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EFFECT OF CLIMATE CONDITIONS ON THE RIPENESS QUALITY INDICATORS OF SOME RED GRAPES FROM VALEA CĂLUGĂREASCĂ VINEYARD

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Abstract

Grape maturation is a very complex biochemical process which influences wine quality. During maturation, grapes accumulates the sugars content, polyphenols, flavors, nitrogenous compounds, mineral substances, enzymes, vitamins, and other chemical compounds that participate in the formation of the wine quality. Grape maturation is strongly influenced by climatic conditions, so the quality of raw materials for wine varies widely from one year to another, from one vineyard to another. The aim of the present work is o evaluate the effects of pedo climatic influence of the year 2017 on grape maturation and quality parameters for 3 red cultivars in Valea Călugărească vineyard. For this purpose, three grapes cultivars: Cabernet Sauvignon, Merlot and Fetească neagră were analised from characteristics such us : sugar content, total acidity, 1000 grain weight , glucoacidimetric index. The experimental measurements were conducted during august-september of 2017 year. The research established the relation between the heliothermal regime of those year and quality indicators of the raw material for obtaining a good technological, phenolic and aromatic maturation for a superior quality of red wine.

Key words*: glucoacidimetric index, grapes characteristics, grape maturation, sugar content, total acidity.*

INTRODUCTION

Wine is a complex matrix which contains many classes of compounds like sugars, alcohols, acids, tannins, and other components like minerals and proteins. Its composition is influenced by many factors related to the specific production area, like grape variety, soil and climate, ripening of the grapes, yeasts, and winemaking technique (Gonzálvez et al., 2009; La Torre et al., 2006).

There are various reasons for which the concentrations of some major and trace elements in wines are further monitored (Geana et al., 2014). Some of them are related to the effects these elements may have on the organoleptic properties of the wines (Lara et al., 2005) and to their ability to discriminate wines according to the geographical region in which grapes were grown (Geana et al., 2013) as well as to detect wine adulteration (Geana et al., 2014).

The presence of phenolic substances in wine and the pedoclimatic conditions are fundamental, these being a major contributor to the formation of specific characteristics such as color, aroma, and flavor, making the difference between different assortments of wine (Mitic et al., 2010).

For these reasons, there is an increased tendency to study the wine composition in its minor constituents with the aim to achieve better characterization, contributing thus to the commercial enhancement of the product (Geana et al., 2014).

The type and concentration of the phenolic compounds in wine depends on grape variety, ripening, atmospheric conditions, viticulture and winemaking techniques. Generally, the major determinant factor for the variation in the polyphenolic content of different red wines throughout the world is probably the amount of sunlight to which the grapes are exposed during cultivation (Geana et al., 2011).

To determine the optimum moment to harvest red wine grapes, as well as the sugar/acidity ratio (technological ripeness), it is also important that the grape has a high concentration of easily extractable phenolic compounds in the skin, such as anthocyanins and tannins, and that the seeds have a hard-outer coating (Cuzmar et al., 2018).

The optimum moment to harvest red wine grapes is therefore defined by technological and phenolic ripeness (Ribereau-Gayon et al., 2006).

Maturity could be described as the time when the analytical parameters such as sugar content, acidity, and other compounds reach the proper balance, and the varietal characteristics, including aroma, flavor and color are fully developed for the style of wine to be produced. The determination of harvest time is a complex compromise between availability of harvesting labor or a mechanical harvester, the weather, the likelihood of pest and disease damage, and the stage of ripeness of the grapes. Timing is most critical when all the fruit is harvested concurrently since only rarely is it economically feasible to selectively and repeatedly harvest for fruit of a particular quality for winemaking. The best harvest decisions are made by grape growers and winemakers who work closely together using a practical, integrated approach toward maturity assessment[1].

The objectives and goals of the work is to study the effects of pedoclimatic influence of the year 2017 on grape maturation and quality parameters for 3 red cultivars in Dealu Mare region. The aim of this study was to quantify the different components during the maturation process of Cabernet Sauvignon, Merlot and Fetească Neagră grapes grown in Valea Călugărească vineyard center, from the beginning of maturation until harvest to verify whether they meet the requirements to produce high-quality wines.

MATERIALS AND METHODS

Most varieties for wine grapes fall into maturation in seasons like IV and V. The period of grapes ripening is 45-50 days (second half of August-September month) that harvesting grapes period begins after the 15th to the 20th of September.

Technological ripeness

The maturation process is followed from the entrance of the first fruits in grape (early ripeness) by taking periodic samples of the grape who are analysed in the laboratory.

At the beginning of ripening, grape samples are taken from 5 to 5 days, and as the aging process progresses, samples are taken more often from 3 to 3 days. The sample of grapes come from at least 10-20 stocks of plot, located in various points. There are taken small portions of bunches from the grapes who are in the middle of the hub, grapes on the sunny side and the ones inside the hub.

Sampling is taken in plastic bags where a label is insert, with the following characteristics: variety from which the sample is taken, in our case from Cabernet Sauvignon, Merlot and Fetească Neagră; date of harvest; the name of the place where the plantation is; any data on plantation. Samples of grapes are brought on the same day in the laboratory to be analysed.

Sample analysis consists of the following determinations: weight of 100 grains, total sugar content and acidity of the grapes and glucoacidimetric index. First is proceeded to detaching bunches grain from residues by cutting with laboratory scissors above grape grain burelet so the berries remain intact and not lose the juice.

Healthy grapes berries are counted, separating the healthy from the damaged ones. Grapes berries are weighted at technically, laboratory balance setting the weight of 100 berries.

After weighting the berries are crushed in gauze bag and by hand squeezing the must is divided. Must collection is made in conical flasks Erlenmeyer glasses which then are kept in the fridge for 2-3 hours for clarifying the wine pressing. From the clear must, unfermented, are determined the total acidity and total sugar content. The sugars content is determined out by refractometer method. The total acidity is determined by the titrimetric method, neutralizing the acidity of the must with a 0,1 N NaOH solution in the presence of bromothymol blue indicator.

The tests are listed in the register of laboratory and the graphs are drawn based on their maturing varieties.

Starting from the fact that the sugar content of grapes during maturation moves backwards with the total acidity, for determining the ripeness degree was considered the report sugars content/total acidity (S/A):

Glucoacidimetric index (S/A) = Sugars (%)/ Total Acidity (g H_2SO_4/l)

[1] Vineyard and Vintage view, July/August (1995), *10*(4), 325.

Glucoacidimetric index values in the full maturation of the grapes are between 35-45, depending on the variety. Between these limits the grapes values have reached optimum degree of maturity that insures good quality wines.

Phenolic ageing

The rich grape phenolic compounds (anthocyanins, tannins) is a technological condition for insuring the quality of red wines.

When colored grapes (black) have reached ripeness, peeled grains make up cell membranes to disrupt through the action of enzymes and let to distribute in must (juice grapes) the colorants materials, so the grapes are makeing phenolic maturation.

Seed maturity is a controversial concept because oenologists often wait too long for the grapes to reach this hypothetical maturity stage and excessively delay the harvest without achieving any advantages (Casassa et al., 2013) suggested that delaying harvest to achieve seed browning may be a relatively lesser factor affecting tannin extraction during maceration. This controversy springs from a confusion between seed browning and seed maturity; the former is related to a chemical composition as well as to representative colour, and the latter to acoustic and mechanical properties (Torchio et al., 2012), seed texture (Le Moigne et al., 2008), chemical properties (Kennedy et al., 2000), as well as seed colour properties (Ristic & Iland, 2005).

RESULTS AND DISCUSSIONS

Valea Călugărească vineyard center shows viticulture potential for the culture of vine varieties to obtain high-quality red wines. For the elaboration of the study concerning the climate, vineyard center have used data recorded at the meteorological station Valea Călugărească (latitude 44º59', longitude 26º13', altitude 210 m).

The global radiation, considered as the most important factor of climate, in its viticultural center Valea Călugărească has some annual values ranging around 125 kcal/cm^2.

The highest values of global radiation records during the warm year (April-September), varies around 92.5 kcal/cm^2 horizontal surface.

The number of insolate hours totalling the average amount in 2071 hours by year providing a normal ripening grapes and wood chords.

Pluviometric data indicate the average annual amount of precipitation being between 510-590 mm, with large variations in them from one year to another.

Distribution of rains during the vegetation period is uneven, in May-June a single maximum rainfall. Hail falls fairly infrequently, but can produce significant damage.

From the ecoclimatic point of view, the year of 2017 was characterized by a moderate regime heliothermic, against a background of rich water resources, especially in April and May, when it was overcome multiannual values.

The vegetation period (April), it started with temperatures lower than the normal (10.9ºC to 11.7ºC), and a higher water regime (107 l/m^2 to 44.8 l/m^2), confronted with multiannual values.

Air wettability in 2017 year was higher by 1.3% in April, with 0.6% in June, by 7.7% in July and 1.6% less in May, and by 4.3% in August (Table 1) compared to the previous year.

Tabel 1. Rainfall, wettability during the period April - October 2017

Year	Month	Precipitation (mm)		No days with rain	Hygroscopicity %	
		Normal	IV-X 2017	>10	Normal	IV-X 2017
2017	IV	44.8	107.0	9	67.7	68.3
	V	67.3	56.4	9	68.4	65.9
	VI	81.5	84.7	6	70.1	69.5
	VII	75.8	86.6	11	67.5	71.0
	VIII	62.7	36.4	6	66.5	61.1
	IX	54.4	40.2	9	70.7	65.3
	X	46.2	86.8	4	77.0	76.4

The optimal time for harvesting the grapes was established both by the weight of the berries and grapes glucoacidimetric index (sugar levels to acidity). At first these indices were followed up by 5 to 5 days, then with 5-6 days before harvesting, the grapes were pursued every day (maturation stroke).

Vintage achieved optimal time when the weight of 100 grains reached the maximum value, the acidity of the grapes won't change, and the

sugar level from the berries has not increased for 2-3 days.

All these factors can be found in experimental records below (Tables 2, 3, 4, 5):

Table 2. Ripening grapes on 24.08.2017

No.	Variety	Parcel	Characteristics of grapes			
			Sugar (g/l)	Total Acidity (g/l H_2SO_4)	W 100 berries (g)	Glucoacidimetric Index
1	Cabernet Sauvignon (CS)	4406	140.80	7.09	119.19	20
2	Cabernet Sauvignon (CS)	4403	155.60	6.90	109.27	23
3	Cabernet Sauvignon (CS)	4409	153.50	6.52	103.42	24
4	Merlot (M)		187.50	4.10	122.04	46
5	Fetească Neagră (FN)		155.60	4.92	110.45	32

Table 3. Ripening grapes on 30.08.2017

No.	Variety	Parcel	Characteristics of grapes			
			Sugar (g/l)	Total Acidity (g/l H_2SO_4)	W 100 berries (g)	Glucoacidimetric Index
1	Cabernet Sauvignon (CS)	4406	150.00	6.04	120.00	25
2	Cabernet Sauvignon (CS)	4403	172.60	5.65	107.86	31
3	Cabernet Sauvignon (CS)	4409	160.00	6.15	105.00	26
4	Merlot (M)		174.80	4.44	97.70	39
5	Fetească Neagră (FN)		179.00	4.34	135.69	41

Table 4. Ripening grapes on 07.09.2017

No.	Variety	Parcel	Characteristics of grapes			
			Sugar (g/l)	Total Acidity (g/l H_2SO_4)	W 100 berries (g)	Glucoacidimetric Index
1	Cabernet Sauvignon (CS)	4406	168.00	5.30	120.00	32
2	Cabernet Sauvignon (CS)	4403	172.60	5.07	113.43	34
3	Cabernet Sauvignon (CS)	4409	183.30	4.35	114.09	42
4	Merlot (M)		225.80	3.04	132.92	74
5	Fetească Neagră (FN)		189.60	3.72	151.30	51

Table 5. Ripening grapes on 14.09.2017

No.	Variety	Parcel	Characteristics of grapes			
			Sugar (g/l)	Total Acidity (g/l H_2SO_4)	W 100 berries (g)	Glucoacidimetric Index
1	Cabernet Sauvignon (CS)	4406	182.3	4.40	119.24	41
2	Cabernet Sauvignon (CS)	4403	202.40	4.63	118.47	44
3	Cabernet Sauvignon (CS)	4409	183.30	4.35	114.09	42
4	Merlot (M)		225.80	3.04	120.98	74
5	Fetească Neagră (FN)		189.60	3.72	157.71	51

From the point of view of grape maturation the following results have been registered:

- Following the dynamics of grape ripeness by setting specific parameters we concluded that the highest accumulation of sugar was recorded in Merlot, which achieved the maximum on the 14.09.2017, 225.8 g/l (Table 5). Over a period of 13 days, Merlot has accumulated 38 g of sugar, a daily average of about 3 g/l. Regarding Cabernet Sauvignon grapes the accumulation are slower, fact that made the grape harvest to start later compared to other black varieties.

- The total acidity expressed in g/l H_2SO_4 with sugar content pursue the ripening evolution of grapes. Acidity reduction is quantitatively the most important biochemical process that occurs in grapes during maturation. In the variety Cabernet Sauvignon we may notice a decrease in acidity from 7.09-6.52 g/l H_2SO_4 (Table 2) up to the target of 4.63-4.35 g/l H_2SO_4 (Table 5). For Merlot variety a significant decrease can be observed up to 3.04 g/l H_2SO_4 (Table 4), which was maintained constant for 7 days - 3.04 g/l H_2SO_4 (Table 5). For Fetească neagră total acidity decrease became constant, from values of 4.92 g/l H_2SO_4 (Table 2) up to 3.72 g/l H_2SO_4 (Table 4), and the value remains the same after a week. The lowest total acidity was registered to Merlot variety.
- Weight of 100 berries is an important parameter in determining the optimum date for harvesting grapes and it must reach the maximum. Both Cabernet Sauvignon and Fetească neagră are reaching increase values from 114.09 to 118.47 g Cabernet Sauvignon (Tables 4 and 5) and 157.71 g Fetească neagră (Table 5). Merlot increased from 97.70 g (Table 3) to 120.98 g (Table 5).
- Values of glucoacidimetric index are between 35-45 which indicates a full maturity of the grapes, as demonstrated by the experimental measurements carried out, so: for the Cabernet Sauvignon and Fetească Neagră the values are starting from 20.32 (Table 2) to 31.41 (Table 3), reaching a maximum at 42-44 for Cabernet Sauvignon (Table 5) and 51 for Fetească neagră (Table 5). Merlot maximum values are recorded to 74 (Table 4 and Table 5).

To highlight the degree maturation of grape varieties under study I prepared the schedule of ripening-indicating the weight evolution of berries, accumulation of sugars and the reduce of the acidity from grape Figure 1 to Figure 4.

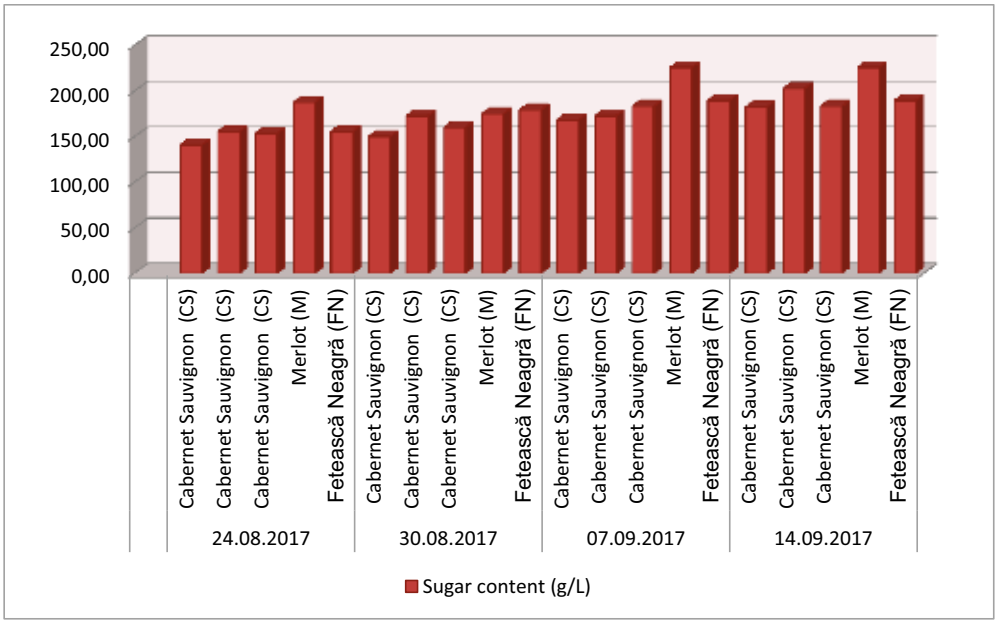

Figure 1. Graphical representation of grapes sugar content (g/l) from august-september 2017

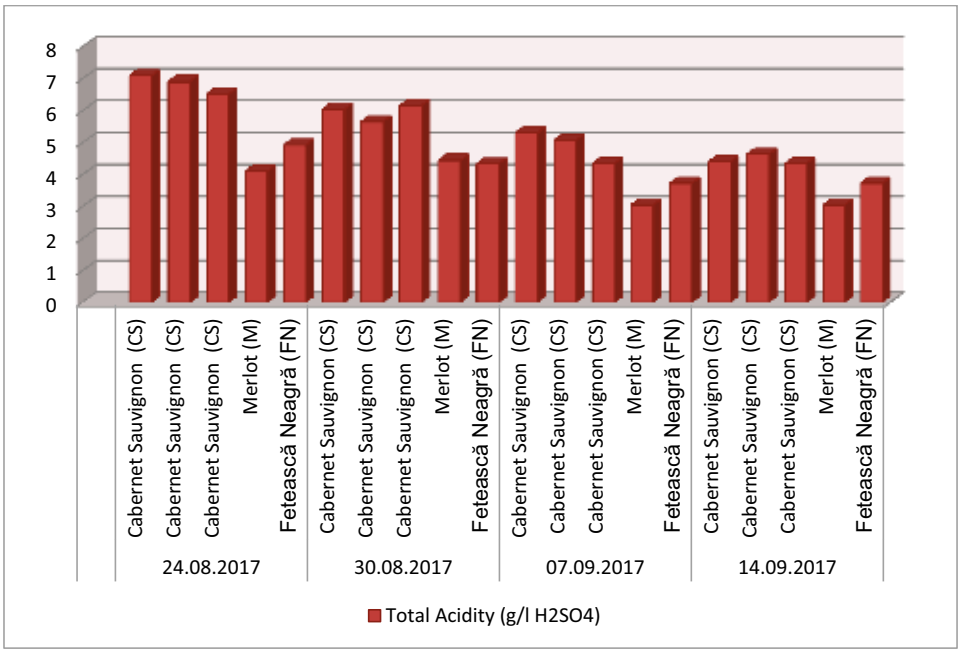

Figure 2. Graphical representation of grapes total acidity (g/l H_2SO_4) from august-september 2017

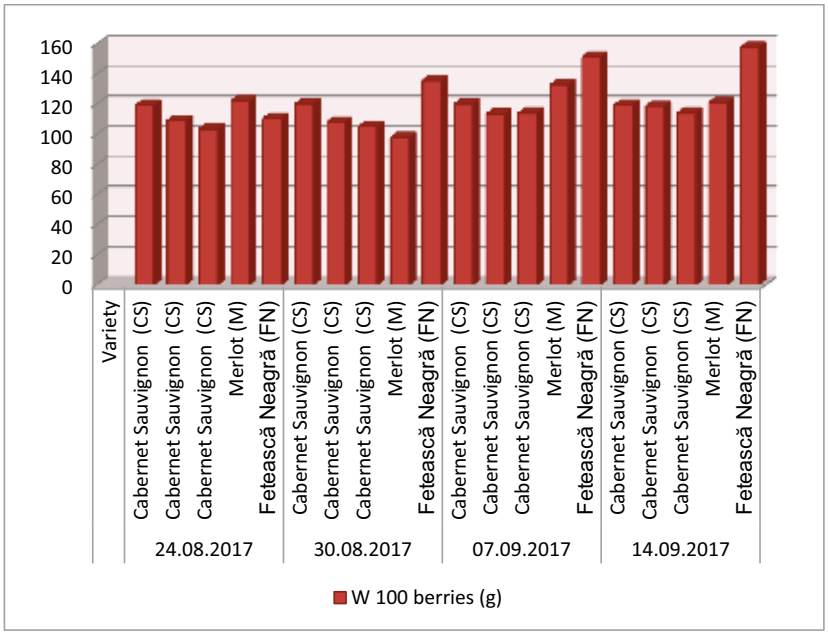

Figure 3. Graphical representation of grapes W 100 berries (g) from august-september 2017

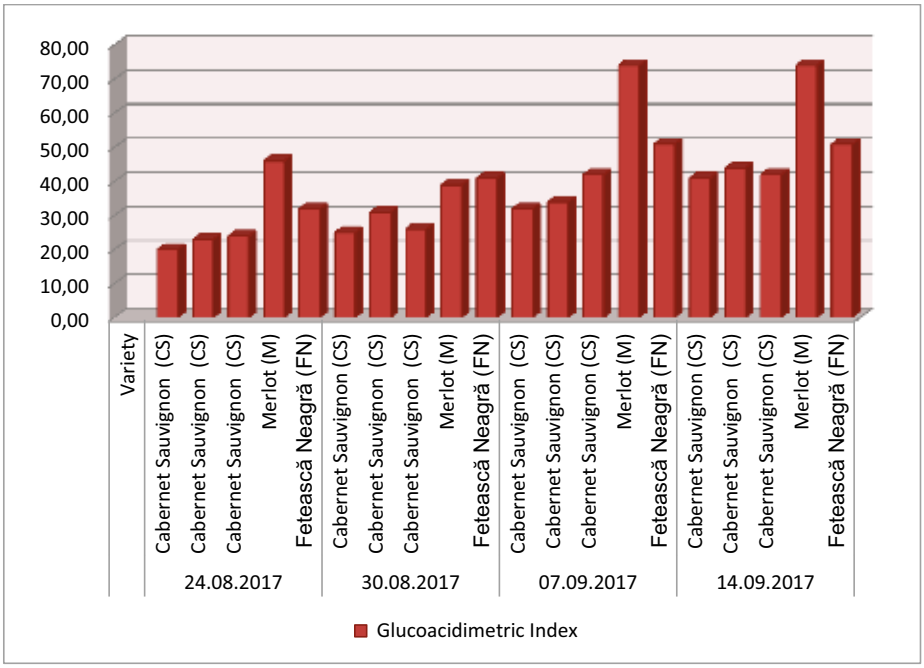

Figure 4. Graphical representation of grapes glucoacidimetric index from august-september 2017

Full maturation of the grapes (MF) is when the grapes reached their maximum weight and curve of evolution begins to descend; grape sugar content is also the maximum (Figure 1) and the curve of evolution of sugar remains stationary for a few days; total acidity decreesed substantially (Figure 2) and evolutionary curve indicating a slow decrease acidity.

In the full ripeness of the grapes the largest as the maximum weight of the grapes is reached (Figure 3). Any delay harvest thereafter translates into loss of production (harvest).

A combination of sugar and acid concentrations are generally used to determine whether the grapes have reached optimum ripeness (Falcao et al., 2008). Environmental factors are important to obtain high quality *V. vinifera* grapes for winemaking. The wine style that a region produces is the result of the specific local climate and soil characteristics. Climatic changes therefore have the potential to bring about changes in wine styles (Falcao et al., 2008).

Grape berries, like other berry fruits, undergo a complex series of physical and biochemical changes during development (Deluc et al., 2007) as we can see from the presented measurements.

The grape berries mass during maturation is correlated with sugar accumulation, availability of water in the soil and atmosphere, and the number of seeds. Smaller fruits ultimately release larger quantities of minerals including potassium, calcium, and magnesium, which greatly influence pH and total titratable acidity. Smaller grapes berry also affect the organoleptic characteristics of the wine due to the release of high quantities of tannins, which are present in large concentrations in the seeds and may turn the wine astringent (Conde et al., 2007).

CONCLUSIONS

Valea Călugărească vineyard centre belongs to a temperate climate, with the most warm month temperature (July) with more than 22ºC and a maximum rainfall in early summer.

Thermal regime is characterized by annual average temperatures of 10.4-10.6ºC and a sum of active temperatures ranging between 3300-4040ºC.

Autumns are generally warm, dry and quite lengthy, which allows carrying out in good conditions of the process of maturation of the grapes and coloring substances accumulation in red wine varieties.

Winters are relatively short, the average temperature of the coldest month of stage (January) being -2.1ºC. Number of days that records average temperatures more than 10ºC varies between 175-226 days/year.

Grapes varieties reach maturation stages according to their biological nature and the evolution of climate conditions of that year.

Grape maturation has three main aspects: technological maturation (refer to the accumulation of sugars in the grapes and to reduce acidity); phenolic ripeness refers to the accumulation of anthocyanins and tannins in grapes; aromatic maturation refers to the accumulation of the primary grape flavors.

Winemaker technologist who is interested in obtaining good quality wines follows the evolution of ripening grapes, in order to determine the best time to harvest.

In red grape varieties, the polyphenol composition can be perceived as the key element that significantly differentiates the final products, considering their specific agro-biological characteristics, in conjunction with the biosynthetic pathways of phenolics. Therefore, the harvest stage, the temperature, the duration of the maceration-fermentation process, and the winemaking technique are among the factors involved in the quality of the resulting product (Palade & Popa, 2018).

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