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PRODUCTION AND TECHNOLOGICAL CHARACTERISTICS OF THE MINOR GRAPEVINE VARIETY *SREMSKA ZELENIKA*

ABSTRACT: Minor grapevine varieties represent enormous value in terms of cultural heritage, diversification of products with higher economic value and adaptation to environmental conditions. This paper presents the results of research on certain production and technological characteristics (mechanical composition of clusters and berries, as well as chemical composition of grape must) of a local, i.e. minor white wine variety *Sremska Zelenika* examined in the agro-ecological conditions of the Fruška Gora wine-growing sub-region (Srem wine-growing region) in the locality of Sremski Karlovci. In the two-year research (2020 and 2021), without any yield reduction, it was determined that the average mass of the cluster was 266.5 g. The average sugar content in the grape must of the tested variety was 19.8%, the average content of total acids was 6.75 g/l and the average pH of the grape must was 3.27. Comparing the results of previous researches conducted in the same locality, it is concluded that in this research the minor variety of *Sremska Zelenika* has some better production and technological characteristics.

KEYWORDS: *Sremska Zelenika*, Fruška Gora wine-growing sub-region, production and technological characteristics

INTRODUCTION

Grapevine (*Vitis vinifera* L.) is, economically, the most important fruit species in the modern world (Vivier et al., 2002). This claim also applies to Serbia, as the first reported occurrence of *Vitis vinifera* in the Balkans in the form of wild grapes dates back to the Neolithic period (Burić, 1972).

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The turbulent history of the Balkans and Serbia and change of different cultures resulted in rises and falls in the development of viticulture. Thus, rare traditional varieties used in the past have been forgotten after modern varieties were discovered. They are particularly endangered and their existence in vineyards have been gradually decreasing. Cindrić et al. (1997) note that commercially inferior varieties were gradually pushed out of production with a high probability of being lost forever. In the past, the now minor varieties used to be the leading varieties in the Fruška Gora wine-growing sub-region (Lazić, 1982). Apart from other local (indigenous and regional) old varieties, a similar situation, i.e. gradual clearing of vineyards also happened with the *Sremska Zelenika* minor variety.

However, the data show that it is necessary to preserve genetic diversity and maintain the gene pool at least at the current level. Traditional varieties are well adapted to local conditions and therefore valuable for breeding modern varieties, but they are also interesting from a historical perspective, where they have their place at open-air exhibitions presenting varietal diversity and the history of viticulture (Baránková et al., 2020).

Minor grapevine varieties have an enormous value in terms of cultural heritage, diversification of products with higher economic value and adaptation to environmental conditions. Over the last 20 years, the reputation of minor grapevine varieties has considerably increased (Maul et al., 2019). Countries like Italy and Spain have long been using the potential of their indigenous varieties and, with modern growing cultivation, constant yield control and good oenological practices, they produce wines that are known throughout the world (Maletić et al., 2012). In the last period, in Serbia, wines have been increasingly produced from local grapes, i.e. minor varieties of the vinegrape, and some research has been done on certain varieties, such as *Grašac*, *Prokupac*, *Bagrina*, *Smederevka*, *Tamjanika* (a group of varieties) and others (Korać et al., 2007; Rakonjac et al., 2010; Ivanišević et al., 2012; Jakšić et al., 2023)

Although mentioned in the literature, the local, or minor, variety of *Sremska Zelenika* is not present in large areas of Serbia or in the region (Galbács et al., 2009; Lázár and Bisztray, 2011; OIV, 2017). In terms of surface area, this variety holds the 107th place when it comes to distribution in commercial vine plantations and the only vineyards intended for commercial grape production are in the wine-growing regions of Subotica and Srem. The vineyards with this variety are located at an altitude in the interval of more than 100 m to 200 m, on the eastern and somewhat less on the southern exposures of the terrain. They are located on terrain slopes with inclination of more than 1 ° to 5 °, and the average area of commercial vineyards with this variety is only 0.07 ha (Jakšić et al., 2019).

The *Sremska Zelenika* variety originates from the area of the Pannonian Plain (Cindrić et al., 2000), which is confirmed by the geographical designation “Sremska” in the name of the variety. In the international database Vitis International Variety Catalog (VIVC) (<https://www.vivc.de/>) it is stated that the origin of this variety is from the Balkans. According to literature data, the synonym of this variety in Serbia is *Zelenika*, while in Hungary the synonym

Szerémi Zöld is used (Cindrić et al., 2000). In the VIVC database (<https://www.vivc.de/>), in addition to the name *Sremska Zelenika*, 17 synonyms are listed, namely: *Gruene Spitzler*; *Gruener Schitzler*; *Gruenspitzler Matarski Riesling*; *Serem yellow*; *Spaetgreen*; *Spaetgruen the whiteness of Srem*; *Sheremi Szeremi Zoeld*; *Szrem whiteness*; *Szrem Zlte*; *Teremi*; *Teremi Zoeld*; *greens*; *Zoeld Szeremi*; *Zoeldszeremi*, which may indicate there was widespread cultivation of this variety in the region in the past. As many as eight of the listed synonyms have the geographical term “Srem”. Through genetic identification, it was determined that the parent pair of this variety is *Purcsin* x *Francuse* (<https://www.vivc.de/>). According to some authors, the *Sremska Zelenika* variety was grown in Yugoslavia, i.e. Serbia, Hungary, and Romania (Cindrić et al., 2000; 1994), and there is information that it was also grown in the Zakarpattia region in Ukraine, where grapes, due to high acid content, were used for production of sparkling wines. However, in all these countries of the region, as well as in Serbia, it has gradually disappeared, so that today it is classified as a minor variety, present on in less than 2% of the total area of vine plantings (OIV, 2017).

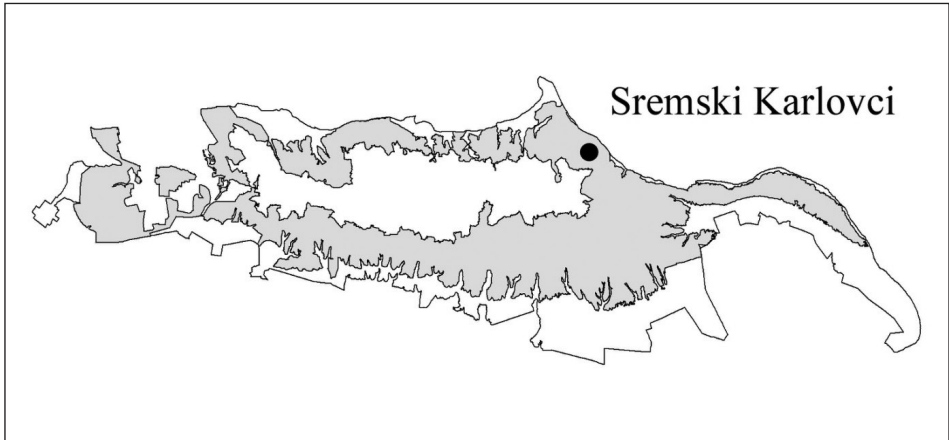
The variety *Sremska Zelenika* is characterized by great vigor. It has characteristic deeply incised and serrated leaves. The bunch (cluster) is medium-sized and compact. The berries are medium-sized, round, green in color, with a very sour taste. It is a late-maturing and high-yielding variety (Cindrić et al., 1994; 2000). Grown in unfavorable agroecological conditions, vine plants of this variety can freeze a lot (Lázár and Bisztray, 2011), however, the variety is high-yielding, which may favor grape quality over quantity. In unfavorable years, due to the compaction of the berries, the grapes may be susceptible to rotting (Lázár and Bisztray, 2011), which could be one of the reasons for gradual clearing of vineyards with this variety. When this genetically high-yielding variety is grown in unfavorable localities, its grapes can have a lower sugar content and a very high acid content; however, when well ripened, it produces a very solid wine with a mild aroma (Németh, 1967; Lázár and Bisztray, 2011; Cindrić et al., 2000). However, one should keep in mind that earlier research was carried out in less favorable, colder conditions and that the climate in Serbian wine-growing areas has shifted towards higher temperatures. Such changes mostly go in favor of growing grapevine varieties with a later ripening time (Jakšić et al., 2023), such as the minor variety *Sremska Zelenika*. Due to a higher content of acids in the grape must and a fresh character of the wine, this variety may deserve more attention in future scientific research and production in conditions of climate change and increased temperatures.

Until now, in Serbia, no work has been done on the clonal selection of the *Sremska Zelenika* variety, or on detailed systematic testing in terms of the application of various measures to reduce the yield and increase the quality of grapes and wine. For that reason, the goal of this work was to examine certain production and technological characteristics of the *Sremska Zelenika* variety, to explore a possibility for spreading this variety in the conditions of the Fruška Gora wine-growing sub-region and other areas with favorable agro-ecological conditions in the future.

MATERIALS AND METHODS

Object of the research

The research was carried out on estate demonstrational vineyard of the Department for fruit growing, viticulture, horticulture and landscape architecture of the Faculty of Agriculture of the University of Novi Sad, located in the Srem wine-growing region, the Fruška Gora sub-region (Map 1).



Map 1. Srem wine-growing region, Fruška Gora sub-region, and location of vineyards

The two-year research (2021 and 2022) of the production and technological characteristics of the *Sremska Zelenika* variety was carried out in a vineyard, i.e. a collection plantation set up in 2008. The planting distance between the rows in the vineyard was 2.8 m, and between the plants in the rows was 1 m. The research on selected production and technological characteristics of the examined grapevine variety was carried out on a sample of ten grapevine plants. The plants were grafted onto *Berlandieri x Riparia* Kober 5BB. The training system was a modified Single Guyot, i.e. the Karlovci training system, where long canes were left at the top of a tall trunk, bent in a semicircle and tied to the lowest wire (Cindrić et al., 2000) (Picture 1). The time of phenological maturity of the tested variety, i.e. the harvest date in the first year of research (2021) was October 5th, while in the second year of research (2022) it was September 26th.

The predominant type of soil on which the vineyard is located is eutric cambisol, and there are also other types of soil, to a lesser extent. The terrain has a very slight slope from the south to the north, in which direction the rows were set up. The collection of grapevine varieties, where the research was done, is located at an altitude of 110 m (45°11'30.3" N; 19°55'58.1" E).



Picture 1. Sremska Zelenika variety

The agrotechnical and ampelotechnical measures applied in both years of the research were not different from the measures applied in the whole collection plantation. Therefore, the grapes were not reduced, but were allowed to express the full genetic potential of the variety.

METHODS

The researchers used the method of selecting representative grapevine plants for this variety and chose ten grape clusters. To ensure the same load, the same training method was carried out during dormancy, where 12 buds were left on the canes and two buds on the spurs.

When it comes to the production and technological characteristics of the examined variety, the mechanical composition of clusters and berries, as well as the chemical composition of the grape must were determined.

The mechanical analysis of the clusters and berries (chemical analysis) was done by using a modified Prostoserdov method (Prostoserdov, 1946). In laboratory conditions, the structural composition of the cluster was determined: length (cm), width (cm), and mass of the cluster (g), as well as the number and mass of all berries in the cluster (g). From the structural indicators of the berry, namely the mass of 100 berries (g), length (cm), and width of the berry (cm) were also determined. To investigate the mechanical composition of the grapes, ten representative clusters from all selected vines were used.

The grape must for determining the chemical composition was obtained by mixing and crushing 100 berries taken from the 10 representative clusters. The researchers determined the following parameters of the chemical composition: the content of sugar and the content of total acids in the grape must, as well as the pH of the grape must. The content of sugar in the grape must was determined by an electronic refractometer and expressed in %. The content of total acids was determined by using the method based on the color change of the indicator. This method is based on titration with NaOH solution in the presence of a phenolphthalein indicator. The acid content was expressed in g/l of tartaric acid. The pH of the grape must was determined using a pH meter. The method is based on the measurement of a potential difference between two electrodes immersed in the tested liquid. The result was expressed with an accuracy of 0.05 pH units.

Using the method of questionnaires, 4 growers of the *Sremska Zelenika* grapevine variety from different wine-growing regions were inquired on the average sugar content in 2021 and 2022.

RESULTS AND DISCUSSION

The important production and technological characteristics in the period 2021–2022 for the wine grapevine variety *Sremska Zelenika* are shown in Tables 1, 2 and 3, as well as in Graphs 1 and 2.

Mechanical composition of the cluster

The research determined that the mass of the cluster in the first year (2021) of the research was 289.2 g, and in the second year (2022) was 243.80 g, while the mass of the cluster of the examined variety for both years was 266.5 g (Table 1). The mass values of ten clusters from this research are slightly higher than the ones recorded in previous studies in the Fruška Gora wine-growing sub-region in the same location (Cindrić et al., 2000) in the period 1981–1998, when the average mass of the cluster not only of the *Sremska Zelenika* variety, but also of all the examined plants from the collection was 244 g. The determined average number of berries in a cluster of the *Sremska Zelenika* variety was 173.

The research has established that the cluster of larger size was recorded in the first year (2021), with the length of 16.33 cm, and the width of 10.33 cm. In the second year of the research (2022), the cluster was somewhat smaller in size being 15.50 cm long and 9.00 cm wide. The average length for both years was 15.92 cm, while the average width was 9.67 cm.

Table 1. Grape characteristics of the *Sremska Zelenika* variety

Year	Cluster mass (g)	Cluster length (cm)	Cluster width (cm)	Number of berries in a cluster
2021	289.20	16.33	10.33	165
2022	243.80	15.50	9.00	181
Average	266.50	15.92	9.67	173

Analyzing the results of the research, there were some differences between years observed in the following characteristics of the grape cluster: cluster mass (g), length and width of a cluster (cm), as well as the mass and number of all berries in a cluster (g). For all tested characteristics of mechanical composition of a cluster, higher values were recorded in the first year of the research (2021).

Results of the mechanical composition of the berry

The mass of 100 berries (g) in the examined variety *Sremska Zelenika* was different. Namely, this value of mechanical composition ranged from 179.10 g (first year of examination) to 108.30 g (second year of examination). The average value of the mass of 100 berries for both years of the *Sremska Zelenika* variety was 143.70 g (Table 2).

Table 2. Properties of the berry of the *Sremska Zelenika* variety

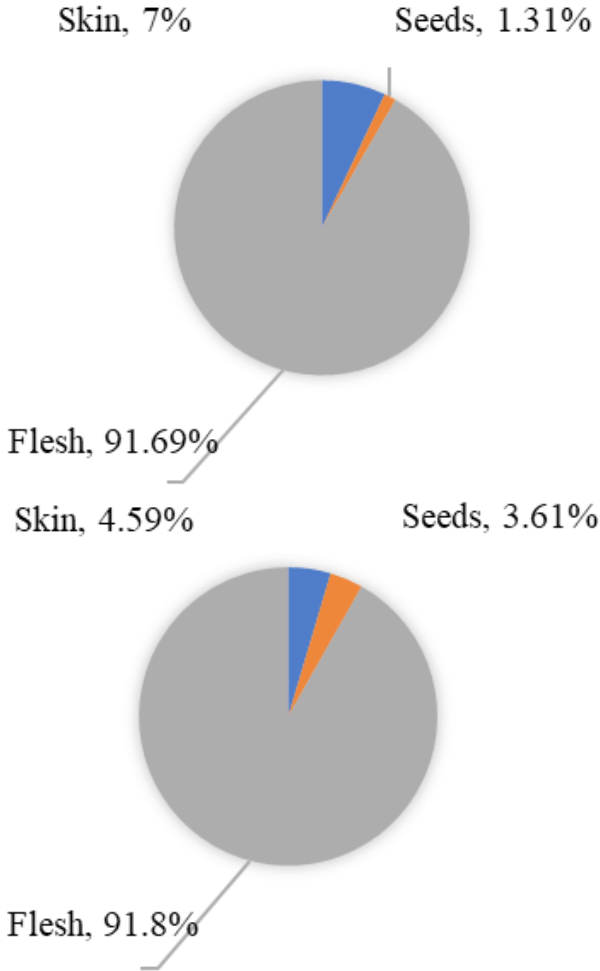
Year	Mass of 100 berries (g)	Berry length (mm)	Berry width (mm)
2021	179.10	13.11	13.38
2022	108.30	12.50	12.68
Average	143.7	12.81	13.03

In the first year (2021), the berries were larger, being 13.11 mm long and 13.38 mm wide, while the average length of the berries for both years was 12.81 mm and the width 13.03 mm.

The results of the structural indicators of the clusters and berries

The research determined that the percentage of flesh in 100 berries was approximately the same in both years. In the first year, the value was slightly

higher (91.8%) than in the second year (91.69%). Skin-wise, a significantly lower percentage of the skin was recorded in the first year (4.59%) than in the second year (7%) (Graphs 1 and 2).



Graphs 1–2. Percentage of skin, flesh and seeds in a berry of the *Sremska Zelenika* variety, Graph 1 2021 (left) and Graph 2 2022 (right)

The rest of 100% of the total individual share is made up of seeds, where no approximate shares were recorded in the examined years. Namely, the highest percentage was recorded in the first year (2021), 3.61%, which also corresponded to the number of seeds in 100 berries, which was 204. In the second year, the percentage of the seeds was much lower amounting to 1.31%, which also corresponded to the number of seeds in 100 berries, being 74.

The results of the chemical composition of the grape must

The results of the analysis of must made of the grapes of the *Sremska Zelenika* variety are presented in Table 3. The sugar content in the grape must (%) was in a narrow range from 20.3% in the first year to 19.3% in the second year. The average sugar content was generally quite high, compared to earlier research, amounting to 19.8%. Namely, the average sugar content recorded in the period 1981–1998 in the same Fruška Gora sub-region (in the same varieties collection), in vineyards with the same training system, was 15.4% (Cindrić et al., 2000). However, one should keep in mind that neither in this nor in previous research there was yield reduction, i.e. reduction of grapes of this high-yielding variety. The results of the research on the chemical composition are more broadly correlated with the achievement of phenological maturity when the average harvest time of the tested variety was September 30th, compared to the earlier research by Cindrić et al. (2000) when the average harvest date was October 7th.

The data obtained from a survey of several grape growers on the sugar content in the must made of the *Sremska Zelenika* variety show similar values compared to this experimental research. Namely, the grape growers in several vineyards in the Fruška Gora sub-region had 19% and 20% sugar in 2021, and 20% in 2022. In the area of the Palić wine-growing sub-region, the average sugar content in the grape musts in 2021 and 2022 was 20%.

Table 3. Chemical values of the grape must made of the *Sremska Zelenika* variety

Year	Sugar (%)	Total acids (g/l)	pH
2021	20.3	7.5	3.11
2022	19.3	6.0	3.43
Average	19.8	6.75	3.27

The results of the content of total acids (g/l) showed this parameter was 7.5 g/l in the first year, and 6.0 g/l in the second year of the research. The average content of total acids for the examined variety was 6.75 (g/l) (Table 3). The results of the content of total acids in this research differed from earlier research within the same facility when the average content of acids was 12.3 g/l (Cindrić et al., 2000). Without going into detailed studies of climatic and other conditions that led to a discrepancy in the obtained data, these results can lead to the conclusion that climate changes with increasing temperatures can positively affect the expression of this quality parameter of grape must.

The experimental grape musts in this two-year research had approximately similar pH values. The average pH was higher in the first year (3.43), while in the second year, the pH was 3.11. The average pH value for both years was 3.27 (Table 3).

CONCLUSION

Based on the research on certain production and technological characteristics of the minor grapevine variety *Sremska Zelenika* without yield reduction measures, it can be concluded that there are some differences between the years of research in terms of the mechanical composition of the clusters and berries, i.e. the structural indicators of the clusters and berries, as well as the chemical composition in the grape must.

Analyzing the results, the average value of the cluster mass (g) of the *Sremska Zelenika* variety for both years was 266.5 g, which is higher than it was recorded in earlier research conducted in the same vineyard in Fruška Gora sub-region.

The chemical indicators of the grape must exhibited a lot of variability between years. The average sugar content was generally high and amounted to 19.8%. The average content of sugar in the grape must in this research is significantly higher than that the same parameter determined in the earlier research in the same locality. The average content of total acids in the grape must was 6.75 (g/l), which is much lower than the values of this parameter found in earlier research in the Fruška Gora sub-region. The experimental grape musts used in this two-year study had approximately similar results, with the average pH of 3.27.

Based on the above-mentioned, it can be concluded that the minor grapevine variety *Sremska Zelenika*, in addition to its high cluster mass, exhibited somewhat improved individual production and technological characteristics under the conditions of the Fruška Gora sub-region (Srem wine-growing region) compared to the results of earlier research. For this reason, this variety deserves further, more detailed research, as well as the possibility for establishing new vine plantations in selected localities with suitable ecological conditions for this variety, all with the reduction of grapes in order to improve the quality of grapes and eventually wine.

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ПРОИЗВОДНЕ И ТЕХНОЛОШКЕ КАРАКТЕРИСТИКЕ
МИНОРНЕ СОРТЕ ВИНОВЕ ЛОЗЕ *СРЕМСКА ЗЕЛЕНИКА*

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РЕЗИМЕ: Минорне сорте винове лозе представљају огромну вредност у погледу културног наслеђа, диверсификације производа веће економске вредности и прилагођавања условима животне средине. У овом раду су приказани резултати истраживања појединих производних и технолошких карактеристика (механички састав грозда и бобица, као и хемијски састав шире) локалне, односно минорне беле винске сорте *сремска зеленика* испитиване у агроеколошким условима Фрушкогорског виногорја (Сремски виноградарски рејон) на локалитету Сремски Карловци. У оквиру двогодишњих истраживања (2020. и 2021), без редукације приноса утврђено је да је просечна маса грозда била 266,5 грама. Просечан садржај шећера у шири износио је 19,8%, просечан садржај укупних киселина био је 6,75 грама/литри, док је просечна рН шире од грозђа испитиване сорте била 3,27. Упоредјујући поједине утврђене карактеристике са ранијим истраживањима на истом локалитету, закључује се да је минорна сорта *сремска зеленика* показала боље производне и технолошке карактеристике у односу на резултате тих ранијих истраживања.

КЉУЧНЕ РЕЧИ: *сремска зеленика*, Фрушкогорско виногорје, производне и технолошке карактеристике