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FOUNDATION OF RED WINE MAKING STRATEGIES ON ASSESSMENT OF GRAPES MATURATION AND MATURITY

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Abstract

The maturation and maturity of the grapes are concepts which in recent decades have gained knowledge and approaches. In the classical system the maturation was considered as a process of accumulation of sugars in the grape followed by the modification of their appearance and weight, while in the present, grape maturation is clearly differentiated from grape maturity. The maturation of the grape represents a dynamic mathematical model of the compounds with enological value, while the maturity is a moment during the grapes evolution which is characterized by an enological potential. The researches were conducted during 2007–2013 period at the Research and Development Institute for Viticulture and Enology, Valea Calugareasca, located in the Dealu Mare viticultural area. The experimental device was organized in 4394 vineyard parcel representing a collection of varieties from Valea Calugareasca viticultural area wine assortment. The varieties which were taken into study were: 'Burgund mare', 'Cabernet Sauvignon', 'Feteasca neagra', 'Merlot' and 'Pinot noir'. The methodology concerning the maturation and maturity of the red grapes was developed during 2007 year by IC-DVV, Valea Calugareasca. The samples were taken during the ripening process, every 7 days and the following parameters were determined: sugars (g/l), titrable acidity (g/l sulfuric acid), weight of 100 grains (g), glucoacidimetric index, total phenolic potential and anthocyanins. Grape polyphenolic potential has been evaluated at harvest by means of standard Glories method. The information was organized into a database which has the following components: climate, maturation and oenological potential. The processing of information was done by mathematical modeling. The obtained results have allowed the identification and parametrization of the three types of grapes maturation and three levels of enological potential.

Key words: *Maturation, maturity, enological potential, mathematical modeling, winemaking strategies*

INTRODUCTION

In the classical way the maturity of grapes is evaluated by the dynamically analysis of the main compounds in grapes (Dubourdieu et al., 2004; Reynier A., 2007). In most cases these data are presented as such, and therefore the existing basic data remain unexploited. For maturation it is important to define its kinetics and to evaluate the potential of black grapes at harvest at the technological and polyphenolic level. In order to characterize the black grapes maturation kinetics, a parametric model of the grapes sugar content evolution was created by Severin et al., (2010). The model is a sigmoid described by the equation 1.

$$Ts = Tsver + \frac{Ts\max - Tsver}{1 + e^{\frac{t1/2 - japv}{\tau}}} \quad \text{(equation 1)}$$

in which: Ts-sugar content of the grapes; Tsver-sugar content at ripening of the grapes; Tsmax-date on which Ts is Tsmax/2, inflection point of the curve, 1/τ-inflection point of the curve; japv-number of ripening days.

The assignation of the curve for each harvest in a period of time, gave the possibility to determine objectively the similarity between them. The phenolic potential of the black grapes was complexly defined by Glories (2004), which gave information about the content of the grapes in total polyphenols and anthocyannins, the anthocyannins extractibility and the tannins maturity in seeds. The above informations, to which the information related to the technological potential and the basic data of vinification are added, can be used in order to define the style of wine which could be obtained from the grapevine harvest. In the actual context, the maturation of the grapes is represened by the kinetics of the compounds with oenological value, mathematicaly modelated by the t1/2 indicator. The richness of the grapes in such compounds is a basic technological condition in vinification. The evaluation of the phenolic maturation of the

grapes gave the possibility to design the style of the red wines and to modelate the vinification tehnologies of grapes.
The objectives of the study were the following:

- Identification the maturation types of the black grapes for wine;
- Determination the technological potential of the grapes at harvest;
- Analysis the phenolic potential of the grapes at harvest;
- Analysis the quantitative potential of the harvest.

MATERIALS AND METHODS

Five vinifera varieties for red Appellation of Origin Dealu Mare wines from the Valea Călugărească assortment were studied. These varieties are established in the National Collection of the Research and Development Institute for Viticulture and Enology, Valea Calugareasca (Table 1).

Table 1. Variety and origin of the tested wines

Code	Cultivar	Location
BM	Burgund mare	National Collection
CS	Cabernet Sauvignon	National Collection
FN	Fetească neagră	National Collection
ME	Merlot	National Collection
PN	Pinot noir	National Collection

The modeling of grapes maturation kinetics was based on the Tsmax. and $t_{1/2}$, parameters according to Dupin S. et al., (2010). Tsmax. represents the maximum content in sugar registered in the period of the grapevine maturation, while $t_{1/2}$ indicator is the day (Julian day) at which the sugar content reaches half from the maximum amount. Phenolic maturity is defined as a moment when seeds tannins and skin anthocyanins concentrations are minimum and maximum, respectively. It was evaluated according to Glories method (Anneraud C., Vinsonneau, 2009), by using the following parameters: Potential of the extractible antocyanins (ApH3,2); total antocyanins potential (ApH1); Total Polyphenol Index (TPI), Percentage of Anthocyanins Extractibility (PAE%), Contribution of grape seeds tanins (MP) and contribution of grape skins polyphenols (MS).

RESULTS AND DISCUSSION

The grapes maturation kinetics

In the 2007-2013 period, the parameter t1/2 varied between 194 and 217 with an average value of 206. The variation interval of this parameter was in good corelation with the grapes maturation kinetics: when its value was very big (210<t1/2<217), the period of maturation was long, when its value was medium (202<t1/2<209) the maturation was normal, and in case of a low value (194<t1/2<201), the period of maturation was short (Table 2).

Table 2. Defining of the grapes maturation kinetics function of t1/2 indicator

Code	Type of the maturation kinetics	Limit of variation for the t1/2 parameter
KM 1	short maturation	194-201
KM 2	normal maturation	202-209
KM 3	long maturation	210-217

The maturation kinetics is in relation with the harvest. Taking into account the 2007-2013 period the black grapes from the Appelation of Origin Dealu Mare Valea Calugareasca had a rapidly maturation in the 2008 and 2010 years, normal in 2007, 2011, 2013 years and slowly one during 2009 and 2012 years. The frequency of the years with normal grapes maturation kinetics was of 57% percent. The variety significantly influenced the t1/2 parameter of grapes maturation kinetics (Figure 1).

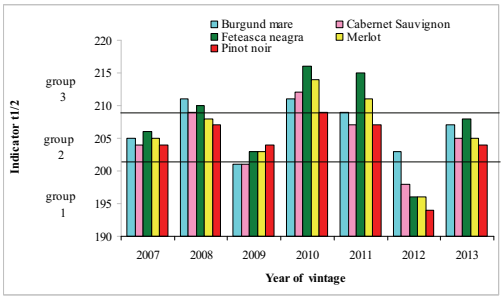

Figure 1. The variation of the t1/2 indicator depending on the variety

The analysis of the primary data conducted to the following: in case of Pinot noir, the t1/2 indicator had an weight of 86% in the group 2, represented by a normal maturation of the grapes at harvest, followed by 'Burgund mare',

'Cabernet Sauvignon' and 'Merlot' varieties with an weight of 57%; a late maturation given by variation of t1/2 parameter in the group 3 was observed with a weight of 43% at 'Feteasca neagra' variety, 29% at 'Burgund mare' and 'Merlot' and 14% at 'Cabernet Sauvignon'.

The technological potential of the grapes at harvest

At the variety level, a strong correlation between the maturation glucoacidimetric index (GI) and the type of the maturation kinetics was identified. In case of 'Merlot', 'Burgund mare' and 'Cabernet Sauvignon' varieties, the value of GI was lower than 45 when the periond of the grapes maturation was short, having values between 45 and 60 in a normal maturation condition and bigger than 60 when the maturation was long (Table 3). In normal maturation conditions, GI ranged between 45 and 55 in case of 'Feteasca neagra' variety and between 40 and 70 for 'Pinor noir' variety.

Table 3. Variation of the glucoacidimetric index function of the vinifera variety and the maturation kinetics

Vinifera variety	Maturation kinetics		
	KM 1	KM 2	KM 3
'Burgund mare'	<45	45-60	>60
'Cabernet Sauvignon'	<45	45-60	>60
'Fetească negră'	<45	45-55	>55
'Merlot'	≤45	45-60	>60
'Pinot noir'	<40	40-70	>70

At the level of each variety, a strong correlation (R^2= 0,98-0,99) between GI and t1/2 was identifiend (Table 4).

The increase of the t1/2 indicator by one unit has determined the increase of the GI with values beteen 1,12 ('Merlot') and 2,00 ('Burgund mare').

Table 4. Modeling of the relation between the glucoacidimetric index and the maturation kinetics parameter t1/2 at the variety level

Code	Regression equation	Determination coefficient
BM	GI=-359,75+2,0016* t1/2	0,9860
CS	GI=-297,10+1,6962*t1/2	0,9808
FN	GI=-212,45+1,2896*t1/2	0,9900
ME	GI=-174,17+1,1204*t1/2	0,9840
PN	GI=-342,57+1,9649*t1/2	0,9926

The phenolic potential of the grapes maturation at harvest

The phenolic potential of the grapes maturation at harvest is in relationship with the grapes maturation kinetics.

The analysis regarding 'Feteasca neagra' variety showed that in case of a low value of the t1/2 indicator (short maturation) the phenolic potential was maxim registering the following values: the amount of the total polyphenols (TPI) 55 UA, the value of the total anthocyanins (ApH1) 1119 mg/l, the anthocyanins extractibility (PAE) 88,2% (987 mg/l) and the maturity of seeds (MS) 29,1%. The report between the amount of polyphenols in the skin and in the seeds was 2,06.

In 2013 year characterized by a normal grapes maturation kinetics, the phenolic potential had au averages value, the content in polyphenolys (TPI) being 42 UA and in total anthocyanins 835 mg/l

From the total amount of anthocyanins, only 55,7% were extractible anthocyanins (465 mg/l). The maturation registered 54,8%, percent in case of the seeds and 45,2% percent in case of the skins (Figure 2a. and Figure 2b.).

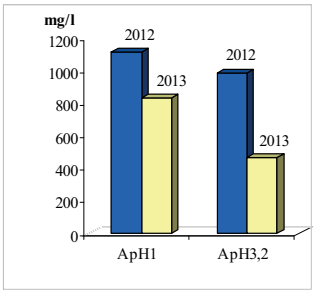

Figure 2a. Influence of the vintage upon the total and extractible anthocyanins content in the grapes, 'Feteasca neagra' variety

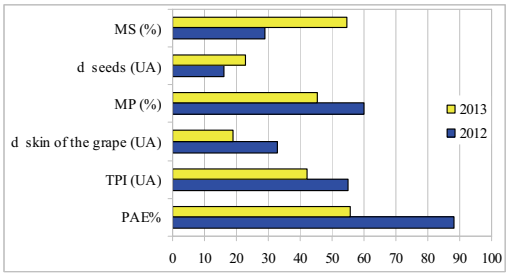

Figure 2b. Influence of the vintage upon the polyphenols and tannins in the grapes, 'Feteasca neagra' variety

Quantitative potential of the harvest

Quantitative potential of the variety is a typical characteristic of the harvest. It is in relation with the average weight of the grape and the number of clusters on the vine (Table 5)

Table 5. Influence of the harvest on the efficiency indicators in case of 'Feteasca negra' variety

Year of vintage	Average weight of the grape (g)	No. of grapes/ vine	Production (Kg/ vine)	Weight 100 grains (g)
2012	115	29	3,34	121
2013	181	26	4,71	138

The highest production (4,71 kg/vine) was registred at 'Feteasca neagra' variety in normal maturation conditions, typical for the 2013 year.

In these conditions, the cluster had an averege weight of 181g and the berry had an average weight of 1,38 g.

When the maturation was short, specific situation for 2012 year, the average weight of the cluster was lower with 66 g, which determined the decrease of the production (3,34 kg/vine).

The adaptation of the vinification technology to the harvest quality

For the enologist, the winemaking methods and multiple enological practices are available. Their theoretical and practical knowledge concerning the influence of each technological element allow to choose that combination which guarantees an optimal exploatation of the enologic potential of grapes.

In order to increase the enological potential of the wines, the vinification of the grapes which have a good enological maturity, can be achieved by using classical method or the method which involve a partial elimination of the grape free-run juice.

CONCLUSIONS

The maturation kinetics of the black grapes with the Appelation of Origin Dealu Mare Valea Calugareasca was evaluated based on the following parameters: the maximum content of sugar in the grapes (Tsmax), the minimum content the sugar in the grapes (Tsmin) and the date on which the sugar content was half from the maximum value (t1/2).

The black grapes maturation kinetics in relation with the harvest was the following: rapid maturation in 2008 and 2010 years, normal in 2007, 2011, 2013 and slowly in 2009 and 2012 years.

The phenolic potential of the grapes at harvest was influnced by the grapes maturation kinetics; the maximum value of the phenolic potential of the grapes at harvest was registered when the grapes had a rapid maturation.

The grapes production is specific to the harvest. In case of 'Feteasca neagra' variety, the grapes production was 4,71 kg/vine in 2013 year and 3,34 kg/vine in 2012.

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