IVES Technical Reviews
vine & wine

https://doi.org/10.20870/IVES-TR.2023.7528

Aromatic ripeness may be the type of maturity that impacts red wine typicity the most. Part II: terroir factors and management practices affecting aromatic ripeness

Cornelis van Leeuwen[1], Jean-Christophe Barbe[2], Justine Garbay[2], Mark Gowdy[1], Georgia Lytra[2], Marc Plantevin[1,2,3], Alexandre Pons[2,4], Cécile Thibon[2], Stéphanie Marchand[2]

[1] EGFV, Univ. Bordeaux, Bordeaux Sciences Agro, INRAE, ISVV, F-33882 Villenave d'Ornon, France
[2] Univ. Bordeaux, Bordeaux INP, Bordeaux Sciences Agro, UMR 1366 OENOLOGIE, ISVV, F-33140 Villenave d'Ornon, France
[3] Château La Tour Carnet, 33112 Saint-Laurent-Médoc, France
[4] Tonnellerie Seguin-Moreau, ZI Merpins, 16103 Cognac

Harvesting grapes at the appropriate maturity is key to the production of high quality red wines. Viticulturists, oenologists and winemakers define several types of maturity: technological, phenolic and aromatic. Aromatic maturity is probably the most important for determining wine quality and typicity, including terroir expression. This article (part II) reviews the influence of terroir factors and management practices on aromatic maturity; the latest knowledge regarding compounds that underpin aromatic maturity was addressed in a previous article (Part I).

Terroir factors that influence aromatic ripeness

As perceived in sensory assessments of wine, typicity is the result of complex interactions between numerous molecular compounds and involves collective knowledge about the sensory characteristics of the product[1]. Major quantifiable factors driving the terroir effect on grape and wine typicity, and aroma expression include air and soil temperature, vine water status, solar radiation, and vine nitrogen status[2]. Of these factors, air temperature appears to have the strongest impact on grape ripening and aromatic maturity, followed by soil temperature, vine water status and radiation. Air temperature is highly variable across winegrowing regions worldwide and is a clear driver of grape maturity. Soil temperature has a similar impact on grape maturity, with cooler (generally wetter) soils delaying maturity; however, its effects are smaller in magnitude compared to those of air temperature. Vine water status also influences grape ripening, as does radiation.

In a previous article (Part I), a classification of wine aromas in an increasing order of perceived maturity was given (see also Carbonneau, 2007)[3]. It is possible to identify some general trends related to the effects of environmental factors on their presence in grapes and wines. Perceived aromatic maturity increases with air and soil temperature. Green, herbal and spicy aromas can be linked to low temperatures, while ripe, dried or cooked fruit nuances are more often perceived when grapes ripen under warm conditions. Increased radiation decreases green aromas in wine due to associated lower levels of methoxypyrazines, while it may increase aromas associated with ripe and, sometimes, overripe fruit. High radiation can, however, increase fresh peppery notes in wines linked to the abundance of (-)-rotundone. Vine water deficits lead to a higher degree of perceived maturity in wines. Ripe fruit aromas in red wine attributed to esters are reinforced by the presence of DMS[4]. After aging, the concentrations of DMS in red wine are higher when vines are exposed to high temperatures and water deficits. A more detailed overview of the impact of temperature, radiation and vine water status on these aroma compounds can be found in van Leeuwen *et al.*, 2020[2].

Grapevine variety selection based on local climatic conditions

When producing wine at a specific site, the temperature regime during grape ripening depends not only on the local climatic conditions but also on the phenology of the variety being cultivated. The growers cannot change the temperature regime of a site, but they can advance or delay the ripening period by choosing an early or late ripening variety respectively. Hence, it makes sense to cultivate early ripening varieties under cool climatic conditions and late ripening varieties in warm climates; however, in the former case, attaining full ripeness is a challenge, and in the latter, the decoupling of technological, phenolic and aromatic maturity is a potential risk. Temperature requirements for attaining sugar ripeness have recently been published for a wide range of varieties, allowing varietal choices to be fine-tuned according to local temperature summations[5].

Each variety has an aromatic signature[6]. This signature, however, is extremely variable depending on the level of aromatic maturity at grape harvest, because of either the time of harvest or the local environmental conditions, in particular temperature. When grapes ripen under similar temperature conditions, Merlot, Syrah and Cabernet-Sauvignon wines exhibit aromatic similarities: green, herbal or spicy aromas when having ripened under cool conditions, or jammy or cooked fruit aromas when having ripened under very warm conditions. The aromatic signature of each of these varieties, however, can differ greatly depending on if they have ripened under relatively cool or very warm ripening conditions; e.g., Merlot from Bordeaux (French) versus Merlot from Alentejo (southern Portugal) or Syrah from Northern Rhône (French) versus Syrah from the Barossa Valley (Australia).

Influence of management practices on perceived aromatic maturity

The environmental resources offered by a specific site (i.e., terroir) can, to a certain extent, be manipulated through the design of the training system and annual management practices. Long term decisions on planting densities and vine architecture, or annual canopy management practices, can modulate light and temperature in the fruit zone. Water availability can be managed through irrigation practices. When excessively cool ripening conditions increase the risk of green aroma nuances, improving bunch exposure by leaf thinning can increase radiation and temperature, and hence improve aromatic maturity (Table 1). Under these conditions, water deficits can also help avoid green aroma nuances. Conversely, in warm temperatures, canopy management that results in the partial shading of grape bunches can limit the risk of cooked fruit and oxidised prune aromas. Moderately low vine nitrogen status and cover cropping limit green aromas in cool and wet climates through reduced vigour and improved bunch exposure[2]. Nitrogen deficiency and excessively competitive cover cropping should be avoided in warm climates, because these practices favour bunch exposure, which enhances the development of cooked fruit and oxidised prune aromas (Table 1).

Trends in the management of harvest dates

Viticulturists, oenologists and winemakers are generally keen

The translation of this article into English was offered to you by Moët Hennessy.

TABLE 1. Training systems, management practices and plant material choices to limit green, cooked fruit and oxidised prune aromas in cool and warm climates.

Management practices and plant material choices	Impact on green aromas	Impact on cooked fruit and oxidised prune aromas
Leaf removal	Carry out early leaf removal in cool and wet climates to reduce green aromas	Limit leaf removal to avoid excessive bunch exposure in warm climates which favors cooked fruit and oxidised prune aromas
Training systems	Use training systems that favour open canopies (VSP, Smart-Dyson, Lyre trellis) in cool and wet climates	Use training systems that favor bunch shading (globlet bushvines, pergola, VSP without leaf removal and limited hedging) to limit cooked fruit and oxidised prune aromas in warm climates
Water management	Water deficits reduce green aromas in cool climates. Full irrigation favours excessive vigour which may lead to green aromas in cool and warm climates trough excessive bunch shading and late shoot growth cessation	Avoid late-season severe water deficits in warm climates, which may lead to berry shrivel and enhance cooked fruit and oxidised prune aromas
Nitrogen fertilisation	Excessive nitrogen fertilisation leads to high vigour and favours green aromas through bunch shading, in cool and warm climates	Nitrogen deficiency leads to low vigour and excessive bunch exposure that favours cooked fruit and oxidised prune aromas in warm climates
Cover cropping	Cover cropping reduces vigour, improves bunch exposure, and limits green aromas in cool and warm climates	Avoid low vine nitrogen status through competitive cover cropping in warm climates, as it enhances the development of cooked fruit and oxidised prune aromas through excessive bunch exposure
Variety choices	Use early ripening varieties in cool climates to avoid green aromas	Use late ripening varieties in warm climates to limit development of cooked fruit and oxidised prune aromas
Rootstock choices	Use low to medium vigor rootstocks in cool and wet climates to limit green aromas through improved bunch exposure	Use medium to high vigour rootstocks in warm climates to reduce bunch exposure and delay maturity in order to limit cooked fruit and oxidised prune aromas
Harvest date	Late harvest reduces green aromas in grapes and wines	More cooked fruit aromas when harvest is delayed

to improve phenolic ripeness; i.e., the moment when anthocyanin concentration in the skins reaches a maximum and tannin concentrations have decreased after veraison, both in skin and seeds[7]. They share a common belief that delaying harvest can increase fruity characters, mouth feel and colour in wine, although scientific evidence is limited and mostly anecdotal[8]. Reliable metrics to measure phenolic ripeness in production conditions are also not easy to define. The trend in increasing alcohol levels in wines worldwide is partly due to changing climatic conditions, but it is also due to an increased delay between veraison and harvest[9]. When delaying harvest in an attempt to improve (poorly defined) phenolic ripeness, there is a clear risk that grapes will be picked not only at an unbalanced technological maturity with excessively high sugar levels and pH, but also at an undesirable level of aromatic maturity, with cooked fruit and oxidative prune aroma nuances becoming predominant.

The effects of climate change

Wine styles are changing worldwide in most production areas as a consequence of the effects of climate change. Trends of increasing alcohol levels and pH are well documented, which is not the case for modifications in aromatic maturity. However, it is very likely that aromatic maturity in grapes and wines will continue to increase under climate change, if no adaptative measures are implemented. To maintain wine typicity in production areas, grape ripening must be delayed and maintained as much as possible at the end of the season when temperatures are cooler (September or early October in the northern hemisphere, or March or early April in the southern hemisphere). This can be achieved by modifying training systems, decreasing leaf area/fruit weight ratio, performing late pruning or planting later ripening clones (Table 1). The most drastic adaptive measure, but also one of the most effective, is changing the grapevine variety. Growers and consumers sometimes fear that this will change the aromatic typicity of the produced wines, because each variety has its own aromatic signature. This signature, however, is extremely variable depending on the level of aromatic maturity at grape harvest, because of either the time of harvest or the local environmental conditions, in particular temperature. Hence, with view to preserving wine typicity, adopting a later ripening variety that will ripen in similar temperature conditions, even in a warmer climate, may be a better option in the long term than that of maintaining an existing variety, which will ripen increasingly early under much warmer conditions.

Conclusions

Aromatic maturity is a key factor of wine typicity. Technological, phenolic and aromatic maturity are attained within a short time frame when grapes ripen at the end of the growing season under mild temperatures. This implies planting early ripening varieties in cool climates and late ripening varieties in warm climates. The desired level of aromatic maturity can be fine-tuned by choosing adequate training systems and annual management practices, as well as by making appropriate harvest date decisions. ■

Source : *Sourced from the research article: "Aromatic maturity is a cornerstone of terroir expression in red wine" (OENO One, 2022).*

1 Barbe, J. C., Garbay, J., & Tempère, S. (2021). The sensory space of wines: from concept to evaluation and description. A review. Foods, 10(6), 1424. https://doi.org/10.3390/foods10061424.

2 van Leeuwen, C., Barbe, J. C., Darriet, P., Geffroy, O., Gomès, E., Guillaumie, S., Helwi, P., Laboyrie, J., Lytra, G., Le Menn, N., Marchand, S., Picard., M., Pons., A., Schüttler A. & Thibon, C. (2020). Recent advancements in understanding the terroir effect on aromas in grapes and wines: This article is published in cooperation with the XIIIth International Terroir Congress November 17-18 2020, Adelaide, Australia. Guest editors: Cassandra Collins and Roberta De Bei. OENO One, 54(4), 985-1006. https://doi.org/10.20870/oeno-one.2020.54.4.3983

3 Carbonneau, A. (2007). Théorie de la maturation et de la typicité du raisin. Le Progrès agricole et viticole, 124(13), 275-284.

4 Lytra, G., Tempere, S., Zhang, S., Marchand, S., de Revel, G., & Barbe, J. C. (2014). Olfactory impact of dimethyl sulfide on red wine fruity esters aroma expression in model solution. Journal International des Sciences de la Vigne et du Vin, 48(1), 75-85. https://doi.org/10.20870/oeno-one.2014.48.1.1660

5 Parker, A. K., García de Cortázar-Atauri, I., Gény, L., Spring, J.-L., Destrac, A., Schultz, H., Molitor, D., Lacombe, T., Graça, A., Monamy, C., Stoll, M., Storchi, P., Trought, M. C. T., Hofmann, R. W., & van Leeuwen, C. (2020). Temperature-based grapevine sugar ripeness modelling for a wide range of *Vitis vinifera* L. cultivars. Agricultural and Forest Meteorology, 285–286, 107902. https://doi.org/10.1016/j.agrformet.2020.107902

6 Garbay, J., Cameleyre, M., Le Menn, N., Barbe, J.-C. & Lytra, G., 2022. How does aromatic composition of red wines, resulting from varieties adapted to climate change, modulate fruity aroma? TerClim 2022, 14th International Terroir Congress and 2nd ClimWine Congress, 3-8 July 2022, Bordeaux.

7 Carbonneau, A., Champagnol, F., Deloire, A., & Sévila, F. (1998). Récolte et qualité du raisin, 647-668. C. Flanzy, Œnologie. Fondements scientifiques et technologiques.

8 Bindon, K., Holt, H., Williamson, P. O., Varela, C., Herderich, M., & Francis, I. L. (2014). Relationships between harvest time and wine composition in Vitis vinifera L. cv. Cabernet Sauvignon 2. Wine sensory properties and consumer preference. Food Chemistry, 154, 90-101. https://doi.org/10.1016/j.foodchem.2013.12.099

9 van Leeuwen, C., & Destrac-Irvine, A. (2017). Modified grape composition under climate change conditions requires adaptations in the vineyard. OENO One, 51(2-3), 147-154. https://doi.org/10.20870/oeno-one.2016.0.0.1647

This work is licensed under a Creative Commons Attribution 4.0 International License.