New method to determine optimal ripeness for white wine styles

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Optimal grape maturity criteria is multi-faceted. Several important classes of compounds are biosynthesized during the berry growth period, before and/or after véraison (aromatic precursors, phenolics, hormones, organic acids, etc.), while 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. These pathways differ between cultivars and are also influenced by seasonal climatic factors and vineyard practices. To add to this complexity, each berry within a bunch has its own dynamic of growth and maturation.

The question therefore can be raised as to how to explain and manage this complexity at both the scientific and practical levels? There are several methods already used by viticulturists and winemakers to choose an appropriate harvest date. All of these methods are highly relevant when put in the context of a winery's strategy. The different methods are:

A. harvest according to previous knowledge of a specific cultivar and vineyard, without any analysis but through visual observations, building up personal experience as a producer (or a traditional grower);

B. harvest according to one criteria that requires simple, routine analysis, such as Brix (the most commonly used indicator in the wine industry today);

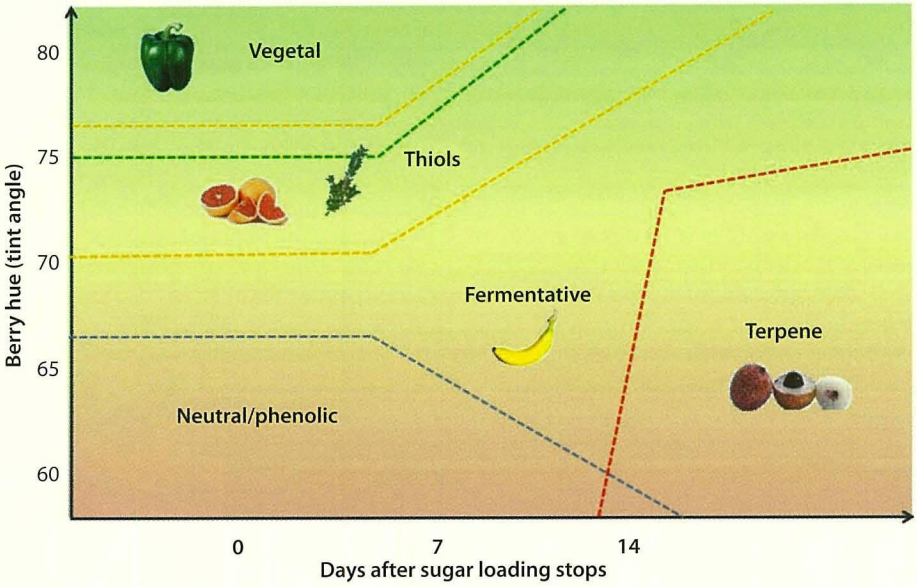

Figure 2: White cultivars berry aromatic model (from Vivelys, France). The method uses the berry color evolution from véraison to harvest (berry hue or tint angle in degree: y-axis) and the berry sugar loading concept (x-axis). According to the evolution of the berry hue, the method allows to predict the wine style (see Table I). The Sauvignon Blanc berry aromatic model for the Western Cape region is under development and calibration by Distell group within a collaboration with the Department of Viticulture & Oenology (Stellenbosch University).

C. harvest according to berry tasting, which can be efficient but is also very subjective; the decision depends on the personal experience and training of the taster;

D. harvest using a series of indicators and appropriate analysis methods. This implies that the necessary apparatus is available at the estate, or in an appropriate nearby laboratory. Knowledge in interpreting analytical results to take the appropriate action is required. The cost per acre has to be considered;

E. harvest using new tools and taking into consideration new scientific findings. This implies the ability to access the information, understand, assimilate it, and implement it successfully. In addition, the ability to afford this new technology, which may be expensive, has to be considered.

This list is not complete. When scientific indicators are used to determine harvest date, it is important that appropriate skills and information be transferred to the people who are using them. For example, such skills include being able to interpret analytical data, using analytical tools properly with a standard protocol, and sampling correctly. The important question of transfer, which has many facets, will not be discussed in this article but is an aspect which needs to be addressed.

Optimal grape ripeness

Optimal grape ripeness is defined according to the style of wine required, which in turn is dictated by market demand or by the objective to produce a wine that respects the expression of a typical terroir-related character. Professionals working within the sector are therefore obliged to accurately char-

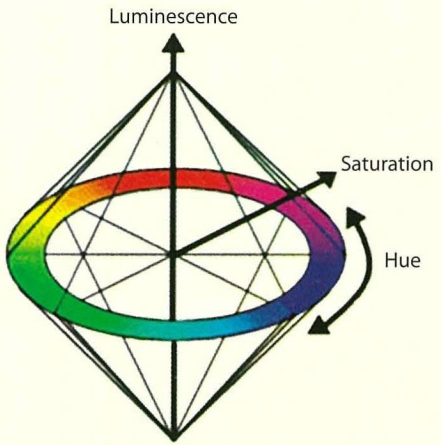

Figure 1: The Hue, Saturation, and Luminescence (HSL) model of color representation which gives hue values in degree from 0 to 360°.

acterize the grapes in order to make an informed decision to optimize the harvest date and adapt fermentation practices to obtain a target wine style. This characterization also provides important information on vine growth patterns.

One of the most important and difficult parts of a viticulturist and winemaker's job is to predict wine style from the berries and the enological process. 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. It would also be very useful to be able to predict or predetermine the future wine style in terms of aroma. This is one reason why the question of fruit maturity and optimal ripeness is still a relevant subject in the scientific community and the wine industry.

Grape quality is a crucial determining factor in the quality of the finished wine, and is fundamentally linked to optimum ripeness. But how is grape quality determined? What are the relevant parameters of the berry that enable the dynamics of ripening to be monitored?

Grape quality – a complex and relative concept

Grape quality is not a simple concept,[11] that depends on several vineyard parameters and on the wine style goal. A classic example is Chardonnay grapes produced for making Champagne and Burgundy respectively. The ideal ripening conditions of this variety will not be the same for production of these two quite different wines.

In other words, a specific wine style demands a particular set of ripening conditions,[5,16] and the concept of grape quality at harvest should be considered in terms of the required wine composition and sensorial properties – in short, what grape quality for which type or style of wine? Particularly, what is meant by grape berry quality?

Apart from the hygienic quality that depends on grape bio-aggressors (fungi such as *Botrytis cinerea*, yeast such as *Brettanomyces*, insects etc.), a

Table I: Thresholds of berry hue (degrees F) according to the HSL model of color representation and expected style of wine for Sauvignon Blanc (*Vitis vinifera* L.).*

Berry hue thresholds degree related to angle (0 to 360)	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

*In some specific climatic conditions, the thresholds need to be adjusted. The thresholds calibration is done by establishing a relationship between the berry hue angle and the wine style (wine tasting and/or sensorial analysis).

discussion of the grape berry profile in terms of harvest potential would be more pertinent than the quality of the grape berry itself which is a far more ambiguous concept.

Grape berry profile is a combination of different biochemical parameters of the fruit, associated with other factors, such as berry skin color development for white cultivars, extractability during fermentation and fruit compartmentalization. Harvest potential describes the potentiality of a vineyard block in terms of grape profile, whereas typicality is the reproduction of a given grape profile based on its conformity to a specific type in an identified terroir.

The aim of this paper is to describe and propose the use of a recent indicator to monitor ripening of white cultivars in relation with the desired wine style (for red cultivars see Deloire, 2011).[8]

A new indicator should be used in conjunction with other classical indicators of berry ripening. Berry color development and the associated reasoning for the method will be presented below as a relevant new indicator.

Berry color development for white cultivars

Berry color is a new and important indicator, notably of the ripening of white varieties, because a proven relationship exists between berry color and their aromatic potential. Carotenoids, phyto-protective pigments produced by photosynthesis, are localized in the skin and are considered as biogenetic precursors of C_{13}-norisoprenoid glycosides. Certain aromas are derived from the degradation of such skin pigments.[12,13,14,15,17,18,19,20,22,23,24]

The technology to measure berry skin color has been developed by Vivelys Society (France) in partnership with Montpellier SupAgro (France) and is currently being used in the Northern and Southern Hemisphere. The method uses the development of the berry tint angle (berry color evolution), which is determined using optical technologies, as an indicator of berry ripening versus wine aromatic profile.[10] This method is based on an indirect relationship between the evolution of the berry tint angle (according to the HSL model – Hue, Saturation, Luminescence; Figure 1) and the wine sensorial analysis (Figure 2), and as can be seen, has potential to be very useful for profiling berry maturation, harvest potential, and selection of the most appropriate harvest dates for white cultivars.

In addition, measurements can be taken with relative ease and, in a short time, should the instrumentation be available. This technology is currently being refined and used for the wine regions of the Western Cape coastal area of South Africa, within a collaboration with Distell group and Winetech financial support.[9] Table I shows examples of berry hue thresholds and related style of wine for Sauvignon Blanc in the Western Cape region.

The first results of research conducted in South Africa in 2009 show different rates of berry color evolution, from green to yellow, which seem to be mainly related to temperature (meso- and micro-climatic

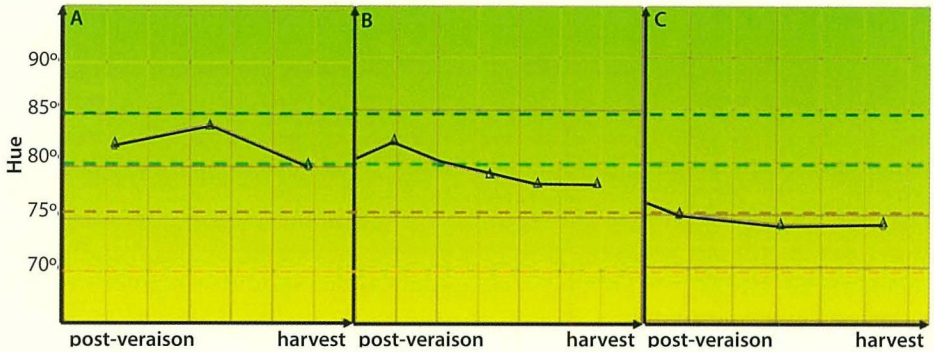

Figure 3 (A, B, C): Examples of Sauvignon Blanc berry color evolution during the ripening period. These examples give an indication of possible styles of wine, within the context of three different macro, meso, and microclimates. A) The wine related to this berry hue threshold (85 – 80) was described with an asparagus/citrus aromatic profile. This wine profile could be found in the Elgin region, mainly from shaded bunches. B) The wine related to this berry hue threshold (80 – 75) was described with a asparagus/tropical fruit/citrus aromatic profile. This wine profile could be found in regions as Stellenbosch (vineyard under sea breeze influence) or Elgin from a vineyard with exposed bunches and under sea breeze influence. C) The wine related to this berry hue threshold (75 – 70) was described with a tropical fruit aromatic profile, meaning a more one-dimension aromatic profile. This wine profile could be found in a warm region, even from shaded bunches.

levels) and light at the bunch level (micro-climatic level). The wine style (tropical/citrus/grapefruit or green/herbaceous/asparagus characteristics) is mainly related to the climate of a specific region (hot or warm versus cool). For the Western Cape area, a cool area is characterized by fresh nights during the ripening period (fresh night index,[21] and by the sea breeze effect,[1,2,3,4,6] which cool down the berry temperature during the ripening period.[7] No direct relationship has yet been established between berry color development from veraison to harvest, and Brix and titrable acidity. Although berry color monitoring will give a far better understanding of berry aromatic sequence evolution during ripening, it is therefore still recommended that at least two of the other classical indicators are used to monitor sugar and acidity in order to achieve the correct wine style.

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