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## CHARACTERISTICS OF GRAPE MUST OF PERSPECTIVE GENOTYPES IN AUTOCHTHONOUS GRAPEVINE VARIETY *PROKUPAC*

**ABSTRACT:** The autochthonous, i.e. local, red wine variety *Prokupac* is one of the most important varieties in Serbia. In the past, this variety was the leading one in the largest number of wine-growing areas of our country. The *Prokupac* variety is currently the most represented in the Tri Morave wine-growing region (Central Serbia), while the largest number of vineyards with this variety are located in the Župa wine-growing subregion. Due to its importance as an old and traditional variety, certain researches of this variety have been initiated in recent years in wine-growing areas where *Prokupac* is traditionally grown. Certain scientific activities were initiated to isolate different genotypes with improved production and use value, all with the aim of clonal selection of this variety. In this paper, some characteristics and quality parameters of the more promising *Prokupac* genotypes that were isolated in the Župa wine-growing subregion in the Aleksandrovac municipality are presented. More extensive research was carried out on grapes from the harvest of 2019, 2020 and 2021 with 16 selected genotypes, namely eight genotypes from the Latkovac locality and eight genotypes from the Drenča locality. In addition to laboratory analyses of sugar, acid and pH content in the grape must, the theoretical alcohol content was also calculated. Furthermore, spectrophotometric methods were used to determine colour intensity A-420, colour intensity A-520, colour intensity A-620 and total colour intensity, as well as colour tonality. The analyses showed that certain main quality parameters from the research are within the value limits as in earlier research, but that the acid content is generally more optimal for red wine varieties compared to the research of that parameter carried out in the earlier period in other wine-growing areas (Fruška Gora and Čegar wine-growing subregions).

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Moreover, in our research, the sugar content of the grape is higher than the established values of that parameter in the grape must from the Čegar wine-growing subregion.

KEYWORDS: grape must, *Prokupac*, Župa wine-growing subregion

## INTRODUCTION

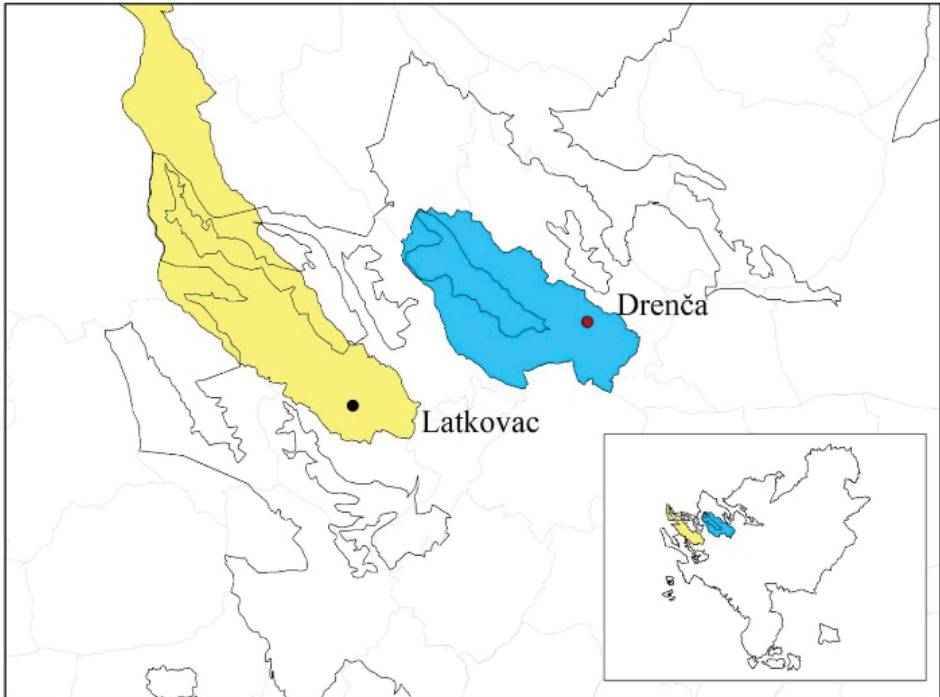
The *Prokupac* grapevine variety is a Serbian autochthonous variety (Zirojević, 1974; Radojević et al., 2013; Marković and Atanacković, 2013; Petrović et al., 2019) that, according to most authors, originates from the vicinity of Prokuplje, a historic vineyard centre in Serbia (Zirojević, 1974; Radojević et al., 2013). This red wine variety belongs to the *Convarietas pontica* group, *subconvarietas balcanica*, and has numerous synonyms such as *Rskavac*, *Kameničarka*, *Niševka*, *Crnka*, *Prokupka*, and others (Zirojević, 1974; Cindrić et al., 2000; Jakšić et al., 2019). In terms of total vineyard area, *Prokupac* is the leading local and regional grapevine variety in Serbia compared to 31 other old local grapevine varieties. Additionally, when considering the distribution of vineyard areas for this variety across wine-growing regions, the Tri Morave region (Tomić et al., 2019) stands out with the largest areas of this local variety, with the Župa wine-growing subregion being particularly notable (Jakšić, 2019). The precondition for valorizing wine from local grapevine varieties and expanding vineyards with such varieties is the identification of valuable genotypes and research aimed at clonal selection of the best and most promising genotypes of local grapevine varieties. However, one of the challenges facing contemporary scientific practice is the insufficient representation of vineyards with local varieties. Over the years, vineyards with such varieties in Serbia have been largely cleared, and their share in the total vineyard area (excluding the widespread local variety Grašac) is just over 15%, with a share in the total number of vineyards being slightly less than 34% (Jakšić et al., 2022a). For this reason, the preservation and development of local varieties, such as the *Prokupac* variety, pose a special challenge to today's domestic science. One of the first steps in this process is the selection of promising genotypes in old vineyards that are the subject of research for clonal selection. Such a scientific-professional process has been initiated by the Centre for Viticulture and Oenology in Niš for the *Prokupac* variety and other local grapevine varieties in the Župa wine-growing subregion and other wine-growing areas in Serbia. Given that the analysis of current and future climate change has shown that climate change will have a positive impact on the *Prokupac* variety (Jakšić et al., 2022b; Jaksic et al., 2022c), as a variety with a later grape ripening time, special attention is paid to the selection of promising genotypes of this variety.

The aim of this paper is to present the results of laboratory analyses of the quality parameters of the grape must in selected individual promising genotypes of the *Prokupac* variety from the Župa wine-growing subregion.

## MATERIALS AND METHODS

### Data on Vineyards with Selected Genotypes

The production vine plantations where the selection of prospective genotypes of the *Prokupac* grapevine variety was carried out are located within the Tri Morave wine-growing region, Župa wine-growing subregion. The vineyards are situated in two localities, within two cadastral municipalities, namely Latkovac and Drenča (Map 1).



Map 1. Localities of vineyards where *Prokupac* genotypes were selected

The vineyard in Latkovac (Lat/Lon: 43° 27' 57.8496" N, 21° 01' 00.8199" E) was planted in 1972, situated at an altitude of 543 metres, with a slope of 17.2° and a southern exposure. The rootstock used is *Rupestris* du Lot, and the vineyards follow the traditional (Župski) training system. Promising genotypes from this locality are marked with numbers from 1 to 8.

The vineyard in Drenča consists of two parts, Lukarevina (Lat/Lon: 43° 28' 22.5215" N, 21° 02' 31.9569" E) and Gubovac (Lat/Lon: 43° 28' 36.5154" N, 21° 03' 26.5526" E). The genotypes marked from 9 to 13 are from the part of the vineyard planted in 1920, while those marked from 13 to 16 are from the section planted in 1900. This vineyard is located at an altitude of 403 metres,

with a slope of 16.7° and a southern exposure. Similar to the Latkovac vineyard, it also uses *Rupestris* du Lot rootstock and follows traditional (Župski) vine training system.

### The methodology for preparing grape must samples

Grapes from the selected 16 genotypes, with eight genotypes from each of the two localities, were harvested in the years 2019, 2020, and 2021. Before harvesting, the analysis determined that the grapes were 100% healthy. After harvesting the entire grape crop from the vines of the selected genotypes, they were transported and temporarily stored under cold conditions. Subsequently, the grapes were crushed, ensuring that the grape must extraction was moderate. Laboratory analysis of the grape must quality parameters was conducted at the Center for Viticulture and Oenology in Niš.

### The laboratory analyses

Determination of sugar content in grape must be carried out using a digital refractometer following the method specified by the International Organization of Vine and Wine (OIV): Method OIV-MA-AS2-02 (OIV, 2016).

Determination of total acidity in grape must was performed through titration using a titrator in accordance with the OIV method: Method OIV-MA-AS313-01 (OIV, 2016).

Determination of pH of grape must was carried out potentiometrically following the OIV method: Method OIV-MA-AS313-15 (OIV, 2016).

The theoretical alcohol content in grape must was determined computationally by multiplying the sugar content in percentage by the factor 0.59 (fermentation of 1 gram of sugar yields approximately 0.59 ml of alcohol) (Jakšić, 2023).

The colour intensity and colour intensity analyzed using spectrophotometric methods following the OIV method: Method OIV-MA-AS2-07B (OIV, 2016).

## RESULTS AND DISCUSSION

### Grape Must Quality Parameter Analysis

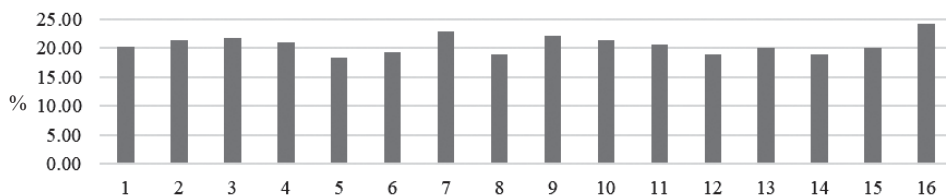
All the data for the selected and analyzed quality parameters of grape must from prospective genotypes of the *Prokupac* variety for the period 2019–2021 are presented in Appendix 1, Table 1. Laboratory analyses have shown that there are certain differences in parameter values among prospective genotypes.

Table 1. The main quality parameters of the grape musts of selected perspective genotypes of the Prokupac variety (2019–2021)

Genotypes	Vineyard localities	Sugar content (%)	Total acids (g/l)	pH	Theoretical alcohol content (%Vol.)
1	Latkovac	20.29	6.05	3.36	11.96
2	Latkovac	21.33	5.89	3.56	12.59
3	Latkovac	21.72	5.84	3.54	12.81
4	Latkovac	21.00	5.62	3.51	12.38
5	Latkovac	18.39	9.10	3.37	10.85
6	Latkovac	19.23	7.35	3.32	11.33
7	Latkovac	22.83	6.27	3.62	13.47
8	Latkovac	19.00	7.37	3.41	11.20
Average	Latkovac	20.47	6.69	3.46	12.07
9	Drenča	22.18	6.12	3.71	13.08
10	Drenča	21.30	4.95	3.82	12.56
11	Drenča	20.67	5.78	3.71	12.18
12	Drenča	18.98	5.66	3.66	11.19
13	Drenča	20.16	7.26	3.46	11.88
14	Drenča	18.93	5.81	3.49	11.17
15	Drenča	20.08	5.60	3.65	11.83
16	Drenča	24.20	4.82	3.68	14.25
Average	Drenča	20.81	5.75	3.65	12.27
Total Average	Latkovac and Drenča	20.64	6.22	3.55	12.17

### Sugar Content

The average sugar content (%) in the grape must of the investigated perspective genotypes of the *Prokupac* variety under the conditions of the Župa wine-growing subregion at the Latkovac locality was determined to be 20.47%, while at the Drenča locality, it was 20.81%. Laboratory analysis revealed that among the eight genotypes at each of the two localities, the highest average sugar content at the Latkovac locality was found in genotype 7 (22.83%), and at the Drenča locality, it was in genotype 16 (24.20%) (Graph 1).



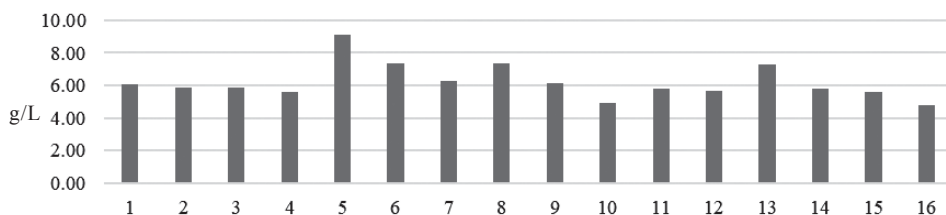
Graph 1. Average sugar content (%) in grape must of *Prokupac* genotypes (1–16) (2019–2021)

Comparing the average sugar content in the grape must from prospective genotypes at both localities, it can be concluded that this quality parameter of the grape must is slightly better in the genotypes from the Drenča locality. This is somewhat understandable, given that the vineyards at that locality are older and located at a slightly lower altitude.

The results of sugar content obtained in this research are similar to previous studies, falling within the approximate range of results from earlier investigations of this grape must parameter. Specifically, the similarity of these analyses aligns with the average sugar content in grape masts in the Čegar wine-growing subregion (Niš wine-growing region) during the period 1958–1972 (21.06%) (Zirojević, 1974) and the Fruška Gora wine-growing subregion (Srem wine-growing region) during the period 1981–1998 (20.10%) (Cindrić et al., 2000). However, the sugar content in the grape must in our research is higher compared to more recent studies conducted in the Čegar wine-growing subregion during the period 2009–2010 (18.95%) (Radojević et al., 2013).

#### Total acidity content

Regarding the average total acidity content (g/L) in the grape must is always expressed in grams of tartaric acid per liter, it amounted to 6.69 g/L for the investigated prospective *Prokupac* genotypes at the Latkovac site, and 5.79 g/L for the genotypes at the Drenča site. The highest average total acidity content was observed in the grape must of genotype 5 at the Latkovac locality (9.10 g/L) and genotype 13 at the Drenča locality (7.26 g/L) (Graph 2).



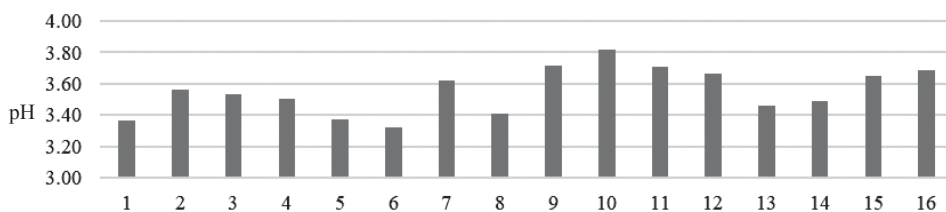
Graph 2. Average amount of total acids in grape must genotypes (1–16) of the *Prokupac* variety (g/L) (2019–2021)

The results of the research on the average acidity content (g/L) of the grape must indicate that this parameter is higher in the grape must from the prospective genotypes of the *Prokupac* variety located in the Latkovac locality.

The results of the total acidity content (g/L) of the grape must obtained in this research are similar to previous studies on this parameter, specifically in line with earlier research conducted on grape must from the Čegar wine-growing subregion during the period 1958–1972 (6.97 g/L) (Zirojević, 1974) and in the period 2009–2010 (6.84 g/L) (Radojević et al., 2013). However, the average acidity content obtained in our research is much lower compared to the high acidity content in the grape must of the *Prokupac* variety determined for the period 1981–1998 in the conditions of the Fruška Gora wine-growing subregion (9.10 g/L) (Cindrić et al., 2000).

### pH of grape must

The average pH of the grape must in the investigated prospective genotypes of the *Prokupac* variety under the conditions of the Župa wine-growing subregion in the Latkovac locality was 3.46, while in the Drenča locality, it was 3.65. Laboratory analysis revealed that among the eight genotypes at each locality, the grape must from genotype 6 in the Latkovac locality had the lowest average pH (3.32). In the Drenča locality, the grape must from genotype 13 had the lowest pH (3.46) (Graph 3).



Graph 3. Average pH of grape must genotypes (1–16) of *Prokupac* variety (2019–2021)

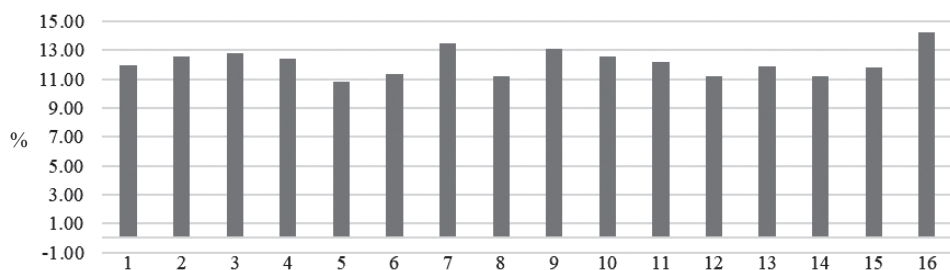
The results of the pH of grape must indicate a slightly better pH value in the grape must from the genotypes located in the Latkovac locality compared to the genotypes from the Drenča locality.

### The theoretical alcohol content

The average value of the calculated theoretical alcohol content (%Vol.) for future wines in the investigated prospective genotypes of the *Prokupac* variety in the Latkovac locality was 12.07%Vol., while for the genotypes in the Drenča locality, it was 12.27%Vol.

Laboratory analysis revealed that among the eight genotypes at each locality, genotype 7 from the Latkovac locality had the highest average value of

theoretical alcohol content (13.47%Vol.), and from the Drenča locality, genotype 16 had the highest (14.25%Vol.) (Graph 4).



Graph 4. The average theoretical alcohol content in grape must genotypes (1–16) of *Prokupac* variety (%Vol.) (2019–2021)

As with the average sugar content in the grape must, the average theoretical alcohol content in future wines is slightly higher for the genotypes from the Drenča locality compared to the genotypes from the Latkovac locality.

#### Colour intensity and colour tonality of grape must

All results of the grape must colour intensity analysis (including color intensity –  $A_{420}$ , color intensity –  $A_{520}$ , and color intensity –  $A_{620}$ ) and the colour tonality of the grape must from the investigated prospective genotypes of the *Prokupac* variety for the period 2019–2021 are presented in Appendix 1, Table 2.

Table 2. Color intensity and color tonality in grape musts of perspective genotypes of the *Prokupac* variety (2019–2021)

Genotypes	Vineyard localities	Color intensity – $A_{420}$	Color intensity – $A_{520}$	Color intensity – $A_{620}$	Color intensity	Color tonality
1	Latkovac	1.099	0.587	0.275	1.961	1.872
2	Latkovac	1.026	0.652	0.246	1.925	1.573
3	Latkovac	0.894	0.521	0.201	1.615	1.716
4	Latkovac	0.671	0.485	0.142	1.298	1.383
5	Latkovac	1.176	0.586	0.259	2.021	2.007
6	Latkovac	0.929	0.459	0.203	1.591	2.024
7	Latkovac	0.975	0.544	0.215	1.733	1.793
8	Latkovac	1.110	0.573	0.231	1.914	1.938
Average	Latkovac	0.985	0.551	0.221	1.757	1.788
9	Drenča	1.076	0.628	0.250	1.954	1.712
10	Drenča	1.067	0.640	0.267	1.974	1.667
11	Drenča	1.024	0.554	0.231	1.809	1.848
12	Drenča	0.958	0.559	0.228	1.745	1.714

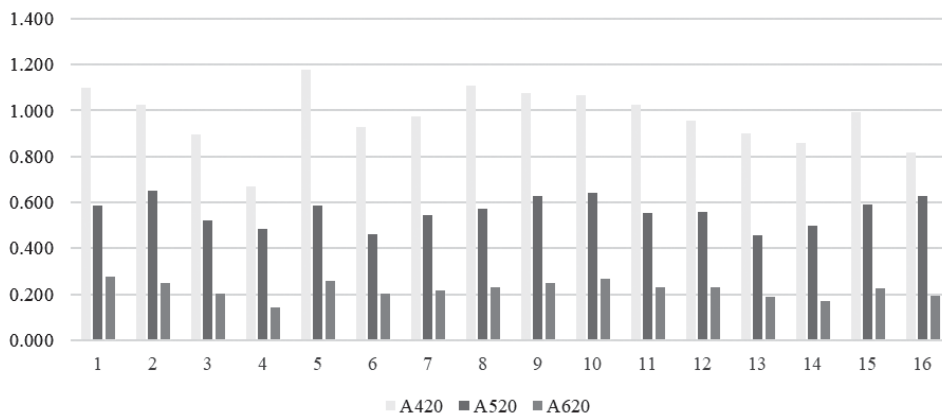


13	Drenča	0.900	0.457	0.188	1.544	1.970
14	Drenča	0.857	0.500	0.169	1.526	1.714
15	Drenča	0.993	0.590	0.223	1.807	1.683
16	Drenča	0.817	0.629	0.194	1.639	1.300
Average	Drenča	0.961	0.570	0.219	1.750	1.688
Total Average	Latkovac and Drenča	0.973	0.560	0.220	1.753	1.738

### Colour intensity analysis of grape must

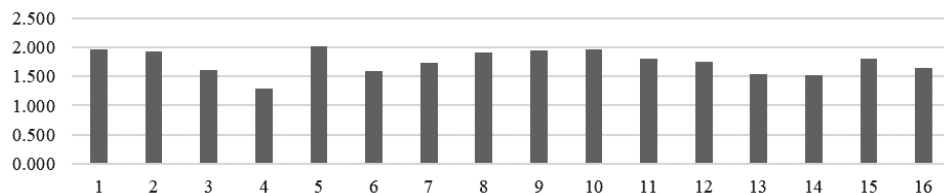
From 2019 to 2021, the average value of colour intensity –  $A_{420}$  in the grape must of the investigated prospective genotypes of the *Prokupac* variety in the Latkovac locality was 0.985, while in the Drenča locality, it was slightly lower at 0.961. The average value of colour intensity –  $A_{520}$  in the grape must from the genotypes in the Latkovac locality was 0.551, and in the Drenča locality, it was slightly higher at 0.570. The average value of colour intensity –  $A_{620}$  in the grape must from the genotypes in the Latkovac locality was 0.221, while in the Drenča locality, it was slightly lower at 0.219.

Analysis results of the grape must from individual prospective genotypes showed that the highest average value of colour intensity –  $A_{420}$  within the Latkovac locality was found in the grape must from the prospective genotype 5 (1.176), while in the Drenča locality, it was genotype 9 (1.076). The highest average value of colour intensity –  $A_{520}$  within the Latkovac locality was determined in the grape must from the prospective genotype 2 (0.652), and in the Drenča locality, it was genotype 10 (0.640). The highest average value of colour intensity –  $A_{620}$  within the Latkovac locality was found in the grape must from the prospective genotype 1 (0.275), while in the Drenča locality, it was genotype 10 (0.267) (Graph 5).



Graph 5. Average colour intensity of grape must genotypes (1–16) of *Prokupac* variety (2019–2021)

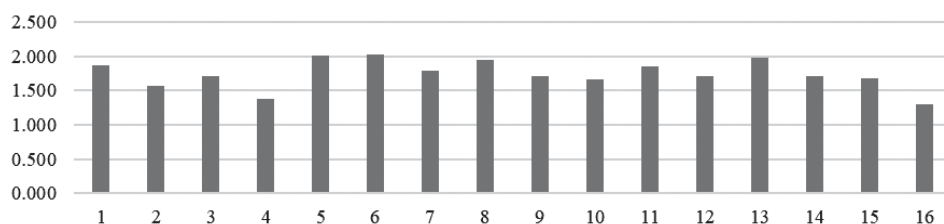
Analyzing the total colour intensity of the grape must from prospective genotypes of the *Prokupac* variety, it can be concluded that the highest average value of total colour intensity was observed in the grape must from genotype 5 from the Latkovac locality (2.021) and genotype 10 from the Drenča locality (1.974) (Graph 6).



Graph 6. The average value of the total colour intensity of grape must genotypes (1–16) of *Prokupac* variety (2019–2021)

The average value of the total colour intensity of the grape must from the investigated prospective genotypes of the *Prokupac* variety for the period 2019–2021 in the Latkovac locality was 1.757. This average value was slightly lower in the grape must from the genotypes in the Drenča locality, specifically 1.750.

Results of the analysis of the colour tonality of the grape must showed that genotype 6 had the highest average value of colour tonality (2.024) within in the Latkovac locality. In the Drenča locality, the grape must from genotype 13 exhibited the highest colour tonality value (1.970) (Graph 7).



Graph 7. The average value of the color tonality of grape must of selected genotypes (1–16) of the *Prokupac* variety (2019–2021)

## CONCLUSION

Based on the analyses of various quality parameters of grape must from 16 selected prospective genotypes of the autochthonus *Prokupac* variety for the period 2019–2021 from two localities (Latkovac and Drenča, with 8 genotypes each), the following conclusions can be drawn regarding the overall quality of the *Prokupac* grapevine variety in the Župa wine-growing subregion.

The average sugar content (%) in grape must of the investigated prospective *Prokupac* genotypes ranged from 18.39% to 24.20%, with genotype 16 from the Drenča locality showing the highest average sugar content. The average total acidity (g/L) in the grape must ranged from 4.82 g/L to 9.10 g/L, with genotype 5 from the Latkovac locality having the highest value. The average pH of grape must were in a range from 3.32 to 3.82. The pH values suggest slightly better acidity levels in the grape must of genotypes from the Latkovac locality compared to those from the Drenča locality. The calculated theoretical alcohol content (%Vol.) of future wines from the investigated *Prokupac* genotypes ranged from 10.85%Vol. to 14.25%Vol., and similar to the average sugar content, the theoretical alcohol content in future wines was slightly higher for genotypes from the Drenča locality. The average colour intensity –  $A_{420}$  in the grape must of prospective *Prokupac* genotypes was 0.973, with genotype 5 from the Latkovac locality showing the highest value. The average colour intensity –  $A_{520}$  in the grape must was 0.560, with genotype 2 from the Latkovac locality exhibiting the highest value. The average colour intensity –  $A_{620}$  in the grape must was 0.220, with genotype 1 from the Latkovac locality having the highest value. Analyzing the total colour intensity of the grape must, it can be concluded that the average value was 1.753, with genotype 5 from the Latkovac locality showing the highest intensity.

Regarding the average colour tonality, the results indicated that this parameter was higher for genotypes from the Latkovac locality compared to those from the Drenča locality. Genotype 6 from the Latkovac locality had the highest average colour tonality.

In summary, the prospective genotypes from both locations exhibited main quality parameters of grape must that fall within general limits based on available data from previous research in the Čegar and Fruška Gora wine-growing subregions. However, certain main parameters have more favourable values, and above all the acid content in the grape must, which is within optimal limits for red wine varieties compared to earlier research conducted in the Fruška Gora wine-growing subregion, when the acid content was somewhat less favourable. In addition to this broader quality parameter, the sugar content was higher in this research compared to the analyzed values of that parameter determined in the conditions of the Čegar wine-growing subregion.

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КАРАКТЕРИСТИКЕ ШИРЕ ПЕРСПЕКТИВНИХ ГЕНОТИПОВА  
АУТОХТОНЕ СОРТЕ ВИНОВЕ ЛОЗЕ *ПРОКУПАЦ*

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**РЕЗИМЕ:** Аутохтона, односно локална црна винска сорта винове лозе *прокупац* једна је од најважнијих сорти Србије. Некада је та сорта била водећа сорта у највећем броју виноградарских подручја наше земље. Сорта *прокупац* је тренутно најзаступљенија у виноградарском рејону Три Мораве (Централна Србија), док се највећи број винограда са овом сортом налази у Жупском виногорју. Због значаја који има као веома стара и традиционална сорта, последњих година су покренута извесна истраживања ове сорте у виноградарским подручјима у којима се *прокупац* традиционално гаји. Одређене научне активности су покренуте на издвајању различитих генотипова са побољшаном производном и употребном вредношћу, а све у циљу клонске селекције ове сорте. У овом раду представљене су неке карактеристике, односно параметри квалитета шире перспективних генотипова сорте *прокупац* који су издвојени у Жупском виногорју у општини Александровац. Испитивање шире извршено је од грозђа из бербе 2019, 2020. и 2021. године са 16 издвојених генотипова, и то 8 генотипова са локалитета Латковац и 8 генотипова са локалитета Дренча. Осим лабораторијских анализа садржаја шећера, киселина и рН, извршен је и обрачун теоретског садржаја алкохола. Такође, спектрофотометријским методама је одређен интензитет боје А – 420, интензитет боје А – 520, интензитет боје А – 620 и укупни интензитет боје шире, као и тоналитет боје шире. Анализе су показале да су одређени главни параметри квалитета шире из наших истраживања у границама вредности као и у ранијим истраживањима, али да је садржај киселина у шири оптималнији за црне винске сорте у односу на истраживања тог параметра вршена у ранијем периоду у другим виноградарским подручјима (Фрушкогорско и Чегарско виногорје). Такође, садржај шећера у шири је већи у нашим истраживањима у односу на утврђене вредности тог параметра шире од грозђа из Чегарског виногорја.

**КЉУЧНЕ РЕЧИ:** *прокупац*, Жупско виногорје, шири