PRODUCTION CHARACTERISTICS OF THE MALBEC VARIETY GROWN IN THE CONDITIONS OF THE ŠUMADIJA WINE-GROWING REGION

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Abstract

Malbec is a grapevine variety used for the production of red wines. It is a newly introduced variety in Serbia with less-known production and oenological characteristics in the conditions of the Šumadija wine-growing region.

The study includes the analysis of the mechanical parameters of grapes and berries, chemical analysis of the grape juice, microvinification and physicochemical analysis of the wine produced. The average bunch weight was 184.7 g, with the total weight of all berries in the bunch averaging 165,1 g and the average rachis weight of 12,6 g. The grape juice had a sugar concentration of 23,6% and 6 g/l of total acids expressed as tartaric acid. The physicochemical analysis of the wine showed an alcohol content of 12,20% vol, a total extract of 22.10 g/l and 1700.0 mg GAE/l of total phenols. The color intensity was 0.942 and the nuance was 0.66, with red being dominant (49,57%), followed by yellow and blue (32.9 and 17.5% respectively).

It can be concluded that Malbec, as a newly introduced variety in the Šumadija region, delivers satisfactory results and has a pronounced oenological potential for producing top-quality colored wines.

Keywords: Malbec, grape, berry, wine, Šumadija region

INTRODUCTION

According to the 2023 agricultural census, there are 18,201 ha of vineyards in Serbia, of which 6,724 ha are located in the Šumadija region (Vucicevic, 2023). According to the International Organization of Vine and Wine (OIV), the Republic of Serbia ranks 17th to 19th in the world with an annual wine production (2227 ± 68 million hectolitres) and an average annual wine consumption of 2.0 ± 0.49 liters per capita (OIV reports). Šumadija is a traditional wine-growing region in Serbia with a long history of viticulture.

In the last ten years, viticulture in Serbia has been characterized by significant changes, which are reflected in the production of top wines, thanks to which Serbia is increasingly recognized on the world wine market (Marković and Pržić, 2022). This is the result of the introduction of new varieties and clones with better productivity potential, the application of a modern concept of vineyard management, a new approach in oenological practice, the use of new modern technologies, a new trend in wine consumption, etc. The introduction of new varieties that were previously unknown in Serbian viticultural practice, such as Malbec, improves the list of varieties and enriches Serbia's wine offer (Pržić and Marković, 2019).

According to one hypothesis, the Malbec was introduced from Cahors (southwest France) in the 16th century under King François I (1494-1547). In the 18th century, it was also cultivated in Champagne and Bordeaux and coined the common name Malbec. In the west of

France, it is usually called Cot or Côt (www.glossary.wein.plus/cot).

Malbec originates from the southwest of France. According to a genetic analysis carried out in Montpellier, it is probably the result of a cross between Magdeleine noire des Charantes and Prunelardh (www.vivc.de/index.php?r=passport%2Fview&id=2889). It is also known under 189 different synonyms, the most commonly used of which are Cot de Or, Auxerrois, Pressac (France), Malbech (Italy) and Malbek (Austria). In 2018, there were 7680 hectares of Malbec vineyards worldwide (www.plantgrape.fr), most of them in Argentina (especially in the Mendoza region).

The variety is vigorous and high-yielding and requires mixed pruning. Top of the young shoot is densely covered with needle-like hairs, the young leaves are dark green with a bronze reflection. The leaf is three-lobed with pronounced sinuses in the shape of the Latin letters "U" or "V". The cluster and berry are medium-sized. The berry is round. The ripening period is 2-3 weeks after Šasla (2 epochs). It is a vigorous variety. Resistant to most diseases, sensitive to *Phomopsis viticola*. The wine is well colored, aromatic with pronounced tannins. It gains in quality as it matures, with herbal notes. The variety is suitable for the production of red and rose wines. The Malbec wine is structured, rich in tannins and with pronounced fruity tones of ripe red fruit. It gains quality through aging and belongs to the premium wine category.

During the clonal selection, 16 clones were isolated: 42, 46, 180, 279, 353, 419, 592, 593, 594, 595, 595, 596, 597, 598, 1061, 1127, 1128.

MATERIALS AND METHODS

The research was carried out in 2023 on the experimental vineyard, which belongs to the Šumadija wine region and the Rača subregion. It was planted in 2019 with a row spacing of 2.5 m and a distance of 0.9 m between plants in the rows. The Malbec was grafted onto the Kober 5BB rootstock. The experimental vines were pruned uniformly according to Guyot's mixed pruning (one spur with two buds and one arch with eight buds were left).

The laboratory examination of the grapes and microvinification were carried out in the laboratory of the Department of Viticulture of the Faculty of Agriculture of the University of Belgrade. The tests included mechanical analysis of grapes and berries, analysis of qualitative parameters of grape juice and physico-chemical analysis of wine.

The mechanical composition of grapes and berries was carried out according to the method described by Marković and Pržić (2020). For the mechanical analysis of bunches and berries, 10 randomly picked bunches at full ripeness were used. The results for bunch length, bunch width, bunch stem mass and berry mass of 10 randomly selected bunches were presented in a paper. Bunch length and width were determined by measuring with a ruler before the bunches were placed on a surface with graph paper. To determine the mass of the berries, the stem of each berry was carefully cut off with scissors so that as little mesocarp (brush) as possible remained on the grape stem. The mass of the berry skin and seeds was measured after drying at room temperature using an analytical balance. Other parameters were determined by calculation.

The sugar content of the grape juice (must) was determined by physico-chemical methods using the Oeschle

hydrometer and the values were calculated using the Dujardin-Salleron tables. The operating principle of the Oechsle hydrometer is based on the determination of grape juice density, which is measured in degrees Oechsle (°Oe). This number of degrees corresponds to the difference between the density of water and must at 4°C. The sugar content is expressed as a percentage and was determined using the following formula:

$$\text{sugar (\%)} = \text{°Oe} * 0.266 - 3$$

°Oe value of the sugar content in grape juice, expressed in Oechle degrees

The total acidity was determined by the neutralization method using 0.1 M NaOH solution for titration. Phenolphthalein was used as a color indicator. The total acidity was calculated using the following formula:

$$\text{Total acidity (g/l)} = \text{used NaOH} * F * 0.75$$

F – normality factor of the 0.1 M NaOH solution

The glycoacidometric index (GAI) is expressed as the ratio of sugar (%) and titratable acidity (g/l). The pH value was determined using a pH meter.

Microvinification was carried out according to a standard procedure with the addition of a selected yeast strain *Saccharomices cerevisiae*.

After fermentation and a short aging of the wine in the bottle, the physico-chemical analysis of the wine was carried out: content of reducing sugars, total acids, volatile acids, malic acid, pH value, alcohol and total phenols as well as the determination of the wine color.

RESULTS AND DISCUSSIONS

The Šumadija region is characterized by a temperate continental climate with hot summers and cold winters. The climatic conditions considered in this study refer to the period 2000-2023 (RHSS report and Digital Atlas of Serbia). The average annual temperature was 12.7 °C and the average vegetation temperature (April-October) was 18.2 °C. The coldest months on average were January (1.5°C) and February (3.7°C). The average temperatures in August and September were 22.7°C and 18.1°C respectively. These temperature conditions are suitable for optimal ripening of the grapes. The average annual precipitation for the period studied was 769.3 mm. The region has a favorable distribution of precipitation throughout the year.

The mechanical composition of clusters and berries is an important scientific and practical indicator for evaluating the oenological potential of the grapes, as it indicates the percentage of skin, mesocarp and seeds in the berry. It varies from variety to variety, but also depends on the environmental conditions and the ampelological measures applied. The results of the mechanical composition of Malbec cluster and berries are shown in Table 1.

Table 1. Mechanical composition of the Malbec clusters and berries

Cluster mass (g)	184.7
Berry mass (g)	165.1
Rachis mass (g)	12.6
Berries per cluster	117.7
Mass of 100 berries (g)	175.0
Skin mass of 100 berries (g)	16.2
Seeds mass of 100 berries (g)	9.3
Mass of 100 seeds (g)	4.4
Seeds per 100 berries	188.0

The determined cluster mass (184.7 g) and the number of berries per cluster (117.7) are greater than the values

reported by Netzer et al. (2022) in their three-year research. These authors found that the mass of the Malbec grape in the Mediterranean conditions of Israel ranges from 94.6 to 164.2 g and the average number of berries in the cluster ranges from 75.0 and 140.8. Another comparative study on Malbec was conducted in Brazil by de Barros et al. (2018), in which the average cluster mass was 123.43 g and the average number of berries per cluster was 71.0.

The mechanical composition is characterized by the mass ratio of the morphological cluster parts: berry skin, pulp, seeds and rachis. The ratio of these parts in the cluster and their composition are of great oenological importance (Makuev et al., 2022).

A higher proportion of berry skin and seeds in the cluster can significantly affect wine quality (Marković and Pržić, 2020). The structure of the cluster structure is shown in Figure 1.

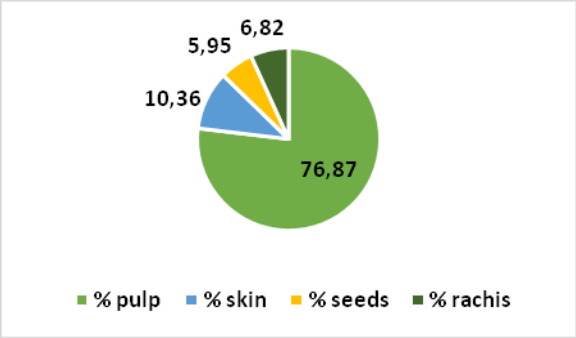

Figure 1. The grape cluster structure of Malbec

During the alcoholic fermentation of grape juice, complex biochemical processes and various physical and chemical changes take place, resulting in wine. The grapes were harvested when fully ripe, i.e. when the sugar concentration in the berries was optimal for the production of premium wine. Sugar and acidity are among the most important quality parameters of grape juice. The quality of the wine depends mainly on their content. The results of the chemical analysis of the grape juice are shown in Table 2.

Table 2. Chemical composition of grape juice

Sugar content	°Oe	99.19
	%	23.60
Total acid content	ml NaOH	8.00
	g/l	6.00
Glycoacidometric index		3.16
pH		2.90

The sugar content result was determined according to Shellie and King, 2020 and Morgani et al, 2023. These authors report that the total acidity is between 3.63 and 5.29 g/l. Acid concentration is important in winemaking, as wines made from grapes with lower acidity are unbalanced in taste and prone to spoilage (Kalathenos et al., 1995; Chidi et al., 2015). This is a particular problem today given climate change, which contributes to higher sugar and lower acidity levels in grape juice (de Orduña, 2010). Based on these results, the Malbec grapes studied meet the requirements for the production of high-quality wines. The results of the physicochemical analysis are shown in Table 3.

Table 3. Physicochemical analysis of wine

Parameters	Values
Reducing sugar (g/l)	2.25
Alcohol (%vol.)	14.10
Titratable acidity (g/l)*	6.93
Malic acid (g/l)	1.47
Volatile acids (g/l)**	0.43
pH	3.34
Total phenols (mg GAE/l)	1700.00

*As tartaric acid;**As acetic acid; GAE-gallic acid

The alcohol content in the wine was in the range of 14.10 % vol. and contributes to the stability of the wine and reduces the astringency of the tannins in red wines (Fontoin et al., 2008). Compared to the study by King et al. (2014), which was

based on Malbec wines from California and Mendoza (traditional Malbec growing region in Argentina), the experimental wines had slightly lower alcohol content but higher concentration of titratable acids (6.93 g/l). Same authors reported an alcohol content between 14 and 17% vol. and an acidity between 3.76 and 6.06 g/l. In their four-year study of Malbec wines from the Spanish region of La Mancha, Sánchez-Palomo et al. (2017) reported similar alcohol content (13.5-14.2% vol.) and lower acidity (4.92-5.35 g/l).

A total phenolic content of 1700.00 mg GAE/l was found in the wine, which is higher than that reported by Buscema and Boulton (2014) (836.70-1764.40 mg GAE/l) in Malbec wines from California and Mendoza. Netzer et al. (2022) also reported a lower phenolic content in Malbec wines (797.00-1249.00 mg GAE/l) in their study. Polyphenols are thought to have antioxidant, anti-inflammatory, cardioprotective, neuroprotective, antibacterial, antiviral, antifungal, anti-obesity and other positive effects on human health (Visioli et al., 2020; Gutiérrez-Escobar et al., 2021).

As an important quality indicator for red wine, color is usually considered the first sensory (visual) attribute perceived by consumers (Lourdes et al., 2007) and is a key factor directly affecting consumer acceptance and preference for red wine (Boisier et al., 2009). The analysis of the color distribution of Malbec wine is shown in Figure 2.

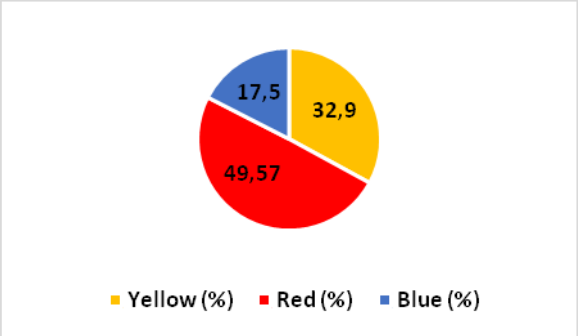

Figure 2. Wine colour analysis

The colour intensity of the Malbec wine was 0.942 and the colour nuance was 0.66, with red dominating (49.57 %), followed by yellow and blue (32.9 % and 17.5 %).

CONCLUSIONS

Malbec is a newly introduced variety that is being cultivated for the first time under Serbian conditions. The analysis of climatic conditions shows that the Šumadija region is well suited for the cultivation of Malbec varieties. The weight of the bunch was 184.7 g, the weight of all berries in the bunch was 165.1 g, which indicates a high proportion of berries in the bunch. The proportion of skin in the berry was high (10.36%), which underlines the oenological potential of the variety, considering that the largest proportion of phenolic substances is stored in the skin. The qualitative parameters of the grape juice (sugar content - 23.6% and total acidity - 6 g/l) are within the range of varieties for the production of premium quality wines.

According to the results of the physical and chemical analysis of the wine, the quality of the wine produced is not inferior to that of wines where Malbec is the main variety grown.

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