THE VINEYARD • THE WINE • THE HISTORY

# Vigna Gustava

## Barolo

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## King Barolo

*by Bruno Quaranta*

Can a king exist without his castle? What kind exiled fate would befall the Barolo of Vigna Gustava were it not lulled, caressed, even spoiled, season after season, by the Grinzane estate? This fruit of ancient etiquette, agrarian wisdom, magical exchanges between the earth and the sky. This noblest of vines. In this place, as a reminder, as a demand, the footprints of Camillo Benso, Count of Cavour. He achieved Italian unification, his great soliloquy, in part because he was no stranger to a clod of soil, a vine leaf, a barrel, the tragedy of a hail storm; he understood that blessing which could only have come from Dante himself: 'the sun's heat that becomes wine.'

The jewel of the earth that Vigna Gustava sumptuously, tenderly, protectively grows: Barolo. Its nobility goes without saying, likewise its veneration. Didn't a theologian, asks Geno Pampaloni, perhaps call it 'Saint Barolo'? A meditative wine, which: 'escorts one's thoughts toward the mysteries of our being.'

Vigna Gustava, in the Eden of Barolo. A lively lineage: from the Marquis Gustavo, to whom the vineyard owes its name, to Camillo, his statesman brother; from the jurist Pietrino Belli, the sixteen-


IL CONTE CAMILLO BENSO DI CAVOUR
FU DI QUESTO COMUNE
SINDACO OPEROSO E BENEFICO
DAL MAGGIO MDCCCXXXII AL FEBBRAJO MDCCCXLIX
DEVOTO CULTO
DI SACRE IMMORTALI MEMORIE
ALLA TENACIA SECOLARE
DI QUESTE MURA VETUSTE
NE VOLLE PIAMENTE AFFIDATA
LA RICORDANZA
XXIV OTTOBRE MDCCCXCVI

th-century lord of Grinzane, to the Fallettis, the venerable Marquise Juliette Colbert and her consort Tancredi. A *nunc est bibendum* throughout the centuries, a *carpe diem* salvaged from every moment of dissipation, moral phylloxera, sloppiness, amnesia…

It is a hymn to the earth, Vigna Gustava. Here Luigi Einaudi's lesson shines out, that is to say it resounds in its deep, timeless truth: 'Men, families, they did not see themselves as uprooted from the earth, from the home, from the community; these are the very sentiments that give rise to a sense of attachment and devotion to the homeland and a spirit of sacrifice, on which basis only stable States grow.'

The Langhe, which are not lost. Which cannot be lost. From Dogliani, where Luigi Einaudi nurtured his Dolcetto vines, in close, frank and expert dialogue with the Bersia family who managed the vineyard, to Grinzane Cavour, a castle which, as Einaudi himself hoped with 1961 approaching (the centenary of the Unification), was honoured with a 'new life'.

Did Einaudi not say that '*signore*' ('sir' or 'lord') is 'the most beautiful title among the many forms of address that the Italian language possesses'? And so: Lord Barolo, Lords of Barolo. Thus Giovanni Arpino honoured them: 'They will never protect themselves with large enclosures or gates with golden spears like the 'barons' of Reims and Epernay and those incredible '*veuves*' who reign over the vineyards of Champagne: Our 'Lords of Barolo' are more cautious, worn down by ancient derision and distrust, the fatigue of their peasant ancestors still in their bones, they know that the wine they produce is pure gold, but never succumb to a single conceited gesture, steering clear of all theatricals.'

From vineyard to vineyard. Where, between one row and another, the yarn of 'once upon a time' is spun. In the days of the rolling sea, when the sirens sang, when pirates, with or without an eye patch or peg leg, ruled the waves. Awaiting the age of Barolo, which—high praise indeed—'neither muddles your head nor weakens your legs; it sets you up for a calm and dreamless sleep, and the next morning you wake up asking the world for a battle to win'. Did Cavour not remind himself and posterity of this, perhaps, while savouring his Vigna Gustava Barolo?


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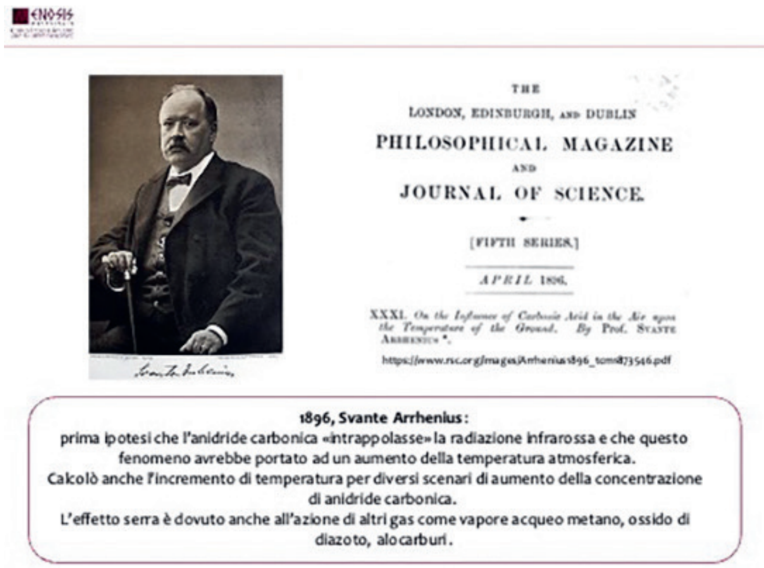
## Climate Change and Nebbiolo

*by Dora Marchi*

Climate change, discussed throughout the wine-growing world for several decades now, presents multiple concerns: a) a general increase in ambient temperature; b) very long periods with high temperatures and low rainfall both before and then during ripening, c) a decrease in the organic content of soil, caused by these events, either due to extreme weather events or inadequate human attention, d) an increase in atmospheric $CO_2$ levels, e) an increase in brightness due to reduced cloud cover, f) an increase in sea temperature and g) the frequency of extreme weather events. These effects are largely attributed to increased levels of greenhouse gases ($CO_2$ and $CH_4$) in the atmosphere.

The first person to hypothesize that carbon dioxide 'trapped' infra-red radiation and that this phenomenon could lead to a rise in atmospheric temperature was Svante Arrenhius in 1896.

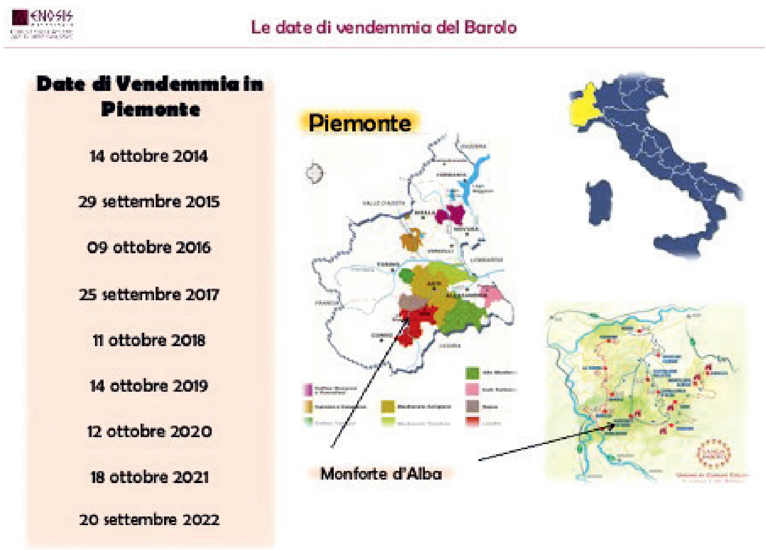
Numerous studies have been conducted in different wine-growing environments to determine the influence of these factors on the metabolism of vines (e.g. production of primary and secondary metabolites at the level of the grape, influence on the metabolism of the vine, and influence on production). The results, however, are somewhat contradictory and suggest that the effects of climate change must be studied and assessed in the context of individual environments. Indeed, the effects of climate change have



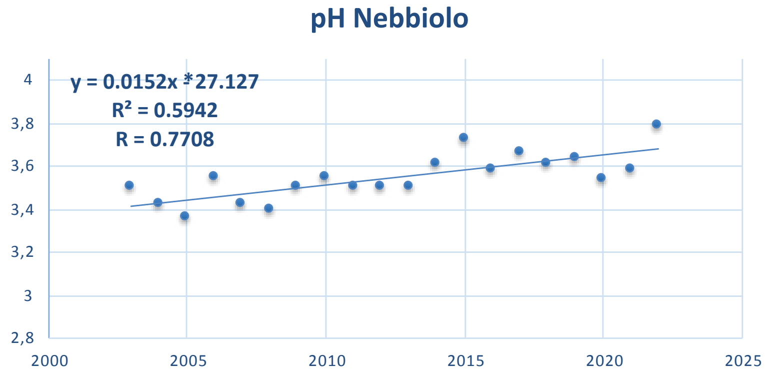

negative results in some environments, and positive results in others. Moreover, the influence of individual variables has only been clear in some cases, since they are usually interdependent, with results depending on how they interact with each other.

One finding in all studies published so far is that vines are flowering earlier and, consequently, fruit is ripening earlier than it did in the mid-twentieth century or even more recently. This is also happening in the Barolo region, where the harvest date has been earlier than usual some years. Earlier flowering means that the spring climate also has an important impact on the period in

which veraison occurs, on the ripening process and, as a result, on the composition of the grapes at harvest.
One major problem that also affects traditional wine production areas is the significant increase in the sugar content of grapes at harvest. This phenomenon is generally accompanied by a drop




in malic acid content and, though not always, a drop in total acidity and an increase in the pH of the must that can be extracted from the grapes. All this means that potential damage to vines and grapes after long periods of high temperatures must also be assessed, taking into account the water conditions of the soil as well. The combination of high temperatures over long periods and water scarcity in the soil causes the highest damage in terms of the composition of the grapes.
Our research in the Barolo territories has shown a significant positive correlation between the year and the pH of the wine




over the last twenty years. Variables such as heat summation (ΣGDD), the number of days with temperatures above 34°C, and the amount of rainfall also had a significant impact on wine pH.

Despite these problems, the quality of Barolo wines has neither varied significantly nor been negatively impacted over the last twenty years, even though some years (2017/2022) were challenging for technicians both in the vineyard and in the cellar.

Generally, in coloured grapes exposed to high temperatures for long periods, we see a decrease in anthocyanin content, compared to the varietal, environmental and annual average. This can be due both to the inhibition of the synthesis of these compounds and to their degradation. However, it has not yet been clarified whether this degradation is heat related or hydrolytic, even if the latter is caused by overheating of the grape. The expression of some genes involved in the flavonoid biosynthetic pathway is inhibited by high temperatures, and this phenomenon is even more dramatic if temperatures are sustained for a long time, meaning that the degradation reactions of individual flavonoid classes may exceed their synthesis reactions. The synthesis of skin flavanols (catechins and polymeric and oligomeric proanthocyanidins) is less affected by extreme heat events than anthocyanin synthesis, as it occurs before veraison when the soil, in certain environments, still has water reserves and when periods of high temperatures are likely to be shorter. In any case, we can also expect to see the influence of high temperatures on the synthesis of flavanols, as the genes that govern their synthesis (up to the action of leucoanthocyanidin reductase, LAR, and anthocyanidin reductase, ANR) are the same as those that govern anthocyanin synthesis. The effects of these events on wine making and wine quality have not been studied in any depth. In heat-stressed grapes, we sometimes see poor extractability of polymer flavanols (tannins), and the wines may be deficient in both anthocyanins and tannins. These phenomena, not yet fully recognized and posing a challenge to wine producers, also require dedicated studies, currently entirely lacking in the oenological literature.

In grapes such as Nebbiolo, where anthocyanins are predominantly disubstituted at the lateral ring, varietal anthocyanic profile fluctuations due to climatic and cultivation factors are far more perceptible. The Nebbiolo cultivar does not have a strong tendency to synthesize anthocyanins and, under certain conditions, the profile can be altered, and the tendency to biosynthesize anthocyanins can be compromised. We can assume that the low anthocyanin content of grapes with a prevalence of disubstituted anthocyanins is due to heat or water stress or both, which is similar to what has been observed in grapes with a prevalence of trisubstituted anthocyanins in semi-arid climate environments where the amount of anthocyanins that can potentially be accumulated is significantly lower than in areas where stress factors are absent or minimized. Indeed, the likely halt in the use of atmospheric $CO_2$ in the photosynthetic process induced by heat stress could explain the reduced synthesis of anthocyanins and probably flavonols. However, the most dramatic effect is that, under extreme climatic conditions, coloured grapes reach a good stage of cellular maturity (commonly referred to as phenolic maturity: the ability of anthocyanins to diffuse in the aqueous phase) when their sugar content is high, total acidity is low, and pH is high. Moreover, highly uneven ripening of the berries has been observed, even among the same cluster. If the proportion of unripe berries is high at harvest, the wine will not only be deficient in anthocyanins, but contain tannins with excessive green astringency. When levels of inhomogeneity are high in terms of the sugar content and total acidity, we run the risk of reaching technological ripeness and the optimum harvest time when some grapes are still unripe (the seeds of unripe berries are still green, and the hydrolytic reactions in the skins and flesh that lead to the release of polysaccharides that stabilize and compete with salivary proteins in binding to tannins have not been completed). Grape variety has a decisive effect on such occurrences. The gap between technological maturity and other types of maturity is mainly due to the fact that technological maturity is an average value and, as such, does not take sample variability into account.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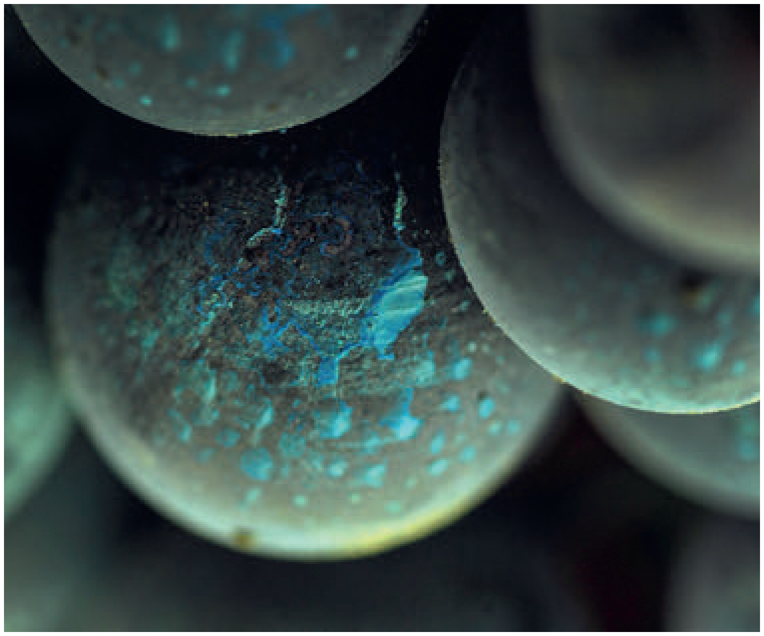
When heat and water stresses occur under bright light conditions (factors which are often closely linked), to defend against UVA rays, cells in the grape skins synthesize flavonols, whose contents may make the wine unstable (quercetin precipitates). This is detrimental to wines lacking in anthocyanins, which oppose the precipitation of quercetin through the formation of soluble anthocyanin-quercetin molecular associations called copigmentation complexes. The quercetin molecule is found in wines and originates from the enzymatic and chemical hydrolysis of its glycoside forms during fermentative maceration and in the wine, respectively. In recent years, in some red wines produced from Sangiovese grapes, significant aglycone quercetin precipitation has been observed in the bottle, making it difficult to market.

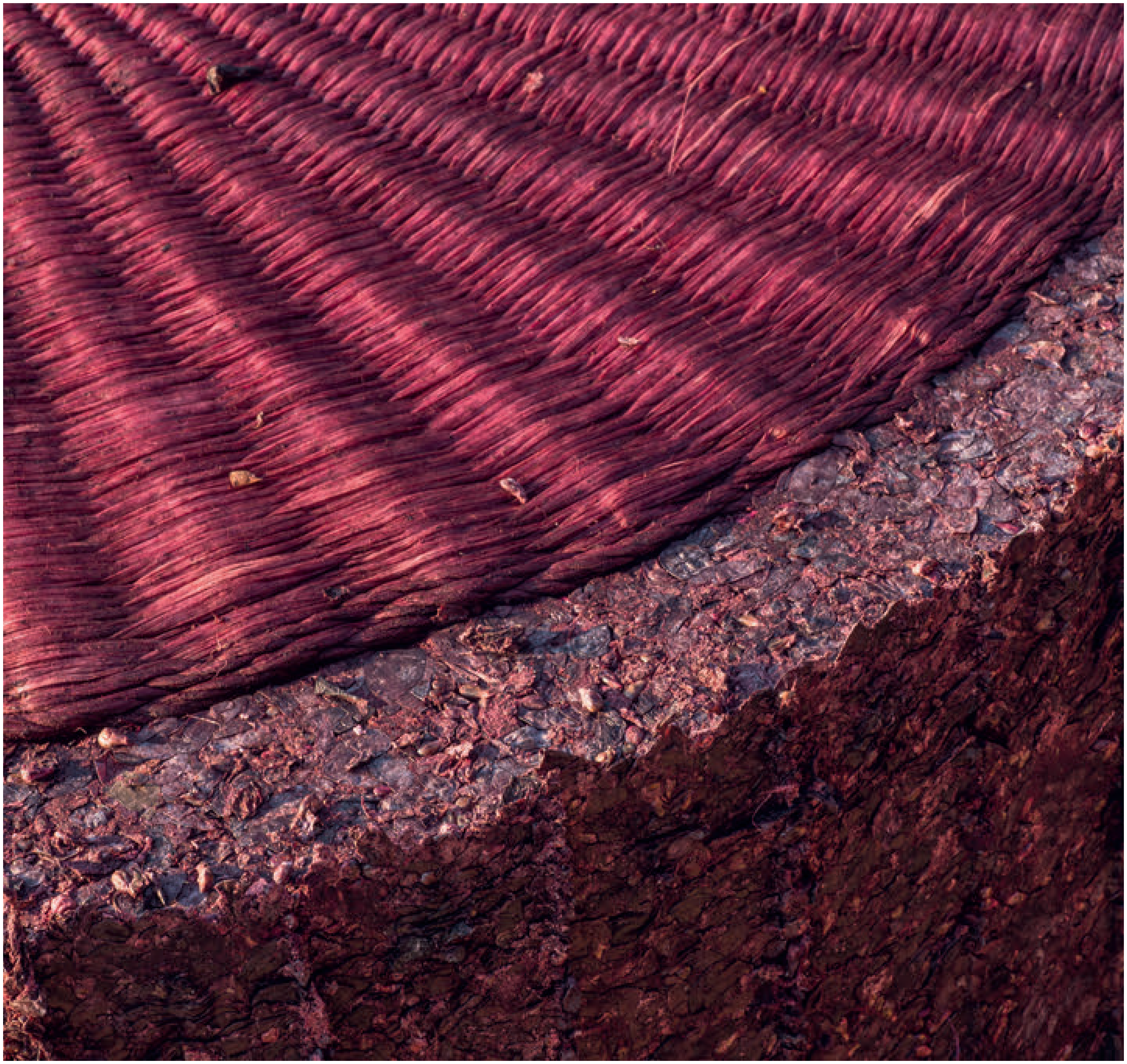
Described many times in Sangiovese wines, this phenomenon is now also affecting other cultivars: in some wines from Nebbiolo grapes in particular, precipitation has occurred, in smaller quantities, at the point where the cork comes into contact with the wine.

The brightness associated with periods of excessive heat, on the other hand, should have a positive impact on the norisoprenoid content of grapes and red wines. Indeed, these compounds derive from the photolytic degradation of carotenes and xanthophylls and are present in the grapes mainly in the form of glycoside polyols which undergo chemical hydrolysis and molecular transformations in the wine, giving rise to compounds with a perceptible aromatic impact.

However, it has been noted that in hot, dry years such as 2017

and 2022, the varietal aromatic potential of Nebbiolo, characterized mainly by norisoprenoids, peaked before the grapes reached their technological and phenolic ripeness and then declined. Therefore, the wines obtained in those years had less varietal aromatic potential than those produced in cooler, rainier years. It is clear that new techniques are required for wines made from grapes that have suffered heat stress for long periods, but that the various national and international research centres are not currently showing an interest in developing them. In conclusion, it is only recently that we have become aware of the dramatic effects of climate change on viticulture and wine making.
There is ample scope for studies aimed at limiting the impact of these phenomena on grape composition and wine quality.





## Nebbiolo: Varietal characteristics

*by Donato Lanati*

La The Nebbiolo grape variety and its traditional areas of cultivation for the production of fine wines is well known, even to those with minimal knowledge of wine. Designations of origin such as Barolo and Barbaresco have always been the standard bearers for Piedmontese oenology, much like Valtellina wines for Lombardy. The Nebbiolo grape variety provides wines of fundamental economic importance for Piedmont, such as Barolo and Barbaresco; wines whose qualitative characteristics derive from the interaction between the known intravarietal variability of the vine and the various soil and climatic characteristics of the many areas in which it is cultivated (terroirs). The wide intravarietal variability of the cultivar is evident in the numerous clonal selections listed in the Registro Nazionale delle varietà di Vite (Italy's national register of vine varieties). Nebbiolo clones vary widely in terms of their morphological characteristics and aptitudes, and therefore the oenological potential of the grapes does as well. The Nebbiolo variety is the ultimate example of the link between grape and territory. The formation of phenolic and aromatic precursors in the grapes, capable of substantially influencing the oenological characteristics of red wines for aging, is in fact closely linked to both genetic and environmental variables. The greatness and the success of Italian wines lie in the unique characteristics of the various territories and the varieties cultivated within them, and the interaction between the two, now firmly established over time.

The Nebbiolo variety is distinguished by the composition of its grapes, commonly used to produce great wines for aging like Cabernet, Merlot, etc. on an international level. Nebbiolo is strongly affected by the environment in which it is grown, so much so that attempts to cultivate it have not been successful in areas, both in Italy and beyond, other than Piedmont and Lombardy, where it produces the best quality results. Nebbiolo is also grown in other parts of the world, such as the United States and Mexico, South America and Australia, but with rather disappointing results.

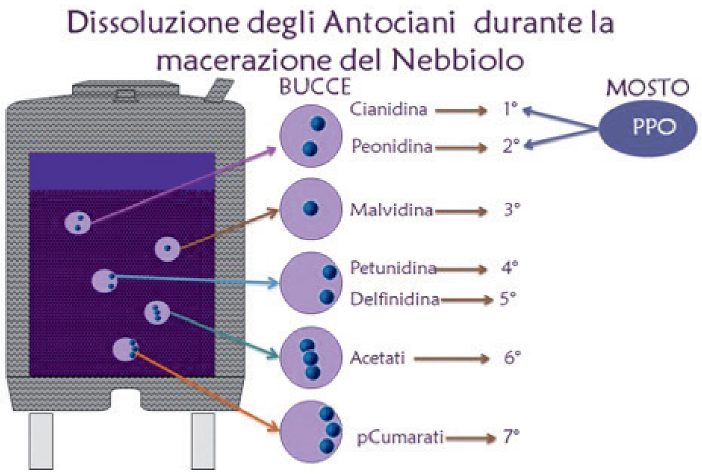
One of the characteristics of Nebbiolo-based wines is without a doubt their colour. The colour of the wine is an important product characteristic, both because of its influence on the consumer and because of its technological implications.

### Nebbiolo anthocyanins: from the colour of the grapes to the colour of the wine

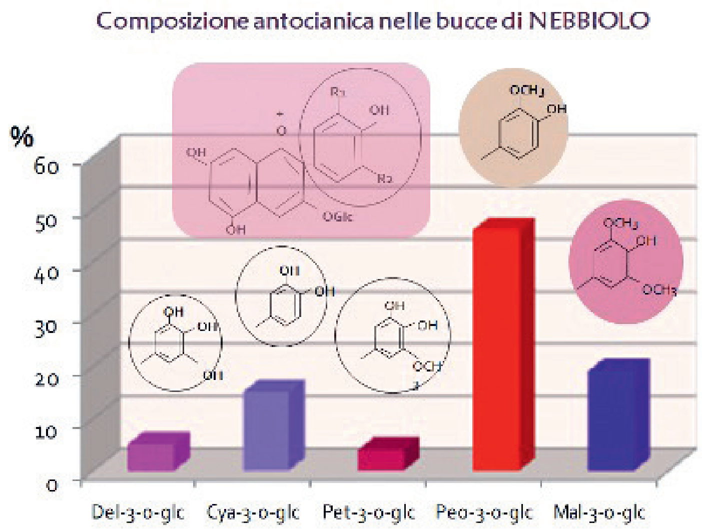
Anthocyanins, water-soluble pigments in the flavonoid family, are found in the skins of grape berries. During fermentative maceration, they pass from the skins to the must, giving rise to the colour of the must and the wine.

The anthocyanins present in the skins of Nebbiolo grapes and other vine cultivars are derivatives of cyanidin, delphinidin, peonidin, petunidin and malvidin. These five anthocyanins are bound to a sugar in position 3 (cyanidin-3-glucoside, delphinidin-3-glucoside, peonidin-3-glucoside, petunidin-3-glucoside and malvidin-3-glucoside) which, in turn, can be esterified with acetic acid, caffeic acid and para-coumaric acid, resulting in acylated anthocyanins (particularly para-coumarates and acetates)

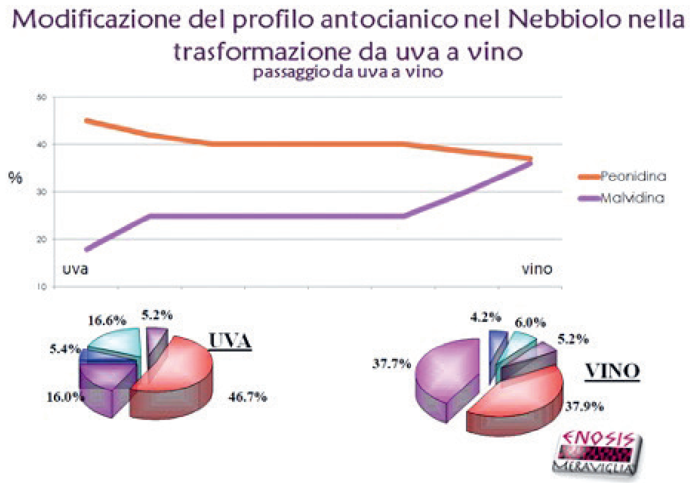
Each coloured-grape variety has a very specific anthocyanic profile. During the fermentative maceration process (for Nebbiolo, this occurs at the pressing stage), anthocyanins pass from the skins to the must and undergo certain transformations, mainly as a result of oxidation reactions. The anthocyanic profile of the wine, compared to that of the grapes, undergoes certain changes based primarily on the variety and partly on the wine-making technique. During maceration, the 3-glucosides of cyanidin, peonidin and malvidin are the fastest of the anthocyanins to diffuse from the skins to the must: their containing cell structures have a lesser hold on them since the chance of weak bonds forming with them is smaller. However, the 3-glucosides of cyanidin and peonidin are also the fastest to decline, in the first stages of vinification; crushing introduces high levels of oxygen, which causes the oxidation of cyanidin-3-glucoside in particular through enzymatic reactions mediated by polyphenol oxidases (catecholases and cresolases acting on the substrates p-coumaryl tartaric acid and caffeoyl tartaric acid). The 3-glucosides of delphinidin and petunidin, with more substituent hydroxy groups at the lateral ring (i.e. a greater chance of weak bonds forming with cell structures), only pass into the must later (after the yeasts have consumed the oxygen required for oxidation reactions), and therefore stand a better chance of remaining unchanged in the wine. The malvidin-3-glucoside diffuses from the skins fairly quickly because, with fewer hydroxy groups at the lateral ring, it is retained to a lesser degree. For the same reason, and because ortho-quinones cannot be formed, it is also the most resistant anthocyanin to oxidation reactions. As a result, it will be present in a higher percentage in the wine than in the grapes. With a greater number of substituent hydroxy groups (at the lateral ring of the anthocyanins and the benzene ring of the p-coumaric acid), and owing to the hydrophobic structure of p-coumaric acid, the p-coumarate derivatives diffuse so slowly that they are retained by the skins in significant amounts, unlike the acetate derivatives. As a result, we sometimes see a reversal of the acetate/p-coumarate ratio in the transition from grapes to wine



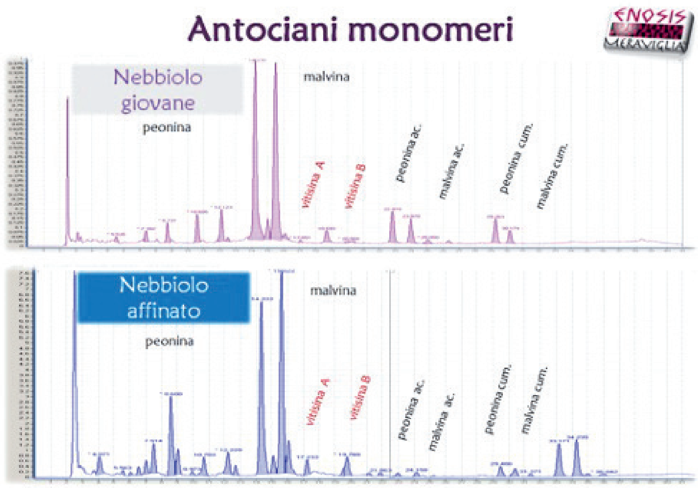

In the anthocyanic profile of the Nebbiolo cultivar, we see more di-substituted anthocyanins (3-glucosides of cyanidin and peonidin) than trisubstituted anthocyanins (3-glucosides of delphinidin, petunidin and malvidin). The percentage of peonidin-3-glucoside (the most widely represented molecule) exceeds that of malvidin-3-glucoside, cyanidin-3-glucoside, petunidin-3-glucoside and delphinidin-3-glucoside (in descending order). The percentage of acylated anthocyanins is around 10% of the total on average, with a prevalence of p-coumarate derivatives over acetates. Of the acylated anthocyanins, peonidin-3-p-coumarylglucoside is the most widely represented.




In the transition from Nebbiolo grapes to wine, we see a significant modification of the varietal anthocyanic profile after the pre-fermentative stage, including a heavy loss of the 3-glucosides of cyanidin and peonidin. Moreover, the percentage of p-coumarate derivatives falls by more than that of acetates. At the end of fermentation, cyanidin-3-glucoside will be around 6%, peonidin-3-glucoside 36%, and malvidin-3-glucoside 40%, with small percentages of peonidin-3-glucoside and delphinidin-3-glucoside.




Wines from Nebbiolo grapes also contain other monomer pigments which are absent in the grapes: these are always derived from anthocyanins by means of reactions with carbonyl compounds from fermentation (acetic aldehyde and pyruvic acid, other keto acids) called vitisins (pyranoanthocyanins). The formation of vitisins begins with fermentation and continues during aging. Pyranoanthocyanin-class pigments are also formed by the reaction between anthocyanins with



other compounds such as vinylphenols and free hydroxycinnamic acids (pinotins) and with vinylflavanols (flavanyl-pyranoanthocyanins). In aged wines, these compounds play a crucial role in stabilizing colour, as they are unaffected by pH changes and the bisulphite ion.

### The tannins of Nebbiolo

The prevalence of anthocyanins disubstituted at the lateral ring has indicated that in the synthesis of these molecules, which starts around the veraison period or, more properly, when the synthesis of flavanols ceases, the dihydroquercetin line prevails over dihydromyricetin. Despite the scarcity or lack of studies on the genes that regulate the prevalence of the two biosynthetic pathways, experimental evidence suggests that they are independent, transitioning from the synthesis of flavanols to that of flavonols and anthocyanin. Indeed, it has been observed that cultivars with a clear prevalence of anthocyanins trisubstituted at the lateral ring possess skin tannins that are low in flavanols trisubstituted at the lateral ring (prodelphinidins). Contrary to what we would expect from a grape with a prevalence of anthocyanins disubstituted at the lateral ring, Nebbiolo skin tannins have a high proportion of flavanols trisubstituted at the lateral ring. This is an interesting feature demonstrated by an increase in the rate of oxygen consumption during wine aging. The rate of oxygen consumption depends on the ability of the flavanols and other phenolic molecules to undergo autoxidation so that ferric iron can be reduced to ferrous iron, and oxygen can continue to be reduced to hydrogen peroxide and hydroxyl radicals; this in turn enables the production of acetaldehyde and the continued production of ethyl-bridged tannin and anthocyanin polymers and ethyl-bridged tannin polymers, which contribute significantly to stabilizing colour and limiting astringency respectively. The nature of Nebbiolo skin tannins should be studied more closely, since the above observations suggest that a change in traditional wine-aging techniques may be in order, based on limited contact with oxygen to protect the wine's limited anthocyanin content. Nebbiolo seed tannins, on the other hand, are not substantially different from those of other cultivars. They are flavanols disubstituted at the lateral ring; the percentage of galloylated molecules (which have the highest astringency) among the constituent monomers depends on the level of ripeness achieved by the grape. As a late grape, the much earlier harvesting required by the current climatic conditions may lead to elevated proportions of free and constituent galloylated monomers.

### The aromas of Nebbiolo

Wine aroma is produced by the presence of several hundred volatile compounds belonging to different chemical classes, whose respective concentrations vary from a few nanograms to a few milligrams per litre. In a wine, we find both free molecules and non-volatile glycosylated compounds that form during the ripening of the grapes and which are important precursors of compounds with a high olfactory impact. These glycosylated compounds belong predominantly to the class of norisoprenoids, terpenes and benzenoids, and are useful indicators for varietal characterization of the cultivar. The main varietal ratios are unconnected to environmental variables and remain fairly constant over the years.

The total concentration of these glycosylates constitutes the varietal aromatic potential of the cultivar, a parameter closely related to the quality of the grapes. In non-aromatic grapes like Nebbiolo, much of the aromatic potential is made up of norisoprenoids, a class of compounds formed by the photolytic (and oxidative) degradation of carotenes and xanthophylls. Vomifoliol, 3-oxo-Σ-ionol and 3-OH-Σ-damascone are some of the most numerous polyhydroxylated norisoprenoids in Nebbiolo grapes. Geraniol is the most typical of the terpene compounds, along with hydroxygeraniol and hydroxylinalool, while dihydroconiferyl alcohol is the most typical alcohol. With Nebbiolo grapes, you need a very high varietal aromatic potential to begin with in order to obtain high-quality, long-lasting wines such as Barolo which retain the typical characteristics of the grape over time. To achieve this, you must be able to recognize the optimum time to harvest the grapes, making the most of technological and phenolic maturity data combined with data on aromatic maturity.

The aromatic profile of a wine produced from Nebbiolo grapes is characterized by the presence of free volatile compounds formed primarily during alcoholic fermentation, such as alcohols, the acetic esters of superior and pre-fermentative alcohols, the ethylic esters of medium-chain fatty acids and of hydroxy acids, and medium-chain fatty acids, with important changes occurring during malolactic fermentation and especially during aging, when molecules interact with each other to form new compounds. It also features, in free form, varietal compounds with low olfactory thresholds formed by the hydrolysis of glycoconjugate precursors derived from the grapes. These include norisoprenoid derivatives such as Σ-damascenone (note of exotic fruit), Riesling acetal, actinidols and vitispiranes.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