Journal of Agricultural, Food and Environmental Sciences Vol 76 No 6 (2022) 57-67
DOI: https://doi.org/10.55302/JAFES22766057jc

TECHNOLOGICAL CHARACTERISTICS OF INTERSPECIFIC HYBRIDS BRONNER, MUSCARIS AND MORAVA IN BANJA LUKA REGION

Tatjana Jovanović-Cvetković*, Rada Grbić, Danijela Starčević, Milena Milašin

University of Banja Luka, Faculty of Agriculture, Republic of Srpska, B&H
*e-mail: tatjana.jovanovic-cvetkovic@agro.unibl.org

ABSTRACT

Interspecific hybrids are increasingly finding their place in the assortment structure of modern viticulture, thanks to their notable resistance to diseases and adaptability to different climatic conditions. The aim of the research was to determine and compare the basic ampelographic and technological characteristics of the interspecific hybrids - Bronner, Muscaris and Morava with the conventional white wine variety Pinot Blanc, grown in the Banja Luka region (Bosnia and Herzegovina). The variety Muscaris stood out compared to the other analyzed varieties on the basis of the largest grape cluster weight (244.99 g), the weight of 100 grape berries (173.06 g), the weight of 100 grape skins (17.54 g) and the weight of seeds in100 grape berries (11.50 g). This variety also had the highest sugar content in grape juice (27.63 °Brix), followed by the Bronner variety (24.67 °Brix), which, according to the OIV categorization, ranks them among varieties with a very high sugar content. The Morava and Pinot Blanc varieties had a relatively similar sugar content (22.02 and 21.77 °Brix, respectively). The content of total polyphenols in the skins of Bronner variety grapes was statistically significantly higher (1876.73 mg/kg) compared to the other analyzed varieties, while a similar situation was observed in the seeds of the Pinot Blanc variety (2913.68 mg/kg). Based on the results, it was concluded that the variety Muscaris showed the best qualitative characteristics.

Key words: Bronner, grape, interspecific variety, Morava, Muscaris, quality.

INTRODUCTION

The grapevine (*Vitis vinifera* L.) is one of the oldest and most widespread agricultural crops. The total worldwide area under grapevines intended for all purposes (production of wine and juices, table grape and raisins, as well as, young vines that are not yet at reproductive age) was 7.3 mha in 2020 (OIV, 2021).

The existing genetic diversity of the grapevine has largely been determined by the historical development of viticulture and different methods of grapevine cultivation (This et al., 2006). The history of European viticulture can be divided into three periods (Gessler et al., 2011). The first period (before 1845) is characterized by the absence of major phytosanitary issues. Then came the half-century period of facing and searching for solutions to the problems caused by the appearance of new diseases and pests: downy mildew and phylloxera. The last period, which continues to this day, was marked by the application of chemical protection in viticulture. With the appearance of the aforementioned diseases, a new chapter begins in the grapevine growing and breeding. According to Alleweldt (1997), French scientists then formulated two breeding goals: the development of rootstocks resistant or tolerant to phylloxera and the development of interspecific hybrids that would represent a combination of the quality of *Vitis vinifera* grapes with disease resistance of American species of the genus *Vitis*. The result of the above mentioned program was the creation of hybrids called "direct

producers" (Alleweldt & Possingham, 1988), and French-American hybrids, which remained in France until the second half of the 20th century (Reynolds, 2015). The spreading of the above-mentioned interspecific hybrids in France was gradually stopped, not only because of the poor wine quality, but also because of the legal regulations related to the cultivation prohibition (Crowley, 1993). In addition, French-American hybrids later remained part of breeding programs in other countries: Germany, Hungary, Russia, Ukraine, Moldova, etc., as the resistance gene donors (Töpfer et al., 2011; Karlagić Kontić, 2014). Resistance to the most significant diseases and low temperatures of certain American and East Asian species of the genus *Vitis* (*Vitis labrusca, Vitis riparia, Vitis rupestris, Vitis amurensis* etc.), multiple interspecific hybridization and characterization of different generations of interspecific hybrids have been the subject of work and study by many world researchers - breeders in the past and present (Koleda, 1975; Bouquet 1986; Eibach, 1994; Staud, 1997; Lu et al., 2000; Kozma, 2000; Pavloušek, 2007; Hajdu, 2015; Wang et al., 2020). Research conducted in the Western Balkans countries also made a great contribution in the mentioned segment (Cindrić & Kovač, 1988; Avramov, 1991; Žunić et al., 2002; Korać et al., 2005; Nikolić, 2006; Jovanović-Cvetković & Mijatović, 2007; Ivanišević et al., 2012; Radojević et al., 2012 ; Karlogan Kontić et al., 2016).

Environmental awareness has led to significant changes in the area of grape breeding, production methods and assortment selection. Breeding programs are aimed at creating varieties adaptable to the influence of biotic and abiotic factors, with high fruit quality and ripening period in accordance with market requirements. Resistance to fungal diseases and low temperatures is the primary goal of many breeding programs, thereby expanding the limits of grape production (Reisch et al., 2012). The result of the above mentioned programs is the creation of a respectable number of disease-resistant varieties in Europe and North America, applicable in conventional and sustainable grape production (Pedneault & Provost, 2016).

With their characteristics, interspecific hybrids meet the objectives of the mentioned breeding programs in many ways and they are part of the production assortment in countries dedicated to organic grape production (Germany, Italy, Hungary, etc.), in countries with cold climates (Lu & Liu, 2015; Diez-Zamudioetal et al., 2021; Kuang et al., 2022) and in countries with hot and dry conditions (Camargo et al., 2014; Volynkin et al., 2021). The positive economic, ecological and health-safe effects of grape and wine production from interspecific hybrids are indisputable, due to the reduction in fungicide usage, as much as 73-82 % (Jackson, 2014).

In Bosnia and Herzegovina (BiH), interspecific hybrids occupy insignificant areas, but there is a noticeable tendency of a slight increase in certain microregions. Mijatović & Vuksanović (1987) recommended the cultivation of the mentioned hybrids for experimental purposes by evaluating the pedoclimatic conditions of the northern parts of Bosnia and Herzegovina. In the last decade, the results of research of the agrobiological and technological characteristics of certain interspecific hybrids grown in the northern Bosnian (Kozara region) area are also available (Jovanović-Cvetković & Mijatović, 2009; Mijatović et al., 2015; Jovanović-Cvetković et al., 2017). The knowledge that certain interspecific hybrids are grown in these areas, whose characteristics have not been analyzed so far, was the reason for the research of some interspecific hybrids grown in the ecological conditions of the Banja Luka region (northwestern part of Bosnia and Herzegovina), in order to determine their ampelographic and technological characteristics.

MATERIAL AND METHODS

The research was conducted in 2021. The subjects of the research were three white wine interspecific varieties: Bronner, Muscaris and Morava and the conventional white wine variety Pinot Blanc (the standard variety in the experiment), grown in the Banja Luka region. Basic data on the origin of the analyzed varieties are given in Table 1.

Table 1. Basic data on the origin of the analyzed interspecies hybrids/varieties.
https://www.vivc.de (Vitis International Variety Catalogue, 2022)

Hybrid/ Variety	Variety number VIVC	Country or region of the variety origin	Pedigree as given by breeder	Year of breeding
Bronner	17129	Germany	Merzling x Geisenheim 6494	1975
Muscaris	22628	Germany	Solaris x Gelber Muskateller	1987
Morava	23777	Serbia	[(Kunbarat x Tramin) x Bianca)) x Rajnai Rizling GM 239-20	-
Pinot Blanc	9272	France	Pinot Noir Mutation	-

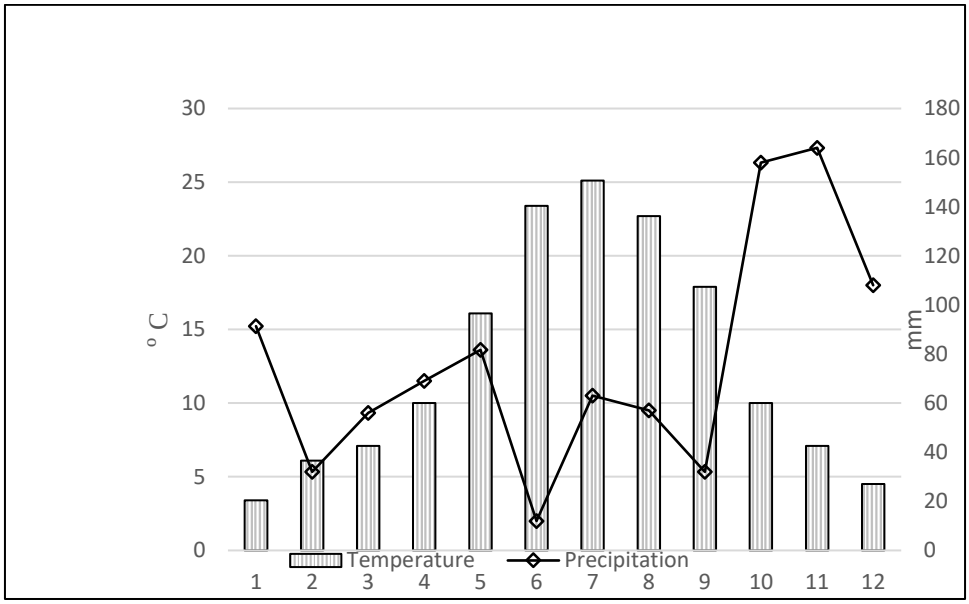

Figure 1. The average of monthly air temperature (ºC) and monthly total precipitation (mm) (Banja Luka, 2021)

In general, the area of northern Bosnia, where the Banja Luka region is located (the valley of the river Vrbas), has a continental and moderately continental climate (Republic of Srpska Hydrometeorological Institute, 2022). Meteorological conditions in the year of the research were of a rather moderate character, excluding the occurrence of a significantly higher amount of precipitation in September (Figure 1).

Ampelographic characteristics (grape cluster weight, weight of 100 grape berries, skin and seed weight of 100 grape berries and number of seeds in 100 grape berries) were analyzed on a sample of 10 representative grape clusters, i.e. 100 grape berries, according to the Prosteserdov methodology, 1946. The basic technological characteristics of the tested varieties were evaluated on based on the grape juice analysis: the percentage of total soluble solids - sugar (°Brix), total titratable acidity and pH value of grape juice. The content of total soluble solids - sugar (°Brix) was measured with a digital refractometer (Atago Pal-3), the must total titrable acidity (TTA) was determined by potentiometric titration with neutralization method using 0.1 M NaOH solution (g tartaric acid/L) and the pH value was determined by using a pH meter (HannaHI 2211). In addition, an analysis of the phenolic compounds of the tested samples of the varieties was also performed. The determination of total polyphenols content in the skin and seeds of grapes was carried out according to the protocols applied in the research within the framework of the COST Action FA1003 project, "East-West Collaboration for Grapevine Diversity Exploration and Mobilization of Adaptive Traits for Breeding" (Rustioni et al. 2014, Di Stefano et al. 1989), by measuring the absorbance of the extract at 700 nm with a spectrophotometer UV/VIS mini-1240, Shimadzu. The total polyphenols content in the extract of grape skins and seeds was expressed as (+) catechin concentration ($mg \cdot L^{-1}$), and then converted to $mg \cdot kg^{-1}$ of grapes. All data were analyzed in Microsoft Office Excel by applying two-factorial analysis of variance (ANOVA). All values in tables for parameters are shown as arithmetic mean with standard error (X ± Se) and coefficient of variation. Significant interaction effects were identified and further analyzed. Duncan's test was used to evaluate the pomological and chemical data and to detect significant differences ($p \leq 0.05$) between the mean values.

RESULTS AND DISCUSSION

Ampelographic characteristics

The ampelographic characteristics of grape cluster and grape berries of analyzed varieties are presented as average values of 10 grape clusters, i.e. 100 grape berries, in Tables 2, 3 and 4.

Table 2. Grape cluster weight (g) and number of grape berries per grape cluster of analyzed varieties

	Grape cluster weight (g)			Number of grape berries per grape cluster		
	$\bar{x}$	S $\bar{x}$	Vc	$\bar{x}$	S $\bar{x}$	Vc
Bronner	192.62^{bc}	13.36	21.94	157.80^{a}	9.79	19.61
Morava	169.44^{c}	9.26	17.29	106.70^{b}	5.57	16.51
Muscaris	244.99^{a}	9.50	12.27	146.30^{a}	5.95	12.86
Pinot blanc	222.63^{ab}	14.09	20.01	173.90^{a}	10.69	19.44

$\bar{x}$ - mean values; S$\bar{x}$ - standard error of mean; Vc – coefficient of variation

a-c: Different letters within the same column indicate statistically significant difference at $p < 0.05$ by Duncan's test

The obtained results for the grape cluster weight of analyzed varieties (Table 2) are ranged from 169.44 g (Morava variety) to 244.99 g (Muscaris variety). The result for Muscaris variety grape cluster weight was statistically higher compared to the results for other observed varieties, with the exception of the Pinot Blanc variety, that was not statistically different from the Bronner variety in terms of grape cluster weight. The variety Morava had the lightest grape cluster among the observed varieties. Grape cluster weight was fairly uniform, as indicated by the coefficient of variation for this characteristic.

The difference in the number of grape berries (Table 2), excluding variety Morava, did not differ statistically significantly in the mutual comparison of the other analzyed varieties. The highest number of grape berries per grape cluster was recorded in the variety Muscaris (173.90) and the lowest in the variety Morava (106.70).

The variety Muscaris had a statistically significantly higher weight of 100 grape berries (173.06 g) compared to the other analyzed varieties (Table 3). The variety Morava had a slightly higher weight of 100 grape berries (151.47 g) compared to the varieties Bronner and Pinot Blanc, among which no statistically significant difference in the weight of 100 grape berries was observed. A similar situation was observed with the grape skin weight of 100 grape berries. The grape skin weight of 100 grape berries ranged from 9.79 g (Bronner) to 17.54 g (Muscaris). Compared to the results of a two-year study (2017-2018, Spain), Casanova-Gascón et al, 2019a, the weight of 100 Muscaris berries was lower (132.95 g and 128.30 g, respectively).

Table 3. Weight of 100 grape berries (g) and weight of the skin of 100 grape berries (g) of the analyzed varieties

	Weight of 100 grape berries (g)			Weight of the skin of 100 grape berries (g)		
	$\bar{x}$	S $\bar{x}$	Vc	$\bar{x}$	S $\bar{x}$	Vc
Bronner	131.07^{c}	3.71	8.94	9.79^{c}	0.33	10.62
Morava	151.47^{b}	5.68	11.86	12.39^{b}	0.45	11.47
Muscaris	173.06^{a}	4.95	9.05	17.54^{a}	0.63	11.30
Pinot blanc	138.24^{bc}	3.22	7.37	10.55^{bc}	0.44	13.15

$\bar{x}$ - mean values; S$\bar{x}$ - standard error of mean; Vc – coefficient of variation

a-c: Different letters within the same column indicate statistically significant difference at $p < 0.05$ by Duncan's test

The weight of seeds in 100 grape berries (Table 4) was quite uniform in all varieties, except for the Pinot Blanc variety (7.63g), which had a statistically significantly lower weight compared to the other tested varieties.

Table 4. Weight of seeds in 100 grape berries (g) and number of seeds in grape 100 berries

	Weight of seeds in 100 grape berries (g)			Number of seeds in 100 grape berries		
	$\bar{x}$	S $\bar{x}$	Vc	$\bar{x}$	S $\bar{x}$	Vc
Bronner	10.35^{a}	0.41	12.40	321^{a}	9.53	9.39
Morava	10.78^{a}	0.74	21.61	219^{b}	11.87	17.14
Muscaris	11.50^{a}	0.37	10.24	300^{a}	8.37	8.82
Pinot blanc	7.63^{b}	0.33	13.49	216^{b}	5.69	8.83

$\bar{x}$ - mean values; S$\bar{x}$ - standard error of mean; Vc – coefficient of variation

a-b: Different letters within the same column indicate statistically significant difference at $p < 0.05$ by Duncan's test

In the other varieties, an uniform weight of seeds in 100 grape berries was observed, ranging from 10.35 g (Bronner) to 11.50 g (Muscaris). The number of seeds in 100 grape berries was statistically significantly lower in the varieties Pinot Blanc (216) and Morava (219) compared to the varieties Muscaris (300) and Bronner (321), which did not differ from each other.

Technological characteristics

The results of the analysis of technological characteristics of the studied varieties grapes are presented in Figure 2 and Table 5.

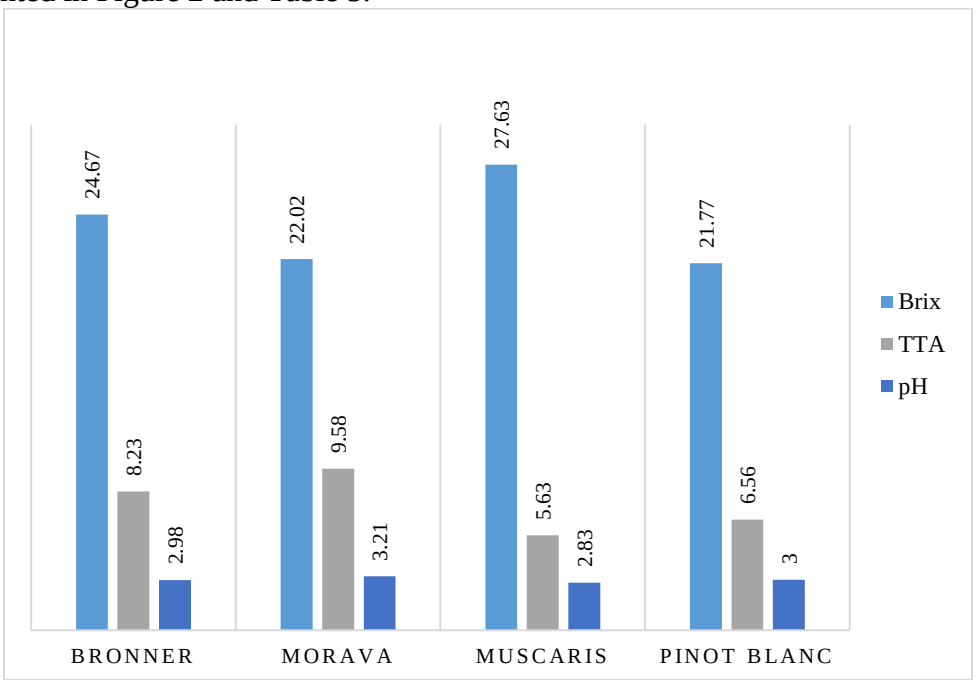

Figure 2. °Brix, TTA (g/L) and pH value of the analyzed varieties

Based on the presented results of the analysis of the technological characteristics of the studied varieties with histogram (Figure 2), it is visible that the must of Muscaris variety had the highest sugar content (27.63 °Brix), while the lowest content was observed in the Pinot Blanc variety (21.77 % °Brix). According to the OIV codes, the interspecific hybrids Bronner and Muscaris have a very high sugar content, the Pinot Blanc variety has a high sugar content, while the Morava has a sugar content between high and very high. Regarding the must total titratable acidity, interspecific hybrid Morava's must had the highest total acidity (9.58 g/L), while the lowest was observed in the must of interspecific hybrid Muscaris (6.3 g/L). According to the OIV codes, the must of Muscaris and Pinot Blanc varieties had a low total acidity, Bronner had high, while Morava was classified in the category between high and very high total acidity. According to the results of research carried out in Poland, in colder climate conditions (Czaplicka et al., 2022), the sugar content in Muscaris hybrid was 22.0 °Brix. The average results of a three-year study (2015-2017) conducted in northern Italy (Pedò et al., 2019) showed that the sugar content in the must of interspecific hybrid Muscaris was 23.7 °Brix , and total titratable acidity 6.53 g/L, while in interspecific hybrid Bronner's must, the sugar level was observed to be 20.4 °Brix, and total titratable acidity 6.33 g/L. Porro et al., 2019 reported similar results of the sugar content in must of Muscaris and Bronner (Muscaris 24.17 °Brix, Bronner 20.19 °Brix), grown in the northeastern region of Italy (2013). In contrast to the above mentioned, according to the results of research conducted in Spain (Casanova-Gascón et al, 2019b), the acid level in the must of Muscaris variety was significantly lower, 3.79 g/L in 2017, and 3.79 g/L in 2018. A four-year study (1995-1999) conducted in northern Bavaria, Germany (Schwab et al., 2000) and a two-year study (2004-2005) in Switzerland (Tuchschmid et al., 2005) found that the must of interspecific hybrid Bronner had an approximate content of sugar as in the aforementioned growing conditions of this variety in northern Italy, 20.6 °Brix, i.e. 19.6-22.5, °Brix, while the total titratable acidity was 10.1 g/L , i.e. 7.3-9.6 g/L. According to

published data, the interspecific hybrid Bronner, grown in the warm climate of Brazil, had a slightly lower sugar content in the must, 19.0 Brix (de Bem et al., 2016a).

According to Guguchkina et al., 2020, the sugar content in the must of interspecific hybrid Morava, in the Krasnodar region of Russia, ranged from 18.3-21.5 °Brix, and total acidity from 8.9 to 11.5 g/L., while the sugar content in the same hybrid grown conventionally (2015-2018) in Sremski Karlovci, was 20.54 °Brix, and total titratable acids were 7.34 g/L (Ivanišević et al., 2022). The Pinot Blanc variety, grown in Sremski Karlovci (Serbia), according to multi-year research data, 1981-1988 (Cindrić, et al., 2000), had an average sugar content of 18.5 °Brix, and total titratable acidity of 8.8 g/L.

Based on all the above, it can be said that the sugar content in our analyzed interspecific hybrids, Muscaris and Bronner, was higher compared to the results of other authors, while the sugar level of Morava was relatively in line with the published statements. The comparative results of the must total titratable acidity show that the acidity of the Bronner's must was relatively close to the must acidity of the mentioned interspecific hybrid grown in the conditions of northern Germany and Switzerland, while the lower acidity values of the must of interspecific hybrid Muscaris were relatively in accordance with the measured acidity values of the said hybrid, grown in northern Italy.

The obtained must pH values of the interspecific hybrids Muscaris and Bronner in our research are in line with the research of other authors. According to the data of Czaplicka et al., 2022b, the pH value of the Muscaris must was 2.92, while in our research it was 2.83. According to our analysis results, the must pH value of the interspecific hybrid Bronner was 2.98, which is in line with de Bem et al., 2016b, where the pH value was 2.96. The exception to the above are the results of the research conducted by Casanova-Gascón et al, 2019c, where the must pH value of the interspecific hybrid Muscaris was higher compared to our research, i.e. 3.15 in 2017 and 3.71 in 2018.

Table 5. Content of total polyphenols in the skin and content of total polyphenols in the seed (mg/kg)

	Content of total polyphenols in the skin (mg/kg)			Content of total polyphenols in the seed (mg/kg)		
	$\bar{x}$	S $\bar{x}$	Vc	$\bar{x}$	S $\bar{x}$	Vc
Bronner	1876.73[a]	14.65	2.34	1881.26[b]	38.42	6.13
Morava	742.98[c]	11.57	4.67	847.30[d]	16.54	5.85
Muscaris	1072.76[b]	32.90	9.20	1582.06[c]	55.11	10.45
Pinot blanc	1060.58[b]	6.11	1.73	2913.68[a]	27.15	2.80

$\bar{x}$ - mean values; S$\bar{x}$ - standard error of mean; Vc – coefficient of variation

a-b: Different letters within the same column indicate statistically significant difference at $p < 0.05$ by Duncan's test

The content of total polyphenols in the skin was statistically significantly higher in the Bronner variety (1876.73 mg/kg) compared to the other tested varieties. A fairly uniform content of total polyphenols in the skin was observed in the interspecific hybrid Muscaris (1072.76 mg/kg) and the variety Pinot Blanc (1060.58 mg/kg). The lowest content of total polyphenols was found in the skin of the variety Morava (742.98 mg/kg). The content of total polyphenols in the seeds was statistically significantly different in the analyzed varieties in a mutual comparison. The highest values were obtained in the Pinot Blanc variety (2913.68 mg/kg), and the lowest in the Morava variety (847.30 mg/kg). The obtained results are in line with the results of the research conducted in Turkey (Atak et al., 2021), where the content of phenolic compounds (catechin and epicatechin) in the analyzed 5 interspecific hybrids and 17 varieties of *V. vinifera* was higher in the grape seeds compared to the skin and pulp. Although

the average weight of 100 grape berries, skins and seeds was the highest in the Muscaris variety, the content of total polyphenols in the skin and seeds was not, which is in contrast to the results of the research by Pascale-Gagne et al., 2016, where the size of the grape berry (weight and diameter) and a higher relative proportion of the skin and seeds in the structure of the grape berry of the studied disease-resistant varieties, positively influenced the content of total phenols in the skin and seeds.

CONCLUSIONS

Based on the evaluation of the ampelographic and technological characteristics of the analyzed interspecific hybrids of Bronner, Muscaris and Morava and comparative analysis with the commercial white wine variety Pinot Blanc, it was concluded that the grapes of the hybrid Muscaris had the best ampelographic characteristics, followed by the grapes of Bronner and Morava. Based on the must analysis, it can be said that the interspecific hybrids Muscaris and Bronner stood out with a high sugar content, higher even compared to the results of other mentioned authors, and that the must quality of the Morava variety was at a satisfactory level. Since there is considerably less data in the literature regarding the phenolic compounds content in interspecific hybrid grapes, compared to commercial varieties, only a general assessment of the phenolic status was possible, according to which the content of total polyphenols was higher in the seeds compared to the skin.

The fact that the research so far has shown satisfactory potential and quality of all analyzed interspecific hybrids indicates the need to continue research in order to more comprehensively determine their agro-technological potential.

REFERENCES

Alleweldt, G. (1997). Genetics of Grapevine Breeding. In H.-D. Behnke, U. Lüttge, K. Esser, J. W. Kadereit & M. Runge (Eds.), *Progress in Botany, Vol. 58* (pp. 441-454). Springer-Verlag Berlin Heidelberg.

Alleweldt, G. & Possingham J. V. (1988). Progress in grapevine breeding. *Theor Appl Genet,75,* 669-673.

Atak, A., Göksel, Z., & Yılmaz, Y. (2021). Changes in Major Phenolic Compounds of Seeds, Skins, and Pulps from Various *Vitis* spp. and the Effect of Powdery and Downy Mildew Diseases on Their Levels in Grape Leaves. *Plants 2021, 10,* 2554, 1-18.

Avramov, L. (1991). *Vinogradarstvo.* Polak. Beograd, SFRJ: NOLIT.

Bouquet, A. (1986). Introduction dans l'espèce *Vitis vinifera* L. d'un caractère de résistance à l'oïdium (*Uncinula necator* Schw. Burr.) issu de l'espèce *Muscadinia rotundifolia* (Michx.) Small [Introduction in the species *Vitis vinifera* L. of a resistance trait to powdery mildew (*Uncinula necator* Schw. Burr.) from the species *Muscadinia rotundifolia*]. *Vignevini, 12,* 141–146.

Camargo, U. A., Maia, J. D. G., Quecini, V., & Ritschel, P. (2014). Brazilian Grape Breeding Program. In *Proc. Xth Intl. Conf. on Grapevine Breeding and Genetics*. Eds.: B.I. Reisch and J. Londo. *Acta Hort. 1046,* 219-224.

Casanova-Gascón, J., Ferrer-Martín, C., Bernad-Eustaquio, A., Elbaile-Mur, A., M. Ayuso-Rodríguez, J. M., Torres-Sánchez, S., Jarne-Casasús, A., & Martín-Ramos, P. (2019). Behavior of Vine Varieties Resistant to Fungal Diseases in the Somontano Region. *Agronomy 2019, 9,* 738, 1-16.

Cindrić, P. & Kovač ,V. (1988). Interspecific hybridization as a method of creating grapevine varieties resistant to low temperatures, *Zbornik matice srpske za prirodne nauke, 75,* (pp. 87-102).

Cindrić, P., Korać, N., & Kovač, V. (2000). Sorte vinove loze. Poljoprivredni fakultet Univerziteta u Novom Sadu i "PROMETEJ", Novi Sad.

Crowley, W. K. (1993). Changes in the french winescape. *Geographical Review, 83,* (3), 252-268.

Czaplicka, M., Parypa, K., Szewczuk, A., Gudarowska, E., Rowińska, M., Zubaidi, M. A., & Nawirska-Olszańska, A. (2022*). Appl. Sci. 2022, 12,* 5534, 1-7.

De Bem, B., Brighenti, E., Bonin, B. F., Allembrandt, R., Araújo, L., Brighenti, A. F., & Bogo, A. (2016 October). Downy mildew intensity in tolerant grapes varieties in highlands of southern Brazil. *In BIO Web of Conferences 7, 01015, 39th World Congress of Vine and Wine Proceedings* (pp. 1-5). EDP Sciences.

Di Stefano R., Cravero, M.C., & Gentilini N. (1989). Metodi per lo studio dei polifenoli dei vini. *L'ENOTECNICO. MAGIO,* 83-89.

Diez-Zamudio, F., Laytte, R., Grallert, C., Ivit, N. N., & Gutiérrez-Gamboa, G. (2021). Viticultural Performance of Hybrids and Vitis vinifera Varieties Established in Annapolis Valley (Nova Scotia**).** *Horticulturae 2021, 7,* 291, 1-14.

Eibach, I. (1994). Investigations about the genetic resources of grapes with regard to resistance characteristicsto powdery mildew (*Oidium tuckeri). Vitis 33,* 143-150.

Federalni hidrometeorološki zavod BiH. (2022 October 11). *Klima Bosne i Hercegovine.* https://www.fhmzbih.gov.ba/latinica/KLIMA/klimaBIH.php.

Guguchkina, T., Antonenko, M., & Yakimenko, Y. (2020 October). New grape varieties for production of high-quality wines, and assessment methodology for varietal characteristics of the product. In *BIO Web of Conferences 25, 02016, Bioengineering 2020 Proceedings* (pp. 1-7). EDP Sciences.

Gessler, C., Pertot, I & Perazzolli, M. (2011). Plasmopara viticola: a review of knowledge on downy mildew of grapevine and effective disease managemen. *Phytopathol. Mediterr. 50* (1), 3-44.

Hajdu, E. (2015). Grapevine breeding in Hungary. In In A. Reynolds (Eds.), *Grapevine Breeding Programs for the Wine Industry,* (pp.103-134). Woodhead Publishing Series in Food Science, Technology and Nutrition: Number 268. Elsevier Ltd.

Hidrometeorološki zavod Republike Srpske (2022).
https://www.fhmzbih.gov.ba/latinica/KLIMA/klimaBIH.php (pristup sajtu 12.09.2022)

Ivanišević, D., Korać, N., Čabilovski, R., Manojlović, M., Paprić, Đ., Kuljančić, I., & Medić, M. (2012 December). Wine grape cultivars suitable for organic production. In *International symposium for agriculture and food Proceedings* (pp. 171-180).

Ivanišević, D., Kalajdžić, M., Cindrić, P., Korać, N., & Božović, P. (2022). Characteristics of fungus-tolerant grapevine cultivar 'morava' grown under organic and conventional management. *Contemporary Agriculture, Serbian Journal of Agricultural Sciences, 71* (1-2), 9-12.

Jackson, R.S., (2014). *Wine science: Principles & applicatation.* Academic Press, Elsevier Inc.

Jovanović-Cvetković T. & Mijatović, D. (2007). Karakteristike rodnosti novosadskih interspecific hibrida vinove loze u agroekološkim uslovima Niša [Productivity traits of interspecific grape vine hybrids from novi sad in agroecological conditions of Niš]. *Savremena poljoprivreda, 56* (6), 262-267.

Jovanović-Cvetković, T., & Mijatović, D. (2009 February). Lucia and Mediana interspecies grapevine hybrids for white wine and distillate. In *44th Croatian & 4th International Symposium on Agriculture Proceedings* (pp. 842-846).

Jovanović-Cvetković, T., Mijatović, D., Ranković Vasić, Z., Radojević, I., & Nikolić, D. (2017 February). Mogućnosti uzgoja stolnih sorata međuvrsnih križanca u uvjetima Kozaračkog vinogorja [The possibility of growing table grape varieties of interspecific hybrid type in conditions of Kozara wineregion]. In *52nd Croatian and 12th International Symposium on Agriculture Proceedings* (pp. 602-606).

Karlagić Kontić, J. (2014). Grapevine varieties resistant to fungal diseases. *Gospodarski list, 17,* 39-49.
Karlogan Kontić, J., Rendulić Jelušić, I., Tomaz, I., Preiner, D., Marković, Z., Stupić, D., Andabaka, Ž., & Maletić, E. (2016). Polyphenolic Composition of the Berry Skin of Six Fungus-Resistant Red Grapevine Varieties. *International Journal of Food Properties 19* (8), 1809-1824.
Koleda, I. (1975). Ergebnisse von Kreuzungen zwischen Vitis amurensis und Vitis vinifera in der Züchtung frostmuststandsfähiger Reben [Results of crossing Vitis amurensis and Vitis vinifera in breeding frost resistant grapes]. *Vitis 14,* 1-5.
Korać N., Cindrić P., Paprić Đ., Kuljančić I., Medić M. (2005). The results of 50 years of work on the creation of new grapevine varieties and clones in Sremski Karlovci. Z*bornik naučnih radova xix savetovanja o unapređenju proizvodnje voća i grožđa, Komnenić,* (pp. 5-22).
Kozma, P. (2000). Vinegrape breeding for fungus disease resistance. In *Proc. VII Int. Symp. on Grapevine Genetics and Breeding.* Eds. A. Bouquet and J. M. Bourisiquot. *Acta Hort. 528,* 505-510.
Kuang, Y., Ren, C., Wang, Y., Kirabi, G. E., Wang, Y., Wang, L., Fan, P., & Liang, Z. (2022). Characterization of the Berry Quality Traits and Metabolites of 'Beimei' Interspecific HybridWine Grapes during Berry Development andWinemaking. *Horticulturae 2022, 8,* 516, 1-22.
Lu, J. & Schell & Ramming D. W. (2000). Interspecific hybridization between *Vitis rotundifolia* and *Vitis vinifera* and evaluation of the hybrids. Proc. *In VII Int. Symp. on Grapevine Genetics and Breeding. Eds*. A. Bouquet and J. M. Bourisiquot. *Acta Hort. 528,* 479-486.
Lu, J., & Liu, C. (2015). Grapevine breeding in China. In M. V. Moreno-Arribas, & M. C. Polo (Eds.), *Wine Chemistry and Biochemistry* (pp. 273-310). Springer Science+Business Media, LLC.
Mijatović, D., &Vuksanović, P. (1987). Interspecific hybrids and their perspective for expansion in the area of northern Bosnia. *Poljoprivredni pregled,* 41-47.
Mijatović, D., Jovanović-Cvetković, T., Prpić, B., & Slavnić, A. (2015). Fertilizy characteristics of newly intrduced interspecific grapevine varietes in Kozara vineyarda region. In *IV International Symposium and XX Scientific- Professional Conference of Agronomists of Republic of Srpska, Book of abstracts,* 268.
Nikolić, D. (2006). Components of variance and heritability of resistance to important fungal diseases agents in grapevine. *Journal of Agricultural Sciences, 51,* (1), 47-54.
OIV - International Organisation of Vine and Wine (2021 April). *State of The World Vitivinicultural Sector in 2020. Vineyard Surface Area.* OIV.
Pascal-Gagne, M., Angers, P., & Pedneault, K. (2016). Phenolic Compounds Proile of Berries and Wines from Five Fungus-Resistant Grape Varieties. *Annal Food Processing and Preservation 1*(1*),* 1003, 1-9.
Pavloušek, P. (2007). Evaluation of resistance to powdery mildew in grapevine geneticre sources. *Journal Central European Agriculture, 8* (1), 105-114.
Pedò, S., Bottura, M., & Porro, D. (2019). Development, yield potential and nutritional aspects of resistant grapevine varieties in Trentino Alto Adige. In *BIO Web of Conferences 13, 02004, CO.NA.VI. 2018* (pp. 2-5). EDP Sciences.
Porro, D., Wolf, M., & Pedò, S. (2019). Evaluation of mechanical properties of berries on resistant or tolerant varieties of grapevine. In *BIO Web of Conferences 13, 01005, CO.NA.VI. 2018* (pp. 1-4). EDP Sciences.
Prostoserdov, I. I. (1946). *Tehnologičeskae harakteristika vinograda i produktiv ego pererabotki. Ampelografija SSSR. Tom I,* Moskva.

Radojević, I., Nikolić, D., Jovanović-Cvetković, T., & Pajić, V. (2012). The indicators of yield and grape quality of intraspecies grapevine hybrids developed at the Centre of viticulture and enology in Niš. In *22nd International Scientific-Expert Conference of Agriculture and Food Industry, Sarajevo, Bosnia and Herzegovina Proceedings*, (pp. 150-152). Ege University, Faculty of Agriculture.

Reisch, I. B., Owens, L. C., & Cousins, S. P. (2012). Grape. In M. L. Badenes, & H. D. Byrne (Eds.), *Fruit Breeding* (pp. 225-262). Springer New York Dordrecht Heidelberg London.

Reynolds, A. G. (2015). Grapevine breeding in France - a historical perspective. In A. Reynolds (Eds.), *Grapevine Breeding Programs for the Wine Industry*, (pp. 65-76). Woodhead Publishing Series in Food Science, Technology and Nutrition: Number 268. Elsevier Ltd.

Rustioni L., Maghradze D., Popescu C.F., Cola G., Abashidze E., Aroutiounian R., Brazão J., Coletti S., Cornea V., Dejeu L., Dinu D., Eiras Dias J.E., FIori S., Goryslavets S., Ibáñez J., Kocsis L., Lorenzini F., Maletic E., Mamasakhlisashvili L., Margaryan K., Mdinaradze I., Memetova E., Montemayor M.I., Muñoz-organero G., Nemeth G., Nikolaou N., Raimondi S., Risovanna V., Sakaveli F., Savin G., Savvides S., Schneider A., Schwander F., Spring J.L., Pastore G., Preiner D., Ujmajuridze L., Zioziou E., Maul E., Bacilieri R. & Failla O. (2014). First results of the European grapevine collections' collaborative network: validation of a standard eno-carpological phenotyping method. *Vitis. 53,* (4), 219-226.

Staud, G. (1997). Evaluation of resistance to grapevine powdery mildew *(Vncinula necator* [ScHw.] BuRR., anamorph *Oidium tuckeri* BERK.) in accessions of *Vitis* species. *Vitis 36* (3), 151-154.

This, P., Lacombe & Thomas, R. M. (2006). Historical origins and genetic diversity of wine grapes. *TRENDS in Genetics, 22* (9), 511-519.

Töpfer, R., Hausmann, L., Harst, M., Maul, E., Zyprian, E. & Eibach R. (2011). New Horizons for Grapevine Breeding. *Fruit, Vegetable and Cereal Science and Biotechnology, 5 (Special Issue 1),*79-100.

Tuchschmid, A., Vonesch, G., & Wins, T. (2006 March). Evaluation of agronomic characteristics of grape varieties resistant to fungal diseases in Wädenswil, for the year 2005. In *Congrès De Viticulture Biologique 8.3.2006 Proceedings*, (pp. 25-30). Edition Suisse FIBL.

Vitis International Variety Catalogue (2022 October 13). *Pasport date.* https://www.vivc.de.

Volynkin, V., Vasylyk, I., Volodin, V., Grigoreva, E., Karzhaev, D., Lushchay, E., Ulianich, P., Volkov, V., Risovannaya, V., Blinova, S., Alekseev, J., Gorislavets, S., Likhovskoi, V., Beatovic, A., & Potokina, E. (2021). The Assessment of Agrobiological and Disease Resistance Traits of Grapevine Hybrid Populations (*Vitis vinifera* L. x *Muscadinia rotundifolia* Michx.) in the Climatic Conditions of Crimea. *Plants 2021, 10,* 1215, 1-17.

Wang, Z., Chaia, F., Zhub, Z., Kirabi Eliasa, G., Xinb, H., Lianga, Z. & Lia, S. (2020). The inheritance of cold tolerance in seven interspecific grape populations. *Scientia Horticulturae, 266*, 1-7.

Žunić, D., Matijašević, S. & Todorović, V. (2002). Economic and technological characteristics of newly introduced interspecific grapevine hybrids. *Zbornik naučnih radova, 8* (2), 5-12.