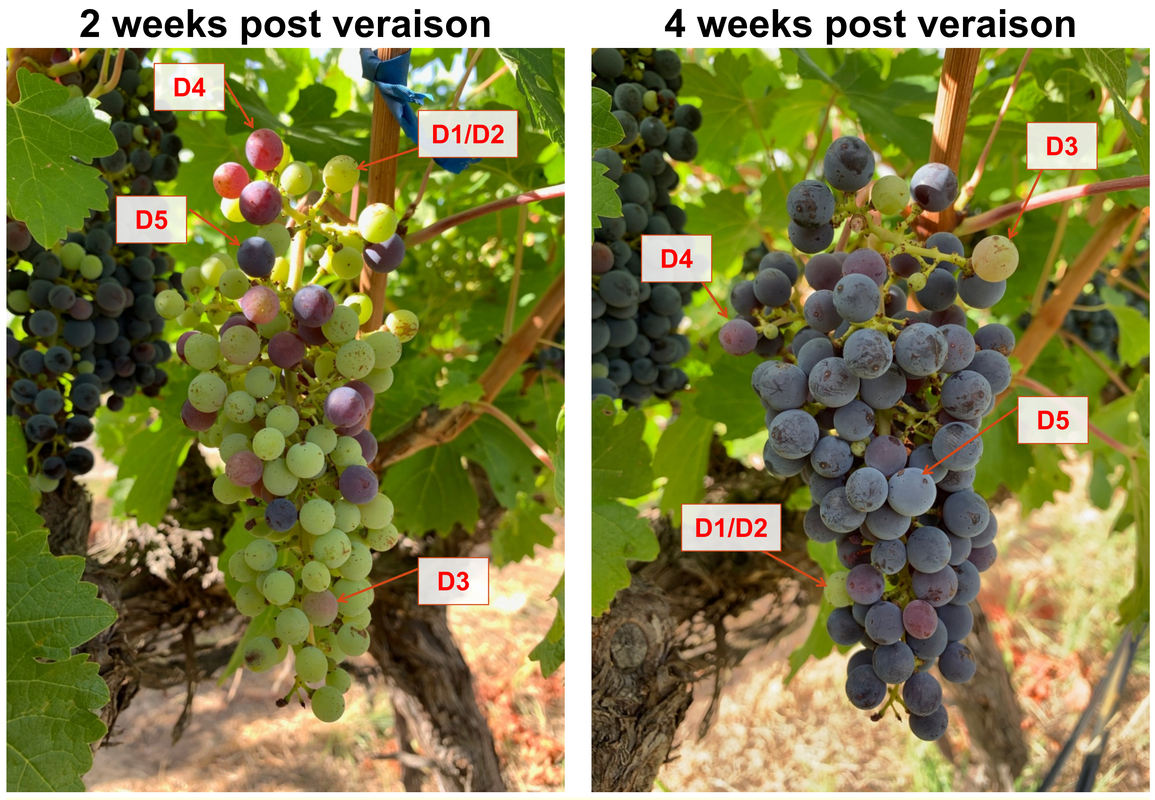

Figure 1: Berries of different classes of development at different time points: 2 wpv (Jan 30) and 4 wpv (Feb 14). D1: green hard; D2: green soft; D3: pink/blush; D4: purple/red; D5: blue berries.

C6 compounds and TSS correlation

At increasing TSS levels, berries displayed an increasing content of most of the C6 compounds responsible for green and leafy notes (Figure 2). A negative correlation was found between TSS and (*Z*)-2-hexen-1-ol, the concentration of which (i) sharply decreased when individual berries transitioned from green to pink/blush and (ii) was found at minimal levels in subsequent stages of ripening.

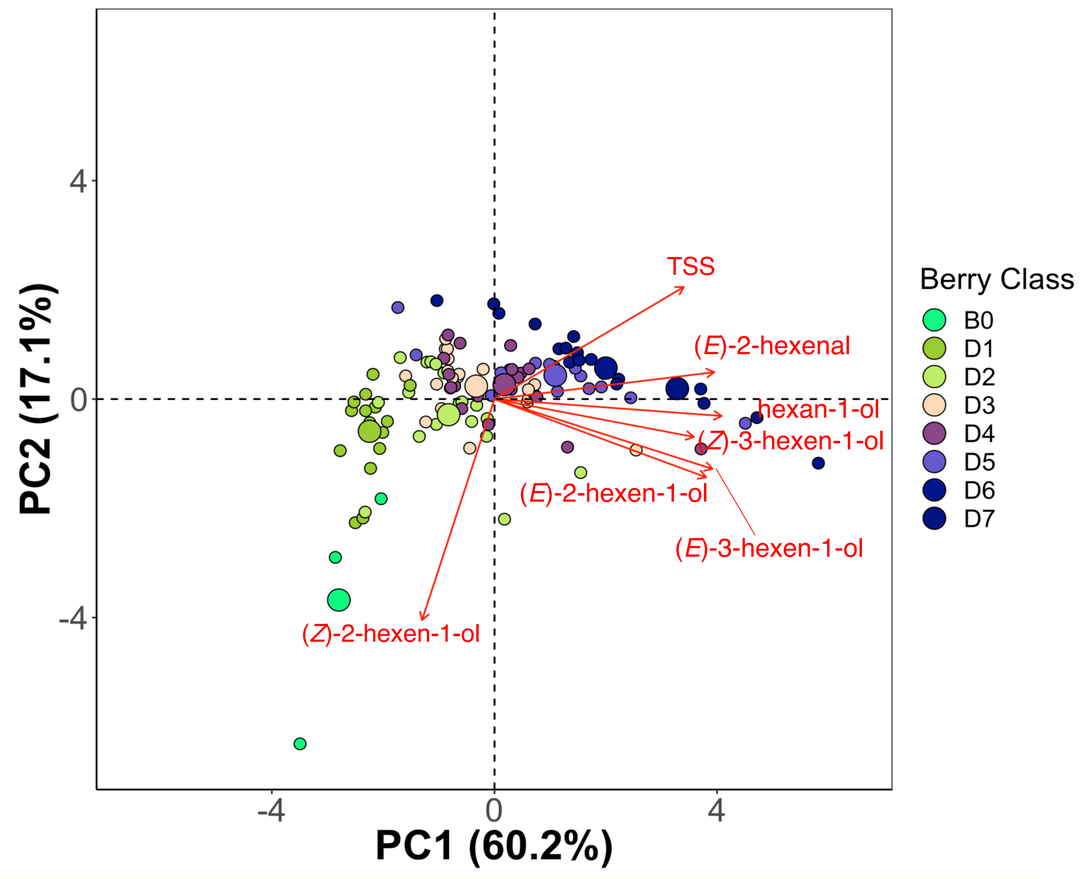

Figure 2: The PCA biplot shows individual berries' scores and variable loadings on the first two components. Colours indicate the class of development assigned to each berry.

Qualitative differences among single berries through IR spectroscopy

For each berry, the TSS value was recorded and the spectrum of absorption in the IR region (4000 to 400 cm^{-1}) was acquired. The highest degree of variation was observed in the range of the Medium Infrared (MIR) fingerprint (1500 to 900 cm^{-1}) which provided the best classification for berry stage of development. The bands of absorption of sugars and organic acids are located in this region and their high concentration compared to secondary metabolites explains the discriminative power of the MIR fingerprint. This experiment showed that the spectrum of berries in the investigated IR region can be used to predict the stage of development. Spectral data showed that the differences among classes were predominant over those within each class, supporting the hypothesis that the stage of development has a strong influence on the composition of grape berries. Nevertheless, little information can be extrapolated in terms of aroma compounds due to their low concentration and spectral properties.

FOR MORE INFORMATION

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