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STUDY OF THE POLYPHENOLIC POTENTIAL OF RED WINE GRAPE VARIETIES CULTIVATED IN DIFFERENT VINEYARD AREAS IN OLTENIA

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ABSTRACT

The basic idea that governs the tracking of the ripening of grapes, in order to determine the time of harvest, is that the grapes harvested at the best time, considered optimal, allow the extraction of the maximum quality from the constituents of the grains (in our case, the maximum of phenolic compounds).

The degree of ripening of the grapes largely determines the must yield during primary vinification, but especially the composition and quality of the resulting wine. A premature harvest leads to a decrease in the must yield, while a delay results in harvest losses and a decrease in the total acidity of the must, both inconvenient situations leading to a decrease in the content of polyphenols.

All these considerations converge towards the final goal, namely, to capitalize as effectively as possible on the oenological potential of the varieties, for the production of quality red wines, polyphenolic and sensorial balanced.

INTRODUCTION

High-quality red wines currently enjoy the highest appreciation from discerning consumers due to their complex chemical composition and the chosen organoleptic properties they present. They are in the attention of hygienists and nutritionists for the beneficial influence they exert on human health (Koyama K., et al., 2023).

The phenolic compounds in horticultural crops have received much attention for their potential contribution to human health due to their antioxidant, antimicrobial, antiviral, and anticarcinogenic properties (Jackson R.S. et al., 2000). In addition, phenolic compounds are important contributors to the organoleptic qualities of fresh fruit, fruit juices, and wine (Cheynier V., 2005).

The richness of grapes in phenolic compounds (anthocyanins, tannins) is a basic technological condition for the quality of red wines (Dixon R.A.& Sarnala S., 2020).

Variable amounts of phenolic compounds accumulate in grapes, depending on the biological nature of the varieties, the ecological conditions of the vineyard and the degree of ripening of the varieties (Koyama K., et al., 2017). When the grapes

are harvested at the optimal time, the conditions for obtaining the best quality wines are created.

Terroir, understood as the environmental, edaphic, and cultural factors of a grapegrowing region (Rocio. B., et al., 2023), can have a great impact on the chemical composition and sensory attributes of young wines and, consequently, on their AP. In turn, factors associated with winemaking (pH, antioxidant concentration, access to O_2, phenolic composition, and ripening conditions, among others) and external factors (aging temperature, closure type, bottle size, humidity, light exposure, etc.) are expected to also have a major impact on sensory changes.

Numerous researches have highlighted the dependence of the amount of pigments in the skin of the berries on: the area of origin, the variety, the climatic conditions of the respective area, the degree of ripening of the grapes (Medina-Plaza C., et al., 2021). It is unanimously recognized that red wines are obtained only in southern vineyards, which have, first of all, plenty of heat and light, factors with a decisive role for the synthesis of polyphenols and especially anthocyanin pigments

MATERIALS AND METHODS

Due to the favorable conditions and the special economic importance of red wines, it was necessary to design a study in this sense and the following objectives were outlined:

a) The study of the variability of the oenological potential of the varieties, depending on the area and the year of cultivation.

b) The study of the dynamics of some quality constituents, but especially of phenolic compounds during the ripening of grapes.

From the assortment of varieties for the production of red wines, the varieties: Cabernet Sauvignon, Merlot, Burgund mare, Novac, Fetească neagră, confer, under the conditions offered by the Banu-Mărăcine (Dolj), Drăgăşani (Vâlcea), Sâmbureşti (Olt), qualitative potential raised.

Drăgăşani, Sâmbureşti and Banu-Mărăcine vineyards meet excellent climate and soil conditions for the biosynthesis of phenolic compounds in grapes, a decisive factor on which the quality and general appearance of red wines depends.

The research of this study was carried out in the vineyards: Banu-Mărăcine (Dolj), Drăgăşani (Vâlcea) and Sâmbureşti (Olt), in the years 2022 and 2023.

In order to achieve the proposed objective, the bushes from the plots cultivated with the varieties: Cabernet Sauvignon, Merlot, Burgund mare, Novac and Fetească neagra, located in the mentioned wine areas, were marked.

In the studied areas, comparative studies were made on the Cabernet Sauvignon and Merlot varieties, but in each area a different variety was studied, corresponding to each separate area, namely: Novac in Drăgăşani, Burgund mare in Sâmbureşti and Fetească neagră in Banu-Mărăcine.

The grape samples consisted of grapes or portions of grapes, harvested from several bunches and from different heights of the bunch, also from the parts of the bunch exposed to the sun and shaded.

For each individual sample, 100 berries were counted, selected and weighed, to follow the ripening of the grapes and to determine the anthocyanins in the skin.

The dynamics of grape ripening was followed based on the evolution of carbohydrate content, acidity and the weight of 100 berries, establishing the moment of full and technological maturity.

The weight of the grains was determined by weighing on the analytical balance 100 grains, previously detached, by cutting from the front part of the burelet.

The method for determining the carbohydrate content was refractometric. The total acidity of the must was determined by the titrimetric method (titration with NaOH n/10 of a sample of 10 ml of must) and was calculated according to the relationship:

$$\text{Total acidity (g/l } H_2SO_4) = N \cdot 0.0049 \cdot 100$$

The proportions of coloring matter in grapes were established based on the anthocyanin extracts from the skins of 100 grapes (weighed with great precision), by the spectrophotometric method (by the pH difference).

The color appreciation was characterized both by the proportions of the different pigments and by the following elements: coloring intensity (Ic), color tonality (Tc) and proportions of flavyl cations (dA%), specific to the anthocyanin "dowry" of each variety. In order to define the chromatic structure of the coloring matter from the grapes of the studied varieties, the optical density was determined at the wavelengths of: 420 nm (corresponding to yellow pigments), 520 nm (corresponding to red pigments) and 620 nm (corresponding to blue pigments).Based on the obtained values, the chromatic properties expressed by: Ic, Tc, dA% were quantified

RESULTS AND DISCUSSIONS

1. Results regarding the main quality constituents of grapes during ripening

A fairly accurate image of the wine's characteristics is revealed by how it evolves, especially carbohydrates, acids and, in our case, the coloring matter expressed through anthocyanins. These categories of chemical compounds in relation to the evolution of the weight of the grapes, which represent, in fact, the production of grapes and it in evolution, through a rigorously scientific conjugation, through their contents can delimit the phenophases of the fallow, full maturity and over ripening, strict benchmarks necessary in establishing the logistics of obtaining different categories of wines.

Recently, in the situation of the production of red wines, which are increasingly demanded by discerning consumers, the phenolic maturity is considered to be a factor of major importance, with reference to the anthocyanin content. This phenolic maturity is positioned in the evolution of grape ripening, different from full maturity, usually in over ripeness. Currently, it is considered that the first factor that conditions the quality of the grapes, from which naturally follows that of the wine, is their state of maturity.

The estimation of the quality of the harvest is done by determining the content in carbohydrates, total acidity and through the prism of the richness in phenolic compounds (especially in anthocyanins).

The main quality characteristics of grapes from different wine-growing areas of Oltenia are presented in table 1.

Table 1

The main quality characteristics of grapes (overripe) from different wine-growing areas of Oltenia

Variety	Vineyard	Year	Carbohydrates g/l	Total acidity g/l (H_2SO_4)	Antocians mg/kg grapes
Cabernet Sauvignon	Banu Mărăcine	2022	217,6	4,45	1291
		2023	214,2	4,83	1095
	Drăgăşani	2022	227,8	4,21	1350
		2023	207,4	5,09	1130
	Sâmbureşti	2022	238,0	4,80	1215
		2023	202,3	5,16	1054
Merlot	Banu Mărăcine	2022	238,1	4,36	1213
		2023	224,4	4,65	982
	Drăgăşani	2022	214,2	4,31	1098
		2023	212,5	5,34	966
	Sâmbureşti	2022	221,0	4,65	1380
		2023	205,7	4,97	902
Fetească neagră	Banu Mărăcine	2022	245,0	3,82	1315
		2023	234,6	4,65	1210
Novac	Drăgăşani	2022	238,0	3,43	1125
		2023	210,8	3,92	1100
Burgund mare	Sâmbureşti	2022	195,5	6,02	1360
		2023	193,8	6,12	1280

In 2022 and 2023, the grape ripening process presented some particularities, depending on the year and the cultivation area.

From the analysis of the data entered in table 1, it can be seen that in 2022, all the varieties presented higher carbohydrate contents, compared to 2023. The carbohydrate content values were (in both years) over 200 g/l, with the exception of the large Burgund variety, with just under 200 g/l (193.8 – 195.5 g/l).

Looking at a comparative analysis of how the Cabernet Sauvignon variety manifests itself in the three wine-growing areas, it is observed that in 2022 the highest values were recorded in the Sâmbureşti vineyard (238 g/l) and Drăgăşani (227.8 g/l). On the other hand, at Banu-Mărăcine, the carbohydrate content values are very close: 214.2 g/l (in 2023) and 217.6 g/l (in 2022).

On the same date, the acidity contents of grapes showed lower values in 2022 (4.21 – 4.80 g/l in H2SO4) than in 2023 (4.83 – 5.16 g/l in H2SO4).

The same can be said about the evolution of anthocyanins in grapes, which register significant increases, 13-15% higher in 2022, compared to 2023.

The highest value of the content of carbohydrates in the Merlot variety is observed in the Banu-Mărăcine vineyard, both in 2023 (224.4 g/l) and in 2022 (238 g/l).

Total acidity registers proportions between 4.65 and 5.34 g/l (H2SO4) in 2023 and 4.31 – 4.65 g/l (H2SO4) in 2022, balanced values, in accordance with the levels set for quality wines superior.

If in 2023, the anthocyanin contents were between 902 and 982 mg/kg grapes, in 2022, they far exceeded 1000 mg/kg grapes (1098 – 1380 mg/kg grapes).

Although Feteasca neagra is not a variety specific to the Banu Mărăcine wine growing area, it still behaves spectacularly, registering very high contents both

in sugars (234.6 g/l in 2023 and 245 g/l in 2022) and in anthocyanins (1210 – 1315 mg/kg grapes).

Among the varieties recently planted in the Drăgăşani vineyard, investigations regarding the technological potential focused on the Novac variety (created at S.C.D.V.V. Drăgăşani).

It is interesting to note that the Novac variety has the high peculiarity of biosynthesizing significant proportions of carbohydrates (210.8 - 238 g/l) and anthocyanins (1100 - 1125 mg/kg grapes), with a titratable acidity of just under 4 g/l (3.43 – 3.92 g/l in H2SO4).

The large Burgund variety, present in the Sâmbureşti vineyard, has values in carbohydrates slightly below 200 g/l but with a slightly higher acidity (≈ 6 g/l in H2SO4) and with high contents of anthocyanins (1280 – 1360 mg/kg berries).

2. Results regarding the chromatic structure of the anthocyanin complex in grapes

It is well known that in high-quality red wines, the typical attractive color in order to satisfy the current requirements for these products, depends not only on the content of coloring matter but also on the chromatic structure of the anthocyanin complex, conferred by the proportions of the different categories of pigments (yellow, red, blue). The proportions of the categories of pigments in the finished products are found in direct relationships with the same components of the red coloring matter of black grapes, but also with the degree of extraction of anthocyanins in the maceration-fermentation process.

Table 2 shows the proportions of different categories of pigments of the coloring matter in grapes, in the phase when their content has reached the maximum level.

On all the varieties and vineyards concerned, the chromatic structure of anthocyanins is dominated by red pigments (DO 520 nm), followed by yellow ones (DO 420 nm) and at a great distance from the blue component (DO 620 nm).

▪ Yellow pigments occupy proportions between 23.2% (Merlot - Drăgăşani) and 27.7% (Cabernet Sauvignon - Banu Mărăcine). Close to the upper threshold of yellow pigments are: Feteasca neagra - Banu Mărăcine (27.4%), Burgund mare - Sâmbureşti (27.3%), Cabernet Sauvignon - Drăgăşani (26.9%).

▪ The red pigments present proportions between 62.4% (Cabernet Sauvignon – Banu Mărăcine) and 68.9% (Merlot – Sâmbureşti). Cabernet Sauvignon - Sâmbureşti, Cabernet Sauvignon - Drăgăşani, Merlot - Drăgăşani, Novac - Drăgăşani also show important proportions of red pigments (with values of 68% or above this threshold).

▪ The blue pigments - on all varieties - present proportions between 4.8% (Merlot - Sâmbureşti) and 9.9% (Cabernet Sauvignon - Banu Mărăcine). Slightly higher contents of blue pigments are found in Merlot - Drăgăşani (8.2%), Merlot - Banu Mărăcine (6.6%), Novac - Drăgăşani (6.2%).

Table 2

Chromatic structure of anthocyanin extracts from grapes of different varieties, at anthocyanin maturity

Vineyard	Variety	Yellow pigments		Red pigments		Blue pigments		Ic	Tc	dA%
		DO 420nm	%	DO 520nm	%	DO 620nm	%			
Sâmbureşti (Olt)	Cabernet Sauvignon	0,539	26,5	1,381	68,0	0,112	5,5	2,03	0,39	76,4
	Merlot	0,445	26,3	1,134	68,9	0,106	4,8	1,69	0,39	75,7
	Burgund mare	0,421	27,3	1,035	67,2	0,081	5,5	1,54	0,41	75,7
Drăgăşani (Vâlcea)	Cabernet Sauvignon	0,549	26,9	1,388	68,0	0,103	5,1	2,04	0,40	76,5
	Merlot	0,486	23,2	1,325	68,6	0,116	8,2	1,93	0,37	77,3
	Novac	0,778	25,6	2,073	68,2	0,186	6,2	3,04	0,37	76,7
Banu Mărăcine (Dolj)	Cabernet Sauvignon	0,902	27,7	2,035	62,4	0,324	9,9	3,26	0,44	69,9
	Merlot	0,735	25,7	1,937	67,7	0,189	6,6	2,86	0,40	76,1
	Fetească neagră	0,673	27,4	1,642	66,7	0,144	5,9	2,46	0,41	75,1

The analysis in the context of these chromatic structures, in which the red component clearly dominates, generating flavyl cations, and the blue component shows very low levels, highlights the achievement even in young wines of a coloring without intense, annoying shades of blue or purple. It seems, however, that in the maceration-fermentation process, the extraction of the three categories of pigments is percentageally different. Thus in wines, in relation to the total contents of anthocyanins and the level of coloring intensity, the proportions of different categories of pigments differ, compared to those present in grapes.

The chromatic properties, established on the basis of the optical densities at 420 nm, 520 nm and 620 nm of the anthocyanin extracts, under the same experimental conditions, separate the varieties into: very rich in coloring matter, rich in coloring matter, with sufficient contents in coloring matter to obtain wines normal tomatoes. The first category includes: Novac and Cabernet Sauvignon from all vineyards; the second category includes the Merlot variety from all vineyards; in the third category are the varieties Fetească neagra and Burgund mare.

3. Results regarding the elements of productivity and yield

In the Banu-Mărăcine (Dolj) viticultural area, the elements of productivity and yield of the studied varieties are presented in figure 1. The mentioned data show a clear superiority of the Merlot and Fetească neagra varieties both in terms of grape production and vinification yield. The amount of carbohydrates (kg/ha) was also determined, obtained based on the relationships between the production of grapes per surface unit (kg/ha), the carbohydrate content (g/l) and the must yield (l/100 kg grapes).The Fetească neagră variety presented a very high production (8150 kg/ha) and the highest winemaking yield (75.9 l/100 kg grapes), which naturally determined its ranking in the first place for the amount of carbohydrates (1423 kg/ha).

The same technological aspects taken into account for the varieties from the Drăgăşani vineyard are listed in figure 2. The Novac variety (9880 kg/ha) ranks first in grape production, followed by Merlot (9520 kg/ha) and Cabernet Sauvignon (7150 kg/ha). Looking at the involvement of grape production, carbohydrate content (g/l) and must yield (l/100 kg grapes), the amount of carbohydrates per surface unit ranks the varieties in descending order: Novac (1876.4 kg/ha), Merlot (1602.2 kg/ha) and Cabernet Sauvignon (1262.3 kg/ha).

Table 3

The elements of productivity and yield of the varieties grown in the Banu-Mărăcine – Dolj viticultural area (2022)

Variety	Grape production kg/ha	Carbohydrate content g/l	The winemaking yield l/100 kg of grapes	The amount of must l/ha	Amount of carbohydrates Kg/ha
Cabernet Sauvignon	5625	214,2	73,1	4111,8	880,7
Merlot	8200	238	75,2	6166,4	1467,6
Fetească neagră	8150	275,4	75,9	6185,8	1703,5

In the Sâmbureşti-Olt vineyard, the large Burgund variety stands out, followed by Merlot and Cabernet Sauvignon (figure 3).The lowest production (in all three wine-growing areas) is presented by the Cabernet Sauvignon variety, but quite satisfactory considering its high quality and the massive demand for this type of wine on the world market.

Table 4

The elements of productivity and yield of the varieties grown in the Drăgășani – Vâlcea viticultural area (2022)

Variety	Grape production kg/ha	Carbohydrate content g/l	The winemaking yield l/100 kg of grapes	The amount of must l/ha	Amount of carbohydrates Kg/ha
Cabernet Sauvignon	7150	227,8	77,5	5541,2	1262,3
Merlot	9520	212,5	79,2	7539,8	1602,2
Fetească neagră	9880	238	79,8	7884,2	1876,4

Table 5

The elements of productivity and yield of the varieties grown in the Sâmburești – Olt viticultural area (2022)

Variety	Grape production kg/ha	Carbohydrate content g/l	The winemaking yield l/100 kg of grapes	The amount of must l/ha	Amount of carbohydrates Kg/ha
Cabernet Sauvignon	6100	73,0	4453	980	6100
Merlot	8252	74,9	6180	1390	8252
Fetească neagră	10500	75,5	7927	1593	10500

CONCLUSIONS

The vineyards of Sâmbureşti, Drăgăşani and Banu-Mărăcine proved once again to meet all the conditions of maximum favorability for obtaining high quality red wines.

The compositional characteristics of the grapes (carbohydrates, total acidity, anthocyanins) present levels corresponding to obtaining high-quality red wines with designation of origin. In this sense, the data from the years 2022 and 2023 are eloquent.

Although the year 2023 was relatively similar to 2022 from a climatic point of view, the contents of carbohydrates, acidity and anthocyanins were clearly higher in 2022. Thus, in advanced over ripening, in Fetească neagră grapes (in 2022) the

sugar contents exceeded 240 g/l. Cabernet Sauvignon (at Sâmbureşti), Merlot (at Banu-Mărăcine) and Novac (at Drăgăşani) also showed very good carbohydrate contents this year, which exceeded 230 g/l carbohydrates. The highest value of the carbohydrate content is recorded in the Banu-Mărăcine wine growing area. During the ripening of the grapes, the acidity contents in most cases were between 4 and 6 g/l (in H2SO4). The Novac variety, recently planted in the Drăgăşani vineyard, has the high peculiarity of biosynthesizing significant proportions of carbohydrates (210.8 - 238 g/l) and anthocyanins (1100 - 1125 mg/kg grapes), with a total acidity below 4 g/ l (3.43 – 3.92 g/l in H2SO4). Due to the genetic nature and the considerable grape production, the large Burgund variety presented, during the two years of study, lower carbohydrate contents, slightly over 190 g/l, but with quite high acidity, reaching over 6 g/ it.

Both at full maturity and at over ripeness, in 2022 the anthocyanin contents presented values that ensure an abundant color for the products.

In all the varieties studied in the three wine-growing areas, the chromatic structure of the coloring matter provides the guarantee that: the varieties (through their genetic endowment), the cultivation areas (through their readiness to obtain red wines) and through the application of appropriate technologies, can be obtained top quality red wines.

We can say with certainty that all the studied varieties meet in a balanced way, the elements of productivity with those of quality, and can give rise to the premises of obtaining red wines with high quality potential

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