

Grapevine berry ripening and wine aroma

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The criteria for optimal maturity of grapes are multi-faceted. Several important classes of compounds are biosynthesised during the berry growth period, before and/or after véraison (aromatic precursors, phenolics, hormones, organic acids, etc.), whilst others are provided by roots and/or leaves (water, minerals, sugar, etc.). Several of these compounds change during the ripening stage of the grape berry. These changes do not occur in a highly coordinated fashion, and instead, suggest a series of independently regulated pathways of synthesis. Each pathway is influenced by seasonal climatic factors and vineyard practices as well as cultivar.

The concept of terroir needs to be taken into account when harvest potentiality and the related style of wine are considered. The concept of terroir is a complex notion because, apart from climate and soil, it includes people, social organisations and activities such as agricultural practices. The idea of geographical origin is important for products which lay claim to a terroir-linked typicality. Measuring the terroir effect on an agri-food product remains difficult for both trained experts and for the consumer, for whom the appreciation of the product or lack thereof remains the principal criterion in their evaluation. This does not exclude the capacity to recognise the product's properties, but it should be remembered that the perceived taste and aromas will be transformed by the individual's experience into a unique overall sensory impression. It would seem that the development of the terroir concept over the centuries is a strong indication of its increasing social importance. Terroir-derived food products, the preservation of landscapes and development and encouragement of people are important values that merit current support and advocacy in the future.

Optimal grape ripeness is defined according to the style of wine required, which in turn is dictated by market demand or by the objective of producing a wine that respects the expression of a typical terroir-related character. Professionals working within the sector are therefore obliged to accurately characterise the grapes in order to make an informed decision about optimum harvesting date, and to adapt fermentation practices to obtain a target wine.

The quality of the grapes is a determining factor in the quality of the finished wine. But how is grape quality itself determined? What are the relevant parameters of the berry that enable the dynamics of ripening to be monitored?

One of the most important and difficult parts of a viticulturist and winemaker's job is to predict the style of wine from the berries and the oenological process. The classical indicators like brix, malic and tartaric acids, titratable acidity, tannins, anthocyanins, etc. are strongly related to the perception of the taste of the wine (mouth feel). Therefore, it is also highly useful to be able to predict or predetermine the future style of wine in terms of aroma, from the fruit itself.

The department of Viticulture and Oenology is leading an ambitious project on grapevine berry ripening, studying the berry aromatic sequence during fruit maturation in relationship with the wine flavour profiles. The scientific aim is to better understand fruit growth and composition (i.e. fruit quality) and to develop practical tools and methods to predict or predetermine the future style of wine in terms of aromatic characteristics. Berry ripening, wine flavours and the elaboration of low alcohol wines are today among the priority of the worldwide wine industry, mainly in the context of climate change (i.e. increase of temperature and evapotranspiration) and scarcity of water. The research program, financed by WINETECH, THRIP and DISTELL, has already allowed the transfer of two methods to the wine industry, for the red and white cultivars respectively, to predict the harvest date and the associated style of wine. The method for the red cultivars uses the concept of berry sugar loading (Deloire, Wineland, January 2011) and the method for the white cultivars uses the berry colour evolution (Deloire, Wineland, April 2011). Both methods are based on the fact that from véraison

onwards the berry aromatic sequence seems to be preprogrammed, and therefore can be predicted. The berry aromatic sequence could be explained as following:

Red cultivars. When sugar per berry reaches a plateau, there are four stages which progress in the same sequence (Figure 1):

stage 1) fresh fruit/green plant like aroma /unripe plum

stage 2) neutral/spicy like aroma;

stage 3) mature berry aromas such as blackcurrant, raspberry, cherry;

stage 4) over ripe aromas such as dried fruit, prune.

Stage 1 always occurs from 10 to 20 days onwards after sugar per berry has reached a plateau (stopping of berry sugar loading), respectively for Merlot (Figure 1) and Cabernet Sauvignon. Stage 3 always occurs from 20 to 40 days onwards after sugar per berry has reached a plateau, respectively for Merlot and Cabernet Sauvignon. Stage 2 has to be avoided and could be determined using the sugar loading method.

The berry aromatic stages are not directly related to berry brix and titrable acidity evolution (Figure 1). As can be seen in the figure, stage one (fresh fruit aroma) is reached from 10 days onwards after sugar per berry plateaus. Stage three (mature fruit aroma) is reached from 20 days onwards after sugar per berry plateaus. The terroir (soil and climate) and the cultural practices will play a role mainly on the intensity of the fruit aromatic profile. Between fresh and mature fruit stages, the stage two is called neutral/spicy or pre mature and may vary according to situation. There is no direct relationship between fruit brix level and the berry aromatic sequence stages, meaning that fresh, neutral and mature stages can be reached at the same brix value. In that regards, the model shows that harvesting using only brix value is not relevant.

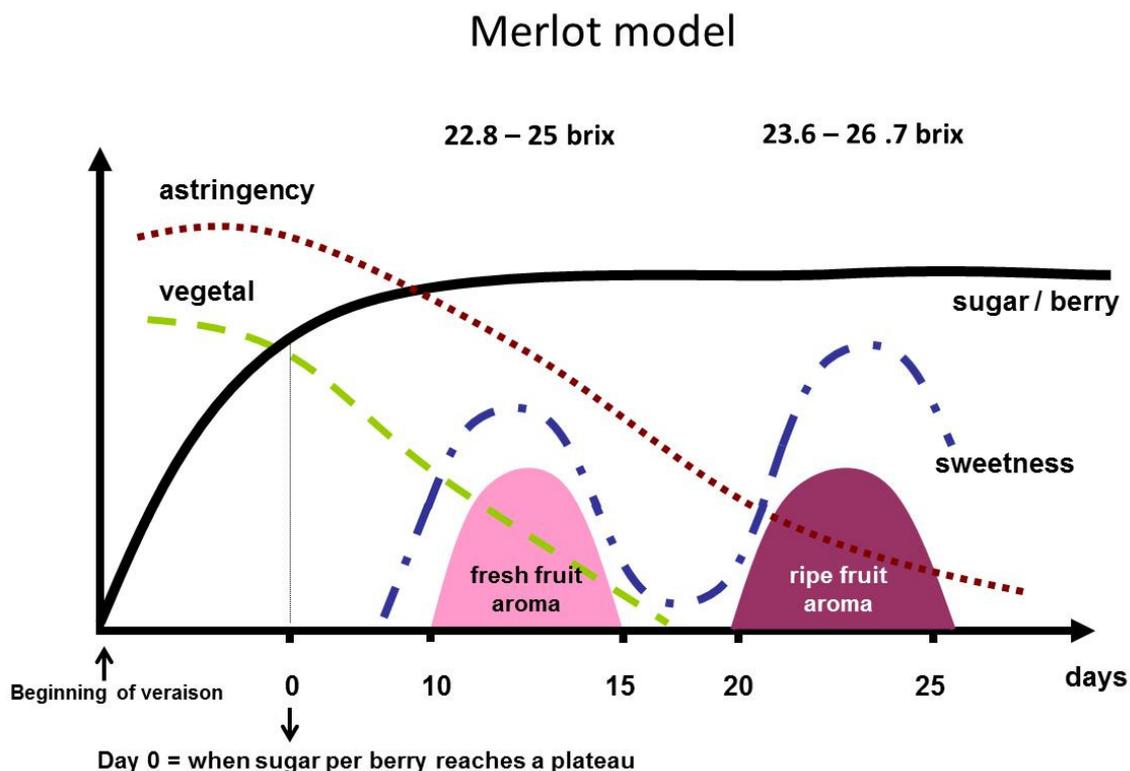


Figure 1: Example of Merlot berry aromatic sequence.

White cultivars. The method is using the berry colour evolution (table 1).

Table 1: Thresholds of berry hue (in degree) according to the HSL model of colour representation and expected style of wine for most of the white cultivars. Simplified thresholds (berry colour evolution occurs irrespectively of Brix and titrable acidity):

> 80 = green/asparagus/citrus/unripe

< 80 and > 70 = tropical/grapefruit/citrus/boxtree

< 70 = fermentative/neutral/terpene

Berry hue thresholds (in degree)	Expected wine aromatic profiles
> 90	Green/unripe
90 - 85	Green/asparagus
85 - 80	Asparagus/citrus
80 - 75	Asparagus/Tropical fruit/grapefruit/citrus
75 – 70	Tropical fruit
70 - 65	Fermentative/terpene
65 - 60	Phenolic/neutral/terpene

Montpellier SupAgro (France), Vivelys (France), DISTELL (Stellenbosch, South Africa), WINETECH (South Africa) and Food Sciences department (Stellenbosch University, South Africa) are partners directly or indirectly involved in the development of the methods. New collaborations will be established within OENODOC Erasmus Mundus international consortium (10 countries),

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