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Detailing ripening phenological stages: discrepancies, usefulness and proposal

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It is crucial to optimise the choice of picking date to get the most out of a harvest. Close monitoring of grape ripening dynamics and comparison with previous years and other vineyards/regions are necessary. Due to the climate challenge, high vintage-to-vintage variability and unprecedented vintage scenarios, it has become risky to use previous references. Providing a standardised and detailed phenological scale to monitor/record ripening stages is paramount for the industry. The need for accuracy is quite high in order to analyse the dataset and thereby collectively build up assumptions on the influence of every event on fruit juice quality, and draw conclusions on the most sustainable practices.

The standard viticultural word for berry ripening inception is veraison. It can be found in the French language dictionary written by Littré in 1874, and its definition is "*ripening of a bunch of grapes, which turns black*". The word comes from the old verb "vérir", which is mentioned in a sixteenth century edition and means to ripen, ripen too much, and sometimes mould.

Today veraison refers to the start of the third and last period of berry development, when berry growth resumes - mainly by cell elongation[1] - after the (second) lag phase. This is when sugar starts to accumulate in the berry, as do other compounds, such as phenolics, potassium and water. In addition, acidity drops mainly as a result of the decrease in malic acid biosynthesis and degradation via respiration (highly dependent on ambient temperature).

Differences between the scales of ripening stages, and discrepancies with vine physiology

The multiple scales, differing methods and inconsistent literature are problematic for the industry and therefore need to be standardised. A recent OIV resolution (2023) refers to veraison with an OIV code of 303 as: "*time of beginning of berry ripening; observation when berries start softening & examination when about 50% of the plants reach this stage*" [2]. The next stage, 304, refers to "*the time of physiological stage of full maturity of the berry*"[2]. These nicely correspond to the 1993 Baggiolini codes M & N respectively, and the stages mark then the start and the end of berry ripening.

Many winegrowers worldwide still use the modified E-L system, which describes in detail berry ripening at different degrees of maturity, from stage 34: *berries begin to soften; sugar starts increasing*; to 39: *over-ripe berries*. However, no method has been proposed for assessing berry ripeness.

The current reference code BBCH (*Biologische Bundesanstalt für Land- und Forstwirtschaft, Bundessortenamt und CHemische Industrie*) applies stage 8 to the berry ripening period which can theoretically be divided into nine sub-stages from 81 to 89 (Table 1). This gives an excellent opportunity to describe the key steps of the ripening period up to harvest, which is thus included in stage 8 (stage 9 being senescence). Of the four first sub-stages defined in 1995, 81 corresponds to *beginning of ripening: berries begin to brighten in colour*, and 85 to *softening of berries*.

However, this contradicts Carbonneau *et al.* (2020)[1], who note that veraison - the start of berry ripening - is characterised by an initial sudden softening of the berry that is shortly followed by an active entry of sugars into the berries, after which the white grape berries become translucent and red grape berries acquire their colour. By measuring colour and firmness using specialised tools, Abbal *et al.* (1992)[3] made it possible to objectively and quantitatively assess the state of veraison.

The Agroscope Changins-Wädenswil research centre defines veraison using the BBCH scale[4], but from stage 81 through to stage 85, and stage 89 as "*harvest: full maturity*" - which is unclear, since harvest is not necessarily linked to "full" maturity.

In the recent PERPHECLIM project, researchers defined veraison as stage 85: "*50% of the berries are in veraison; a berry has reached this stage when it is soft*". They recommend weekly observations and the date is finally calculated by interpolation (before and after 50% berries in veraison). It should be noted that this growth stage is widely adopted but is often improperly named *50% veraison*, or even *mid-veraison*. They also mention that it is acceptable to use the colour change as an indicator in very specific cases, such as when making interannual comparisons of the same variety on the same site. However, Bigard *et al.* (2019)[5] found there was a delay of several days between berry softening and colouring.

Finally, Antalick *et al.* (2023)[6] divide berry ripening into two periods: before and after the sugar loading plateau. During the second period, the berry goes through three different sub-stages, known as Fresh fruit, Intermediate and Mature fruit.

Necessity of a detailed coding system that is clearly referenced

As reviewed in the first section, historical indicators of ripening consist of berry size, firmness and colour, and sugar and acidity contents. Other key components which impact wine style include nitrogen and polyphenols. At veraison, the berries are rich in nitrogen, mainly as NH_4^+, and the quantity of amino acids gradually increase up to a certain point. According to Verdenal *et al.* (2021)[7], nitrogen content at veraison is well correlated with nitrogen content in the must at harvest. Oliveira Lago *et al.* (2023)[8] noticed that anthocyanins accumulate in the berry for five to six weeks after the onset of veraison, after which their content stabilises and then decreases after approximately the ninth week.

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The main difficulty to deal with is probably the very high berry variability, which makes it hard to fix the parameters and methodology for determining each stage. From flowering and berry set, berries within a cluster do not start developing simultaneously, and the gap between late and early berries is never bridged. At harvest, there is therefore a pool of berries that are at different levels of maturity[1]. In addition to berry asynchrony, the number of seeds within a berry, which varies between 1 and 4, can also add another level of heterogeneity. Berry variability is also high because of bunch variability within a plant due to its position (microclimate, sun exposure), and *a fortiori* within a block (zonal difference, plant variability).

Before sampling it is thus helpful to first define block units that are as even as possible. Considering the degree of berry heterogeneity, it is essential to divide a sample of, for instance, 300 berries into three sub-samples of 100 berries to monitor the mean and the variability (standard deviation between the three sub-samples). And finally, to gain in robustness it is also essential to monitor ripening dynamics weekly from veraison to harvest[9].

Using the 9 sub-stages of the BBCH scale: a proposal

It is important to date veraison — the start of berry ripening — correctly, since this will be used to calculate the duration of the ripening phases. By analysing malic acid concentration in the must at veraison, its peak value between vintages can be compared and its degradation monitored. Measuring berry nitrogen as YAN (*Yeast Assimilable Nitrogen*) reveals the efficiency of the nutrition programme and enables the technical team to make certain operational decisions, such as foliar applications.

Monitoring berry colour at the early stages is very common in the industry, because berry colour is easy to determine and it reflects the situation in the field very well. It is important to start analysing the must from the early stages, and weight the results of sugar with berry fresh mass, as proposed by Deloire *et al.* (2023)[9]; this is a very practical approximation of sugar content in the berry and allows the sugar loading concept to be applied.

When pursuing a defined wine style, it does not seem possible to establish harvest as a stage, because the harvest date is decided based on factors such as sugar level, acid/sugar ratio and flavour, or just on disease pressure, weather forecasts or logistics constraints. Researchers talk about technological maturity (a certain concentration in sugar and/or organic acids), aromatic maturity (an optimum level of varietal aromas), polyphenolic maturity (maximum quantity of qualitative polyphenols in skin & seeds), while winemakers look for a balanced maturity; i.e., a combination of all of the aforementioned. When deciding on an optimum harvest date, winemakers taste the berries and assess seed development first by their colour and then by their texture and aromas. Over time, berry quality progresses, but beyond a certain point the skin loses all plasticity and the fruity aromas decrease significantly. This indicates the end of berry ripening and corresponds to stage 89.

Based on weekly monitoring, the different steps of berry ripening could be recorded as proposed below.

TABLE 1. The different steps of berry ripening based on weekly monitoring.

BBCH	Observation	Recommended analysis (must)
81	Veraison: berries begin to soften	Sugar, malic acid, YAN
82	25% coloured berries	Berry fresh mass, sugar, malic acid
83	50% coloured berries	
84	Active sugar loading (> +10% in mg/berry/day)	
85	sugar loading plateau (first slowdown below +5%; mg/berry/day)	
86	Taste: fresh fruit & green notes	°Brix, total acidity, pH, anthocyanins
87	Ripe seed (brown), fruit with varietal flavours	
88	Extra ripe characters, berry shrivelling	
89	Over ripe characters, undesirable quality	

Some stages can be difficult to record with accuracy because of variety specificity; it is hard to define the degree of berry colouring for a Sauvignon blanc in a vegetative canopy, for instance. Others can be determined only statistically from the frequency of the observations. However, it is very important to focus on the most appropriate stages for each block, and to grade harvest using the scale for technical, scientific and modelling purposes. ■

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1 Carbonneau, A., Torregrosa, L., Deloire, A., Pellegrino, A., Pantin, F., Romieu, C., Ojeda, H., Jaillard, B., Metay, A., & Abbal, P. (2020). *Traité de la vigne - 3e édition. Physiologie, terroir, culture.* Collection : Pratiques Vitivinicoles, Dunod. 712 p.

2 OIV (2023). *Resolution OIV-VITI 702-2023. Publication of the 3rd edition of the OIV descriptor list for grape vine varieties and Vitis species.* https://www.oiv.int/node/3028.

3 Abbal, P., Boulet, J.-C., & Moutounet, M. (1992). Utilisation de paramètres physiques pour la caractérisation de la véraison des baies de raisin. *OENO One, 26*(4), 231–237. https://doi.org/10.20870/oeno-one.1992.26.4.1185

4 Bloesch, B., & Viret, O. (2008). Stades phénologiques repères de la vigne. *Rev. Suisse Vitic. Arboric. Hortic., 40* (6): I-IV. https://api.agrometeo.ch/storage/uploads/Poster_stade-pheno_Vigne_F_Ecran.pdf.

5 Bigard, A., Romieu, C., Sire, Y., Veyret, M., Ojeda, H., & Torregrosa, L. (2019). The kinetics of grape ripening revisited through berry density sorting. *OENO One 2019, 4*, 709-724. https://doi.org/10.20870/oeno-one.2019.53.4.2224

6 Antalick, G., Šuklje, K., Blackman, J., Schmidtke, L., & Deloire, A. (2023). Plasticity of red wine sensory profiles: improved understanding through grape berry sugar loading profiles. *IVES Technical Reviews.* https://doi.org/10.20870/IVES-TR.2023.7797

7 Verdenal, T., Dienes-Nagy, Á., Spangenberg, J.E., Zufferey, V., Spring, J.-L., Viret, O., Marin-Carbonne, J., & van Leeuwen, C. (2021). Understanding and managing nitrogen nutrition in grapevine: a review. *OENO One 55*, 1–43. https://doi.org/10.20870/oeno-one.2021.55.1.3866

8 Oliveira Lago, L., Swit, P., Moura da Silvac, M., Telles Biasoto Marques, A., Welke, J., Montero, L., & Herrero, M. (2023). Evolution of anthocyanin content during grape ripening and characterization of the phenolic profile of the resulting wine by comprehensive two-dimensional liquid chromatography. *J. Chromatogr. A 1704, 464131.* https://doi.org/10.1016/j.chroma.2023.464131

9 Deloire, A., Pellegrino, A., Antalick, G., & Suklje, K. (2023). *Proposal for a protocol for measuring berries sugar loading and the evolution of berry fresh mass.*